A Methodological Quest for Studying Interactions in Advanced Video Conferencing Environments

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Abstract. The paper describes the development of a new methodological approach to the study of the features enabling the simulation of face-to-face (FTF) interactions using Advanced Video Conferencing (AVC) technologies. The methodology is based on the notion of Grounded Theory and utilises the study of users of the technology for discovering the criteria needed for the investigation of AVC as simulating FTF. The methodology enabled the development of an informed scheme of criteria which will be used in customising an annotation system suitable for the study of AVC interactions. The paper illustrates initial experimentations with various existing annotation systems in a search for further exploring the needs outlined by the methodology. The paper describes the implementation of the new methodology in a New Zealand based case study which investigated the reasons underpinning uptake of the technology across nationally dispersed research staff and students.

Introduction

The Global Knowledge Economy is about fast and effective decisions making processes, it is about mobility and connectivity, reliant on interdependent production processes and requires collaboration across often geographically dispersed sites(Carlaw, Oxley, Walker, Thorns, & Nuth, 2006; Drucker, 1969; Drucker, 2003; Oxley & Thorns, 2007; Toffler, 1990). However, it is operating within a growing awareness of the impact of human activities on carbon emissions(Wiedmann & Minx, 2007). This link between human activities and the environment paved the way for the conflict of interest between the Global Knowledge Economy's need for business and trade travel, and sustainability concerns calling for a reduction in the carbon footprint. Manufacturers and vendors of Advanced Video Conferencing(AVC) propose the technology as an effective solution to the conflict, offering cheaper, greener and quicker alternative to business travel(Beattie & Greenberg, 2007; Irwin, 2004).

The notion of using electronic telecommunications for enabling geographically dispersed people to connect is not new, and has been around since the first days of the telephone. However, the convergence of multimedia aspects such as video and graphics with telecommunications triggered the notion that these could be used to facilitate a close to real life communication experience(Egido, 1988), and bring telecommunication closer to the gold

standard of communication, the face-to-face (FTF) interactions. These are perceived as the most robust form of interactions entailing multiple channels of communication, and various forms of embodiment and practices. Since the début of video conferencing in the 1960s designers and engineers have been developing and trialling numerous solutions devised to enhance the performance of AVC and bring them closer to producing FTF experience. However, uptake is lower than anticipated (Frost & Sullivan., 2005; Hirsh, Sellen, & Brokopp, 2005; Sankar, 2006; Vilaboy, 2007), implying that expectations have not been fully met and the FTF experience has not yet been satisfactorily transported to the world of telecommunications.

Numerous attempts have been launched in the search for the reasons leading to the low uptake of AVC and the changes needed for improving the situation. Some studies focused on issues of infrastructure, cost, or user awareness as possible barriers to uptake (Frost & Sullivan., 2005; Hirsh et al., 2005; Sankar, 2006; Vilaboy, 2007), others studied the effect social presence and media richness have on user experience (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002; Biocca, Harms, & Burgoon, 2003; Daft & Lengel, 1986; Dennis & Valacich, 1999; Goffman, 1963; Short, Williams, & Christie, 1976; Wainfan & Davis, 2004). Innovation diffusion studies looked at processes of adoption of AVC (Molina, 1997; Voss, Mascord, Fraser, Jirotka , Procter, Halfpenny, Fergusson, Atkinson, Dunn, Blanke, Hughes, & Anderson, 2007).

Considerable resources have been invested in enhancing the design of AVC in an attempt to improve the experience of the users. Today state of the art technologies offer high definition studio quality audiovisual signals to be experienced in specially fitted rooms designed to create an immersive surrounding that will emulate FTF. However, here again uptake is lower than anticipated(Burnham -Finney, 2007). In spite of the extensive efforts of designers to simulate FTF environments people are still travelling to participate in FTF meetings(Maung, 2008), suggesting that FTF is still the preferred mean for communication. However, the looming environmental crisis and the rising petrol prices signal a genuine need to change meeting practices.

So far the various approaches to the problem attempted to begin by asserting preconceived hypotheses about the reasons for adopting or rejecting the use of AVC technologies for tele-meetings. This paper proposes to approach the situation with no preconceptions about the technology, its functionality and uptake. It is anticipated that this grounded approach will lead to new understandings of the reasons underpinning users' decisions for or against the use of AVC for tele meetings.

The paper proposes a model of inquiry which begins with a grounded approach, and culminates in the construction of grounded based criteria to be configured in the design of computerised annotating tools which will enable informed systematic annotation of observations. Data collected through annotation will inform ways of bridging the gap between present experience of the technology and users' perceptions about its potential. This will hopefully increase uptake, reduce the need to travel and eventually contribute to the change of tele- meeting practices.

Research problem

Our study investigates the reasons underpinning uptake of AVC technologies from a grounded approach in which we look to discover how functionality is constructed by the users rather than how functionality is portrayed by the designers.

The methodology was developed using a *case study* in which we attempted to analyse the processes of diffusion and uptake of a specific AVC technology, the Access Grid (AG) among research students and staff in New Zealand, and the ways in which the technology may have changed tele-meeting and collaborating practices.

The Case Study- The Access Grid and the New Zealand (Aotearoa) Context

Advanced Video Conferencing technologies surpass traditional video conferencing in that participants are able to simultaneously share resources such as presentations, video clips, slide shows, and real time drawing. Access Grid technology is an example of AVC tool, which enables real time sharing of resources through its 'multicast' feature, which maximises the ability to deliver resources across sites.

The AG technology was adopted in New Zealand through the BRCSS[1] programme, which set out to create a national social science network to link researchers across the eight universities in the country and stimulate collaborative research activity between researchers in the social sciences across disciplinary and institutional boundaries(Lewis & Thorns, 2005; NZGovt, 2005). The pioneer work of setting the first Access Grid in New Zealand was recognised by the Ministry of Research, Science & Technology(MoRST) in the context of the development of the country's Advanced Network, KAREN[2] and the BRCSS network was transferred to KAREN (Bedford, 2006).

KAREN became fully operational in February 2007, opening the way for more intensive use of Access Grid (AG) and other Advanced Video conferencing technologies, and triggered the need to research the ways in which the technology can support changes in tele-meetings and collaboration practices.
To address these questions we embarked on a 2.5 years research project. So far we have observed 17 AG sessions and disseminated a Web survey to Access Grid (AG) users around NZ universities. We sent a total of 454 invitations to potential participants from a group of research students and faculty members who have had some experience with the AG technology, and received 137 (30%) completed questionnaires.

Population of study

Our population of study consists of two major groups categorised not by the structure of their members but rather according to the context in which they use the AG.
One group consisted of individual researchers and research students participating in postgraduate seminars organised by the BRCSS network. These seminars are conducted over the AG and are open to postgraduate students and academic staff from all eight universities in the country. Some of the participants may have a common history outside the AG sessions,

[1] BRCSS- Building Research Capabilities in the Social Sciences
[2] KAREN - KIWI Advanced Research and Education Network

others do not. Some have attended several seminars so could be seen to have a history, although at times at the very rudimentary level of recognising faces. The use of the AG in this group is mainly for transmitting presentations in the form of lectures across multiple sites.

The second group consists of three cohorts of students studying for a postgraduate tertiary teaching certificate. The programme includes two single semester courses and is taught in collaboration between two universities, each based at a different geographical region. Students from each of the universities meet periodically on the AG, and also use Blackboard (a Web based learning system) as a discussion and posting space for assessments and peer review. Blackboard is used throughout both courses. The use of other technologies further highlighted features of FTF in comparison to other media. The teachers at each campus coordinate the order in which the course is taught so that both groups will study the same content concurrently. The AG sessions are used as a meeting point for the two groups to exchange and share ideas, solve problems together, or work in teams and share products with the greater group.

Methodology

AVC tools are said to enable close to real life 'meetings' between geographically dispersed individuals or groups. The similarity between FTF and AVC enabled interactions stems from the ability of the technology to transfer a richness of media channels similar to those conveyed in FTF meetings:

1. Synchronicity- the ability to engage in temporal turn taking interactions that enable the smooth alternation of speaker and listener who are co present(Bosch, Oostdijk, & Ruiter .J.P. (de). 2004)
2. Multimedia information incorporating Mehrabian's '3V's' – verbal, vocal, and Visual(Mehrabian, 1971)
3. A sense of being with one another, a sense of presence(Heeter, 1992), and co-presence (Goffman, 1963; Schroeder, 2006)

Transferring these features from the FTF to the technologically mediated environment has been the task of designers and engineers who are constantly striving to improve and enhance the technology so that users' experience will be as 'real' as possible. However, the low uptake suggests that users are not convinced.

To learn more about users' opinions we propose to begin with a grounded approach based on Glaser's Grounded Theory in which he argues for 'unpolluted' free from 'preconception' investigation (Glaser, 1992, 1998).

We began our investigation with a set of unstructured observations of AG sessions and manually recorded users' interactions.

The key themes identified in the observations provided the basis for formulating survey questions. One set of survey questions asked users to describe their actions. A second set of questions asked users to describe their perceptions of what activities they visualise as facilitated by the technology. The findings of the survey were analysed to discover a gap between activities experienced and activities perceived possible. Furthermore, the survey provided detailed information as to the exact areas around which the gap evolved. Experienced activities were then juxtaposed with actions traditionally associated with FTF interactions to discover level of similarity of experience in AVC. The purpose of this

juxtaposition was to ascertain what is needed for AVC interactions to become more like FTF meetings. Findings were used for constructing a set of features to be systematically explored. Features identified are to inform the design of computerised annotating tools which will enable informed systematic annotation of observations. Figure 1 illustrates the model of the methodology.

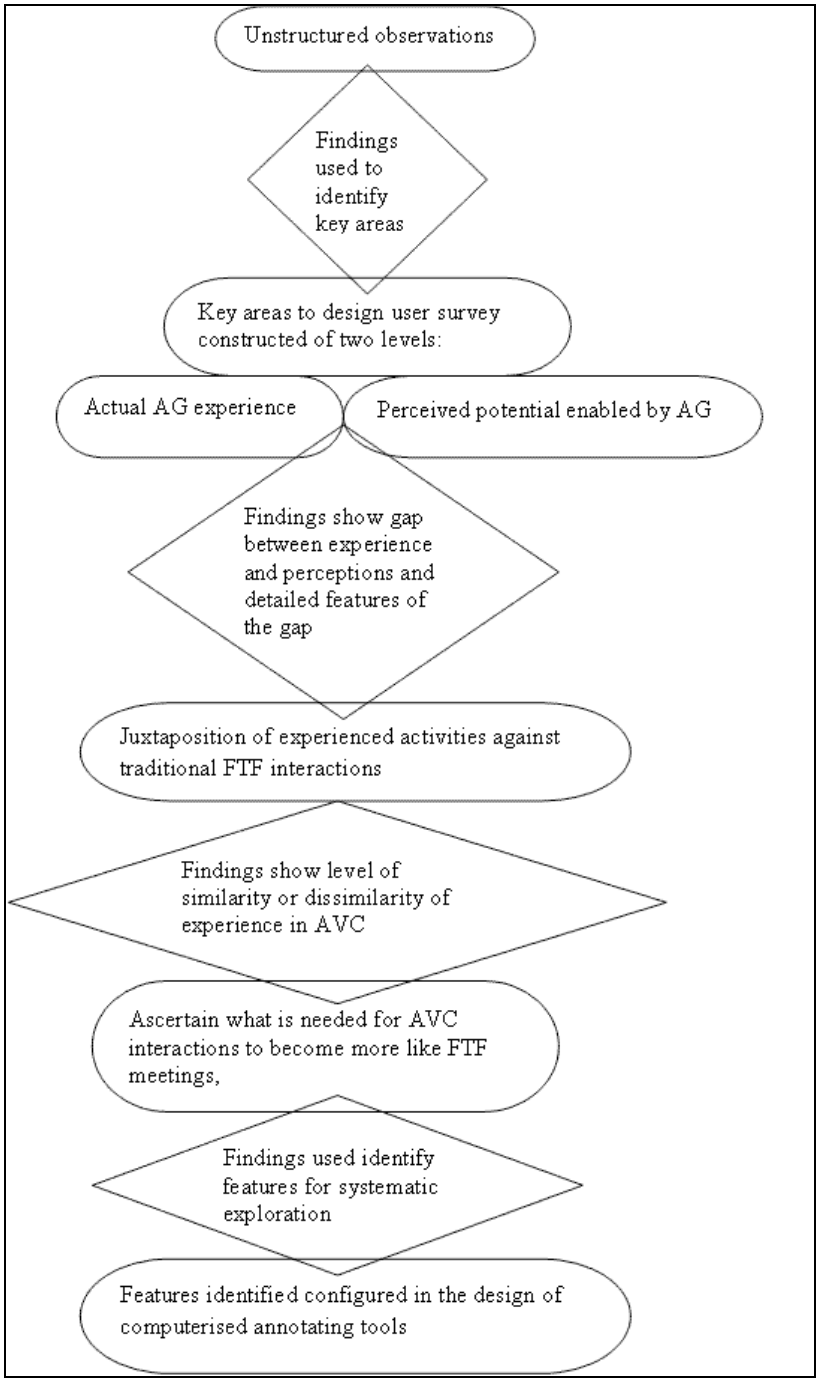

Figure 1-Methodology

Methodology Model - Case Study Trial

Unstructured observations- Findings

We observed a total of 17 sessions and manually annotated as many details we could capture in real time. We were unable to record sessions because this phase of the project preceded the implementation of our high speed connection, KAREN, and the limited bandwidth available did not permit recording. A compilation of the notes from across all the observations enabled us to detect remerging phenomena which we aggregated into the following key themes:

1. Socio technical interactions- the way people interacted with other people in and across nodes, and the way they related to the technology in their environment
2. Group dynamics across different contexts
3. Group dynamics within and across nodes
4. Different modes of disseminating information

Survey design

The design of the survey was informed by the key areas identified through the analysis of the observations as shown in table I

Table I- key terms

Key Themes	Survey Questions
Socio technical interactions	Are AG interactions different from FTF Is it **possible** to participate in AG in the same way as in FTF What was the nature/ atmosphere in the AG What is it like talking to people through video screens?
Group dynamics in contexts	What type of session did you attend? reasons for attending, and for contributing reasons for contribution or non contribution personal aims and expectations driving attendance
Group dynamics within and across nodes	Who did you consider part of your group Did seeing self image affect interactions What is it like talking to people through video screens? What was the size of the group in your node /in other nodes
Modes of information dissemination	What did you take away from the session How did you participate/contribute to the AG session What outcomes resulted from the session

Open ended questions asked participants to:

- Describe what they liked about the AG and what they did not like;
- What would encourage them to attend a session?

Survey Findings and Analysis

The findings of the survey showed that the overall attitude towards the use of the AG was positive, with 90% acknowledging its potential for increasing collaboration, and 66% perceiving AG as enabling frequent communication with colleagues. 82.4% agreed that it is **possible** to participate in AG sessions the same way as in FTF interactions. However, 92% noted that the AG environment changes the way in which people interact compared to FTF. This seemingly contradicting result may indicate a gap between the perceptions respondents have regarding the potential of the AG, and the actual experience**.** When asked to describe their perception and expectations from the AG experience participants said:

> *"Phones are a very 'naturalised' way of communicating so we tend to factor in all the missing aspects - body language etc. my initial expectation of the access grid is that it would feel 'richer' and 'more normal' than phones"*

"It seems to me like talking face-2-face. Like talking through telephone and being able to see the partner's face as well "

However, when describing their experience participants commented:
"Detached is a good description"
"It remains highly impersonal and the inability to read peoples body language, know who is talking and where from can be quite disconcerting"
(Thorns, Allan, Barclay, Chamberlain, Kerr, & Scott, 2008)

Literature identifies traditional FTF features along three main areas:

1. Synchronicity- the ability to engage in temporal turn taking interactions that enable the smooth alternation of speaker and listener who are co present(Bosch et al., 2004)
2. Multimedia information incorporating Mehrabian's '3V's' – verbal, vocal, and visual(Mehrabian, 1971)
3. A sense of being with one another, a sense of presence(Heeter, 1992), and co-presence (Goffman, 1963; Schroeder, 2006)
4. Intuitiveness(Hornecker & Buur, 2006)

We juxtaposed the findings of the survey against these themes and identified the specific areas around which the experience and the similarities between FTF differed. Table II illustrates these.

Table II -Juxtaposition

FTF	AG aspects different to FTF	Comments
Synchronicity	▪ Turn taking in AG requires different practices to those of FTF ▪ Time lag affects turn taking	Total=14 17%
Multimedia information	▪ Presence of camera altered interactions ▪ View of self image, and the image of others was different to that experienced in FTF ▪ Quality of sound sometimes inadequate ▪ Ability to discern body language and facial cue, not always possible	Total=31 38%
A sense of being with one another, a sense of presence	• AG does not allow participants to follow the gaze of their conversation partners • Positioning of people facing screen rather than camera altered the interaction within and across nodes" *facing the wall, not us* • Proximity to camera determined presence or absence • Sharing space- muting microphones was used to exclude groups	Total=27 33%
Intuitiveness	Clunkiness of technology, lack of flow	Total=8 9.7%

We collated the totals showing in the right column of the table and produced a graph illustrating the levels of difference identified in each of the areas. Figure 2 shows the illustration

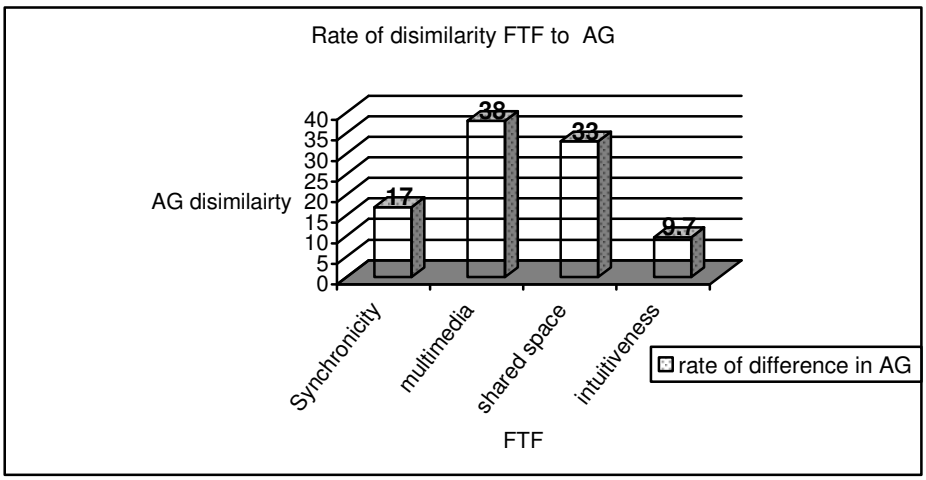

Figure 2 Gap features

Figure 2 shows that the highest number of comments made was around issues relating to visual aspects, indicating that these are prominent issues contributing to the 'gap' between AG and FTF experience. The participants in our case study commented that "*having the camera changes the dynamics of the group a little bit which is why it isn't the same as a face to face session*" and *"Looking into camera to speak meant that you were excluding those in the room with you (We were all sitting facing the screen/camera)"* participants also commented about the limited ability to detect body language saying that: *"although everyone can see each other and contribute you don't get the same body language cues when someone wants to speak'.*

The comments of the participants reiterated the findings of our observations. Figure 3 demonstrates a situation where people are facing the camera and projecting screen turning their backs to the participants sitting in their physical node.

Figure 3- facing screen and camera

Summary of survey analysis

Analysing the findings of the survey enabled us to identify the points of difference between the AG experience and the perceptions and expectations of similarity to FTF as expressed by the users. Juxtaposing the differences identified against the traditional FTF features enables a clearer view of what is obstructing the AG experience from becoming more like FTF and paved the way for bridging the gap between experienced and perceived potential. The analysis of the survey findings enabled the measurement of the levels of dissimilarities in a way that facilitates focusing on detailed features of the gap preventing AG from accomplishing its potential as perceived by the participants of the study. This level of specificity provided detailed information enabling formulating the criteria for the design of a systematic annotating tool for the study of interactions in AG environments and the discovery of an informed solution for bridging the AG > FTF gap. We began a search for annotating tools that would facilitate implementing the criteria identified and proceed to a systematic exploration of interactions.

Using off the shelf annotation system

In our search for an annotating system we came across the Memetic software developed by the National Centre for E Social Science(NCeSS) in the UK involving researchers from Manchester, Southhampton and Edinburgh Universities (Buckingham Shum, Daw M., Slack R., Juby, Rowley, Bachler, Mancini c., Michaelides D., Procter R., De Roure, Chown, & Hewitt, 2006). However we encountered problems when attempting to install the software on our NZ system because of different configurations to the ones used on the UK system. After weeks of international collaboration between the UK team and our project partners from HIT Lab NZ we were finally able to install the Memetic software, only to find that it will not suit our needs. A casual meeting at the 'Third International conference on E social Science' (2007) led to a new collaboration with the Nottingham based developers of the Digital Replay System (DRS) (Greenhalgh, C., French, A., Tennant, P., Humble, J. and Crabtree, A).

In order to use the DRS system we needed to convert AG recordings to a file format recognised by the DRS. We applied the Camtasia software and converted the files first to AVI format ,and after discussing the matter with the DRS developers converted to QuickTime format (.mov). Using Camtasia meant that we had to limit the length of the recordings to avoid crashing our computers. Through trial and error we reached the optimal length of 20 minutes segments of recordings.

We trialled annotating recordings using the DRS, and found it useful for annotating micro-level actions and measuring their frequencies, such as for example tracking varying levels of participation from each node /or individual participant(Thorns et al., 2008) However, the system was not very useful in annotating the more prominent features we have identified as needing further study. The DRS was not effective in analysing the areas we identified earlier as most prominent in bridging the gap between AG and FTF:

Multimedia information - 38%

- Presence of camera altering interactions
- View of self image, and the image of others
- Quality of sound
- Ability to discern body language and facial cues

A sense of being with one another, a sense of presence - 33%

- Inability to follow the gaze of their conversation partners

- Positioning of people facing screen rather than camera altered the interaction within and across nodes
- Proximity to camera determined presence or absence
- Sharing space

Summary of Methodology trial

The approach applied here allows us to study how functionality emerges and discover its features using as our criteria the perceptions of users rather than any preconceptions on our part or those of designers. The methodology we have developed and trialled here contributes to the construction of an informed and systematic way for identifying what is needed for bridging the gap between AG and FTF, and provides a detailed scheme of criteria for further investigation needed. This scheme will provide the variables needed for configurating a customised annotation tool for the study of AG and other AVC interactions. It is anticipated that the information obtained through this methodology will contribute to bridging the gap between AVC mediated interactions and FTF. Furthermore, the reliance on users' input applied here will hopefully prove effective in increasing uptake of the technology and change in the practice of tele-meetings.

Limitations

The model was trialled on a single case study. Further trials are needed to ascertain its effectiveness and reliability in informing the design of a computerised annotation tool.

Ideas for Future study and development

Develop a tool that will enable large scale observations to be annotated and analysed in a more effective and hopefully less time consuming way using the grounded processes we described here to inform its annotating schemes.
Ways of enhancing the Design of Annotating Tools:

- Easy synchronisation of recordings of AG and other AVC sessions
  - change- AG recording format or allow for format to be read by annotating system
- Speech recognition system to recognise repeating speakers
  - annotator identifies speaker first time and system to recognise that speaker from then on
- Gaze tracking system able to work across cameras and follow gaze not only in physical node but across nodes
  - calculate how each camera is distorting the gaze to arrive at who the person is actually looking at

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