Posture Platform and *The Drawing Room*: Virtual Teleportation in Cyberspace

Luc Courchesne, Emmanuel Durand, Bruno Roy

Luc Courchesne
Society for Arts and Technology
luc@courchel.net

Emmanuel Durand
Society for Arts and Technology
emmanueldurand@gmail.com

Bruno Roy
Society for Arts and Technology
bruno.o.roy@gmail.com

ABSTRACT

Three-hundred-sixty-degree audio/visual immersion and the restoration of non-verbal communication cues are essential features for interfaces inviting the human body in cyberspace. The Posture Platform is a network of bases that offers access to a shared virtual environment. Each base is composed of an immersive 360-degree visual display, a surround-sound system, an array of image capture devices, a microphone, an omnidirectional controller/pointer, and a computer with wifi and an internet connection. *The Drawing Room* is the most recent virtual space developed for the platform. It invites participants to a blank shared space where they draw their own environment collaboratively. The platform, and the project it hosts, is an example of the art, design, and engineering challenges and opportunities associated with development of inhabitable cyberspace.

Introduction

One of the most significant results of the development of computers and networks since the mid-20th century has been a deep transformation of the concept of space: with nearly instant data transmission on Earth, practical physical space is contracting, while tools designed to model and form new terrains of experience are expanding virtual space. These contracted and expanded spaces now merge to create opportunities and challenges for humans to rethink and redesign their position and role in the complex system of interconnections that is giving form and substance to a new "nature." In light of the ongoing development and expanding influence of computer networks and systems, one question remains central: How is the human body invited to participate?

From early CRTs to the contemporary LCD and OLED screens of our computers and intelligent portable devices, digital and electronic media have mostly materialized within the frame of computer displays. *Exploding that frame* is one of the first tasks required to include the sensory body. Video projectors and mapping techniques have expanded the displays into visually immersive information spaces. Handheld screens and head-mounted displays equipped with geo-localizers, motion trackers, and orientation sensors have started to reveal layers of data in the environment all around us. After a century (20th) of media dominated by the framed cinematic experience, this is an interesting re-enactment of the idea, born at the end of the 18th century (De Saussure and Barker) and popularized through the 19th century, of placing the observer at the center of an artificial visual field for an embodied experience of space [1]. There is more to it though than simple sensory immersion. By consciously positioning the observer at the center of the visual representation (Figure 1, left), 18th- and 19th-century visionaries designed the nest of the modern human being: immersed, involved, in command, and responsible [2].

For social animals such as humans, these sensory immersive spaces that invite more of the body to participate would be very lonely if they were visited only one at a time. To qualify as "terrains of apparition" [3], where the complex set of strategies in play when we meet in physical space are represented, we must be able to join others in a manner that includes all the mechanisms of

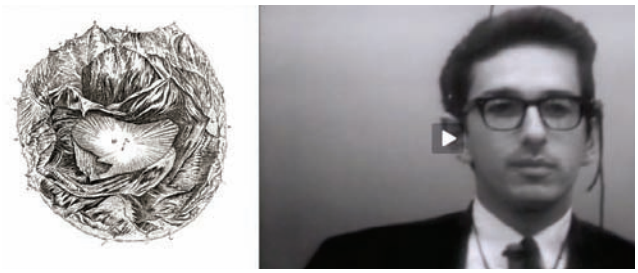
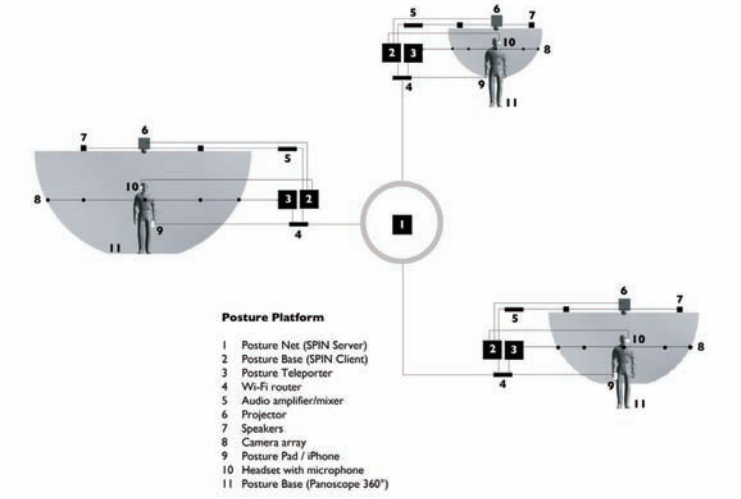


Figure 1. Left: "Circular View of the Mountains as Seen from the Summit of the Buet Glacier." De Saussure/Bourrit, 1776. Right: Jeff Rulifson as he appeared onscreen during Doug Engelbart's 1968 demo. Photo courtesy of Special Collections of Stanford University.

non-verbal communication. If Engelbart's demo of video conferencing in 1968 convinced everybody of the potential of distant face-to-face conversation (Figure 1, right), essential non-verbal communication cues such as eye contact, posturing, and positioning have until now remained beyond the means of most available technologies. The restoration of eye contact, body posturing, dynamic spatial positioning [4], and other forms of non-verbal communication remains essential to an experience of presence for the whole body [5].

The aim to create an immersive telepresence installation that invites encounters in a shared virtual environment where non-verbal communication is restored led to the development of the Posture Platform and to its latest incarnation as a *Drawing Room* inviting visitors' collaboration in the construction of a shared terrain of experience.



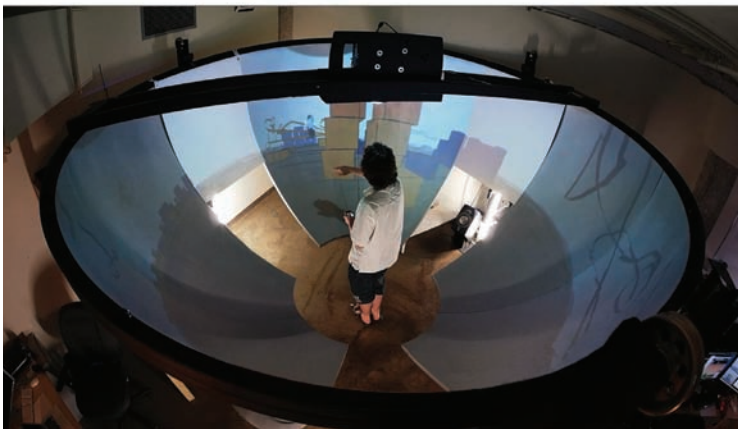


Figure 2. Top: Posture Platform diagram. Bottom: Posture base using Courchesne's Panoscope. © 2010 Luc Courchesne. Photo © 2013 Luc Courchesne.

The Posture Platform

The Posture Platform combines a series of developments at Montréal's Society for Arts and Technology (SAT) made over the last 15 years. An early public experiment in telepresence in the fall of 1999 demonstrated the artistic and social interest in staging virtual encounters in a more engaging way. Courchesne in particular was interested in exploring live encounters after his work with pre-programmed interactive video characters, which began in 1990. In parallel, following his four-channel panoramic interactive installation *Landscape One* (1997), he embarked on a project to develop a single-channel immersive display, the *Panoscope* (Figure 2, bottom), which premiered at SIGGRAPH 2000 in New Orleans. The idea of adapting the device for immersive telepresence

formed shortly after. First formulated in the project *Where Are You?* (2005), it passed through a series of developments to evolve the concept for a distributed network of connected bases working as "phone booths" in the old telephone system to give access to a shared virtual space (Figure 2, top).

The Posture Platform is a network of bases connected through the internet to an online server and asset manager. These bases offer access to a shared virtual environment, selected from a bank of options, which is constantly and simultaneously updated whenever a user- or system-induced change occurs. Each base is composed of an immersive screen that displays the entire 360-degree horizon, a surround-sound system, an array of image capture devices, a microphone, an omnidirectional controller/pointer, and a computer with wifi and an internet connection.

The software running the Posture Platform includes SPIN, a collaborative network architecture composed of a real-time renderer (SPIN Viewer) and an asset integrator/manager (SPIN Server); SCENIC, data-transmission software that manages the traffic and connections between the bases; and Posture Vision, a capture system and method to generate a photorealistic real-time 3D rendering of live participants [6].

Lastly, the selectable and shared virtual spaces must be generated or designed, constructed, and distributed over the network. As in online game design, the tools and processes vary depending on the desired aesthetics and functionalities. Standard 3D modeling and animation tools can be used for asset creation, which are then assembled in SPIN as nodes with definable properties. The SPIN server simultaneously shares all the property changes over the network, thus ensuring perfect synchronicity of events and transformations in a given world.

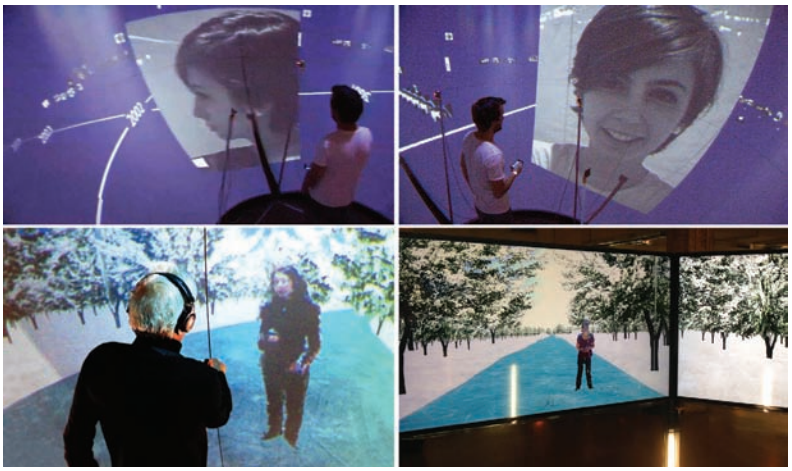


Figure 3. Top: Posture Platform, first iteration (array of DC cameras). Bottom: Posture Platform, second iteration (three point-cloud capture devices). © 2010 Luc Courchesne. Photos © 2011 Luc Courchesne.

Development of the Posture Platform telepresence technology is now in its third iteration. A first iteration used an array of four to eight DC cameras to capture and transmit each participant's video representation from many horizontal points of view. In a much simpler approach than the 3D reconstruction from 15 RGB cameras used by Prince et al. [7], characters were moved around by simply switching to different camera views that matched the viewer's position in relation to the observed character (Figure 3, top row).

A second iteration used three point-cloud capture devices (Kinect/PrimeSense) placed equidistantly around each participant to produce live, full-3D representation of a participant's body, positioned and keyed dynamically in the shared virtual space. This approach increased the perception of shared presence and lent to longer and more engaging conversations and spatial plays between participants (Figure 3, bottom row).

A third iteration, akin to the work of Dimitrios, Dimitrios and Petros [8], refines and adds resolution to the keyed 3D rendering of participants while reducing the bandwidth needed to transmit their presence across the network. This is achieved with the same capture devices by mapping the acquired RGB video onto a mesh extracted from the point-cloud data. For example, using a mesh with only 20k vertices and a texture that uses the whole resolution from the input camera retains the same amount of details (especially for the face) as the 160k color point-cloud, while reducing the frame size from 2.56MB to 0.4MB for the uncompressed geometry and the texture, which can also be highly compressed through well-known file formats.

The Drawing Room

The concept for *The Drawing Room* evolved from a workshop at the Society for Arts and Technology (SAT) in November 2012 with artists and developers from Montréal and Liverpool. It started with an overview of the technologies at hand and was followed by a discussion of the SAT lab's ambition to treat virtual environments as living systems whose fragile balance can be tripped one way or another by participants' actions. The idea of inviting participants into a blank space, where they could construct their own context, quickly gained traction:

- It was unpredictable.
- It explored a form of participatory art by giving visitors full responsibility over the formal and symbolic space of encounter.
- The possibility of leaving traces and making a territory would appeal to the younger audiences we were aiming for.
- The decision-making process would certainly fuel interaction between live (synchronous) participants in the brief daily contact hours allowed by the time difference.
- It would also work asynchronously when participants explored and added to the space on their own.
- Such a visually-driven experience would ease the cultural and language differences between Montréal and Liverpool.

Figure 4. At work in *The Drawing Room*. Photo © 2013 Emmanuel Durand.

Drawing was the simplest and most direct way to let participants alter the space around them. To make the process intuitive, the participants drew with their bare hands. Each participant (location) had its own color, and the lines appeared simultaneously to the drawer and to other remote participants. A proof-of-concept for *The Drawing Room* was quickly prototyped. It used the same three Kinect/PrimeSense devices used to record participants' hand movements as they created the lines. Cube generation and positioning planes in the virtual space were added along the way (Figure 4).

The current version of *The Drawing Room* networked installation uses six large LCD monitors (Figure 5) to create a high-resolution cylindrical panorama in each location [9]. After entering the installation with a smartphone displaying *The Drawing Room* web application, the participant swipes left or right to select the navigation screen (Figure 6, center) and explores the space before deciding on a position to start drawing. Swiping right to the tool screen, the

participant then selects between the drawing or cube-generating tools (Figure 6, right). If the pencil is selected, pointing with one hand while touching the button on the screen begins a line that develops with the hand movement in space; if the cube is selected, pointing with one hand while touching the button creates a cube that drops until it settles on the ground or on another cube. Returning to the navigation screen at any time lets the participant move in and around the objects and lines that were created. In the virtual presence of other participants, the drawings and cube assemblies are visible to all in real time. Swiping left to the "mirror" screen, participants can adjust their own image (point-cloud) orientations to ensure correct positioning for face-to-face encounters (Figure 6, left).

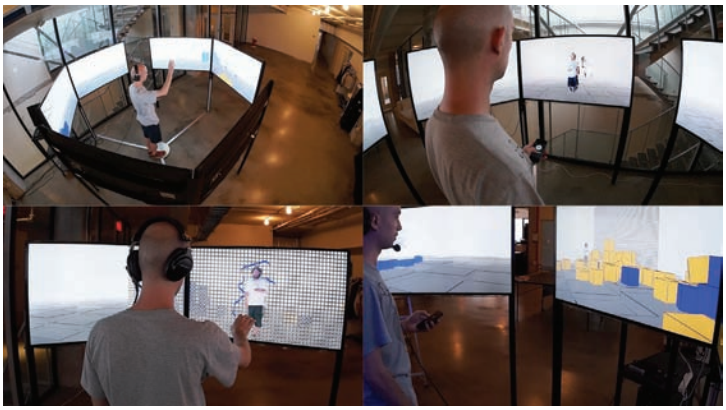


Figure 5. Posture base featuring *The Drawing Room* at SAT. © 2013 Luc Courchesne.

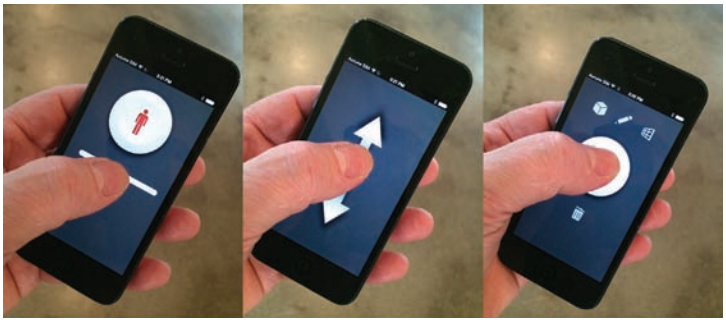


Figure 6. Smartphone web application. Left swipe: Tool for point-cloud self-calibration. Center: Navigation tools. Right swipe: Tool selection and activation. © 2013 Luc Courchesne.

Participants find comfort in using their own devices to interact within the Posture Platform and *The Drawing Room*. The interface accommodates either iPhone or Android smartphones, or any device equipped with an accelerometer, a compass and a gyroscope—required to turn the phones into omnidirectional pointers. The device simply displays data from a web application and uses wifi to transmit to the SPIN server on the network.

The soundscape is designed to characterize the actions of drawing (spray can) or the sounds of the generated cubes hitting and bouncing on other objects. The forms created also generate harmonies that resonate for some time. Some participants' conversations are also sampled and replayed randomly at times as traces (echoes) from previous visits.

Participants wear wireless microphones to engage in conversation with other participants in their virtual proximity. Because participants' physical positions within the posture bases are consistent with the positions of their virtual representations in the shared space, they see and engage with one another exactly as they would if they were in physical space. Eye contact is thus possible as well as other essential non-verbal communication cues such as gesturing, posturing, and positioning.

This iteration of the Posture Platform (using point-cloud capture) was first deployed between Montréal's SAT and Liverpool's FACT in September 2013. To make the best of the short window of live time every day (10:00–13:00 in Montréal and 15:00–17:00 in Liverpool), we invited groups of college and university students in media art and design to enter *The Drawing Room*.

Observing participants in both locations showed that most of our initial assumptions were correct. Communicating the concept to participants was quite easy and facilitated by mutual observation. The tools felt natural to both local and remote participants. Although the imprecision of the drawing tools at the time was identified by many as a problem, it nevertheless triggered interesting conversations and fun games. One of them was trying to guess what the other had drawn or meant, which helped dissolve the observed shyness among young adults from different backgrounds and cultures.

With the available bandwidth between SAT and FACT (10 mbps) handling bidirectional sound, point-cloud data, and all the traffic generated by constant real-time updates of the shared virtual environment, the resolution of participants' renderings had to be reduced to a point where facial expressions became hard to read [10]. Despite this, the participants' renderings conveyed enough information to maintain essential body language such as gaze, gesture, posture, and position and to demonstrate the potential of the approach.

Besides improving resolution and reducing data flow, the new meshing and mapping approaches for the participants' capture, transmission, and keying make the Posture Platform and *The Drawing Room* easier to deploy. They also help meet the requirements for facial recognition, eye contact, posturing, positioning, and all other essential components of body language and forms of non-verbal communication. Work on Quality of Service (QoS) will further help scale the network architecture [11] to invite more participation in a shared immersive telepresence experience. This is where the concept of virtual teleportation (virtual presence in shared, immersive, virtual environments) becomes practical.

Virtual Teleportation

There are many other examples of shared virtual environments where participants can create, meet, and collaborate (in the popular realm, virtual environments such as World of Warcraft or Second Life, for example). Projected immersive virtual environments such as the cubic CAVE [12] or the cylindrical and spherical theaters by Jeffrey Shaw [13], JoAnn Kuchera [14], and now many others [15], to which may be added networking and telepresence features, are also candidates. The major differences between these and the proposed paradigm in the Posture Platform (and its incarnation as *The Drawing Room*) are, first, the replacement of avatars by real-time photorealistic representations of participants and, second, easily replicable devices (bases) that afford reciprocal sensory immersion. Participants are able to enter these shared virtual spaces as they are, and behave as they do in physical space. The restoration of most of the usual cues and strategies in relation to space (with immersion, navigation, and control) and to interpersonal communication (with eye contact, posturing, and positioning) considerably reduces the gap between the experience of physical and virtual spaces. The experience of being recorded, transmitted, and keyed into these shared worlds thus qualifies as a form of teleportation. Not quite the transmission and remapping of atoms from one physical location to another, but certainly a form of virtual teleportation enabling someone to suddenly show up and disappear simply by walking in and out of a device that acts both as a recorder of individual presence and a display of the collective occupation of a given space.

The recognized value of telepresence is to facilitate human interaction and remote operation without the absolute necessity of physical travel. Enhancing telepresence with sensory immersion and virtual teleportation will only add to the benefits and facilitate its attraction to human participants. The environmental and lifestyle benefits of enhanced telepresence are immense in an economy that has become global and where ways of redrawing socio-political maps have little to do with physical territory anymore. If humans can meet spontaneously to learn, play, and

collaborate with the same ease as they do in their immediate physical neighborhoods, the virtual neighborhoods [16] (synchronous in the same time zone, and increasingly asynchronous as connections stretch farther east and west) will truly develop into alternatives, or in complementarity, to physical ones offering an embodied experience.

An Open Call to Artists

To survive our current environmental challenges, individuals and societies must balance the use of natural resources for energy and supplies with the need for progress and growth. The development of technologies that invite the sensory body and conscious mind into a unified, practical, and inspired physical/virtual "space" will open a host of opportunities. Among these, construction of an inhabitable cyberspace, and design of experiences within it, represents a formidable enterprise that will engage human societies in new ways and promises to keep artists, designers, architects, engineers, sociologists, anthropologists, and philosophers busy for generations to come.

As it progresses, the development of computing, networks, and interfaces gives form and substance to the concept of ambient intelligence where a new symbiosis incorporates humans and machines in an intricate web of interconnections. In this technologically enriched "terrain of apparition," it is interesting to observe how the old questions about life, death, love, and beauty are addressed and formalized by artists and others.

Acknowledgements

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References and Notes

1. De Saussure's instructions to Bourrit in 1776: "I instructed the draftsman to start by tracing a large circle on paper which he would call the horizontal circle; he would then place on this circle all the visible points that are at eye level; he will finally draw outside of this circle everything he sees above the horizon and within, everything he sees below. I wanted each object above and below the horizontal circle to be positioned at a distance proportional to the corresponding angle of elevation or depression." De Saussure, Horace-Bénédict, *Voyages dans les Alpes* (Neuchatel: Samuel Fauche, 1779), 496.
2. Seventeenth- and eighteenth-century philosophers (Leibniz, Hume, De Condillac, Rousseau, Goethe) introduced modern ideas on systems, sensualism, education, citizenship, participative governance, and democracy. Doing so, they invented the "sensitive subject," whose perception of reality went beyond the mere observation of natural phenomena to account for human feelings. Their insights filtered and brewed through generations until today's immersive, interactive, and networked technologies, participatory cultures, and social media.
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5. Barthes, Roland, and Frédéric Berthet, "Présentation," in *Communications no. 30* (Paris: École des Hautes Études en Sciences Sociales/Seuil, 1979), 141. The importance of gaze in shared virtual environments is also well described by Jeremy N. Bailenson et al. in "Gaze and Task Performance in Shared Virtual Environments," *Journal of Visual Computer Animation* Vol. 13, No. 5, 313–320 (2002).
6. The SPIN Framework, SCENIC, and Posture Vision are developed in open source at the Metalab, the research department of Montréal's Society for Arts and Technology (SAT), <www.sat.qc.ca>.
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9. Although less visually immersive than the hemispherical screens typically used, the panoramic display created with six large LCD monitors for the Montréal-Liverpool connection worked in creating a context for interaction and collaboration.
10. Asset management over the network is essential to the unified experience of the Posture Platform and its materialization in *The Drawing Room*. To make for a shared real-time experience, every change each participant makes in the virtual environment, including movements and creation of lines or cubes, and the sounds associated with voices or objects, must be instantly distributed to others in real time. All local or remote changes and alterations are thus managed online by the SPIN server.
11. Arefin, Ahsan, Raoul Rivas, and Klara Nahrstedt, "Prioritized Evolutionary Optimization in Open Session Management for 3D Tele-immersion," *Proceedings of the MMSys* (Oslo: February 26–March 1, 2013).
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