Supporting computer supported cooperative work

A case study from telemedicine

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Abstract

Networked multimedia applications are increasingly deployed to support co-operative work. They may, however, pose novel challenges to design and implementation of the technology. This paper presents an empirical study of a video-based telemedicine project - the DIMedS project (Development of Interactive Medical Services). The experiences from the project are summarised, with focus on the requirements that this kind of video-based co-operation poses to support activities, as well as on the implications for design.

Keywords: telemedicine, network, multimedia, support

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Introduction

Multimedia applications are finding their way from leisure to working life, and one area where the deployment of multimedia support is expected to give large benefits is medicine.

This paper reports on a field study of the development, use and adaptation of a broadband multimedia network between two major Norwegian hospitals. Broadband technology (in this case an ATM network and MPEG2 real-time coding of video and audio) facilitates use of high quality video transmission. This extends the scope of telemedicine from the traditional data or still-image transfer usage, to interactive use in areas where demands on image quality are high. Video-based telemedicine is different also from ordinary video-conferencing (within or outside medical settings) in the respect that the video is not only a support for interpersonal communication across distance, rather the video itself is the *data* and the focus of interest. This is the case both within the operation room, as shown by Nardi et al. (1996), and across a network.

The focus of this paper is on the requirements this kind of real-time video-based telemedicine poses, with a special emphasis on the need for support both on development of technological solutions and during routine usage. Support work has received relatively little emphasis in research, despite its indisputable importance.

In most reports from telemedicine projects, the focus is on the medical content and the technology's feasibility for medical work. This includes a large amount of evaluations of transferred image quality in radiology and pathology. If the supporting surroundings are discussed, this relates mostly to network requirements (e.g. reliability, delay, bit rates), safety and confidentiality, economic viability, and legal and ethical issues. A survey of four volumes (1995 to 1998) of one major telemedicine journal revealed only three articles that emphasise aspects of technical support and user-friendliness (Hobsley et. al, 1997), (McClelland et al., 1995), (Yellowlees, 1997). However, only one of these describes a video-based application similar to the one described here (Hobsley et al., 1997).

Video-supported collaboration is a much-focused issue within the CSCW field. However, the need for support required during the collaborative sessions that the telemedicine applications discussed in this paper, have not been addressed. We believe this is due to the fact that the work process (minimal invasive surgery) into which the technology is introduced is more complex, and consequently require more technical support than those studied previously.

Some CSCW papers are, however, addressing related issues. One of the few contributions in this area is Bowers (1994), which describes the challenges when a CSCW application is put into action and not only tested in a laboratory or trial setting. He emphasises the unanticipated overhead or "the work to make a network work" (including support, which is not merely "oiling the wheels"). Network and system management is often neglected, despite it being a substantial source of extra, unanticipated work. He therefore suggests support for the supporters as a research area.

Another contribution comes from Okamura et al. (1994), where the role of mediators is analysed in the context of a local network. They find that the mediators who actively intervened (guided and manipulated the technology and the use), contributed significantly to the shaping of the technology and its use. These persons were users as well as mediators, therefore sensitive to user feedback, at the same time they were technically adept.

Support work, generally speaking, has the character of becoming invisible or transparent once it is well done. Only on breakdowns does it become visible. The focus on primary tasks in an "ordinary" or smooth-running situation may explain that the support requirements have seldom been the focus of studies. Consequently, support personnel, especially technical personnel, are a group of actors that has received relatively little emphasis in the literature. This implies that knowledge about support work in order to inform design, to a large degree is lacking. This paper seeks to contribute to this empirical literature in order to inform design, as well as to actually perform design. The project itself is described, with an emphasis on the support requirements. The experiences from the DIMedS project may be relevant to other efforts at multimedia-based and networked co-operation within health care.

The DIMedS project

Background

The DIMedS project is the result of an initiative taken by Telia to establish collaboration within telemedicine (or the use of ATM networks within medicine) between Telia and

Ericsson and the hospitals Rikshospitalet and Ullevål Sykehus in Olso. The first concrete activity was the establishment of an ATM (Asynchronous Transmission Mode, a wide-bandwidth technology) link between the two hospitals in June 1997. The aim of this activity was to get the first hands-on experience with ATM as a medium for transmission of the images from cameras (monitors) used for guiding the surgeon when using minimal invasive and image guided techniques. The main objective was to compare the quality of the images depending on encoding algorithms (compression rate) and transmission rate. (MPEG, M-JPEG, H.261/H.263), and comparing ATM with ISDN.

The conclusion from this experiment was that ATM was far better than ISDN, and that ATM opened up possibilities for developing a wide range of new medical services related to minimal invasive surgery. The conclusion was followed up by discussions between the 4 partners mentioned above and University of Oslo about the establishment of a more long-term project developing such services. A project planned for three years started the summer 1998, and a new ATM connection and required equipment at each hospital was up and running in September 1998. (Changes in strategy in Telia and the merge between Telia and Telenor made the future of the project more uncertain).

The intention for the DIMedS (Development of Interactive Medical Services) network is to assist in one area where the demands to image quality were high; more specifically in minimal-invasive techniques ("peephole surgery"). The project aims at providing opportunities for education of surgeons through transmission of high-quality digital video and audio from live operations across an ATM network, and later also through recorded material.

Minimal invasive surgery and telemedicine

Minimal invasive surgery is a collective term for a range of medical procedures where the "invasiveness" of the procedure is minimised. Minimal invasive surgery of the abdomen (also called "peephole" or laparoscopic surgery) avoids an ordinary open surgery by making three to five small holes (with a diameter of 5 – 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 telecommunication networks. However, the requirements for image quality after transmission is high, as important information may be related to subtle texture and colour variations, as well as delicate structures (e.g. vessels).

Method

All authors have been members of the DIMedS project organisation, and the first author has spent one year as a participant observer at the Interventional Centre, with several visits to the Ullevål Hospital as well. Semi-structured and free interviews were conducted with a wide range of personnel groups, including surgeons, operation theatre nurses, anesthesia nurses, technicians, students and lecturers. Other ethnographic methods were used as well, including observation, video-recording of work, and analysis of textual documents. General participation in the daily life and interaction with the rest of the personnel at the Interventional Centre has proved 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.

The technical support work has been focused in this paper, and the first author has participated in this work for many of the transmissions. This includes planning work, actual preparation and set-up, as well as assistance during transmissions. Keeping a log over the activities and experiences has also been one important task.

The technical solution

These demands to image quality dictated the choice of technology in the project. Broadband technology (in this case an ATM network and MPEG2 real-time coding of video and audio) facilitates use of high quality video transmission. At transmission rates of 6-8 Mbit/s the quality differences between original and compressed (coded) video were imperceptible. Locally within the hospitals two operation rooms are connected to a control room with mixing facilities. In the control room up to 16 images from the two operation rooms are displayed on small monitors, and several microphones and loudspeakers provide two-way audio communication. This control room is connected to two local lecture halls as well as to the external ATM (and ISDN) network.

Project evolution

In the planning phase the project was seen very much as an experiment, i.e. as a project transmitting images from various kinds of minimal invasive techniques using different transmission rates and encoding algorithms. Based on a series of experiments, it was assumed that one would have the required knowledge to specify the requirements for a set of new telemedicine services for minimal invasive surgery. This related to the services as seen from a medical point of view (the interaction and collaboration between the medical personnel) and the technology to be used. The project planning assumed that the technology was given, the question was just to figure out how to use it, and using meant just selection of bandwidth and encoding algorithm. When the ATM connection was up and running, we soon realized that this assumption was false. The technology was anything but given.

Bricolage, tinkering

When the ATM connection was up and running, the project soon changed character. It was not any longer about the careful execution of well-planned experiments, but rather a process best characterized as improvisation, tinkering or bricolage (Ciborra, Orlikowski). This improvisation process unfolded as a continuous iteration through the following loop:

- find users
- find use areas
- plan the use
- use the network
- identify problems
- find solutions - organisational as well as technological.

Improvisation is in fact the only strategy for developing new services based on this kind of new technology for two reasons: lack of experience with the technology within the use areas, and complex working practices.

Firstly, using distributed multi-media technology within minimal invasive surgery is more that selecting image compression/encoding algorithm and transmission rate. To make the technology useful, the technology and work practices have to be integrated and adapted to each other. This mutual adaptation can only take place through a process of experimentation and trial and error. And only when the technology and work practices are adapted and integrated can one more systematically test what is the proper combination of transmission rates and encoding algorithms in the specific situations.

The experimental and mutual adaptation and integration of the technology and work practices involved in the DIMedS project was unavoidable as use experience and knowledge about real time multi-media technology in use areas like minimal invasive is very limited in general, and none of the partners in this project had such experience. The only way to obtain the required knowledge and experience is through practical use of the technology.

Secondly, obtaining the required knowledge is challenging, as experimentation with the technology just to test out how it works is difficult. To decide whether a proposed solution works for supporting the communication relevant in relation to minimal invasive surgery, the technology has to be tested out in real surgery. When testing most prototypes of technological solutions, the prototype can be tested in a simulated environment, which is very close to the real one. This is not very easily done for surgery. Simulating surgery without patients is in practice impossible. (The only exception is doing surgery on animals, but that is not an easily available option either.) On the other hand, surgery is a difficult and critical activity. This means that all involved should be experienced with the procedures followed and the technology used.

Taken together these two arguments imply that we are caught in a dilemma: The personnel involved in a surgery can only use technologies and procedures with which they are familiar. On the other hand, new technologies can only be developed through experimental use. We can escape this dilemma by identifying use areas where we are sure that

- the technology will by and large satisfy the needs of the users,
- the users have obtained the required experience in using the technology from related use areas, and where
- the critical aspects of the surgery do not depend on the technology with which the users are inexperienced.

This strategy for escaping the dilemma, then, requires an evolutionary process where we are iterating through the loop presented above. For each cycle, the technology will be improved, the users get more experience, and we move from one simple use area to a more demanding one.

Managing this improvisation process is very challenging, as the work practices as well as the technologies are very complex. Further the project has to “sell” the technology to find users willing to be involved in the experiments, at the same time one has to be careful not to oversell it. Overselling may lead to experiments and demonstrations that fail to fulfil the users’ expectations. Several of them will then loose faith in the technology and become more negative towards participation in future experiments.

Use

The actual use became different from the expected use, which was education of gastro-intestinal surgeons through transmissions of live operations and recorded material. Several other medical specialties became involved, and transmissions of meetings, lectures and demonstrations were an important part of the use. Operations involving laparoscopic surgery were transmitted, and in addition radiologists, immunologists, and ear/nose/throat-specialists used the network. This is a result of the iterative development process described.

Problems and solutions

Installation and testing

In the early phase most of the transmissions were test-oriented. Some related to the equipment itself and camera and microphone solutions. Others focused on image quality. Video images from operations were transmitted and the image quality was evaluated by a surgeon in orders to establish whether the quality was adequate. Agreement soon formed that MPEG2 at 4-8 Mbit/s was indeed adequate. The focus of interest then shifted to other, equally important aspects.

As the usage of the network evolved to encompass “real” transmissions (with attendees), a need for local adaptations and additional technical equipment became apparent. This relates to needs for additional equipment such as microphones, audio mixers, or video mixers, and also to cabling plans for other set-ups outside the local facilities. Most of this need was concretised during transmissions where the planning revealed needs or problems, or when minor breakdowns occurred. These situations provided possibilities for learning. The learning on this level has been substantial, indicated by the fact that the need for external consultants has decreased. This is in accordance with Tanriverdi and Iacono (1998), who state that technical knowledge barriers (in addition to economic, organisational, and behavioural knowledge barriers) have to be lowered in order for telemedicine to be used.

Much of this practical and technical learning occurred in connection with lectures or meetings, one of two types of transmissions (the other is transmission of live operations). The live operations provided learning of other aspects related to work practice and tasks of the medical personnel. It may be appropriate to analyse these two types of transmissions in more detail.

Experimental use

We will here describe how the technology has been used within two areas: lectures (and meetings) and live operations. We will describe the problems encountered and the solutions implemented.

For **lectures and meetings** the technical support needed to learn about both technical solutions and about optimal organisation of the production itself. A lecture may involve use of ordinary audio-visual aids in addition to a variety of image sources with differing requirements to image quality. In addition to ordinary text-based slides also schematic pictures for overview, VHS from diagnostic or therapeutic procedures (ultrasound, surgical camera etc) or radiological images (digital or analogue) were shown. On the first large-scale demonstrations (for several hundred participants) technical support on audio-visual and production technology were bought from external consultants. On later occasions the support personnel borrowed some equipment, but managed the rest themselves, and lately (after the necessary equipment has been purchased) external consultants are seldom needed. In general, these transmissions were planning intensive (average: 7.3 hours of preparation per hour of transmission). The planning activities included:

- planning of the cabling and equipment needs (e.g. number, kind and length of cables, number and placement of cameras, and video and audio mixers)
- obtaining the necessary equipment (make (cables), borrow or buy) and physically transporting and installing it (only parts of the needed equipment were permanently installed in the lecture halls)
- discussing the meeting plan in detail with the responsible person (particularly the AV needs as these have decisive importance for the technical set-up). When discussing with first-time users the planning sessions may have an educational character, the lecturers need to learn what is possible and not possible, or which opportunities and constraints the technical solutions have. Then the technical support personnel may need to borrow video-tapes beforehand in order to see which video-format and to know the appropriate audio level for this particular cassette, or to check up the screen resolution of the particular laptop that are to be used. In addition they must know the meeting plan in order to make a detailed plan for image and audio mixing and equipment needs, and the planned level of interactivity in order to design appropriate microphone solutions for the session. The lecturer may continue to use earlier prepared material, but the need to inform the technical support personnel in detail about the lecture introduces a more constrained way of working (compared to more ad hoc approaches which are possible in ordinary settings).
- making a local plan for the sending where each person's tasks were spelled out in detail (e.g. which camera image is transmitted during which part of the sending, when does switching occur, when is the videotape started and by whom, who operates the remote control for the video projector, who is responsible for light adjustments in the lecture hall, when shall which microphones be muted?)
- exchange of this local plan with the technical personnel at the other side, in some instances also co-ordinating with external consultants concerning each part's responsibilities
- booking the lecture hall for the actual lecture as well as the necessary testing time beforehand
- arranging with the other side (and sometimes external consultants) for testing
- doing the testing of the internal and external communication channels, and solving emerging problems before the actual transmission. Testing may occur separate from transmissions, but usually it occurs the day before in addition to immediately before a transmission. Testing, especially sound testing, is highly interactive and iterative, and is in its nature synchronous. An adjustment is done and commented on, leading to new adjustments and responses and so on. The amount of such testing work has been astonishingly large, which partly relates to the learning required and partly to the lack of permanent set-up for lecture transmissions. Some amount of tests will most probably remain even with permanent set-ups.
- planning, producing (recording), and editing videotapes and other material (e.g. slides) that are to be used in the lecture

During transmissions of lectures several persons were needed (typically 3-5 on the sending site, average 3.7 hours of support per hour transmission). The tasks included camera control, light adjustments, microphone administration and sound and image mixing in lecture hall (mixing of outgoing images as well as locally displayed images from video projector). The person(s) responsible for the control of network connection and set-up were located outside the lecture hall in the control room, available for contact with the ”other” side if the need would arise. Probably due to extensive and detailed planning few situations occurred where improvisation was necessary, despite some rather complex productions involving several image and sound sources, as well as several parties interacting.

For **live operations** there were less demand for planning and set-up work as a permanent set-up was in place in the local facilities (only 0.5 hours of planning per hour of transmission). The images from the operations were transmitted using wall- or roof-mounted cameras during the preparations and early phases of the operation, and video-scopic image (video) when the actual surgical work started. Several other imaging sources could be used as well, mainly x-ray cine (a sequence of separate images taken during a brief period, in fact an “x-ray video”), or image from the gastroscope (which is entered into the stomach through the mouth). Verbal communication between the surgeon(s) and the viewers were facilitated through use of microphones and loudspeakers.

The required image sources for a particular procedure were (or ought to be) specified so that the imaging equipment could be connected to the network beforehand. This was mostly done by the nurses, alternatively the technicians. The operation theatre nurses have got other new tasks: in addition to connecting the imaging equipment, they turn on the camera system, adjust microphone position or hold up things in front of the camera. The surgeon must talk loud enough for receivers to hear (louder than ordinary level), and do additional explanations on patient case and planned and actual procedure. Some of this goes for education in ordinary settings as well (with students in the operation room), but in network-based education some of these tasks take on a different form. E.g. in order to show instrument positioning, the surgeon must now ask for a camera overview of the operation field instead of the students seeing it for themselves without any need for technical adjustments. The surgeon has the responsibility of informing the patient, and the question of patient consent has been raised. In general, the operating room personnel encounters a more ”messy situation” (several additional cables on the floor, a technician may enter and do some work).

In the first test phase the attendees (at the receivers’ end) did not always stay during the whole procedure. So the concern over who the listeners and viewers were arose early in the project period. This is an example of concerns over privacy, which is also identified and analysed by Nardi et al. (1996) in a similar setting. Instead of a solution with audio messages (”I am joining you/leaving you now”), the video image from the receiver end was transmitted from the control room to the operating room and displayed on a monitor. The operating room team could then throw a glance on the screen to see if someone (and who) was watching them. This solution (as opposed to the surgeon explicitly asking who watches) gives all members of the operating team an increased feeling of control over the situation. At another (satellite-, not ATM-based) transmission when the operation was just one part of a presentation of the centre, the outgoing image (the one which was transmitted to the receivers in Moscow) was also displayed in the operation theatre. Then the team could see when the operation room was “on air”, and which camera was used in the room. This raises issues concerning mutual visibility, the information providers (senders, operation room team) wishes to know who watches them and what they see. One wants to control the self-representation.

In transmissions of live operations the content is less structured than a lecture. For example, an operation may be delayed, cancelled or converted from a minimal-invasive procedure to an ordinary, open procedure, or the duration of an operation may not be predictable. A higher amount of improvisation was necessary (as compared to lecture transmissions), often a technician had to go to the operating room to adjust or connect something or solve a problem and there was more communication between the two control rooms (at the two hospitals) during transmission. However, the work required during transmission was not very complex and did not necessitate as many persons as a lecture transmission did (Average 2.7 hours/hour transmission). During ordinary transmissions one person was needed in the control room, and one (or several) for additional tasks, e.g. improvisations in the operating room. There were some instances where a need for co-ordination with the technical staff at the other side occurred, related to emerging practical problems. (E.g. sub-optimal use of microphones on the other side needs 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). Some interaction between the technical personnel occurred over the network itself, especially during tests, but ordinary telephone conversation has also been much used in order to avoid interference with the medical content of the transmission.

An unexpected problem was the difficulty for the technical staff in deciding which pictures to send, i.e. doing the mixing of the sending. In some procedures, several imaging techniques are used and there may be extensive switching between these, in terms of only a few seconds focus on each separate source. The receivers do not see more than one image of what is going on in the operation room, and the technical personnel (who has access to all of the images) do not know the procedures in detail. Consequently, there were situations where the receivers did not get all the relevant information. Either the surgeon had to mention explicitly that he was looking at the x-ray cine (or the gastroscopic or laparoscopic 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. Under some formalised educational transmissions, a students' facilitator was present in the operating room, assisting the surgeon and taking care of some of the verbal explanations. Then the surgeon's use of image was explicitly commented, aiding the switching task. This allowed the surgeon to concentrate on the patient and the technical personnel to switch image following explicit commands instead of having to guess.

Realisation of the need for technical support personnel

As the usage evolved, new settings and concepts were tried out and new user groups became involved. The importance and the complexity of the support work consequently became more obvious to the project members. This happened partly because the personnel documented their work and made it visible in other ways, and partly because lack of personnel (in some situations) were found to constitute a serious problem hampering full use of the network.

As reported by (Bowers, 1994), the network management and support overhead was also in the DIMedS project unanticipated and large. The experiences indicate that there is a definite need for additional expertise when introducing video-based telemedicine into a hospital. The technical challenges are not trivial, and require a diversity of competent personnel, production competence (technical and content-related) being one large part. One may argue that this need arises mostly in the implementation phase, and will be reduced once the technology is in place. This may be true, but experience suggests that the implementation and adaptation phase is substantially stretched out in time in a development project like the DIMedS project. An experimental and evolutionary approach to technology development presupposes continuing *ad hoc* adjustments and interventions in order to appropriate the technology. This is not easy to specify *a priori*, and in-house competence is therefore an advantage over using external consultants. Apart from continuing development, regular use of the technology also requires support.

The nature of the support work

It is interesting to take a closer look at the support personnel; their roles, tasks, and skills, as well as the challenges and problems they encounter. A parallel kind of support work is then described in order to see how related challenges are met in other settings.

Roles

At one of the hospitals (where most of the transmissions originated) two or three additional engineers had many of their daily tasks related to the DIMedS work. At the other site (mostly receiving site) one or two persons were responsible for the support, neither being fully allocated to the project. The support personnel are not recognised as “important” in the organisation in terms of position, status, or salary. However, they provide highly valued services in producing presentation material for several doctors (videotapes, slides, and other presentation material) – this is separate from the DIMedS project. On one of the sites, the support personnel work (almost for free) at the hospital as an alternative to ordinary army service. This service lasts for about a year, and they are not considered as ordinary employees.

In the DIMedS project, the support personnel have occasionally attended a few meetings, but only one person is listed as participant in the project. In practice, their work for the project is crucial, as shown by the earlier descriptions. The technical support personnel work at the interface to the technology and they act as facilitators for the ”end users” (i.e. the lecturers, surgeons and students). As a result, they make the technology to a large extent transparent to the end users. In order to achieve this transparency and invisibility, a lot of underlying work tasks needs to be carried out.

Tasks

The technical support personnel do not initiate transmissions (other than for test purposes), but when a transmission has been scheduled, they start their work. This involves technical and practical development and production work, as well as extensive planning and support during transmissions. These tasks are described in the previous part. When properly done, most of these tasks are invisible from the end user’s point of view. When they are not properly done, breakdowns occur, and the work (or lack of work) becomes visible. There has been a varying distribution of the tasks within the team, and between the team and the other personnel groups, especially the operation room nurses.

Skills

These new work tasks presuppose a diversity of technical competence and skills, previously unfamiliar to an ordinary hospital organisation. This includes competence on:

- analogue and digital video technology (and conversion between the many video standard formats)
- some degree of network management (as the set-up of each connection has been done by the hospital themselves)
- audio technology (microphone and loudspeaker characteristics and set-up, sound testing, audio mixing etc – done by one of the engineers who is also a musician)
- video production (editing tapes to be used in lectures or demonstrations)
- TV/movie/studio production (e.g. real-time mixing of both audio and video, camera control, light adjustment etc).
- combined technical and medical knowledge for appropriate mixing of images.

Challenges and problems

The examples from the previous description show that the technical support personnel need to co-ordinate both vertically**,** (or locally, with the other personnel in the local organisation, i.e. the lecturer, the students or the surgeon) and horizontally (with the technical support personnel at the ”other” side, or with external consultants). The co-ordination work is both asynchronous (e.g. some parts of the planning work) and synchronous (e.g. sound testing). The necessary amount of **co-ordination work** is large, and in the early phases of a project most of it is performed ad hoc and is not routinised, i.e. it is explicit. As experience is gained, some of the co-ordination needs may vanish or become embedded in routines and shared practices. But a lot of the challenges will remain.

The technical support personnel are physically located in *the control room.* This means that they have a lot of power in a practical and physical sense. They control the network access equipment and can set up and terminate connections. They determine which video sources shall be transmitted or displayed and which audio channels should be interconnected (who shall be able to communicate with whom?) This change of the locus of **control over the communication situation** may have some unwanted and problematic effects, as is illustrated by the previously mentioned problems the technical staff have in deciding which picture to send, i.e. doing the mixing of the sending. Another illustration: When the students were in the operation room, the instrument positioning could be shown directly, using only verbal explanations and gestures. Now the surgeon must ask the technical support personnel to transmit the image from the roof-mounted camera and zoom in on the area so that the recipients may see it. On the other hand, a student present in the operation room could look at what he or she wanted (provided it was accessible), while a student who watches images transmitted across a network do not have the same degree of control over the received information. Requests for other camera views or other image sources must be made explicit, and someone else will then (probably) perform the necessary actions.

There is also a general need for recognition of the support work in the organisation. This relates to recruitment and allocation of personnel to these tasks, providing them with necessary purchasing and negotiating power etc.

Similar support work

One obvious parallel comes to mind when describing the support work. TV or movie production has a lot of similarities with production of video-based telemedicine. A production team for TV studio productions could serve to illuminate/contrast/ (as a parallel description of) the work done by the technical support personnel. The following description is based on (Braa and Ruvik, 1989) and (Saltrøe, 1999).

Many of the tasks are similar, e.g. camera control, light adjustments, mixing of image and sound. A certain degree of detailed planning is necessary in both cases. Studio productions are in most cases relatively easier to plan in advance than real-time productions outside a studio, and a telemedicine production could be of both kinds. There are real-time co-ordination needs within the team, and interdependence of the team members of each other. Consequently, it might be instructive to explore how this support work is organised and supported.

A TV studio typically consists of the studio itself, a control room for images (control, switching and editing) where the producer, the script and the image mixer is located, and another control room for sound (control and switching).

The **producer** is responsible for the production as a whole and gives the orders to the mixers about when to switch between images, or to switch to a video-tape. The **script** is responsible for the continuity in the production. He /she prepares the other persons of what is going to happen next, a few seconds before the producer will give the corresponding order. The script also checks that everything runs smoothly, for example that the next camera image to be selected appears as it should according to the previously made manuscript. The **mixer** is located in the control room and is responsible for carrying out the orders from the producer. One or several **camera operators** in the studio controls the camera(s), sometimes after a previously made, detailed list on the different positions and sometimes after instructions from the producer. The **sound technician** sits in a separate sound control room, adjusting the sound level of the microphones and choosing audio source. The **floor manager** is located in the studio and is the contact (and communication channel) through headphones, between the personnel in the studio and the producer/script. The **presenter** is the person in the studio who is (apparently) leading the program. He/she may receive signs and messages from the floor manager, but else the communication within the production team is hidden from the presenter.)

The necessary co-ordination within the team occurs through extensive preplanning and through real-time **audio messages**. A network connecting all implied parts carries verbal messages, mainly from the producer and the script. The members of the team who are located in the studio wear headphones, while the control rooms have loudspeakers and microphones. A network discipline with short and standardised messages exists, but unstructured conversation also occurs. To a certain extent, the receivers of messages can be singled out, but most of the messages go “on the air” to everybody on the network.

Of course, there are some limitations when using this model for describing the work done by support personnel in a telemedicine network. The studio team’s work and co-ordination is only local, (between studio and control rooms). True, some productions may involve outdoor broadcasting teams, increasing the complexity of the co-operation and co-ordination. The same control network is used then. Another difference is that this is broadcasting, i.e. one-way transmissions, while telemedical transmissions often is a two-way, interactive session. A real-time telemedical network transmission usually involves communication with one or several receiver sites. This may include complex interactivity and the resulting mixing will be complex as well. In addition, complexity as related to co-ordination needs increases when several partners each shall be able to communicate. (Schedule, messages, sound tests etc).

Implications/Conclusions

The analysis of the DIMedS project experiences supports the finding of Bowers (1994) in that "the work to make a network work" is substantial and often unanticipated. The important role of the support personnel has been demonstrated. Their support is crucial both in the implementation and adaptation phase, and to ordinary use of the technology. The nature of the support work for video-based telemedicine has been described, emphasising the complex co-ordination necessary both in time and in physical and organisational "space".

It is necessary for designers to recognise the importance of support work for the practical usability and consequent success of the network. Its complexity must also be recognised and analysed, and systems and networks must be designed accordingly.

Based on the experiences with the DIMedS project, it seems appropriate to suggest some guidelines for design of video-based telemedical solutions:

- Expect and prepare (as far as possible) for the network management and support overhead work. This relates both to the necessary amount of manpower, and to the personnel's competence areas. The role of the support personnel can be seen as that of mediators, and, as (Okamura et al, 1994) shows, the mediator should be both sensitive to the users needs and wishes, and technically adept
- counteract the problematic parts of re-distribution of control. This means to give the receivers and the senders back the possibilities of choice that the transmission takes away. In this particular case this could be done by moving the mixing as close to the receivers as possible by providing several images at the same time. Remotely controlled camera (for room overview) is another possibility for solving other parts of the problem. Providing the operation room team with an image of the receivers as well as the sent image, is a solution to the experienced loss of control that the operation room team expressed.
- design solutions that may support co-ordination needs of the support personnel. The TV production team's technology (audio communication channel) may be a helpful idea as regards the local co-ordination needs. A separate audio channel may also support the co-ordination that occurs between the two (or more) sites. Another part of the co-ordination work (within and between sites) is the planning process. Booking of resources and scheduling of transmissions may occur across the network as well (e.g. web-based scheduling system).

However, more analysis and experimental development may give further insights relating to these challenges and their solutions, and our work will continue along some of these lines.

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