# Making interaction and interactivity visible: on the practical and analytical uses of audiovisual recordings in high-tech and high-risk work situations

Schubert, Cornelius

Veröffentlichungsversion / Published Version
Arbeitspapier / working paper

*Cornelius Schubert M.A.*

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# Institut für Soziologie

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## Cornelius Schubert M.A.
Technische Universität Berlin, Institut für Soziologie, Franklinstr. 28/29, D-10587 Berlin

**Abstract:** The use of video equipment has not been and still is not a methodological focus of mainstream research in the social sciences. This paper will argue in favour of video observation and the qualitative analysis of this kind of empirical data. The argument will consider current areas of interest for videographic methods and the methodological implications that need to be taken into account. Furthermore it will give a short 'how-to' guideline for those starting to use video equipment based on personal experiences as well as methodological aspects. This paper will not deal with the analysis of audiovisual material produced for other reasons than scientific research (e.g. television, motion pictures, surveillance).

## 1. Introduction

The empirical method of observation in the social sciences is commonly used to produce scientific knowledge about the way individuals perform actions and interactions. Empirical data on interaction can lead us to new insights as to how people perform in 'natural' situations and can thus help us to develop new hypotheses or to change and modify existing theories about the nature of sociality on the micro level.

It is the aim of this paper to highlight some practical and methodological aspects of video-based observation and analysis

The following expositions are concerned with the analysis of *cooperation* in *high-tech work environments*[1]. Thus they do not account for all types of interaction, but for certain variations of interaction occurring specifically in those areas.
The domains of interest are, e.g. operating rooms (OR) in hospitals, nuclear power plants, cockpits or traffic control centres. These workplaces share three common features in the way they are designed:

1. Work is carried out by a set of professionals who use highly advanced technological equipment to accomplish a given task.

2. The contingencies of the tasks can never be averted, but must be dealt with by the actors every day.

3. The consequences of the actions may severely affect the health of the actors as well as others.

The field where our observations were conducted is the OR. Empirical research has been done there by other researcher, who have also noted the unique characteristics of these workplaces. In the case of anaesthesia, Norros studied the habits of anaesthetists and describes the situation thus:

> "Anaesthesia is characterised by complex interactions between physiological systems with mostly unknown cause-effect relationships especially when disturbed by pharmacological means, and extremely tight time pressure. Moreover, information available during anaesthesia concerning the changes in patient's state is scarce and often contradictory" (Norros & Klemola, 1998)

The complex problems arising out of such situations are rarely solved by single individuals. The social and technical constellations in ORs need to be included

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[1] The research presented in this paper is based on the project 'Routines and Risk of Distributed Action' (RISK), which is part of the interdisciplinary research programme 'Cooperation and Safety in Socio-Technical Systems' (KOSIS) at the Technical University of Berlin.

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in the study of how problems are solved and tasks are performed.

The physical presence of multiple actors calls for the analysis of their bodily activities. Structuring interaction relies on the formation of bodies in space. The analysis of interaction therefore relies on the recording of those formations. Furthermore, the operation of technical devices is often done by routine bodily activities, activities that are not subject to cognitive reflexivity, but to manual skills.

Because of the high amount of technology found in these situations this paper will not only concern the *face-to-face* interaction of humans, but will also stress the importance of *face-to-interface* interactivity between humans and machines.

This paper will focus on *qualitative* methods to analyse observations, because they are especially useful for exploring previously unknown social realms, especially if they are of a dynamic and complex nature (Badura, et al., 1995: 373; Dehn, 1997: pp.33).

Qualitative data analysis offers the opportunity to develop theoretical categories in accordance with the empirical findings. First we go into the field and then we check whether the observed phenomena still fit into the existing sociological categories.

Therefore, a central aspect of qualitative analysis the generation of the relevant categories out of the observed data, and not to try and force the findings into predetermined patterns.

Concerning the main areas of interest for this paper, i.e. complex, high-tech work situations, a qualitative research method is warranted, because the researcher first has to understand what the observed people are actually doing and what questions are relevant to their work. This however does not completely exclude the presence of certain analytical interests or theoretical assumptions the researcher might have.

It is the ongoing reflection of observation and assumptions / hypothesis that promises a valid description and analysis of the field data.

How does the proposed analysis of interaction and interactivity fit into the discourse of sociological theory? Main analytical concepts are of course *work and cooperation/collaboration.* The qualitative and quantitative increase of technology in the workplace does not merely substitute manual labour but produces *new kinds* of interaction and interactivity.

The analysis of this empirical change and its consequences for the relations between social processes (including work) and technology dates back to the writings of Karl Marx (1818-1883). He was strongly influenced by the social impact of the industrial revolution and sought to explain the changes he witnessed by analysing the preceding and accompanying social circumstances of industrial technology as well as the effects it had on the workers jobs and lives.

Today's high-tech workplaces have little in common with the situation of industrial workers 150 years ago. One reason is, that technology itself has changed over time. New technologies such as computers and communication technologies are changing the way work itself is performed, away from mere material production in factories. (Rammert, 1998; Moldaschl & Voß, 2002).

Exactly what some of those changes are, and how we can describe them will be a central issue of this paper.

The following sections of this paper will be concerned with the historical and methodological context of observations in the social sciences, as well as the research areas where it is currently used. Later the actual gathering and analysis of video observations will be dealt with, supported by examples from our own research in the OR.

# 2. Observation

To analyse changes in work situations one needs to make those changes subject to empirical scientific research. Our main method is participant observation, combined with video recordings.

First I will outline a brief history of observation as an empirical method in the social sciences, especially sociology, and put video observation in the context of 'classical' observations, especially participant observation. Later I will go into more detail about the use of video recording.

There are eight commonly differentiated types of observations which can be organized in a three dimensional pattern[2] as follows:

|  | non-participant | | participant | |
| --- | --- | --- | --- | --- |
|  | covert | open | covert | open |
| systematic | 1 | 2 | 5 | 6 |
| unsystematic | 3 | 4 | 7 | 8 |

see (Friedrichs, 1980:273)

This paper will deal exclusively with type 6 and 8 with a first focus on type 8, the unsystematic open participant observation (field work), because this will be the most likely form of observation used to explore uncharted areas, as it is the least assumptive and functions without a great number of premises.

After the first unsystematic observations it is of course advisable to establish a certain systematic order or system to classify and focus the observations, depending on the research question.

Observation is quite frequently used to document *behaviour* of organisms (humans, animals, plants) by different scientific disciplines, e.g. biology or psychology. Analysis of this kind are often

quantitative in so far, that movements (i.e. the raising of an elephants trunk) are counted or the time intervals between the movements are measured.

In the field of sociology this approach is in some cases not sufficient, because sociologist are largely concerned with the *meaning* of the observed actions (verbal and nonverbal), rather than their plain description. The movements of people and even the material environment in social situations have indexical properties (Hindmarsh & Heath, 1998). Therefore it is essential to observe and analyse not only which activities are being conducted, but also how and why they are conducted.

Sociological theory makes the specific difference between *social action* (Weber, 1990: 11) and behaviour. Social action accounts for the meaning the actors attach to their actions in relation to others. Social action thus only accounts for one section out of the full range of human activities, but in the study of interaction, it becomes quite important.

To understand social situations and social actions, the researcher must have some understanding of the context and the intentions of the actors. The best way to gain such knowledge of the context is to do the actual field work, i.e. participant observation in natural settings.

## 2.1 Participant Observation

Participant observation as an empirical technique has been developed primarily by cultural anthropologists since the 1920s. Bronislaw Malinowski was one of the first, studying the Trobriand Islanders of New Guinea in the southwest Pacific from 1915 until 1918 (Malinowski, 1979).

The fields in those days were mainly foreign cultures, preferably on far away islands, and later on as sociologists adopted the technique, the metropolises of the western world.

Since then, a lot of (now considered classic) participant observations have been

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2   There are actually two more dimensions: the fourth is if you observe the field or a laboratory situation, the fifth whether you observe yourself or somebody else. (Dehn, 1997). Our focus will be on field observations of somebody else.

carried out in numerous fields by all kinds of scientists, i.e. Samoan girls (Mead, 1928) or street gangs (Whyte, 1943). All those studies have one thing in common, though: they are interested especially in *local* action and performance on a micro sociological level, i.e. the interaction of individuals in smaller groups in their natural environment.

Traditionally the scientist approaches the field in a paper and pen style of data fixation (field notes, memory protocols). This approach has its advantages, because it can be done almost instantly and with few material, technical and technological demands.

Also the researcher is supposed to spend a certain amount of time in the field and sometimes actually participate in the observed activities. How much time the researcher has to spend in the field for it to be considered a valid observation is not generally defined and should be adjusted according to the field and the researcher.

The second matter connected to the above question is how much participating the researcher has to do. Malinowski stressed the importance of participating in the rituals and activities of the observed cultures. His aim was to get anthropology 'out of the armchair' and closer to the research subject. If we use participant observation in high-tech and high risk settings, the amount of participation is limited (e.g. by law) for various good reasons. The researcher should not try to participate in all the activities of the field, simply because he or she is not qualified to perform surgical operations, maintain nuclear reactors or control air traffic.

Therefore we should not take 'participating' in the literal sense of the word, but as a method to get closer to the field. A participatory researcher then only needs to take a 'field role', e.g. as an observer. He or she can then conduct research in the role of the observer and does not need to perform the activities of the field. Nevertheless participation in the situation is still achieved.

These concerns aside, it is the aim of this paper to concentrate on the gathering (recording) of electromagnetic audiovisual data, subsequently called just video.

The term 'observation' tends to stress the visual aspects of the data, but it should be noted that the importance of sound cannot be underestimated.

Human interaction is often organised by talk. There is a large body of research conducted with audio tapes and a variety of transcription methods are available. Conversation analysis has produced profound insights into the organisation of interaction using audio recordings.

In high-tech environments it is not only the humans who make noises. There are machines that will ring an alarm or confirm an action with a certain sound. The machines generate a soundscape in which the actors work. The acoustic environment certainly has effects on the interaction, but I will be concerned with visual analysis from now on.

## 2.2 Videography

Videography as an empirical method is of course dependent on technical equipment as such (i.e. cameras, cables, formats and monitors) and the general and special abilities of the researcher to handle the equipment.

Jordan and Henderson (Jordan & Henderson, 1995) have written a concise paper on the methodological foundation and practice of video based interaction analysis which is strongly recommended for further reading.

The vast majority of sociological studies conducted with video cameras focus on the *interaction* of people. This makes sense in two ways: a) interaction is a main aspect of sociology anyhow and more important b) with the aid of videotape one can preserve the otherwise volatile nature of social interaction.

To pay increased attention to objects in the analysis of interaction is a rather recent development. This perspective has so far only been adopted in a small number of studies.

Even in cases where objects are integrated in the study, they often are treated as mere resources to the human actors who manipulate them according to their own needs. Hindmarsh and Heath (Hindmarsh & Heath, 1998), point out how objects are mutually constituted by the participants in a telecommunication centre. Knoblauch (Knoblauch, 1998), shows how people use the positions of their bodies and computer screens to organise their performance while solving complex computer-related problems. Suchman and Trigg (Suchman & Trigg, 1991) analyse how a certain sheet of paper used by airport personnel can serve many different purposes at a given time.

To make the point even more provocative, this paper will try to take the notion of objects beyond that of means, towards the attribution of agency to objects, towards a symmetrical observation of (wo)man and machine (Latour, 1996).

The cited studies are connected to three areas in empirical, sociological research, where videotaping has been and still is in frequent use, namely ethnography, workplace studies and studies in computer supported cooperative work (CSCW).

They will now be portrayed in this order respectively. These research fields are not independent of each other in their evolution. Also the agency of objects increases in importance from the first to the latter.

## 2.2.1 Ethnography

Ethnography has a long tradition of using visual methods (film and photos) among others for its purposes. The ethnographic film dates back to the birth of the medium itself in the late 19th century.

The videographic technique received special attention in the 1950's when ethnographers like Margaret Mead conducted their research now commonly known under label of *visual anthropology*. Mead's aim was to record and preserve behaviour on film before it vanished without a trace:

> "All over the world, on every continent and island, in the hidden recesses of modern industrialised cities as well as in the hidden valleys that can be reached only by helicopter, precious, totally irreplaceable, and forever irreproducible behaviours are disappearing, while departments of anthropology continue to send fieldworkers out with no equipment beyond a pencil and an notebook, and perhaps a few tests or questionnaires …" (Mead, 1975: 4).

The main research focus of ethnography is to study the organisation of everyday life in different cultures, though the particular topics of the research projects may vary widely. Be it knowledge systems, indigenous science, neighbourhood relations, civilisation processes, war dances, folk tales, mobility strategies or social change. This list is by no way complete and should only emphasise the scope and diversity of ethnographic research.

How people make sense of their environment is one question of ethnography, another is how they produce and reproduce a stable social system. As a result, ethnography offers a situation-based, context-sensitive *description* of peoples' action and behaviour which is neither normative nor judgemental. Ethnography takes an 'open' approach toward its data.

Categories emerge during the research process and are not postulated a priori. Therefore scientists are not tied to decisions made before they even enter the field. The research process is more likely to be constrained by the interest the scientist takes and which aspects of the

observed situation are within the given research focus.

This approach is also valid for the following two research areas.

## 2.2.2 Workplace Studies

Drawing upon ethnographic methods, so called workplace studies are especially interested in the interaction of humans and technology (Knoblauch & Heath, 1999). For the last ten years they have been gaining momentum by offering a new perspective on how to analyse interaction in complex settings. The main argument is that of situated action, postulated by Lucy Suchman (Suchman, 1987), which emphasises the manifold relations of action and the situations in which it occurs:

> "In exploring the design of new technologies at work, we begin with the view that work is a form of situated activity. By this we mean that work activities in every case take place at particular times, in particular places, and in relation to specific social and technological circumstances" (Suchman & Trigg, 1991: 205).

This quote shows workplace studies' perspective on work and also their interest in new technology, mainly computers or otherwise complex machines and the design of those machines.

In contrast to ethnography, workplace studies concentrate on certain special situations, a limitation that is due to the close relations with, and mutual interest in some areas in the computer sciences, namely AI (artificial intelligence), HCI (human-computer interaction) and CSCW.

Historically this interdisciplinary connection emerged in the mid 1980's. The computer sciences were in need of practical help from social scientists concerning the design, implementation and the specific problems of certain computer technologies. The main interest was in how people (experts as well as laymen) actually use computer programmes, because it was plain to see that they did not always proceed in the fashion foreseen by the manual.

## 2.2.3 CSCW

The main aspect separating 'classical' workplace studies from studies in CSCW, is that work in the latter is most often geographically and temporally *distributed*. The problem posed to the social and computer scientists is to enable the fruitful cooperation of human actors over space and time through information and communication technology. Accordingly, it is the ambition of CSCW to improve the design of these technologies. Videographic methods are used to analyse the workflow as it is and the way in which it changes through the use of IT.

Examples are the work practices of teleradiologists (Karasti, 1997) or of computer supported telecooperation in geographically distributed teams (Meier, 1998).

# 3. Methodology

In this section the advantages and disadvantages of video based observation will be discussed. First of all, there will be a section on the practical advantages, afterwards the practical disadvantages, then the theoretical implications.

Because video based observation is, although not completely new, still a fairly unregulated business, it is of utmost importance to stretch the methodological points and generate a common ground to widen the acceptance and prove the usability of this method.

Some quantitative hardliners like to characterise the sections on observation in methodological handbooks as being there for the sake of exhaustiveness only. This claim may be judged by everyone for themselves, but I would like to take it as a

starting point and develop a short argument on the importance of observation from here on.

To a large extent the research focus determines choice of method. In analysing work situations, it is no doubt essential to look at the practices in the field, as they happen.

Video observation is an empirical method that produces a record of the situation which is unbiased by subjectivity, because it is not susceptible to the distortions of human memory and perception. Of course video has its own biases, and they will be dealt with later

Memory loss, the wrongful reconstruction of past events or selective perception are only three of the effects that might occur. The reconstruction of events from memory always tells a story that is aligned along one perspective.

This problem is of some importance for reconstructive methods, e.g. interviews. In some cases the scientific reconstruction might not be the story of 'how-it-actually-was', but how people thought it was (Jordan & Henderson, 1995: 50).

Additionally there is a difference between attitudes and actions, a.k.a. the *say-do-problem*. The classic study of LaPiere (1934) shows that when people were asked to state their attitude toward Chinese people it did not conform with their prior actions. This shows that attitudes are bad predictors for action and also implies that post hoc reasoning of past actions may also be distorted.

The counsellor experiments (Garfinkel, 1967) showed that if people use presupposed interactional patterns they tend to constitute meaning in meaningless situations according to their interactional expectations.

Also Heider and Simmel (1944) showed, that people try to construct causality in their narratives. They showed a film of randomly moving geometrical objects and later asked the audience to describe what they had seen. The descriptions were rich in interpretations of action and intention, e.g. the triangle was chasing the circle, etc.

Research in complex high-tech settings calls for adequate empirical methods. As argued above, ex post methods (questionnaires and interviews) have their shortcomings, however they should not be neglected. To optimise the research, it is probably best to *mix the methods*. Video observations *and* interviews *and* questionnaires[3] together can provide a higher level of validity and a rich, focussed and verifiable account of the empirical findings.

## 3.1 Practical advantages of audiovisual observation

Karen Ruhleder proposes video-based interaction analysis (IA) as a component for workplace ethnography, especially under complex, distributed conditions, e.g. the study of remote meetings:

> "… IA looks for orderliness and patterns in people's routine interactions …" (Ruhleder & Jordan, 1997)

Given this research focus she states that the advantages are that video-based IA:

1) creates a permanent data corpus

2) provides access to behaviour invisible without replay technology

3) captures complex data

4) counteracts certain forms of recorder bias

5) counteracts the bias of the individual analyst

6) avoids the say/do problem

7) provides access to members' categories and world view

8) exposes mechanisms and antecedents.

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3 Not to forget 'classic' observation and document analysis.

The *invisibility* and *inaccessibility* of routine activities pose a twofold problem to the research, because they might be invisible and inaccessible not only to the observer but also to the observed themselves.

### 3.1.1 Observation of routine actions

Once formed routines are less accessible to reflection than novel and innovative action.

> "Insofar as actions are repeated, they become over time so routinized as to fall mostly out of consciousness until something happens to call attention to them" (Strauss, 1993: 193)

The actor only becomes aware of his routines, once they do not yield the desired, anticipated consequences. Therefore research can be focussed on the *breaching*[4] or breaking of routines and on the activities that are produced in order to stabilise the situation again. The analysis of successful routines is a little more complicated, as the following points will illustrate.

Because of the lack of reflection by the actors, routines have a tendency to hide themselves from the researcher, blending into the background of day to day activities in a fourfold way:

*First*, they are often carried out quickly, making them partly invisible to the naked eye, or they take place in different localities making it impossible for one observer to observe them simultaneously.

*Second*, they are carried out in a nonverbal way, because the participants do not communicate their routine actions.

*Third*, they often are of an implicit nature, meaning that they may once have been

explicit knowledge but now are implicit and therefore not communicable anymore.

*Fourth*, the researcher, being human, might fall prey to paying more attention to exciting and spectacular incidents.

Still routine activities play a crucial role in the performance of tasks in socio-technical systems. To neglect their importance would lead to a wrongfully shortened analysis of work and interaction.

In our research[5] we analysed the interaction of the anaesthetist and the nurse while performing an intubation.

Intubation is the process where a plastic tube is put into the patients trachea (windpipe) to allow artificial breathing during narcosis.

The intubation took 79 seconds and there are numerous occasions where cooperation is displayed.

At some stages of the sequence, the interaction is very densely packed. The routine movements are carried out in a quick manner, with very little verbal coordination, so we had to play, pause, rewind, play, stop, rewind and play the video again numerous times to analyse them in detail.

The coordination of routine actions is structured by gestures more than by words. Face-to-face interaction always relies on gestures and body movements (Heath, 1986), anyway, but in the case of routines these gestures are specifically used to accomplish fast and efficient cooperation during standard procedures.

In our example the anaesthetist makes a slight upward motion with his head to catch the nurses attention and then a demonstrative gesture with his hand to indicate to the nurse that he wants her to hold the patient's Adam's apple in place:

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4  I use the term 'breaching' according to 'breaching experiments' (Garfinkel, 1967) where students were told to deliberately breech the understood, but unspoken, rules of everyday encounters.

5  Informed consent for the video recordings was obtained from staff as well as patients.

**Fig. 1** OP04 - video still #1  (14:42)

Prior to the above sequence, the anaesthetist has trouble inserting the tube. The nurse notices this and places her hands on the patient's chest, ready to help the anaesthetist.

The cooperation of the two actors is accomplished by a high level of standardised procedures and mutual anticipations, based on education and experience.

In this case the anaesthetist and the nurse are well adjusted to working together. An unskilled nurse might require verbal, more complex instructions as to what she is supposed to do. The same is true for the surgical team. During a standard operation the team might not talk for minutes, sometimes there is a radio that plays music, or conversations which are generally not directly related to the current operation.

In a in situ interview a surgeon told me that the best routines are those that enable a team to cooperate without many words, where a glance is as good as a spoken sentence.

Video analysis can reveal how much work is actually done in a routine manner and the sequences of routines can be analysed in detail, giving access to issues like shared knowledge, anticipation or mutual orientation in interaction.

### 3.1.2 Interactivity

Our research focus includes the integration of objects into the analysis. Interactivity is a widely used term. It this paper it describes a sequence of reciprocal activities displayed by humans and machines.

The functionality of technology largely rests on its routine handling (e.g. riding a bicycle). To the user this is the case if the performance of activities is goal-orientated and the course of actions is foreseeable and calculable, with as little surprise as possible. Especially in high risk situations the absence of surprise is a desirable situation.

The most common way to treat technology is to simply take it as a feature of the environment in which humans interact. However, if artefacts are attributed with some form of activity of their own, the analysis of work can stretch beyond the interaction of humans and include the activities of machines. (see Rammert, 1999; 1999b)

I would like to argue in favour of a symmetrical approach of  description and analysis (Latour, 1996b).

Since there are only very few situations where people interact in the absence of technology, research into work in particular should incorporate the activity of objects in relation to the accomplishment of the task.

The question of whether technology has agency or not can not be answered within the scope of this paper, but I suggest that one step towards the answer would be to analyse video observations where some kind of technological agency can be presumed.

Work in surgical theatres has always been closely linked to the available technology. In recent years the amount of electronic equipment has steadily increased and the new high-tech appliances are much more than mere instruments. They are able to store information and execute procedures

by themselves. In anaesthesiology this trend is more obvious than in 'classical' scalpel surgery.

Take for example an automatic medication pump. This device is able to assist the anaesthetist in calculating the right amount of narcotics and then administer the resulting dosage over time, without the anaesthetist having to monitor the procedure. In combination with artificial breathing, the patient can be safely kept in narcosis without the anaesthetist actually being there.

Each appliance has its own demands and functions. At one stage during our observations, the automatic medication pump demands that a syringe be placed in the appropriate compartment, otherwise it refuses to work, spilling out error messages on its little display.

The anaesthetist and the nurse try to solve the problem together. The resulting interaction directed towards the solution of the problem proves to have an experimental nature, with the humans relocating the syringe, pressing the reset button, changing the power source until the problem disappears. The nurse turns away, thinking the automatic medication pump now functions within the regular parameters, but is called back by an alarm tone indicating the opposite.

Malfunctioning technology often is a cause for interaction. Video observation can show how *repair work* is organised between the actors and also how the actors react to the technology.

Repair work can be understood as the sum of activities displayed to compensate a technical failure. The activities are not strictly predetermined by emergency protocols but emerge out of the problematic situation. Depending on contextual features, they combine actors and artefacts in a problem-solving socio-technical constellation that will exist until 'normality' is restored.

Of course individual characteristics of the actors do have a significant effect: if they

are competent, their movements are fluent and quick. If they are unsure, they hesitate or may overreact[6]. Nevertheless, the technology moves to the centre of attention:



**Fig. 2** OP04 - video still #2 (09:43)

Those minor 'hiccups' in the workflow tend to occur as an inevitable side effect of modern anaesthesia.

### 3.1.3 Protocols of actions

Drawing on the work of Latour again, the concept of the protocols of action is based on his *programs of action* (Latour, 1996). The core of the concept is, that the use of technical artefacts is inseparably bound into the cooperative activities.

We use the word protocol instead of program, because in our interdisciplinary cooperation with computer scientists the word program carries a different meaning, especially for the computer sciences. We use the term protocol in analogy to the *diplomatic protocol*, i.e. interactional rules of conduct or communication.

Protocols of action can be the product of careful planning as well as spontaneous interaction. They are established in advance by the actors and regulate their cooperative actions.

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6   An anaesthetist put the relation between experience and action this way: "You have to know a lot not to do anything".

In our research context we are interested in the generation of protocols of action through spontaneous, situational interactions and the importance of technology for this interaction.

Take for instance the patient's file: it contains important information on the medical history and present state of the patient, therefore it determines the protocol of action concerning the operation to some extent.

Using the video camera it is possible to follow an individual actor around and establish a near complete account of the protocols he or she uses during his or her work.

### 3.1.4 Distributed activities

Video yields more data than the naked eye because of the replay feature. This is true not only for routines but also for parallel, distributed activities.

A wide shot of the surgical theatre shows the simultaneous work of many different actors. While two nurses prepare the surgical instruments, one surgeon washes his hands and the other helps the anaesthetist with the bladder catheter. Meanwhile the anaesthetist's nurse is busying herself with taping the breathing tube to the patient's mouth and the machines supplying the patient with oxygen and medication.

The preparation of the actual operation is roughly organised by functional requirements (sterility) and professional authority, but a large part is being done according to the present situation.

The work in this 'ant hill' of activities takes place in five different locations with different tasks to be accomplished. People stand with their backs to each other engaged either in team work or working by themselves. The analysis of this sequence, which took place between intubation and the first cut, reveals that the organisation of the work process depends on the active

coordination of the actors and their ability to cooperate.

By replaying the sequence several times, we can concentrate on the different *locales of action* (see chapter 4.2.2) one after the other and see how they are coordinated with other tasks.

The anaesthetists nurse for instance looks at the patients head while taping the tube, at the same time she tells the anaesthetist where to find the catheter instruments she prepared earlier, turning her head and nodding in the general direction:



**Fig. 3** OP04 – video still #3 (16:59)

The density of interaction in distributed settings can be made visible with the aid of video.

### 3.1.5 Construction of 'hard facts'

Videographic methods not only have advantages in the gathering and analysis of data. On the level of making scientific presentations they provide a means to produce *hard facts* from qualitive material. Where other disciplines in science rely heavily on pictures, the social sciences are still quite attached to plain text in order to express their ideas. Bruno Latour sees the process of creating *immutable mobiles* as a central feature of modern science. This process is essentially the transformation of the subject of scientific enquiry (rats, chemicals, people) into paper and also into pictures:

"The rationalization that took place during the so called "scientific revolution" is not of the mind, of the eye, of philosophy, but of *sight*." (Latour, 1986: )

The existence of a shared perspective makes scientific artefacts communicable and universally understandable.

When social scientist work with other, more visual, disciplines (e.g. medicine, engineering) we need to take the importance of visual material into account and be it only for the sake of producing visual examples or copies of past situations.

Video serves the transformation of 'soft', diffuse acts to 'hard', clear-cut pictures and provides the means to capture the fugitive nature of social interaction and to produce a permanent corpus of data that can be analysed by other people than the actual observer.

## 3.2 Disadvantages of audiovisual observation

One of the main problems video observation has, is the distortion of the field through the observation. This means that if the observed know they are being videotaped they might change the way they act.

Actions may be reconsidered in favour of their social acceptability[7]. This is especially important, because it is very hard to guarantee anonymity when you are actually filming people, their bodies and faces.

Videotaping is a very personal matter and in the course of our research often infringes delicate matters, especially when critical situations concerning the patients' safety develop.

### 3.2.1 Reflexivity of the field

The question of how social situations are influenced by the presence of an observer can be answered with either denial (the observer has no effect at all) or with total distortion (the situation changes completely).

One way to get around this problem is to make covert observations, so the observed don't know they are subject to analysis, but this approach poses ethical problems.

In my opinion it is futile to argue in favour of any of those two extreme positions, and so I would like to point out an alternative to the problem.

Reflexivity should not only be seen as unwanted distortion, it can lend a valuable perspective to research if the researcher reflexively analyses *how* her or his presence distorts 'natural' social interaction (Lomax & Casey, 1998). Performance changes between video and naked eye observation can be compared and used for methodological purposes.

Lomax shows how the interaction of midwives and clients incorporates the researcher into a new situation. Our research in surgical theatres leads to the similar conclusion.

Observers become part of the interaction, no matter how low they try to keep their profile. In highly specialised teams of experts, the observer is bound to stick out from the first minute.

The initial attention towards the observer tends to fade away over a certain period of time, i.e. the people get used to the presence of the observer. It does not matter if the observation is conducted with field notes or video equipment, however the accustoming process takes more time when using video.

When the research is conducted in very large organisations (e.g. hospitals with rotating team members) the people rarely have a chance to get properly accustomed to the researcher.

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7  This is likewise true for the answers given in questionnaires.

This was the case in our research since the team was slightly different every day. While I was taking field notes, I was given curious looks and sometimes the people whispered and pointed at me. This attention decreased during the day and also over the weeks and in the end I was informally known as 'the spy'. I gave everybody access to my field notes and told them about my work and intentions. The situations I observed came close to what I think is 'normal' for a surgical theatre of this type.

When I was using video for the first time a few weeks into the field work the situation changed. After initial hesitations, I was granted permission to video tape some operations by all team members and the patients.

The awareness of video surveillance led the team to perform a what could be called an 'ideal type operation' where everybody was concentrating on the job with very few task-unrelated activities. Voices were kept very low often reduced to a mumble, which was only understandable in the vicinity of the speaker.

It seemed that the team members can enact such a situation without prior notice since they have a shared knowledge about what a 'good' operation and an appropriate way of conduct is. The importance of standards and routines for the switch from a 'natural' workflow to a handbook like processing of tasks becomes quite clear.

By analysing the distorting effect participant research has on the field the results are less vulnerable to biases.

Maybe because of the ever-increasing presence of cameras in everyday life through the media as well as surveillance, people will become more accustomed to and therefore less affected by cameras in the future, also reducing the distorting effects.

### 3.2.2 Technical disadvantages

Although a video camera can record a very large amount of data, it can not distinguish between important and unimportant data. The camera records useful information as well as noise at the same level. Imagine a tape recording of a busy pub. It is very hard to focus on distinct voices or follow conversations, because the background music appears to be quite prominent on tape or packs of crisps are being torn open right next to your microphone.

Furthermore the camera is not as quick as the eye. When observing with the naked eye, the focus of attention is easily moved in space and the line of sight can be changed rapidly. With a camera this takes a lot more time.

# 4. Taping & Analysis

Once a video tape has been made, the analysis of the content is the next step. So far there are no fixed rules on how to analyse video tapes, but there are quite a few useful hints and procedures as how to proceed.

## 4.1 Recording & Storing

There are a variety of different video tapes available in stores. Either classic VHS or the new digital video DV and Mini-DV and MICROMV. Other solutions exist, but play a marginal role. I recommend using the digital formats for the following reasons:

The digital camcorders are small and lightweight. New MICROMV camcorders only weigh 310 grams. They can easily be operated and have technical features that help to make decent footage. Which format to chose depends on the requirements of the research.

The video taping of situations with a extended duration demands a format with long recording time. Digital 8 has the

longest tapes and records up to 135 minutes in longplay mode. Mini-DV camcorders are smaller and hold up to 90 min. in longplay mode. MICROMV is the smallest format with tape capacities of 60 min.

If long sequences are to be recorded, it is advisable to use a tripod to support the camera.

All the digital formats can easily be converted to a computer. About 60 minutes of footage can be compressed to fit on regular CD-R Media in decent quality using either the AVI or MPEG format.

Storing the footage on a computer gives easy access to the data. There is no more fore-winding or re-winding, sequences of interest can be found almost instantly Modern software makes it easy to edit the material in many ways. Short sequences can be inserted into presentations. The widespread use of computers makes the additional use of video recorders and TV screens redundant. Copies are quickly made and distributed.

## 4.2 Setting

In complex dynamic situations the locales of action and interaction often change. Using a fixed position for the camera does not account for this fact and relevant parts of the situation might be missed. Therefore the spatial dimension of interaction becomes important in distributed settings and it is the decision of the observer to use either stationary or mobile cameras according to the research focus.

### 4.2.1 Topography

The amount of machinery sometimes blocks the view of the researcher. The camera has to be moved and the picture zoomed to get a better angle and a close shot.

A schematic picture of a surgical theatre illustrates this Problem:
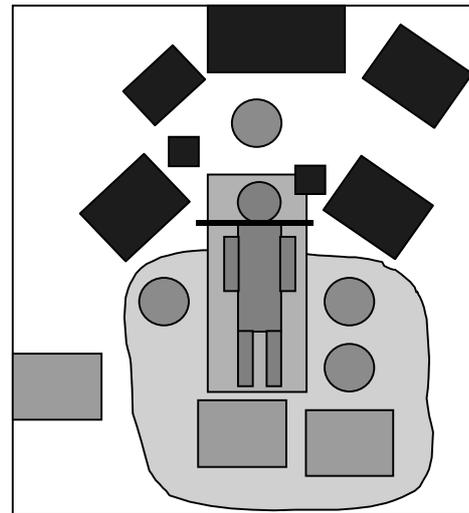


**Fig. 4** schematic picture of an OR

The squares symbolise machines that block the view of, or access to, areas of interest. The non-geometric shape at the bottom indicates the area of sterility, the circles represent the team members. In the middle are the operating table an the patient.

The architecture of the room as well as the functionality of the workplace determine the way in which situations can be recorded.

The anaesthetist is walled in by machines and the surgeons stand very close to each other, often hiding the focus of their action with their bodies.

Because of the risk of contamination, the observer has to keep a safe distance from the sterile areas.

These factors limit the line of sight and some things can not be recorded at all.

### 4.2.2 Locales of action

The term *locale* is used to encompass not only the geographic space in which an action occurs, but also the material and interactional resources available to the people in the situation[8].

High-tech workplaces have either centred or distributed locales of action, or both.

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8  Fitzpatrick, for instance, has used the notion of locales to inspire system design in CSCW (Fitzpatrick, 1995 / 2001.

The requirements of the task and other constraints of the situation, like the use of stationary equipment, determine the topographic areas where action, interaction and interactivity occur.

Some work can only be done in front of a computer screen and surgeons need to be right next to the patient. These situations can best be recorded with a stationary camera, because the actors can not move away from their workplace and we call this a centred locale of action.

Distributed locales of action on the other side are not bound to a specific physical space. The workplace of the anaesthetist for instance starts outside of the surgical theatre in the anaesthetic room, where the patients are prepared. It then moves with the patient into the surgical theatre and finally follows the patient out into the waking room.

Operating and sedating a patient are central but not exclusive modes of work in surgical theatres. Especially in cooperative settings, coordinating the teamwork is a very important part of the work. The coordination occurs in many places in and outside the surgical theatre. It is not strategically planned by the actors but rather 'happens', whenever and wherever the actors need to coordinate their cooperation.

To record this spontaneous and dynamic interaction the observer needs to use a mobile camera, i.e. when the actors move to another room.

## 4.3 Knowledge of the context

The analysis of high-tech work situation is only possible with a certain amount of context knowledge. When reconstructing interactions, the researcher should be able to judge the situation according to the meaning that the actors attached to it.

Sometimes the observer can simply ask what is happening at the moment or may be able to conduct spontaneous interviews afterwards. A simple rule for how many

observations should be done is: the more the better. Especially in the first, explorative phase of research one can not have too few field observations.

When analysing video tapes , the person who did the video recording can give useful information on the circumstances of the situation that have not been recorded.

In complex organisations actions are distributed over time and it might be necessary to know what happened, for example, the night before. Only a participant observer can get this kind of information through asking the research subjects.

In some cases the action recorded on video might be completely incomprehensible to a naïve observer unless the context knowledge, the reasons for the action, are made available to him.

## 4.4 Content log

After a situation has been recorded it is very useful to create a content log (see: Suchman & Trigg, 1991; Jordan & Henderson, 1995). The content log can either be a short written summary of the video or a more detailed report of interesting parts of the video.

In our research, the identification of important sequences is the primary use of the content log. Sometimes three different people watch the same video separately and write three different content logs. Afterwards a meeting is being held, where the three content logs are compared, then merged into one.

In this way we hope to counteract idiosyncratic observer biases and generate a more comprehensive account of the taped situations.

In the domain of the OR, it is often essential that the person who did the video taping participates in the writing of the content log, so that the knowledge of the context can be included in the analysis of the video.

## 4.5 Classification

Once sequences have been identified as important to the research they are classified in a rough pattern of different observations. Classifications can be something like: routine action, interactivity, negotiation, etc. The first classifications that are made lead to the formation of preliminary categories of action.

The categories are refined in the research process, as the researcher acquires more knowledge and new data is being analysed. Of course, the data gathered from interviews and field notes also gets used in the construction of the categories.

## 4.6 Sequential analysis

As a central aspect of conversation analysis, sequential analysis is concerned with how conversation is structured in terms of exchanges-in-sequence (turn taking). The main aim is to identify how one action is followed by another, and how this order of events is organised. This perspective can be easily adopted for video analysis, when the analysis is assigned to visual (posture, gesture or gaze) as well as verbal expressions (see Knoblauch, 1998) in the interaction of humans alone or with technology.

# 5. Conclusion

Video recording as a form of observation certainly enriches the scope of methods available to the social sciences.

Its advantages warrant a closer look at he possibilities it offers and its disadvantages do not account for the marginal role it plays in social research.

The key elements of 'doing video' can be summarised in five points:

1. Videography is best supported by participant observation and interviews, i.e. it rarely is a 'stand alone' method.

2. Videography is of great use in focussing on 'unseen' and 'hidden' phenomena like routines and habits, to make interaction and interactivity visible.

3. Videography aids the analysis of situations with dense interaction of multiple actors.

4. Videography can capture the face–to-interface interactivity between humans and machines.

5. Video recordings provide a permanent data corpus of volatile phenomena, like interaction, and allow replay or slow motion.

In our case, the interaction and interactivity in the OR was able to be analysed on a level formerly unavailable to the researcher.

The coordination and cooperation in the OR is relies heavily on *tacit* skills[9] to bring together the socially, professionally, geographically and technically distributed actions. Also, the team members are engaged in constant mutual monitoring, situated adaptation and structuring of their cooperation.

The interactivity with machines is situated and of an experimental nature. It consists more of routine compensations for minor flaws in the workflow than reflective problem solving strategies.

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9    See also: Hindmarsh & Pilnick, (in press)

# 6. Acknowledgements

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