Introduction

A common data entry task observed in Study 1 was entering expenses. Office workers receive expense claims from staff, check the information is correct, and enter it, along with other information, into a computer system. They have to enter different types of information such as numbers and alphanumeric strings, these do not all come from the same source, and different sources can have different IACs. For example, some information can be recalled from memory, some has to be typed from a paper sheet, some numbers have to be calculated first, and some information has to be looked up in an electronic information system.

The purpose of this study is to investigate the information sources people need for an expenses task, and how they currently manage subtasks of looking up information from an expenses task. Do they look up information as they need it, or get all the required information first and then enter it? They may also change their strategies as they get more experienced with the task and know where to get the information from, or enter all information that is easy to access first.

Ten finance employees will be observed at their workplace, with a particular focus on the information resources they need and use for entering expense claims into the financial computer system. I will shadow them doing their work, and will ask them to demonstrate the task while thinking aloud. They will be interviewed afterwards and I will ask them questions about observations I made.

In order to better understand how people switch between applications for office work, \citet{Cangiano2009} made screen recordings of workers' activities in a law office. They then played these back to the workers, and asked them to explain their activities. These screen recordings were useful for workers to accurately recall what they were doing at the captured moments, and why they had certain windows open.

One of the advantages of using screen recordings is that it provides a detailed account of activity, however there are also privacy issues and not all participants agree their activity to be recorded \citep{Rule2015}. In a finance setting, there are additional confidentiality issues and participants may not be allowed to share financial data. Participants in the current study will instead be video recorded while doing the expenses task. The video recordings capture the participants' interactions with the artefacts involved in the task, but the financial data on the information sources cannot be identified from these recordings. The video recordings will be used to supplement my written observation notes, and after the observation part of the study, some video segments may get played back to participants and they will be asked to explain what they were doing at certain moments.

Method

Data analysis

At the end of each day, the videos would be played back to complement written observation notes. Interviews were transcribed verbatim. These transcripts and written observation notes were read to get familiar with the data and develop the models in Stage 1. In Stage 2, the transcripts and notes were coded using NVivo.

As the focus is on the distribution of, and access to, information sources in the task environment, distributed cognition was used as a theoretical framework to organise the data and develop models (Hollan et al, 2000).

While distributed cognition is good in understanding complex interdependencies of a system, a criticism of the original framework is that it is difficult to translate findings to design (Furniss&Blandford, 2006). Furniss and Blandford (2006) presented DiCoT (Distributed Cognition for Teamwork) as an approach to facilitate bridging contextual analysis to design considerations. While their approach was specifically focused on teamwork settings, they presented models, inspired by contextual inquiry models (Beyert & Holtzblatt, 1998) which can help applying DC principles in this study as well. For the current study, three of their proposed models were used: a physical model, information flow model, and artefact model.

The physical model models the physical layout of the environment in which the task was done.

The information flow model shows a diagram of how information is processed through the different task stages. The artefact model gives an overview of all artefacts that are used as part of the task.

Based on these models, several design issues are identified which are illustrated by leading quotes.

Findings

Information sources

The external information sources people need for an expenses task are:

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| **Paper** |
| Paper receipts |
| Paper personal file employee |
| Post-its |
| Paper claim forms |
| **Digital** |
| E-mails |
| The expenses entry system |
| Excel spreadsheets |
| Intranet |
| External websites |
| PDF files |
| Calculator |
| Verbal instructions |
| Central forms |
| Locally made copies |
| Colleagues |

The user did not always know beforehand what the cost of accessing a source was going to be.

First, they did not always know which source to use. For example, people in Central Finance had to validate if the person signing off a claim form was authorised to give this signatory. The information to check this could be in a spreadsheet, but was sometimes also in a different PDF file. At other times, this information had to be looked up on the intranet. Second, if people did know which specific source to access, they did not always know the associated cost to access it. If information about a certain employee needed to be looked up, people would go to Google to type in the person’s name. Sometimes they would find the information fairly quickly, but sometimes it would take a while before they found what they needed. Third, even if they did know the specific source and the normal cost, this cost was not always the same. For example, a website could take longer to load than usual.

Strategies

Observed strategies for looking up information were:

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| People make their own local copies of information and do not consult central copies. |
| People with a second screen used this for various reasons.  Even though people often knew the information they were going to need, a second screen was only used to display sources in one instance.  It was more often used for other tasks unrelated to the expenses task, such as checking email, but this was not consulted during the expenses task. This way the primary screen was solely used for entering expenses. As they needed additional information during the task, they used the primary screen to look up this information. |
| People initially look up information as they need it. If they experience it takes too long to look up information, they lay the claim in question to one side to process later. |
| People only self-interrupt to look up information, and defer external interruptions. |
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Models

Physical model

Information flow model

Artefact model

* Table with photos/screenshots video

Issues

Based on the distribution of information across sources, observed strategies, and the descriptive models to lay out the task environment, a number of issues are identified. These are grouped into three areas and illustrated with quotes taken from the interviews.

Local copies of information (Lack of coordination mechanisms)

central copies are too costly to access so people make their own local copies, and work with different information.

Transparency of task information (Limitations in communication bandwidth)

the expenses task involves several departments, but people are not aware of activities in other departments.

The design of the expenses system is inadequate.

In order to prevent people from interrupting the expenses task, people would get logged out of the system after a period of inactive use and all their entered information would be lost. However, people often did not know beforehand what the cost to access information is going to be. Furthermore, it was also not clear after how long this timeout would be.

Discussion

The purpose of this study was to investigate the information sources people need for an expenses task, and how they currently manage subtasks of looking up information from an expenses task. *Do they look up information as they need it, or get all the required information first and then enter it? They may also change their strategies as they get more experienced with the task and know where to get the information from, or enter all information that is easy to access first.*

Summary results

It was not as straightforward to link observed strategies with observed IAC, as the user did not always know beforehand what the cost of accessing a source was going to be.

Information was centrally available, but this was perceived as being difficult to use. As a result, users made their own local copies of information they needed and used these sources instead. Furthermore, procedural information was passed on via colleagues rather than the central information sources. This caused people to use outdated information. Multiple departments were involved in the task. There was no transparency of information and progress of activity, and explicit information exchange was needed. The system had a timeout to prevent long interruptions, but people still looked up information as they needed it. They often did not know the associated IAC and as a result were locked out.

Multiple screens

People dedicated one screen for the expenses task and maximised their window, so it filled the entire screen. This is in accordance with Bi and Balakrishnan (2009), who found that when dealing with two screens, people dedicate one computer screen to the primary task. However, they found that they use a second screen for subtasks. This was also found by Dearman and Pierce (2008)’s study on how people use multiple devices found that people assign sub-tasks to secondary devices to minimise the need to transfer information between devices.

People in the current study often also used their primary screen to look up information for the expenses task, and switched back and forth between maximised windows, rather than look up and display information on the second screen. In contrast, previous studies on the use of multiple screens showed that people dedicated a second screen to look up information (e.g. Bi & Balakrishnan, 2009; Grudin, 2001). Even if people knew beforehand which digital information they were going to need, they often started the task and looked up information as they needed it. For paper information, they did collect all information they knew they were going to need, such as the paper receipts, the claim form, and any additional post-its with instructions.

Whilst there was a possibility to place information on the second screen, this is also time-consuming (Bardram et al., 2006). With paper sources, it is perhaps less time-consuming: no time was spent on arranging the sources on the physical space of the desk, but they were stacked in a pile on their desk or lap and the right source was picked out when needed.

Dearman and Pierce (2008)’s study on how people use multiple devices found that people assign sub-tasks to secondary devices to minimise the need to transfer information between devices. Potentially people used the primary screen for looking up information so the information was on one screen and try could try to copy and paste it. Often though this was either not possible or users chose themselves to manually transcribe it.

People used additional screens for other tasks. For example, the second screen was often used to display the email inbox, but this was not consulted during the expenses task. Even in instances when people had to look up information from an email, they would open their inbox on the primary screen, rather than look it up on the second screen.

Lookup-as-you-go

People do not always know which information they were going to need for a task, which made it challenging to collect all information beforehand. Furthermore, collecting and organising information can be time-consuming (Bardram et al., 2006). This was also observed in the current study. Therefore, people usually started a task and looked up information as they needed it. There was however some information that they knew they were going to need. For paper sources, people collected this information beforehand, such as the paper receipts, the claim form, and any additional post-its with instructions. For digital sources however, people still chose to only look this up at the moment in the task they needed it. Even if they did not know where to get it from, they would still try to look up the information. This is in contrast with Sohn et al. (2008), who found that uncertainty of the location of information would cause people to leave looking for it until later. A difference with this study is that Sohn et al. (2008) looked at people’s information search behaviour for personal tasks. Perhaps there was a pressure for employees to finish their work tasks and the urgency of finishing the task weighed more than the potential time cost of looking up information.

Lockouts

If people did not

People batched and deferred interruptions, in order to finish the task.

However, they did interrupt their data-entry task whenever they needed information. As they did not know beforehand what the time cost of looking this information up was going to be,

Rule and Youngstrum (2013) warned that even if the primary task interface is left for a related task such as looking up information, it is still disruptive and can take time to resume the primary task.

In the current study, it was potentially more disruptive as a long interruption would log people out of the primary task interface, causing them to resume from the beginning rather than the point in the task where they left.

Future work

In previous studies, accessing information always had the same cost and people could adapt their strategies according to this cost. The current study showed, perhaps unsurprisingly, that people can not always predict the expected IAC of a source as this varies. How do people deal with this uncertainty? Based on this study, the hypothesis is that without knowing the cost, people will look up information as they need it. The next study varies the time cost and observes frequency, number and timing of visits.

If there are differences in strategies and some people will save looking up information, it will also observe if this has an effect on performance.