

5. QUALITÉ DU PROGRAMME DE RECHERCHE-CRÉATION

Concept:

This project calls for the creation of audiovisual works that operate in a combined physical and spatially modeled audiovisual space, where boundaries between spectator and performer diminish, and limits in the creation and experience of audiovisual works extend. We refer to these kind of works as "Volumetric Audiovisual Art". Specifically, these are works which: 1) consist of 3D modeled audiovisual content; 2) are presented via audio and graphic display devices that form an audiovisual representation of the work in three physical dimensions (as opposed to the planar image of traditional screens that simulate depth); 3) are conceived for, and operate in, real 3D space, encompassing (bridging) both the three-dimensional modeled audiovisual content and the real volumetric physical display arrangement--both have common geometry (*see CD-ROM figure: "volume display"*). As with sculpture or architecture, works are created to be experienced in real spaces from multiple points of view; and form/structure and content are merged in space. An example of this kind of work, "Beauty and Abandon" (*see CD-ROM "Beauté et Abandon"*), employs the flow of sounds and images across a ribbon like audiodisplay, which consists of a series of adjacent projection screens arranged in a line.

In such "augmented" spaces, the projected image on screens serves as a "window" into some larger volumetric scenscape where audiovisual objects, audible at any location, may be seen as well. In this scenscape, complex interplay among the elements of a videomusic composition can be rendered tangible and direct. Concepts of music in space can be revisited, where streams of composed music can intermingle in the manner of the parade music that Charles Ives spoke of. The pervasive nature of the audiovisual content, scattered about in several directions, on multiple displays in the physical space, lends particularly well to dramatic forms, such as opera, dance or music theatre, where, the rendering and use of the performance space is germane to the work. In such spaces, performers can be immersed in an audiovisual scenscape; musical elements "flowing by" can be displayed in audio and image. This potentially includes the libretto text, voice signal processing units that electronically modify the sound of the singer's voice, and dynamic volumetric images, which accompany the music. Most important, our approach to creating art in the way we propose can stimulate the composer's imagination, and allow for the discovery of radically different approaches to experiencing and creating works for music with image. The ultimate artistic goal of this project is to discover and realize new kinds of works for performance, composition, and musical play.

Context:

Professor Piché and artist Settel are established artists who have collaborated on several music and software development projects in the past. They have been involved in audiovisual creation and computer-based audiovisual engineering for a number of years. While Piché has developed an important repertory of works exploring electroacoustic music linked to abstracted moving images on multiple displays, Settel has concentrated his research and creation efforts on establishing a viable platform for 3D audio displays. They are both principal researchers in the Laboratoire Art&D project which received major CFI funding last year. This project is motivated by the combined interests of the applicants and is situated at a timely point in their respective work, thus a high degree of synergy is implicit. Their association in this project is natural and they have been planning to collaborate on this project for a few years.

Demonstration of the originality of the research-creation program:

Our work proposes novel and important advances for the techniques, creation and experience of volumetric electronic audiovisual art. We propose the creation of volumetric audiovisual artworks (electronic 3D content) which operate, and are experienced, in real physical spaces (e.g. similar to holography). We employ volumetric display techniques using multiple coordinated audiovisual displays, arbitrarily arranged (planar or

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not) the physical volume of the performance space. These displays serve as an artistically structural element, spatially integrated with the 3D content they render, and encompassed by the artwork's concept or logic (*see CD-ROM figures: "volume", "tiled" and "ribbon" displays*). The displays may be scattered among the users and perspective, singular or multiple, may be manipulated dynamically, ranging from: singular (coherent across all displays) to multiple (display independent), or some combination of the two. In configurations where only one perspective is used, the "sweet spot" (the location in the real space for which the given "coherent" display perspective is rendered) may be dynamically relocated in the viewing/listening space: users in one location of the space will encounter a coherent representation of the content, while others, elsewhere, will encounter a deconstructed. And then at another moment, the opposite (*see CD-ROM figure "anamorphosis"*).

Several well-known artists video, such as Gary Hill, David Hall, Bill Viola, Emil Radok, Michael Naimark, Nam June Paik etc., have worked with multiple displays in the past; and their works have made use of displays in structural ways, endemic to each work. During the past 10 years, a number of cinema artists and new media such as Char Davies and Jeffrey Shaw, have created works with 3D visual content using one-perspective, surrounding graphics displays, e.g.: "Cave", IMAX, "Panoscope" style systems; their works have used graphic perspective rendering for essentially a "wider" but "transparent" display (all the way to 360 spheres). Building on the work of others above, our work integrates the "display" as an artistically structural and formal element; and our visual content is modeled in three dimensions, using potentially "wide" displays. Unlike previous work, our work: 1) incorporates volumetric display techniques; 2) geometrically encompasses 3D audiovisual content and display structure in space; and 3) proposes a novel a formal technique: the ability to use perspective rendering as an artistic means of expression.

While for years, 3D graphics rendering environments have readily provided for multiple displays; the manipulation of viewing frustums for multiple displays has remained static, and largely for the purpose of providing for a "wider" (more surrounding) single-user perspective across adjacent multi-projector displays. Unlike other approaches, ours is based on volumetric display, which calls for organization and coordination of non-planar and discontinuous viewing frustums, and the dynamic manipulation of "point of view" (coherent or otherwise) among them. Unlike other approaches in volumetric graphics display, such as holography, we seek to render the volumetric "image" using multiple viewing planes, volumetrically distributed about a given physical space.

Specifically, the technical innovation in this project is centered on our particular approach to volumetric audiovisual display rendering, and calls for the following:

1. The extension of an existing real-time 3D audiovisual authoring and rendering environment (*see CD-ROM: "Audioscape"*) to provide for the management and designing of volumetric (multi-screen) display configurations.
2. The development of a simulator (*see CD-ROM figure: "simulator"*) which will allow creators to experiment with and prototype different multiple display configurations (for a given real physical space), displaying the 3D audiovisual content of a particular artwork. The simulator will take a particular volumetric display configuration for a given physical space, and simulate a user's experience of the displayed 3D audiovisual content from any location within that space.

Objectives:

The project aims to achieve the following objectives:

- The creation of two major audiovisual works whose conception, approach and mode of operation integrate the novel and rich possibilities intrinsic to the volumetric audiovisual creation/performance

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environment we propose.

- The development of a suitable volumetric audiovisual display creation/performance environment for: (1) the production and presentation of the audiovisual works to be realized in this project, and (2) use in the public domain (i.e., student and artistic communities) for the creation and performance of volumetric audiovisual artwork.
- Specifically, the project's research and development work will include: (1) the extension of existing audiovisual environments to provide for volumetric audiovisual display, and (2) the development of a simulator for rapid prototyping of volumetric audiovisual display configurations in the context of artistic creation.
- The training of Master's and Doctoral students (music composition and voice) in the context of the project's realization.
- Dissemination of art works, publications and knowledge, generated by the project.

Creation:

Specifically we seek to realize two major works that will allow us to discover and refine our approach to volumetric audiovisual works.

“Siwalik”, by Jean Piché; This piece is for four percussionists and four video screens, and includes performer tracking and video control, premiere: Montreal, 2010 Elektra Festival.

“Beauté et Abandon”, by Zack Settel; Opéra en espace 3D audiovisuelle, Libretto by Wajdi Mouawad, premiere: Montreal, Chants Libres 2010-11.

Each work is intended to explore different aspects of working with electronic audiovisual content which occupies three-dimensional space. As shown in the support materials on the included CDROM, the long ribbon-like continuous multiple perspective display organization for Settel's work, is sharply contrasted by that of Piché, which is discontinuous, mono-perspective, and scattered in the volume of the performance space. The production of the works to be realized will also serve another important function: they will provide researchers Bohu, Marier et Bélanger with valuable and timely feedback (testing, suggestions etc.) in the research and development stages of this project. In general, Piché and Settel will collaborate in the realization of the works below; Piché will focus on dynamic (video-based) imagery, and Settel, on 3D model-based audio. It should be noted that premiere performances for each work are already planned during the course of the project (see letters of intent in support materials). The reader may peruse the support materials (see CD-ROM: *Silwalik* and *Beauté et Abandon*) where a detailed description of each work is available, including sketches etc.

Research and Development:

The primary technical objective of this project is to extend the existing real-time 3D audiovisual authoring and rendering environment, Audioscape, to provide for volumetric display, i.e., to produce an audiovisual representation of the work in three physical dimensions (as opposed to the planar image of traditional screens that simulate depth). We will extend the OpenSceneGraph (OSG) graphics environment in Audioscape to provide for the design, management and coordination of of multi-screen display configurations. In addition, we will develop an extension simulator application for Audioscape which will allow creators to experiment with and prototype different multiple display configurations (for a given real physical space), displaying the 3D audiovisual content of a particular artwork. The simulator will take a particular volumetric display configuration for a given physical space, and simulate a user's experience of the displayed 3D audiovisual content from any location within that space. The simulator will output specific viewing frustum and display

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configurations for specific works. The coordinates of real physical displays located in a performance space may also be loaded in the simulator making it possible to adjust viewing frustums to existing "real-world" conditions; this is particularly useful when setting up a work for performance on the road, and less-than-ideal conditions prevail.

Specifically, we intend to realize the following core development:

- 1) virtual camera / viewing frustum authoring/editing interface, to create display configurations.
- 2) multi-frustum real-time management module, to manage frustum assignments to projectors, with multi-screen configuration utilities for display scaling and offset, and debugging.
- 3) Extend OSG to provide frustum output buffer capture, for instant use as dynamic texture maps for simulated displays within the same OSG environment.
- 4) Simulator user interface, and high-level utilities, including configuration presets, authoring and management utilities (including display screen plan generator, providing coordinates and orientation of projection screens in real space)

In addition to the above, the following additional development is required:

- 1) Develop network-based synchronization layer to synchronize spooled audio/video content and audio across audiovisual rendering slaves running on different machines.
- 2) Extensions to OSG for dynamic texture maps
- 3) Extension to OSG for kinematics, to model bouncing, collisions etc...
- 4) Extension of Audioscape to create a timeline player to evaluate Cecilia Control control streams for mapping to audiovisual object parameters
- 5) Linux Scripting for system configuration, diagnostics and maintenance and show (live) control.
- 6) Spatial Tracking / motion capture/analysis modules, for 3D user interface for editing and live performance.
- 7) "Gestureal Demodulation", to translate user's physical activity to a video-flux control.
- 8) Extension of Audioscape to support multi-cast messaging to networked rendering machines.
- 9) Real projection display tuning utilities, to correct for error in screen/projector placement.

Problems and Solutions:

1. The Volumetric Audiovisual Artworks that we propose to create employ novel techniques and conceptual frameworks for creating and experiencing art via audiovisual volumetric display systems. There are many unknowns; approaches, methods and strategies for creation will need to be discovered and refined, as the project advances. Similarly, approaches to technical aspects, such as interface design, and representations will need to be researched and developed. We draw our experience with Audioscape in multiple audio display rendering when we address the issues above.
2. We have no way to quickly and easily prototype different volumetric display configurations because each one requires a particular logistic in a real physical space (i.e., multiple screen/projector placements). Yet, prototyping is essential to the development the artworks we propose, and the underlying approaches, methods and strategies for their creation. The development of a simulator for prototyping display configurations is essential.

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3. The logistics for presenting works using with multiple displays is complicated. Errors in the placement of the projectors and display screens can distort, or even ruin perspective for the volumetric display. The simulator, mentioned above, will input coordinates of real projection screens, and update the viewing frustums accordingly. In addition, utilities for calibrating and tuning viewing frustums to existing real displays will be developed.
4. Multiple displays mean multiple rendering machines. The configuration and coordination of these machines can be time consuming and fastidious, and especially problematic when time is limited due to performance constraints. Utilities for the automatic scripting of machine configuration will be developed.
5. Current public-domain software for live tracking of multiple moving objects or persons in space tends to be slow and unreliable. We will research optimized solutions and techniques, such as using IR tags for video tracking, etc.

Impact of the research-creation program on the development/renewal of the artistic field:

We are convinced that our work will raise some new issues about creating and presenting volumetric audiovisual artworks. Rather than using the "transparent" planar display, where a third dimension is implied via techniques for perspective (anamorphosis) rendering, we create three dimensional audiovisual works that physically occupy the volume of the performance space. The music and image are still composed and performed, but are experienced in quite an active manner. As with sculpture, the final experience of the work is based on the one's physical relationship to it. From a compositional point of view, the ideas about creating audiovisual works for volumes will be greatly developed, as we intend to engage the audience member actively in the experience of the work. The works will also examine the persistent difficulties of mapping strategies between vectorial movements of images and sound together. Videomusic continues to reveal an unsuspected wealth of possible interactions that go beyond the simple "illustration" of one medium by the other. It is our hope to contribute to the specification of co-related grammars for image-sound-space relationships. Finally, our volumetric audiovisual environment lends particularly well to live performance in Drama, such as Opera and Music theatre where the use of space is so important. We are confident that our work in these areas will anticipate a future trend towards the application of augmented reality techniques and compositional strategies to these forms.

Approach and the stages of implementation of the research-creation program:

Profs. Settel and Piché will manage the production of their respective creations, and will assist each other in their respective areas of expertise: Piché: image, and Settel: 3D audio. They will both co-direct the project research and development, and supervise the graduate students, Pohn, Marier, Bélanger, and others who will be working on the project. Independent consultant Mike Wozniowski, and long-time former McGill research collaborator with Settel, will assist with the specialized development of the simulator bringing with him, expert knowledge for programming and student training. Individual techniques and developments germane to the creation of the works will be liberally shared amongst the researchers. The schedule is as follows:

Month [0-6] Researching of existing volumetric display: techniques, implementation and arts applications; development of extensions to OSG environment; spatial tracking research and prototyping;

Month [0-6] Development of extensions to OSG; spatial tracking improvements; development of simulator;

Months[13-18] Development of timeline player; development of simulator; development of projection display tuning utilities.

Months[19-24] Testing and prototyping with simulator; development of audiovisual synchronization layer.

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Month [25-30] Linux utilities and scripting. Production of artworks using simulator.

Months[31-36] Completion, installation, testing, and performance of proposed Art Works; documentation; software bundling for public distribution; final report.

Training

Students who will participate in the project will benefit from the knowledge and experience of two well-known artists who have had a serious involvement in engineering over the years. Contemporary artists, whether in music, the visual arts or performance cannot escape the new possibilities of high technologies in the production and dissemination of the arts. The principal training aim is to address the idea of polyvalence, where a young artist/researcher is not only expected to be proficient with the aesthetic issues of his/her artistic discipline but also to be adept at developing the tools needed to advance the reach of their discourse. In the case of this project, many of the technical requirements are shared between different disciplines. Our project necessitates a tight coupling between engineering and creation, as the skills of each are critical to the success of the other, and jointly motivate the artistic and technical developments we anticipate. The students will be expected to assist in the development of the requisite software architectures, for example, supporting video rendering, manipulation of objects in the environment, and integrated sensing, while also designing the rich audiovisual environment itself. Students will receive training through formal instruction in audiovisual design, image/sound processing techniques, image processing, network communications, and through attendance at workshops in collaboration with the Société des Arts Technologiques (SAT).

Dissemination and external funding plan

Production commitments have been secured for the presentation of works realized within this project. In addition, Settel with students, will continue to publish papers on his research work in immersive audiovisual environments. Workshops and roundtables will also be planned during the course of the project. Specifically, two production groups below have agreed to present the project works in international venues (see letters of intent in the support materials).

- Group: ACREQ, Montreal Canada, venue: Elektra Festival, 2008
- Group: Chants Libres Opera Company, Montreal QC: venue: Season 2009

During the period of the project, workshop/round-table will be arranged by both production groups named above, and likely by other groups in Canada, the US, and in France, with whom we have collaborated in the past.

The researchers are both principals in a group that recently obtained a major grant from the Canadian Foundation for Innovation. The Laboratoire ART&D is a gathering of 10 "chercheurs-créateurs" from the Université de Montréal. The 3.2 million dollar grant received in 2007 is earmarked for research infrastructures and equipment that will be deployed in four locations at the University de Montréal. The present request to the FQRSC will be used strictly for research personnel and other expenses not permitted with the CFI grant.