

# # IMPLEMENTING OPEN NETWORK TECHNOLOGIES IN COMPLEX WORK PRACTICES: A CASE FROM TELEMEDICINE

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## **Abstract**

*New non-desktop technologies may turn out to be of a more open and generic nature than traditional information technologies. These technologies consequently pose novel challenges to systems development practice, as the design, implementation, and use of these technologies will be different. This paper presents empirical material from a project where multimedia technology was introduced into a complex medical work practice (surgery). The implementation process is analyzed at the micro-level and the process is found to be highly complex, emergent, and continuous. Using actor-network theory, we argue that conceptualizing the process as cultivating the hybrid collectif of humans and non-humans, technologies and non-technologies (Callon and Law*

1995) is a suitable and useful approach. This concept may capture the open-ended and emergent nature of the process and indicate the suitability of an evolutionary approach.

**Keywords:** Telemedicine, multimedia, network, actor-network theory, cultivation, *hybrid collectif*.

## 1. Introduction

This paper reports from the development, use, and adaptation of a broadband multimedia network between two major Norwegian hospitals. The study is positioned at a stage where a potentially useful technology “out there” has already been identified and recruited by the hospitals. A rather simple (although not cheap) technology was installed, providing two parallel two-way audio and video streams. The focus at the time of the study was on trying to use it, adjusting and adapting it as necessary, before it eventually would become fully integrated and seamlessly functioning. However, the seemingly simple tasks of adapting and utilizing this technology turned out to be a challenging and non-trivial implementation process. The process through which the technology and the clinical practice became at least temporarily integrated was a continuous, iterative, and interwoven process where the activities of design, implementation, and use are not clearly separable.

As the case stories show, complete integration and routinization of use is still far away. In fact, it is our belief that the present stage of the process may turn out to be the normal state of affairs for a long time still, due to the open and generic nature of the technology and the complex hospital organization into which it is introduced. This means that the word “implementation” may not be the best choice for an analytical approach. The traditional view on implementation as a rationally controlled, linear process consisting of separate design, implementation, and use phases has long been challenged, but in practice this view is still prevalent. In real life, implementation turns out to be a notoriously complex and unmanageable process, and failure stories abound. The introduction of notions such as *drift* and *improvisation* (Ciborra 1996b; Orlikowski 1996) points to the unplanned and unmanageable aspects of the processes. Other alternative metaphors that have been suggested are *care*, *bricolage*, and *tinkering* (Ciborra 1996a), *cultivation* (Dahlbom and Mathiassen 1993), and *hospitality* (Ciborra 1999). These metaphors capture other aspects, like the lack of total control, the presence of risk and ambiguity, and the importance of dedicated commitment and attention. Matthew Jones (1998), introducing the notion of *the double mangle*, emphasizes the temporally emergent nature of the interaction between human and material agency, and the inherently open and evolving character of the process. We think it is possible to gain valuable insight into implementation challenges from analyzing particular instances of “the dialectic of accommodation and resistance” or “the ongoing double dance of agency” (human and material agency) (Jones 1998). This empirical study aspires to analyze this mutual and multifaceted process at a micro-level.

We will have to employ concepts that encompass and cover the aspects that these modifications of the implementation concept suggest. The concept of a translation process

from actor-network theory may be a path to explore. It is offered as an alternative to *diffusion* by Bruno Latour (1987), and has been used to describe IT diffusion (McMaster, Vidgen, and Wastel 1997) and implementation (Linderoth 1999).

Latour (1987) argues that when a technology diffuses, it is not an artifact with fixed meaning that is adopted in the same way by each user. In each single case, the adopter has to figure out how to use the technology in her work or life. This implies a reinterpretation—translation—of the meaning assigned to the technology by its designers and previous adopters and at the same time a reinterpretation—translation—of her understanding of herself and her work tasks. In this way, Latour sees adoption and diffusion as mere co-design of both users and technologies.

Broadband multimedia technology is not adopted inside hospitals by individual users in isolation. Rather the opposite: the technology is adopted as a shared infrastructure for the “whole” medical community. But in the beginning, the technology must be adopted by a small user community that subsequently grows. In this process, the technology and the users are both continuously changed and aligned to each other. Together they constitute a collective of humans and non-humans (Latour 1999), a *hybrid collectif* (Callon and Law 1995). The implementation of broadband multimedia technology throughout the hospitals can be seen as a such a collective that is growing in terms of members and where each member as well as the collective as a whole learn and improve their performance. Managing the implementation of this kind of technology could then be seen as the cultivation of such a collective.

The case stories illustrate the details of such a cultivation process by using the concepts *translations*, *enrolment*, and *alignment*. Our focus will be on the detailed and mundane activities that occur in a given practical situation, focusing on the relation between the new technology and the activities of the human actors.

Integral to the actor-network perspective is the view that there is not one single, universally “right” solution or resulting condition of an implementation process. One may envision several equally probable end results, depending on the character of the network(s) involved, the actors’ strategies, the success of enrolment attempts, the appeal of translations, and the strength of the inscriptions. The situated and emergent nature of the translation process is evident from the empirical data, and we think this open-ended view of any implementation process is an essential and crucial feature of reality. Consequently, we argue that this view should be integrated into systems development practice.

## **2. Multimedia Networks Entering a Hospital**

### *2.1 Project Background*

The intention of the telemedicine project was to explore the potential of networked multimedia technology in minimal invasive surgery (also called “peephole surgery”). Minimal invasive surgery is a collective term for a range of medical procedures where the “invasiveness” of the procedure is minimized. Minimal invasive surgery of the abdomen (laparoscopic surgery) avoids an ordinary open surgery by making three to five small holes (with a diameter of 5mm to 10 mm) and using instruments that are entered through

these “ports” to perform the operation. The surgeon’s view of the workspace is mediated through video images on a monitor and, consequently, is easily available for capture and transmission across communication networks. However, the central role of the images (as a substitute for direct vision in ordinary, open surgery) motivates the very strong requirements to the image quality. Important information may be related to subtle texture and color variations, as well as delicate structures (e.g., vessels), and these details may be lost if the video is compressed too heavily. These demands to image quality dictated the choice of technology in the project. Broadband technology, in this case a 34 Mbit/s ATM network (Asynchronous Transfer Mode) and MPEG2 real-time coding of video and audio, facilitates use of high quality video transmission. Additional information on the project may be found in Hanseth et al. (1999).

Most of the descriptions in this article relate to the process within one of the two hospitals. The focus is thus on the local adaptations and learning “within” one of the project partners, more than on the project process as a whole. The site is a research and development center, and attracts large numbers of visitors. In order to facilitate the information and education work, a permanent set-up of audio and video transmission was installed (independently of the telemedicine project). The presence of this local infrastructure turned out to be an important asset in the later telemedical activities. Several image signals from each of the two operating rooms are connected to a control room with mixing facilities. In the control room up to 16 images from the two operating rooms are displayed on small monitors and microphones and loudspeakers provide two-way audio communication with the operating rooms. This control room is also connected to two local lecture halls as well as to the external ATM and also to the ordinary ISDN network.

## **2.2 Research Method**

The study is an empirical study situated within the interpretative strand of information systems research (Klein and Myers 1999; Walsham 1995) and has thus mainly employed qualitative methods.

The main method for data collection has been participatory observation. The authors have been members of the project organization and the first author spent approximately 50% of her time for one and a half years (from the summer of 1998 to the end of 1999) as a participant observer at one of the sites. The other site has also been visited several times for parallel observations. The first author participated in the technical support work for most of the transmissions in this particular project. This work includes planning, actual preparation, and set-up, as well as assistance during transmissions. Keeping a formal log over the activities and experiences and writing up an evaluation report have been important tasks in gaining and revising an understanding of the process. Personal diary notes have provided additional detail on the detailed case stories below.

Semi-structured and free interviews were conducted with a wide range of personnel groups, including surgeons, operating theater nurses, anaesthesia nurses, technicians, students, and lecturers. The interviews were mainly focused on bringing out experiences, opinions, and feelings after specific transmissions and to a lesser degree around the project and the multimedia technology in general. Findings and conclusions have been

discussed informally (after most of the transmissions) and formally (in discussion meetings) with the staff involved. Other qualitative methods were used as well, including observation of medical work, video recording of work, and analysis of textual documents. General participation in the daily life and interaction with the rest of the personnel has proven useful to gain an understanding of the values and the resources of the medical practice, as well as the challenges and problems that are encountered.

### **2.3 New Technology Meets Surgical Work**

The project intended to perform experimental development of technological solutions for minimal invasive surgery. The focus was on determining sufficient and cost-effective image quality. However, “using” the new technology soon turned out to be more than selecting the optimal bandwidth and encoding algorithm. The project changed from the careful execution of well-planned experiments into a process best characterized as improvisation, tinkering or bricolage (Ciborra 1996a, 1996b; Orlikowski 1996). The actual use became different from the planned use, which was education of gastrointestinal surgeons through transmissions of live operations and recorded material. Several other medical specialities became involved and transmissions of meetings, lectures, and demonstrations became an important part of the use.

One of the main reasons for this *drifting* of the project is the fact that the work practice into which the technology was introduced (surgery) is a complex practice with many requirements. Patient safety is of utmost importance, which implies low tolerance of disturbances and problems introduced by the technology. There are also certain demands on where the equipment can be placed, how it can be used, and requirements to design with regard to cleaning and sterilization. Thus the technology had to “learn” or “discover” how to comply with these new criteria. At the same time, the technology was not “allowed in” before it could perform satisfactorily. This situation creates a “deadlock”: real use was the only way to learn, but real use was not allowed until learning had taken place. Simulations are not feasible, as they either become too simple or too expensive and time-consuming. The way out of the deadlock in this project was to build iteratively on earlier experience from simple settings and to generate increasingly demanding opportunities for further learning. Use evolved from simple and small-scale transmissions to more demanding, more “marketed” (and, therefore, more high risk) situations. Thus transmissions of lectures (non-critical) have direct relevance for transmissions of surgery (critical), as it generated valuable experience with the technology.

In addition to the learning-driven change of project focus, the fact that different medical disciplines cooperate in practice and need to share a common infrastructure is important. Focusing on separate discipline-specific system is thus not desirable. What needs to be developed is a common and shared resource. This was realized in the project and steps were taken to expand the scope of the experimental use. Such an expansion is not without challenges, as the involvement of other departments and institutions implies an increased complexity of the translations necessary to enrol all actors.

## 2.4 Actants in Networks

A central feature of actor-network theory is that humans and non-humans (i.e., technology, organizations, institutions, etc.) are treated symmetrically. Technological and social elements are considered tied together into networks, based on the assumption that technologies are always defined to work in an environment including non-technological elements, without which the technology would be meaningless and it would not work. In the same way, as humans, we use non-human objects (technologies and other artifacts) in all our dealings in our world; our existence in the world is based upon the existence of these objects. Accordingly, neither humans nor technological artifacts should be considered as pure, isolated elements, but rather as heterogeneous networks. When any actor acts, this very actor is always such a network, not a single element. An actor is always a *hybrid collectif* (Callon and Law 1995). In the same way, elements in a network are not defined only by their “internal” aspects, but rather by their relationships to other elements, i.e., as a network. This further implies that elements in such a network are not initially defined as human, social or technological; they are referred to by a common term: actant. These assumptions do not deny any differences—or borders—between what is human or social and what is technological. However, these borders are seen as negotiated, not as given.

According to actor network theory, stability, technological and social order, is continually negotiated as a social process of aligning interests. As actors from the outset have a diverse set of interests, stability rests crucially on the ability to translate (reinterpret, represent, or appropriate) others’ interests to one’s own. Through translations, one and the same interest or anticipation may be presented in different ways, thereby mobilizing broader support. A translation presupposes a medium or a “material into which it is inscribed.” Translations are “embodied in texts, machines, bodily skills [which] become their support, their more or less faithful executive” (Callon 1991, p. 143). Design is then a process where various interests are translated into technological solutions as well as organizational arrangements and procedures to be followed to make the technology work properly. In this process, existing technology will be reinterpreted and translated into new ways of using it. To make the technology work, all these elements must be aligned, i.e., cooperating toward a common goal. This is achieved through a translation process, which, if successful, may lead to *alignment*. An aligned network is in a kind of equilibrium or stable state (at least temporarily). The alignment attempts occur through *enrolling* the different and heterogeneous *actants* in this *network* by translating their interests. As large actor-networks are aligned, they may become irreversible and hard to change (Callon 1991; Hanseth and Monteiro 1997).

## 3. The Anatomy of Translation

The natural starting point for an analysis of the introduction and adaptation of the technology and the organization is to focus on the *work that is required* in order to facilitate the meeting between the technology and the work practices. In actor-network terms, a “successful” implementation is a *stabilized network*, where the actants are *aligned*. The following three stories from particular instances serve as illustrations to the

ongoing, mutual process of alignment or stabilization efforts. The medical work practice has its demands to an acceptable or desirable state of affairs, but so has the technology (illustrated by the first story). These different demands may peacefully coexist in a stable network, or they may initially be in conflict and thus require “translation work” in order to enrol and align the different actants into the same stable and working network. The second story in particular focuses on this translation work. The situatedness and emergent character of the mutual learning process is evident. Most of it is unplanned and it occurs in real life and in practical use situations, i.e., transmissions. This emergent character of the process, together with its openness and dependence on adjacent networks, also implies lack of control, and the third story illustrates the fragility and vulnerability of the achieved alignment.

### *3.1 the Demands from Medical Work Practice*

For transmissions of live operations, the previously installed permanent set-up was in place in the operating room. Video from wall- or roof-mounted cameras would be transmitted during the preparations and early phases of the operation, and images directly from other imaging equipment when the actual surgical work started. The technician could watch and choose between all of these image sources in the control room. Verbal communication between the surgeon(s) and the viewers were facilitated through use of permanent microphones and loudspeakers in the roof above the operating table. The transmission must be prepared by connecting the imaging equipment to the network (this involved connecting a dedicated piece of cable from the monitors to a wall-mounted panel) and turning on the camera system, which has to be done inside the operating room. This feature together with a red “on air” light, was introduced in an early phase (before this project) to give the operating room team control over the situation. Before this particular transmission, an additional wish from the team had been accommodated: The image from the receivers, which earlier had been shown only in the control room, was displayed on a monitor inside the operating room. Now the surgeon did not need to ask explicitly who was watching, but the whole team could see whether there were any receivers, and who they were.

Here we already see several translations of different actants’ interests. The placement of the cameras reflects a focus on the surgeon’s work (as opposed to nursing work, which takes place in larger areas of the room). The operating room team’s wish for control over the communication situation was translated into physical pieces of technology: the red light, the camera control facility, and the additional monitor showing an image of the receivers. Or viewed the other way round, the “technology” has to be able to provide the team with the required control, in order for it to be accepted and allowed into the operating room (this is an example of “learning” on behalf of the technology). The wish to transmit images and sound to the receivers leads to the enrolment of several physical devices (cables, microphones, and loudspeakers). Also, the telemedicine project leader needs to enrol the technicians and nurses to actually perform the required work of connecting and turning on equipment in order for the transmission to be possible or the network to be aligned.

A procedure known as endoscopic retrograde choleangio pancreaticography (aptly abbreviated to ERCP) would be transmitted to a group of medical doctors specializing in endoscopy. This procedure consists of accessing the duodenum and the pancreatic channel for diagnosis and treatment of gallstone-related problems, through a gastroscope entered via the mouth. An ERCP involves the simultaneous use of several image sources, at least the image from the gastroscope and a x-ray cine (a sequence of separate x-ray images taken during a brief period, in fact an “x-ray video”). In this particular procedure, a so-called “mother- and child-scope” was to be used. This is a gastroscope where a second imaging scope (the “child”) is extended into the pancreatic channel, generating a third image.

The surgeon and the rest of the team were informed by one of the support technicians that the procedure would not only be transmitted to the other (partner) hospital, but to three additional hospital as well (expanding the project network). For some reason, the patient did not show up at time and the operation was delayed for one hour. Then the lack of routines for informing the receivers was discovered. First, the telephone was used to inform one of the receiver sites, then a PowerPoint slide announcing the expected starting time was made on a computer and transmitted to the whole network. By then, several of the potential receivers had left due to other duties at their local hospitals. When the patient arrived, the surgeon took on the responsibility of informing and asking for consent.

The gap that occurs between the receivers waiting for the transmission to start and the missing patient is a threat to an aligned network and needs to be remedied. Several parallel activities occur: a search for the patient is conducted and the possibility of summoning the next patient in the queue is checked out. The technical team use telephone and a PowerPoint slide to inform the receivers. However, the attempts are not entirely successful in ensuring that the receivers stay, as the demands from other networks (local hospital’s work schedule) turn out to be stronger. A crucial part of the alignment needed for a successful transmission (i.e., an obligatory passage point) is the patient consent: if the patient had rejected the idea, the transmission would have to be cancelled. Also, the operating room team needs to agree to become enrolled into the network and to take part in the transmission. This is achieved through the telemedicine activities being defined as a formal activity of the department and accepted as such.

When students are present in the operation room, they may detect the surgeon’s changing focus on the different image sources (gastroscope or x-ray image) without this being explicitly mentioned. The receivers across a network do not see more than one image at a time, and the technical personnel (who have access to all of the images) do not know the procedures in detail. Consequently, at several instances, the receivers did not get all the relevant information. In order for the image switching to be appropriate, either the surgeon had to mention explicitly that he was looking at the x-ray cine or the gastroscopic image, or the technicians had to detect where the activity seemed to happen (e.g., switch when the x-ray cine sequence was started). In some instances, the receivers would ask to be shown a particular image. During this session, a students’ facilitator was present in the operating room, assisting the surgeon and taking care of some of the verbal explanations. When this problem was discovered, he started to comment on the surgeon’s use of images more explicitly, which aided the technical personnel’s switching task.

The discrepancies between what the surgeon sees and what the network transmits to the receivers is a problem that must be solved. The means for doing this may be several. As indicated, either the surgeon must perform an additional task (explicit verbal comments), additional training of technicians can be done, or the organization can provide extra personnel resources. The intended result of any of these translations is an aligned network where the receivers see what they want and need to see. In any of the scenarios, the human actants must relate to the requirements and overcome the limitations of the technology. One may also envision other solutions where the technology takes on more responsibility for solving this problem. One solution could be to transmit all image sources in parallel all the time, and leave to the receivers to watch whatever image they want. This would require high bandwidth and several monitors. Another solution could be a tracking system for the surgeon's direction of gaze, and an automated image switching facility. Both of these possible translations were too expensive for the project according to its rather short-term goals.

At the point in the procedure where the child-scope was extended from the mother-scope and activated, an additional image was generated and displayed on the surgeon's monitor in a Picture-in-Picture (PIP) manner. This additional image was not included in the image that was transmitted to the control room and further to the receivers, and one technician had to enter the operating room to detect why the child-scope image was not included. The solution consisted of finding another place to tap the signal, something that introduced another problem. The monitors allow video signals to be tapped either in a so-called Y/C format or as composite video. To allow for the transmission of the higher quality Y/C signal to the control room, some special adapter cables had been made previously. In this particular instance, only composite video was available if the PIP function was required and the lower quality signal had to be chosen. This meant that, in addition, the technician had to find other cables and substitute them for the special cables.

Here we see the previous translation of the wish for optimal image quality into the physical material of adapter cables. Or conversely, we could say that the technology has to "learn" how to fulfil the demands for high image quality. However, another wish from the medical community, namely to transmit the PIP image, gets higher priority. The technology introduces some obstacles to this wish and a technician and other cables have to be enrolled to create the new stable network where the receivers can watch the PIP image.

There was some noise from the suction machine (which was an old one and not ordinarily used), and some activities occurred in order to minimize this disturbance. Disturbances arise also from the fact that discussions between technicians on the audio lines between the sites are sent to the operating room. This included messages such as sub-optimal use of microphones on the other side needed to be corrected, camera position not optimal, discussions of whether to try specific solutions to problems, or whether to terminate the connection after the attendees had left. In many cases, the technicians chose to make separate telephone calls to avoid disturbing the operating room team and the receivers. In general, the operating room personnel encounter a more "messy situation" during transmissions (several additional cables on the floor, a technician may enter and do some work).

As we see, not all actants are completely enrolled into the network and noise and disturbances are the result. One way to avoid these specific problems is through use of

the telephone (enrolment of the telephone into the network). Another potential solution would be to provide a separate audio channel for control messages (again, technology would have to “learn” to comply with demands from the organization). New silent suction machines may be enrolled or “intelligent” microphones may be provided (which renders voice well and filters out noise).

### 3.2 *The Work of Alignment*

The need for learning and gaining experience with the technology induced the search for different use areas. One opportunity for a different kind of use came with a regional meeting of ENT (ear, nose, and throat) specialists. Both hospitals are regional hospitals for one region each (which together comprise approximately half of the population of Norway). Much of the health care administration occurs *within* a region, which implies less contact *between* regions. A regional seminar was planned at the same time in both regions and the network between the two hospitals provided a unique opportunity for the two groups to perform a joint meeting. This required some activity from the project members on both sites in order to enrol the local ENT departments. The network had previously been used in one meeting, and then the support was purchased from an audio-visual consultant company. Thus this meeting was the first transmission of a high profile meeting managed by the local support team.

The meeting would consist of lectures and discussions and the support personnel were provided with a program for the meeting (time slots, name of speaker, title of lecture). This, however, was not sufficiently detailed information. A separate meeting between the technical support personnel and the organizers was needed to clarify additional issues, such as: At which of the two sites was each lecturer going to be located? What kind of presentation was going to be used (electronic, such as PowerPoint, or videos, where the signal could be tapped directly, or analog, such as ordinary slides or overheads that had to be filmed by an additional camera)? What level of interactivity was expected (would one cordless microphone to be passed around suffice)?

After this clarifying round, the technical planning work could start. The equipment needs were thought through and the number of video cameras, video selectors and distributors, monitors, microphones, audio mixers, and cables was established. Some of this had to be purchased or borrowed, cables had to be made, and the operation of the equipment had to be planned. Each of the four members of the technical support team was allocated to tasks (one in the control room, three in the lecture hall) and the responsibilities were spelled out. This involved getting access (and the keys) to the lecture hall before the meeting for set-up and tests. One person operated the projector in the lecture hall and switched between incoming video and two sources for local presentations (video or PC-based). He also started the videotapes when appropriate. Another person operated the video selectors and audio mixers, choosing to send to the other side either camera on lecturer (or on screen), camera on audience, local video signal, or projector signal (for the PC-based presentations). He also mixed and controlled the audio (in and out), muting microphones when needed and adjusting the sound level. The third person in the lecture hall operated the camera on the lecturer and the screen and also adjusted the room light in order to achieve a good image quality. The person in the control room

(some distance away from the lecture hall) was responsible for the connection to the other side and for appropriate switching when an ordinary ISDN videoconferencing session from a third party was to be connected and transmitted to both hospitals. A lot of “ordinary” articulation work (Strauss et al. 1985) comes in addition: for instance, arranging with the support personnel at the other site for testing (especially sound testing is highly interactive), the physical work of carrying and connecting equipment, telephone conversations to clarify details, tidying up after meeting, and locking rooms, etc.

We see the myriad of minute details that are necessary for the transmission to succeed, i.e., for the network to be stabilized (aligned) when it needs to be. The work of the support personnel can be seen as translating the interests of the different users and user groups with the interests (or requirements and needs) of the technology. This process of translation involves work. The amount of work is extensive; for this particular meeting, which lasted for three hours, 47 hours of technical support work was needed before, during, and after the transmission. If lecturers could be induced to take the detour to digitize all the material they wished to present in a lecture or a meeting, the network would look different. The additional technology and support work necessary catering to the analog parts would not have to be enrolled, and a simpler network would result, which might have been easier to align. This simplification will, of course, depend on the success of the previous translation (digitized material), but the important point is that there is a choice between several routes toward alignment (different translations of interests). Due to the availability of technicians (low-paid community workers), this solution was chosen instead of educating and enforcing lecturers to go digital, where the risk for failing to enrol them might have been greater.

### *3.3 The Fragility of Alignment*

The third case is an example of the problems that may arise when the alignment of the network breaks apart. This is another lecture transmission with yet another kind of medical content, with different requirements to the technology. This was going to be a “low-risk” session, i.e., a short and simple transmission for a small group. The weekly lunch lecture for radiologists on one of the sites was to be transmitted to the other site. Several transmissions had been carried out for this group before and the amount of work in planning was not as high as it had been on the first and novel cases.

Due to external factors (the lecture halls at both sides were occupied by others), the time for set-up and testing before transmission became very short (less than 30 minutes). Therefore, all the needed equipment (cameras, monitors, microphones, cables, etc.) had been prepared and loaded on a cart and one of the technicians went to install it in the lecture hall. Another stayed in the control room to work on establishing the network connection (which on “bad” days might take hours). The third (and most experienced) technician was ill that day.

The technician in the lecture hall reported that he could not get the local video projector to work and another projector was requested, searched for, and installed before he discovered that he had used a wrong remote control and the projector worked after all. Then it was discovered that the image received from the other side was displayed in black and white in the lecture hall. The time did not allow for extensive fault searching and the

initial remedies did not help. Finally, one of the microphones generated a lot of noise, the source of which was also not found. Such unfortunate and accidental pile-up of problems could have been managed with either more time or more personnel, but in this situation the breakdowns were not corrected before the transmission was about to start. The lecturer (on the other side) had to stop after a couple of minutes and start his lecture anew because the sound in the lecture hall was turned down and no technician who knew how to operate the equipment was present. The technician in the control room had to be summoned by telephone and had to run to the lecture hall, which was several floors away, in order to correct the audio problems. The image was displayed in black and white and the lecture hall was too dark for the other side to see (through the audience camera) who was present, as the room had to be dark in order for the projected images to be visible.

Another point of disappointment was the image quality of the x-ray images that were the focus of the lecture. X-ray images that are projected as ordinary (analog) slides are of a sufficient quality. When these images are filmed by a digital video camera and transmitted as a video signal, the quality is not satisfactory (at least according to some radiologists). This had been done earlier, but the technicians had not been told that this was inadequate and they had consequently not tried to find other solutions for transmissions of analog x-ray images. In the earlier lectures that had been transmitted for this group, the radiological images were not the main part of the lectures.

Here we see so-called “external factors” affecting the transmissions. These indicate the presence of other, potentially stronger networks. These networks determine the availability of infrastructural resources (Kling 1987), which here were lacking: access to facilities, systems for resource reservation, adequate time, systems for information exchange or de-briefing, large enough support organization, presence of skills and competence. There is a need also to align with these other networks (the “infrastructure”), as they may influence this particular network. The interdependence with the rest of the world is also evident if we take a look at the more practical and technical details.

We see that the stability of an aligned network may be fragile and vulnerable: the failure of aligning even small parts may turn out to be disastrous if these details are obligatory passage points. One slider on the audio mixer must be enrolled into the network and aligned with the other actants’ interests if the meeting is to be possible at all. The transmission of sound is an obligatory passage point. In order for this tiny slider to be aligned (put in the right position), a telephone (and a telephone network), somebody who makes the call, a person with audio-technical competencies (actually a musician), and his physical presence in the lecture hall are all necessary. The presence of an image with sufficient quality is necessary (i.e., another obligatory passage point) if the rationale for the existence of the network (i.e., the joint lunch meeting) is to look at images. “Behind” the presence of a sufficiently high-quality image lies a host of other actants that need to be aligned. For example, a few of these actants are the cables where the whole image signals is let through, not only the black/white part, a working video projector, a sufficiently high-quality capture mode (previous digitization of radiological images would have been appropriate), technicians’ knowledge of the importance of images for radiologists, and so on *ad infinitum*. The network never ends.

#### **4. Open, Network Technologies Meet Complex Work Practices**

The project from which the three snapshots presented above are selected was the involved hospitals' first encounter with broadband multimedia technology. Accordingly, some experimental activity was required in order to figure out how to use it properly. One might, possibly, believe that the use of the technology become routine and the degree of experimentation will decrease as experience is gained, and accordingly that the kind of problems and challenges described above will not play any major role after this initial experiment-oriented phase. We do not think that is the case. Rather the opposite: we believe that the use of this kind of technology in organizations like large hospitals will regularly be of this experimental character. This is so because of

- the open and networking character of the technology,
- the complexity of the work practices into which the technology is introduced, and
- the potential “revolutionary” benefits of the technology.

Multimedia network technology is open, or generic, in the sense that it might be applied in virtually any kind of work. But this open and generic character implies that it is not “given” how the technology should be used in the specific settings where it is adopted. The technology is not designed specifically for surgery; accordingly, its designers cannot tell the surgeons how they should use it. They have to figure this out themselves—through a learning process involving trial and error.

Medical work is very complex. There are many different tasks carried out by different kinds of medical personnel. (There are, for instance, 44 different medical specialties in the Norwegian health care sector.) Each task (like endoscopic surgery) is complex in itself. In addition, different activities are highly interdependent. They are linked directly in the sense that one department is delivering services to another (support services such as labs, radiology, and anaesthesia), patients are treated by many different departments almost concurrently, etc.

Broadband multimedia technology is supposed to be very useful in almost any kind of service as it opens up possibilities for collaboration among medical personnel independent of time and space. It is envisioned that medical expertise might help in treating a patient independent of the physical location of both patient and expertise. This is supposed to improve most medical services and open up more efficient ways of organizing the health care sector. Reaching this point is a long walk. And every single step requires experimentation, as illustrated above. Within each area, like surgical endoscopy, the technology may be used in many different ways and for many different purposes. Further, because the work practices of different departments and personnel groups are interdependent, the practices have to be changed in a coordinated fashion. And the technology and services developed are serving as a shared infrastructure for the health care sector, as was illustrated for surgery, ENT, and radiology in the examples above. This means that existing technological solutions and working practices must be changed to fit new requirements as one moves to each new use area. For each step, technology and working practices must be translated and aligned as illustrated in the first snapshot above. This alignment requires considerable work. Because the technology is constantly changing, it will permanently have an immature character and be highly fragile. We

believe this continuous process can be seen as cultivating a collectivity of humans and non-humans.

## 5 Cultivating the *Hybrid Collectif*

Conceptualizing the organizational implementation process as cultivation of a hybrid collectif may lead to a more natural focus on the translation work so crucial for success. In the case stories, both the organization and the technology can be looked upon as “children” or new members to be socialized and educated: they both have a lot to learn. From the point of view of the medical community, some rules are absolute and the technology has to learn and obey them. The new technology is not allowed to adversely affect the patient outcome and it has to perform satisfactorily (sound and image transmission quality). Its way of working must be adjusted to fit with the organization (physical placement of cameras and microphones, timing of transmissions, expanding its “skills” to allow flexible mixing of several image sources used). Also, if we take the opposite point of view (from the technology’s position), we see absolute rules where the organization needs to comply. A speaker who wants to communicate with the other side must use a microphone, the image signals to be obtained and displayed need to have the right format, physical entities need to be introduced into the operating room. The descriptions of actual usage show that the translations are not only performed by the humans. The process is not only one-way (users inscribing their interests into the technology). Mutual translations and inscriptions occur. Routines within the operating room are altered to accommodate the technology’s interests (e.g., the nurses get additional tasks in order to care for the demands of the microphones and cameras). Also, modifications and adaptations of the technology are carried out to facilitate the users’ demands on the services of the network. There is a concurrent design and redesign of technology, individuals, and work practices; all parts in the network are involved.

We think the temporally emergent nature of the interaction between the human and non-human actants is a salient feature of such a cultivation process, as well as the inherently open character of the process. Conversation analysis shows the irreducibly interactional structuring of talk (Suchman 1994). It is tempting to look for a parallel to this phenomenon in design and implementation. The parallel could be that the dialogue between an organization and the technology is irreducibly interactional and consequently not possible to plan or specify in advance. Thus the concept of cultivating the *hybrid collectif* to be an adequate approach toward analyzing this process in detail.

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