Video conference platforms: A tool to foster collaboration during inter-organizational *in vivo* simulations

Cecilia LEMUS-MARTINEZ, PhD (c), MSc, Eng.
Institute of Population Health, University of Ottawa
Ottawa, ON, K1N6N5, CANADA

Louise LEMYRE, Ph.D., FRSC
GAP-Santé, School of Psychology, and Institute of Population Health, University of Ottawa
Ottawa, ON, K1N6N5, CANADA

Paul BOUTETTE, MBA., Jo RIDING, Media Developer, David RIDING, Web Programmer, Celine PINSENT, PhD and Colleen JOHNSON, B.A.H.
GAP-Santé research unit, University of Ottawa
Ottawa, ON, K1N6N5, CANADA

ABSTRACT

Inter-organizational problem solving of emergencies and extreme events are complex research fields where scarce experimental data is available. To address this problem, the *Inter-GAP In Vivo System*, was developed to run behavioural experiments of complex crisis. The system design and testing included three categories of participants: for pilot testing, first year university students; for theoretical validity, college students engaged in emergency management programs; and for field validity, expert decision makers who managed major crises. A comparative assessment was performed to select the most suitable video conferencing software commercially available, since it was more cost-efficient to acquire a tool already developed and customized it to the experiment needs than it was to design a new one. Software features analyzed were: ease of use, recording capabilities, format delivery options and security. The *Inter-GAP In Vivo System* setup was implemented on the video conference platform selected. The system performance was evaluated at three levels: technical setup, task design and work flow processes. The actual experimentation showed that the conferencing software is a versatile tool to enhance collaboration between stakeholders from different organizations, due to the audiovisual contact participants can establish, where non verbal cues can be interchanged along the problem solving processes. Potential future system applications include: collaborative and cross – functional training between organizations.

Keywords: Collaboration, simulation, video conference, inter-organizational problem solving.

INTRODUCTION

The study of emergency management is a complex research arena that involves the intersection of many different disciplines. One of its main challenges is the low likelihood of occurrence of emergencies and disasters, plus different uncertainty factors surrounding each one of these events. For this reason, historical retrospective studies involving qualitative approaches such as ethnography (Latiers and Jacques, 2009), phenomenology (Klein et al, 1989), open ended interviews (Hart, 1997), and case studies based on documental evidence (Lemyre, 2009) have been used to understand the many variables involved in the development of an emergency response. These approaches have the advantage of providing a general view of the events. However *aposteri* reports have a lower reliability level, since they lack the precision of an experimental design. Another problem of retrospective approaches, is the challenge to overcome the social desirability bias (Fisher, 1993), where participants tend to portray an enhanced positive image of themselves while accounting their narration. A second approach employed to study emergency management, are field studies. Field studies or field simulations have the advantage to provide data collection *in situ* and in real time. Field simulations also facilitate transitions from planning to practice, to test different organizational capacities (Hart, 1997). However simulations can be extremely complex and costly (Nja & Rake 2009;Latiers & Jacques, 2009). Oftentimes, field simulations are bounded by specific contexts and can easily become very technical (Hart, 1997).

An alternative approach to research emergencies has been the use of laboratory exercises based on computer games and simulations. The challenge, as Rolo and Diaz-Cabrera (2005) explained, is for computer simulations to allow participants to experience *complex and dynamic environments*, under controlled conditions that aim to capture the realistic settings of a field study. Brehmer and Dorner (1993) called these computer simulations "*microworlds"* since they can emulate the realistic conditions needed for research. Three main characteristics of microworlds are described: 1) *opaque*, which means that a micro world must allow researchers to hide from participants as much features and attributes of the simulation as needed. 2) *Complex* to enable participants with novel, uncertain and overlapping activities that challenge their regular professional roles and workloads. And the last characteristic is that micro worlds should be 3) *dynamic*, allowing participants to experience the accelerated step of real emergencies. These features aim participants can have lively experiences and therefore the reactions and behaviours observed resemble real ones. Computer simulation games have also be named as *role playing games* (Woltjer et al, 2006), where several stake holders participate and problems must be solved in a collaborative manner.

However, one main shortcoming of computer simulations is that participants have been university students (Pearsall et al, 2010)(Homan et al, 2007) who lack the level of professional background and knowledge needed to manage real emergencies. Another limitation according to Nja and Rake (2009), is that laboratory based approaches under controlled conditions will not encompass as much characteristics of a real emergency, nor of field simulations. Despite these shortcomings, interesting results have been found under laboratory controlled conditions (Pearsall et al, 2010;Homan et al, 2007), which can potentially inform field simulation studies based on the laboratory settings.

One of these computer simulations was a training system developed by Alison and Crego (2008) called HYDRA. This system was created to train the police in England. However the design of the system was aimed to target only the security forces. For this reason in 2010 Lemyre et al, developed the *Inter-GAP In Vivo System*, which purpose was to run behavioural computer simulations that look at inter organizational problem solving, expanding from previous work (Alison and Crego, 2008) that had focused on the intra organizational level only.

During an *Inter-GAP simulation system* session, participants are assigned to groups of participants, called "*pods*". Each pod is equipped with a computer and communication equipment. Teams work along a simulated emergency event while all their interactions are recorded to be further analysed. The simulation stream is delivered from a separate control room using video conferencing software, with the simulation, tasks and injects rendered following a set script. Each session is initiated with a briefing session where participants are oriented on the materials to be used and the technology available for the experiment, as well as to acquire an informed consent from each participant.

Rationale to use video conferencing software

The experimental design had two main requirements: First, simulated data should be delivered simultaneously to each pod; and second, text, audio and video outcomes should be recorded. This last feature was of vital importance for the experiment given the large amount of data that was needed to be collected in order to perform later analyses.

The commercial video conferencing software was able to provide a suitable solution to meet the experimental requirements. Many advantages were found in commercially available software, such as offering a robust study environment, given that simulation sessions have to be delivered not only locally but also to remote locations. The commercial software also provided the seek feature of storing data outcomes in different formats such as text, audio and video, which was essential for the experiment data collection. Another related significant feature is that video streaming itself, allowed participants to hold fluid "*face to face"* interactions and communications with each other. Therefore non verbal communications through visual cues were possible.

Another relevant feature of commercially available conferencing software is that it represents a readily available cost-efficient alternative. Due to the fact that the experiment was run over a limited budget, and holding strict delivery timelines, it was not possible to develop a full system to then run the experiment based on it. On the other hand, an available feature of the software, not yet fully exploited is the capability of deploying simulations to remote geographical locations. The following sections explain how the software selection was developed, the system tested, then results are discussed pointing out implications for future research.

METHODS

Software selection process

Different video conferencing software providers were considered to be used in the experiment: Nefsis™, GoToMeeting™, NetMeeting™, Adobe Connect™, DimDim™ and WebEx™. Overlaps in the features offered by the suppliers were found. However after the assessment, Nefsis™ was the software that best fitted the experimental requirements. Features assessed were:

- Ease of use for participants
- Recording of meeting sessions
- Recording of chat messaging
- Security
- Delivery of information in multiple formats
- Smooth delivery of audio/video files

In terms of easiness of use, most of the applications assessed have a friendly environment that allows users to intuitively navigate along the different software's tools.

Although many platforms offered to record the video conference sessions, Nefsis™ allowed recording them in a commercial video format (.avi). While many of the other providers offer to record sessions in their own proprietary formats, which could only be played afterwards using also proprietary applications.

In terms of chat availability, most firms offered this feature. When assessed, GoToMeeting™ and Nefsis™, offered simple solutions. Nefsis™ allows users to save each chat enabled as a text (.rtf) file which was considered as a powerful solution for research analysis.

In terms of security, the experiment required each session to be kept securely. For this reason software were evaluated on this feature. Nefsis™ offered user access control through virtual private networks deployed for each session to be held. Additionally the software allowed researchers to control the "*opacity"* of the simulation by enabling control of the simulation injects, by individual pod.

Most of the video conferencing software evaluated, allowed the delivery of simulation injects in multiple formats, such as documents, power point presentations, audio and video files, hand writing and drawing; as well as desktop, applications and, web browsers sharing.

For the purpose of the deployment of the experiment simulation we aimed for good management of long pauses and poor transitions. The challenge was to avoid these kinds of distractions while rendering good media files to the participants. Nefsis™ allowed smooth data streaming; at the time of the system design, it was the only software that worked with cloud computing to deploy the video conference simulation. Box 1 summarizes the software features assessed:

Box 1. Features assessed

- Ease of use for participants
- Recording of meeting sessions
- Text recording
- Security
- Delivery of information in multiple formats
- Smooth delivery of audio/video files

Equipment and facilities requirements and set-up

The basic equipment and facilities needed to operate the video conference software for the experimental design are shown in Table 1. Each POD room was equipped with a desktop computer and a dedicated broadband internet connection, a duet microphone / speaker, and a webcam placed at an angle that would capture the image from all the pods participants. The control of the simulation was delivered from a different room equipped with a desktop computer, a broadband internet connection, and a microphone / headset headphone. Nefsis™ licenses allowed up to 16 different computers to be connected to each session.

Table 1. Video conference equipment

Quantity	Item	Features
3	POD rooms	Rooms in close proximity to each other to assist in troubleshooting
1	Control room	
3	Web camera	Logitech™ Web cam C260
3	USB Conferencing mics/speakers	Phoenix™ PCS duet conference phone
10	Computers	Any brand of PC
1	Microphone/ headphone headset	Logitech™ USB Headset H360
16	Licences internet web conferencing	NEFSIS™ web conferencing

System performance evaluation

Technical evaluations were performed over the system, and its experimental set-up. The goal of these tests was to guarantee the appropriate functioning and system layout. System resilience was tested by rehearsing under "real" simulation conditions. These tests also included simulation deployment and reception from remote locations. The system design and testing included three different categories of participants: for pilot testing, first year university students; for theoretical validity, college students engaged in emergency management programs; and for field validity expert, decision makers who had managed major crises in their career.

Pilot testing with participants allowed researchers to update system settings to improve the overall simulation content, workflow, processes, and system performance. The original system set up was designed for 18 laptops, one per participant, and for each researcher involved in the experiment run-through, participating either as technical staff or as experiment observers. This first system set up was intended to run remotely. However, at this stage of the system performance evaluation, it was noticed that technical staff should also need to be deployed to each remote location to comply with all the experiment requirements, and data collection. Additionally it was noticed that the deployment of the simulation was dependant on the infrastructure available at the delivery point. For this reason, it was decided to run the experiment at the University of Ottawa facilities only.

During the pilot testing with university student volunteers, simultaneous visualization of nine webcams on each monitor saturated the screen, and it took participant's attention away from the core experimental tasks. Moreover, the only way to connect simultaneously 18 laptops to the internet was through a wireless connection. Given the local wireless infrastructure, the deployment of the simulation presented delays, interference, glitches and echo between computers. For these reasons it was decided to group three participants per computer, to ensure a broadband internet connection and accurate system performance.

In terms of audio and video quality during pilot testing, the webcams proved to be a reliable source for video. However the sound transmitted from the integrated web camera microphone was poor. For this reason usb conferencing speaker / microphones were integrated into the system. These devices have the advantage of cancelling echoes and background noise, while allowing a clear audio transmission.

Participants for system evaluation

University volunteer students were required for the pilot testing sessions. At this level, participants provided valuable feedback in terms of simulation content, workflow processes, as well as perceived easiness of use, technical set-up, and overall system layout. The next level of assessment included junior level career professionals and students related with emergency management programs, military and non governmental organizations. During these sessions the objective was to refine the experiment instruments, simulation materials and provided cues for further analysis. The third evaluation level included senior managers, feedback from this session help to refine simulation's task design, to test work flow processes and overall technical system setup. At all levels, participation in the study was voluntary and consent was obtained from each participant as per ethics requirements.

RESULTS

A total of fourteen *in vivo* sessions have been deployed. They have included participation of senior decision makers, early career professionals and university student participants (to pilot). In terms of system performance, workflow process and task design, the number of challenges to be overcome decreased notably from one session to the next one. Technical and process improvements were immediately incorporated as opportunities arose. The end product was an appealing, efficiently delivered simulation exercise that reflected high professional standards (according to feedback received from senior officers participating).

The experience of using video conferencing software for research purposes brought forth valuable learning insights. On the minus side, one has to mention that the deployment and reception of the study simulation was dependant of the local physical infrastructure. And if not appropriate, the quality of the simulation was not at its full extend. Specifically, an important element of the technical infrastructure is the networking bandwidth available for the deployment of the simulation. Another limitation is the number of participants with individual webcams per session, limited to no more than eight for proper visualization. The loading of the video conferencing software at each computer implied the installation of additional plug-ins and login access requirements, which were not intuitive for end users who are not familiar with the video conferencing software.

Another important constraint while controlling the workflow for the experiment simulation was to control the individual audio settings for both experiment participants and research observers. This posed a challenge, given that these kind of software are design to broadcast simultaneously the same information to all video conference participants. However, the experiment required to hide and control simulation elements for participants at given periods, which pose an enormous challenge to provide a flawless and smooth flow of the experiment simulation.

A last limitation experienced, is the time available to use the video conferencing software, bound to the license period purchased. Box 2 summarizes the limitations experienced using video conferencing software for research purposes.

Box 2. Experienced video conferencing software limitations

- Dependent on local physical infrastructure
- Bandwidth dependent
- Limited number of participants per meeting
- Limited to license duration to use software
- Technical challenges for end users to install the application
- Challenging to control audio settings to follow experiment requirements

On the other hand, the benefits offered by the video conferencing software surpassed the limitations to be overcome. One of these benefits was the accurate work flow control offered by the many video and audio controls, which allow group and individual adjustments. Another relevant feature is the users' access control, which is managed by granting administrative session permissions to each participant. These permissions are not only for access, but also extended to resource sharing of the multiple data formats available to be shared: audio injects, video streaming, whiteboard sharing, power point presentations, desktop sharing, and internet browser sharing.

Another benefit provided by the video conferencing software was the smooth delivery of video and audio streaming. The modularity of the software allowed controlling the video and audio quality which had a direct impact on the simulation delivery performance. In order to provide participants a high quality immersive experience, all the video conference software settings were setup to the maximum. An additional benefit the video conference software offered, were the multiple options for data collection. For experimental purposes, video and text were the formats chosen to be kept for further analysis. The formats chosen to store the data were .avi for video, and .rtf for text.

In terms of experimental results, the preliminary observational outcomes pointed out the fact that there was an increased group interaction when the video conference option was open for senior managers, enabling them with "face to face" communication. However text was the preferred option for university students. Meanwhile, the junior level career professional used both options, text and video-conference, to interact with each other.

Nevertheless, when the video conference option was used by participants, behavioural cues others than explicit verbal communications were used, and visual contact facilitated these interactions. Box 3 summarizes the benefits of using conferencing software for research purposes.

Box 3. Experienced benefits offered by video conference software for behavioural research purposes

- Simulation work flow control
- User access control
- Control of resource sharing
- Smooth video / audio streaming
- Data collection: Audio + video + text
- Facilitates communication between pods
  - Visual contact
  - Behavioral cues
- More group interaction between pods when video conference option was available, for senior managers and junior level professionals
- Text option was poorly used by senior managers and junior level professionals

DISCUSSION

After assessing the benefits and limitations offered by the video conferencing software to run *in vivo* simulations, we found it is a very useful tool for behavioral research purposes. In these terms, it proved to be a cost efficient tool. given tat the research benefits obtained by using commercial software surpassed the investment made to acquire the software license, and the technical limitations of the system. Potentially, video conference software may offer solutions to overcome geographical and environmental challenges. Additionally video conference platforms may assist in fostering collaboration by enabling resources and information sharing. And the most salient feature, in our experience, was that it enabled a virtual “face to face” communication. In terms of future research, video conference software is a potential platform to develop training programs. Given that they provide the necessary conditions to layout modular and flexible training and research designs.

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REFERENCES

[1] Lemyre, L**.,** Boutette, P, Pinsent, C., Corneil, W., Riding, J., Riding, D., Johnson, C., Markon, M.-P.L., Gibson, S., Lemus, C., Blust, S., Kitchener, H. (2010). Research Using In Vivo Simulation of Meta-Organizational Shared Decision Making (SDM): *Task 2: Development of an experimental plan for in vivo exercise and simulation*. Report for Defence Research and Development Canada Published Report DRDC CSS CR 2010-07

[2] Alison, L. & Crego, J. (2008). *Policing critical incidents: Leadership and critical incident management*. Portland, OR: Willan Publishing.

[3] Latiers, M., & Jacques, J. (2009). Emergency and crisis exercises: Methodology for understanding safety dimensions. *International Journal of Emergency Management*, *6*(1), 73-84.

[4] Klein, G. A., Calderwood, R. & MacGregor, D. (1989). Critical Decision Method for eliciting knowledge, *IEEE Transactions on Systems, Man and Cybernetics*, 19, 462 -472

[5] Hart, P. (1997). Preparing policy makers for crisis management: The role of simulations. *J. Contingencies Crisis Management, 5*(4), 207-215.

[6] Lemyre, L**.,** Boutette, P, Pinsent, C., Corneil, W., Johnson, C., Munoz, M., Lemieux, V., Markon, M.-P.L., Gibson, S., Riding, J., Lemus, C., Blust, S., Dennie-Filion, E. (2009). Research Using In Vivo Simulation of Meta-Organizational Shared Decision Making (SDM): *Task 1: Synthesis of Case Studies to form a SDM framework.* Report for Defence Research and Development CanadaPublished Report DRDC CSS CR 2010-04.

[7] Fisher, R. (1993). Social Desirability bias and the validity of indirect questioning. *The Journal of Consumer Research, 20(2), 303-315.*

[8] Nja, Ove; & Rake, E. (2009). An essay on research methodology: An alternative approach to incident command research through participatory action research. *International Journal of Emergency Management, 6*(1), 55-72.

[9] Rolo, G., & Díaz-cabrera, D. (2005). Decision-making processes evaluation using two methodologies: Field and simulation techniques. *Theoretical Issues in Ergonomics Science*, *6*(1), 35-48.

[10] Brehmer, B., & Dorner, D. (1993). Experiments with computer-simulated microworlds escaping both the narrow straits of the laboratory and the deep blue sea of the field study. *Computers in Human Behavior, 9*(171), 184.

[11] Woljer, R., Trnka, J., Lundberg, J., & Bjorn, J. (2006). Role-playing exercises to strengthen the resilience of command and control systems. *Proceedings of the 13th European Cnference on Cognitive Ergonomics Trust and Control in Complex Socio Technical Systems, Session: Socio Technical and Systems Design*, 71-78.

[12] Pearsall MJ, Christian MS, Ellis AP. (2010). Motivating interdependent teams: Individual rewards, shared rewards, or something in between? *Journal of Applied Psychology, 95*(1), 183-91.

[13] Homan, A. C., van Knippenberg, D., Van Kleef, G. A., & De Dreu, Carsten K. W. (Sep 2007). Bridging faultlines by valuing diversity: Diversity beliefs, information elaboration, and performance in diverse work groups. *Journal of Applied Psychology, 92*(5), 1189-1199.