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Multimedia Support of Collaboration in a Teleservice Team

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Abstract: The purpose of this paper is to outline an architectural model for how multimedia can establish and support cooperative work. The proposed architecture emerged from empirical work in a large UK bank. Previous efforts have, as we see them, been largely experimental, and have focused on supporting informal work Few examples concern the support of actual work tasks in companies outside a research context. The outlined model offers a conception of work as distributed across time, space, tasks, people, and artefacts It aims to integrate informal and formal aspects of work by supporting the initiation and management of interaction as well as the cooperative work process itself.

Introduction

Multimedia communication has been a central part of CSCW systems development and research for a number of years. Considerable effort has been needed to establish the technical feasibility of multimedia. The development of conceptual demonstrators that highlight the possibilities offered by this form of technology, has as a result been limited to experimental use within laboratory settings. Limited possibility has existed for considering the use of cooperative multimedia in natural work environments. The development of commercial products based on ISDN technology means that it is now possible to examine the use of video systems in actual work settings and to consider the relationship between the work taking place and the technology supporting it .

This paper reflects on the use of the current generation of video systems and the implications for future cooperative systems that make extensive use of video. The paper is based on an empirical study of video communication in a large UK bank. The Bank is structured such that central units provide branches with the additional infrastructure

and personnel needed to handle specialised products. The role of the Teleservice team, which is one of the service providers within the bank's national insurance centre, is to give customers advise about home insurance and related issues. They deal with existing customers, as well as those responding to advertisement campaigns. A video link has been introduced to support the communication with the customers and hosts in selected branches. The empirical study focuses on how the work is being performed today, as well as to what extent a multimedia conference system can establish and support cooperative sessions in the Teleservice team.

The empirical study reported in this paper is the result of observations and unstructured interviews in mundane working situations. The study was undertaken in conjunction with a wider ethnographic study of the bank. Focus was on the situated, everyday performance of work. The study included the manager of the Teleservice team, the project leader for video conference development and one of the branches connected to the Teleservice centre.

Unlike models that represent the details of the media (for example, QuickTime™ or MPEG) we wish to focus on the construction of an architectural model that more closely links multimedia communication and cooperative applications, based on the experiences of our empirical study. Several ways of structuring multimedia applications have been proposed. For example, HyTime is a hypermedia document structuring language that can represent relationships between datatypes with temporal character, like video, audio and animation (Newcomb et al. 1991). However, existing models for structuring media focus on multimedia documents rather than the interactive applications that are our principle concern.

The translation from detailed ethnographic descriptions into high-level, abstract, and general concepts is not trivial (Shapiro 1994; Hughes et al. 1994). In this effort, the system designer is also responsible for the ethnographic fieldwork, only guided by a sociologist with extended practical and theoretical experience from ethnographic work. This approach obviously hides the problem of translating between phenomena and concepts, and the need for debriefing meetings is reduced (Bentley et al. 1992). The problem of making this translation explicit for others to assess persists. In this paper we have attempted to document the appropriateness of the model by example scenarios showing how it could be implemented in a given situation. Sufficient as it might be as evidence within the scope of this paper, we appreciate that further research is called for in the CSCW field at large to solve the problems related to the use of ethnographic descriptions in system design.

The video based communication architecture developed here addresses the current detachment between video communication and the nature of the work taking place. The focus on informal cooperation prevalent in multimedia does not sit well with the very legal and procedural view of work evident in the Bank. Limited facilities exist to express the distribution of work and the relation between the video communication and the procedural representation of the work taking place. To address these issues the developed model aims to handle the control and workflow aspects of work together

with open, more expressive channels like video. The model also allows integrated support of informal and formal work to be documented for future use. This paper presents in outline the study motivating our work and the resulting architectural model that has been informed from the empirical study.

Existing Limitations of Video

This paper is concerned with systems that combine audio, video, computing and networking technologies to provide an environment for cooperative work To distinguish this class of technology from Videophones and systems based on analogue video-switches we focus on Multimedia systems as the flexible combination of communication and computing media with software applications. When examined in the context of real world settings, existing approaches to design of these systems present a number of shortcomings. This section focuses on these existing limitations and their implications for the work reported in this paper.

Unspecified support

The integration of video communication and computer systems is a relative recent technological development. As a result, many systems have the character of technical experiments rather than tools designed to support a dedicated task. The focus of research has been on demonstrating the technical feasibility of the emerging designs. For example, Watabe et al. (1990) focus on general meeting support in a research context to demonstrate the applicability of the MERMAID architecture. Bly et al (1993) describe an experiment that aimed to study interpersonal computing in the context of systems design. A predominant focus of the work on media spaces is how awareness can be used to promote informal communication and cooperation independently on the work taking place. Gaver et al. (1992) report on how they implemented and used the Ravenscroft Audio Video Environment (RAVE) to allow physically separated colleagues to communicate. A software layer called Godard is implemented on top of the basic multimedia facility in RAVE to offer control over the video connections (Dourish 1993). The Porthole system intends to support social awareness as well as explicitly looking for colleagues by providing a database with images from video cameras in geographically separated public areas and offices (Dourish and Bly 1992).

Mantei et al. (1991) describe a media space called CAVECAT. Its purpose is to enable a small number of individuals or groups to participate in cooperative work without leaving their offices. The experiences of media spaces in use within research labs highlight the need for new interaction metaphors (these include Portholes (Dourish and Bly 1992) and office based metaphors (Mantei et al. 1991; Gaver 1992; Fish 1988)). The developed metaphors have considered the setting of the work taking place and the properties afforded by the technology rather than the relationship between the

particular work undertaken by users, the properties of the communication media, and the nature of the support provided.

Formal and informal work

A prevalent advantage of video has been that it can support the informal aspects of work through spontaneous interaction, thus focusing on the use of video as a way to augment and coordinate work activities leaving more procedural aspects to be supported by structured applications. This is perhaps best characterised in the development of Cruiser (Root 1988); a tool specifically designed to promote social interaction rather than dedicated tasks. Cruiser aims to support the office as a social institution by facilitating communication, negotiation, spontaneous interpersonal communication Based on the assumption that brief, unplanned encounters appear as a result of physical proximity, Root (1988) introduces the term "social browsing" to describe the dynamic process of person-to-person, mobility-based, social interaction. Experiments indicated that Cruiser is convenient, but not sufficiently expressive. Users found the use of the system to be more privacy invading than expected. It is described as marginally adequate to support spontaneous conversations, but did not did not manage to simulate face-to-face conversations (Fish et al. 1993).

The detachment between formal and informal work has continued as a dominant theme in video communications research. Users are expected to exploit their "natural" social skills to control and mediate the cooperation. One further illustration of this approach is the VideoWindow project (Fish et al. 1990) which aimed to extend a shared space over considerable distance without impairing the quality of the interaction. The core design intent was to provide "low cost" interaction, and the focus was on spontaneous, informal and socially situated communication afforded by a concentration of suitable partners, simulated co-presence, mechanisms to initiate the session, and a visual channel to facilitate coordination. Of the possible encounters however, very few resulted in prolonged conversation between people who were interested in each other's work. The degree of informality was also less than expected, a result attributed to the lack of reciprocity.

Moving into the real world

A significant limitation facing the development of video systems has been the need to construct these systems in experimental laboratory settings. Albeit the researchers have to some extent used the prototypes in their own work, the experimental nature of the technology involved has meant that most video systems have been developed and used within research labs (Ishii 1990), and use has often been limited because of the "prototypical" nature of the technology (Ishii et al. 1993). Whilst answering significant questions concerning video, a lab based approach has shortcomings for the designers of new technologies and techniques (Tang & Isaacs 1993). As Tang and Isaacs (1993) state in their consideration of video and desktop conferencing

> " we should strive to understand how new forms of interaction can be integrated with existing ones in people's day-today work. By understanding how these new technologies augment, complement and interact with people's existing work practice, we can design new technology that can be smoothly and naturally adopted " (Tang & Isaacs 1993, page 194).

Pagani and Mackay (1993) report from a study of video supported cooperative work in a real-world, albeit limited setting. In a similar move toward more realistic settings, Tang and Isaacs describe three studies of synchronous, distributed cooperation in small groups (Tang and Isaacs 1993). One of the central findings from this study was that as many as 57% calls did not lead to a conference session. These results motivated research on how to support the coordination activities that take place before the call, to facilitate cooperation. The early experiments with the Montage prototype, described by Tang and Rua (1994), did not, however, clearly demonstrate that the system was used as intended.

Systems like Montage and TeamWorkStation have given considerable insight into the possibilities offered by multimedia systems We wish to complement this work with a study of the use of video within an actual work setting and the consequences for design. In particular we wish to consider.

- The role of video in supporting directed work in real world organisations.
- The integrated support of work that has a more formal and procedural nature.
- Mechanisms that embed video in the software support for a variety of work.

The motivation for our work is principally driven from the current isolated nature of video in cooperative applications. Video is seldom integrated or related to existing cooperative software and its use is characterised as an additional and independent communication channel. We seek to understand the use of video in commercial, non-research organisations and to develop techniques that allow video to be used in the support of planned and structured tasks as well as social and informal activities.

The Teleservice Team

The Teleservice Team is one of the bank's service centre teams, and receives approximately 1500 calls each day. Some of the calls are from the branches, others are from customers calling through on the freephone numbers associated with different campaigns. Each specialist enjoys on average 50 seconds of "idle" time before the telephone system distributes the next call to him. This time is used to keep the paperwork associated with calls up to date.

The Teleservice Team is situated in a dedicated room. The specialists sit side-by-side and face-to-face. A low wall on each side and a bookshelf in front define their private workspace. The manual documents created throughout the day are handled and archived by two clerks working in a back room, in which the Video Link is also installed. One person is handling the Urgents; files on existing business that needs to be amended immediately. The archives themselves are easily accessible at the side wall of the room.

The physical lay-out of the room is important considering the open availability of work, through which co-workers at a glance can get a picture of what is going on (Heath et al. 1993). The files in the archive are common artefacts. It is easy to see when people access them, and notes can be made on the covers as well as the individual document. In essence, files are instruments with functionality derived from the nature of work (Hughes et al. 1993).

Rather than present the work of The Teleservice Team in detail in this section we wish to focus on the relation between "formal" and "informal" work and the means by which interaction is managed. This focus allows us to consider the assumptions and shortcomings evident in existing video systems as video moves into the workplace and the lessons for developing support.

Formal and informal work

Work within The Teleservice Team is highly contingent and seldom follows a prescribed course of action. The specialists use glance and gesture continuously; they shout to each other across the desks that separate them and often call upon others to help meet the demands of the work. The specialists wear headsets all the time. As a result it is not possible to implicitly detect who is available. One has to ask "Are you on the phone?" or "Can I talk to you, please?". To leave their workstations they have to disconnect physically, by removing the plug from their headsets. Members of team demonstrate considerable skill in managing the communication technology in the room as part of their work. For example:

> Alice turned to ask Peter for some rates that she was not familiar with She disconnected, and Peter handed her a binder that he kept in his drawer It seems that they found the right rates in there, after thumbing through some of the pages A few moments later, Alice did the same thing again, but this time without asking Peter. She disconnected and walked over to his desk to get the binder, but this time she didn't locate the right answers and turned around instead to ask Lou
>
> Suddenly she shook her head and indicated with the finger to her head that she was unhappy with something the customer said These gestures were intended for Lou as well as Peter. She disconnected and walked over to one of the supervisors and returned to her desk only to fetch the binder The customer didn't want to pay the extra rate for a removable car stereo, and suggested that he would just not tell them that it was removable, rather than paying the extra rate The reason Alice went to ask Jackie about it was that Peter had an old manual, and it wasn't clear on this point The supervisor told her that a claim could be declined if the customer didn't give the right information about the type of stereo in the car, and Alice told him about that

This type of contact is not purely social or informal and is often a means to support the formal aspects of the work. For example, specialists often receive calls regarding customers someone else has responsibility for, or need to find specialised expertise to support an enquiry. It might not be obvious who treated a particular case last time. During the highly social interactions that occur between calls specialists exchange important information and coordinate formal work. The following illustrates this fairly routine situation within the work:

> Jackie answered the phone, it was a customer that knew he talked to Anne earlier

"Anne, there's someone who wants you for a couple of minutes", Jackie got up, and turned around to get eye-contact with Anne before addressing her. Because the two specialists were located closely together, Jackie did not have to leave her desk to talk to Anne She asked for her extension number, sat down, keyed the number in and talked to Anne She gave her the name and policy number before transferring the call The critical moment here is between Anne acknowledging that she can take the call, and the call being transferred If Anne does not log out, she will be given a call very soon by the telephone system before Jackie gets through to her She would then have to get back to the customer and say, "Sorry, she's on the phone", maybe even after telling the customer that "Yes, she's here, hold on a minute and I'll get her for you, ."

Managing the interaction

It is not uncommon for a specialist to be working on several cases in parallel. When a call comes in, the current task is temporarily suspended. Often they have two instances of the same application up and running at the same time to handle these situations. The reason is that the system will not save a record unless it is complete and consistent Since the work is extremely event driven, the specialist has little control over this condition when jobs are processed in parallel.

Specialists are very adept at managing the interaction with customers and software. When engaged in a lengthy discussion with a customer, specialists often manipulate the workflow aspects of the program by running two instances simultaneously, but they articulate their work in different ways; using pen and paper is as common as running one or several instances of the computer based systems for direct registration. Similarly, the specialists disconnect from their workstations to leave their physical workspace, or discuss with colleagues to meet the demands of interaction with customers and staff external to the service centre.

Video access to expertise

Selected members of The Teleservice Team have being using a video link for an 8 month trial period. So far, 1000 customers have used the video system, and given their response immediately by questionnaire. Given that the team currently manages perfectly well using only the telephone it is worth considering why the video link was suggested by the bank. The use of video was not a case of discarding the telephone as an insufficient medium of communication with customers Rather, like many organisations the Bank has a complex development trajectory, implementing and evaluating new technologies whilst responding to a changing market, as well as managerial and organisational pressures. Like many financial institutions the Bank is looking for cost reduction through the centralisation of machine room processing. This requires technology research efforts whilst at the same time attempting to defend market shares and changing from an organisation that traditionally focus on administration to one that focus much more on selling. To put it simply, the Bank is looking for experiences with

a set of technologies they feel make it easier to market and sell their products even when the people with product competencies are withdrawn from branches.

A goal of the video link is to make remote expertise instantaneously accessible to the branches and use this expertise to sell home insurance cover to the person in the branch. This is a highly competitive commercial situation, where the number of sales is paramount Higher sales can be achieved either by dealing with more customers each day, or through a higher conversion rate between possible and actual sold policies. The duration of an average call using the video link is twenty minutes. The normal telephone call in the Teleservice Team lasts six minutes. The conversion rate in the team is 1 from 4. For the bank to conduct this type of business over the video link, a conversion rate of 3 from 4 or 5 calls an hour would be a minimum performance requirement. In the bank they hope that access to expertise in combination with a more personal touch will increase the conversion rate compared to use of the telephone

The interview is designed as a procedure to be followed by the specialist. During this process, the customer and host in the branch are relatively passive, only responding to the questions asked by the specialist. With few exceptions, the possibilities for the specialist to manage the interview is removed. Because the customer can see her all the time, it is not a feasible alternative to "disconnect" and leave the workstation in order to discuss the case with others. This means that situations that integrate formal and informal aspects in The Teleservice Team, i.e. when the manager has to acknowledge an exception from the rule, cannot easily be supported The system separates the articulation of the task from its formal structure, its legal aspects and business goals, and it is, among other thing, this separation that the model described below seeks to address.

To initiate a video session the specialist assigns a local host and the customer to a video link terminal. The local host then calls from their own workstation in the branch Although one specialist told us that using the video link was "second nature to us now, eight months down the line,. ." developing instantaneous access to expertise and a personal touch is problematic. The following example highlights some of the problems that can occur when the specialist finds herself dealing with an "awkward customer"·

> The customer was hostile from the start, and did not respond to any of the small talk Only reluctantly did he give out personal information Suddenly he started to challenge the specialist's expertise, and asked about a life rather than home insurance Because the video link is set up in a dedicated booth at both ends of the connection, the specialist only answered, although she could have disconnected and placed a call to the Life Department:
>
> -"We're not actually connected to the Life Department"

In the telephone supported Teleservice room, she could have asked nearby specialists, or suspended the call as she talked the matter through with someone from a different department. The lack of immediate access to expertise served to heighten an already tense situation.

> In addition this particular customer focused on the host in the branch, not the screen, so the experts "personal touch" could not help alleviate the situation She moved on to tell the customer about restrictions he would have to comply with to receive a discount for having smoke detectors The

customer then asked about another property that he owned, at the time rented to a professional couple

-"I will just have to go back and amend this information to the system, it's going to take me a couple of minutes to do that "

The customer lost patience and told the expert to forget it, and the interview ended

In this situation, the system's lack of flexibility and the shared application screen prevented the expert from using a second instance of the home insurance software to answer questions immediately. Her image as an expert was reduced requiring her to engage in an improvised effort to restore her position as a response to his antagonistic attitude. The system architecture restricted her responses to the situation, as the more formal aspect of the work is embodied in the workflow software and separated from the "informal" video support, reducing her ability to manage these in tandem

Outlining a supporting model

The work of The Teleservice Team illustrates that the relationship between formal and informal working is highly flexible and that members of the team have considerable skills in managing the relationship. This coupling of the formal and informal does not sit well with the facilities maintained in existing approaches to video. To explore the implications of these initial studies of video in The Teleservice Team, this section seeks to formulate a general design framework that can embed temporal datatypes, like video, audio and animation as part of CSCW applications. It describes a basic data structure and some of the operations to manipulate it. It is also a perspective through which users can understand the organisation.

Requirements of the model

The work the Teleservice Team performs using the telephone introduces several challenges to multimedia systems. Work is subject to relaying, parallel processing and queuing, and any model reflect this flexibility. The model should treat formal and informal aspects of work in an integrated manner, to yield a uniform access to task-support as well as situated action. The model must offer a framework to describe distribution across people, time, space, tasks and resources in a meaningful and consistent way.

The following example of work as it was performed over the telephone, taken from the fieldnotes, will be used as an example situation that our multimedia communication support systems would have to support:

Karen was talking to an angry customer, and he introduced himself by asking "where is my money?" Karen was ready to help, but couldn't find him in the policy register, and the customer didn't have a reference number, so it wasn't obvious where to look The customer admitted that he had not paid his premium yet, "how could I do that when you won't give me my money? I'm working myself into a right state here, I am "

His claim was from Feb. 8 and it wasn't clear from the database whether they had put the customer on cover at that time. Karen had to tell him that, "Mr. W.! If you are going to keep on swearing at me, I won't continue this conversation!"

While Karen is struggling with this customer, George (sitting diagonally to Karen's left) caught his name, "Mr W? Karen, who is it?" The customer complained about how he can't tell Karen what the problem is because the loss adjuster wouldn't tell him what was wrong, "he just tells me that he can't tell me, and that there is something about my policy that he doesn't like, he found several thing that was unclear, he said, but he couldn't disclose what they were"

George had by now got the customer's name, and realised that he was the specialist who put him on cover originally It gradually became clear that what the loss adjuster, among other things didn't like, was the fact that in the policy he couldn't find anything about the place being burgled twice before. In itself this is probably enough to decline liability, we were told, although the workflow system does not prompt this question at all, it only asks for previous claims The customer claims that he told George about his and that he will sue him if he isn't given his money George just shook his head and laughed.

"I've got naught in my house, someone threatened to burglar my place, that's why I got the insurance in the first place, isn't it, because I knew this was going to happen "

Suddenly Lisa interferes, because George went over to see her as soon as he found out that his old customer was on the phone Lisa is currently dealing with this case, liaisoning with the Claims department

On a logical level this situation is distributed across people, (George, Lisa and Karen in The Teleservice Team, Paul in the Claims department and an independent loss adjuster). Geographically, it is locally distributed between the desks, as well as globally (between the Teleservice room and the Claims department). The case in question has taken place over a period including three distinct steps, (the customer asking to be put on cover, the customer claiming, and the Claims department declining liabilities). It is also distributed across artefacts (the policy record, the police report and the written assessment from the loss adjuster), and it is treated using different media (like the telephone, letters, database records and face-to-face meetings). At the same time all of the above are used to articulate the process in an integrated fashion.

Cooperative work involves tasks that aim to manage the relationship between individuals in the organisation (Bannon and Schmidt 1991). Our model makes this relationship central, thus affording the articulation and coordination of work. Previous work on video indicates that simulation of physical co-location (Fish et al. 1990), explicit naming of the recipient (Tang et al. 1994), or spatial metaphors (Fish et al. 1993) do not appear to work as well as hoped. By focusing on the co-operative relation, easy access to the shared artefact (Sørgaard 1988) is also supported. The suggested model offers a lightweight implementation and makes no assumptions about the behaviour of the participants. This way the model encourages system implementations that support the unconstrained negotiation and articulation of task between the users

Components of the model

The proposed model uses the data structure needed to support cooperative video as its point of departure. The elements in the structure are read out of the fieldwork. This allows the model to serve as an architectural framework on which tools and task oriented applications can be built, whilst still being founded in the social arrangements and processes in the workplace:

The ConnectionObject: The model populates a distributed object store with persistent objects that represent a potential cooperative session. The ConnectionObject enacts the cooperative sessions independently of their physical link, so that they can exist as entities before, during and after connection. The ConnectionObject may represent multiparty links The relationship between Karen and George, or Karen and the customer, or Lisa and the loss adjuster are examples of binary relationship, but adding Lisa to the discussion between the customer, Karen and George shows how it can be extended.

The ParticipantObject: The ConnectionObject contains a list of participants. Examples of participants include Karen, George, the angry customer, and Lisa The number of participants is unlimited, and so is the number of connections that a participant can be part of These objects are simply representations of the potential collaborators.

The ServiceObject: The list of ServiceObjects specifies which tools the connection provides for its participants. In the case of a video channel, it describes its physical properties, the translation tables between participant identifier and addresses, and a Quality of Service specification. In the observed situation, the telephone, the workflow system, the manual documents from the loss adjuster, and the policy database are all examples of services.

The ReferenceObject: The ConnectionObject manages a list of ReferenceObjects that relate to the services the ConnectionObject offers. For example, the page in the customer script in which previous claims are registered, or the record in the policy database showing that Mr. A Customer never paid the first installment, will both be paramount in the case described. The list of ReferenceObjects is a sequence of states that describe properties of a service at a given point in time. This list allows a connection to playback a set of services in concert.

Dynamic properties of the model

The components outlined above can in a static manner describe how people in the organisation relate to each other. Moreover, it can describe distribution along several dimensions in a way that supports localisation of participants and establishment of sessions according to a range of criteria. Dynamically, the model can be used to support and manage activities within the organisation. These aspects of the model will be supported through a range of device independent media managers that manipulate the model components Access to the potential collaborators through explicit identification

is supported by an ConnectionObject's ParticipantList containing the relevant actors in the organisation. Based on the excerpt of the fieldnotes describing the angry customer, the following example (figure 1) instantiates and illustrates the model:

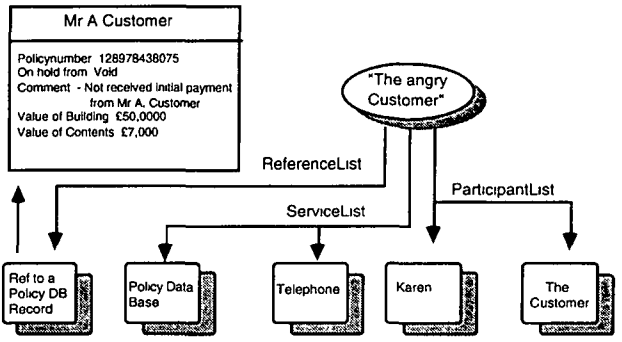

Figure 1 Instance of the model

Often a common task or shared material is the only link between parties. The ConnectionObject from which participants access the structure defines a perspective on the organisation. Many parallel structures are possible as an unlimited number of ConnectionObjects can point to each ParticipantObject. The implication is that the collaborators can create and maintain a set of perspectives on the organisation of work, that optimise specific tasks or situations. A group can dynamically redefine its structure and the model does not limit the users to describe formal organisation structures. In this situation George would have a ConnectionObject with this particular customer as one of the participants in his space of potential cooperative sessions, and we could imagine a mechanism alerting George about this customer being active again. If he responded to this call, the active instance of this part of the model would look like this (figure 2):

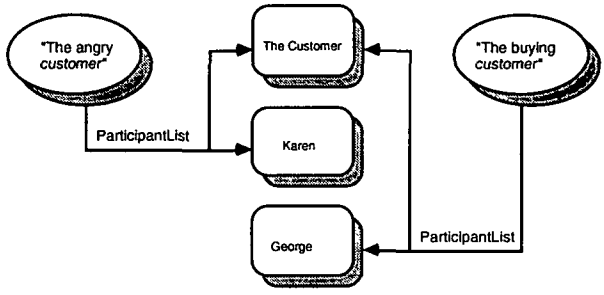

Figure 2 Instance of the model

George could in this situation generate a new ConnectionObject to make Karen available for conferencing without interfering with the established ensemble of herself and the customer, thus elaborating the network of connections. The model can be queried about the objects of work that can be reached from a ConnectionObject. Thus, a

list can be compiled of shared artefacts, electronic records, or pointers to manual documents through which potential collaborators can be found and new cooperative sessions established, thus yielding a description of the actual communication patterns in the organisation.

The description is instrumental in the sense that mechanisms to localise potential collaborators and maintain the cooperative configuration can be build on it. In the above example George can chose between inviting Lisa to join the conference, i.e. attaching her own ParticipantObject to the "Who is this Mr W?" ConnectionObject to engage in a synchronous discussion of the case, or he can suspend it and leave it for her to invoke later, asynchronously passing the conference, with context in the form of database records, workflow script pages and media connection to her for her to look at later (figure 3):

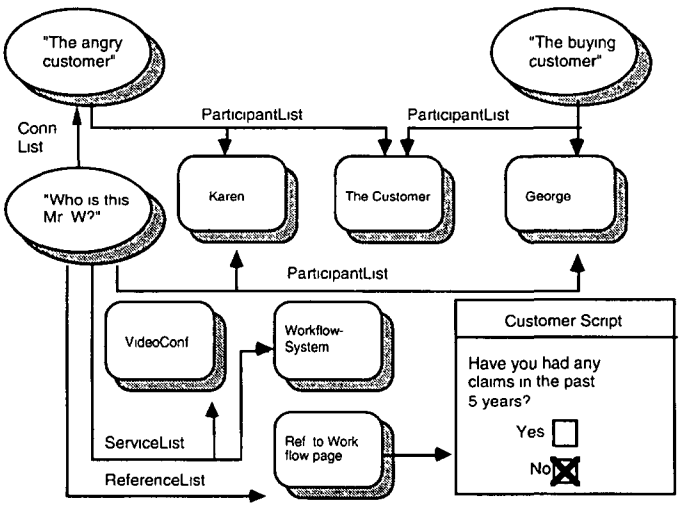

Figure 3. Instance of the model

It is possible to use the model to create a picture of how different activities create dependencies between ConnectionObjects. Each ReferenceObject can be viewed as a milestone along a path. Where two ConnectionObjects have a ReferenceObject in common, their paths have crossed, and the users can pursue this as a potential for further collaboration.

Because the ConnectionObject also contains pointers to the physical arrangement of the services, the model can describe distribution across geographical space. The ServiceObject also provides a related dimension of distribution, that of service types. From a ConnectionObject it is possible to issue queries for a given set of service specifications among those registered. The participants can use this information to coordinate the utilisation of resources.

Perhaps the most important issue that the model can address is that of synchronous versus asynchronous communication. Because the ConnectionObject is loosely coupled

with the physical links, its state might change from active to passive and back again. This change of state is in reality a crossing of the borderline between synchronous and asynchronous communication.

Discussion

The most significant difference between the framework offered in this paper and previous work, is that it recognises the need for an architectural model in video based communication systems. The proposed model can through the view of organisations as relations between potential collaborators describe distribution across a wide range of dimensions, thus yielding a variety of addressing schemes. This is in contrast to earlier systems where participants can only explicitly identify each other by their name or picture (Mantei et al. 1991; Gaver 1992; Dourish 1993; Tang et al. 1994). Others rely on the physical location of people in offices or common areas to establish collaborative sessions (Fish et al. 1990; Bly et al. 1993). However, the model allows these metaphors to be implemented on top of such an architecture, like the media "space" (Bly et al 1993) or virtual "hallway" (Root 1988).

The Rendezvous Architecture represents a similar approach to the model described although it does not address multimedia issues (Patterson et al. 1990). Contrary to our approach however, support for users who need to join an advanced session is not addressed by Rendezvous, neither does it attempt to bridge the gap between synchronous and asynchronous communication.

Many modelling efforts have been criticised because they assume determinism in the performance of work and ignore the interpretation and improvisation that people depend on to articulate their work (Robinson and Bannon 1991). Our proposal is not prescriptive about the work it is intended to support and makes no assumptions about the behaviour of the collaborators. It is in this sense more similar to that of Reeves and Shipman (1992) when they aim to gradually populate an information space.

It might be of interest to compare the properties of the suggested model to the design principles for future workflow management systems set forward by Abbott and Sarin (1994). As an alternative to the vision of workflow as "simply another invisible capability that permeates all applications", we have outlined an architectural model that offers integrated multimedia support for the apparently social activities in the workplace as well as the tasks that are the purpose of the organisation. A strong point to make here is that the model reflects the organisational setting, rather than the current technological possibilities. The model offers a number of advantages:

- It associates the communication supported by video with the formal, directed work of the organisation.
- It provides a means of maintaining history and supporting a context for the work taking place.
- It provides an integration framework for video communication and existing CSCW applications.

- It offers a flexible basis to bring together and address a collection of resources in a particular set of activities.

The model represents our initial response to the fieldwork of multimedia communication within the Bank. Work will continue to implement tools and applications based on the proposed architecture and assess its properties in line with the demands of the Bank.

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