HUMAN TECHNOLOGY

An Interdisciplinary Journal on Humans in ICT Environments ISSN: 1795-6889

www.humantechnology.jyu.fi Volume 7(3), November 2011, 216–249

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,

URN: NBN:fi:jyu-2011112211713

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, I developed the model in Figure 1.

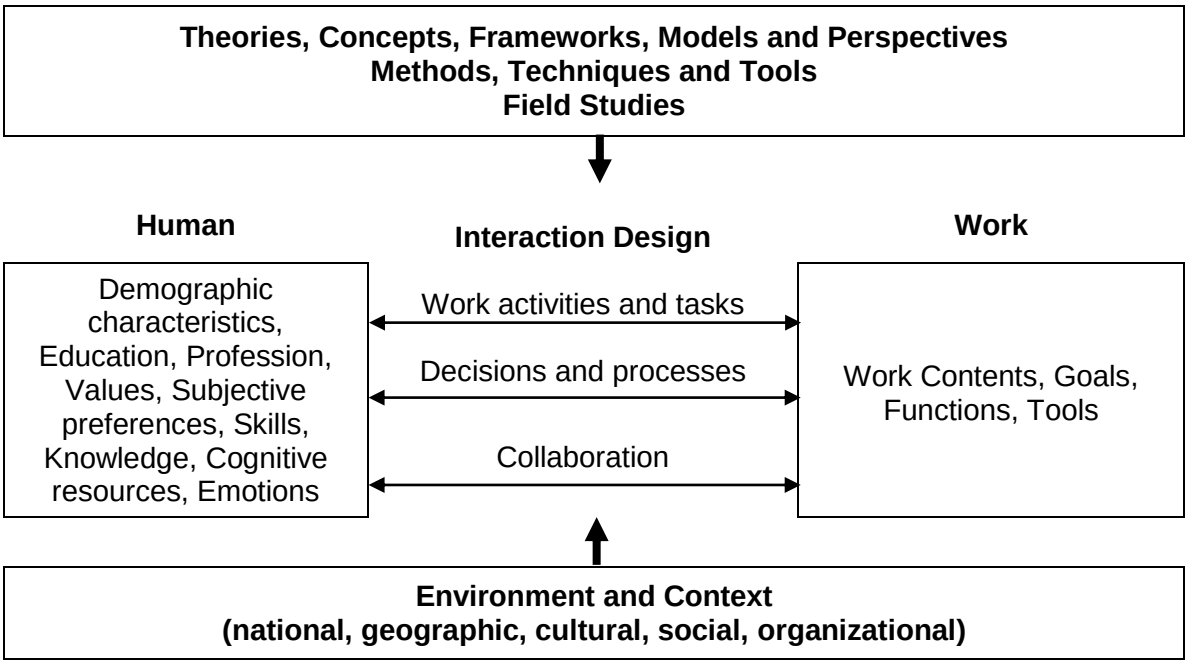

Figure 1. The general HWID framework (Adapted from Orngreen et al., 2008).

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).

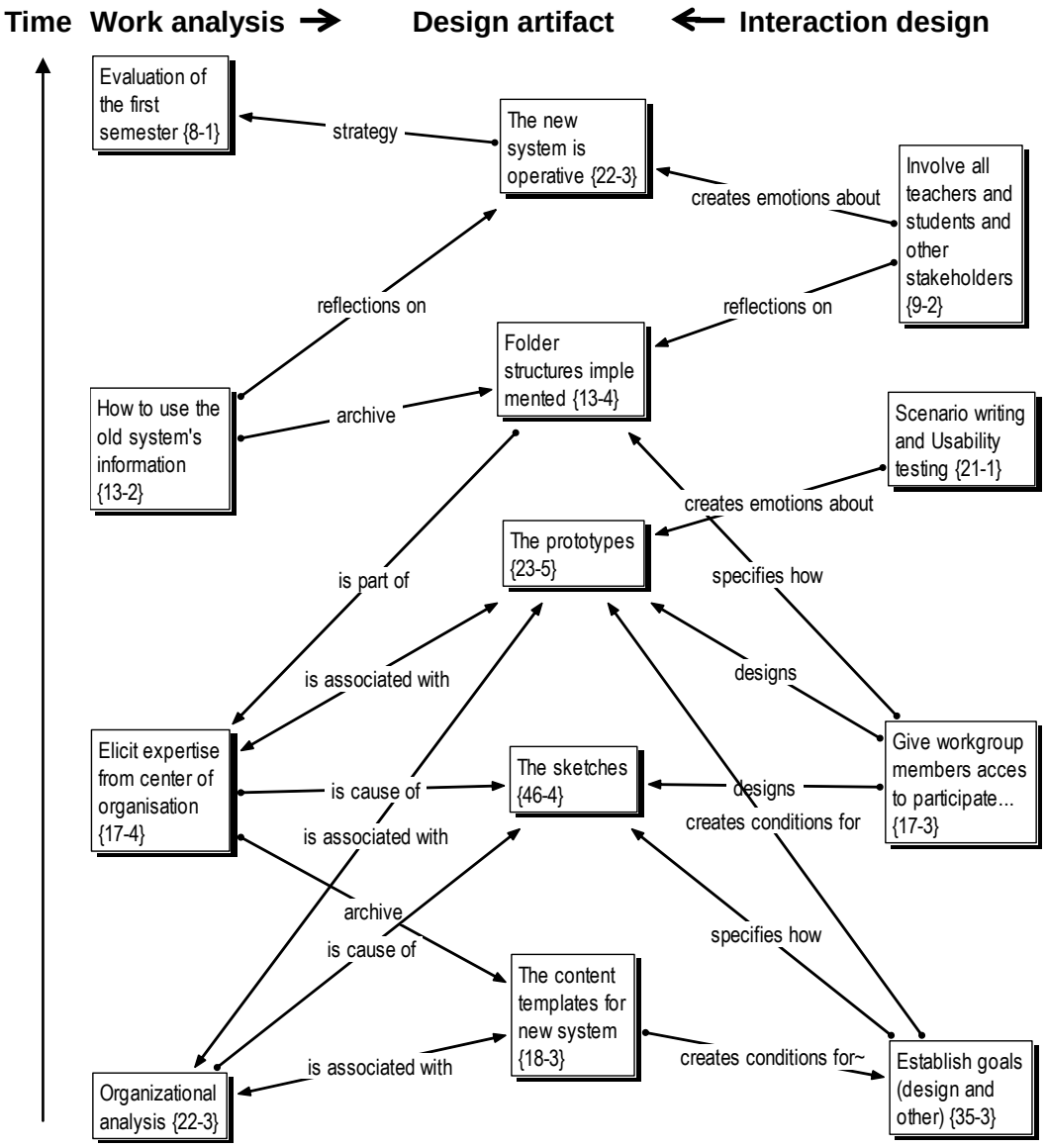

Figure 3. The model of HWID in this study of a case of designing a simple folder structure for a study program. The numbers after the text in the boxes indicate, first, the total number of related quotations arising from the 105 source documents (note that since each quotation can be related to more 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.

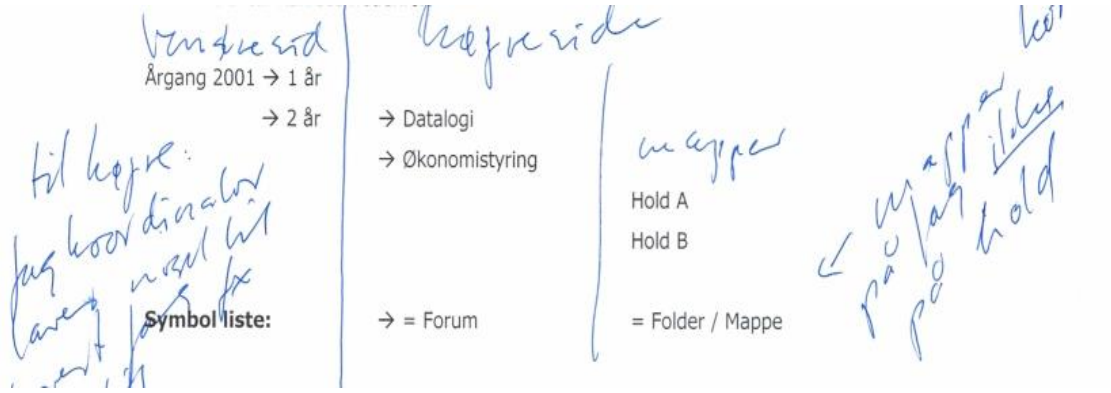

Figure 4. The students' sketch. The typed text is the students' suggestions for a hierarchy in the folder structure, with the top level at the left side and bottom level at the right. The handwritten comments (the author's) are from the discussion when the students explained their sketch to the developer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

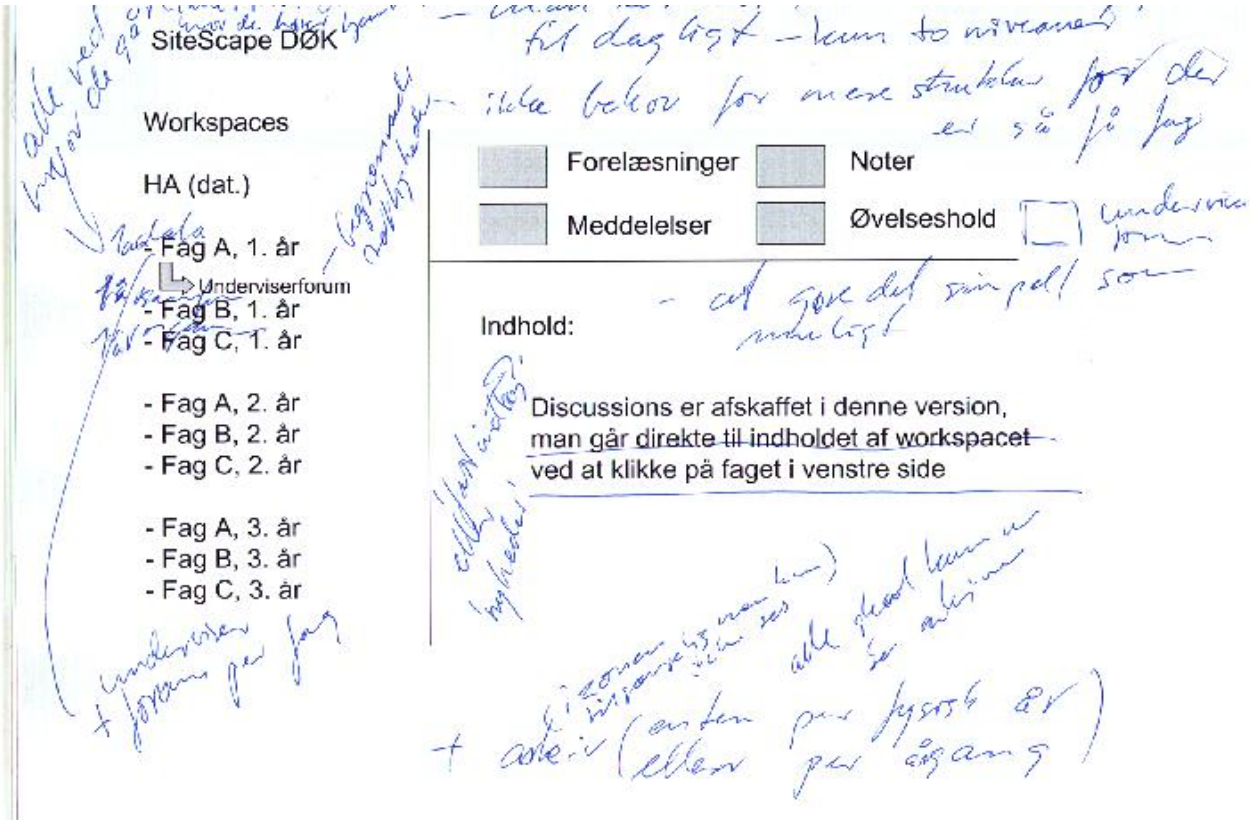

Figure 5. The teachers' sketch**.** The typed text is the teachers' suggestions for a hierarchy in the folder structure, with the top level at the left side and bottom level at the right. The handwritten comments (the author's) are from the discussion when the teachers explained their sketch to the developer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

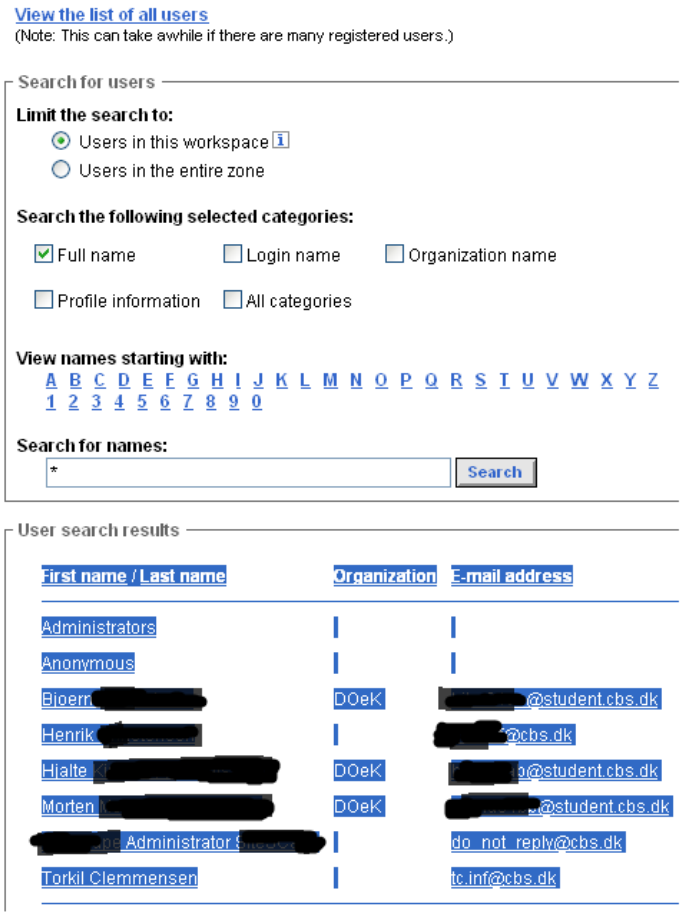

Figure 6. Screen dump of members of the developer group and their access rights in the system.

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.

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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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Human Technology: An Interdisciplinary Journal on Humans in ICT Environments
ISSN 1795-6889
www.humantechnology.jyu.fi

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