

# A Framework for Analyzing Social Interaction Using Broadband Visual Communication Technologies

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## **ABSTRACT**

This chapter addresses the challenges of analyzing social interaction among people using broadband visual communication (BVC) technologies. BVC technologies – such as videoconferencing and sharing videos online - allow the exchange of rich simultaneous or pre-recorded visual and audio data over broadband Internet and broadband networks. Our solution is an analytical framework, a common reference point that can be used by multi-disciplinary teams working with BVC technologies to understand the variables that help and hinder how people use these technologies for social interaction. The framework has four main categories, each with a number of sub-categories covering variables that are both social and technical in nature. We use our research framework to understand the social aspects of technology design and implementation and the social implications of BVC technologies. We also apply our framework to our technology usability and effectiveness studies and technology needs assessments.

## **INTRODUCTION**

People, groups, organizations and communities are increasingly using broadband visual communication (BVC) technologies for social interaction in a wide range of settings - from institutional uses such as business, government, health and education to more informal uses such as entertainment for family and friends, social networking and digital storytelling.

Researchers use the terms 'broadband visual communication' and 'broadband video communication' interchangeably. The term 'broadband' refers to both broadband networks and broadband Internet - telecommunication in which a wide band of frequencies is available to transmit information. BVC technologies allow both simultaneous and pre-recorded exchange of rich visual and audio data over broadband. The visual and audio data may also be accompanied by text data. Our research institute has used the term 'BVC' for many years to refer to videoconferencing, which allows synchronous audio-visual communication. More recently, we use 'BVC' to refer also to asynchronous communication using pre-recorded videos, such as video-sharing on the Internet by people with the capacity to both create and view videos. Increasingly, synchronous and asynchronous BVC are used together for social interaction.

Videoconferencing technologies were introduced commercially in the 1970s and for the next decades were used almost exclusively in health care, military, and educational institutions, failing to gain more widespread acceptance. In the past few years the decreasing costs and increasing penetration of broadband has stimulated a huge uptake in videoconferencing. Set-top videoconferencing units are now found not only in the previously mentioned locations but also in voluntary organizations, community centres, community health clinics, and primary and secondary schools. Videoconferencing has several immediate and tangible benefits: it allows the exchange of visual information like facial expressions that encourage trust and intimacy, it encourages 'green' meetings that reduce participants' travel and carbon footprint, and it encourages exchanges between people who cannot meet in person. Videoconferencing can also be an important tool for knowledge building, provide essential social services and supports for people in rural or remote communities, and aid in community-building and development (Molyneaux et al., 2007a, 2008a).

Home computers with webcams and digital video cameras are becoming more ubiquitous. Sharing videos online has exploded in popularity in a very short time. The most popular video sharing website, YouTube, claimed to receive more than 100 million views per day by more than 20 million users internationally, with more than 65,000 new user-generated videos uploaded daily - a mere 22 months after its launch. YouTube users also posted millions of text comments about the videos and engaged in text exchanges with other users. In 2006, *Time Magazine* named its 'Person of the Year' as 'You,' claiming that the users of YouTube and other user-generated content-sharing Internet sites were 'seizing the reins of the global media... founding and framing the new digital democracy ...and beating the pros at their own game' (Grossman, 2006).

The objective of this chapter is to discuss the requirements for analyzing social interaction using BVC technologies and to provide an overview of our solution – an analytical framework. The framework is a common reference point for multi-disciplinary teams working with BVC technologies seeking to understand the variables that help and hinder how people use these technologies for social interaction. We use our research framework to understand the social implications of BVC technologies and the social aspects of technology design and implementation. We also apply our framework to our technology usability and effectiveness studies and technology needs assessments. We illustrate how the framework can be used by presenting a brief case study of BVC in remote and rural First Nations communities in Canada.

## **BACKGROUND**

BVC involves simple and more complex social and technical interactions. The basic social interaction is communication; the complexities arise as the interaction grows from communication between two individuals in the same location to communication between multiple individuals in multiple locations, working for multiple organizations rooted in different communities. The main technologies are a camera, a microphone, and some recording and viewing software and hardware; the complexities arise when there are multiple hardware and software versions and platforms with compatibility problems, using broadband networks that have access, bandwidth and management challenges.

In 1997, a book was published that outlined different ways to approach research on video-mediated communication (Finn, Sellen and Wilbur, 1997). Referring to this publication, in 2002, colleagues working on BVC at our research institute developed a description of evaluation factors for analyzing BVC among multiple stakeholders in different geographical locations. Their five evaluation factors were: social infrastructure, technical infrastructure, physical space, interaction style, and content (Barfurth et al., 2002).

Since 2002, broadband with bandwidth capable of supporting high-quality visual communications has become mainstream in most developed countries. This has led to a virtual explosion of visual communications. Applications such as online video sharing, which until 2006 were unknown by the general public, are now used regularly by hundreds of millions of Internet users globally. The use of desktop videoconferencing has also seen a huge upsurge, particularly in young people: a recent study of 1,060 adolescents found that 57% occasionally use webcams while instant messaging and 32% sometimes use microphones (Peter et al, 2007).

Given these new developments, we decided it was time to develop a more comprehensive framework for analyzing social interaction using BVC technologies. Our framework started with our colleagues' earlier work (Barfurth et al., 2002) and reconfigured and expanded it to focus on social interaction and to include not only videoconferencing but also online video sharing. This moves it from the realm of small groups to both small groups and very large groups of people, communicating either synchronously or asynchronously, or both.

## **ANALYTIC FRAMEWORK**

### **1. Basic requirements**

We aimed for the analytical framework to meet four basic requirements.

#### **Provide a common point of reference for multidisciplinary teams**

There is a move in technology research and development toward multi-disciplinary teams. Members of our own research team together have advanced degrees in 10 different disciplines. The framework needed to be flexible enough to embrace a wide variety of theoretical and methodological approaches and research interests. We envisioned the framework as a focal point that would let us share a common language.

If we review literature from disciplines as diverse as those found in our research team - communications and media studies, computer science, clinical psychology, cognitive psychology, educational psychology, philosophy, electrical engineering, sociology, history, and educational technology - we find that there are literally hundreds of variables involved in social interaction using BVC. The concept that many different variables will help and hinder communication using technology is understood and theorized in many different fields. The framework needed to encompass many variables – enablers and constraints – of many kinds. To give a practical example, excellent audio quality during a videoconference enables communication in one location, and poor audio quality constrains it in another location. Other constraints would be if

certain participants in one location cannot access the technology to make videos or view them online because they cannot afford it or if their rural community does not have adequate bandwidth. These enablers and constraints shape social interaction. The framework needed to accommodate variables that address different types of concerns from different disciplines.

### **Include both social and technical elements**

Along with the trend toward multidisciplinary research teams, there is a growing recognition in the technology development field of the need to address both the social and technical elements of technology use and deployment. Actor network theory and the social actor concept posit that the technical and the social are inseparable - people together with their technologies comprise social networks and social actors are simultaneously enabled and constrained by socio-technical affiliations and environments (Blechar, Knutsen, Damsgaard, 2005; Lamb and Kling, 2003; Rowlands, 2006). In particular, our framework is guided by the social informatics approach of Rob Kling: the relationship between the social and technical is complex and mediated by context, structure and agency, history, culture and meaning systems, political and social processes and symbolic and material interests and resources (Kling, 1999; Lamb and Sawyer, 2005; Robbin and Day, 2006).

### **Emphasize both the production and reception of visual content**

A novel feature of new media is the ability for ordinary people to be both producers and viewers or audiences of digital content (Lievrouw and Livingston, 2006). Traditionally, videoconferencing research has included both the production and reception aspects of communication, but research on traditional forms of video and visual content generally has focused on either the production or the reception, but not both. Analyzing online videos presents a new challenge for researchers because it is important to understand the users of the technology as both producers and viewers or audiences (Molyneux et. al, 2008b).

The most influential theorist of how people respond to visual images is Stuart Hall (1999). His central argument is that although creators of a visual image may have a message in mind when they create or 'encode' it for its viewers, it does not necessarily follow that the viewers will 'decode' the message the way it was intended. Viewers actively construct meanings rather than passively receive them. Both encoding and decoding are socially constructed activities, and Hall's theory stresses that visual messages will be constructed and interpreted differently depending on socio-cultural contexts. Some messages are connected to specific beliefs, practices and interests and are thus dominant in social groups that share these perspectives. Therefore analyzing visual images can reveal the dominant beliefs held by the encoders, and analyzing the viewing audience can reveal the different interpretations decoded by different social groups.

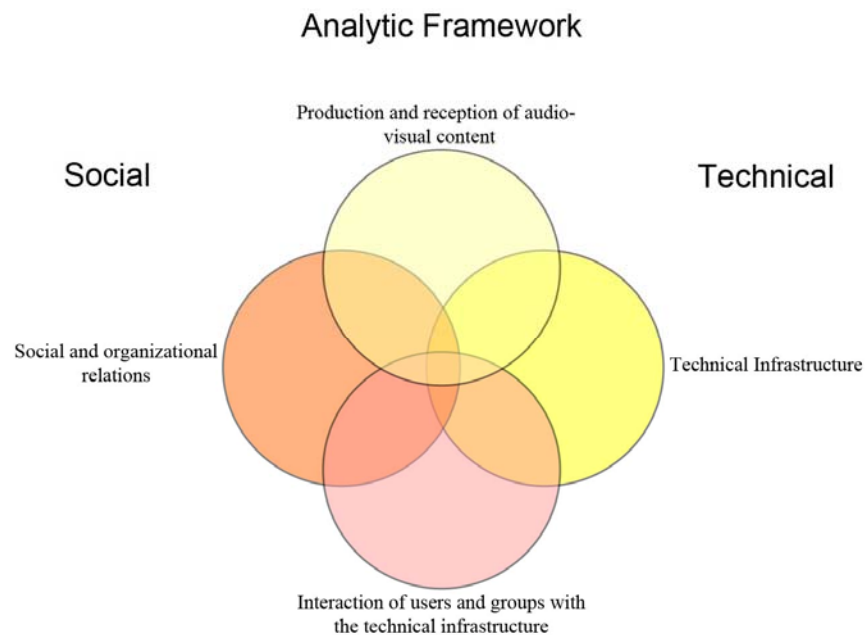
### **Focus on multiple levels of social interactions**

As noted earlier, using BVC for social interaction is a complex process. Visual communication among multiple people in multiple locations rooted in different contexts implies many analytical variables. There are numerous theories and approaches that build understanding of social interaction using communication technologies at the levels of individuals, groups, organizations

and communities. For example, at the group level, the concept that different groups of people have different levels of acceptance and use of a new technology is implicit in influential theories such as Rogers' (2003) diffusion of innovations in communications and media research and the TAM, Davis' technology acceptance model in management information systems research (Davis, 1985). In the TAM model, people who perceive technology as useful and easy to use will accept it more readily than those who do not, with usefulness more important than ease of use. Extensions of the TAM model identified gender differences (Gefen and Straub, 1997) and cultural differences in email perception and use (Straub, Keil and Brenner, 1997). The framework needed to include variables for social interaction using BVC at the individual, group, the organization and community level.

## 2. Core categories and variables

Based on the basic requirements outlined above, our analytic framework includes both social and technical variables in four core categories, illustrated in Figure 1. The categories are not entirely discrete - there is some overlap among the variables in each category.



*Figure 1. Analytic Framework*

To identify variables within these four categories, we first conducted a wide-ranging review of almost a hundred published articles and reports on the use of videoconferencing and multi-site videoconferencing and participatory communication in many different contexts, including health and medicine, education, government, corporate, non-profit, research and community uses (Liu, Molyneaux and Matthews, 2008; Molyneaux et. al, 2007a; Molyneaux et. al, 2008a). The studies included, for example, literature on virtual teams (Becker and Goodwin, 2005; Jarman, 2005; Jarvenpaa and Leidner, 1998; Mankin, Cohen and Fitzgerald, 2004; Mansour-Cole, 2001;

Nemiro, 2000), literature on multi-party videoconferencing (Anderson, 2006; Blignault, 2000; Sonnenwald et al., 2002), and literature on videoconferencing in health, education and other areas (Blignault, 2000; Ho and Jarvis-Selinger, 2005; Rees and Haythornthwaite, 2004). The review focused on identifying issues and variables of concern under the four core categories.

We then refined our framework through a series of studies that allowed us to validate the variables and add new variables under each of the core categories. These studies produced publications on the use of YouTube (Milliken et al., 2008; Molyneaux et al., 2008a, 2008b; O'Donnell, 2008), the use of videoconferencing and online video technologies in a live discussion on topical issues by students in six high schools across Canada (O'Donnell et al, 2007; Simms et al., 2008); the use of videoconferencing and online video by First Nation (Indigenous) communities in remote and rural areas of Canada (O'Donnell, Perley and Simms, 2008), challenges to conducting participatory research on videoconferencing in a health organization (Gibson and O'Donnell, 2008a) and the use of multi-site videoconferencing by a regional health board in Canada for non-clinical health administration and education (Gibson and O'Donnell, 2008b). Whenever possible we also solicited and included feedback from our research partners and participants to inform our procedures, findings, and thinking; some of our studies also used participatory research approaches.

The four core categories and their associated sub-categories are described below.

## **Technical infrastructure**

This category covers the variables that are primarily technical. To date we have identified four main sub-categories:

### **Quality and availability of networks and bandwidth**

Broadband visual communication requires considerably more bandwidth than text exchange, and two-way communication requires similar upload and download speeds. The term 'broadband' is used to describe many different types of networks and Internet connections, not all of which support adequate two-way exchange of audio visual data. For example, some people have 'broadband' Internet connections that allow them to download and play videos easily but they run into difficulties when uploading their own videos to share with others. Another infrastructure variable affecting social interaction is the need for managed networks and quality of service (QoS) for synchronous visual communications in remote communities - especially areas serviced by satellite connections. For example, a videoconference from a community with limited bandwidth may have poor visual and audio quality if QoS is not managed, thus limiting the quality of social interaction. Another variable in this sub-category is firewalls in corporate networks.

### **Type of software and hardware for video capture, storage and playback**

For videoconferencing, there are several brands of set-top units and a wide variety of desktop options. Videoconferencing by mobile phone is now possible as well. Each of these options presents different possibilities and challenges. Some of the variables are the capacity of the devices and software, the flexibility of the technology to support different group setups, locations, and time constraints; the maximum number of users and groups who can communicate

synchronously and asynchronously using the technology; the availability of a critical mass of the technology; the technical compatibility of systems, hardware, software; and the flexibility and capacity of system for incorporating new features and elements.

#### **Availability of a videoconference bridge and video sharing server**

For some kinds of multi-site videoconferencing, a videoconferencing bridge (also known as an MCU) is required, and technical challenges for bridging different kinds of software and hardware can be considerable. A server is required for sharing videos, and again there can be many technical challenges associated with this.

#### **Quality and placement of cameras, microphones, screens and speakers**

In other publications we have discussed the many issues involved with cameras and microphones for BVC (Molyneaux et al., 2007a, 2008a). Not having a good quality audio or visual connection when communicating with this technology can be a significant inhibitor to communication in many settings.

### **Interaction of users and groups with the technical infrastructure**

This category includes variables that have both technical and social elements. To date we have identified four main sub-categories:

#### **Access by users and groups to the hardware, software and network**

As noted earlier, BVC, and its software and equipment requirements, is more complex than text-based communication. Most households in the US and Canada have computers and an Internet connection; however, not all of these households also have a digital video recorder or a webcam and microphone attached to their computer. Accessing higher-end videoconferencing equipment can be a challenge and may have prohibitive associated costs.

#### **Levels of awareness, comfort and technical skills of participants**

Different people have varying levels of awareness, comfort and technical skills with BVC, and these will have an impact on the communications and social interaction. One variable is that some people are camera-shy. Our study of online video production and viewing by 150 high-school students in three Canadian provinces found that more than 25% said that in general they do not like to appear on camera (Simms et al., 2008); our work with the health board found anecdotal evidence that sometimes participants will point the videoconference camera at the site location sign rather than themselves if they do not want people looking at them that day.

#### **Levels of technical support**

For videoconferencing in particular, the technical support required is generally beyond what an ordinary computer user can manage. Participants who have ready access to technical support will find it much easier to participate in many different forms of BVC.

#### **Ease of use, ease of viewing**

Many variables are involved in making BVC easy to use and easy to view. These include the computer interface, position of the screen or monitor, and a wide range of human-computer interaction variables.

## Production and reception of audio-visual content

This category also includes both social and technical variables; to date we have identified four main sub-categories.

### **Task relevance and usefulness of broadband visual communication**

Broadband visual communication can be very useful for supporting certain kinds of interactions and tasks; at other times BVC might not be worth the effort. For it to be successful for social interaction, BVC must be a good fit with the group or organization process and be a real solution to a real communication need. Participants will not be motivated to use the technology effectively if they do not believe it will be useful for them (Davis, 1985).

### **Use of protocol and etiquette**

Successful meetings by videoconference will use established etiquette, which we have described elsewhere (Molyneaux et al., 2007a). Sharing online videos successfully also requires that certain protocols are followed, for example considering concerns about privacy and not sharing material without permission of everyone on camera.

### **Use of communication modes and methods**

For video sharing in particular to have a communication impact, the video producers should be thinking about the communication value of their production. It does not necessarily follow that the message intended will be the one received by the viewer; however a video made without any consideration of the communication intent and impact on the viewers will likely not have a good communication outcome. There are many variables involved in making an effective audio-visual message, from body language and clarity of the speaker to the production values of the video. For videoconferencing as well, if the speakers are not actively trying to communicate with people at the remote sites, their communication is not likely to be effective. Other variables in this sub-category include how the visual is framed, the use of colour and movement and other visual elements.

### **Use of participants' physical space**

For videoconferencing and also for making and viewing videos, there will be an optimum use of the physical space. Variables include furniture (position, quality), room (size, obstructions), lighting, room configuration, and even the colour of the wall or background. To give an example, in our multi-site videoconferencing study in a health authority (Gibson and O'Donnell, 2008b), it was clear that room size could have a significant impact on the success of a videoconference. In one instance, the room could comfortably fit up to 16 people but it was not uncommon for 45 individuals to be put into this room for the videoconference event, leaving many people without a view of the videoconference screen, without a seat, and without the opportunity to ever appear on the video.

## Social and organizational relations

This category includes purely social variables. To date we have identified five main sub-categories.



### **Impact of group dynamics: trust, norms, group size, leadership**

Many variables in the sub-category of group dynamics can make the difference between a successful and unsuccessful social interaction using BVC. Trust is a primary consideration. Participants who prefer to build up trust by meeting in person rather than by video and who have that option readily available will not be very interested in meeting by videoconference or by sharing videos. Other variables in this sub-category are group size, structure, and stage of development; group norms; and group leadership. For multi-site videoconferencing, we have identified a tendency for people who come together for a committee meeting to rate their feelings of connection (e.g. perceive that a warmer environment is created, feel more like part of a group) with the other videoconference participants as higher than people who do not consider themselves to part of a group and who meet for educational videoconference events (Gibson and O'Donnell, 2008b).

### **Influence of gender, class and race**

A sociological perspective on communication will always consider the core sociological issues of gender, class and race – and they do need to be considered when analyzing BVC for social interaction. There are many ways that these variables will have an impact on social interaction using BVC technologies. Our study of gender on YouTube, for example, found differences between how females and males used video sharing to connect with the YouTube community (Molyneaux et al, 2008b).

### **Participants' culture and community membership**

Broadly speaking, BVC is used among people separated by geographical distance; often this will mean participants are living in different cultural and community contexts. Some communities and cultures will have different levels of comfort with and attitudes toward communicating visually using technology. For example, in our research with First Nations (Indigenous) communities in Canada, we found concerns about cultural exploitation by sharing videos online: one participant interviewed said it was important to get permission of community leaders before making a video about their culture (O'Donnell, Perley and Simms, 2008).

### **Location of participants**

One's social location and position will shape the social interaction experience – in our multi-site videoconferencing study within a health organization we found that often the remote and rural sites were at a disadvantage. For example the majority of individuals in a videoconference session, including the event's chair or facilitator, were situated at an urban site. The rural and remote sites were sometimes forgotten, as noted by several participants in our study who added that if they are lucky they may be solicited for feedback a few times during a session (Gibson and O'Donnell, 2008b).

### **Economic and political factors**

Finally, structural social relations can shape social interaction using BVC technologies in numerous ways. If there is a stakeholder organization involved, it will make a difference if it has a governance model that is top down vs. community-based and bottom-up. Other variables are the availability of funding and business models to support development of audio-visual content and the demand for and marketing of services and information.

### **3. Case Study**

Our analytic framework is a tool that can be used by multidisciplinary research teams to explore how BVC is used and can be used for social interaction. The expectation is that every investigation we conduct will consider not every single variable in the framework – that would be unrealistic - but rather variables from each of the four core categories, so that social and technical issues, production and reception issues, and social relations are included. In this section we present a brief case study based on our recent research using the framework (O'Donnell, Perley and Simms, 2008).

#### **Challenges for broadband visual communications in remote and rural First Nations in Canada**

For Canada's remote and rural communities, BVC provides a vital lifeline. We used our analytic framework to explore the challenges for BVC in remote and rural First Nation (Indigenous) communities. We collected data from actual users of visual communications technologies in First Nation organizations and communities. The study, part of an ongoing participatory research project with First Nation partners, draws on data from 18 in-depth interviews, 43 completed survey questionnaires, and the transcripts of two public meetings held by multi-site videoconference with participants from many remote and rural First Nations across Canada. This research, and all our other research involving people, was approved by our institution's research ethics board.

We used our analytical framework at four stages of the research. First we used it to develop the questions for the in-depth interviews and survey questionnaires. This involved selecting variables from each of the four categories and formulating questions for the interview participants and survey respondents about their experiences with these variables. Second, we used the framework to identify major coding categories for qualitative data analysis of the interview transcripts. This involved creating codes for variables in the four core categories and their sub-categories. With these codes, we coded the transcript text using a qualitative data analysis software tool, NVivo. Third, we drafted the research paper using the four core categories from the framework as headings and the relevant variables as sub-headings. Finally, we verified the draft findings by consulting with our First Nation research partners. This checking process allowed us to validate the framework in the specific community context, add more variables to our framework, and strengthen our confidence in this framework as a research tool.

Using the framework in this specific study enabled us to identify the many and varied challenges to using BVC for social interaction in remote and rural communities. All the examples and quotes below are from our publication about the study (O'Donnell, Perley and Simms, 2008).

The main technical infrastructure challenges identified in the study were network and bandwidth constraints, the need for network management and quality of service (QoS) in remote communities serviced by satellite, the need for a critical mass of quality videoconferencing units in communities, and specific technical challenges for sharing videos online in communities with limited bandwidth. For example, one participant interviewed stated that: 'In our regions, in our

communities and in our organizations, we have to carefully manage a limited resource. There is no such thing as unlimited bandwidth, so it has to be carefully managed, just like the highway has to be carefully managed and taken care of.'

The main challenges identified for community members interacting with the technology were the lack of awareness of and comfort with using BVC technologies in communities, low levels of skills training and few community champions, the low level of technical support in many of the remote communities, and difficulties accessing equipment in the communities. To give an example, we found in that although a community centre may have videoconferencing equipment, it may only be available at certain hours that are not convenient for everyone in the community, and it may be difficult to find the key to the room with the equipment.

The main challenges for the production and reception of audio-visual content were the varying levels of time, interest and motivation to produce audio-visual content, the low levels of knowledge about topics of interest to other community members, low levels of knowledge of videoconference etiquette, the lack of visibility of existing audio-visual content in the communities, and concerns about cultural exploitation by sharing video content online.

Finally, the two main challenges for social and organizational relations were the need for program developers and funders of broadband infrastructure to have a community development focus, and the low level of BVC activity by urban organizations. One participant interviewed described the need for a community development focus for funding BVC: 'Because too often in the communities, there's such a small pool of people that are comfortable enough and trained to use the equipment, and if we can support those persons and if we make sure they're compensated, then they're going to take a lot better interest in keeping the equipment and therefore be more willing to use it. So it's not only supporting the community network, but supporting the community people as well.'

## **FUTURE WORK AND TRENDS**

We are confident that social interaction using BVC technologies will continue to increase in both institutional and informal settings. Market research reports predict that videoconferencing will see solid and steady growth over the next five years – 19% growth in North America and 24% for Europe, the Middle East and Africa (Frost & Sullivan, 2008a, 2008b). The use of online video is exploding - predictions of 40% growth per year are common. There is little doubt that the rapidly growing use of these technologies will involve increasing levels of social interaction.

The analytic framework described in this chapter identifies the core categories and sub-categories with variables that enable and constrain social interaction using BVC technologies. Using the framework and exploring these variables in specific situations is the focus of future work. We consider this framework a work in progress and will continue to refine it as our research on BVC technologies continues. Further research needs to be conducted to find ways to encourage the enablers and mitigate or overcome the constraints using practical and innovative social processes and technological solutions.

One of the next steps for us as researchers is to explore and expand our use of participatory research methods for doing this kind of research. We are mindful of the feminist approach of standpoint theory (Harding, 2004) - which suggests that although there are commonalities and differences between different members in a group, there can also be solidarity among diverse group members. Drawing on the assumptions of standpoint theory we value the experiential knowledge and perspectives of the users of the technology. Consequently, much of our research is participatory-action research and involves working closely with authentic user groups and using their knowledge and experience to inform our needs assessments, interventions, and evaluations.

## **CONCLUSION**

The use of broadband visual communication (BVC) technologies for social interaction is increasing rapidly as digital video cameras, webcams on computers, videoconferencing equipment and broadband become more ubiquitous. Analyzing social interactions using BVC technologies is challenging. We created an analytical framework as a reference point for our multidisciplinary research and development team working in this area. We developed our framework initially by reviewing almost a hundred studies of BVC technologies and participatory communication. We further developed and validated our framework by conducting a series of studies of social interaction using BVC technologies in different social and cultural contexts. Our framework is key research tool that guides our work from the development phase through to data analysis and interpretation and presentation of findings. We will continue to strengthen and develop our framework in the coming years through ongoing and new research projects. Our hope is that our analytic framework will be useful for other researchers in this exciting research area.

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## **KEY TERMS & DEFINITIONS**

**Broadband:** In this article broadband refers to both broadband networks and broadband Internet. In general, broadband refers to telecommunication in which a wide band of frequencies is available to transmit information.

**Broadband visual communication (BVC) technologies:** BVC technologies allow simultaneous or pre-recorded exchange of rich visual and audio data over broadband networks.

**Videoconferencing:** Synchronous audio-visual communication using broadband networks.

**Online video sharing:** Posting and viewing asynchronous (pre-recorded) videos over broadband networks.