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Contents

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From the Editor in Chief

QUESTIONS AND ANSWERS

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Innovative thinking has become a significant need nowadays. Businesses, governments, and large organizations such as the European Union investigate how innovations could best be fostered. Indeed, policy makers speak often about the importance of innovative thinking. An important social goal of governments involves growing innovative thinking as much as possible in support of their economies. Consequently, one can find abundant literature regarding innovation processes on policy and management level. Yet, we do not have much knowledge or research on innovation as human thinking (Saariluoma, Hautamäki, Väyrynen, Pärttö, & Kannisto, 2011).

It is intuitively evident that thinking creates innovations. Money, information systems, and organizations can create the positive or negative circumstances for innovation processes, but they cannot create innovations. Innovations arise from one single source: human thinking. Animals seldom have innovative processes that create cultural evolution because their neural systems do not allow sufficient capacity to store symbolic and cultural information. Thinking is thus a human property like language, and it is the necessary precondition for innovative thinking. This means that it is necessary to add one additional dimension to innovation research, that is, innovating as human thinking. This kind of research has been termed *microinnovation research* (Saariluoma & Kannisto, 2008).

Innovative thinking is important also in human–technology interaction research. New ideas frequently spread around the world. New services, such as games or business or government information systems, migrate quickly from their place of origin, and have been changing modern daily life significantly from what it used to be as recently as a decade ago. Ideas become innovations for many reasons, such as addressing some human need or achieving some outcome in an efficient manner. However, these changes and progressions would not exist unless someone invested time and creativity in the necessary thought work. Thus it is essential to understand how thinking operates within innovation processes. Importance is placed on uncovering the theoretical concepts that could clarify the role of human thinking in innovation processes.

Among researchers dedicated to understanding thought and thinking, the process of thinking is viewed as a mental process that emerges when people have a goal but do not have immediate means to reach this goal (Duncker, 1945; Newell & Simon, 1972). Following this

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definition, Nobel Prize laureate Herbert Simon developed his first artificial intelligence programs to solve problems using heuristics such as means ends, in which a computer compares its current "mental state" with the properties of the goal and chooses a transformation operator, which decreases the difference between the current mental state and the goal (Newell & Simon, 1972). Thus, solving a problem can be seen as transforming one mental state into another, while innovative thinking is viewed as a large process of solving small problems and integrating the results (Saariluoma et al., 2011).

So what role can technology play in innovative thinking? Computers can store helpful information, solve mathematical problems, inductively generate laws of natural science from data, or play chess. Although helpful in many ways, technology is still far from generating innovative thinking—or providing anything practical in analyzing innovative thinking. But technology can still benefit research in to the challenge of innovation: Models of human thinking benefit from the exploration into why, for example, computers cannot solve innovation problems in the area of human technology.

The core problem with attempts to model human thinking with technology is the formal nature of the knowledge computers use. Turing (1936, 1950) created an abstracted version of human thinking. Turing machines manipulate meaningless symbols by following the laws of logic. With a high processing speed, it is possible to search all logically possible solutions and thus succeed in well-defined areas, such as the game of chess. However, Turing machines (1950) cannot provide meanings to their symbols, and therefore they lack some essential human capacities. This was first noticed by Ludwig Wittgenstein (1958, 1969) in his late philosophy. Since then, other critics, such as Searle (1980) and Dreyfus (1972), have illustrated the differences between computational models of the mind and human thinking. To me, the core discussion about intentionality and other related issues is that computers do not "know" what the information content is, and therefore they cannot "know" about the relevance of the things they process. The main reason for this is the poverty of mathematical theory languages in expressing relevance. There is no mathematical way to express what is relevant and what is not. Therefore, to be able to articulate the relevant elements and functions in a Turing machine, extra-formal theory languages are needed (Saariluoma, 1997). Relevance itself is necessary because, without understanding what is relevant and what is irrelevant, how can one know what makes sense?

The goals of thinking, and their contents and relevance, are the very essence of innovative thinking. Indeed, the primary and related questions about the matter form the core substance. If the machines do not comprehend the contents of the bits of data they amply classify and select, they cannot analyze the important questions. In the case of chess, information can be dressed in a symbolic and logical form, making computational problem solving very effective. However, the questions are still presented and defined by people.

Edison was an innovator in that he was able to find good material for his version of the light bulb. Yet he also was innovator in that he understood the significance of the relevant infrastructures and publicity (Millard, 1990). Thus his innovation made an impact because he understood the right questions and, consequently, could find solutions, although sometimes with substantial effort. Had he not formulated the right questions, he certainly could not know how to answer them.

The process of setting, asking, and answering questions forms the core of innovative thinking. However, this process, in the case of human thinking, cannot be random: The contents of the questions are determined by and make sense in the context of the design

process. Thus the target of design sets the parameters for what the relevant questions are. On highest level, various design processes share many abstract similarities. Or, products may belong to same product type, or the product line may share similar questions. For example, when considering most vehicles, it makes sense to ask about the anthropometry of drivers so that these specified parameters can be used in various design processes.

Innovative thinking is often based on inherited systems of questions. However, the most important property of the question series is its organization, or ontological structure (Chandrasekaran, Josephson, & Benjamins, 1999). All questions are relevant when considering the final outcome of the design process: They must make sense with the design context, and they are unified together into a whole. Therefore, the connectedness of the design-relevant questions is vital: Developing ontologies of questions and answers allows us thus to consider the organization of design processes around an ontology of product-relevant questions.

When considering any human technology interaction plan, a number of task-necessary questions must be posed and resolved. The design of a house requires a roof—and a floor—otherwise it would be unusable for its inhabitants. Yet, these kinds of questions are mostly irrelevant when designing a banking system. This means that all products have their own system- and domain-specific interaction design problems. In developing human–technology interaction (HTI) innovation management as thinking, a system of the right questions must be considered so that an ontology is created to support the HTI-design thinking.

The logic of questions and answers is a core difference between people as innovators as compared to computing machines. People can ask relevant questions. To assure that the questions remain relevant to the design process, it is essential that the tacit ontological structures of this important field of innovating are explicated clearly.

In this final issue of our Volume 7, we have four papers contributing to their respective areas of HCI. The first paper, by **Harr, Wiberg and Whittaker**, explores the nature of interaction in professional social networks. Specifically, this paper takes foraging theory as a framework to identify how social factors impact decision making and collaboration by professionals in distributed work environments. They conclude that "survival of the social" underscores how the social component is foundational in executing an efficient and long-term professional network.

Next, **Clemmensen** uses grounded theory to extend thinking on human work interaction design (HWID) theory. By analyzing a diversity of data sources gathered from a working group designing an on-line folder structure, Clemmenson finds asymmetrical relations between work analysis and the design artifacts, as well as between the design artifacts an interaction design. As a result, he suggests modifications to the general HWID framework and approaches to artifact design.

The third contribution to our issue is from **Leung**, who investigated the effects of ICT connectedness, flexibility and permeability in the borders between work and home, and negative spillovers between those two domains on the potential for workers' burnout and their job and family satisfaction. His data from workers in Hong Kong suggest that the supposition that ICT connectedness negatively impacts workers' perceptions on their jobs and family lives is not as reliable a predictor of burnout and dissatisfaction as is the workers' personal control over what crosses the boundaries between their work and home environments.

The final paper comes from **Marchitto and Cañas**, who apply a methodology to assist in innovative thinking for improved user experience in product design. They focus on the

continuity of technologies (multiple devices can be used to conduct a single activity). These researchers envision how such methodologies can assist in new product conceptualization or current product extension for investigating the phenomenon of continuity.

REFERENCES

Chandrasekaran, B., Josephson, J. R., & Benjamins, V. R. (1999). What are ontologies and why do we need them? *IEEE Intelligent Systems*, *14*, 20–26.

Dreyfus, H. L. (1972). *What computers can't do*? New York: Harper & Row.

Duncker, K. (1945). On problem solving. *Psychological Monographs 58*(5), i-113.

Millard, A. J. (1990). Edison and the business innovation. Baltimore, MD, USA: Johns Hopkins University Press.

Newell, A., & Simon, H. A. (1972). *Human problem solving*. Engelwood Cliffs, NJ, USA: Prentice Hall.

Saariluoma, P. (1997). *Foundational analysis.* London: Routledge.

Saariluoma, P., Hautamäki, A., Väyrynen, S., Pärttö, M., & Kannisto, E. (2011). Microinnovations among the paradigms of innovation research: What are the common ground issues? *Global Journal of Computer Science and Technology*, *11*, 12–23.

Saariluoma, P., & Kannisto, E. (2008). Designing micro-innovation mechanism: How basic science can be implemented in product development. *In Enterpreneurship as an Engine for Regional Development, RENT XXII.* (pp. 173). Brussels, Belgium : European Institute for Advanced Studies in Management (EIASM).

Searle, J. (1980). Minds, brains and programs. *Behavioral and Brain Sciences*, *3*, 417–424.

Turing, A. M. (1936). On computable numbers, with an application to the Entscheidungsproblem. In *Proceedings of the London Mathematical Society*, *42*, 230–265. Retrieved November 15, 2011, from http://www.thocp.net/biographies/papers/turing_oncomputablenumbers_1936.pdf

Turing, A. (1950) Computing machinery and intelligence. Reprinted in A. R. Anderson (Ed.), Minds and machines (pp. 4–42). Englewood Cliffs, NJ, USA: Prentice Hall.

Wittgenstein, L. (1958). *Philosophical investigations*. Oxford, England: Basil Blackwell.

Wittgenstein, L. (1969). *On certainty*. Oxford, England: Basil Blackwell.

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UNDERSTANDING INTERACTION SEARCH BEHAVIOR IN PROFESSIONAL SOCIAL NETWORKS

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Abstract: *We present an empirical study of social interaction in a professional social network. As the point of departure, we take previous research into distributed work and information foraging theory to explore interaction search behavior of individuals active in professional networks, examining how social factors govern their behavior. For this exploration, we focused on the process through which relevant collaborators are chosen to execute shared work tasks in the area of logistics, and identified six characteristics of the explored processes. We recognized the "survival of the social" as a cornerstone for efficient and long-term professional networks and outlined design implications arising from our findings. More specifically, we found that participants are oriented to solutions that involve active social agents and social relations, rather than optimizing based on task characteristics, efficiency, and cost. These behaviors motivate the need for the concept of social interaction foraging.*

Keywords: *social interaction foraging, information foraging, social network, distributed work.*

INTRODUCTION

Distributed work (Hinds & Kiesler, 2002) is a common approach to effective collaboration. With the marriage of big professional social networks and sophisticated ICTs (information and communication technologies), organizations now can arrange effective geography-spanning work tasks. People therefore can conduct their work from remote locations or as mobile peers in these new technology-enabled forms of work. These socially organized work arrangements are better equipped for handling the dynamics of modern work settings and enhancing flexibility

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in cooperation (Hutchins, 1995; Kraut, Fish, Root, & Chalfonte, 1990; Mintzberg, 1999; Schmidt, 2006; Van de Ven, Delbecq, & Koenig, 1976), but they also face a wide range of challenges. These challenges include achieving efficient coordination and task delegation without causing situations of interaction overload (Ljungberg & Sørensen, 2000), communication overflow (Ljungberg, 1996), work fragmentation, and interruptions (Czerwinski, Horvitz, & Wilhite, 2004; Hudson, Christensen, Kellogg, & Erickson, 2002; Iqbal & Horvitz, 2007; O'Conaill & Frohlich, 1995; Rouncefield, Viller, Hughes, & Rodden, 1994; Speier, Vessey, & Valacich, 2003). In order to avoid these pitfalls, it is of key importance to extend the understanding of distributed work organization and interpersonal interaction in real life contexts. Failing to address these problems will inevitably have negative effects for individuals as well as the networks to which they belong.

Workplace interaction is a phenomenon that has been a focal object of study within the areas of HCI (human–computer interaction) and CSCW (computer-supported cooperative work) for around 20 years now. During this time, the character of workplace interaction has been explored from a wide range of perspectives ranging from empirical studies of one-shot interaction (Aaronson & Carroll, 1987), serendipitous interaction (Landgren & Nuldén, 2007), casual interaction (Borning & Travers, 1991; Whittaker, Frohlich, & Daly-Jones, 1994; Whittaker, Swanson, Kucan, & Sidner, 1997), long-term social interaction (Whittaker, Jones, & Terveen, 2002), and spontaneous interaction (Lim, Zhang, Zhu, & Zheng, 2007), to studies of formal interaction (Oehlmann, Thoben, & Weber, 1997), planned interaction (Isaacs, Tang, & Morris, 1996), and structured interaction (Rogers, 1995). While this body of research has mainly focused upon the formal and informal aspects of workplace interaction, we have so far seen few studies with an explicit focus on how individuals active in these social work arrangements go about searching for each other to establish interaction, and how social factors govern this behavior. The closest related studies address expertise location usually within organizations (McDonald & Ackerman, 2000; Zhang & Ackerman, 2005), but it is likely that individuals' level of expertise is only one of the factors influencing the decision about who to establish contact with.

Our main focus in this paper is on *social interaction search behavior*, that is, how individuals search for each other in social networks with the goal of establishing interaction for executing collaborative work. We also are interested in developing an understanding of how the social dimensions of work in professional networks affect this behavior. Current theories and concepts for describing and understanding individual search behavior seem to take the individual, and not social networks, as the focal point of departure. Furthermore, we are interested in exploring the extent to which information foraging theory (Pirolli & Card, 1995, 1999), a theory typically focused on search behavior of individuals, might be helpful in this analysis. Information foraging theory has been used extensively in the areas of HCI and CSCW. It overlaps considerably with theories and models for describing and understanding information search behavior in library science and information science (Ellis, 1989, 1993; Kuhlthau, 1993; Marchionini, 1995; Meho & Tibbo, 2003). Our choice of information foraging theory for our exploration was based primarily on the previous use of the theory within the network development research community, and the fact that social dimensions were included in early work on foraging theory (see Giraldeau & Caraco, 2000). We do, however, acknowledge that other theories and models from the library science and information science communities might have been used in our exploration. We are aware as well of the fact that searching for

information might be characteristically distinct from searching for people, and that it might seem controversial to apply concepts from one area to an intuitively different problem. At the same time, transdisciplinary studies might add important new perspectives to further understanding of the object of study, in the same way that foraging theory (Stephens & Krebs, 1986), with its roots in behavioral ecology, once did for extending understanding of the information search behavior of human beings. Given this point of departure, we take information foraging theory as one source of influence, while simultaneously acknowledging previous and current research on this topic within other areas and disciplines. Vast amounts of research also have been assigned to explorations of social networks and information sharing among actors (e.g., Barabási, 2002; Granovetter, 1973; Scott, 2000; Wasserman & Faust, 1994) and, within the area of CSCW, the framework of distributed cognition (Hutchins, 1990, 1995; Hutchins & Hazlehurst, 1992) has proved to be a powerful theory for providing descriptions of interactional processes in smoothly functioning sociotechnical networks. Our exploration complements these other areas of research through an explicit focus on finding out whether the theory of information foraging can serve to illuminate precisely how individuals search for others in highly distributed professional social networks. For our empirical exploration, we targeted a communication-intensive organization called Bilfrakt.se, a logistics company for whom effective social interaction and a distributed form of work are crucial for carrying out its business.

The rest of the paper is structured as follows: First, we introduce and describe information foraging theory and current research within this area. We then present the method we used for studying social interaction search behavior, followed by a description of our empirical research site Bilfrakt.se. Having outlined our case study, we then characterize search behavior within the social network, that is, how participants go about searching for each other to establish interaction, and which factors govern their behavior. We then present six identified strategies that influence search behavior within the social network, before discussing implications for the design of social networking technologies in support of professional distributed work.

SOCIAL INTERACTION FORAGING

One of the underlying motives behind this paper is to explore to what extent information foraging theory can illuminate how search behavior processes unfold in distributed professional social networks. We first introduce information foraging theory and the problems to which it has been applied. We conclude this section by arguing for *social interaction foraging*, a new concept for describing and analyzing the interpersonal dimensions of social network maintenance.

Basic Description

Information foraging theory (Pirolli & Card, 1995, 1999) concerns how people search for information, especially on the Web. The theory is built upon the foraging constructs in human behavioral ecology (Pirolli & Card, 1995). These food foraging constructs have proven to be useful for describing the processes by which people identify relevant information, and the ways they navigate complex information spaces. But while food foraging models measure the gains in terms of energy, information foraging models do so in terms of experienced value

(Pirolli & Card, 1995). Information foraging theory attempts to understand how technologies and strategies for the seeking, gathering, and consumption of information are adapted to the flux of information around us. The theory presupposes that individuals

> will modify their strategies, or modify the structure of the interface if it is malleable, in order to maximize their rate of gaining valuable information. A cognitive strategy will be superior to another if it yields more useful information per unit cost. (Pirolli & Card 1999, p. 644)

Research in different domains (which we review below) verifies the foraging model as a useful heuristic for exploring academic research and communication behavior. Sandstrom (1994, p. 415) suggested that "subsistence foragers face similar constraints and conform to the same set of principles in how they make decisions to allocate scarce resources, such as time and energy, among alternative ends in the game of survival."

Information foraging theorists have embraced several anthropological constructs in order to conceptualize data-seeking behavior. A key concept is *scent,* which refers to the cues that information foragers use to make judgments about which information source to pursue and consume. Other important constructs are *diet* (the conscious selection of specific type of data chosen from a wide selection of data sources), *patches* (the fact that valued information is often unevenly distributed in the foragers environment), and *enrichment versus exploitation* (referring to the process through which foragers can choose to modify the context or information environment in relation to their available strategies for locating information, or start to exploit them; Pirolli, 2007; Pirolli & Card, 1999).

Previous Research on Information Foraging

Most studies of information foraging theory have investigated the usefulness of the theory or its underlying concepts for developing new access tools, improving usability, and reducing search time for Web sites (Card, Robertson, & York, 1996a, 1996b; Chi, Pirolli, & Pitkow, 2000; Pirolli, 1998; Pirolli, Card, & Van der Wege, 2000) or in large collections of text (Pirolli, 1997). One example of a new access tool informed by information foraging is the Hyperbolic Tree browser (Pirolli et al., 2000; Pirolli, Card, & Van der Wege, 2001). The Hyperbolic Tree is a "focus plus context" information visualization that was developed to increase users' abilities to navigate complex information environments. It was designed based upon the foraging concept of scent and how task-relevant display cues guided the user's visual search behavior and navigation decisions. Another example of a design influenced by information foraging is the WebBook (Card et al., 1996a, 1996b). It allows users to group together related pages on the Web and to manipulate them as a single unit. The unit is displayed using an augmented simulation in 3D graphics of a book and the use of interactive animations for indicating the relation between the pages of the book (each page of the WebBook is a Web page). By allowing users to enrich their environment, the system promotes more rapid access to information by reducing access time to different information resources. A related design is the Web Forager (Card et al., 1996a, 1996b), an application that inserts the WebBook and other objects into a hierarchical workspace. The Web Forager supports interaction with units of Web pages and enables the necessary trade-offs between screen space, number of entities or units, and fast access.

Arguing for Social Interaction Foraging

The above studies illustrate how information foraging is concerned with individual users searching and accessing information. It typically focuses on the goal or the content of an individual information search activity. It does not examine, however, the process through which people active in highly distributed professional social networks go about searching for each other for establishing and maintaining interpersonal social interaction (i.e., how they do it and which factors govern their behavior in terms of reaching out to their social peers).

Moving beyond the individual level to account for the social dimensions of work and social networking, we argue for the need to extend the level of analysis. Although information foraging behavior has provided valuable ways for understanding the information-seeking individual, new theories and concepts are needed to describe and analyze the social dimensions of interpersonal network maintenance. Accordingly, we propose social interaction foraging to work as one such concept.

Inspired by current theoretical work describing social networking in terms of coordination (Malone & Crowston, 1990, 1994), turn-taking (Sacks, Schegloff, & Jefferson, 1974; Schegloff, 2007), and common ground (Clark, 1996; Clark & Brennan, 1991), we base our proposed concept in already established theoretical frameworks for analyzing the social dimensions of networking. Our approach defines social interaction foraging as the ways in which networking individuals execute a set of strategies to search for collaborators within the social network while at the same time preserving that network. We use this new concept to analyze an empirical case characterized by its social networking practice while being geographically dispersed.

The concept of outeraction (Nardi, Whittaker, & Bradner, 2000) was introduced to describe the additional efforts of an individual to keep his or her social network functional and intact. We expected to find similar mechanisms on a social level among and within a highly distributed social network of professionals.

RESEARCH METHODS

In this section we present the data-gathering techniques we used, as well as our research site, the logistics company Bilfrakt.se. The site was a good candidate for studies of highly distributed professional social networks. Bilfrakt.se has centrally placed dispatchers and distributed drivers equipped with various communication technologies, and their work practice involves continuous social interaction on a daily basis. A quantitative study (e.g., based upon log analysis) of the frequency of these social interactions could be of interest for understanding the amount of coordination necessary to work in a highly distributed organization. In contrast, however, our focus was directed towards the nature and meaning of the searches for interaction across this distributed professional network of dispatchers and drivers. For our purposes, we just as well could have chosen a socially structured network of professionals active in another organizational domain. This case did turn out, however, to serve our purpose well, primarily due to the network's dependency on rich and frequent interaction for managing its activities.

Data Gathering and Work Organization at Bilfrakt.se

In our study of social interaction, we relied upon on-site observations and qualitative interviews. The data-gathering process was very traditional when it came to the planning and execution of the interviews and observations, but the focus of the study had a unique character in that instances of social interaction and professional networking were sought. The study started off by a visit to the site, followed by several days of observations before the interviews were arranged. Although the observations spanned only days, they gave us an initial view of the work situation and atmosphere of the logistics dispatchers, which was beneficial when creating questions for interviews.

There were five dispatchers, of whom four were interviewed (one declined to participate in the study). A dispatcher is responsible for coordinating which drivers will work on which delivery jobs. All interviews were conducted with the respondents individually, on four separate occasions in the facilities of Bilfrakt.se. One interview took place in the respondent's open-plan office and the others' were in a meeting room in the same building. All interviews were structured around the same set of questions, recorded, and later transcribed by one of the authors. Each interview lasted between 45 and 90 minutes. The aim of the interviews was to get the dispatchers' views of how they get their work done; the analysis of the gathered data was based upon the information foraging theory. Since the interviews were conducted in Swedish, all excerpts in the paper have been translated from Swedish to English by the first author. To guarantee the respondents' privacy, they were given the opportunity to read through the paper before submission. These are some examples of questions that we asked:

- How do you as a dispatcher prioritize between different customers and drivers?
- What kind of feedback do you get from a completed driving mission?
- What is the rationale behind the selection of a vehicle for a certain driving mission?

Subjects

Four dispatchers were interviewed, of whom one was female. Their ages ranged from 25 to 50; one of them had 15 years of experience as a dispatcher, whereas the others were much less experienced (2.5 to 5 years). No specific education is required for dispatchers at Bilfrakt.se, but they all had some experience from the area of logistics, some from their current employer and some from other companies. Being a dispatcher is a demanding job and, as will be shown, it is of great importance to understand the mentality and strategies of individual drivers.

Bilfrakt.se

Bilfrakt Bothnia AB (or more commonly, Bilfrakt.se, a name especially useful for on-line contacts it serves as the company's Website URL) strives to be the first choice in logistics companies in northern Sweden. The company transports a wide range of materials, ranging from gravel and industry goods to fragile consumer products and provisions.

The company has offices in Umeå, Skellefteå, and Malå, three cities located in the north of Sweden. It employs 89 workers, has an annual turnover of approximately €65 million, and is owned by 148 haulage contractors who have a total of 400 vehicles and 610 coworkers at their

disposal. There are several reasons why effective coordination and communication are essential for the success of Bilfrakt.se. First, coordinating the available vehicles is required to maximize their use, so that drivers either are delivering for a customer or are on their way to a customer. This is extremely important to achieve profitability and competitiveness. Second, logistics is a service-based, often outsourced function, and customers demand that the service works effectively, with no room for error. Third, the daily turnover in orders is very high and the range of missions is often extremely unpredictable, which results in repeated coordination efforts.

Since coordination is so important for the logistics company, the individuals involved in the processes of assigning suitable vehicles to driving missions (the dispatchers) are key players in the organization. The five dispatchers are located in an open-plan office in Umeå; their job is to coordinate all logistics activities remotely. Each dispatcher is responsible for a specific area of driving missions (except in one case, construction, where two dispatchers are needed due to the high turnover in orders). The specific mission areas are

> Thermo: transportations in which the environment in the cargo space needs to be cold or warm. The dispatcher involved in this mission area is also responsible for long distance shipments of perishable provisions. Typical deliveries involve fish or flowers.
>
> Distribution: the regular delivery of goods and provisions in the province of Västerbotten. The vehicles coordinated by this dispatcher have a specific route that they follow every day, with more or less the same cargo every time. Typical deliveries would be dairy products.
>
> Fangio: short-range distribution of smaller goods, often with smaller trucks or pick-ups. These cars/trucks often distribute items such as additional equipment to construction sites and personal deliveries.
>
> Construction: logistics related to construction work. These trucks distribute sand or topsoil, but also frequently work on excavation and removal of material. The nature of the work for these trucks differs from the others, not only because of what they carry, but also because they sometimes stay and work with a customer for an extended and often unpredictable period of time.

The nature of a working day varies for each dispatcher, depending on the mission area for which he/she is responsible. We are interested in exploring the character of search behavior within social networks and examining how information foraging could be helpful in this exploration. We therefore chose to focus upon the two areas of transport planning where the frequency of interaction and the need for cost-efficiency is highest, namely the areas of Fangio and construction. These areas differ from the others (distribution and thermo) in that they are dependent upon intensive communication for success. To support them in this work, dispatchers have arranged their work environments accordingly (see Figure 1).

The work environment of the Fangio and construction dispatchers is arranged to enable quick access to multiple sources of information and interaction channels. Not visible in Figure 1 are a fax machine and the dispatcher's colleagues. Mission dispatchers in both areas use a software system named CockPit (see Figure 2), although the Fangio dispatcher used an older version of the software. Such a system is used to keep track of vehicles and driving requests. A delicate matching process between driving requests and driving resources takes place as soon as a request is made. The process of finding a suitable driving resource is based

on information kept in the software system, involving information in the head of the dispatchers, as well as formal and informal procedures.

Figure 1. The work environment of a dispatcher.

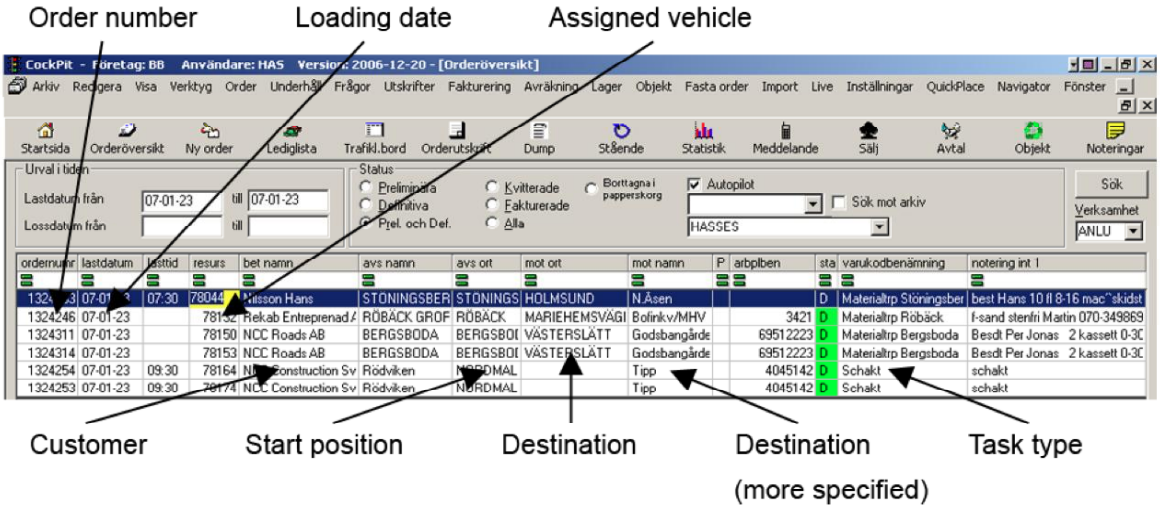

Figure 2. The CockPit interface used by construction dispatchers to keep updated on incoming requests for driving missions.

The dispatchers make use of a vehicle queue for their work (see Figure 3), in which they can see who is available and next in line to receive a driving mission. In Figure 3, the left column provides a short description of the vehicle and the second-from-the-right column lists a two-digit number describing the availability status of a driver. The code 02, for example, indicates "available, in the car."

When a customer makes a request, often by telephone, the dispatcher stores the request in the CockPit system and assigns a vehicle from the vehicle list. The stored data includes customer name, destination, assigned vehicle, and so forth. In principle, the process dispatchers use to identify which vehicle to allocate to the next job should be obvious: They would simply look in CockPit for the first available vehicle with an appropriate specification. However, this straightforward procedure is not what they do typically. We explore why in the next section.

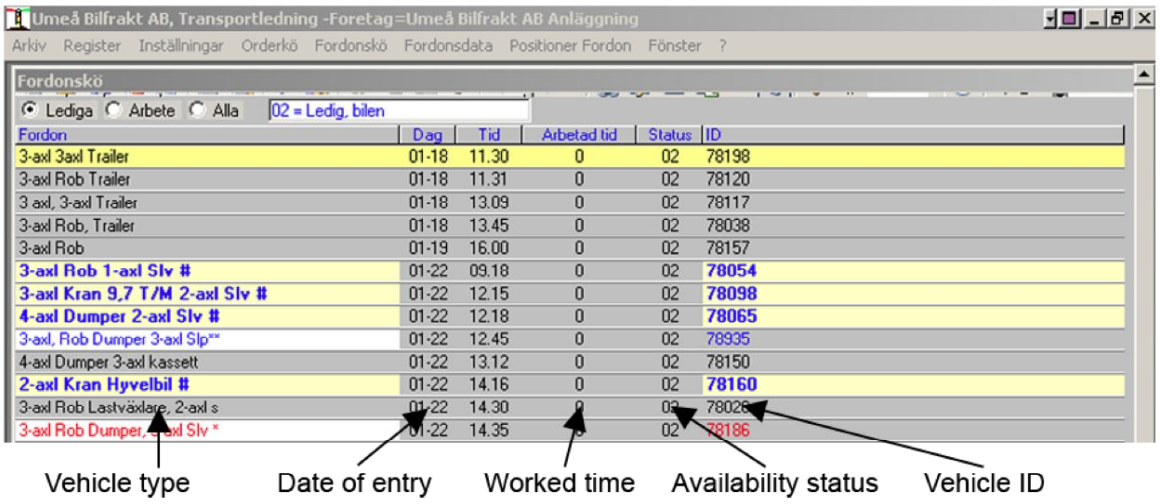

Figure 3. The vehicle queue in which the dispatcher can see the order in which vehicles should be assigned driving missions.

WORK ASSIGNMENT AT BILFRAKT.SE

In this section, we present through quotations the process of work assignment at Bilfrakt.se, a process that involves several dispatchers and numerous drivers in possession of various vehicle types. In translating to English, we attempted to remain as close to the informants' original Swedish wording, even though the spoken words at times may look odd in a written form. Occasionally, however, we added clarifying words or sentences to improve the understanding of the quotes provided. These clarifications are placed within brackets. To protect the anonymity of the construction and Fangio informants, no identifying information is attached to the quotes.

Selection of Drivers for Job Assignments

The main objective of the dispatcher is to match an available vehicle with a driving request from a customer. A construction dispatcher described the idealized process as follows (please note that he addresses himself in both first and second person in the quote):

> *I receive orders and then I write on a pad what the customer talks about and what account number, and so on. Then I enter an order for the respective customers. You enter account number, what he has ordered, and contact telephone number and where he wants to load and unload, the unloading location, and then you write what kind of material he wants to load since that is the basis for pricing. When you are finished with that and have chosen a vehicle then you check which vehicle is available on this* [vehicle queue] *list. This is the availability list; these vehicles are available, so to speak. Then it says here that this vehicle is a big vehicle: It has three axles. It varies: This one has a trailer. And then you choose the first one on the list of the ones that matches, so to speak, and then you call that vehicle and say that this and this customer wants help with this.*

This is how the work assignment process should be done in principle, by matching the incoming request with the first available vehicle in the Cockpit queue. But in further probing, we found that this process is often replaced by an alternative, far more complex, procedure. Other factors related to the customer, driver, task, and circumstances affect the selection of a driver for the assignment. Although the total population of vehicles needs to be assigned jobs, as governed by formal agreements, some vehicles receive more jobs than others. One dispatcher gave the following example of how the intended assignment process is altered by circumstantial aspects, in this case the location and expected duration of the task:

> *Their position on the list is priority one. But then you know that this vehicle* [the driver of the vehicle] *lives a couple of mil* [a mil is a distance of 10 kilometers] *outside the city. This job, maybe it involves several hours of driving or the whole day, then you bring him in, but if it's just a load then you pass him by on the list since it will cost more money to bring him in than what he will be able to make.*

To be clear: Overall, all vehicles are used by the dispatcher and are provided with jobs. The haulage contractors own Bilfrakt.se, and it would be unwise from the company's perspective to favor some contractors or to treat others unfairly. There are, however, complex factors that affect precisely which vehicle is assigned a certain request. One such factor is the identity of the requesting company:

> *It is nothing to put under the chair* [Swedish expression meaning that it is public knowledge] *that we have certain customers that we prioritize. The largest customers, you need to hold them under their arms more* [i.e., provide better support] *since they are such large assigners for us.*

This means that a certain vehicle might be saved for the driving request of a large assigner, which in turn means that another less suitable vehicle might be assigned to other requests made by less important customers. In construction, some requests are associated with a higher risk of the vehicle getting "stuck" at the site, for example, excavation requests. Thus, the dispatcher becomes less prone to assign a rare type of vehicle to such a mission because that vehicle may be needed for assignments for which only this particular vehicle is suitable. Another factor that influences the assignment decision is the relation between certain customers and drivers: Sometimes customers notify the dispatchers that they do or do not want a certain driver to work for them.

Factors related to specific drivers also enable the dispatcher to make a successful match. Such factors include the location of a vehicle (since proximity speeds up the execution of the task and reduces the between-task time), the current status of the vehicle (drivers are able to

signal their availability from their vehicles), the estimated chances that a certain driver will accept the mission (some drivers are known for their tendency to reject driving missions during some periods), and the flexibility of a certain driver (his or her ability to take on ill-defined tasks). Flexibility is one driver characteristic that is mentioned by several dispatchers as important for the assignment of requests:

> *Some manage themselves, and some I know that they are skilled, and some are incredibly, well, they should have a job where they just drive from position a to position b, preferably all summer. But others are incredibly flexible and manage their own problems,* [are] *customer friendly and, and, of course, they exist as well.*

Another important characteristic of a driver that plays into the assignment decision is whether or not the driver can work quickly. One respondent gave the following answer to the question regarding whether he knew which drivers to assign to a very time critical request:

> *Yes I do and you learn that really fast, how they are as a person. Some are impossible to speed up and some have that speed even if it's not necessary. It is how you are as a person. Some need more time. That is just the way it is.*

Thus there are multiple reasons why the official procedure described in the beginning of this section is not followed. In fact, it is unusual for the incoming request to be directly matched with the queue list, with the first available driver allocated. Instead, other complex aspects, both human and highly contextualized, govern the matching process. There also are situations when a customer asks for not only one but several specific drivers for a job:

> *Sometimes the customer has had 4-5 vehicles driving on a job and then they have had a halt for a week or two and then he calls and says, "I want those two." And it can be for practical reasons or it can be equipment reasons—that their vehicles are constructed in a certain way. But it can also be a group that works very well with the excavator and the tractor and everyone.*

In some situations, drivers take active part in the process of work assignment. One respondent commented,

> *It happens that I try to reach a driver and he turns me down and that he refers me to another driver that he knows is available. And that sometimes happens.*

This useful information for the dispatcher will most likely reduce the effort spent to achieve a successful work assignment. As mentioned above, drivers sometimes reject assignments for a variety of reasons; thus, sometimes four or five phone calls have to be made before assigning a vehicle to a job. This is, of course, unfortunate that the dispatcher expends effort without being able to assign a job. Another negative byproduct is that those drivers that turn the dispatcher down are disrupted in the work they are involved in by these short conversations.

The location of a specific driver is a factor included in the decision making of dispatchers regarding to whom a job should be assigned. Dispatchers therefore have created a working environment well designed for this purpose. As depicted in Figure 1, multiple channels for interaction and numerous sources of information, such as maps, previous work assignments, and so forth, surround dispatchers in their workstations. Worth mentioning is the fact that it varies to which extent a dispatcher is aware of the exact location of a driver.

While the construction dispatchers often have a hunch based upon recent interaction or because of more longitudinal assignments, the situation is quite different for the dispatcher at Fangio, since the drivers are less stationary and more autonomous. As a consequence, it is less likely for these drivers to be able to help the dispatcher regarding the availability of others. The dispatcher does, however, have an open channel to most of the drivers, which means that when a request is assigned to a certain driver, another driver can interrupt and say that he is located at the exact position of the current request and could do it instead. As a consequence, the dispatcher at Fangio is much more dependent upon drivers to inform him about their position, thus allowing a better-informed allocation.

IDENTIFIED STRATEGIES OF SOCIAL INTERACTION FORAGING

Based upon analysis of the empirical data, we have identified a number of key strategies in the process of searching for social interaction in distributed professional social networks. We have decided to term these strategies *social interaction foraging* because they all relate to how and why the members of this highly distributed social network search for other persons within this network as part of their everyday work. To strengthen this analytical perspective of foraging, we have chosen to label the person searching for social interaction an *interaction forager*. What is worth mentioning here is that the process that we describe by our term social interaction foraging should not be confused with the behavior of individuals in other contexts where interaction could be foraged for with the sole purpose of interacting.

Reliance on Social Negotiation

When the interaction forager decides to contact another member of the social network and succeeds, a negotiation starts between the forager and this particular member. One dispatcher exemplified the negotiation procedure as follows:

> *They* [the drivers] *can argue when I distribute driving missions. They can see that they have received this and this, but this, they* [the drivers] *will not have time to do* [those tasks] *and then they can reject them. And then I see that, and usually call them and ask them why they have rejected it. "Well it's because these three things that you suggest I start with will take two hours, because there are time limits for driving missions, when it should be done, and on this* [driving request] *it says that I should do it within half an hour and I won't be able to do that." Either you have to say that it's not that urgent and that he can do it later or I am aware of the situation and have to look for someone else to do it.*

This instance of negotiation takes place between the actors in the social network, and the outcome of this process potentially affects the relationship between the involved parties and possibly the whole social network. In order to maintain an efficient social network, it is in both parties' best interests that the negotiation satisfies both the forager as well as the network actor.

This could mean for the driver, for example, that it is worth taking on a driving mission that is less attractive in order to be able to get a more attractive one another day. Based upon the outcome of such a negotiation, the forager can estimate whether it is beneficial to keep on negotiating with a specific network actor or whether another person should be sought who is more likely to agree.

Recurring Encounters and Maintaining Relations

In a network of professional actors, the participants are likely to have been involved in numerous negotiations in the past and likely to be in more negotiations in the future. This means that all negotiations contribute to the development of a shared history among the involved parties, a history that is influential in the maintenance and economics of the social network, as well as in the domain in which the network is active. This highlights aspects such as the popularity of certain drivers due to their honesty, willingness to work, speed, and reliability. A driver's reputation is not something factual and predetermined, but rather is socially constructed between and among the different actors, over time and during episodes of negotiations. These relations are developed primarily between the interaction forager and the network actors, based upon previous interactions and negotiations, although other sources of information, for example, from actors outside the social network, can also play a role.

A Network of Competent Actors

The popularity of a specific driver relies not only upon his or her character, but also his or her actions. Drivers can provide information about their current status, the status of others, the state of a current task, or they can redefine the task they have been allocated, meaning accepting multiple tasks in combination by using complex problem solving. One of the interaction foragers in our study gave an example of how drivers take an active part in the joint activity by choosing to have their communication channel open, which affords a certain problem-solving behavior. The dispatcher explains how this works in practice:

> *I can call* [using the radio] *a car and say that there are some goods to collect at the hospital,* [and to] *take that when you have been to Ersboda* [an area in Umeå]. *But* [another driver might interrupt and say], *I am at the hospital right now, I can take it, and then it is settled that he takes it. This is much faster than the telephone, and the major advantage is that you can get help.*

Note that this solution is achieved by social means. The forager does not know the exact location of the driver at the hospital (even if he knows that he will be there some time during the day), but another driver, by being an active social agent, provides new information to assist the forager in finding a better solution. The activity of the network actors combines with experiences from previous encounters (negotiations), statements from customers, and other sources of information. The totality of this information enables the forager to develop an understanding of the competencies of different actors, which is taken into consideration when striving for efficiency in the social network and the joint activity. On the other hand, network actors can boost in several ways their potential for being chosen by foragers during task delegation. They can build a reputation by always being accessible (i.e., carrying their cellular phones at all times) or by sharing awareness and availability information (e.g., using the code system to notify the dispatcher about their current situation). Another influential method for signaling competence is to solve tasks in the best possible way and hopefully impress the dispatcher or the customer, which might result in a situation where the customer asks for a specific driver when making future requests.

Symmetrical Relations

Another implication of recasting the network actors into a more active role is that their relation to the forager should be considered as more symmetrical than one might initially assume. This is due to the ability of the network actors to negotiate; to develop a reputation, a relationship and shared history with the interaction forager; and to take an active role in the total joint activity. Independently of a network actor's reputation, another influential factor when it comes to selecting a driver for a job is current location. A dispatcher describes how this works in practice:

> *It can be good to know that this vehicle is driving between our gravel 21 in Röbäck* [a location in the south of Umeå] *with sand to Haga* [another location in the north of Umeå], *then it is possible that some customer has a load of gravel in Stödingsberget* [a location in Umeå] *that is located north of the town, to Teg* [a location in the south of Umeå]. *Then you know which route the vehicle takes and then you can call another customer and ask him if he has any loads to Teg. If he* [the driver] *is able to take that then it will be a return load and when we do not have that many available vehicles you have to utilize them as much as possible. Then you can call the* [first] *customer and ask if it is okay that the driver squeezes in a load. You have to check with the customer first so he, he* [the driver] *will be a little bit delayed. Most of the times this is not a problem; it might instead benefit the customer next time.*

As a consequence, it is beneficial for a driver to keep the dispatcher updated on his or her position. The only way to do this is through interaction, either by informing or by being frequently engaged in work-related communication, such as negotiations with the dispatcher.

Network Maintenance

All involved actors benefit when the network is kept intact. The dispatcher at Bilfrakt.se must delegate tasks to all involved actors within the network: Failing to do so will likely cause disturbance and potentially might reduce the overall capacity of the enterprise because more peripheral network actors are likely to drop out. It is easy to imagine how some network actors are less attractive for an interaction forager during certain periods, but failing to delegate the tasks during those periods could be devastating in other times. Based upon the study at Bilfrakt.se, it is apparent that some tasks are, by nature, tasks that most network actors are capable of fulfilling, while others are more specific and require a much more selective choice in delegating. As indicated by the following excerpt, what distinguishes these types of tasks in the logistic domain is to a high degree dependent upon the level of problem solving involved in the task execution. Active network participants set out to solve customer problems themselves:

> *Many times the driver notices* [when at a customer site] *that there is something that should be done and contacts the foreman and says that, "I have some time left so I can help you with that," something that the foreman thinks needs to be done. He* [the driver] *takes the initiative himself and is autonomous. On the other hand there are drivers that are not autonomous.*

As described above, the dispatcher makes use of the available vehicle queue, and the instructions to the dispatchers are that they should follow this priority list. But we have also shown that this queue is not strictly followed and, in fact, it cannot be if the dispatcher wants

the logistics activity to be as effective as possible. However, if interaction foragers continually overlook some network actors, these might drop out and, as a result, the network would suffer during busier periods of time. Thus, the maintenance of the entire social network is very important for the forager to be successful in the overall social interaction foraging activity.

Commitment and the Survival of the Social

In the Bilfrakt case, the commitment between involved actors plays an important role. The interaction forager does not consume other social actors, as food is consumed in classic foraging theory. Instead, by committing themselves, drivers become temporarily less available for interaction. This marks an important difference from information foraging theory, in which the forager consumes the information found. One example of this social process occurs when dispatchers avoid assigning certain actors (who are considered to have unique competencies) to a task so as to have them available if a more important and highly prioritized task comes up. This is a situational trade-off since the dispatcher has to see to it that the resources of the social network are optimally used. Whether a task is prioritized is highly dependent upon the customer. Some customers are more important than others, which leads to their work becoming more highly valued and prioritized than that of others.

We have also discussed the issue of commitment within the social network and how some actors are viewed as more valuable than others by the dispatcher. This estimation is based upon ability to work fast, but also upon these actors' social abilities, that is, problem-solving skills, their attitude in instances of social negotiations, their routines for making themselves reachable and for signaling availability, and so forth. This suggests that what makes a single actor successful is not completely based upon his or her individual strengths or abilities, but also upon his or her social abilities. Because commitment is such an important aspect of successful participation in networks of social actors, the term *survival of the social* is very much related to its precursor, the survival of the fittest. The key to large, functioning, professional social networks is not the survival of the strongest, but is instead individuals who are skilled at understanding the interpersonal, that is, social, dimension of their actions that transpire through negotiations with peers in the network, through building symmetrical relations, through contributions to the social networks' joint history, and through commitment to the other actors and shared tasks within the group.

DESIGN IMPLICATIONS

Various technologies have been developed for construction, maintenance, and usage of cost-effective social networks in professional settings. There has been some exploration of work-related social networking in products such as the business-related social networking site LinkedIn, and in deployed prototypes such as the social bookmarking service Dogear (Millen, Feinberg, & Bernard, 2006). However, these should be considered as exceptions rather than as common technologies. In this paper, we have presented an empirical study from which we have been able to extract a set of useful concepts for understanding social interaction foraging behavior in professional social networks. This set of concepts has been extracted from the empirical data, but also contrasted with the theory of information foraging, generating important theoretical implications, in particular

about the active nature of social agents, the need for negotiation, and the long-term maintenance of social networks. These contrast with the passive view of information consumption presented in classic information foraging theory. In classic information foraging, information is first located and then consumed: In those accounts, information does not negotiate or actively make suggestions about other information that is better suited to the forager's needs.

In addition to these theoretical implications, we also have been able to arrive at some design implications. As the first, and somewhat obvious recommendation, we believe that systems designed to support social interaction foraging need to be flexible and dynamic in relation to the multithreaded nature of human social communication. In other words, such interaction technologies should support multiple, integrated, and open channels that allow for lightweight and effective negotiations for the best person for that particular job. Such technologies also need to support finding the right person to contact in terms of competence (which is in line with previous findings in the area of expertise location). However, we have also seen that expertise is not the sole determinant of driver allocation. In this context, choice is also influenced by the current location and availability of a specific driver at the time when the dispatcher needs to delegate a job. Here, we envision systems that provide information about how to reach the members of the network, as a complement to today's peer awareness systems. This might include typical buddy lists showing who is on-line in the network and their availability status. But we are also envisioning systems that support channel awareness, which could indicate the available communication channels (phone, radio) for each peer in the network.

Any technology designed to support social interaction foraging also needs to account for the social dimensions of interpersonal interaction in order to create a balanced social network. All peers need to be actively engaged in the network, and the linkages between the peers (i.e., the persons in the network) need to be strong in terms of frequent short-term interactions. They also need a common understanding of the task at hand, while at the same time ensuring that the network is working at an acceptable level of effectiveness. This includes the building and maintenance of trust, reputation, and division of labor, which is a recommendation related to the ongoing process of social negotiations within the network. Here, interaction technologies in support of social interaction foraging behavior should support the forager in his/her making of individual annotations about actions and interactions within the network to help maintain a history of activity. However, we do not advocate that the activity notations be widely distributed within the network because some network actors may lack a common understanding of the history of the social network and could easily misinterpret such information.

Second, we can see how technologies to support social interaction foraging should include functionality to provide some selected users with overviews of social network interaction histories (similar to the work done on e.g., ContactMap, Whittaker et. al, 2004; RoamWare,Wiberg, 2001; or Themail, Viégas, Golder, & Donath, 2006) but also complemented by information related to agreements and allocations of shared resources (e.g., an overview of a person's commitments and what peers in the network have committed to that person). Even though these options might be beneficial in relation to our theory of social interaction foraging, we do note, on the other hand, that such technical support would need to be carefully implemented to avoid becoming unwieldy. Still, we view this recommendation as tightly coupled with the issue of transparent commitments among the peers who constitute the social network.

However, designers of technologies to support social interaction foraging need to consider a couple of paradoxes related to these design recommendation. The first paradox is how to

support an equal distribution of work among the peers in the network to make sure that everybody is actively involved while, at the same time, making sure that work is carried out as effectively as possible (Karau & Williams, 1993). The second paradox concerns the fact that most social interaction foraging is informal and highly dynamic; clumsy attempts to computerize this interpersonal interaction might compromise these critical features. We do not wish to impose a more formal, explicit routine for making prioritizations and achieving divisions of labor within the social network, which also might lead to an overly heavyweight articulation of work. This is a complex question for any designer of social interaction foraging technologies, but we have taken the individual interaction forager as our point of departure in computer support instead of technical solutions for shared views on individual social interaction foraging behavior. By supporting individual foraging behavior, we seek to promote stronger social networks, rather than trying to support the complete network as one intact unit. The latter goal risks over-formalizing the currently informal social interaction practices.

DISCUSSION

In this paper we presented social interaction foraging as a guiding concept for understanding everyday social interaction within highly distributed professional networks. This understanding is fundamental for supporting networks of collaborating actors with the tools and procedures that are needed to achieve coordination across distance, without creating escalating levels of various forms of overloads (Farhoomand & Drury, 2002; Hancock et al., 2009; Ljungberg & Sørensen, 2000), work fragmentation, and interruptions (Czerwinski et al., 2004; Hudson et al., 2002; Iqbal & Horvitz, 2007; Speier et al., 2003). Even though this new concept has some relations to previous research on social foraging, we want to clarify that social interaction foraging does not refer to the joint collective foraging process as it is described in Giraldeau and Caraco (2000), nor the joint social searching for information as in Chi and Pirolli (2006). Rather social interaction foraging in our research provides a perspective for how people identify resources in a social setting where they have to identify various people for work allocation. From the individual dispatcher's perspective it involves the process of creating and maintaining efficient forms and structures for effective social interaction. In terms of (cost-) effective social interaction, there have been some studies on the computerization of manual routines (Iacono & Kling, 1996), primarily focused on office automatization. A related area concerns maintenance of social relations at the individual level, that is, contact management (Nardi et al., 2002; Whittaker et al., 2004; Whittaker et al., 2002). There is, however, little research related to social interaction search behavior within highly distributed social networks. Our view is closely related to work concerning expertise location (McDonald & Ackerman, 2000; Zhang & Ackerman, 2005), even though we acknowledge that there are also differences. For example, one thing that has not been discussed in the expertise location literature is the long-term aspect of maintaining a relationship with an expert. We are interested in developing a more detailed understanding of the social mechanisms that enable and control the interplay between the actors in large professional social networks, instead of taking the perspective of a social group as a unit and its foraging behavior in relation to an isolated piece of information. Work moving in our direction is, for example, Harr and Kaptelinin's (2007) research on the influence of social factors on effects of and strategies for managing interruptions, even if the scope of that work is much more narrow than this.

To summarize our efforts, we applied information foraging theory to a new domain. We found that dispatchers engaged in social foraging develop relationships with the drivers, and thus a model of negotiation as opposed to consumption was more appropriate. Drivers might refuse missions, recommend others for them, or actively suggest that they could take on a new job. In turn, dispatchers built up a nuanced picture of the capabilities of different drivers and made their choices for work allocation based on this information. Future work needs to extend these initial concepts and develop new technologies to support them better.

CONCLUSIONS

We presented in this paper an empirical study of social interaction foraging behavior in a highly distributed professional social network. We showed that social interaction foraging behavior can best be described as an ongoing process of social negotiation rather than one-shot information consumption, as well as the importance of recognizing this process in terms of recurring encounters. We also advocated a move from viewing other network participants as containers of information to competent actors who contribute to successful problem resolution. These are fundamental divergences from classic information foraging behavior. As such, social interaction foraging contains aspects of cultivation that is preparatory work needed in order to promote efficient social interaction search behavior at a later stage. This notion is similar to what Nardi et al. (2000) termed outeraction, even if their focus is on a specific technology (instant messaging) and not on interaction search behavior in professional networks in general. To some degree this aspect of cultivation is also covered in information foraging, that is, in the enrichment versus exploitation concept but, as previously mentioned, not with a focus on social activities, and not in order to prepare for the establishment of interaction.

Our study contributes important findings leading to extensions of information foraging to social settings. Furthermore, we identified and acknowledged that functioning social interaction foraging behavior builds upon symmetrical relations, a shared view of the importance of network maintenance, and a strong commitment towards each other and towards the tasks that need to be carried out by the group. Given our extended perspective, we also identified the survival of the social as a central cornerstone for any efficient and long-term professional social network. Finally, we identified and outlined some design implications in relation to our findings, and contrasted our results to previous research regarding social foraging theory. Our future research on this topic will include further analysis of social interaction foraging behavior, the construction and validation of models to describe the relations between the concepts identified and design, and evaluations of prototype systems specifically designed to support social interaction foraging in highly distributed professional social networks.

REFERENCES

Aaronson, A., & Carroll, J. M. (1987). Intelligent help in a one-shot dialog: A protocol study. *ACM SIGCHI Bulletin, 18*(4), 163–168. doi: 10.1145/30851.275624

Barabási, A.-L. (2002). *Linked: The new science of networks.* Cambridge, MA, USA: Perseus.

Borning, A., & Travers, M. (1991). Two approaches to casual interaction over computer and video networks. In S. P. Robertson, G. M. Olson, & J. S. Olson (Eds.), *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 13–19). New York: ACM Press. doi: 10.1145/108844.108847

Card, S. K., Robertson, G. G., & York, W. (1996a). The WebBook and the Web Forager: An information workspace for the World-Wide Web. In B. Nardi, G. C. van der Veer, & M. J. Tauber (Eds.), *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 111–117). New York: ACM Press. doi: 10.1145/238386.238446

Card, S. K., Robertson, G. G., & York, W. (1996b). The WebBook and the Web Forager: Video use scenarios for a World-Wide Web information workspace. In M. J. Tauber (Ed.), *Conference companion on human factors in computing systems* (pp. 416–417). New York: ACM Press. doi: 10.1145/257089.257407

Chi, E. H., & Pirolli, P. (2006, February). *Social information foraging and collaborative search.* Paper presented at the HCIC Workshop, Fraser, CO, USA. Retrieved November 22, 2011, from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.69.2132&rep=rep1&type=pdf

Chi, E., Pirolli, P., & Pitkow, J. (2000). The scent of a site: A system for analyzing and predicting information scent, usage, and usability of a Web site. In T. Turner & G. Szwillus (Eds.), *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 161–168). New York: ACM Press. doi: 10.1145/332040.332423

Clark, H. H. (1996). *Using language*. Cambridge, UK: Cambridge University Press.

Clark, H. H., & Brennan, S. E. (1991). Grounding in communication. In L. B. Resnick, J. Levine, & S. D. Teasley (Eds.), *Perspectives on socially shared cognition* (pp. 127–149). Washington, DC, USA: APA.

Czerwinski, M., Horvitz, E., & Wilhite, S. (2004). A diary study of task switching and interruptions. In E. Dykstra-Erickson & M. Tscheligi (Eds.), *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 175–182). New York: ACM Press. doi: 10.1145/985692.985715

Ellis, D. (1989). A behavioral approach to information retrieval system design. *Journal of Documentation, 45*, 171–212. doi: 10.1108/eb026843

Ellis, D. (1993). Modeling the information-seeking patterns of academic researchers: A grounded theory approach. *The Library Quarterly, 63*, 469–486.

Farhoomand, A. F., & Drury, D. H. (2002). Managerial information overload. *Communications of the ACM, 45*, 127–131. doi: 10.1145/570907.570909

Giraldeau, L.-A., & Caraco, T. (2000). *Social foraging theory.* Princeton, NJ, USA: Princeton University Press.

Granovetter, M. S. (1973). The strength of weak ties. *American Journal of Sociology, 78*, 1360–1380. doi: 10.1086/225469

Hancock, J., Birnholtz, J., Bazarova, N., Guillory, J., Perlin, J., & Amos, B. (2009). Butler lies: Awareness, deception, and design. In D. R. Olsen, Jr. & R. B. Arthur (Eds.), *Proceedings of the 27th International Conference on Human Factors in Computing Systems* (pp. 517–526). New York: ACM Press. doi: 10.1145/1518701.1518782

Harr, R., & Kaptelinin, V. (2007). Unpacking the social dimension of external interruptions. In D. W. McDonald (Ed.), *Proceedings of the 2007 international ACM Conference on Supporting Group Work* (pp. 399–408). New York: ACM Press. doi: 10.1145/1316624.1316686

Hinds, P. J., & Kiesler, S. (2002). *Distributed work*. Cambridge, MA, USA: The MIT Press.

Hudson, J., Christensen, J., Kellogg, W. A., & Erickson, T. (2002). "I'd be overwhelmed, but it's just one more thing to do": Availability and interruption in research management. In D. Dixon (Ed.), *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 97–104). New York: ACM Press. doi: 10.1145/503376.503394

Hutchins, E. (1990). Organizing work by adaptation. *Organizational Science, 2*(1), 14–39. doi: 10.1287/orsc.2.1.14

Hutchins, E. (1995). *Cognition in the wild*. Cambridge, MA, USA: The MIT Press.

Hutchins, E., & Hazlehurst, B. (1992). Learning in the cultural process. In C. Langton, C. Taylor, D. Farmer, & S. Rasmussen (Eds.), *Artificial life II* (pp. 689–706). Boulder, CO, USA: Westview Press.

Iacono, S., & Kling, R. (1996). Computerization, office routines, and changes in clerical work. In R. Kling, (Ed.), *Computerization and controversy: Value conflicts and social choices* (2nd ed., pp. 309–315). San Diego, CA, USA: Academic Press Inc.

Iqbal, S. T., & Horvitz, E. (2007). Disruption and recovery of computing tasks: Field study, analysis, and directions. In B. Begole, S. Payne, E. Churchill, R. St. Amant, D. Gilmore, & M. B. Rosson (Eds.), *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 677–686). New York: ACM Press. doi: 10.1145/1240624.1240730

Isaacs, E. A., Tang, J. C., & Morris, T. (1996). Piazza: A desktop environment supporting impromptu and planned interactions. In G. Olson, J. Olson, & M. S. Ackerman (Eds.), *Proceedings of the ACM Conference on Computer-supported Cooperative Work* (pp. 315–324). New York: ACM Press. doi: 10.1145/240080.240316

Karau, S. J., & Williams, J. (1993). Social loafing: A meta-analytic review and theoretical integration. *Journal of Personality and Social Psychology, 65*, 681–706. doi: 10.1037/0022-3514.65.4.681

Kraut, R. E., Fish, R. S., Root, R. W., & Chalfonte, B. L. (1990). Informal communication in organizations: Form, function, and technology. In S. Oskamp & S. Spacapan (Eds.), *Human reactions to technology: The Claremont Symposium on Applied Social Psychology* (pp. 145–199). Beverly Hills, CA, USA: Sage Publications.

Kuhlthau, C. C. (1993). *Seeking meaning: A process approach to library and information services*. Norwood, NJ, USA: Ablex.

Landgren, J., & Nuldén, U. (2007). A study of emergency response work: Patterns of mobile phone interaction. In B. Begole, S. Payne, E. Churchill, R. St. Amant, D. Gilmore, & M. B. Rosson (Eds.), *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1323–1332). New York: ACM Press. doi: 10.1145/1240624.1240824

Lim, B. Y., Zhang, D., Zhu, M., & Zheng, S. (2007). Context-aware framework for spontaneous interaction of services in multiple heterogeneous spaces. In W. Zeng & Y. Shi (Eds.), *Proceedings of Multimedia and Expo, 2007 IEEE International Conference* (pp. 328–331). Beijing, China: IEEE. doi: 10.1109/ICME.2007.4284653

Ljungberg, F. (1996). An initial exploration of communication overflow. In COOP Group (Ed.), *Proceedings of the Second International Conference on the Design of Cooperative Systems* (pp. 19–36). Rocquencourt, France: INRIA Press.

Ljungberg, F., & Sørensen, C. (2000). Overload: From transaction to interaction. In K. Braa, C. Sørensen, & B. Dahlbom (Eds.), *Planet Internet* (pp. 113–136). Lund, Sweden: Studentlitteratur.

Malone, T. W., & Crowston, K. (1990). What is coordination theory and how can it help us design cooperative work systems? In F. Halasz (Ed.), *Proceedings of the Third Conference on Computer-supported Cooperative Work* (pp. 357–370). New York: ACM Press. doi: 10.1145/99332.99367

Malone, T. W., & Crowston, K. (1994). The interdisciplinary study of coordination. *ACM Computing Surveys, 26*, 87–119. doi: 10.1145/174666.174668

Marchionini, G. (1995). *Information seeking in electronic environments*. New York: Cambridge University Press.

McDonald, D. W., & Ackerman, M. S. (2000). Expertise recommender: A flexible recommendation architecture. In W. Kellogg & S. Whittaker (Eds.), *Proceedings of the ACM Conference on Computer-supported Cooperative Work* (pp. 231–240). New York: ACM Press. doi: 10.1145/358916.358994

Meho, L. I., & Tibbo, H. R. (2003). Modeling the information-seeking behavior of social scientists: Ellis's study revisited. *Journal of the American Society for Information Science and Technology, 54*, 570–587. doi: 10.1002/asi.10244

Millen, D. R., Feinberg, J., & Bernard, K. (2006). Dogear: Social bookmarking in the enterprise. In R. Grinter, T. Rodden, P. Aoki, E. Cutrell, R. Jeffries, & G. Olson (Eds.), *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 111–120). New York: ACM Press. doi: 10.1145/1124772.1124792

Mintzberg, H. (1999). *Structures in fives: Designing effective organizations*. Englewood Cliffs, NJ, USA: Prentice-Hall.

Nardi, B. A., Whittaker, S., & Bradner, E. (2000). Interaction and outeraction: Instant messaging in action. In W. Kellogg & S. Whittaker (Eds.), *Proceedings of the 2000 ACM Conference on Computer-supported Cooperative Work* (pp. 79–88). New York: ACM Press. doi: 10.1145/358916.358975

Nardi, B., Whittaker, S., Isaacs, E., Creech, M., Johnson, J., & Hainsworth, J. (2002). Integrating communication and information through ContactMap. *Communications of the ACM, 45*(4), 89–95. doi: 10.1145/505248.505251

O'Conaill, B., & Frohlich, D. (1995). Timespace in the workplace: Dealing with interruptions. In I. Katz, R. Mack, & L. Marks (Eds.), *Conference companion on human factors in computing systems* (pp. 262–263). New York: ACM Press. doi: 10.1145/223355.223665

Oehlmann, R., Thoben, K.-D., & Weber, F. (1997). Capturing and assessing formal interaction at task level in product development. *Computers in Industry, 33*, 179–189. doi: 10.1016/S0166-3615(97)00023-7

Pirolli, P. (1997). Computational models of information scent-following in a very large browsable text collection. In S. Pemberton (Ed.), *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 3–10). New York: ACM Press. doi: 10.1145/258549.258558

Pirolli, P. (1998). Exploring browser design trade-offs using a dynamical model of optimal information foraging. In M. E. Atwood, C.-M. Karat, A. Lund, J. Coutaz, & J. Karat (Eds.), *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 33–40). New York: ACM Press/Addison-Wesley Publishing Co. doi: 10.1145/274644.274650

Pirolli, P. L. (2007). The use of proximal information scent to forage for distal content on the World Wide Web. In A. Kirlik (Ed.), *Working with technology in mind* (pp. 247–266). Cambridge, UK: Oxford University Press.

Pirolli, P., & Card S. K. (1995). Information foraging in information access environments. In I. R. Katz, R. Mack, L. Marks, M. B. Rosson, & J. Nielsen (Eds.), *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 51–58). New York: ACM Press/Addison-Wesley Publishing Co. doi: 10.1145/223904.223911

Pirolli, P., & Card, S. K. (1999). Information foraging. *Psychological Review, 106*, 643–675. doi: 10.1037/0033-295X.106.4.643

Pirolli, P., Card, S. K., & Van der Wege, M. M. (2000). The effect of information scent on searching information: Visualizations of large tree structures. In S. Levialdi, V. Di Gesù, & L. Tarantino (Eds.), *Proceedings of the Working Conference on Advanced Visual Interfaces* (pp. 161–172). New York: ACM Press. doi: 10.1145/345513.345304

Pirolli, P., Card, S. K., & Van der Wege, M. M. (2001). Visual information foraging in a focus + context visualization. In J. Jacko & A. Sears (Eds.), *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 506–513). New York: ACM Press. doi: 10.1145/365024.365337

Rogers, I. (1995). The use of an automatic "To Do" list to guide structured interaction. In I. Katz, R. Mack, & L. Marks (Eds.), *Conference Companion on Human Factors in Computing Systems* (pp. 232–233). New York: ACM Press. doi: 10.1145/223355.223543

Rouncefield, M., Viller, S., Hughes, J., & Rodden, T. (1994). Working with constant interruptions: CSCW and the small office. In J. B. Smith, F. D. Smith, & T. W. Malone (Eds.), *Proceedings of the 1994 ACM Conference on Computer-supported Cooperative Work* (pp. 275–286). New York: ACM Press. doi: 10.1145/192844.193028

Sacks, H., Schegloff, E. A., & Jefferson, G. (1974). A simplest semantics for the organization of turn-taking for conversation. *Language, 50*, 696–735.

Sandstrom, P. E. (1994). An optimal foraging approach to information seeking and use. *Library Quarterly, 64*, 414–449. doi: 10.1086/602724

Schegloff, E. A. (2007). *Sequence organization in interaction.* Cambridge, UK: Cambridge University Press.

Schmidt, K. (2006). *Cooperative work and coordinative practices: Contributions to the conceptual foundations of computer-supported cooperative work (CSCW)*. Unpublished doctoral dissertation, IT University of Copenhagen, Denmark.

Scott, J. P. (2000). *Social network analysis: A handbook*. London: Sage Publications Ltd.

Speier, C., Vessey, I., & Valacich, J. S. (2003). The effects of interruptions, task complexity, and information presentation on computer-supported decision-making performance. *Decision Sciences, 34*, 771–797. doi: 10.1111/j.1540-5414.2003.02292.x

Stephens, D. W., & Krebs, J. R. (1986). *Foraging theory*. Princeton, NJ, USA: Princeton University Press.

Van de Ven, A. H., Delbecq, A. L., & Koenig, R. Jr. (1976). Determinants of coordination modes within organizations. *American Sociological Review, 41*, 322–338.

Viégas, F. B., Golder, S., & Donath, J. (2006). Visualizing email content: Portraying relationships from conversational histories. In R. Grinter, T. Rodden, P. Aoki, E. Cutrell, R. Jeffries, & G. Olson (Eds.), *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 979–988). New York: ACM Press. doi: 10.1145/1124772.1124919

Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications.* Cambridge, UK: Cambridge University Press.

Whittaker, S., Frohlich, D., & Daly-Jones, O. (1994). Informal workplace communication: What is it like and how might we support it? In B. Adelson, S. Dumais, & J. Olson (Eds.), *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 131–137). New York: ACM Press. doi: 10.1145/191666.191726

Whittaker, S., Jones, Q., Nardi, B., Creech, M., Terveen, L., Isaacs, E., & Hainsworth, J. (2004). ContactMap: Organizing communication in a social desktop. *ACM Transactions on Computer-Human Interaction, 11*, 445–471. doi: 10.1145/1035575.1035580

Whittaker, S., Jones, Q., & Terveen, L. (2002). Contact management: Identifying contacts to support long-term communication. In E. Churchill, J. McCarthy, C. Neuwirth, & T. Rodden (Eds.), *Proceedings of the 2002 ACM Conference on Computer-supported Cooperative Work* (pp. 216–225). New York: ACM Press. doi: 10.1145/587078.587109

Whittaker, S., Swanson, G., Kucan, J., & Sidner, C. (1997). Telenotes: Managing lightweight interactions in the desktop. *ACM Transactions on Computer Human Interaction, 4*, 137–168. doi: 10.1145/254945.254958

Wiberg, M. (2001). RoamWare: An integrated architecture for seamless interaction in between mobile meetings. In T. Rodden, C. Ellis, & I. Zigurs (Eds.), *Proceedings of the ACM SIGGROUP Conference on Supporting Group Work* (pp. 288–297). New York: ACM Press. doi: 10.1145/500286.500328

Zhang, J., & Ackerman, M. S. (2005). Searching for expertise in social networks: A simulation of potential strategies. In M. Pendergast, K. Schmidt, G. Mark, & M. Ackerman (Eds.), *Proceedings of the ACM SIGGROUP Conference on Supporting Group Work* (pp. 71–80). New York: ACM Press. doi: 10.1145/1099203.1099214

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DESIGNING A SIMPLE FOLDER STRUCTURE FOR A COMPLEX DOMAIN

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Abstract: *In this paper I explore a case of designing a simple folder structure for a new e-learning software program for a university study program. The aim is to contribute to the theoretical base for human work interaction design (HWID) by identifying the type of relations connecting design artifacts with work analysis and interaction design processes. The action research method was used, with the author in a double role as university researcher and project manager of a developer group within the university. Analysis was conducted through grounded theory, inspired by the HWID framework. The findings support the use of a holistic framework with asymmetrical relations between work analysis and design artifacts, and between design artifacts and interaction design. The paper concludes with suggestions for modifying the general framework, and recommendations for a HWID approach to design artifacts.*

Keywords: *human work interaction design, action research, grounded theory, work analysis, interaction design.*

INTRODUCTION

Design artifacts contribute to the outcome of design and development processes, as well as to a greater understanding of the work itself and how people and organizations go about their work. In this paper, I aim to demonstrate how a qualitative methodology can highlight the nuances that matter for designers who are the stakeholders in a team involved in designing and decision making. Taking the case of a simple design of a folder structure in an e-learning system, I attempted to de-layer the various intragroup communications to unveil relations between the artifact and the dialogues that take place between the participants during the development. The analysis involved using grounded theory (Strauss & Corbin, 1998), with the explicit goal of modifying and adding to the general HWID framework proposed by Orngreen, Pejtersen, and Clemmensen (2008).

The HWID framework relates work analysis, design artifacts, and interaction design processes. Applying this framework to an empirical case may involve various analyses. First,

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work analysis (Button & Sharrock, 2009; Wilson & Corlett, 1990) may, for example, include an analysis of the organizational usefulness of the future design. This may involve the analysis of meeting agendas and resumes, consultant reports, organizational content templates and policies, interviews with key individuals in the organization, and other methods (Preece, Rogers, & Sharp, 2007; Rasmussen, Pejtersen, & Schmidt, 1990; Wilson & Corlett, 1990). Furthermore, investigating the different kinds of work procedures that the new design will support may include task analysis. Second, interaction design (Preece et al., 2007) may include analysis of the individual usefulness of the future interaction design by creating conceptual models, that is, explicit ideas about how future users should interact with the new design. Such uses could then be illustrated through scenarios. Furthermore, analysis of who the future users are may involve the construction of personas, that is, ideation of fictive users who represent a target group of the new design. Finally, analysis of the users' mental interaction with the new design may include usability tests. However, in contrast to the many techniques available for work analysis and interaction design, the relation between work analysis, interaction design techniques, and the design artifact itself has not received much systematic treatment. Therefore, I explicitly explore and interpret in this study how design artifacts connect with work analysis and interaction design processes.

The connection between interaction design and work analysis occurs through a series of separate analyses. However, I wanted to explore an approach that focuses on the type of relations that bind work analysis and interaction design together via design artifacts. The focus-on-the-relations approach cover questions such as: Are the words, concepts, and other elements that are used in the design sketch taken from the work analysis? Does the design sketch convey the moods and feelings that the work analysis suggested? Does the design sketch illustrate how a task is supported? Do usability tests show that users find the design artifacts effective and efficient, thus providing them a good user experience? It may also include analysis of how the design as sketched should be maintained and how it will be compared to competitors' choices of similar designs. Many other analyses are possible as well. What may be critical, however, is not to reduce the understanding of how work analysis and interaction design are connected to a series of method steps, but instead to see it from a holistic perspective. Thus the research question is: What types of relations are needed to connect work analyses and interaction design in the design of a simple artifact for a complex work domain?

In the rest of the paper, I first provide a theoretical background for the research, and then describe the research methodology as an action research-oriented qualitative case study using grounded theory. After that I present the analysis of how the developer group in the study approached work analysis and interaction design through organizational analysis, task analysis, scenario development, and usability testing. In addition, I note how these analyses were applied in the discussions and interpretation of sketches and prototypes that were designed and used during the development of the folder structure, and how the developer group's use of design sketches reflected possibilities for supporting different user groups' interaction within their various work, learning, and life contexts. I conclude with lessons learned from the case, and provide further advice on how to conceptualize the process of connecting work analysis and interaction design with a focus on design artifacts.

THEORETICAL BACKGROUND AND RELATED WORK

Work Analysis, Interaction Design, and Sketching

Work analysis encompasses techniques such as analysis of work activities and work systems, and assessment of the workplace and products used in the work (see, e.g., Button & Sharrock, 2009; Kirwan & Ainsworth, 1992; Wilson & Corlett, 1990). Some system developers have perceived work analysis techniques as independent and not directly related to design (Clemmensen & Nørbjerg, 2004). Combining work analysis with design artifacts is closely related to approaches used in ethnographic field methods in participatory design (Blomberg, Suchman, & Trigg, 1996; Harper, 2000; Siegel & Dray, 2005). There is also an overlap with studies of design cognition, where researchers ask whether the abilities of the designer (e.g., general intelligence, visual abilities regarding imagery and perception, and creativity) influence the usefulness and quality of sketching (Akin, 2002; Hamel, 1995), and study design practice to describe how designers imagine their users during design (Hasdogan, 1996).

Interaction design is presented in textbooks as an approach consisting of conceptual models, scenarios, task analysis, persona, think-aloud evaluation, and other user-centered techniques (Cooper & Reimann, 2003; Preece et al., 2007). In addition to being user-oriented, textbook approaches to interaction design also focus on the use of prototypes, storyboards and sketches, which interaction designers see as products or sources of inspiration in the design process rather than the interaction design itself. For example, sketches, such as freehand drawings or low-fidelity prototypes, have been studied for their role in design and have been found to stimulate reflection, particularly in the early stages of design (Oh, Yi-Luen Do, & Gross, 2004). When moving from analysis to design, that is, from conceptual models to physical design, interaction design relies heavily on iterative testing of prototypes with users of the future product (Preece et al., 2007). A large number of techniques for user requirement elicitation and user tests are available for use in interaction design (Preece et al., 2007). In many of these techniques, communication between stakeholders about user requirements is supported by the use of prototypes, mock-ups, and sketches.

In the brief discussion above I stated that work analysis and interaction design partly overlap, but have different key concepts, use of techniques, and relations to design artifacts. Both work analysis and interaction design have been studied a great deal. However, not much has been said about the use of design artifacts, such as freehand sketches or low- and hi-fi prototypes, to connect work analysis and interaction design in one holistic process.

Human Work Interaction Design (HWID)

Although this study could have been set within several social science approaches to information technology (IT), for instance, information systems development research or design cognition, I chose to set the study within a developing research specialty of human–computer interaction (HCI) that is called HWID (Campos & Campos, 2009; Clemmensen, Campos, Orngreen, Pejtersen, & Wong, 2006; Katre, Orngreen, Yammiyavar, & Clemmensen, 2010). HWID is a comprehensive approach in HCI, and to provide an easy understanding and to illustrate the coverage of this research topic, we developed the model in Figure 1.

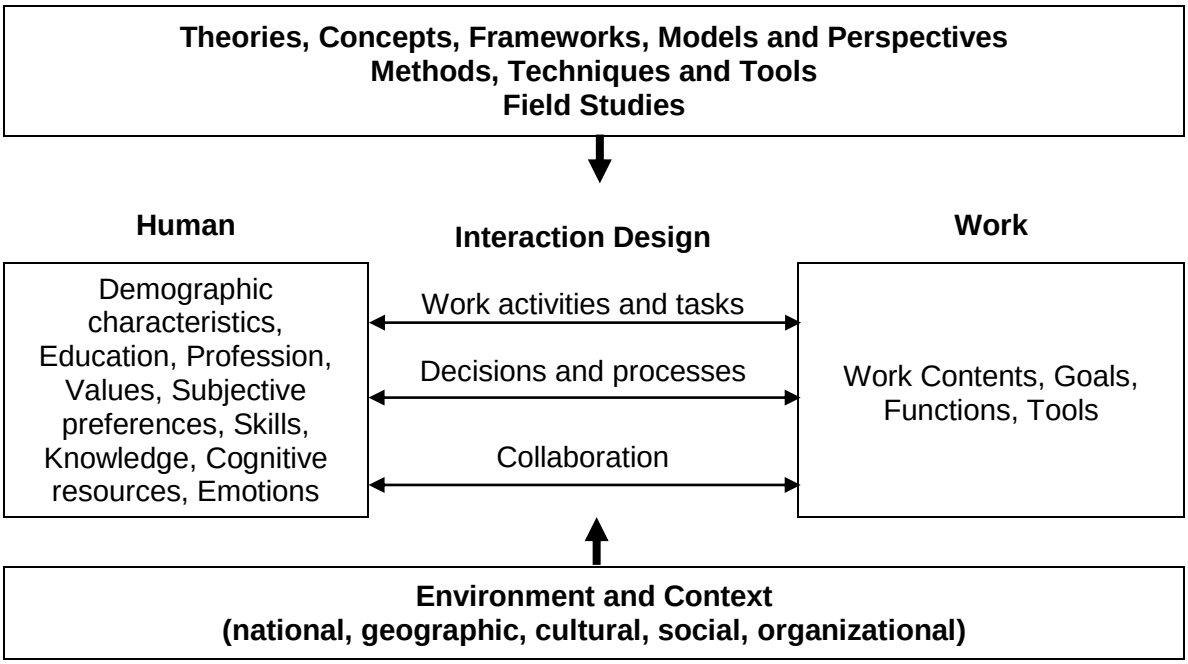

Figure 1. The general HWID framework (Adapted from Orngreen et al., 2008).

Figure 1 shows the characteristics of humans and work domains and the interaction during their tasks and decision activities, individually or in collaboration. Analysis of users' work and life, as well as the design of computer-based information systems, has inspired researchers to develop numerous theories, concepts, techniques, and methods. Some have been widely adopted by practitioners; others are used mainly by researchers, and these are naturally part of HWID research. In either case, such supporting concepts obviously influence work and user analysis, as well as the technology design. This is indicated in the top box in Figure 1.

Environmental contexts, such as national, cultural, social, and organizational factors, impact the way in which users interact with computers in their work and life to the same extent as the nature of the application domain, the tasks, and the users' skills and knowledge. The analysis and design of HWID thus necessarily includes these contextual factors. This is indicated in the bottom box of Figure 1.

Following analysis of previous HWID studies, Orngreen et al. (2008) identified six main themes that reflect the major concerns that researchers perceive in HWID. These concerns fall into two primary categories:

- Within interaction design processes:
  - encouraging the dialogue between users and designers in the design process;
  - bridging the gap between HCI and software engineering by working with user requirements and collaboration in software development processes;
  - supporting communication and design exploration through sketching.
- Within work and user analysis:
  - bridging the gap between work analysis and interaction design through detailed case and field studies and/or action research projects;

- providing rich contextual user descriptions, including methods to study unpredictable and opportunistic tasks;
- broadening the scope of research aims to include social, organizational, and cultural aspects.

Although this list presents these themes and problems as distinct, interaction design and work and user analysis are intertwined in practice, as demonstrated in previously published HWID research (Orngreen et al., 2008). In the qualitative study present in this paper, I develop an interpretive, case-based model of how work analysis and interaction design are connected in the minds of the stakeholders. My aim with this research is to enrich and sharpen the model of HWID that is presented in Figure 1.

RESEARCH METHOD

To answer the research question, I have chosen to do a qualitative analysis of a single case. In the sections below, I present a qualitative case study of the development of the simple folder structure shown in Figure 2 by using action research and grounded theory.

The Case: Designing a Simple Folder Structure for a University E-learning System

In October 2004 the members of the study board (that is, a committee of students, faculty, and administrators appointed to oversee the academic criteria of a university degree program) at a large university in Scandinavia (Copenhagen Business School;[1] CBS) received an e-mail saying,

> *The deans and the university administration have decided that the platform Sitescape now is mandatory for all courses and all students at the university. Therefore you at your study program have to begin using this platform no later than autumn semester 2005.*[2]

The e-mail marked the end of a year-long political discussion in the study board about the value of retaining the old in-house-developed course administration system called DIVE (*Døk [datalogi og økonomi] -studiets Informations-, Vejlednings- og Elektroniske kommunikationssystem*). It also began the transition to the new e-learning system described in this study. Figure 2 shows the

Figure 2. A simple design for a complex work domain: The folder structure of a Bachelor study program's e-learning site. The figure is in Danish; each entry in the folder structure represents a student class.

end of this process, a simple folder structure to be used by teachers, students, and administrators at a bachelor study program in computer science and business administration at CBS.

The case period was from January 2005 to January 2006. The bachelor study program at that time had more than 300 students, 50 teachers, and five administrative workers. It was supported by a small group of IT and e-learning experts from the university's central learning unit, which supported the university's 12 bachelor study programs. Each bachelor study program was given the liberty and the responsibility to design and implement its own folder structure. To this end, the study board established a developer group. The task of this group was to design for the various user groups a new folder structure that would facilitate design teaching and materials, well as to find an appropriate solution for the organizational memory problem, that is, how to store each year's activities on the e-learning site. A number of meetings were held in order to design the work. My focus in the analysis was on the relation between work analysis and design artifacts, and interaction design and design artifacts.

Outline of Methods

Regarding sampling in this study, the rationale for choosing a single case is that the change process from an old e-learning system to a new one in a large university presents a unique opportunity to study the mediating role of design artifacts, such as sketches, within a large, complex organization. Although other organizations, such as commercial enterprises, could have been relevant, I would have had difficulties in obtaining the same kind of access to people and reasoning processes that I could in a public university. Moreover, the case could meet the aim of developing a theoretical base for HWID to address the challenges of HCI in a world where it is more usual to reconfigure and redesign an existing system rather than to develop a totally new system. Migrating to a new e-learning system in a large university happens every day around the globe, and this kind of system change is critical for the development of higher education. Hence I will be able to claim that the developed theory has some face validity. Finally, this case presents a challenge for grounded theory analysis. Compared to a classic qualitative research interview study with a few subjects that basically have the same perspective of the issues studied, this study is methodologically different. This case contains diverse sources, such as e-mails and screen dumps, and involves a large number of people performing various roles.

The context of the case was the decision made by the university's management that the study board was to replace their program's in-house developed course administration system with the university's standard course administration system. From this followed the need to design the folder structure of the new system in a way that accommodated or, in some cases, changed the course administration process familiar to the users. Thus, the researcher–situation interface was optimal because the organization's management (the system owner) supported it.

Materials

I collected archival data, such as background reports, and (concurrent) exchanges of e-mail. Furthermore, I took notes from meetings, recorded videos of usability test situations, and assembled design artifacts used by the development group. The material was in Danish. Although the analysis involved all of the materials, this paper presents sections of the material that were transcribed and translated into English. All data were stored in paper form as well as scanned and

prepared for digital qualitative analysis by making the items primary documents (a proprietary name for the kind of documents or data sources that my qualitative data analysis software could use). This data collection and data management approach was chosen over, for instance, qualitative interviews or diary studies because I was involved personally in creating the change that was studied. Thus this research can be understood—but was not declared as such from the start—as action research, a method in which the researcher plays a double role, that of change agent and researcher of the change process. In this double role, then, I attempted to facilitate and attain the large-scale change in CBS's technology usage as well as theoretical generalization.

Participants

The participants in this study comprised the developer group, drawn from the system's expected users. The users of the system were initially identified as IT and e-learning experts from the university's central learning unit (learning lab), students, administrative staff, and teachers. Since the bachelor study program was a computer science program, all users possessed basic IT skills.

The teachers as a group (50 teachers) included both staff faculty and external lecturers, with diversity in age (25–65) and near equal distribution of males and females. Although most teachers at that time had been teaching for several years, some (e.g., PhD students) had taught only one or two courses. The administrative staff (5, 30–55, 80% female) comprised skilled office workers, employed to fit into the university's administration, and hence with a working overview of the administration. The students (300) were mostly male (80%) and aged in their early 20s. While some students possessed computer and design skills comparable to or better than the other user groups, they lacked or were seen to lack an understanding of the university's organization and purpose. In contrast, the IT and e-learning experts from the learning unit (5; 28–55, 60% male) were administrative staff with an academic background and a special interest in e-learning. They were employed with the specific purpose of promoting the university's use of e-learning, and hence were considered experts with special access to both the university's policies and technologies and pedagogy for e-learning.

The study board recruited participants for the developer group from these user groups. There criteria for the recruitment were that a participant should be interested in the new system and that all user groups should be represented. Consequently, the developer group consisted of 11 individuals: four students, three administrators, two teachers with coordinator responsibilities, one IT and e-learning expert, and a chairperson (myself). This group was reasonably representative for all users of the new system with regard to age and gender, except that the group (as intended) consisted of individuals with a larger than average interest in the system. The group dynamics in this developer group resulted perhaps in even more eagerly expressed viewpoints than were necessary or usual in comparable kinds of system design. Therefore, the data were abundant.

Data Analysis

For the analytic framework, I used the general HWID framework presented in Figure 1, but I focused only on the part that concerns the relation between work analysis and interaction design. Three elements of the relations from the general HWID framework generated the primary interest: work activities and tasks, decisions and processes, and collaborations. The rationale for the analysis strategy was that these three relations were very detailed in the framework.

Therefore, I used the general HWID framework as an initial source of inspiration for conducting a grounded theory analysis.

Three substeps in the grounded theory analysis were performed as open, axial, and selective coding (Strauss & Corbin, 1998). I collected a total of 133 distinct data sources (texts, scanned documents and notes, videos, audios), of which I used 105 in this analysis (the remaining 28 sources were either not of interest or redundant data). The first substep in the postcase analysis had, in fact, begun already during the case, and it consisted of identifying and naming the concepts of interest to the investigation (open coding). I found concepts of interest through an iterative process using an emerging list of codes, and by listening to and looking for related segments in the data that seemed to concern the concept(s). In this way, the relevant data sources were segmented into meaningful units, and the segments were coded into categories that again were refined during the analysis by revisiting the segments of the data sources. The segments were mostly on the section or paragraph level, and the total number of segments for the 105 data sources was 151, giving an average of a little more than one segment per data source. This reflected that many of the data sources were one meaningful unit, for example, an e-mail, and should not be divided into several segments in the way that interview documents often are. In the analysis I focused on the work analysis and interaction design processes, and the different design artifacts. These were coded into 13 main categories that on average were grounded in 12 data segments.

The next substep was the categorization of related phenomena (axial coding). Here I looked for relations between categories and the consequences thereof. In this substep, I visually inspected networks consisting of the 13 coded (and all associated) segments, then did co-occurrence searches of those codes (categories) that shared at least one segment and, based on the segments, named the relation. The final substep in the analysis involved looking for a common theme for all of the categories, to find a core category (selective coding) and its relations to other categories, and perhaps refine and develop these. The main category in the analysis was Design Artifacts. Because this category was in a sense given beforehand, I will focus the presentation of results on the relation between the subcategories of design artifacts, for example, design sketches and prototypes, and how these relate to the subcategories of work analysis and interaction design. The results are presented below in the Findings section.

My presentation of transcript excerpts and analysis is governed by three rules in line with Dahler-Larsen (2008): authenticity (display data in their original form to force the reader to diagnose on the basis of the original situation), inclusion (displays not just examples, but rather the data set itself), and transparency (displays are explained, axes and dimensions made clear to the reader, and data sorting should be intuitive and easy to understand). Moreover, the presentation of the analysis involves using a network model: introducing the key concept design artifact, then the major subconcepts of work analysis and interaction design with their corresponding codes, and then the types of relations that connect these together. Figure 3 illustrates this process: The figure shows a number of codes presented within text boxes and their various relations. A relation is indicated by co-occurring quotations (i.e., two quotations embedded in, enclosing, overlapping, following, or preceding) that thus connect two codes. In the following text, each type of relation is illustrated with one or more quotations. Although the aim was to show every related quotation, I removed similar (i.e., redundant) quotations for the sake of clarity. Two numbers refer the quotation to its data source: The first number specifies the data source, and the second number indicates the quotation number from within the data source (see the Appendix for the list of data sources).

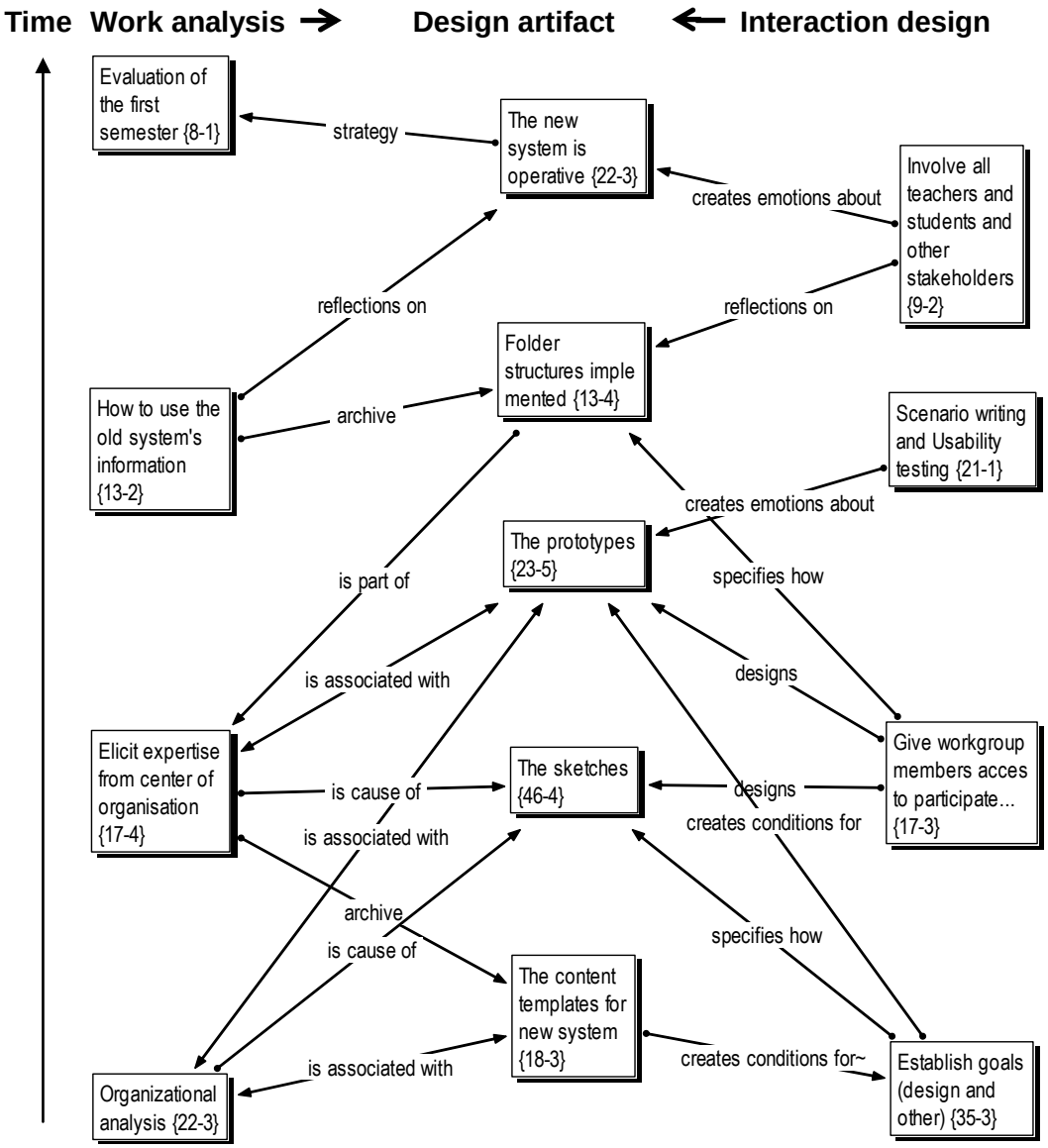

Figure 3. The model of HWID in this study of a case of designing a simple folder structure for a study program. The numbers after the text in the boxes indicate, first, the total number of related quotations arising from the 105 source documents (note that since each quotation can be related to more than one code, adding up the numbers in the boxes does not give the total number of 151 quotes), followed by the number of relations that element has to the other elements in the figure documents.

With respect to the confirmability of the analysis, I used time away from the data as a means of confirming the quality of the coding process. After a significant period of not reviewing the data, I returned to the original data and repeated anew (i.e., without preconceived categories or approaches to the data) a thorough coding process. The first and second coding did have some significant differences. For example, the focus of the first coding process, as reported in Clemmensen et al. (2006), was strictly on the relation between the work analysis and the design sketches. However, the focus of the second analysis, reported here, was broadened and included the relation between the work analysis, the

interaction design, and the various design artifacts. I believe this analysis process, particularly what is observed in the data through iterative coding processes, reflects a sound development typical of qualitative analysis. Furthermore, versions of the coded and clean data sources are available as software project files that can be imported into software packages for qualitative data analysis, which allows other researchers to inspect my categorization and interpretation.

Regarding the credibility of the findings, my part of the analysis involved presenting my intermediate interpretations of the process and the case to the developer group, which comprised a variety of stakeholders from the organization. Their comments on the interpretations were part of the material subjected to grounded theory analysis, as presented below. Furthermore, an early version of this paper was presented to researchers who were not part of the developer group from the organization. On the basis of their personal insights about the organization, general comments, and suggestions for improvement of the analysis, I subsequently modified the paper. Finally, I sought disconfirmatory evidence or alternative explanations for the results by sampling an as-broad-as-possible variety of data sources.

FINDINGS

In this section I present the findings and focus on the relation between work analysis and design artifacts, and between design artifacts and interaction design techniques. The case-specific model of HWID is presented in Figure 3. The figure builds on a total of 151 quotations that were drawn from 105 primary or source documents. In this section, I explain the HWID depicted in the figure by explaining each type of relation.

Reflective Relations between Work Analysis, Design Artifacts and Interaction Design

The first common relation in the presented HWID framework involves Reflection ("reflections on" in Figure 3). In the analysis, I found that reflective relations connected both work analysis and interaction designs to design artifacts.

"Reflections on" Work Analysis and Artifacts

Reflective relations were expressed in eight quotations that concerned both how it was before to use the old system and the fact that the new system was now in operation. These reflections concerned acknowledging and renegotiating social relations within the system.

The first kind of reflective relation between work analysis and artifacts was reflection as acknowledging existing social facts. The relation between the old system's information and the new system being in operation was a reflection on what text should be shown in the old system link and in this way acknowledging who would get access to the information.

> *...the text below should be displayed when you link to* [the old system]*. Notice that contact information by intention is held in a cryptic language...people with bond to the study already know how to call our IT support.* (11:1)

The relation between the old system, which was a one-way information distributing system, and the new system, which was perceived as a two-way interactive system, was made in a careful way. The system owner (the organization's management, in this case the head of the study board) was oriented towards the hard, social facts: That (most of) those who wanted to access the old site already knew how to contact the technical staff, who could give access. In this way, he acknowledged the social fact that some people were already members of the organization (in this case the users of the system), and had some relevant knowledge.

The second kind of reflective relation between work analysis and artifacts was reflection as reopening discussion about who were the stakeholders in the transformation from the old to the new system. This was not only about acknowledging existing social facts, but also about renegotiating them. It was a reflection on how transferring data from the old system to the new one was a complex process that needed social interaction and discussion to be able to function.

> *…we do of course also need to know what the developer group and the study board decide…we need a meeting with the involved…we are responsible for the operation of* [the new system] *and the transfer of data from* [the old system]. (58:1**)**
>
> *I would like to have the project manager at the meeting…he is the one who knows about the details about data transfer, et*c. (60:1)

This reflection reopened the discussion about who actually were the stakeholders in the relation between the old and the new system when the new system was operating. The completeness of the new system in contrast to the old systems stemmed from the fact that it was the new system that was in operation. Work analysis of the old system's information had to be reflected in the new system design.

The third kind of reflective relation between work analysis and artifacts was reflection in the form of the stakeholder-specific identification of the discrepancy between the old and the new system. The discrepancy between the old and new system was seen differently from different stakeholder perspectives: the researcher, the system owner, and the programmer. The researcher focused on theory and data:

> *...and when it comes to those who dismiss sociotechnical theory as an obsolete theory, I can just say that they have* [a wrong approach to research].... (66:1)
>
> *... in the given situation, we absolutely need to ask some students to do the first data collection….* (68:1)

In the above quotation, the researcher's comment on the importance of sociotechnical theory was a part of an argument for investigating the new–old discrepancy by collecting data, preferably by those who the researcher perceived as being directly involved and available for doing the data collection: the students. In contrast to the researcher's perspective, the system owner perceived the reflections on the discrepancy between the old and new system as directed towards administrative, organizational, and commercial concerns:

> *..the* [organization's] *visions about personalization and centralization of data and all other dreams that do not match* [the organization's] *technical or organizational reality, I have some new ideas about going from the old to the new....the* [old system] *was in many ways a closed system that made us introverted and not attentive enough to outsiders' needs...it was also completely embedded in all of the administrative, teacher, and student routine.* (67:1)

From the system owner's point of view, what was worth reflecting upon was not (only) how to understand the relation between the new system and the old one, but also how this discrepancy was embedded in the larger organizational context. Obviously, when seen from the system owner's perspective, the work analysis should have encompassed a wider perspective. In strong contrast to the system owner's perspective, the programmer viewed the reflection on the discrepancy as purely a technical thing that concerned storage, retrieval, development, and costs of information processing:

> *…our programmer wants to check if he needs to go back to the cd to make another data retrieval, because he cannot remember if he transferred all data to the cd…pls check if the study secretary has all minutes of meetings, otherwise we can transfer these for a cost…and we will do whatever we can to announce, on the old system, your close down message.* (61:1)

From the programmer's point of view, the discrepancy between the old and new system was best dealt with by a checklist-style reflection. Summing up, the reflective relation between work analysis and design artifacts should include acknowledgement of existing social facts, renegotiation of who the stakeholders are and their roles, and detailing of stakeholder-specific work and job analysis. For example, the programmer's perspective could be better supported by a functional job analysis approach to work analysis.

"Reflections on" Artifacts and Interaction Design

On the other side of the HWID framework, reflections about the design artifacts and interaction design occurred. Two quotations showed reflections on how to involve all of the teachers, students, and other stakeholders in the discussion of the implemented folder structures. From the interaction design perspective, everybody seemed to agree that several stakeholder groups should be involved in commenting on how the artifact (the folder structure) worked and looked.

> *…I think that we should make sure that the teachers will know about the plans…I've started getting questions* [from the teachers]. (69:1)
>
> *… if you would be interested in participating in meetings…where we want your input and comments to how* [the new system's folder structure] *works and is designed* (75:1)

The system owner and the administrative staff reflected on which representatives of which other key stakeholder groups to involve in the plans for the system and in particular the new interaction design, that is, how to involve them in the discussion of the folder structure.

To sum up the analysis of the Reflections On relation, there were two kinds of reflections that connected work analysis and interaction design through the artifact. From the work analysis side that involved cutting the link between the old and new systems, reflections addressed what the existing social facts were, who the stakeholders were, and how the discrepancies between the old and new system looked from all the different stakeholders' perspectives. From the interaction design side, the reflections were focused on how to get the stakeholders' view of the implemented folder structure.

Work Analysis and Interaction Design "Is Part Of" Developing Design Artifacts

The second type of relation that was common across the HWID framework was "is part of." This relation connected work analysis with design artifacts, and also interaction design with design artifacts.

Work Analysis "Is Part Of" Developing the Design Artifact

From the work analysis perspective, there was a relation that was expressed in two quotations, one regarding eliciting expertise from the core of the organization and the other regarding the implemented folder structure. The design artifact in question, the implemented folder structure, was part of the work analysis in the sense that the implemented folder structure was a key component of the expertise elicited from the organization. The design of the folder structure prototypes called for programming and IT environmental expertise.

> *...pls ensure* [at the meeting] *that there is a mouse available, as there are really many clicks in* [the new system]*...tomorrow I will configure the new zone and give everybody access.* (64:1)

Eliciting expertise in IT and e-learning from the university's central learning unit, was also part of how the folder structures were implemented in the organization.

> *... how to use Sitescape in teaching - presentation of some ideas: 1) lecturing, 2) class teaching/preparation, 3) team assignment/project.* (117:1)

Thus, from a work analysis perspective, having available programming and IT expertise on how to use the system was a part of the implemented folder structure in the organization.

Interaction Design "Is Part Of" Developing the Design Artifact

From the interaction design perspective, 14 quotations demonstrated that scenario writing and usability testing were part of sketching the new system's folder structure. Some type of implicit scenario writing was part of sketching, such as in this quotation where the administrative staff's sketch of the folder structure is discussed (prior to the arrival of experts from the university's central learning unit):

> *...here is an overview of what we agreed to* [about the folder structure] *at today's meeting…. I do not want to present it at the next meeting, because I have no clue about the structure of the study.* (15:2)

Making implicit the possible scenarios was also part of relating to the IT and e-learning experts' sketches.

> *... it has no relevance to developing a whole new proposal for a zone construction* [the folder structure], *I rather think it pays to look at this cand.merc.-zone* [a competing study program's folder structure] *... then it must be up to those who make the final solution to take into account all requirements….* (128:1)

The student-stakeholder group had been taught a unified modeling language, and they applied use cases as part of their sketching. They created two use case scenarios for the new folder structures:

Use case: Find teaching material
1) *Find year*
2) *Find course*
3) *Find module*
4) *Find teaching plan*
5) *Find teaching session*

Use case: Share knowledge with study group
1) *Establish group*
2) *Find group members*
3) *Give access rights*
4) *Agree on rules for cooperation*
5) *Make folder structure for the group*
6) *Upload documents* (77:1)

In the group discussions, the students also sketched out graphically and by annotation how they saw the new folder structure. One such sketch is shown in Figure 4.

The teachers' sketching of the new folder structure encompassed scenario writing that was expressed in annotated sketches (see Figure 5), and later tested in usability testing. The teachers came up with "daily use," "teaching several studies," and "teacher discussions without students" as relevant scenarios.

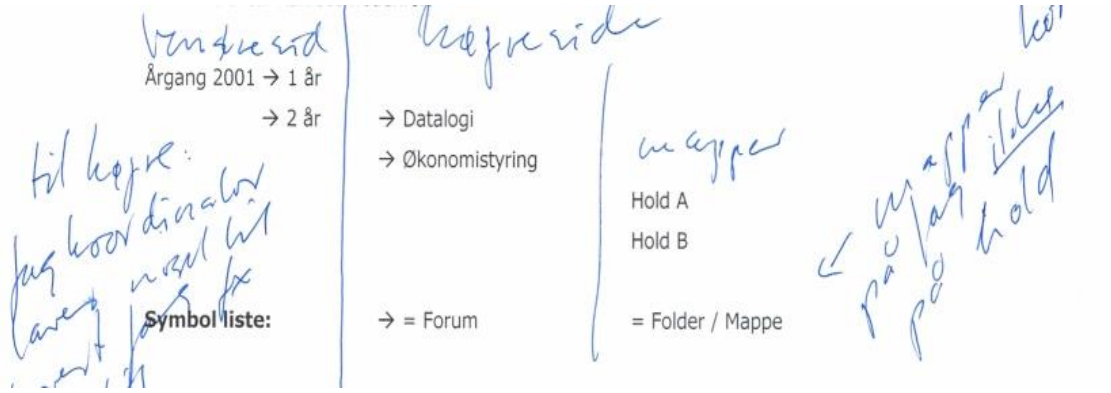

Figure 4. The students' sketch. The typed text is the students' suggestions for a hierarchy in the folder structure, with the top level at the left side and bottom level at the right. The handwritten comments (the author's) are from the discussion when the students explained their sketch to the developer group.

1) For daily teacher use there is only a need for two levels of structure because there are so few courses

2) The teachers want the folder structure as simple as possible due to their heavy workload, often distributed across several studies

3) An additional forum for "teachers only" should be added to the structure (141:1)

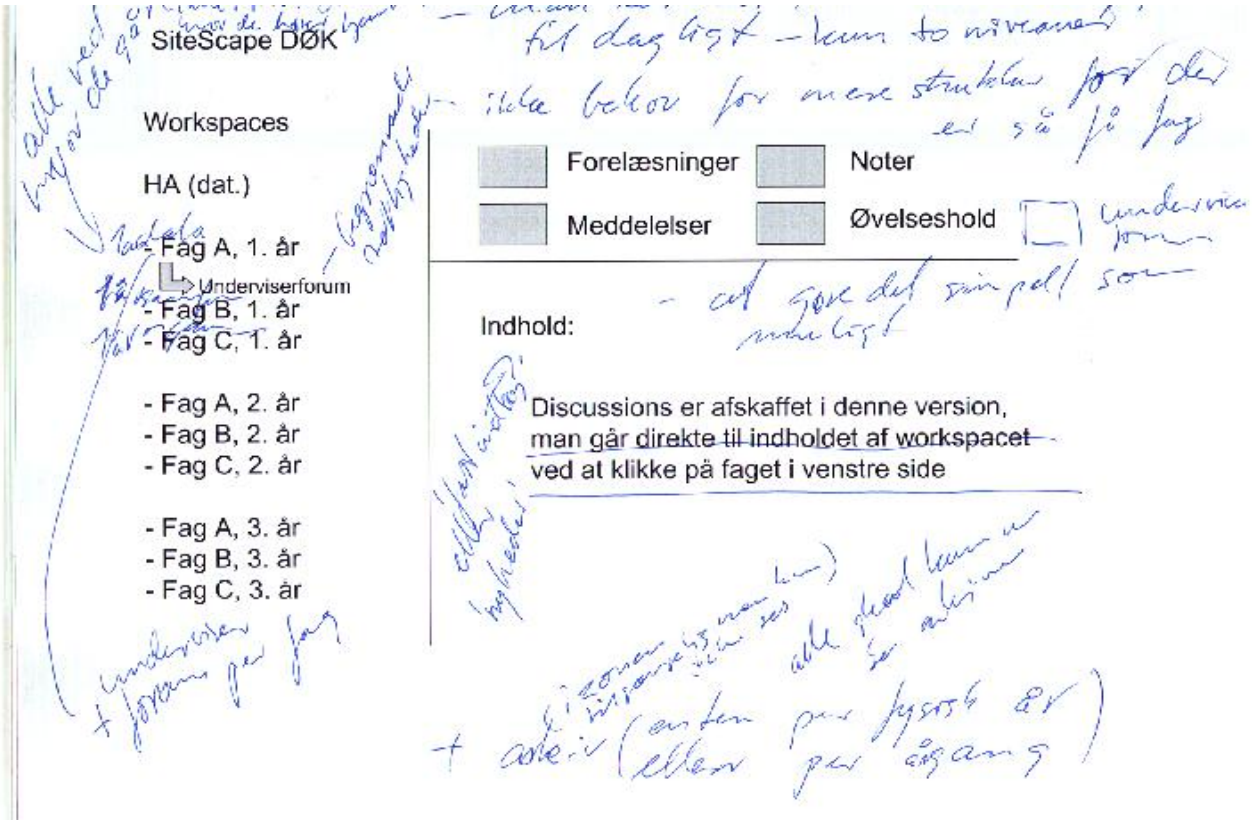

Figure 5. The teachers' sketch**.** The typed text is the teachers' suggestions for a hierarchy in the folder structure, with the top level at the left side and bottom level at the right. The handwritten comments (the author's) are from the discussion when the teachers explained their sketch to the developer group.

Summing up, the relation Is Part Of indicated that a great deal of expertise in how to use the new system was a part of the activity of sketching the new folder structure. However, difference in what kind of expertise was present was also apparent. From the work analysis perspective, the expertise was in IT and programming of e-Learning systems, reflecting primarily the presence of the university's central learning unit. From the interaction design perspective, the scenarios were built on staff's, students', and teachers' experiences from using the old system, and reflected in their idea sketches for the new folder structure.

The "Archive" Relation between Work Analysis and Design Artifacts

Not all relations in the studied HWID case were symmetrical. Figure 3 illustrates that considering how to archive data was only relevant for the work analysis side, although considering how to archive data also should be, in an ideal case of designing a folder structure, a matter of interaction design. At a relatively late point in time of the life of the developer group, a new stakeholder group was introduced: The central IT support unit of the university. This group consisted of more than 40 IT supporters and developers who delivered technical programming expertise to all departments in the organization. The manager (IT manager) and a

programmer from this group became involved to help the developer group and the system owner to decide where and how to archive the data from the old system. Two quotations—one each from the programmer and the IT manager—shed light on the "archive" relation between the work analysis (how to use the old system information) and the artifact (the implemented folder structure):

> *…There are some issues that we need to clarify. The division in* [the old system] *is also used in* [the new system]. *Every folder in* [the old system] *becomes a "workspace" in* [the new system]. *News etc. will not be transferred to the archive, only data and documents etc…. There will be no access control on workspaces. All workspaces will have same rights* [to access] *…registered users can read, administrators can read and write….* (31:1)

From the programmer's point of view, the old system's information structure should be applied directly to the new folder structure. This work analysis was perhaps too simple, and resulted in the old system's archival data being the topmost and hence the first thing seen in the new folder structure. During an e-mail conversation with the programmer, the IT manager gave her opinion on how things should be, and how this would be experienced by the users:

> *…Let us talk about structure when we know who are going to do the other stuff…but I will suggest that we call it archive from* [old system name]. *Then it will be on top* [due to the "a" in archive] *and under it the new folders will come… where there are several folders, the newest year will be at the bottom of the list due to the number… I think that will give a sufficient overview.* (83:1)

The IT manager and the programmer in the two quotations above produced a new kind of work analysis with focus on the use of archival data from the old system. This work analysis suggested that how to archive data was somehow related to the implemented folder structure. However, both the IT manager and the programmer expressed a strong bias towards their own analysis of the work, and they did not consider the already implemented folder structure as something essential to adhere to in their design of the archive. Instead they invented their own, new version of the folder structure, based on the structure in the old system. This illustrates how, even late in the design, a new work analysis may enter the design process, as in this case when a stakeholder group emerges more strongly (in this case the technical group of the IT manager and the programmer). This new work analysis may relate to the design artifact in ways that exert considerable pressure for rethinking the design sketches and prototypes.

Furthermore, when eliciting expertise from the central administration of the organization as part of the work analysis, it turned out that considerations about how to archive data (made by experts from the central IT support unit) were part of the organization wide content templates for new folders in the e-learning system (made by IT and e-leaning experts from the central learning unit). The history of using similar folder structures in the organization was indicated by the experts' work analysis and expressed in the content templates. This analysis was very convincing to the administrative staff:

> *…it became clear during the meeting that the ideas that we had at our teacher meeting will not work in any way in the new system. It will be a waste of time to suggest a folder structure that is not optimal, if you ask those who have worked with the system for many years…. I am 100% convinced that* [the teachers' suggestion] *will not be the final design….* (74:1)

Early in the design process, the administrative staff accepted the perspectives of the IT and e-learning experts. The work analysis completed by the experts showed that the content template design for the folder would benefit the administration.

> *...It has been shown to make the administration less vulnerable... sickness, leave, change of personnel often are the cause of a knowledge loss* [that] *it takes years to overcome… this damages the study's administration and reputation among teachers and students…with a detailed and centralized documentation* [as in the new system]*, the administration will stand stronger in the ability to deal with students and teachers….* (96:1)
>
> *…The structure. In the upper-level discussions for general information, news, teacher forum, administrative forum, study board, etc. Courses listed as workspaces with numbers. At second level, relevant discussions are listed with indication of the year….* (97:1)

The work analysis performed by the experts gave an optimistic view of the content template provided by the experts, as illustrated in the quotations above, and promised several benefits for the administration. Similarly, the content template was presented as a finished solution, with no analysis of how the messy reality of organizational practices had changed the content template in real-life situations.

In summarizing the Archival relation, the case analysis indicated that this relation appeared only on the work analysis side, not on the interaction design side. How to archive data was an issue significant to the central IT unit's and central learning unit's experts, and one about which no other stakeholders had much to say, and thus the experts' view significantly influenced the final artifact. This illustrates that some kind of symmetry in the relation between work analysis and the design artifact, on one side, and the design artifact and interaction design, on the other, should be attempted in HWID.

Work Analysis Focus on "Strategy" in Relation to the Design Artifact

Strategy, in the form of evaluation, was the focus of the work analysis following the first semester that the new system was in operation. When the system was put into operation, it became apparent that a strategy for using the system was needed, something that was not addressed earlier in the process. The next quotations, which occurred between the evaluation of the first semester and the new system becoming operational, resulted from questions about what the old strategy had been and what would be the new strategy for using the system. Work analysis showed that the two systems had different strategies for folder structures:

> ...[the new system] *has inherited a deep folder structure from* [the old system]*. Other studies at the organization apply a flat folder structure which is more user friendly and makes archiving data more easy. Should we change* [the new system]*'s folder structure from the deep to a flat structure*? (18:1)

In this citation, three designs are compared: the old, the new, and other designs of the new system already in operation within the organization. When the new system was put in operation, the previously unaddressed discrepancy between the (old) system, as well as other comparable systems in the organization, became explicit. The obvious action was to ask for development or presentation of a strategy, as illustrated in the following citation.

> *...perhaps it would be a good idea to present the study's strategy for e-learning, if there is such a strategy….* (19:1)

The developer group manager thus asked for a strategy, even while expressing doubt about the existence of such a strategy. Given the late stage of the design process, this doubt was surprising. As it turned out, doubt about the strategy reflected a problem not only for the developer group, but demonstrated as well a general lack of clarity in the work organization. This is illustrated in the following quotation, where the project manager explicitly calls for clarification regarding the different systems within the organization.

> ...[there is a] *need for clarification of the division of tasks in* [the new system] *between study management, study boards and department!* (24:1)

Apparently the environment for the new system was not analyzed prior to the existence of the new system. However, individual users did not have major doubts about the strategy. The following citation illustrates how a teacher felt satisfied with the use of the new system.

> *...I cannot come to the meeting on Thursday, but I have been fully satisfied with* [the new system] - *which I basically only have used to publish documents.* (49:1)

Hence, when the new system was put into operation, it became clear that the work analysis was inadequate on an organizational level, and also in relation to the larger environment of the system. Furthermore, there was no strategy relation between the interaction design and the artifact. Thus it was never clear in the old system what kind of interaction users were expected to have with the system. As the above quotation illustrates, the new system revealed that some teachers may not have held similar expectations as other stakeholders, and thus were satisfied to use the new e-learning system as a simple publishing system. To sum up, the Strategy relation was asymmetrical in its focus on the work situation. In this case, no strategy had been prepared for how users were going to interact with the system. Ideally, however, work analysis and interaction design should both have a strategy relation with the new system.

Work Analysis "Is Associated With" the Design Artifact

The relation Is Associated With was, similar to the Strategy relation, asymmetrical in the sense that it was only present from the work analysis perspective and not from the interaction design perspective. The participants expressed their thoughts about both the prototypes and how to elicit expertise from the IT and e-learning experts, as reflected in the next nine quotations. The elicitation of expertise was associated with the prototypes by presentations, instructions, discussions, questions, and physical handling of the prototypes.

Something to Present

> *...otherwise I can present it….* (52:1)

Something to Be Instructed in

> *...I hereby confirm our agreement about the instruction in* [the new system].... (62:1)

Something to Discuss with and Learn from Experts

Once again thanks for a constructive meeting [on prototypes of e-learning systems], *which gave us several new perspectives on our project.* (70:1)

Something to Discuss with and Learn from Students, Teachers, and Administrators

If you want to have a look at [the new system] *already now, type www.e-cbs.dk and click on cand.merc.dat, but beware, it is rather empty right now.... We cannot, however, just jump from* [the old system] *to* [the new system] *without a bit of preparation from the perspective of the students, teachers, coordinators and administrators. Therefore, the study board will prepare templates for all courses and invite you to a meeting about the use of* [the new system] *as a pedagogical tool in your teaching.* (5:1)

Something to Ask Questions about

Is there a smart way to create the same set of questions on several forums? (76:1)

Something to Handle Physically:

Make sure that a mouse is with the laptop, as there are many clicks in [the new system] (84:1)

Something to Experiment with

You have all administrator rights and may virtually play with everything ... so you can for yourself experiment with design, graphics and functionality. (73:1)

The last quote was one of two quotations in which participants expressed associations between eliciting expertise and the content templates. Thus, eliciting expertise was the first set of ways in which work analysis was associated with the prototypes of the new system and with the content templates. The second set of associations was expressed in quotations about the relation between the content templates and work analysis, and concerned who owned the design artifacts.

Something Related to Different Stakeholder Groups and Work Tasks in the Organization

Following factors:-"student view," -external teachers and coordinators' perception of existing Folder Structures -need for teacher dialogue across class and years -special folder structures, such as integration task, didactic forum, etc. (56:1)

Something Owned by Someone In/Outside the Organization

It must be said that it was pretty obvious that it probably will be me who will stand for it here; I will just have to discuss it with my boss…. therefore suddenly my strong involvement :-) (74:1)

In this quotation, a member of the administrative staff expressed sudden interest in the process because she felt that she was being forced by her boss to take ownership of the prototype. All in all, the relation Is Associated With between work analysis and design artifacts concerned eliciting expertise in a broad sense, as well as concerned the ownership of the artifacts.

Work Analysis "Is Cause Of" the Design Artifact

Work analysis was the "cause of" the sketches in two ways: the elicitation of expertise and the organizational analysis. The causal relation between the elicitation of expertise and the sketches was expressed in the following three quotations. The experts had ideas about how sketches should look, and how the organization would react to the design artifact.

> *...some of the themes in the article would be appropriate to discuss with the students if we are talking about more than just structuring of the content.* (78:1)
>
> *I have tried to give a picture of a group of young university students' feelings for digital aesthetics.* (134:1)

The elicitation of expertise was a cause of sketches to the degree that the experts' designs were seen as versions to choose between (and not as, e.g., opportunities for dialog).

> *Finally, I just confirm that the study board has today decided to go with version 3.* (84:1)

The second relation, the organizational analysis as a cause to have sketches of the new folder structure, came in several versions.

Organizations' E-learning Strategy

> *...Speaking of the talk about e-learning ... Do you know about this site with text and background papers for the CBS e-learning strategy?* (14:1)

Students' Organizational Analysis

> *This is a "rar" file with all documents regarding* [the old system] *that Sebastian and his group have written....* (45:1)
>
> *Management Report* [the old system]*. The next step. Figure 6.1: explanation of the rich picture (shows* [the old system] *as embedded in the organization).* (100:1)
>
> *It is too hard to figure out how things hang together behind the curtain, and no efforts are made* [by the study program's management] *to recruit the study program's many experts to help. Information systems exist only in the shared consciousness of the involved. The Front for* [the old system]*'s improvement (FFDF) is an organization formed to facilitate students' at* [the organization's] *lives by improving their intranets called* [the old system] *.... FFDFs ultimate goal is to take over the operation of* [the old system]*. To give power over the system to a group of students that engage in how their study's communication and information platform looks and works....* (142:1)

Organizational Leaders Organizational Analysis

> *...I frequently find it useful to be able to go back and see what actually happened at this or that course in the past.* (46:1)

Administrators' Organizational Analysis

> *...the structure used in MSc.'s new zone may eventually also be used on our study...* (57:1)

System Developers' Organizational Analysis

> *…each working group (students, administrators, teachers) will submit a proposal for a folder structure of* [the new system]. (144:1)

Summing up, the organizational and work analysis from the IT and e-learning experts' point of view was not the only influence on the sketching. Indeed, a number of other stakeholders' perspectives included in the organizational and work analysis directly influenced the sketching of the new folder structure.

Interaction Design "Creates Emotions About" Design Artifacts

A number of relations occurred only from an interaction design perspective and were thus asymmetrical. One of these relations was Creates Emotions About. The interaction design techniques evoked emotions in the participants about the design artifacts. Six quotations (two presented here) illustrated how the relation between the fact that the new system was in operation and the wish to involve all teachers and students and other stakeholders was about the creation of emotion.

> *REMINDER:* [THE OLD SYSTEM] *IS DEAD! - Invitation to a meeting on* [the new system]. (72:1**)**

In this quotation the project manager declared the old system dead, as if it had been a living entity. The user involvement that was a central feature of the interaction design created emotions around the old and the new systems. Furthermore, the prototypes were objects of emotion, since scenario writing and usability testing were emotionally engaging for the involved stakeholders. This involved also one of the IT and e-learning experts, who clearly was happy to participate in on-site user testing with students, teachers and administrators:

> *I'm on!*. (54:1)

Although this emotion-creating capability does not appear in Figure 3 to have been part of the work analysis, there were indeed indications that the emotions surrounding the software were important parts of the work. For example, the logo of the old system was a picture of a scuba diver because the system acronym was DIVE. People in the organization felt so strongly about the logo that it was kept for the new system. Another example was the strong dissatisfaction with the old system, and a wish to be involved with the design of the new system, which motivated the student members of the developer group, as obvious from the existence of a special student organization with the sole purpose of improving the e-learning system.

Interaction Design "Specifies How" Design Artifacts Should Be

The relation Specifies How was an asymmetrical relation present only in the interaction design perspective. When, as part of the interaction design, the IT manager wanted to give the developer group's members access to participate, she did this by specifying how the folder structures were implemented.

> *The Admin area now has a description of the procedure, from the moment when information about the student is being typed into* [an administrative system]*, and until he*

or she [the student] *has access to* [the new system] *(if these access rights are set correctly there).* (20:1)

In this quotation, the IT manager explained the procedure for giving members access to the implemented folder structures. Similarly, the establishment of design goals as a step forward in the interaction design was done by specifying how the sketching would proceed. This relation was expressed in 12 quotations, a few of which are provided here:

Assignments Given

...Deliberations of the committee must culminate in a report to the study board that contains one or more proposals for templates for structuring [the new system] *for different user groups: secretarial, teacher, student, coordinators.* (1:1)

User Identities Constructed

...Christian comes to the meeting and presents the students' case. (7:1)

I would in fact like that she becomes the person at the department who knows [the new system and] *who can give access rights to people and show them how it works (if it then becomes necessary).* (30:1**)**

Did not answer your mail yesterday. I [administrator] *will attend the meeting on…"* (35:1)

It sounds really exciting. Thanks for the offer! I [expert in the use of such systems] *am eager to help.* (80:1)

I am about to create a discussion forum at [the new system], *where we can share* [the old system] *information in the project. In this connection, I need your official mail addresses so I can create you and give you access.* (81:1)

It is clear, then, that the Specifies How relation was asymmetrical from the interaction design side. It explained procedures, gave assignments, and constructed user identities.

Interaction Design "Designs" Artifacts

The Design relation connected interaction design with the artifacts to be designed. While interaction design and artifact design may be perceived by some as synonymous concepts, I argue that artifact design always involves more perspectives than interaction design does, so it makes sense, at least analytically, to talk about a relation between the two development streams. The following two quotations illustrates the "design" relation between the prototypes (a design artifact) and the wish to give the developer group members access to participate (an interaction design technique).

Establish a Place to Share Sketches and Other Design Artifacts

See figure 6. (121:1).

This quotation is a visual quotation (see Figure 6) that shows members of the developer group and their access rights in the system. Giving members of the developer group access to a place in the new system formed their view of what the system could look like.

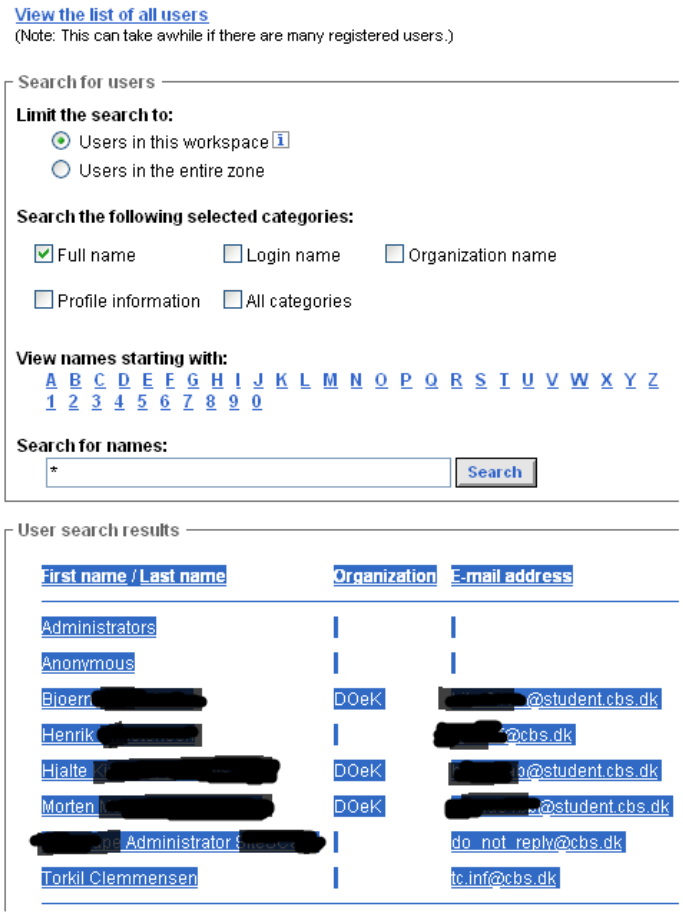

Figure 6. Screen dump of members of the developer group and their access rights in the system.

Establish a Way to Read and Critique Design Artifacts within the Group

> *Prototypes high fidelity; "hierarchical folder structure"; "flat folder structure" – "flat-hierarchical combined"; "Reading the prototypes -group discussion of plus and minus for each prototype."* (139:16)

Similarly, there was one quotation in which a member of the administrative staff expressed the design relation between the sketches and a wish to give developer group members access to participate.

Establish the Importance and Status of Sketches

> *...then it must be left to the people who are responsible for the final version* [of the folder structure]*, they must include all our requirements in the final versions. This is merely my opinion, but since I am only on the sideline, I would not take a strong position on anything, we may figure this out on* [our meeting] *Wednesday.* (57:2)

To sum up, the Design relation established a place and method to share and create sketches. It also addressed the motivation to sketch the new folder structure.

Interaction Design "Creates Conditions For" Design Artifacts

The relation Creates Conditions For was a symmetrical relation only from the interaction design perspective. It reflected how the establishment of design goals created conditions for the content templates for the new system. One quotation illustrated how a participant's creation of a standard folder structure for file sharing and discussion in the system created specific conditions for the developer groups' discussions and design of sketches and prototypes.

> *...I have now created a team workspace for committee members* [the developer group] *and presented a little information material….* (92:1)

In 11 quotations, the participants expressed how the establishment of design goals created conditions for making content templates relevant for the new system. Here are four representative quotations:

Demanding

> *... in consultation with the deans, who decided on the platform,* [the new system] *is now the obligatory platform for all courses and all students at CBS.... There is now much knowledge about* [the new system]*, a knowledge which you can draw on when the platform shall be designed and implemented. I suggest that you contact the IT department and Learning Lab for further discussion on how this can be done….* (3:1)

Demoing

> *I can show you some other study's zones, etc….* (13:1)

Preparing

> *You are invited to join a committee of the DØK Study Board to prepare the transition from* [the old system] *to* [the new system]*.* (17:1)

Requiring solutions

> *Goals for the committee's work:* [the old system] *shuts down in mid-September. All re-exams will be run in* [the old system]*.* (21:1)

All in all, the relation Creates Conditions For connected the establishment of design goals with the design artifacts by applying standard designs, demanding that a process of system development be started, demonstrating other systems as conditions for the new system, preparing for the change from one system to another, and requiring solutions for new systems within a given time frame. In an overall summary of the analysis of the case, I found a variety of relations between work analysis and design artifacts, and between interaction design and design artifacts, as shown in Table 1.

Table 1. Relations Between Design Artifacts and Work Analysis and Interaction Design.

Relation	Frequency	Related to Work Analysis	Related to Interaction Design
Is Part Of	1	✔	✔
Strategy	1	✔	
Archive	2	✔	
Creates Conditions For	2		✔
Creates Emotions About	2		✔
Designs	2		✔
Is Cause Of	2	✔	
Reflections On	2	✔	✔
Specifies How	2		✔
Is Associated With	3	✔	
Total	**19**		

DISCUSSION

The research question was, What types of relations are needed to connect work analyses and interaction design in the design of a simple artifact for a complex work domain? Two main findings arise from this case analysis:

1. During the design of a simple artifact, such as a folder structure for a large organization, different relations between the work analysis, interaction design, and design artifacts are expressed (see Table 1).
2. The pattern of relations in the HWID case studied here is not as symmetrical as expected, but rather asymmetrical (see Figure 3). This suggests that the current understanding of HWID (see Figure 1) should be modified to accept that design artifacts connect, but have different relations to, work analysis and interaction design.

Regarding the first finding, the identification of this complexity supports the idea of having an encompassing, holistic, general HWID framework (see Figure 1) that can help to combine work analysis and interaction design explicitly. Even though it is beyond the scope of this paper to discuss the relationship between HWID and either of the system development or participatory design approaches, the findings can be seen as a justification for a new complex HWID approach that focuses more directly on the relation between organizational work analysis, interaction design, and very simple IT artifacts than existing system development and participatory design approaches do.

Regarding the second finding, only two types of relation are common across the framework: Reflections On and Is Part Of. The balance of the relationships are asymmetrical, as the two last columns in Table 1 show. Hence focusing on either work analysis or interaction design techniques gives only half the picture of the development of the design artifact, and leaves many important relations unexplored. Researchers and work teams need to focus on both

work analysis and interaction design simultaneously in design work. Compared to the symmetrical relations proposed in the general HWID framework (see Figure 1), the model (see Figure 3) appears to be a more idiosyncratic gestalt. The reason for this can be either that the focus on the development of design artifacts in a complex organization is somewhat idiosyncratic itself, or it can be that the general HWID framework should be updated to take into account the asymmetries suggested by the study.

The validity of these results should be judged bearing in mind the two roles I played in this case study, that of project manager of the developer group and primary researcher and analyst of the data. My academic background (a PhD in human factors with a focus on macroergonomics) and professional experience (teaching and practicing system development, interaction design, and work analysis) are thus important to take into account when judging the validity of the analysis and discussion of this case. The necessary qualifications to observe and analyze the relations in the development of the design artifact, together with the full access to make these observations and analyses, should, I would argue, create a solid basis for the findings that are presented here.

Work Analysis and Design Artifacts: A Case of Distributed Cognition in Design Artifact Development

One lesson learned from the HWID case analyzed in this paper is that the design, the discussions, and the use of design artifacts, such as sketches, can reveal a great deal about the work processes in an organization. Although work analysis certainly functions as a motivator and a reason for making decisions about design artifacts, and although organizational practices such as how to archive data are powerful determiners of how a final design artifact will be, the direction of influence is sometimes reversed and goes from the design artifacts to the work analysis. As I found in the analysis of this case, having a new system in operation spurs the development of a new organizational strategy for the use of systems like the new one. Furthermore, many relations between work analysis and design artifacts are vague and merely associations.

A theoretical framework that may help clarify the relation between work analysis and design artifacts in this study is distributed cognition. This theory purports that both individual and collective cognition can be, and generally are, distributed across time and space (Cole & Engeström, 1993; Hutchins, 1995), for example, in a flight cockpit (Hutchins, 1995), a courtroom, or a medical practice (Engeström, 1992). More recently, the distributed cognition approach has been used as the basis for new methods of human-centered design that takes into account public sharing of memory and informal organization memory (Rinkus et al., 2005). Thus the distributed cognition ideas about public sharing of memory point out that, to understand how this phenomenon happens, one needs to sample data through many means, both by talking to members of the organization and by collecting data from a variety of sources about the use of computer systems. This is analogous to the process employed in this study. How to archive data in the organization is deeply embedded in people's minds and behaviors, building structures, software, and more, and discovering how that process works (in people, structures, software, etc.) is what was happening in the analysis of the data in this study. Secondly, the distributed cognition ideas about public sharing of memory indicate that minor breakdowns in interaction may result in significant consequences. This confirms the analysis finding that a few e-mail conversations on how to archive data proved to produce unreasonably large effects both on work analysis and design artifacts. Related to this point, the distributed cognition ideas about informal

organization memory help identify nonoptimal or hitherto unknown ways that information propagates across people and computers, in a way that may have similarities to the connections of work analysis and design artifacts in the HWID approach.

An interesting way forward would be to embed the distributed cognition approach within the HWID general framework so as to shed light on the connection between work analysis and design artifacts. This would make it possible to analyze how information is propagated across different representations during a specific period of time. For example, in this case study, information about how to conduct course administration was propagated across the developer group's design sketches. The design artifacts were used as working memory registers that enabled the group to share immediate thoughts among themselves and with stakeholders. By doing this, the developer group became part of the course administration in a time of difficulty (e.g., occasionally, when working the designing and configuring the folder structure, it was not clear whether the developer group completed concrete course administration work, which they were not supposed to do, or actually developed the practice of course administration, which they were supposed to do). Thus, from a distributed cognition perspective, the design artifacts were tools in the ordinary human activity that development activities support, which in this case were those surrounding the folder structure of the study program. In effect, discussing and developing design artifacts could be evaluated not only as the outcome of work analysis, but as a central contribution to work analysis.

Design Artifacts and Interaction Design: Theorizing the Format and Ownership of Sketching and Prototyping

One obvious critique of the research presented here is that the analyzed sketches were not actually design sketches, but rather PowerPoint low-fidelity prototypes or the equivalent. According to the dominant view of the role of design sketches in design (Buxton, 2007; Greenberg & Buxton, 2008; Tohidi, Buxton, Baecker, & Sellen, 2006), a design sketch is a hand drawing that conceptualizes an idea but which has not been taken too far towards something that can be presented and perceived as a solution. In contrast to this view, the HWID case study presented in this paper illustrates that solution spaces can, and will be, explored by the use of any kind of drawing, including PowerPoint low-fidelity prototypes and other computer drawings by end-users and other stakeholders. Furthermore, someone always "owns" the design sketch; that is, each sketch is an expression of someone's perspectives, immediate feelings, and long-term emotional attachment to the design artifact.

In addition, from a traditional interaction design perspective, the use of different representations, sketches, and low- and high-fidelity prototypes is primarily for communicating with other people and hearing their views on the new system (Preece et al., 2007). From the artifact design side, the cognitive and social answer to design artifacts use in this study's HWID case is different from the creativity-enhancing role of design artifacts identified in current theory of design sketching (Fallman, 2005; Oh et al., 2004; Yi-Luen Do, Gross, & Zimring, 1999). In the case presented here, the use of different representations (sketches, and low- and high-fidelity prototypes) was necessary to address the various levels of organizational learning about the use of the new folder structure in teaching and study administration. Each user group needed to own and have access to at least one design artifact, which was reflected in, for example, the different sketches presented by the students and the teachers. The IT and e-learning expert provided

content template prototypes that were based on the sketches and ideas discussed in the developer group. These design artifacts in turn created the conditions for the establishment of design goals. The relation between interaction design and design artifacts in this HWID case is thus lenient toward the format of the design artifacts (nearly any kind of representation of user-system interaction related to the new system would be considered an artifact) and attentive toward ownership of the artifact (owning or having access to design artifacts both created the condition for and specified the design artifact). This relation between interaction design and design artifacts should be incorporated into the general HWID framework.

CONCLUSION

In this paper I asked questions regarding the relation between work analysis, design artifacts, and interaction design. The main findings were, firstly, that different relations between work analysis, interaction design, and design artifacts are expressed during the design of a simple artifact, such as a folder structure for a large organization. This indicates a need for a new HWID approach that, compared to traditional system development and participatory design approaches, focuses more strictly on the relations between work analysis and interaction design. Secondly, I found that the pattern of relations among work analysis, design artifacts and interaction design in a HWID approach in developing organizational computer artifacts is asymmetrical. This suggests that the current understanding of HWID should be modified into a more gestalt approach accepting that design artifacts connect, but have different relations to, work analysis and interaction design. Previous HWID studies (Orngreen et al., 2008) have identified two areas of major concern: processes that occur within interaction design processes (e.g., encouraging the dialogue between users and designers in the design process) and processes that occur within work and user analysis (e.g., broadening the scope to social, organizational, and cultural aspects). The present study adds to this knowledge by identifying processes that occur between work analysis and interaction design. These relations and also recommendations for employing HWID are given in Table 2.

The HWID recommendations presented in Figure 1 illustrate how researchers in previous research have found that interaction design and work and user analyses are in practice intertwined (Orngreen et al., 2008). This study adds to the model by exploring the type of relations, and by identifying the central connecting role of design artifacts. The model of HWID that is presented in Figure 1 can thus be enriched and sharpened with the type of relations that were found in this study and which are outlined in Figure 3 and Table 2. Design artifacts should be given a central place in future versions of the framework for human work interaction design.

Transferability

This study focused on developing the theoretical base for HWID to be able to face challenges of human–computer interaction in a world where configuration and redesigning of existing systems is more common than developing a new system from scratch. This challenge was met by a grounded theory approach toward the relations in a design artifact-focused HWID case. Furthermore, I indicated what should be incorporated into the general HWID framework from prior research. Theoretically, it should be possible then to modify and apply the modified general framework to new cases. So, although the case study I described the change process

from an old e-learning system to a new one in a large university, on the surface, the findings should then be applicable to many similar contexts.

Table 2. Summary of HWID Relations.

Relations	Advice on Handling the Relations
1. "Reflective" relations exist between work analysis, design artifacts, and interaction design.	Do not take the relation between the understanding of work and the new design artifact for granted. Instead, acknowledge existing social facts, reopen discussion about who the stakeholders are, and pay attention to each stakeholder's perspective on the new–old discrepancy. Involve stakeholders in the interaction design even if they show little interest (see page 224).
2. Work analysis and interaction design "is part of" developing design artifacts.	Acknowledge the paradoxes of a holistic approach: Programming, IT support, and other specialist expertise uncovered by work analysis is part of the design artifact, but so are the user experiences and scenarios from interaction design (see page 227).
3. An "archive" relation is between work analysis and design artifacts.	Make sure the design artifact will fit into existing ways of archiving data. The way of archiving data may be deeply rooted in technical and administrative procedures and be aggressively defended (see page 229).
4. Work analysis focuses on "strategy" in use of design artifact.	Identify and create a new strategy for the use of the design artifact when it is in operation (see page 231).
5. Work analysis "is associated with" the design artifact.	Be aware that there are a great many unspecified ways in which work analysis can be associated with the design artifact, ranging from seeing the design artifact as something to be presented in the context of a work analysis to an analysis of who "owns" the design artifact (see page 232).
6. Work analysis "is cause of" design artifact.	Review existing, and ask for new, organizational analyses from all relevant stakeholders, and use these analyses to identify and argue for specific changes in the design artifact (see page 234).
7. Interaction design "creates emotions about" design artifacts.	Stakeholders' involvement is so important to interaction design that it makes the creation of emotions about the artifact an act that has to be done explicitly and intentionally (see page 235).
8. Interaction design "specifies how" design artifacts should be.	Accept that following an interaction design approach to artifact design put limits on freedom: Certain tasks (e.g., usability testing) are assigned to the developers, and certain user identities (e.g., "super users") are constructed (see page 235).
9. Interaction design "designs" artifacts.	Establish the social processes that enable the design relation between interaction design and the artifact: sharing of sketches and prototypes, procedures for doing critique and assigning status to chosen solutions (see page 236).
10. Interaction design "creates conditions for" design artifacts.	Appreciate the initial conditions for relating interaction design to the artifact: the demands for new systems, the requests for certain solutions and the eagerness to demonstrate the existing, and the preparation necessary for setting design goals (see page 238)

Utilization

I believe that the findings are useful and applicable. As indicated in the paper, the HWID approach is holistic. I have applied this approach with a strong focus on design artifacts, which should make the findings useful and applicable to both developers and researchers seeking holistic approaches to design artifact development. In particular, such an approach will be valuable to those with a strong interest in combing work analysis and interaction design with design artifacts such as content templates, sketches, and low-fi prototypes.

ENDNOTES

1. Copenhagen Business School (CBS) is a Danish university with about 14,000 students, an annual intake of around 1,000 exchange students, about 400 full-time researchers and around 500 administrative employees. CBS is the one of the three largest business schools in Northern Europe.
2. This quote and all the following quotations have been translated from Danish into English by the author.

REFERENCES

Akin, Ö. (2002). Variants in design cognition. In C. Eastman, W. Newstetter, & M. McCracken (Eds.), *Design knowing and learning: Cognition in design education* (pp. 105–124). Amsterdam: Elsevier.

Blomberg, J., Suchman, L., & Trigg, R. H. (1996). Reflections on a work-oriented design project. *Human–Computer Interaction, 11*(3), 237–265.

Button, G., & Sharrock, W. (2009). Studies of work and the workplace in HCI: Concepts and techniques. *Synthesis Lectures on Human-Centered Informatics, 2*(1), 1–96.

Buxton, W. (2007). *Sketching user experiences: Getting the design right and the right design*. Redmond, WA, USA: Morgan Kaufmann.

Campos, P., & Campos, A. (2009, August). *SimCompany: An educational game created through a human–work interaction design approach*. Paper presented at the Human–Computer Interaction–INTERACT 2009, Uppsala, Sweden.

Clemmensen, T., Campos, P., Orngreen, R., Pejtersen, A. M., & Wong, W. (Eds.). (2006). *Human work interaction design: Designing for human work*. Maderia, Portugal: Springer.

Clemmensen, T., & Nørbjerg, J. (2004). Separation in theory: Coordination in practice. *Software Process Improvement and Practice, 8*, 99–110.

Cole, M., & Engeström, Y. (1993). A cultural-historical approach to distributed cognition. In G. Salomon (Ed.), *Distributed cognitions: Psychological and educational considerations.* Cambridge, UK: Cambridge University Press.

Cooper, A., & Reimann, R. M. (2003). *About Face 2.0: The essentials of interaction design*. Indianapolis, IN, USA: Wiley.

Dahler-Larsen, P. (2008). *Displaying qualitative data*. Odense, Denmark: University Press of Southern Denmark.

Engeström, Y. (1992). *Interactive expertise: Studies in distributed working intelligence*. (Research Bulletin, 83). Helsinki, Finland: University of Helsinki, Department of Education,

Fallman, D. (2005, May). *Why research-oriented design isn't design-oriented research.* Paper presented at Nordes, the Nordic Design Research Conference, Copenhagen, Denmark.

Greenberg, S., & Buxton, B. (2008, April). *Usability evaluation considered harmful (some of the time)*. Paper presented at the CHI2008, Florence, Italy.

Hamel, R. (1995). Psychology and Design Research. In R. M. Oxman, M. F. Th. Bax, & H. H. Achten (Eds.), *Design Research in the Netherlands: A symposium convened by Design Methods Group Information Technology for Architecture*. Retrieved from http://www.designresearch.nl/PDF/DRN1995_Hamel.pdf

Harper, R. H. R. (2000). The organisation in ethnography: A discussion of ethnographic fieldwork programs in CSCW. *Computer Supported Cooperative Work, 9*, 239–264.

Hasdogan, G. (1996). The role of user models in product design for assessment of user needs. *Design Studies, 17*, 19–33.

Hutchins, E. (1995). *Cognition in the wild*. Boston: MIT Press.

Katre, D. S., Orngreen, R., Yammiyavar, P. G., & Clemmensen, T. (Eds.). (2010). *Human work interaction design: Usability in social, cultural and organizational contexts.* Hamburg, Germany; Springer.

Kirwan, B., & Ainsworth, L. K. (Eds.). (1992). *A guide to task analysis*. London: Taylor & Francis.

Oh, Y., Yi-Luen Do, E., & Gross, M. D. (2004, October). *Intelligent critiquing of design sketches*. Paper presented at the AAAI (American Association for Artificial Intelligence) Fall Symposium: Making Pen-based Interaction Intelligent and Natural, Washington, DC, USA.

Orngreen, R., Pejtersen, A. M., & Clemmensen, T. (2008, October). *Themes in human work interaction design.* Paper presented at the Cultural Usability and Human Work Interaction Design–Techniques that Connect: NordiCHI 2008 Workshop Sunday, Lund, Sweden.

Preece, J., Rogers, Y., & Sharp, H. (2007). *Interaction design: Beyond human–computer interaction* (2nd ed.). Chichester, England: John Wiley & Sons.

Rasmussen, J., Pejtersen, A. M., & Schmidt, K. (1990). *Taxonomy for cognitive work analysis* (No. Risø-M-2871). Roskilde, Denmark: Risø National Laboratory.

Rinkus, S., Walji, M., Johnson-Throop, K. A., Malin, J. T., Turley, J. P., Smith, J. W., & Zhang, J. (2005). Human-centered design of a distributed knowledge management system. *Journal of Biomedical Informatics, 38*, 4–17.

Siegel, D., & Dray, S. (2005). Avoiding the next schism: Etnography and usability. *interactions, 12*(2), 58–61.

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory.* London: SAGE Publications.

Tohidi, M., Buxton, W., Baecker, R., & Sellen, A. (2006, April). *Getting the right design and the design right.* Paper presented at the CHI 2006–SIGCHI Conference on Human Factors in Computing Systems, Montreal, Canada.

Wilson, J. R., & Corlett, E. N. (Eds.). (1990). *Evaluation of human work: A practical ergonomics methodology*. London: Taylor & Francis.

Yi-Luen Do, E., Gross, M. D., & Zimring, C. (1999, April). *Drawing and design intentions: An investigation of freehand drawing conventions in design.* Paper presented at the Design Thinking Research Symposium, Cambridge, MA, USA.

Author's Note

I extend thanks to each member of the developer group for allowing his/her contributions to be part of this study.

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APPENDIX

The 105 (of the 144 Collected) Data Sources Used in the Analysis.

P 1	E-mail from project manager to developer group members
P 3	E-mail from the organization's director of administration to (previous) system owner
P 5	E-mail from administrative staff to developer group
P 7	E-mail from student developer group member to project manager
P11	E-mail from the system owner (the head of study) to the administrative staff (the study secretariat)
P13	E-mail from IT manager to project manager
P14	E-mail from (e-learning) expert to project manager
P15	E-mail from study program's administrative staff to developer project group
P17	E-mail from project manager inviting developer group members to become a member
P18	E-mail from project manager to study program's administrative staff
P19	E-mail from project manager to system owner
P20	E-mail from IT manager to developer group
P21	E-mail from project manager to developer group
P24	E-mail from project manager to system owner board (study board)
P30	E-mail from administrative leader to project manager
P31	E-mail from programmer to IT manager
P35	E-mail from system administrator or project manager
P45	E-mail from students to project manager
P46	E-mail from system owner to project manager
P49	E-mail from user (teacher) to project manager
P52	E-mail from study program's administrative staff to developer group
P54	E-mail from IT expert to project manager
P56	E-mail from project manager to developer group
P57	E-mail from administrative staff to project manager
P58	E-mail from IT manager (central IT expert in the organization) to developers, IT staff, and system owner
P60	E-mail from system owner to developers and IT staff
P61	E-mail from IT manager to system owner
P62	E-mail from study program's administrative staff to developer group
P64	E-mail from study program's administrative staff to developer project group
P66	E-mail from a colleague to the system owner, in their roles as researchers, about the possibilities for writing a research paper on the system development
P67	E-mail from system owner to colleague
P68	E-mail from a colleague to the system owner, in their roles as researchers, about the possibilities for writing a research paper on the system development
P69	E-mail from system owner to project manager (responsible for the design of the new folder structure)

P70	E-mail from (e-learning) expert to developer group
P72	E-mail from project manager to organization
P73	E-mail from (e-learning) expert to developer group
P74	E-mail from study program's administrative staff to project manager
P75	E-mail from one study program's administrative staff to another
P76	E-mail from project manager to IT manager
P77	E-mail from student member of developer project group to project manager
P78	E-mail from (e-learning) expert to project manager
P80	E-mail from (e-learning systems) expert to project manager
P81	E-mail from (e-learning systems) expert to project manager
P83	E-mail from IT manager to programmer
P84	E-mail from IT manager to developer group
P92	E-mail from (e-learning) expert to developer group
P96	E-learning platform experience document from IT manager
P97	IT manager's description of the organization's content template for the new system
P100	Student report on the old system
P117	PowerPoint slides on the use of the new system presented by an expert from the central administration of the organization
P121	[Screendump]: Members of the developer group and their access rights in the system
P128	E-mail from study program's administrative staff to developer project group
P134	Document on blackboard e-learning platform use from (e-learning) expert to project manager
P139	A personal note from the project manager
P141	Written annotations on teachers' sketch
P142	Excerpt from Website material on the front for improvement of [the old system]– a student initiative
P144	Project manager's minutes of project meeting

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EFFECTS OF ICT CONNECTEDNESS, PERMEABILITY, FLEXIBILITY, AND NEGATIVE SPILLOVERS ON BURNOUT AND JOB AND FAMILY SATISFACTION

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Abstract: *This study investigates the effects of information and communication technologies (ICTs), permeability, flexibility, and spillovers of work into home and home into work on job burnout and job and family satisfaction. Results from a random sample of 612 office workers show that individuals who reported being satisfied with their jobs tended to feel that the Internet could help them accomplish work-related tasks, that traditional media could help them relax after work, and had a highly permeable boundary between their home domain and a highly flexible work environment. On the other hand, people who experienced low job satisfaction faced high work spillovers into home life and high burnout. The findings underscore that the connectedness of ICTs is not the main issue for assessing the consequences associated with ICTs. Rather, individual control over what passes through the boundaries shapes the consequences people experience.*

Keywords: *ICT connectedness, permeability, flexibility, negative spillovers, job burnout, job and family satisfaction.*

INTRODUCTION

Information and communication technologies (ICTs)—the combination of computer, telecommunication, and media technologies—are entrenched in our everyday lives; their convergence creates a powerful force. Research has demonstrated that ICTs can be used to bring work home and home to work. Rakow and Navarro (1993) found that mobile phones allow women to remain available to their families even as they work. Employees have used office technologies to manage personal affairs at work, such as sending personal e-mail, socializing on Facebook, surfing the Internet, completing e-banking, and playing games (Leung, 2004; Sproull, 2000). Scholars have argued that the use of ICTs increases the permeability and flexibility of work–family boundaries (e.g., Haddon & Silverstone, 2000; Lewis & Cooper, 1999; Valcour & Hunter, 2005) because the ubiquitous nature of many ICTs

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allows multiple ways of access (e.g., calling, texting, and twittering) to individuals anywhere, anytime, which makes us more "connected" than ever before.

In previous studies, researchers have argued that blurred work–family boundaries are potentially harmful for workers and families because ICTs promote overwork (Galinsky, Kim, & Bond, 2001; Leung, 2004; Weil & Rosen, 1997), continual interruptions (Ventura, 1995), accelerated family life (Daly, 1996), and possibly isolation (Kraut et al., 1998; Sproull, 2000). Conversely, others have found that ICTs help work arrangements and allow flexibility, thereby reducing tension between work and family, by providing a permeable work and family environment (Hill, Hawkins, Ferris, & Weitzman, 2001; Valcour & Hunter, 2005). Mankin, Cohen, and Bikson (1996) defined the "boundaryless organization" as an organizational form with "flat hierarchies, … flexible, reconfigurable information infrastructures made up of interconnected webs" (p. 241). They also proposed that "offices and work spaces can be characterized by where workers actually generate, process, and communicate information, whether at home or at work, rather than by the location of the building" (p. 241). In recent years, the increased instances of paid work being conducted in a home or mobile workspace rather than a central location have had a significant impact on both workers and workplaces. Technological advances in ICTs, and perhaps economic pressures, have changed the structure and culture of work: Employment such as telework affects organizations, employees, and families. In this study I intentionally avoid narrowly focusing on the teleworking and telecommuting concepts because they generally refer to work located some distance from a regular, main office site—often performed with the help of ICTs—or defined as any form of substituting ICTs for work-related travel (Nilles, 1998), and thus may or may not involve implications for the home life. Rather, my focus encompasses teleworkers, telecommuters, and all other workers who use any form of ICTs to facilitate a permeable and flexible work arrangement, both at work and at home. Thus, the goal of this research is to examine the effects of ICTs in the workplace and at home. In particular, I investigate the effects of ICTs, permeability, flexibility, and spillovers of work into home and home into work on job burnout and job and family satisfaction.

THEORETICAL FRAMEWORKS

ICT Connectedness (ICTC)

Comparable to the Internet connectedness concept proposed by Loges and Jung (2001), I conceptualize that ICT connectedness (ICTC) is a multidimensional construct that can be applied to portray the importance of ICTs in a person's everyday life, especially in influencing the work environment's permeability and flexibility both at work and at home. ICTC reflects a multilevel and contextual approach to assessing the relationship between individuals and ICTs. As Jung, Qiu, and Kim (2001) suggested, if only traditional time use measures were used to assess Internet connectedness, the construct would not capture or adequately depict the full context. Partly because of the limitation of time-based measures (e.g., hours of Internet use per day), which ignore the importance of other contexts such as goals or functions, Jung et al. (2001) developed a measure called the Internet connectedness index (ICI) based on media system dependency theory (Ball-Rokeach, 1998; Loges & Jung, 2001). The ICI encompasses a number of conventional measures, such as time and history,

yet also goes beyond to capture the Internet's scope, goal, intensity, and centrality in a person's life (Jung et al., 2001; Leung, 2010).

In line with the ICI, I propose that ICTC also comprises three dimensions: (a) scope and intensity, (b) centrality and goal, and (c) breadth of ICT use at home. The scope and intensity dimension of ICTC includes the range of on-line applications (e.g., e-mail, IM, chat, blogs, Web surfing, and on-line news) a person uses and the amount of time he/she spends on these activities to assist with office work at home. In addition to on-line technologies, uses of traditional media for working at home (i.e., whether people's jobs require them to read a newspaper, watch TV, or view TV news programs) were also included to provide a composite picture of the extent to which on-line and off-line ICTs are connected with someone's working life.

The centrality and goal dimension of ICTC refers to the subjective evaluation of how the Internet and mobile phones are impacting people's lives, and the extent to which they would miss these two technologies if they disappeared. For some, both the Internet and mobile phone are central in their work because their jobs require some level of Internet and mobile phone connectedness. Others might feel that their life would be happier than it is now without these tools because their job does not depend on them, and without them they would be unavailable and not feel obligated to their boss after work (Leung, 2004; Leung & Lee, 2005). Furthermore, to provide a full picture of the functions and dependency of some ICTs, especially the Internet, I also added the range of personal goals a person seeks to meet through the Internet connection (such as to accomplish work-related tasks, to ask other people for advice, and to provide immediate access to other people anywhere and anytime).

The breadth of ICTs in the home dimension of ICTC reflects the access to and use of other related information technologies and accessories (e.g., 3G mobile Internet access, broadband access, and other office technologies available at home, such as facsimile machines, photocopiers, and scanners). By considering this wide range of ICTs in various contexts to the three dimensions, I believe that ICTC is a well-conceived, multidimensional construct that provides a complete picture of a person's overall relationship to ICTs. With its multiple indicators, I believe that the ICTC index (ICTCI) enables a deep appreciation of the different relationships people have with ICTs that can blur the boundaries between work and family.

Permeability

Permeability refers to the extent to which a boundary allows the psychological or behavioral aspects of one domain to enter another (Ashforth, Kreiner, & Fugate, 2000; Clark, 2000; Hall & Richter, 1988; Pleck, 1977). In other words, permeability means that someone is physically located in one domain, but psychologically or behaviorally involved in another role (Ashforth et al., 2000; Pleck, 1977). Furthermore, some scholars have argued that using communication technologies increases the permeability of work–family boundaries (Haddon & Silverstone, 2000; Lewis & Cooper, 1999; Valcour & Hunter, 2005) because these technologies provide additional ways to access individuals anytime and anywhere. Valcour and Hunter also suggested that the increased permeability of the boundaries between work and nonwork domains is doubtlessly linked to ICTs because of the spatial, temporal, and psychological overlap of work and family roles. Thus, as shown in Figure 1, it is reasonable to expect that

H_1: The more people perceive their lives are connected to/through ICTs, the more they feel their work and family roles are permeable.

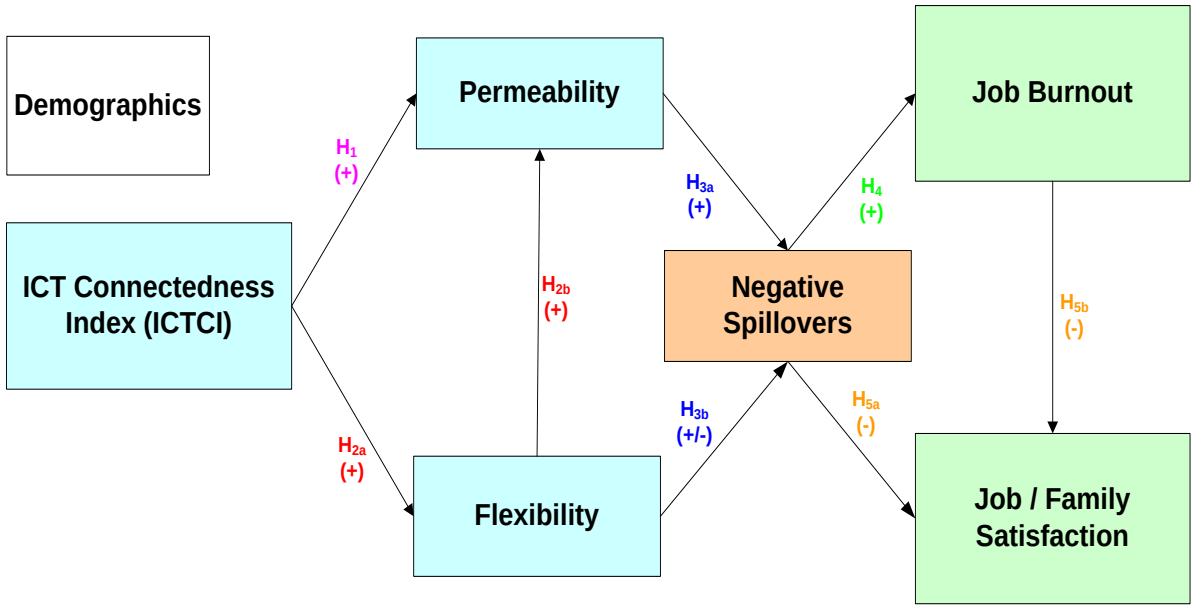

Figure 1. Effects of ICT connectedness, permeability, flexibility, and negative spillovers on job burnout and job/family satisfaction.

Flexibility

Flexibility involves the malleability of the boundary between two or more role domains, which is the ability of a role domain such as *professor* to expand or contract to accommodate the demands of another role domain such as *parent*, and vice versa (Ashforth et al., 2000; Clark, 2000; Hall & Richter, 1988; Pleck, 1977). Scholars also have argued that the use of technology has the potential to support work arrangements that enhance flexibility, thereby reducing conflicts between work and family (Hill et al., 2001; Valcour & Hunter, 2005).

Previous studies have shown that the extent of integration or segmentation in the role domains is indicated primarily by two characteristics: permeability and flexibility. Permeability at work reflects the customary situation at work that reveals how often family matters cross the boundary into the office, and vice versa; flexibility at work generally refers to a corporate culture that reflects the lack of rigidity of company policy in allowing, for example, family matters to be taken care of at work. When two or more domains are highly flexible and permeable with respect to one another, they are said to be integrated. Conversely, highly segmented roles have inflexible and impermeable boundaries (Desrochers, Hilton, & Larwood, 2005). Using a sample of IBM employees working from virtual, home-based, and traditional office settings, Hill, Ferris, and Martinson (2003) found that a technologically mobile virtual office gives people more flexibility than traditional office workers have to meet both work and family needs. Therefore, it is logical to believe that

H_{2a}: The more people perceive their lives are connected to/through ICTs, the more they will feel their jobs are flexible at work and at home.

H_{2b}: The more people feel their jobs are flexible at work and at home, the more permeable they will perceive their work and family roles to be.

Spillover Theory

Spillover theory proposes that there is a relationship between work and home environments such that work patterns and experiences in one domain are carried over into the other through a permeable boundary (Zedeck, 1992). The direction of influence generally is assumed to be from work to home, but empirical research demonstrates that spillover occurs in both directions (Frone, 2003; Roehling, Moen, & Batt, 2003). Therefore, it is possible that increased boundary permeability can let in both negative and positive behaviors and emotions (Grzywacz & Marks, 2000). Past studies have also shown that negative forms of spillover are linked to problematic outcomes. For example, negative work-to-family spillover predicts family dissatisfaction, whereas negative family-to-work spillover predicts work dissatisfaction. Negative spillover in both directions is linked to high distress (Frone, 2003). In this research, the focus is primarily on negative spillover effects.

Other research has shown interesting results with respect to permeability and flexibility. Clark (2002a) found that permeability and flexibility might have positive connotations for participants, such as openness, when applied to the work border, but negative connotations, such as defenselessness to invasion, when applied to the home border. Thus, home border permeability might be more likely to allow work to disrupt home life than work border permeability would allow home life to disrupt work. Therefore, with respect to the negative connotation, I hypothesize that

H_{3a}: The more permeable people feel the boundaries between their work and family roles are, the more negative spillovers they will experience within their home.

However, flexibility in both the work and home domains may bring more and sometimes less negative spillovers. Because no definitive conclusion can be found in previous studies, I raise the following hypothesis and ask a research question:

H_{3b}: There will be a significant relationship between flexibility and negative spillovers both into home and into work.

RQ_1: In what way(s) can demographics, dimensions of ICTC, perceived permeability, and flexibility predict negative spillovers into home and into work?

Job Burnout

During the 1970s, the concept of burnout emerged in the United States. It referred to work-related mental exhaustion (Ossebaard, 2000). In some studies, job burnout has been defined as the result of constant or repeated emotional pressure associated with intense involvement with people or work over long periods of time, and exacerbated by ICTs, which provide users the capability to multitask (Dowler, 2005; Hayes & Weathington, 2007; Lee & Akhtar, 2007; Moore, 2000; Pines, 1993). The operational definition used most widely in job burnout research is a three-component model that defines job burnout as a psychological syndrome of emotional exhaustion, cynicism, and decreased professional self-efficacy (Maslach & Jackson, 1986).

Because ICTs can both facilitate work and promote overwork, I propose,

H_4: The more negative spillover people experience, the more often they will feel job burnout.

RQ_2: To what extent can demographics, components of ICTC, perceived permeability and flexibility, and negative spillover influence job burnout?

Job and Family Satisfaction

Job satisfaction is the extent to which employees are satisfied or dissatisfied with their jobs. Accordingly, Spector (1997) suggested that job satisfaction is a general or global affective reaction that individuals have about their job. Previous studies have revealed that both family and work-related factors are associated with job satisfaction. Any conflict that arises from family and work factors leads to stress, resulting in negative consequences such as job and family dissatisfaction (Dowler, 2005; Duxbury & Higgins, 1991; Hayes & Weathington, 2007).

In a study in which the work–family border theory was tested, Clark (2002a) examined work–family conflict, satisfaction at home and at work, and functioning at home and at work. In multiple regression analyses, Clark found that the greater the home border's flexibility and the greater the work border's permeability, the greater the communication at home about work. The study also indicated that the home border's permeability reduces work–family balance because having little or no cross-border communication was associated with low work satisfaction and low adaptive functioning in both work and family domains. Furthermore, bivariate correlation analysis showed that home border permeability was associated with work–family conflict.

In a subsequent study, Clark (2002b) investigated which combination of flexibility and permeability would best help employees balance work and family. The lowest levels of work–family conflict were found in those who had high flexibility but low permeability. Findings from a study by Rau and Hyland (2002) suggest that the links among high flexibility, low permeability, and low work–family conflict might be related to employees' work–family preferences. Based on Ashforth et al.'s (2000) version of boundary theory, they posited that applicants' preferences for jobs offering flextime or telecommuting would depend on current levels of work–family conflict. Thus, this study predicts that

H_{5a}: The more negative spillover into work and into home people experience, the less satisfied they will be with their job and family.

H_{5b}: The more job burnout people experience, the less satisfied they will be with their job and family.

RQ_3: To what extent can demographics, components of ICTC, perceived permeability and flexibility, negative spillover, and job burnout influence (a) job satisfaction and (b) family satisfaction?

METHOD

Sample and Sampling

Data for this study were collected via a telephone survey[1] from a probability sample of 1,041 full-time office workers in Hong Kong whose jobs required the use of the Internet. Telephone numbers were drawn from the most recent edition of the territory telephone directory. The

Chinese-language survey instrument was pilot tested before the actual fieldwork, which was conducted December 17–27, 2007, with native Chinese speakers. I subsequently translated the texts into English for this publication. The response rate was 58.8%, with a total of 612 complete interviews. The sample consisted of 55.2% females and averaged 36.16 years of age (*SD* = 10.08). Over half of all respondents (61.3%) had a median annual household income of less than US$40,000.[2] Slightly more than half (52.6%) of the respondents were high school graduates; the rest were university graduates. In terms of occupation, 54% were managers, administrators, or professionals; 21% were in clerical positions; and 13% were in sales or services.

Measures

ICT Connectedness Index (ICTCI)

As Table 1 shows, the ICT Connectedness Index (ICTCI) used in this study is an adaptation of the nine-item index used by Jung et al. (2001) for the ICI concept. The ICTCI consists of three dimensions: scope and intensity, centrality and goals, and breadth of ICTs at home.

The *scope and intensity* dimension included the activity scope, activity intensity, and use of traditional media for working at home. The scope of activities was measured by asking respondents "Besides e-mail, do you use IM, chat rooms, blogs, Web surfing, and on-line news to do office work at home?" with 0 = *no* and 1 = *yes* on each activity. The total number of responses represents the breadth of participation, and was recoded: Choosing none of the activities was coded as 1 and choosing one or more activities was coded as 2. Activity intensity asked, "How often do you use the following ICTs (e-mails, IM, chat rooms, blogs, Web surfing, and on-line news)?" on a four-point scale with 1 = *never*, 2 = *seldom*, 3 = *sometimes*, and 4 = *often*. Data ranged from 6 to 24 points. To correct the negative skew in responses, activity intensity was recoded: Responses of 6–8 became 1, responses of 9–13 became 2, and responses of 14–24 became 3. Finally, respondents were asked, "Does your job require you to use the following traditional media at home: reading a newspaper, watching TV, and watching TV news?" with 1 = *no* and 2 = *yes* for each of the items. Data ranged from 3–6 points.

The *centrality and goal* dimension consisted of questions assessing the degree to which certain media were connected to the participants' lives, and how much they depended on these media. Regarding the centrality of two key communication technologies, respondents were asked, "Imagine that you woke up tomorrow to find that your mobile telephone had vanished. How much would you miss being able to use it?" The respondents answered on a 10-point scale, with 1 = *wouldn't miss it at all* and 10 = *miss it extremely*. The distribution of responses to this question was skewed such that the responses were collapsed into four categories, with original responses of 0–1 recoded as 1, responses of 2–5 as 2, 6–8 as 3, and 9–10 as 4. The same question was asked about the Internet, using the same 10-point scale. Again, the responses were collapsed into four categories, but with responses of 0–2 recoded as 1, 3–5 as 2, 6–8 as 3, and 9–10 as 4. Goal scope assessed six aims pursued in on-line activities by asking, "How helpful is the Internet for you in achieving the following goals: to accomplish work-related tasks, to find out what is going on in society, to express your views, to ask people for advice, to provide immediate access to others anywhere and anytime, and to carry out family responsibilities while at work?" The scale indicated 1 = *not helpful at all* to 4 = *very helpful*. Correcting for the positive skew in responses to this question, responses of 6–12 were recoded as 1, 13–18 as 2, and 19–24 as 3.

Table 1. Dimensions in the ICTC Index (ICTCI).

Theoretical Dimensions	Mean	SD	Alpha
Scope and Intensity			
1. Activity scope[a]	7.84	4.55	.78
2. Activity intensity[b]	7.78	2.90	.77
3. Use of traditional media to work at home[c]	3.96	5.13	.90
Centrality and Goal			
4. Mobile phone dependence[d]	9.55	2.18	--
5. Internet dependence[e]	8.19	2.76	--
6. Goal scope[f]	8.02	2.60	.81
Breadth of ICT at Home			
7. 3G mobile Internet access[g]	Yes=46.2%	--	--
8. Broadband access[h]	Yes=97.7%	--	--
9. Office technologies[i]	7.53	2.92	.68

Notes. This nine-item ICTCI scale has an overall mean of 7.3, *SD* = 1.29, and reliability alpha = .71; *N* = 612

[a] Besides e-mail, do you use IM, chat rooms, blogs, web surfing, and on-line news to do office work at home? 0 = *no* and 1 = *yes*.

[b] How often do you use the following ICTs (e-mail, IM, chat rooms, blogs, web surfing, and on-line news) to do office work at home? 1 = *never*, 2 = *seldom*, 3 = *sometimes*, and 4 = *often*.

[c] Does your job require you to use the following traditional media at home: reading a newspaper, watching TV, and watching TV news? 0 = *no* and 1 = *yes.*

[d] Imagine that you woke up tomorrow to find that your mobile phone had vanished. How much would you miss being able to use it? 1 = *wouldn't miss it at all* and 10 = *miss it extremely*.

[e] Imagine that you woke up tomorrow to find that the Internet had vanished. How much would you miss being able to go on-line? 1 = *wouldn't miss it at all* and 10 = *miss it extremely*.

[f] How helpful is the Internet for you for achieving the following goals (e.g., to accomplish work-related tasks, to ask people for advice, and to provide immediate access to others anywhere, anytime)? 1 = *not helpful at all* and 5 = *very helpful*.

[g] Do you own a 3G mobile phone? 0 = *no* (means 2 or 2.5G) and 1 = *yes*.

[h] Do you have broadband Internet access at home? 0 = *no* and 1 = *yes*.

[I] Do you have the following office technologies at home: facsimile machine, photocopier, and scanner? 0 = *no* and 1 = *yes*.

The final dimension of ICTCI is *breadth of ICTs at home*. Three questions were designed to assess whether the respondents had access to a mobile phone and broadband Internet access to facilitate their work at home. The first question was "Do you have Internet access via a 3G mobile phone?" with 0 = *no* (i.e., using 2 or 2.5G) and 1 = yes; and "Do you have broadband Internet access at home?" with 1 = *no* and 2 = *yes*. Finally, the respondents were asked if they had office technologies to assist their work at home: "Do you have the following office technologies at home: facsimile machine, photocopier, and scanner?" with 0 = *no* and 1 = *yes*. Data ranged from 0–3.

I followed Jung et al. (2001) by multiplying each variable in this study by a value to create a common factor of 12. For instance, activity intensity, a three-point scale, was multiplied by four, whereas broadband Internet access, a dichotomous scale, was multiplied by six. Thus, an ICTCI for each respondent was created by summing the multiple of 12 of all nine items and

taking an average, resulting in a range from 1–12. Table 1 shows the mean, standard deviation, and reliability alpha for the multiple-item measures of ICTCI.

Permeability

The permeability of the work domain to family was assessed with the following four items (α = .73) from Clark (2002a), using a four-point scale with 1 = *never* and 4 = *always*: (a) "My family contacts me while I am at work"; (b) "I have family-related items at my workplace"; (c) "I think about my family members when I am at work"; and (d) "I stop in the middle of my work to address a family concern." Similarly worded items (α = .83) measured the family domain's permeability to work, for example, "I receive work-related calls while I am at home"; and "I stop in the middle of my home activities to address a work concern."

Flexibility

Flexibility of the border around work was measured using the following three items (α = .69) adopted from Clark (2002a), also using a four-point scale with 1 = *never* and 4 = *always*: "I can arrive at and depart from work when I want"; "I can easily take a day off work when I want to"; and "My employer lets me perform nonwork projects during spare time at work." Flexibility of the border around family was measured by these similar items (α = .75): "I can arrive at and depart from home when I want"; "I can easily work an extra day when I want to"; and "My family lets me perform work projects during spare time at home."

Spillover

Two separate measures tap two distinct negative forms (or consequences) of spillovers: *work spillover into home* and *family spillover into work*. These measures are abbreviated forms of a similar three-item measure used in the National Survey of Midlife Development in the United States (Dilworth, 2004). The work spillover into home component (α = .72) measures the extent to which a person's job leaves that person feeling "too tired to do the things that need attention at home"; "You wish you had more time to do things for your family"; and "Your job keeps you away from your family too much." Meanwhile, the family spillover into work measure (α = .77) captures the extent to which "worries and problems at home cause you to spend less time at work than you need or want to"; "personal and family worries and problems distract you when you are at work"; and "activities and chores at home prevent you from getting the amount of sleep you need to do your job well."

Job burnout

The job burnout scale (α = .83) measures the extent to which "you feel physically drained when you get home from work"; "you feel emotionally drained when you get home from work"; "you feel you have to rush to get everything done each day"; and "you feel you don't have enough time for yourself." These items were measured using a four-point scale with 1 = *never* and 4 = *always*.

Job and family satisfaction

A five-item scale that measures an individual's satisfaction with his or her job was used (Smilkstein, 1978; Smilkstein, Ashwork, & Montano, 1982). Respondents were asked, on a five-point scale with 1 = *strongly disagree* and 5 = *strongly agree*, whether "they get a lot of satisfaction from carrying out their responsibilities at work"; "they find their activities at work to be personally meaningful"; "their activities at work are rewarding in and of themselves"; "they love what they do at work"; and "they frequently think of quitting their job (reverse coded)." Family satisfaction was measured by items similar to these, except the one about quitting their job. The reliability alphas of these two measures were high, at .86 and .84, respectively.

HYPOTHESES TESTING AND RESULTS

H_1 encompasses the hypothesis that the more people perceive that their lives are connected to ICTs, the more they feel that their work and family roles are permeable. The results presented in Table 2 reveal that ICTCI is positively and significantly related to permeability at work ($r = .19$, $p < .001$) and at home ($r = .43$, $p < .001$). This suggests that the use of ICTs might blur the work–family boundaries, with both positive and negative consequences for working people. Therefore, the results fully support H_1. Similarly, flexibility at work ($r = .14$, $p < .01$) and at home ($r = .17$, $p < .001$) were significantly linked to ICTCI. This demonstrates that the more workers feel that they are connected to ICTs, the fewer conflicts they feel between work and family. Thus, H_{2a} received full support. In the same way, the results in Table 2 show that relationships between permeability and flexibility at work ($r = .23$, $p < .001$) and at home ($r = .11$, $p < .01$) were significantly linked. Likewise, permeability at home was also significantly related to flexibility at work ($r = .20$, $p < .001$) and at home ($r = .28$, $p < .001$). As expected, these results also support H_{2b}. This indicates that the more flexibility workers have both at work and at home, the more permeable they will perceive the boundaries between their work and family roles.

In $H_{3a,}$ I hypothesized that the more permeable people feel the boundaries at home between their work and family roles are, the more negative spillovers they will experience into their home. The results in Table 2 support this hypothesis because permeability at work was significantly linked to negative work spillover into home ($r = .24$, $p < .001$) and negative family spillover into work ($r = .42$, $p < .001$). In the same way, permeability at home was significantly linked to negative work spillover into home ($r = .37$, $p < .001$) and negative family spillover into work ($r = .30$, $p < .001$). Therefore, H_{3a} received strong support.

Results in Table 2 also show that the relationship between flexibility at work and work spillover into home was significant but negative ($r = -.09$, $p < .05$). However, no significant relationship was found between flexibility at work and family spillover into work. On the other hand, flexibility at home was significantly and positively linked to work spillover into home ($r = .15$, $p < .001$), but was not associated with family spillover into work. This suggests that the more flexibility people have at work, the less often work will spill over into their home. In contrast, the greater the flexibility at home, the more work spills over into home. Thus, H_{3b} was partly supported.

I proposed in H_4 that the more negative spillover people experience, the more often they will feel job burnout. This hypothesis also was fully supported because the relationships between job

Table 2. Correlation of ICTCI and Other Variables.

	2	3	4	5	6	7	8	9	10
1. ICTCI	.19***	.43***	.14**	.17***	.16***	.11**	.11*	.28***	.21***
2. Permeability at work		.37***	.23***	.11**	.24***	.42***	.24***	.10*	.10*
3. Permeability at home			.20***	.28***	.37***	.30***	.34***	.19***	.09*
4. Flexibility at work				.18***	-.09*	-.06	-.11**	.27***	.09*
5, Flexibility at home					.15***	.02	.18***	.09*	.13**
6. Work spillover into home						.52***	.50***	-.14**	.01
7. Family spillover into work							.42***	-.11**	-.01
8. Job burnout								-.18***	-.02
9. Job satisfaction									.32***
10.Family satisfaction									

Note. *** $p < .001$; ** $p < .01$; * $p < .05$; $N = 612$

burnout and negative work spillovers into home ($r = .50$, $p < .001$) and family spillover into work ($r = .42$, $p < .001$) were found to be positive and significant.

Furthermore, H_{5a} stated that the more negative spillovers (in either direction) people experienced, the less satisfied they would be with their job and family. The results in Table 2 partially support this hypothesis, in that the more dissatisfied people were with their job, the more work spillover they experienced at home ($r = -.14$, $p < .01$) and the more family spillover they experienced at work ($r = -.11$, $p < .01$). However, no significant relationship was found between family satisfaction and work spillover at home or family spillover at work. Therefore, H_{5a} was only partially supported. As expected, the data also revealed that work satisfaction was significantly and negatively linked to job burnout ($r = -.18$, $p < .001$). In contrast, family satisfaction was not. This partially supports the notion, as hypothesized in H_{5b}, that job burnout directly affects work satisfaction, but not necessarily how happy the respondents were at home.

Predicting Negative Spillovers

To capture how specific contextual factors in the multidimensional construct ICTC can explain dependent variables such as negative spillovers, job burnout, and job and family satisfaction, the nine items measured in the ICTCI were used as individual predictors in a series of regression analyses. The results in Table 3 show that work spillover into home was significantly predicted, in order of beta weight, by permeability at home ($\beta = .29$, $p < .001$), hours worked ($\beta = .23$, $p < .001$), permeability at work ($\beta = .15$, $p < .01$), family income ($\beta = -.15$, $p < .01$), flexibility at work ($\beta = -.12$, $p < .01$), and broadband access ($\beta = .10$, $p < .05$). This indicates that individuals experiencing high negative spillovers from work into home tended to have a low family income, long work hours, and broadband access at home, and feel high permeability in the boundaries between their work and family roles and low flexibility in their workplace. Similarly, the results in Table 3 also reveal that negative family spillover into work was significantly related to permeability at work ($\beta = .42$, $p < .001$) and at home ($\beta = .20$, $p < .001$), flexibility at work

Table 3. Regression Analyses of Negative Spillovers and Job Burnout.

	Negative Spillovers		Job Burnout
	Work spillover into home	Family spillover into work	
	β	β	β
Demographics			
Gender (male = 1)	-.02	.10*	-.10*
Age	-.03	-.06	-.19***
Education	.08	.02	.03
Family income	-.15**	-.11*	.01
Occupation (managerial = 1)	.05	.02	.02
Work hours	.23***	.01	.09*
ICTC			
Activity scope	.04	.02	.01
Activity intensity	.03	.04	-.07
Use of traditional media to work at home	-.00	.01	.05
Mobile phone dependency	-.04	.06	.00
Internet dependency	.03	-.08	.03
Goal scope	.02	-.14**	-.05
Mobile phone (1 = 3G; 0 = 2 or 2.5G)	-.02	.06	-.10*
Broadband Internet access	.10*	-.05	.01
Office technologies	-.02	-.02	-.04
Permeability			
At work domain	.15**	.42***	.11*
At home domain	.29***	.20***	.21***
Flexibility			
At work domain	-.12**	-.18***	-.11*
At home domain	.06	.02	.07
Negative Spillovers			
Work spillover into home	--	--	.30***
Family spillover into work	--	--	.14**
R^2	.27	.29	.42
Adjusted R^2	.23	.26	.40
F	8.03***	9.94***	14.78***

Note. *** $p < .001$; ** $p < .01$; * $p < .05$; $N = 612$

(β = -.18, $p < .001$), goal scope (β = -.14, $p < .01$), family income (β = -.11, $p < .05$), and gender (β = .10, $p < .05$). This suggests that people suffering from high family spillover into work tended to be male, have low family income and highly permeable boundaries between their work and family roles both at work and at home, work in a rigid work environment, and feel that the Internet did not help them to accomplish work-related tasks. The results also show that individuals getting burned out in their job tended to be those with high negative spillovers from work into home (β = .30, $p < .001$) and from home into work (β = .14, $p < .01$), with high permeable role boundaries at home (β = .21, $p < .001$) and work (β = .11, $p < .05$), and with little

flexibility at work (β = -.11, $p < .05$). They tended to be young (β = -.19, $p < .001$) and female (β = .10, $p < .05$), and to have anything but a 3G mobile phone access (β = -.10, $p < .05$). This means that the more people find that their job often keeps them away from their family and leaves them feeling tired, and the more family worries and problems distract them at work, the more they will feel burnout. These equations explained 23–40% of the total variance.

Predicting Job and Family Satisfaction

Demographically, as shown in Table 4, job satisfaction was found significantly linked to age (β = .13, $p < .01$), family income (β = .13, $p < .05$), and working hours (β = -.11, $p < .05$). In terms of ICTC, the more people felt that the Internet could help them accomplish work-related tasks (β = .17, $p < .001$) and used traditional media to relax after work (β = .10, $p < .05$), the higher the job satisfaction they reported. High job satisfaction was also related to a highly permeable home boundary (β = .14, $p < .05$) and a highly flexible work environment (β = .11, $p < .05$). As expected, people experiencing low job satisfaction were facing a lot of work spillover into their home (β = -.13, $p < .05$) and a high degree of job burnout (β = -.17, $p < .01$). As for family satisfaction, goal scope (β = .22, $p < .001$) and Internet dependency (β = .15, $p < .01$) were the two most powerful predictors. This means that the more central the Internet was to their lives and the more they valued its usefulness to their work, the more satisfied they were with their family. Furthermore, people who were satisfied with their family tended to be older (β = .20, $p < .001$), with an impermeable boundary that kept work from spilling over into their home (β = -.11, $p < .05$), and high flexibility to deal with work-related tasks at home (β = .11, $p < .05$).

DISCUSSION AND CONCLUSIONS

The current study was built upon studies by Loges and Jung (2001) and Jung et al. (2001), which linked the ICI concept to the digital divide and inequality. Accordingly, I reported on the development of a modified measure called ICTC. This new measure employs a comparable taxonomy of multi-theoretical dimensions conceptualizing the importance of ICTs, especially the Internet, in a person's life in a broad context beyond traditional dichotomous adoption and time- and need-based measures. I believe that this new measure is more complete than previous measures because it includes additional indicators such as Internet access via 3G mobile phones and broadband, reflecting the increasingly ubiquitous Internet.

The results elucidate the role that ICTC can play in influencing negative spillovers, burnout, and job and family satisfaction among a sample of office workers. At the bivariate level, the evidence from this study suggests that increased ICTC is associated with increases in all other variables. In fact, I hypothesized and confirmed that ICTC is as important as other factors, such as demographics, permeability, and flexibility, in predicting the negative spillovers of work into home and home into work, job burnout, and job and family satisfaction. At the multivariate level, ICTC predictors, such as broadband and Internet-enabled mobile phone access, goal scope, use of traditional media, and Internet dependency, had significant effects on all of the dependent variables tested in the parallel regression analyses. The regression results also show that negative spillovers and burnout were especially and heavily associated with the permeability and flexibility of the work–family borders. In particular, these results indicate that high permeability at work and

Table 4. Regression Analyses of Job and Family Satisfaction.

	Job Satisfaction	Family Satisfaction
	β	β
Demographics		
Gender (male = 1)	-.04	-.02
Age	.13**	.20***
Education	-.02	-.03
Family income	.13*	-.08
Occupation (managerial = 1)	-.04	.05
Work hours	-.11*	-.04
ICTC		
Activity intensity	.05	.01
Activity scope	.01	.05
Use of traditional media to work at home	.10*	-.07
Mobile phone dependency	-.00	.02
Internet dependency	.01	.15**
Goal scope	.17***	.22***
Mobile phone (1 = 3G; 0 = 2 or 2.5G)	.03	.09
Broadband Internet access	-.01	-.06
Office technologies	.07	.06
Permeability		
At work domain	.00	.08
At home domain	.14*	-.11*
Flexibility		
At work domain	.11*	-.01
At home domain	.03	.11*
Negative Spillovers		
Work spillover into home	-.13*	.09
Family spillover into work	-.01	-.02
Job burnout	-.17**	-.04
R^2	.24	.15
Adjusted R^2	.22	.11
F	6.65***	3.10***

Note. *** $p < .001$; ** $p < .01$; * $p < .05$; $N = 612$

at home, and low flexibility at work, rather than ICTC, are much stronger influences in increasing negative spillover. The findings here underscore that ICT connectedness may not be the main issue when assessing the consequences associated with ICT use; rather, individual control over what passes through the work–home boundaries shapes the consequences people experience. Incorporating measures of individual control over how ICTs are used might be a fruitful direction for future research.

It is interesting to note that broadband Internet access predicted work spillover into homes. This suggests that people are under the impression that with broadband, they could do their work later, when they get home, because broadband at home is as efficient as the

network in their office. The results also show that ownership of a mobile phone was an important predictor of job burnout because with a mobile phone, workers are in constant touch with their family and office; this could mean that their job is no longer 9-to-5 but, instead, a 24/7 obligation to their supervisors. Furthermore, people whose Internet use is not motivated by their desire to accomplish work-related tasks, get advice, and take care of family affairs while at work, but instead is, for example, for entertainment or socialization, tend to have a lot of negative spillover from home to work. Consequently, such Internet use, compared to other uses, might diminish the Internet's power to get things done at home, just like at the office.

The data also indicate that individuals becoming burned out with their job tended to be young females with mobile phone access, a high level of negative spillovers from work into home and from home into work, highly permeable role boundaries between work and home, and little flexibility at work. This might be because female workers retain primary responsibility for household and family matters (e.g., child care and domestic duties within the home), which can lead to frustration, stress, and feelings of failure for them (Christensen, 1988; Costello, 1988).

Regression analysis identified nine predictors to explain job satisfaction. Compared to other employees, employees satisfied with their job tended to be older, have a high family income, work fewer hours, and feel that the Internet could help them accomplish work-related tasks and that traditional media could help them relax after work. More importantly, people who were satisfied with their job tended to have a highly permeable boundary at home and a highly flexible work environment. On the contrary, people experiencing low job satisfaction were facing considerable work spillover into their home and a high level of burnout. The positive result in the multivariate context between permeability at home and satisfaction at work seems to conflict with Clark's (2002a) finding that high permeability reduces satisfaction. This may be due to the fact that impermeable boundary at home may protect quality family time from being invaded by work-related matters, but having little or no cross-border communication at home will create work-family conflict and subsequently job dissatisfaction.

As for family satisfaction, the more central the Internet was to the respondents' lives and the more they valued its usefulness in their work, the more satisfied they were with their family. Furthermore, people who were satisfied with their family tended to be older, to have an impermeable boundary to prevent work from penetrating into their home, and to be highly flexible to deal with work-related tasks at home. These findings confirm the notion by Clark (2002b) that the best combination of flexibility and permeability that would lead to the lowest levels of work-family conflict is an environment that has high flexibility but low permeability. Moreover, this finding is also in line with Rau and Hyland's (2002) argument that flextime allows for a flexible but impermeable boundary, so it should be valued by those with considerable work–family conflict because flexibility helps them to cope with work–family conflict, whereas permeability aggravates conflict.

It is also worth noting that boundary permeability in the home domain predicting job satisfaction was positive, but it was negatively correlated with family satisfaction. This finding supports Clark's (2002a) study, which found that the permeability of home borders might have been more likely to allow work to disrupt home life than the permeability of work borders allowing home life to disrupt work.

The present study enlightens researchers and practitioners regarding job burnout and job dissatisfaction but, like any study, it has inherent limitations. The study utilized cross-sectional data, and therefore cannot confirm the direction of causality implied in the

regression model. Although this and prior research have supported the directions of the individual relationships posited in this study, I encourage future research using longitudinal data to test the model as a whole in cross-cultural and cross-generational settings. Because there was a small skew of the sample toward managers and administrators, future studies should include a more balanced group of workers. To further improve the multi-item ICTCI scale, future study should also include specific work related applications of social media (e.g., Facebook, blogs, Twitter, Linkedln, and Dropbox) to examine their impacts on spillovers, job burnout, and job satisfaction.

These findings have implications for practice particularly within the IT fields. The high demand for talented information workers in today's labor market makes retaining valued IT professionals a crucial concern for many organizations. Therefore, effective management that contributes to job and family satisfaction, and to retaining valued information workers, is imperative. Intervention at the managerial level should identify the best combination of permeability and flexibility, which are the root causes of negative spillovers of work into home and home into work. These spillovers will subsequently affect the causes of workers' burnout, job dissatisfaction, and even possible resignations. Interventions tailored to this group of workers should include such things as crisis intervention, stress management, family relations, and family counseling, to work effectively with these sampled office workers.

ENDNOTES

1. Computer-assisted telephone interviewing (CATI) technique was used. It was not an automated, prerecorded voice, push-button responses technology.
2. A US$40,000 annual family income is approximately HKD26,000 a month. This means that over 60% of the sample were in the upper lower class.

REFERENCES

Ashforth, B. E., Kreiner, G. E., & Fugate, M. (2000). All in a day's work: Boundaries and micro role transitions. *Academy of Management Review*, *25*, 472–491.

Ball-Rokeach, S. J. (1998). A theory of media power and a theory of media use: Different stories, questions, and ways of thinking. *Mass Communication and Society*, *1*, 5–40.

Christensen, K. (1988). A hard day's work in the electronic cottage. In T. Forester (Ed.), *Computers in society* (pp. 17–21). Guilford, CT, USA: Duskin.

Clark, S. C. (2000). Work/family border theory: A new theory of work/family balance. *Human Relations*, *53*, 747–770.

Clark, S. C. (2002a). Communicating across the work/home border. *Community, Work, and Family*, *5*, 23–48.

Clark, S. C. (2002b, September). *Borders between work and home, and work/family conflict*. Paper presented at the annual meeting of the Academy of Management Conference, Denver, Colorado, USA.

Costello, C. (1988). A case study of work and family. In K. Christensen (Ed.), *The new era of home-based work: Directions and policies* (pp. 135–145). Boulder, CO, USA: Westview.

Daly, K. J. (1996). *Families and time: Keeping pace in a hurried culture*. Thousand Oaks, CA, USA: Sage.

Desrochers, S., Hilton, J. M., & Larwood, L. (2005). Preliminary validation of the work-family integration-blurring scale. *Journal of Family Issues*, *26*, 442–466.

Dilworth, J. E. L. (2004). Predictors of negative spillover from family to work. *Journal of Family Issues*, *25*, 241–261.

Dowler, K. (2005). Job satisfaction, burnout, and perception of unfair treatment: The relationship between race and police work. *Police Quarterly*, *8*, 476–489.

Duxbury, L. E., & Higgins, C. A. (1991). Gender differences in work-family conflict. *Journal of Applied Psychology*, *76*, 60–74.

Frone, M. R. (2003). Work-family balance. In J. C. Quick & L. E. Tetrick (Eds.), *Handbook of occupational health psychology* (pp. 143–162). Washington, DC, USA: American Psychological Association.

Galinsky, E., Kim, S. S., & Bond, J. T. (2001). *Feeling overworked: When work becomes too much*. New York: Families and Work Institute.

Grzywacz, J. G., & Marks, N. F. (2000). Reconceptualizing the work-family interface: An ecological perspective on the correlates of positive and negative spillover between work and family. *Journal of Occupational Health Psychology*, *5*, 111–126.

Haddon, L., & Silverstone, R. (2000). Information and communication technologies and everyday life: Individual and social dimensions. In K. Ducatel, J. Webster, & W. Herrmann (Eds.), *The information society in Europe: Work and life in an age of globalization* (pp. 233–257). Lanham, MD, USA: Rowman and Littlefield.

Hall, D. T., & Richter, J. (1988). Balancing work life and home life: What can organizations do to help? *Academy of Management Executive*, *3*, 213–223.

Hayes, C. T., & Weathington, B. L. (2007). Optimism, stress, life satisfaction, and job burnout in restaurant managers. *The Journal of Psychology*, *14*, 565–579.

Hill, E. J., Ferris, M., & Martinson, V. (2003). Does it matter where you work? A comparison of how three work venues (traditional office, virtual office, and home office) influence aspects of work and personal/family life. *Journal of Vocational Behavior*, *63*, 220–241.

Hill, J. E., Hawkins, A. J., Ferris, M., & Weitzman, M. (2001). Finding an extra day a week: The positive influence of perceived job flexibility on work and family balance. *Family Relations, 50*, 49–58.

Jung, J. Y., Qiu, J. L., & Kim, Y. C. (2001). Internet connectedness and equality: Beyond the "divide." *Communication Research, 28*, 507–535.

Kraut, R., Patterson, M., Lundmark, V., Kiesler, S., Mukopadhyay, T., & Scherlis, W. (1998). Internet paradox: A social technology that reduces social involvement and psychological well-being? *American Psychologist*, *53*, 1017–1031.

Lee, J. S. Y., & Akhtar, S. (2007). Job burnout among nurses in Hong Kong: Implications for human resource practices and interventions. *Asia Pacific Journal of Human Resources, 45*, 63–84.

Leung, L. (2004). Societal, organizational, and individual perceptual factors influencing the adoption of telecommuting in Hong Kong. In P. S. N. Lee, L. Leung, & C. Y. K. So (Eds.), *Impact and issues in new media: Toward intelligent societies* (pp. 149-171). Cresskill, NJ, USA: Hampton Press.

Leung, L. (2010). Effects of Internet connectedness and information literacy on quality of life. *Social Indicators Research, 98*, 273–290.

Leung, L., & Lee, P. S. N. (2005). Multiple determinants of life quality: The roles of Internet activities, use of new media, social support, and leisure activities. *Telematics and Informatics*, *22*, 161–180.

Lewis. S., & Cooper, C. L. (1999). The work-family research agenda in changing contexts. *Journal of Occupational Health Psychology, 4*, 382–393.

Loges, W. E., & Jung, J. Y. (2001). Exploring the digital divide: Internet connectedness and age. *Communication Research, 28*, 536–562.

Mankin, D., Cohen, S., & Bikson, T. (1996). *Teams and technology: Fulfilling the promise of the new organization*. Boston: Harvard Business School Press.

Maslach, C., & Jackson, S. E. (1986). *Maslach burnout inventory manual* (2nd ed.). Palo Alto, CA, USA: Consulting Psychologists Press.

Moore, J. E. (2000). One road to turnover: An examination of work exhaustion in technology professionals. *MIS Quarterly, 24*, 141–169.

Nilles, J. (1998). *Managing telework: Strategies for managing the virtual workforce*. New York: John Wiley.

Ossebaard, H. C. (2000). Stress reduction by technology? An experimental study into the effects of brain machines on burnout and state anxiety. *Applied Psychophysiology and Biofeedback, 25*, 93–101.

Pines, A. (1993). Burnout: An existential perspective. In W. B. Schaufeli, C. Maslach, & T. Marek (Eds.), *Professional burnout: Recent developments in theory and research.* Washington, DC, USA: Taylor and Francis.

Pleck, J. H. (1977). The work-family role system. *Social Problems, 24*, 417–427.

Rakow, L. F., & Navarro, V. (1993). Remote mothering and the parallel shift: Women meet the cellular telephone. *Critical Studies in Mass Communication, 10*, 144–157.

Rau, B. L., & Hyland, M. M. (2002). Role conflict and flexible work arrangements: The effects on applicant attraction. *Personnel Psychology, 55*, 111–136.

Roehling, P. V., Moen, P., & Batt, R. (2003). Spillover. In P. Moen (Ed.), *It's about time: Couples and careers* (pp. 101–121). Ithaca, NY, USA: Cornell University Press.

Smilkstein, G. (1978). The family APGAR: A proposal for a family function test and its use by physicians. *Journal of Family Practice, 6,* 1231–1239.

Smilkstein, G., Ashwork, C., & Montano, D. (1982). Validity and reliability of the family APGAR as a test of family function. *Journal of Family Practice, 15*, 303–311.

Spector, P. E. (1997). *Job satisfaction: Application, assessment, causes and consequences*. Thousand Oaks, CA, USA: Sage.

Sproull, L. S. (2000). Computers in U.S. households since 1977. In A. D. Chandler, Jr. & J. W. Cortada (Eds.), *A nation transformed by information* (pp. 257–280). London: Oxford University Press.

Valcour, P. M., & Hunter, L. W. (2005). Technology, organizations, and work-life integration. In E. E. Kossek,& S. J. Lambert (Eds.), *Managing work-life integration in organizations: Future directions for research and practice* (pp. 61–84). Mahwah, NJ, USA: Erlbaum.

Ventura, M. (1995). The age of interruption. *Family Therapy Network, 19*, 19–31.

Weil, M. M., & Rosen, L. D. (1997). *Technostress: Coping with technology @ work @ home @ play*. New York: Wiley.

Zedeck, S. (1992). Introduction: Exploring the domain of work and family concerns. In S. Zedeck (Ed.), *Work, families, and organizations* (pp. 1–32). San Francisco: Jossey-Bass.

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USER EXPERIENCE AS A CHALLENGE FOR COGNITIVE PSYCHOLOGY AND ERGONOMICS

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Abstract: *Research on human–technology interaction has been concerned with assessing the experience of interacting with technology that is already in the process of being designed. However, the challenge nowadays is to help industry find out what technology should be designed. In this new context, cognitive psychology and ergonomics should be able to assist the innovation process through an analysis of the actions that constitute human life and the role that technology plays in these actions. In this paper, we present our approach to the definition of the role of cognitive psychologists and cognitive ergonomists in the innovation process. We aim to define new concepts and methodologies that would help in the process. One example, taken from a research project from a Spanish consortium of universities and industries, is described*

Keywords: *user experience, innovation, cognitive psychology, cognitive ergonomics.*

INTRODUCTION

Traditionally, usability approach research has been guided by one primary question: How well do users interact with technology? Thus, researchers have evaluated parameters such as efficiency, effectiveness, and satisfaction in order to address any problems users have had during interaction. As a result, the variables that have interested researchers were the number of errors, time to complete the task, and so on. The core issue of usability studies has been, therefore, the evaluation of interaction process and overall performance (Hassenzahl & Tractinsky, 2006; Light, 2006).

This traditional view of human–technology interaction originated from the work of cognitive psychologists in the fields of ergonomics and human factors in applied contexts, where people used the technology. In such contexts, users served as workers who had to interact with technology to perform tasks. Thus, cognitive psychology and cognitive ergonomics researchers were applying successfully their knowledge from the information processing models of human performance to predict users' efficiency, effectiveness, and satisfaction. Thus, the task and the consequent performance were the primary objects of investigation. Data were collected about

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how this task was accomplished, with cognitive economy, stress avoidance, and error reduction as the relevant goals in the interaction process. Technology was considered well designed if people could interact with it and meet their work goals in a reasonable time and with relatively low cost in terms of the cognitive resources invested.

However, researchers and industry have come to realize that when research moves out of the work context, it meets abundant situations in which the user may or may not want to use technology. Thus, even though users use technologies such as computers, trucks, diggers, airplanes, and so on, to perform their tasks on the job, they might or might not use mobile phones to talk with friends or, for instance, to play videogames. In other words, they might or might not use a mobile phone independently of how effective, efficient, and satisfactory their interaction is with it. Therefore, researchers have begun to consider the "something else" that engages users in technology when they do not need it for performing work tasks (Gaver & Martin, 2000; McCarthy & Wright, 2004).

Nowadays, especially in the academic community, a shift is taking place regarding the actual needs for evaluating interaction with technology. The focus is changing from the evaluation of user performance and technology itself to the exploration of human sense-making processes (or values, Kaasinen 2005, 2009) and positive experiences during technology use, or even before the prototype release. Although it is not possible to design experiences, technology designers have come to realize, instead, that it is possible to design for experiences, that is, for supporting and inducing them (Hassenzahl, 2011). As Norman (2011, para. 2) affirms, "Design, it has been said (Krippendorff, 1989) is creation of meaning, and … the essence of meaning to us people is our experiences." The fact that technologies work well "is a means, not an end. The end is the experiences they engender, the stories we tell, and the way that they enriched our lives" (para. 3).

Therefore, technological designers must consider human experiences. In actuality, human needs can be satisfied through products having qualities quite distinct from efficiency and effectiveness, such as beauty or novelty (Wright, McCarthy, & Meekison, 2003). These matters have been known since the early discussions involving behavioral usability versus emotional usability (Logan, Augaitis, & Renk, 1994). Where the former is more related to the traditional work of usability assessment in terms of efficiency, effectiveness, and satisfaction, the latter deals with other needs such as enjoyment, entertainment, involvement, or personal stimulation. Emotional usability evaluations assess whether a particular design solution affords a positive, exciting, and satisfying experience by considering the emotions resulting from technology interaction. Hedonic qualities of artifacts indeed play a key role in the process of interaction, especially in technologies devoted to recreation and entertainment. For example, a hedonic artifact, such as a game console, could be designed in a way that decreases the user's mistakes when interacting with it, but what is the value if such a design results in the user becoming bored while playing video games? Similarly, a design could present significant novelty to the user in the short run, but its use could decrease in the long run if the product itself does not fit in the user's form of life (Leikas, 2009). Life-based design aims at releasing technology that will be widely accepted by people because their way of living, needs, and everyday contingencies have been explored and integrated into the design process as the actual drivers of satisfactory and desirable technology interaction processes.

Thus a parallelism between the early stages of design for work technology versus hedonic technology could be established. When designing a technology for professional activities (e.g.,

a control panel), task analysis plays a key role in determining functional and system requirements of the final product. But when designing hedonic technology (which also could relate to home contexts, etc.), the investigation of the form of life of the potential end users is the key to successful design.

USER EXPERIENCE

For the reasons discussed so far, researchers have changed their focus of attention towards a vision of interaction in which concepts such as emotion, motivation, hedonic experiences, and so forth, are being evaluated in conjunction with effectiveness, efficiency, and satisfaction (Obrist et al., 2011). This new vision has been called user experience evaluation to mean that interaction with technology is part of the human experience when acting in life (Blythe, Overbeeke, Monk, & Wright, 2003; Blythe, Wright, McCarthy, & Bertelsen, 2006; Vermeeren et al., 2010). Therefore, we could say that user experience (UX) is an extension of the traditional usability approach to human–technology interaction research that includes the user's psychological, sociological, and cultural experiences with technology (Lai-Chong Law, 2011). The goals of a UX evaluation seem to be quite similar to those of life-based design. In fact, we think that the interest in designing appropriate technologies for positive experiences by end users is an objective shared by the two perspectives. This overlap is even clearer when designers do not have a specific technology in mind but try to envision it by preliminary studies of potential users' habits, current problems, and actual, available solutions. We will come back to this point later in the text.

Enclosing the notion of UX within a specific discipline is difficult at best. Its multidisciplinary nature has delivered to the scientific debate a collection of definitions deriving from several perspectives. UX can be considered, simultaneously, a phenomenon, a field of study for evaluating different design solutions, or a design practice (Roto, Law, Vermeeren, & Hoonhout, 2011). In this last sense, envisioning UX could represent a preliminary phase to understanding how a technology could be designed to meet specific needs, both instrumental and noninstrumental. Despite the variety of UX definitions, fruitful efforts have been realized regarding consensus on a general definition and various aspects of UX (Law et al., 2009).

However, researchers evaluating UX typically are working in situations in which they know the technology to be evaluated. Sometimes they have only a conceptual description of the technology to be designed, but other times researchers have already a prototype of the device to be evaluated (Korhonen, Arrasvuori, & Väänänen-Vainio-Mattila, 2010). In either case, they need to know exactly how this technology will fit into user actions and to evaluate it from the standpoint of usability and UX.

But if usability and UX clearly differ from each other in terms of objectives, methods, and the nature of collected data, important differences exist even among UX approaches. UX intended as the direct (or indirect) knowledge of a situation, context, or concept by means of a system (a product, service, or artifact) can include studies of both experiences deriving directly from interaction with commercial products and prototypes and surveys on imagined situations derived from early concept ideas (Obrist, Roto, & Väänänen-Vainio-Mattila, 2009). This latter case represents the challenge designers are facing nowadays, and the clearest similarity to life-based design field.

OUR APPROACH

Although research on UX during interaction is very productive, mostly due to the application of psychological, sociological, and anthropological knowledge, researchers now realize that it is necessary to move one step further. What industry and society are asking now from cognitive psychologists and ergonomists is assistance on the process of technology innovation. In such situations, researchers must start with no assumptions regarding what kind of technology people would like to enhance their lives, but rather envision what that technology could be. The valuable contributions in the methods and techniques that explore (user) experiences with technologies through UX subjectivity and an emphasis on qualitative data (as, e.g., the combination of interviews and discourse analysis, as in Light, 2006, or the use of the novel in early design phases, as in Wright & McCarthy, 2005) are welcome. However, an even greater need exists in supporting design before conceiving any specific technology in order to orientate it towards the most desirable and fitting solutions.

Of course, people should be able to use the technology that we might foresee in an efficient, effective, and satisfactory way while having a positive experience during interaction. However, one aim of this paper is to underscore that researchers must be able to foresee effectively and reliably what kind of technology design is needed in a specific use situation so that it can be evaluated for UX later.

Therefore, the challenge for cognitive psychology and cognitive ergonomics is to develop theoretical knowledge and methodologies for supporting the innovation process that precedes UX evaluation. Achieving this requires researchers to figure out the key aspects that an interaction process could undergo in an innovative redesign process. The future interactions deriving from this early phase of design will constitute the background for UX evaluations, that is, trying to capture human feelings and sense-making processes during a finite period of interaction (Hassenzahl, 2008). The challenge deals not only with new user interface (UI) design methods, but also with new theoretical knowledge and methods able to channel subsequent design choices. In this sense we emphasize the intention to design for experiences.

The research that we are conducting at the University of Granada seeks to address the new issues that technology innovation is raising. We are analyzing the foundations of cognitive psychology and cognitive ergonomics to identify the "right" questions that must be answered.

One of these questions refers to the meaning of "world experience." If interaction with technology involves the totality of human experience, cognitive psychologists and cognitive ergonomists must start their analysis by asking what they mean by the concept of the user experiencing the world.

In our opinion, the answer to that question derives from the fact that human beings experience the world while acting in the world. Experience does not exist without acting. Even when a human dreams, she/he is acting within the dream. Therefore, we view human action as the unit of analysis. Human interaction with an artifact is a human action. In other words, we posit that the unit of analysis is never, for example, my interaction with a pencil, but rather my act of writing a letter. The pen, paper, eraser, and so on, are objects designed to be used during the act of writing. Thus, we believe that any new technology will always serve a single purpose: to help people act in the world. By extension, then, technology must help people to confront challenges in acting in the world. Without a person facing a challenge while acting in life, there is no—and no need for—innovation.

This reasoning is in line with cognitive theories of creative processes. The results of cognitive research on creativity show that people are more creative when they face conditions that impose limitations or constraints on the outcome that the people feel is appropriate for a particular situation. An example of this in the design field is the UA^{2}W (Universal Access Assessment Workshop) by Akoumianakis and Stephanidis (2005), in which some limitations are progressively introduced in a reference scenario in order to figure out new, alternative interactions that guarantee accessibility to special needs users. Such research findings suggest that creativity results when people find a useful object created in a category that they have not seen before. This constraint leads them to disregard the possibility of using a more conventional (and less creative) process from memory retrieval. In short, the experimental results from cognitive psychology (Finke, 1990; Ward, Smith, & Finke, 1999) indicate that a person can be forced into thinking in new and imaginative ways if researchers can prevent that individual from using his/her memory to provide a usual explanation or utility. Therefore, the focus of our work is exploring and implementing a new methodology for helping in the innovation process through imposing limits on the actions people experience in their daily lives.

A CASE STUDY: COMMTINUITY

Our research group participates in a government-funded project lead by the Telefónica Company (Proyecto mIO!) on technology innovation, together with other Spanish universities and industries. Our specific role in this project is to surface opportunities for designing new technologies by applying psychological knowledge and reasoning.

In the context of this project, a Telefónica engineering team is developing several concepts that would guide the process of innovation. One of these concepts is *continuity*,[1] expressed with the term *Commtinuity* to denote continuity within communication technologies. In the project, we posit that continuity exists whenever an activity being conducted through using a device can continue when using a different device. The project explores several interaction paradigms that involve, for instance, augmented reality and gesture interaction by the use of new devices, such as cameras, digital sensors, or multitouch displays. Therefore, work on continuity is needed, both in terms of modeling for the technological implementation of such design solutions (Faconti & Massink, 2000) and identifying the *discontinuities* that arise from the run time use of a system (Graham et al., 2000). In HTI (human–technology interaction), the concept of continuity could be interpreted as the opposite of the concept of plasticity. Borrowing the concept from science of materials, where it indicates the property of materials that expand and contract under natural constraints without breaking and preserving continuous usage, plasticity in HTI has been defined as the capacity of an interactive system to withstand variations of context of use while preserving usability (Calvary, Coutaz, & Thevenin, 2000). In a more extensive way, it could be said that plasticity is when a single artifact can be modified and adapted to a new activity (not only to a new context). For example, a device that is a phone in one context and a text editor in a different situation would have plasticity. By contrast, continuity refers to different devices that could replace each other for the user to continue with the same activity in different situations and contexts. For example, one could start to write an e-mail with a laptop and then continue with a tactile keyboard in a tablet, once electronic mail is accessed and the draft e-mail retrieved.

Figure 1 shows an example of continuity with a communication technology, as intended in the aforementioned project. When talking on the phone while walking down the street, a person is doing two things simultaneously: talking via mobile telephone technology and walking. Upon reaching his/her car, the walking action stops and the driving action starts. However, the talking action via hand-held technology may need to continue while driving. However, in many countries, this action is illegal. Therefore, some cars are now enabled to detect the Bluetooth capability in a mobile phone, and so the talking activity is immediately transferred to the car when the driver enters. Thus the talking activity is no longer mediated by the hand-held phone but through the car. In line with this type of conceptual development, one of our tasks in the project is to develop a methodology that, based on the concept of continuity, can afford the discovery of new technologies.

The methodology we are developing, in which discontinuities are identified and analyzed in terms of context, user, and platform (or system, Roto et al., 2011), consists of two parts. In the first part, researchers and participants elaborate familiar scenarios of use in which actions could be interrupted by a variety of circumstances. In the second part, researchers ask participants to imagine ways of continuing the actions beyond those interruptions. These two method parts are detailed in the next subsections.

Part I: Characterization

In this first part of the method, researchers and participants perform multiple steps. Researchers elaborate scenarios. These scenarios are not complete records, but rather brief descriptions of some activities done in the home. Participants[2] are encouraged to add information that can characterize the scenario better from their perspective.

Figure 1. An example of continuity: Talking via mobile technology does not need to end when driving a car. Photos in clockwise order, from the left: © Stuart Jenner | Dreamstime.com, © Diego Vito Cervo | Dreamstime.com, and © Pauo Resende | Dreamstime.com

1. Researchers read one scenario at a time to the participants.
2. Participants are asked to think about their daily lives and the activities and subactivities involved in that scenario. This phase represents the *task analysis* of the macroactivity proposed by the reference scenario, and it is carried out directly by participants whose proposals are strongly linked to personal, usually direct, experiences. The tasks are identified and agreed on in a group discussion. For example, in relation to the activity "watching TV," some activities could be channel surfing (i.e., to scan channels until something interesting is found), checking out a program, purchasing a program or game via pay-per-view, and so on.
3. Participants then define a set of limits or filters that could act as agents of change by preventing continuity, leading to an interruption in/disruption to the flow of operations within the specific activity. Like the scenarios themselves, these filters are detailed by the participants in a group discussion in terms of change of people, platform, or context. For example, in the watching TV activity, a change of platform could be that the remote control does not work and another device is needed.

Part II: Exploration

In this second part of the method, each participant completes a graphic table in which the columns are the subactivities and the rows are the filters. The inner cells are left empty. The researchers ask participants to fill in the cells by answering the following question: Given this activity, and these specific subactivities (table columns), how could you solve the problem created by the specific change factor (table rows)? Table 1 provides some examples for the watching TV activity.

The participants complete their tables by imagining that the activity is interrupted by a change of user, platform, or context. They are encouraged to think freely—even fantastically—in proposing solutions that would be a possible expression of continuity, the primary goal of the activity.

When the participants have completed their suggestions, researchers plot the data gathered through this second phase into a new table. The exploration that follows the previous phases forced the participants to reflect on typical situations of interruptions and on possible technological solutions that would enhance continuity. Then, based on these results, researchers can make suggestions to the designers by helping to envision innovative solutions for the continuity of UX. In this sense, the method helps UX designers to disentangle the users' experiences for which they will design.

One Example on How to Use These Tables

Due to the qualitative nature of the method used, data interpretation may be neither definitive nor entirely objective. Some relativism is inevitable, but this does not represent a limitation. Rather, depending on the practical needs and theoretical interests of the analysts, it is possible to selectively read the data reported in the tables. Participants' proposals can be reworked into various relations or merged into a design scenario according to the need at hand.

Table 1. Excerpted Example of an Activity-Filters Table Derived from a Continuity Case Study.

Participant-identified subactivities		Channel surf	Discuss contents	Mute the volume	Download or purchase content	Consult teletext	Radio	Gaming
Type of change								
User		Customized favorite channels Camera detection system identifies the user Voice detection system identifies the user	Facebook and TV in parallel in TV screen	Mobile phone as remote control Vocal commands	Personalized download of records Facial recognition & personalized menus		Music programming according to mood Personalized contents	
Platform	**Screen**	Synchronization of PC and TV screens			Download to a central server for the household. Access from any screen.	Touch screen		All screens connect to a network. A central server controls access Viewers can access different things
	Remote control			Gesture control				
Context	**Seat**	Screen automatically orients toward user.		Seat "knows" when we fall asleep and turns off the TV	Possibility of control from any place (wi-fi)		Central audio system available throughout house	
	Room	TV program transfers to mobile phone, or iPad.				Small, portable, touch-screen tablet		
	With spouse	Simultaneous programs (2): split screen	The TV recognizes and identifies the people, and adapts content		System for parental advisory, shared by all devices	Access to favorites Split-screen		
	With family							
	With friends							

In this sense, the final tables constitute a reference frame for making suggestions to designers. Proposals made by participants come from thinking about a specific situation and its related discontinuity (introduced by the agents of change). These proposals, then, actually comprise continuity-oriented solutions. As a result, different proposals could be regrouped in the future into a single device, or alternately, a single feature could be replicated in distinct, synchronized devices.

The first implementation of the method within the mIO! project explored four reference scenarios, using four information and communication technologies: mobile phones, TV,

music players, and Internet devices (laptops, tablets, etc.). Results were organized into matrices, such as in Table 1, and then analyzed.

For example, concerning the watching TV activity, the two basic aspects about which most of the technological suggestions were made were the personalization of content and person detection and recognition. These two aspects, optimally implemented, would represent a solution in terms of continuity for situations in which more than one user shares the TV unit, but not necessarily simultaneously. In such a situation, for example, one user might wish to initiate TV programming in the presence of the TV unit but then display it on another screen, such as a laptop. Examples of technologies that have emerged as suggestions on what to customize regarding the recognition of person included

- recognition by camera (facial)
- fingerprint sensors
- the mobile phone as remote control device.

Participants justified their last suggestion with several reasons. First, they noted their ease of use and familiarity with interface. Second, they pointed out that a personal phone readily allows for a sort of automatic customization, meaning automatic detection and recognition, with consequent display of personal data, records, and preferences. Finally, the simplest and most immediate needs for interactions (e.g., mute the volume) could be universal for all phones, making them able to communicate with a TV. Therefore, in reconsidering the allocation of functions of a mobile phone, its use as a remote control could be considered one outstanding result upon which to focus in the near future.

Custom profiles saved in the TV's memory (and displayed when person recognition occurs) have been a key idea for continuity in relation to several content tasks, that is, subactivities involving the search, processing, and handling of information on TV. These tasks usually have a considerable duration. Some examples are

- channel surfing
- consulting the teletext
- downloading/buying content
- listening to the radio.

Participants sometimes made suggestions not directly related to a specific task of those identified, but at a more general level. For example, an aspect of design that could sensibly contribute to enhance continuity was the synchronization of screens (e.g., PC and TV), and multiple screen vision. Such possibilities can generate new interactive processes, mediated by the TV being connected to Web 2.0 technologies.

In short, the lesson for designing devices that facilitate the continuity of UX within the activity of watching TV focuses on attending to customization options and taking into consideration the requirements of universality (i.e., mute capabilities on the mobile phone). We can therefore conclude that optimal customization of downloaded files, searches, and user profiles allow design instruments to assure continuous favorable UX with the TV or other communication technologies.

Technological platform memory for personal preferences and files, and their automatic display in presence of the user, greatly support the many situations in which users change

rapidly, without interruptions or need of manual operations. The continuity of experience gained would facilitate as well multiuser situations and interpersonal and social exchanges.
In summary, results can be analyzed and reanalyzed by using practical needs as the basis, but starting from different points of view, for example, a specific task or a situation generated by a task and an agent of change. Connections between contents can be made by means of a walkthrough of the various result matrices (see Table 1) that represent the primary source for design choices in relation to the scenarios explored.

CONCLUSIONS

After years of successful application of psychological knowledge to the evaluation of UX during interaction with technology, researchers in cognitive psychology and ergonomics are facing a new challenge. What industry and society are asking from these disciplines is help in envisioning and innovating new technologies that could enhance their lives. Beyond the traditional needs for fruitful evaluation of performance during interaction and the assessment of subjective feelings resulting from technology use, newer methods of exploration help in the early phases of design. These methods can provide insights into the contexts and behaviors upon which the innovation process should act.

In our work in the context of innovation projects, we are developing a methodology that can address that challenge. The idea behind this methodology is that innovation is a creative process that occurs when the activities of daily life meet limits or barriers. Research into the cognitive processes that underpin the creative process show that, contrary to popular belief, innovation is not facilitated by freedom of thinking, but rather by the limitations confronted when trying to reach action goals.

Because the purpose of this phase of the project was to work through insights regarding the concept of continuity in UX during interaction with communication technologies, the method proposed was a means to work on the definition of current, typical discontinuities during interaction in terms of the user, platform, and context. Once participants agreed on the tasks to be analyzed and the experience of discontinuities, the method required participants to think of continuous design solutions for the specific situation. The starting point for any suggestion made by participants was an interaction context constrained by the discontinuities previously identified by the participants themselves.

Depending on the conceptual differences existing between the identified tasks and discontinuities, participants will think about situations that are actually different. If there is conceptual overlap between tasks and between discontinuities, proposals will result in being more general and will probably apply to a number of identified subactivities and agents of change. Therefore, during the characterization phase, researchers must encourage participants to avoid focusing on tasks or discontinuities that are significantly similar, in order to cover a wider range of distinct situations.

In future implementations of the method, it is important to keep in mind the granularity of the expected data. In addition, researchers may need to moderate group discussion for the definition of tasks and discontinuities under analysis, so as to focus on explicitly distinct aspects of interaction contexts.

ENDNOTES

1. See http://www.youtube.com/watch?v=BkZyjVFw9w4 for a video demonstration of the concept of continuity.
2. The participants were 6 volunteers (3 males): 2 students, 2 administrative personnel, and 2 researchers from the Faculty of Psychology of the University of Granada. Mean age was 29 years (*SD* = 6.03). Participants knew each other somewhat, but this factor was not considered to affect final results (participants made proposals at an individual level). The implementation took place in a meeting room at the Faculty of Psychology, University of Granada, and lasted 5 hours. When scenarios were introduced for characterization, participants had to confirm they already had experiences with technologies involved, and that those activities were part of their way of living.

REFERENCES

Akoumianakis, D., & Stephanidis, C. (2005). The Universal Access Assessment Workshop (UA^2W) Method. In C. Stephanidis (Ed.), *Universal access in health telematics: A design code of practice* (pp. 99–114). Berlin, Germany: Springer-Verlag GmbH.

Blythe, M., Overbeeke, K., Monk, A., & Wright, P. (Eds). (2003). *Funology: From usability to enjoyment*. Dordrecht, the Netherlands: Kluwer Academic Publisher.

Blythe, M., Wright, P., McCarthy, J., & Bertelsen, O. W. (2006). Theory and method for experience centered design. In *Proceedings of CHI EA '06: CHI '06 Extended Abstracts on Human Factors in Computing Systems* (pp. 1691–1694). New York: ACM.

Calvary, G., Coutaz, J., & Thevenin, D. (2000). Embedding plasticity in the development process of interactive systems. In P. Emiliani & C. Stephanidis (Eds.), *Proceedings of the 6th ERCIM Workshop: User Interfaces for All* (unpaginated). Retrieved November 24, 2011, from http://ui4all.ics.forth.gr/UI4ALL-2000/proceedings.html

Faconti, G. P., & Massink, M. (2000). Continuity in human computer interaction. In *CHI '00 Extended Abstracts on Human Factors in Computing Systems* (p. 364). New York: ACM.

Finke, R. A. (1990). *Creative imagery: Discoveries and innovations in visualization*. Hillsdale, NJ, USA: Erlbaum.

Gaver, W. W., & Martin, H. (2000). Alternatives: Exploring information appliances through conceptual design proposals. In *Proceedings of the CHI 2000 Conference on Human Factors in Computing* (pp. 209–216). New York: ACM.

Graham, T. C. N., Watts, L., Calvary, G., Coutaz, J., Dubois, E., & Nigay. L. (2000). A dimension space for the design of interactive systems within their physical environments. *In DIS '00 Proceedings of the 3rd Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques* (pp. 406–416). New York: ACM.

Hassenzahl, M. (2008). User experience (UX): Towards an experiential perspective on product quality. In *Proceedings of the 20th International Conference of the Association Francophone d'Interaction Homme-Machine* (pp. 11–15). New York: ACM.

Hassenzahl, M. (2011). User experience and experience design. In M. Soegaard & R. F. Dam (Eds.), *Encyclopedia of Human-Computer Interaction* [e-book, unpaginated]. Retrieved November, 7, 2011 from http://www.interaction-design.org/encyclopedia/user_experience_and_experience_design.html

Hassenzahl, M., & Tractinsky, N. (2006). User experience: A research agenda [Editorial]. *Behaviour & Information Technology, 25,* 91–97.

Kaasinen, E. (2005). *User acceptance of mobile services: Value, ease of use, trust and ease of adoption* (VTT Technical Research Centre Publication 566). Helsinki, Finland: Valopaino Oy.

Kaasinen, E. (2009). User acceptance of mobile services. *International Journal of Mobile Human Computer Interaction, 1*, 79–97.

Korhonen, H., Arrasvuori, J., & Väänänen-Vainio-Mattila, K. (2010). Analysing user experience of personal mobile products through contextual factors. In *Proceedings of the 9th International Conference on Mobile and Ubiquitous Multimedia* (*MUM'10*; pp. 1–10). New York: ACM.

Krippendorff, K. (1989). On the essential contexts of artifacts or on the proposition that "Design Is Making Sense (Of Things)." *Design Issues, 5*(2), 9–39.

Lai-Chong Law, E. (2011). The measurability and predictability of user experience. In *Proceedings of the 3rd ACM SIGCHI Symposium on Engineering Interactive Computing Systems* (*EICS '11;*, pp. 1–10). New York: ACM.

Law, E. L. C., Roto, V., Hassenzahl, M., Vermeeren, A. P. O. S., & Kort, J. (2009). Understanding, scoping and defining user experience: A survey approach. In *CHI'09 Proceedings of the 27th International Conference on Human Factors in Computing Systems* (pp. 719–728). New York: ACM.

Leikas, J. (2009). *Life-based design. A holistic approach to designing human-technology interaction* (VTT Technical Research Centre, Publication 726). Espoo, Finland: VTT.

Light, A. (2006). Adding method to meaning: A technique for exploring peoples' experience with technology. *Behaviour & Information Technology, 25,* 175–187.

Logan, R. J., Augaitis, S., & Renk, T. (1994). Design of simplified television remote controls: A case for behavioral and emotional usability. In *Proceedings of the 38th Human Factors and Ergonomics Society Annual Meeting* (pp. 365–369). Boston: ACM Press.

McCarthy, J., & Wright, P. C. (2004). *Technology as experience*. Cambridge, MA, USA: MIT Press.

Norman, D. A. (2011). User experience and experience design [commentary on the User experience and experience design e-book] Retrieved October 28, 2011, from http://www.interaction-design.org/encyclopedia/user_experience_and_experience_design.html#donald+a.+norman

Obrist, M., Law, E. L.-C., Väänänen-Vainio-Mattila, K., Roto, V., Vermeeren, A., & Kuutti, K. (2011). UX research: Which theoretical roots do we build on – if any? In *Proceedings of the 2011 Annual Conference, extended abstracts on human factors in computing systems* (pp. 165–168). New York: ACM. doi: 10.1145/1979742.1979526

Obrist, M., Roto, V., & Väänänen-Vainio-Mattila, K. (2009). User experience evaluation: Do you know which method to use? In *Proceedings of the CHI '09 Conference on Human Factors in Computing Systems* (pp. 2763–2766). New York: ACM.

Roto, V., Law, E., Vermeeren, A., & Hoonhout, J. (Eds.). (2011). *User experience white paper: Bringing clarity to the concept of user experience*. Retrieved November, 7, 2011, from http://www.allaboutux.org/files/UX-WhitePaper.pdf

Vermeeren, A. P. O. S. , Law, E. L. C., Roto, V., Obrist, M., Hoonhout, J., & Väänänen-Vainio-Mattila, K. (2010). User experience evaluation methods: Current state and development needs. In *Proceedings of NordiCHI '10* (pp. 521–530). New York: ACM.

Ward, T. B., Smith, S. M., & Finke, R. A. (1999). Creative cognition. In R. J. Sternberg (Ed.), *Handbook of creativity* (pp. 189–212). New York: Cambridge University Press.

Wright, P. C., & McCarthy, J. C. (2005). The value of the novel in designing for experience. In A. Pirhonen, H. Isomäki, C. Roast, & P. Saariluoma (Eds), *Future Interaction Design* (pp. 9–30). London: Springer.

Wright, P. C., McCarthy, J. C., & Meekison, L. (2003). Making sense of experience. In M. Blythe, A. Monk, C. Overbeeke, & P. C. Wright (Eds), *Funology: From usability to user enjoyment* (pp. 43–53). Dordrecht, the Netherlands: Kluwer.

Authors' Note

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