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Applying Activity Theory to Video Analysis: How to Make Sense of Video Data in Human-Computer Interaction

Susanne Bødker

This chapter examines how activity theory can be applied to studing artifacts in use. Based on an analysis of the context of use, I outline a technique for the mapping of use situations that have been recorded on videotape and show how focus shifts and breakdowns are instrumental in analyzing human-computer interaction. The analysis uses examples from a project with the Danish National Labor Inspection, where the computer applications used by labor inspectors were studied in detail.
Activity theory helps to structure an analysis of hours of videotape without totally prescribing what to look for. An analysis of the context and history of the actions and operations prevents looking at the interaction in isolation.

In 1991, Liam Bannon and I (Bannon and Bødker 1991) discussed the potential role of a human-computer interaction (HCI) theory based on activity theory. Our focus was the limited view of the use of computer applications put forth by most cognitive science–inspired HCI research. We were further concerned with the lack of breakthrough attempts to reframe HCI research from within the field despite the growing awareness of the limitations of cognitive science. In our paper, we emphasized that a better understanding of use was important to the continuing development of methods and theories in HCI, argued that design must be based on use, and noted the importance of including on the design team those using the technology. We emphasized that activity theory seems to provide an interesting alternative framework for developing a more comprehensive unit of analysis for our studies.

More recently I have sought to develop ways of working with HCI questions based on activity theory (Bødker 1989, 1991, 1993). In various ways, this work has aimed at developing techniques for analyzing computer applications in use in empirical settings, and the analyses have gone hand in hand with various other analyses of the work settings and with design work in these settings (Bødker 1992; Bødker and Grønbæk 1991, 1993; Bødker et al. 1993; Trigg and Bødker 1994). Activity theory challenges us to make analyses on several levels, although not all at the same time. Certainly we need different approaches depending on the focus of analysis.

Engeström's (1987, 1990, 1993; Engeström, Engeström, and Saarelma 1988) approach to work development research emphasizes the development of work of specific groups of people in specific communities of practice. He shows how practice is continuously evolving and notes the role that instruments of work play in this evolution: a change of instruments changes practice, and changes in practice reshape the instruments (in use). His view—that we cannot bring the world to a standstill while we do our analysis, and neither do we leave the world around us unchanged by our analysis—is important to HCI research (see also Ehn 1988; Mogensen, 1994).

These approaches constitute the basis for this chapter, which explores various ways of doing analyses of human-computer interaction based on activity theory. The analyses will be presented and discussed through examples taken from a project with the Danish National Labor Inspection Service (Bødker 1992; Bødker et al. 1993; Markussen 1994). (A more thorough analysis of the examples may be found in Bødker 1993.)

THE GENERAL ROLE OF COMPUTER-BASED ARTIFACTS IN USE

Activity theory lets us study the relationship between the development of the individual and the society in which the person exists. Human activities are driven by certain needs where people wish to achieve a certain purpose. Activity is usually mediated by one or more instruments and is directed toward a certain object.

This mediation is essential to the ways in which we can understand artifacts, leading Kaptelinin (chapter 5, this volume) to suggest that we talk about computer-mediated activity instead of human-computer interaction. Artifacts are there for us when we are introduced to a certain activity, but they are also a product of our activity and as such are constantly changed through the activity. Artifacts thus have a double character: they are objects in the world around us that we can reflect on, and they mediate our interaction with the world, in which case they are not themselves objects of our activity in use.

Although *collective*, each activity is conducted through the *actions* of individuals, directed toward an object or another subject. Activity gives meaning to our actions, though actions have their own focus, and the same actions can appear in different activities. Each action is implemented through a series of *operations*. Each operation is connected to the concrete physical or social conditions for conducting the action and is triggered by the specific conditions present at the time. Operations allow us to act without thinking consciously about each discrete step. They are *transformed actions*, which were consciously conducted in the beginning. Through learning we transform them into operations; but on encountering changed conditions, we may have to change our focus again, and thus former operations once more become conscious actions.

Activities never take place in isolation; they are interwoven with other activities that deal with the same or connected objects, or produce the instruments used in the activity in question. In the course of a specific activity, the object change may be viewed as a change of activity or as a change in the purposeful actions or *clusters* of actions. We can analytically separate the categories of activity, action, and operation by asking why something takes place, what takes place, and how it is carried out (Bærentsen 1989). With this perspective, artifacts need to be studied in use, with a focus on their role as mediators. And even more so, since we may be dealing with artifacts as instruments of a web of activities, we are dealing with artifacts-in-use-in-a-certain-practice. Many computer applications are generic, and their use may be shaped very differently by different communities of practice (Nardi 1993).

An artifact works well in our activity if it allows us to focus our attention on the real object and badly if it does not. Breakdowns (Winograd and Flores 1986) and focus shifts are useful for studying artifacts-in-use. Breakdowns are openings for learning, and in our unhampered daily activity, we can see some breakdowns causing a focus shift by which a use situation becomes the

object of our learning activity (Engeström 1987; Bisgaard et al. 1989). Learning can take place in deliberate learning actions as well, as when one actor teaches another actor about his or her work practice.

Breakdowns related to the use process occur when work is interrupted by something; perhaps the tool behaves differently than was anticipated, thus causing the triggering of inappropriate operations or not triggering any at all. In these situations the tool as such, or part of it, becomes the object of our actions. Breakdowns can occur for other reasons as well. What is important for this analysis are breakdowns somehow caused by the computer application.

A *focus shift* is a change of focus or object of the actions or activity that is more deliberate than those caused by breakdowns. For example, a focus shift can occur when a user teaches a researcher about the technology; here a focus shift occurs not because of a breakdown caused by the artifact, but because the user is trying to articulate the ``otherwise unarticulated.'' Now the operations that she normally does become actions to her. In the following analysis, we investigate focus shifts to determine whether they are breakdowns caused by the computer application and whether breakdowns are caused by poor design.

To learn something about the present shape and use of an artifact, a historical analysis of the artifacts as well as of practice is important (Engeström 1987). That artifacts are historical devices also means that artifacts-in-use are under more or less continuous reconstruction. Replacing one generation of technology with the next is perhaps the most dramatic example of such a change, but use changes also through the influence of other artifacts and through learning—that is, through the development of and breakdowns in the actions and operations in which the computer application is used, as well as the opposite movement (Engeström 1990). In Engeström's model of work development (figure 7.1), he sees contradictions in what he calls the activity system as the major driving force of such change; he bases his analysis on *contradictions* within the activity and between the activity and surrounding activities, since they constitute the basis for learning and change. He looks at contradictions in how tools, objects, and subjects are seen and suggests studying contradictions between, for example, the tools currently used and the object created, or the norms that are part of practice and the division of work, showing how such an analysis may facilitate a change-oriented perspective on work. Here we are particularly interested in changes that occur when computer-based artifacts are involved. (These contradictions are dealt with chapter 2 by Kuutti.) Looking from the point of view of the artifact, which is shaped and used in several different activities, makes it very difficult to identify and delimit the activity system that is of interest for the analysis. This would potentially include all use activities, all teaching and artifact production activities, as well as ideals for changes in the use activities. Despite this, an awareness of contradictions is an important component in our analysis.

Computer applications cause and support focuses and focus shifts through various means. If we want to know more about how this happens, we may distinguish different aspects of the computer application based on characterization of the different focuses in the use activity—for example (Bødker 1991):

- The *physical aspects*—support for operations toward the computer application as a physical object. The physical aspects are the conditions for the physical handling of the artifact. The human adapts to the forms and shapes of the artifact. A maladaptation might prevent the forming of certain operations.
- The *handling aspects*—support for operations toward the computer application. A breakdown in these operations will make the user focus on the artifact. The handling aspects are the conditions for the transparency of the artifact that allow the user to focus on the ``real'' objects and subjects of the activity. This type of operation can be conceptualized (for instance, in breakdown situations), as the user being forced to conduct actions toward the artifact as an object.
- The *subject/object-directed aspects*—the conditions for operations directed toward objects or subjects that we deal with ``in'' the artifact or through the artifact. Different subject/object-directed aspects relate to different subjects or objects, but it is also part of these aspects to support the shift between subjects/objects. This means that although it is possible to talk generically about subject/ object-directed aspects, in a specific analysis it will make sense to identify such aspects for each relevant subject or object.

A user may be handling an object through the computer-based artifact in different types of situations. First, the object may be present only in the artifact (figure 7.2). An example is a spreadsheet, which has no direct relation to objects outside the artifact (a printout of a spreadsheet does not have the same capabilities as the spreadsheet). Second, the object exists as a physical object too but is present in the use activity only as the representation in the computer application (figure 7.3). An example is a word processor; the object is a letter that is present only in the use activity as what can be seen and manipulated ``on the screen.'' Finally, the object is present physically outside the artifact (figure 7.4). Examples are different kinds of control panels; the object is handled through the artifact but is also physically accessible for inspection. The second and third situations similarly apply to relations between human beings as well.

I have used the terms *system*, *tool*, and *medium* to refer to important ways of mediating between users and their surroundings (Bødker 1993). The systems perspective is the bird's-eye control perspective, which views the human user and the computer component as functioning rather equally in exchanging data. The subject is lost in the systems perspective or removed from the level of those who are conducting actions and operations. A system mediates between the individual contributors of actions and operations and their object. At the same time the system is the instrument of the acting subject, who is not directly contributing to the production of the outcome.

The tool perspective emphasizes the human engagement with materials through the computer application. A tool mediates the relation between the subject and the material object being worked on. The tool perspective emphasizes the production of outcome and the direct learning taking place by the material ``speaking back'' to its user. And in a similar way, the media perspective emphasizes the human engagement with other human beings through the computer application. Thus, a medium mediates the relation between the acting subject and the community of practice surrounding the subject and the activity. It is the perspective emphasizing communication, and learning through conceptualization and negotiation. (Figure 7.5 summarizes these perspectives.)

Almost no real-life computer application can be understood in terms of only one of these perspectives. Analytically they are applied by tracing and characterizing the web of different activities that takes place around a computer application and in particular, contradictions among the different uses.

We see an artifact as supporting several interwoven activities that deal with the same or connected objects. In the course of a specific activity, various focus shifts and breakdowns occur, by which the object changes. In some cases, this change may be viewed as a change of activity; in others, the overall activity remains the same, but the purposeful actions change. Being involved with different objects and subjects through or in the artifact is partly determined by the purpose of the activity, and partly by the ``intrusion'' in breakdown situations. The analysis in this chapter suggests that one analyze relevant objects and subjects of the web of activities at two levels: a contextual level, where the purpose is to situate the artifact in the web of activities, and the level of analyzing and tracing the actual focus shifts in specific use situations. Certainly mapping of the contextual level objects could be useful in a general attempt to understand the relationships between work activities and artifacts, but this chapter examines the mapping of specific use situations.

The inquiry into specific focus shifts uses figure 7.6 as an illustration. The secretary initially focuses on the report to be produced. The report generator is mediating her relationship with the material—some information about companies that are put together into a report, the outcome of the work process. For some reason, she changes her focus to part of the report generator—specifying search criteria—and uses the text editor to put together search criteria. Initially she works through the report generator on the report; the focus shift to the search criteria occurs because the report generator does not handle well, that is, because of a breakdown in the handling aspects. The new focus is on an object that is totally in the computer: the mathematical formula and criteria. Further breakdowns may occur because the computer does not support the report writing very well. Here the physical aspects of the computer may play a role because the keyboard does not lend itself to typing formulas. Recovery from this situation requires getting back to a focus on the report as an object—a focus shift that is not a breakdown but nevertheless should be supported by the handling aspects.

The overall contextualization of the computer application in use takes place along several dimensions, considering development and contradictions along and between these dimensions: situating the work and computer application historically, situating the computer application in a web of activities where it is used, and characterizing the use according to system, tool, and medium.

Through the meeting with the artifact, the materials, and other aspects in use, the practice of use is shaped and reshaped, for the individual as well as the group. This process shapes the computer application-in-use, the primary interest of this analysis.

WORKING WITH HCI IN CONTEXT

The AT project and the Aarhus branch of the Danish National Labor Inspection Service (NLIS) worked together to design a number of computer applications for the branch and to develop a

long-term strategy for decentralized development and maintenance.[1] At the same time, a major organizational restructuring was taking place in the branch, with new technology, new management, and new forms of work organization.

The AT project explored the potentials for reshaping the technology in use, partly through redesigning existing computer applications and uses and partly through new computer applications. In the following I shall describe some of the methodological questions applied in analyzing the use of new or existing computer technology and its relation to actual work/use activity.

NLIS uses Word Perfect/Windows, running on portable PCs, and a centralized system (VIRK) to record its interaction with companies. VIRK is a menu-based system, originally running on terminals, that connects to a central company database. VIRK runs in a window on the PCs.

Understanding VIRK in Use: The Empirical Foundation

In our initial interviews we found that employees used VIRK in many ways. Some people used the full capabilities of the system, but only a few knew what these full capabilities were. It was our impression that VIRK could provide many of the functions that people asked for, but they did not know how to access them. As part of our project, we sought to find out how we could help NLIS's secretaries and inspectors make better use of the system that they had available already. We therefore spent hours interviewing the NLIS employees, observed in their offices, presented seminars, and trained them to use VIRK. We also videotaped three activities: a session with two secretaries discussing their typical daily activities, in particular with respect to documentation and information retrieval in VIRK; a session in which a secretary demonstrated VIRK to us; and a session with a secretary who was the ``super-user'' (that is, used it the best) of VIRK. In total more than four hours of videotape of the use of the system were recorded.

Coming to Grips with the Analysis

An analysis of four hours of videotape is a complex matter, and activity theory is useful in identifying what to look for. The basis of the investigation was a combination of Markussen's (1994) historical account of the work practice of labor inspection with investigations of the various materials and artifacts used in this work; VIRK was situated with respect to the web of activities in which it served. We then viewed the videotape and selected interesting sequences for closer inspection (for further detail see Suchman and Trigg 1991; Trigg, Bødker, and Grønbaek 1991). Finally we mapped out interesting situations and analyzed them according to focus shifts and breakdowns.

Situating Artifacts Historically and in the Web of Activities

VIRK was created to help various groups of people, primarily managers, get an overview of the many cases and documents that came into play when the organization grew and diversified and to ensure that all incoming requests were handled according to the law. In the past, VIRK substituted a number of paper-based lists, which were kept to maintain an overview of files with material about companies and inspections. But as the organization grew, these lists had become

inadequate. The files are still used, but VIRK has made retrieval easier, and some overview facilities for statistics have been added.

In order to identify the different activities in which VIRK is applied, the following questions were asked to identify the role that VIRK plays in use:

- Who are the users?
- What are the objects?
- Which are the activities in which VIRK is used (why is a certain activity taking place)?
- Can the mediation be characterized as tool, medium, or system?

We found many different use activities going on simultaneously, and VIRK has several roles in this web of activities (for detail, see Bødker 1993). It is, for example, a system of management for NLIS designed to ensure that the people who contact NLIS are answered in due time. Management at this point is not in any direct contact with VIRK. The why, what, and how map out as follows:

Why (management) people get answered in due time

What (secretaries) enter registration of documents

distribute documents

follow up on deadlines

how (using VIRK) key in document data

extract inspectors' deadlines

VIRK is also a system for following up on the work of the inspectors and the whole branch office. Statistics are the important output; management uses them to control and plan work activity. Data entry is done by inspectors.

Why (management) following up inspectors and branch office

What (management) statistics

How (using VIRK) (inspectors and secretaries) key in production data

VIRK is used as well when distributing cases to inspectors. Secretaries and inspectors complain that they lack access to appropriate statistics to see the work distributed to the individual inspectors and to plan work. VIRK should act as a medium with respect to this purpose, but it does not.

Why distributing cases

What statistics

How (using VIRK) (mainly secretaries) look up who has case/ area, how many cases, etc.

Furthermore, individual inspectors and secretaries use VIRK to handle specific cases. For this purpose VIRK is both a tool and a medium. The inspectors and secretaries would like more support in this area. In particular the kinds of information that can be written down regarding a visit or a case are very limited and in most cases quantitative.

Why (inspector) handle case

What (inspector) ``takes the travel card,'' makes notes, looks for correspondence, etc.

How (using VIRK) browse for relevant data, use search facilities

Finally, secretaries use VIRK every time a document is registered in the system (tool).

Why (secretary) register document

What (secretary) register document

How (using VIRK) key in data using the correspondence form

This analysis brings into focus that VIRK is designed as a planning and control system, and it works rather well: Management gets what it wants, with respect to both the delegation of cases and monitoring the activity of individual inspectors and branch offices. Data entry works rather well too. But when inspectors and secretaries try to use VIRK to work on individual cases, both when registering information about the case and when retrieving information to get an overview of a case, VIRK is less helpful.

Inspectors are much more than bureaucrats, and they do not conceive of themselves as easily controlled. Their work is not easily planned; accidents happen, and what they have to do at a certain visit is not easily predicted. Furthermore the work is not easily reported on and measured. Thus, management seeks to make labor inspection more predictable and better planned. Secretaries and inspectors seek to coordinate cases, derive overviews of their own cases, and register more informal and qualitative data about the cases.

The historical development of the work of labor inspection is characterized by at least three generations of labor inspection activity. Until the mid-1970s, the inspection of the physical work environment in factories was carried out by engineers, each responsible for selecting and inspecting factories. Under new law in 1975, inspection was expanded to cover nonfactory work, the work environment, and the organization of work; now therapists and psychologists were employed for this work, and prevention of stress and injury became a topic. The late 1980s saw further decentralization, a client orientation, quality assurance, accounting ``upward,'' and more structured activities. Only the oldest one of these is actually supported by VIRK, though VIRK was designed rather late in this historical development (Bødker 1993).

Now we see that many of Engeström's contradictions come into play. A primary contradiction concerns VIRK, the instrument: on the one hand, what is needed is an efficient means of registration and accounting, but on the other hand, what is needed is a means for cooperation and coordination of the effort. An important secondary contradiction (primarily seen from the activity of actual labor inspection) is between VIRK, the instrument for upward accounting, and the inspector as a skilled professional who is concerned primarily with the work environment in the inspected companies. The analysis has pointed to and made use of these contradictions, though not in a systematic way in this presentation.

Generally the objects that one can work on, in, or through VIRK have to do with recording the state of the overall activity. Descriptions and lists of documents, lists of cases, deadlines, and various statistics are the objects *in* VIRK. The contents of the cases—the objects dealt with by inspectors and secretaries when handling a case—are almost absent in the system. There are also some objects of normal daily activity present in VIRK, including travel cards that the inspectors take and various lists and overviews, and we shall focus on them next. They are hard to retrieve in VIRK because they can be reached only through the programming of a report generator. (See figure 7.7 for an overview of VIRK.)

Summary: A Checklist for Situation of Computer Applications in Use

The following analyses were carried out in the first part of the project.

- Situating work and computer application historically.
- Situating the computer application in a web of activities where it is used.
- Characterizing the use according to systems, tools, and media.
- Considering the support needed for the various activities going on around the computer application and the historical circumstances of the computer application.
- Identifying the objects worked on, in, or through the computer application.
- Considering Engeström's four kinds of contradictions with respect to activities for which the computer is used.

These analyses were not done in lockstep fashion. Rather, they took place in interaction and iteration.

MAPPING THE SITUATION

We combined ethnography and interaction analysis in working with the video analysis (Suchman and Trigg 1991). The ethnographic fieldwork was especially crucial to our understanding of the sessions particularly with respect to contextualization. Interaction analysis, as described by Suchman and Trigg (1991), involves the ``detailed investigation of the interaction of people with each other and with the material environment....

In work settings..., [the] analyses focus on the joint definition and accomplishment of the work at hand, through the organization of interaction and the use of supporting technologies and artifacts" (Suchman and Trigg 1991).

I will not claim, however, that this study is a representative instance of interaction analysis. Rather, the goal was to apply certain practical techniques from interaction analysis to work better with situated human-computer interaction. For example, an event log of the video record provided a description and chronological index of observed events. The analysis then proceeded with an identification and careful transcription of sequences of activity of particular interest. Partly in opposition to Suchman and Trigg, I suggest the use of the theoretical concepts of focus shifts and breakdown as focus points in gathering collections of instances.

From the four hours of videotape, we selected four interesting situations of a few minutes' length for detailed analysis, and then mapped out the action. The mapping consisted of listing in one dimension the objects that the user focused on during the session and in the other the narrative of the situation, supplemented with annotations of the user's physical acting. The focus shifts appear as lines running from one ``set of coordinates'' to another. The objects can be categorized according to whether they have to do with the objects worked on (the subject/object directed-aspects) or what should have been the handling of the artifact. Furthermore, the focus shifts can be categorized along the same lines. Are they breakdowns caused by the work content, the handling of the artifact, or physical problems with the artifact? In the following example in figure 7.8 we can see what this means and where the analysis might take us.

What makes an interesting situation? It may be that one does not understand it, or that it remains intriguing or surprising even after many times of viewing. Situations in which users appear to be fundamentally uncertain, or certain but then a moment later uncertain, have been intriguing. These situations tell something about when the user feels in charge of or masters the use situation and when she does not. It is interesting to see when everyday routine situations turn into nonroutine ones and which everyday situations are nonroutine ones, and in the end to see what role VIRK has in this.

The focus is initially on the screen image (1), but as soon as A makes her choice, she is working on the report (2). The handling aspects of the artifact support this focus as well as the focus shift. We have reason to assume that her focus was only on the screen image in the first place, because she was explaining VIRK to the researchers. She needs to specify which fields she wants. She has her focus on this; it is not done as an operation (3). This could be because she is explaining, but the way she talks to herself indicates that she is uncertain; she is conscious of the field because of a real breakdown. Dealing with the fields through operations is not possible; it is a matter for the subject/object-directed aspects.

At the end of the session we see more breakdowns with respect to the handling aspects (6–9); she is rapidly moving between focuses on the report, the report generator, the field (in particular, how criteria for this field are specified), and the written documentation and examples that she has available about the program. It is the handling of the search criteria that causes trouble: VIRK gives her no help in specifying syntax or contents. At the end, she finds some help in some examples, which allows her to focus back on the search criteria for the field, and over again at the report, and how the result looks on the screen. In other words, the handling aspects of VIRK cause the various breakdowns encountered here, and it does not give any help for shifting (10–11) the focus back to the real object of work.

In the example we see how the focus shifts back and forth and how only the objects ``field'' and ``report'' (figure 7.9) have to do with contents or purpose of the activity. When the secretary is trying to generate the report, the application is in no way transparent to her, which is seen by the breakdowns with respect to the handling aspects—the times when ``screen image'' and ``report generator'' (5 and 7) come into focus. Here A is concentrating hard on doing the task because it is so difficult; the latter part of the example is a series of breakdowns with respect to the artifact. There is very little attention left for her to explain to us what she is actually doing.

Extending Maps to Windows

As part of our research and design process, we applied the mapping technique to some sessions where pairs of inspectors were using WordPerfect to solve some exercises set up by the researchers. The mapping technique had to be modified to encompass the larger complexity of the screen images and the increased numbers of objects on the screen (anything from scroll bars and menu items to words in the documents) and the physical actions when using the program (dragging, pointing, etc.). Since we were dealing with several users in interaction, there was the possibility we would see that their focuses were different at times. Such differences may be important indicators of situations to examine more closely.

The exercises were meant to explore the ``corners'' of the inspectors' understanding of WordPerfect. In the example that follows, the inspectors were asked to number the pages in a document, excluding the first page and giving the second page number 1. In the following analysis, two inspectors have just looked at Help, where they are asked to put the cursor where the page number is to be placed. After placing the cursor at the top left corner of the page (the first possible character position in the document), they move on to the menu form to add the page numbers (figures 7.10 and 7.11).

This example illustrates that WordPerfect has an underspecified interpretation of what it means to place the cursor where one wants the page number. If the user is using the **Insert Page Number** button, the number is placed at the location of the cursor. If the user is using the rest of the form to place the number in either corner of the paper, it matters only what page one works on.

Looking at the focus shifts in this example, we see that the two inspectors are exploring the menu form (figure 7.11); they are in a breakdown situation with respect to the use of WordPerfect for adding page numbers. From the rest of the exercise (not transcribed here), it became clear that they had never used this form before, yet they knew what to look for and how to explore the menus.

The form menu includes an example of how the page looks given the selection of page numbering. This example consists initially of two blank rectangles. After the selection in **Insert Page Number**, a number pops up in the bottom right corner of each rectangle, but the inspectors do not notice that; they do not get the intended feedback because they are so busy figuring out what else they need to do to finish the form. Obviously it is also not clear to them that **Insert Page Number** is an alternative way out of the menu to pressing OK/Cancel buttons (OK activates the page numbering done through the rest of the form). It is worth noticing, though, that

Insert Page Number actually activates both kinds of page numbering; thus one gets dual page numbers. Though all breakdowns mentioned here have to do with the handling of the artifacts, they are not equally severe. The menu form is actually meant to be looked at, to explain itself in a breakdown situation, and it does not presume a frequent and everyday use. Though attempting to give a window onto the actual object of the work, the pages with numbers, it fails to do so, because of the confusion over the two alternative ways of numbering pages. This confusion could be avoided.

Summary: A Checklist for HCI Analysis through Focus Shifts and Breakdowns

For each specific focus, ask:

- What is the purpose of the activity/actions for the user?
- Which object is focused on by the user? Where is this object located (in, through, or outside the computer application)?
- What is the instrument? Where is it located (in, through, or outside the computer application)?

When two or more users are cooperating, ask:

- Are the purposes, objects, and instruments in accordance or conflicting (between the individuals, as well between the group and individuals)?

For each focus shift, ask:

- From what focus/object to what?
- Is it a breakdown or a deliberate shift?
- What causes the shift: the physical, handling, or subject/object-directed aspects of the computer application?

The mapping technique described above is one way of putting together an overview of the answers to these questions.

THE RESHAPING OF COMPUTER APPLICATIONS IN USE: PUTTING THE ANALYSIS INTO WORK

My perspective on HCI analyses suggests that we must always be concerned with understanding computer applications in use. Although we change the world while we investigate it, the purpose of doing the analysis is to understand how to change computer applications in use. We will look briefly at how the work analysis was situated in the technical and organizational change processes at NLIS.

Although VIRK was developed rather late in the historical development of work at NLIS, it was not designed to reflect this development (Bødker 1993). In many ways VIRK works to support a traditional quantitative perspective, coupled to management planning and control. The more qualitative perspective underlying the work of contemporary labor inspection is not supported

with respect to information and activities regarding a company or with respect to how the work of the inspectors is viewed. These lacks are typically related to individual and group case handling, an area that was not given much attention historically or with respect to the design of the system. The needs and wishes of secretaries and inspectors go in the direction of integration, case coordination, case overviews, and registering more informal and qualitative data on the cases. There seems to be no easy way to extend VIRK to fill these needs even though the data are available in the database.

Based on the examples, though, we can identify various venues for change in VIRK-in-use: First, the labor inspectors who participated in our project found that the analysis constituted an important input to a major redesign of VIRK. Second, the analysis was important in our attempt to educate VIRK users. It pointed to areas where it was possible to do more with VIRK if the users were trained, and it pointed to the real obstacles built into VIRK. Third, it was easy to suggest some improvements in the interface to VIRK that could be implemented through integration of VIRK with WP/Windows. Some of these have happened, though with some difficulty (Trigg and Bødker, 1994).

Regarding WordPerfect, both the placement of the example in the form menu and the double functionality of the menu are inconsistent with how menus work otherwise in WordPerfect, causing confusion among the inspectors. For those inspectors who use the facility regularly, better teaching is a possibility. For less frequent users, training probably would not be worthwhile. This is an important indication that when it comes to complicated applications such as WordPerfect, education must be ongoing, inspectors must regularly be reminded of the available facilities, and they must concentrate on the facilities that they find useful. NLIS has chosen to offer frequent WordPerfect courses to users to help them brush-up and expand their use of the program.

The reshaping of computer applications such as VIRK and WordPerfect is a continuous process that may be influenced in various ways based on analysis of the computer application-in-use. Fundamental redesign of computer applications, customization, and training are among the possibilities that should be considered in interaction with the analysis.

A SECOND LOOK AT ASPECTS OF THE USER INTERFACE

The studies at NLIS show that there are different kinds of handling aspects. For example, the page number prompt is directed toward a rather natural breakdown situation: since many users do not do specific page numbering often, it is natural for them to stop and read the prompt. (Whether this prompt disrupts the fluent conduct of a frequent user is a different matter and is not examined here. The phenomenon is discussed more generally in Bødker 1991.) The prompt should help the user get back to normal conduct, working on the now-numbered page instead of falling prey to more breakdowns. Thus, it is unfortunate that the user cannot identify the two alternative ways of ending the endeavor and that the view of the page with the numbers does not attract the attention of the user. The same is true for the report generator of VIRK. Thus it is possible to distinguish ordinary ``everyday fluent conduct'' from more exotic breakdowns; handling aspects must be designed to support these in different ways. For example, a prompt used when saving a document is encountered frequently by most users and will disrupt work if

not easily dispatched. A prompt for advanced page numbering can count on attention from a larger user community, though not as frequently, and thus it must be designed for this aspect. These conclusions are not very different from those I made in 1991 (Bødker, 1991): ``Although the physical and handling aspects should not call for actions from the user, it is also important that they support the user if a breakdown occurs. How this is done relates directly to the competence and education of the user, but it is important that *error situations be handled within the domain of use practice*. It is important that *the user be able to retract or undo* her operations, if this is important in the handling of the objects or subjects. Proper facilities can prevent breakdowns toward the artifact."

VIRK users have problems using the report generator, because what one does to specify a report is so unlike the actual report. This brings us to the realm of *subject/object-directed aspects*, though at the same time we are dealing with some very fundamental handling aspects, namely, the specification and selection of fields. There are some strong dependencies between the three aspects, and one should not be designed without the other; for example, it does not do the user much good to provide nice handling features for specifying fields if she does not understand what a report is.

Focus shifts, coupled with the three aspects of the user interface, or computer application-in-use, have been useful in spotting various kinds of problematic situations in the human use of a computer application. Furthermore, the examples pointed to the strong design dependencies among these aspects. These aspects help us to identify how to remedy problematic situations, among them training, better help facilities, and more prompts.

CONCLUSIONS

Activity theory allow us to be instrumental without being reductionist in our studies of human-computer interaction. It helps structure analysis without totally prescribing what to look for. It also means that we are constantly reminded in our analysis of the context and history of the actions and operations that we are looking at, thus preventing us from viewing the interaction in isolation.

Breakdowns and focus shifts provide good pointers for understanding how an application mediates (or does not mediate) work activity. They are useful in identifying problems of mediation and in designing an application as well as understanding it when it is brought into use.

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NOTES

1.The project was conducted by Susanne Bødker, Ellen Christiansen, Pelle Ehn, Randi Markussen, Preben Mogensen, and Randy Trigg. For a description see (Bødker et al. 1993).

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Figure 7.1
Engeström's model (Engeström's 1987, 89, from Kuutti).

Figure 7.2
The object is present only in the artifact.

Figure 7.3
The object exists as a physical object but is only present in the use activity as the representation in the computer application.

Figure 7.4
The object is physically co-present outside the artifact.

Figure 7.5
Characteristics of the system, tool, and media perspectives.

Figure 7.6
A breakdown using a report generator.

Figure 7.7
An overview of VIRK, its users, and the objects surrounding it. The syntax is introduced in figures 7.2 through 7.4.

Figure 7.8
Generating a report.
The · indicates the object focused on; boldface type is used to indicate a focus shift. Numbers in parentheses index the objects focused on for reference in the discussion. A is the secretary, S the interviewer.

Figure 7.9
The objects and focuses involved in report generation. The syntax is described in figures 7.2 through 7.4.

Figure 7.10
Using the **page numbering** form to insert page number. The · indicates the object focused on.

Figure 7.11
Screen.