ACO Virtual Orchestra Pilot
## FINAL REPORT 08.18.2010

SYNOPSIS

The virtual orchestra is a tour-friendly audiovisual installation accompanied by a Virtual Reality / Augmented Reality mobile app. Users have the immersive experience of standing amongst musicians while they perform. The installation is designed to enable rapid deployment of the basic configuration to many different locations whilst giving the ACO scope for more sophisticated custom roll-outs and future enhancements. The ACO commissioned a pilot featuring the quartet to test the possibilities. Pilot functionality was to allow testing of creative, technical and budgetary decisions.

PROPOSED USER EXPERIENCE

On entering the installation space, the user is surrounded by images of the players. The sound appears to be coming from the image of each player's location in the projected visuals. The imagery is minimalist and abstract. The performance is approx 10 minutes and looped.
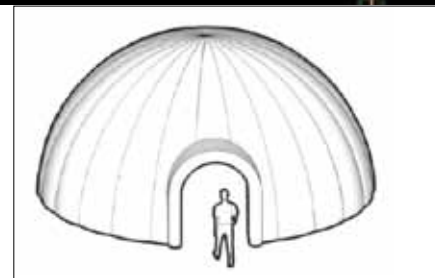
The mobile application provides a replica of the installation space visuals with a virtual camera point of view under the control of the user. The user can call up additional information about the music, the composers, the musicians and their instruments by interacting with the app via prompts. This is a portable marketing device that encourages and enables users to share their experiences of the ACO.

GUIDE

YOUR iPHONE SCREEN IS A WINDOW INTO A VIRTUAL WORLD
HOLD DIRECTLY IN FRONT OF YOU TO SEE FORWARD
RAISE ABOVE YOUR HEAD TO LOOK UP AND LOWER TO LOOK DOWN
TURN WHOLE BODY TO FACE BACKWARDS AND SEE BEHIND YOU

Devices with accelerometer and compass (e.g. iPhone 3GS) can be used to explore the space without touching the screen.
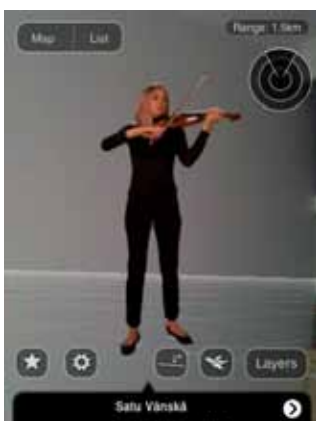
Here are screenshots from the Layar Mobile App

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PLANNED OUTCOMES

1. A prototype installation of four musicians is created
2. Technological and creative decisions are tested in a dome and on iPhone
3. A report (summary of learnings) will be delivered

ACTUAL OUTCOMES

All outcomes as per the original Pilot Project Outline document were achieved

▶ Four ACO musicians (Richard Tognetti, Satu Vänskä, Christopher Moore and Julian Thompson) were filmed simultaneously on greenscreen with eight video cameras (two per player) at Trackdown Sound Studios, Sydney.

▶ Two software application prototypes were developed:
  • The Dome App (using the Unity3D game engine and TouchOSC mobile app as a controller)
  • The Augmented Reality (AR) mobile app (using the Layar mobile AR browser and the Django web framework)

▶ MOD Productions assembled a multi-disciplinary team including a research collaboration with the iCinema Centre, University of NSW (UNSW).

The pilot was tested on flatscreen computer displays, the iCinema iDome and the LittleISkies CosmoDome inflatable fulldome theatre system.

The pilot necessitated five distinct phases

1. Content Acquisition (Video Production)
2. Video Post Production (2D and 3D)
3. Dome App Software Development
4. Mobile App Software Development
5. Planning and Staging of Demonstration to ACO team

PILOT FUNCTIONALITY

Feasibility of functionality was tested but not fully implemented in three interactive modes:

▶ Browser - explore the virtual world, selecting elements for more information, highlighting the content. If the device is equipped with a compass, orienting the device in the direction of the performers in the space turns the on-screen visuals to match. By default the sound mix reflects what is in the real-world installation space but user controlled movement affects the sound mix in 3D.

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▶ Game -
unlock each player through a series of challenges to reveal full audio
a) searching for locations in the area surrounding the installation (e.g. at an outdoor festival)
b) correctly answering multiple choice questions - web searchable information on related composers, tracks, players and their instruments (e.g. in what year was Richard's violin made?)

▶ Mixer -
control each Character (solo, mute and volume), allowing the soundscape to be adjusted with greater precision. By default each track will contain some spill of the other instruments so this will spotlight rather than isolate individual performaces (see Isolated Sound option below) to retain a cohesive experience.

PARAMETERS

The following questions were posed by the ACO at the commencement of the pilot.

Music

Q: What music works best?

Two pieces of music, totaling six minutes, were recorded and tested in both the Dome App and Mobile App:

▶ *Winter movement, Four Seasons* (Antonio Vivaldi)
▶ *Caprice No. 5 arrangement* (Niccolò Paganini)

The ACO players involved in the pilot suggested that the virtual tour repertoire should keep all players busy, unlike in the Paganini piece. The Mobile App, with more limited visuals, could support any repertoire.

Recommendation: further testing to determine audience response to the pilot. The subtle interactions between musicians and the variation in the piece produced by periods of silence from various instruments could be of interest, and of educational value, to the end-user.

Q: Does the surround sound approach work with the ACO's music?

Surround 3D audio (virtual musicians surrounding audience) was tested against the traditional configuration (audience facing the ensemble onstage in a semi-circle).

Support for different speaker modes (basic stereo or multi-channel audio) was built into the Dome App using FMOD interactive audio middleware.

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Audio from each player could either be positioned alongside each video image of that player or simply form part of a stereo mix. 8 channels were tested using a Fireface 800 audio interface.

→
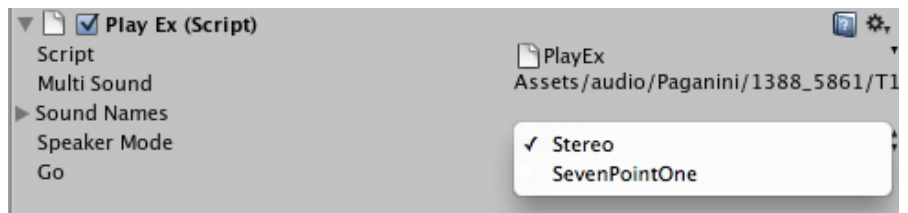
 For a small screen such as the iCinema Centre's iDome, as shown at right, 2-channel stereo from left and right speakers on stands (waist height) were judged to be adequate.
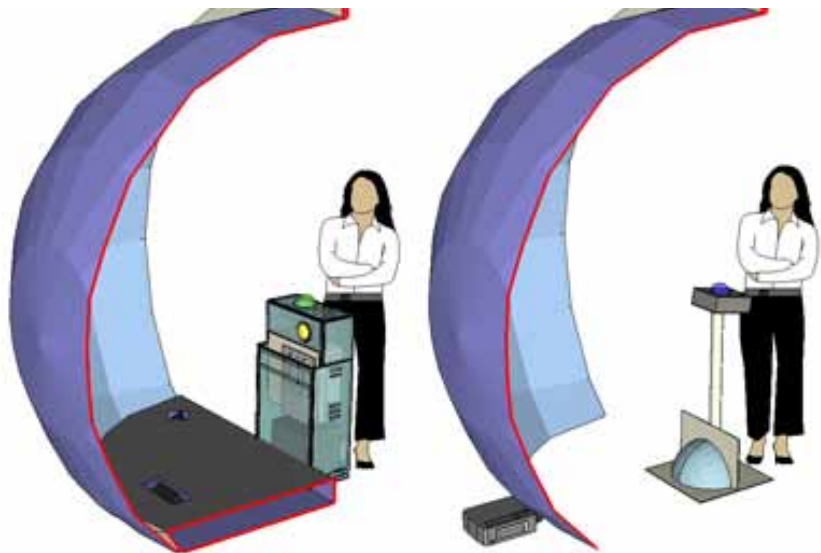
Q: Should a composer be commissioned to write for this media?

The existing repetoire worked well but there is scope to explore commissioning of new work.

Recommendation: the choice of repertoire for the virtual tour be given further consideration and discussion within the ACO

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Q: To what extent will we let the audience manipulate the music?

Audience manipulation options were tested as an 'education mode' that could be controlled by one user at a time. We used an iPhone as a controller to send messages to the Unity application.

Manipulation options were:
1. Show/hide individual musicians
2. Focus on a player (silhouette other players, remix audio so that highlighted musician is louder in the mix)

Both options proved popular with test audiences, particularly the ability to focus on a musician's audio, creating opportunities to learn about the instrument's sound and the musical score.

We opted against providing 3D navigation of the virtual world within the mobile app. Instead, using a multi-channel audio setup, the user can approach individual sets of speakers to hear a player more distinctly.

Recommendation: offer 'education mode' where possible but keep interactivity simple. Explore more sophisticated audio manipulation options (e.g. navigation of 3D virtual world) once users are familiar with the basic options.

Visual

Q: What background works best?

We tested different styles of visual environment.

▶ A static, simple background (blue sky with clouds)
▶ A static, complex photographic background (Sydney Harbour shot from Cockatoo Island)
▶ Moving CG foreground and background elements (snow storm, water droplets)
▶ Stereo 3D variations of CG backgrounds (requiring red/cyan glasses)

Shooting the players on greenscreen provided complete flexibility in terms of manipulating the background and foreground elements in the

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Dome App. The following image shows how different renderings could be produced.
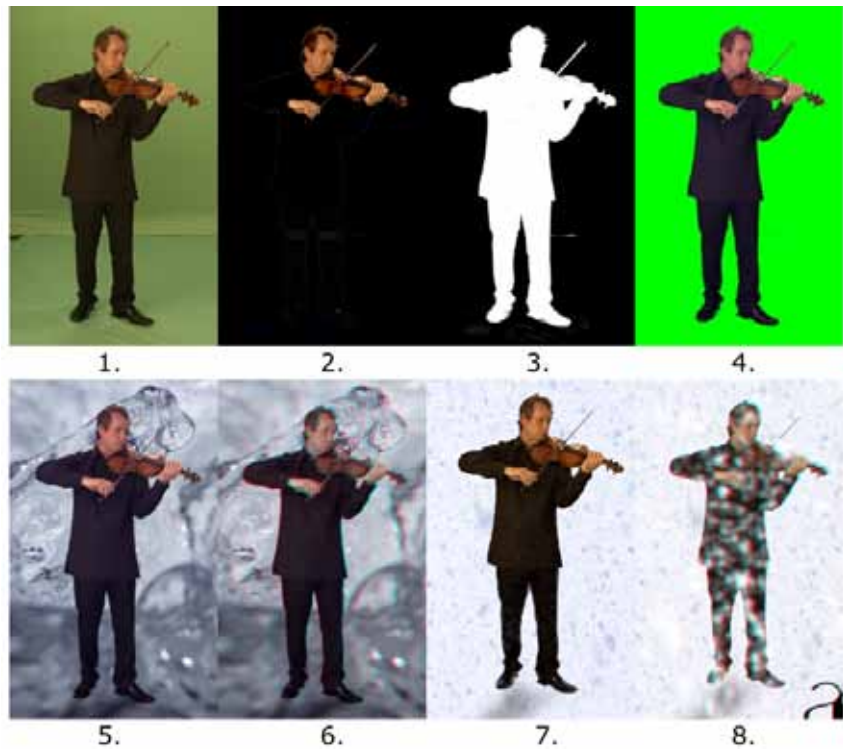
1. The image captured on-set
2. Background removed
3. Alpha channel (white is foreground, black is background)
4. Video optimised for game engine
5. 2D background
6. Stereo 3D musician with 2D background (requiring red/cyan glasses)
7. CG foreground and background
8. Stereo 3D, CG foreground/background and ACO logo
(requiring red/cyan glasses)

The flexibility provided by using a game engine like Unity was not essential for a compelling user experience but it did provide the most flexibility in testing parameters.

e.g. a stereo 3D video with Richard and a falling snow environment took 35 hours to render. Unity allowed video elements to be manipulated in real-time. Unity provides a convenient packaging mechanism if delivering versions of the Dome App across web, desktop, game console and mobile devices if required.

The Dome App supports playback of the performers as silhouettes. This rated well with test audiences and might be easier to integrate into busy urban environments (e.g. crowded bank foyer).

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➔ Performers in silhouette photographic background.

A high-end computer was required to play the Dome App with four separate musician videos at full resolution without a noticeable drop in frame rate (the performances were captured at 25/frames per second). However the production version of the Dome App does not require separate videos for each player. The system will be optimised to be able to cope with the full orchestra (e.g. reducing the number of videos required to play in tandem).

A 3D environment (snow), which took approximately 35 hours to render, provided an example of what could be achieved with a significant post-production VFX budget.

Recommendation: each Virtual Orchestra piece should have a dedicated background matched to the music and budget.

Recommendation: use Unity to distribute an interactive Dome App. For non-interactive audiovisuals, distribute a library of pre-warped video files.

Recommendation: stereo 3D should be investigated further as a delivery option for high-end visuals.

Q: Should visual artists be invited to create backgrounds?

Recommendation: invite visual artists to create additional backgrounds as a 2nd phase, once the framework has been road-tested using visual environments created by Michela Ledwidge, the artist for the pilot.

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Q: What configuration of musicians works best?

The following configurations were tested:

▶ semi-circle (grouped as if on-stage)
▶ surround (players spread equidistant around the space)

The software framework was designed for quick re-configuration to suit different contexts. To produce the surround view, a fisheye lens perspective is created.

A more cost-effective alternative to a video projector equipped with a fisheye lens is a MirrorDome/video projector combination which reflects a warped version of the fisheye image onto the curved surface. This diagram shows how the mirror and projector are positioned within a dome.

Source: http://local.wasp.uwa.edu.au/~pbourke/

http://local.wasp.uwa.edu.au/~pbourke/miscellaneous/domemirror/faq.html
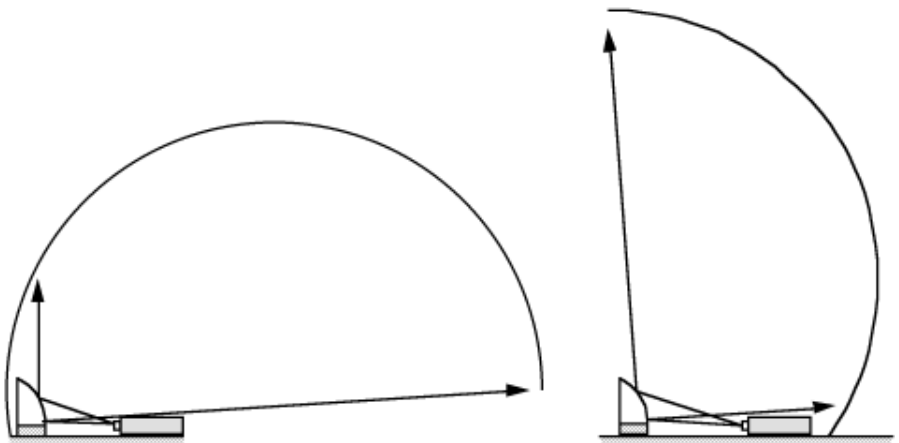
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The following screenshot shows how the projected image must be pre-warped in order for best results in reflecting off the curved mirror. This forms the basis of the surround visual configuration tested in the MirrorDome system.

For the pilot we used the Unity game engine to warp the image on-the-fly. This flexibility comes at the cost of computational power. If the virtual orchestra is to be exhibited without interactivity, the audiovisuals can be created as a regular video file.

Smaller screens such as a computer display or the iCinema iDome (an upright hemisphere) did not support a surround mode. The surround configuration is designed for fulldome environments.

Recommendation: musicians be arranged in a surround configuration wherever an immersive fulldome environment is available. Otherwise grouping the players in a semi-circle would be sufficient.

Recording

Q: Can we film and record the musicians such that one or several can be made prominent at a time?

Musicians were recorded simultaneously with individual microphones. This gave some capability to give prominence to individual players but the effect is subtle. It was not possible to completely isolate each player using this configuration - all microphones pick up all players.

Recommendation: that pilot configuration be used for the full

orchestra with microphones placed to enable groups or sections to be given prominence, rather than to give each individual musician prominence.

Q: How can the sound be recorded without the microphones being in shot?

As long as the microphone and microphone stands do not occlude (visually block) the players or their instruments in any way then these can easily be digitally removed from shot. Care needs to be taken to ensure that bows do not cross the stands or extend beyond the greenscreen on flourishes.

Dome

Q: What is the quality of the audio visual equipment?

Audio recording and playback equipment was selected and supervised by the ACO's Sound Engineer, Simon Leach, within the budget. The system was capable of 16 bit and 24 bit audio playback although most testing was done at 16 bit.

The installation works with consumer quality video projectors (e.g. 1024x768 pixels). Any MirrorDome or fixed dome venue can be fitted with a high-end projector to improve image resolution and brightness (lumens). Each performer was captured at approximately 600x400 resolution (the camera recorded 1600x1400). Higher resolution images could be captured onset using newer DSLR cameras at additional cost. We used the iCinema Centre Spherecam rig of 8 cameras for cost-effective 3D capture. The only significant issue with this rig was the lack of ISO controls - the images had higher than expected digital noise which made greenscreen keying (extracting the background) more costly.

Recommendation: compare the cost of shooting with higher-spec camera rig against the cost of post-producing Spherecam images prior to full production

Q: What expertise do you need to install it?

Each video projection system and audio system will require installation. It is not necessarily a requirement to supply personnel to install the virtual orchestra to all venues, given a base level of technical competence available in-house, but this will need to be tested.

The use of middleware (pre-existing software) means that it will be straightforward to distribute software-only packages to exhibition venues that already show MirrorDome and flat screen video content. No programming expertise will be required. In practice, the virtual orchestra distribution process and packaging will evolve based on testing at initial

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sites to make installation more straightforward.

The following parameters require manual selection in the pilot:

▶ choice of performance

▶ choice of display mapping (e.g. flatscreen, iDome, fisheye, warped fisheye)

▶ IP address of mobile device (if using TouchOSC interactive controller)

The use of a web-based project hub (such as the Rack&Pin service used for the pilot e.g. http://aco.rackandpin.com) will facilitate support and streamline the installation process.

Recommendation: allocate one day of testing for each of the first six touring and exhibition venues/contexts.

Recommendation: the virtual orchestra tour should budget for 1st line (in-house) technical support and 2nd line remote support.

Q: What facilities does the host need?

The Dome App can be exhibited on any recent computer or projected onto any flat surface using a video projector. For best results a dark quiet room with good acoustics and a high quality sound system would be advised.

The Dome app was built to meet de-facto standard MirrorDome specifications pioneered by Paul Bourke at University of Western Australia. Most fulldome content exhibited today in planetariums is based on his research.

For fulldome MirrorDome projection, a spherical mirror needs to be positioned in such a way as to redirect the throw of a standard video projector onto a wider surface. This hardware is available for sale or rental in Australia via CosmoDome and in the US via The Elumenati. Typically a planetarium operator will install a mirrordome projection system alongside a planetarium star projector.

Q: What sizes are there?

There are a number of full dome sizes available in Australia:

Type 1: lightweight domes

Little|Skies

http://iskies.com

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NSW based CosmoDome inflatable dome supplier. Regular exhibitions in school halls, museums and shopping malls.We used this system for the pilot testing. 30 person capacity - approx 40kg. 6m Dome.
Requires a clear indoor area of 6.5m x 6.5m x 3.5m – LxWxH

The Orb Lounge
 http://www.orblounge.com.au/

Rental of the Orb Lounge with the 6.5m diameter projection dome and equipment contained inside the inflatable 12 metre diameter exterior dome.

This system comprises 2 inflatable domes; a 12 metre diameter waterproof inflatable dome which contains a 6.5m diameter inflatable projection dome with an airlock. For their crew to freight the domes from Ocean Shores (northern NSW) to Sydney and set up will cost $7000 + gst for anything from a one day to a one week event. Price to be confirmed.

The Dome Company
http://www.domecompany.com.au
NSW based portable geosedic dome supplier.
Interior projection screen was not available during pilot period but is under development for September event in Martin Place.

1. Purchase of a 15 metre diameter Dome Company event dome with block out exterior canopy and lightweight internal projection canopy. Retail price will be around $75,000.
2. Purchase of 15 metre diameter Dome Company event dome with block out exterior canopy but no interior

projection screen. The dome frame will be visible on the inside. Retail price of around $55,000.

3. Rental of existing 20 metre diameter event dome (currently in Perth) with block out vinyl canopy (shown on Dome Company web site), no interior projection screen. Rental to Sydney for one week = $35,000

Type 2: permanent full domes

Most fixed dome installations are planetariums, e.g.:

▶ Flinders University (Adelaide). *alison.wotherspoon@flinders.edu.au*
▶ Melbourne Planetarium (Melbourne) *http://museumvictoria.com.au* 16m
▶ Science Centre (Woollongong) *glen_moore@uow.edu.au*
  Elumenati SX7 1400x1080pixels
▶ Scitech - Horizon - The Planetarium (Perth). *carley@scitech.org.au*
  18m, 194 seat, tilted dome, 4k image

Q: How much does it cost to install and maintain in
a) an Australian capital city for 3 weeks or
b) an Australian regional centre for 1 week
c) European, US or Asian city for 1 week

The following are estimate rental/installation and maintenance costs based on preliminary discussions

a) LittleISkies rent their Sydney-based inflatable MirrorDome including operator (free Sydney metro delivery) - i.e. approx $22000
b) The Orb Lounge - approx. $12,000 a week
c) The Elumenati (US dome operator) costs approx. $10,000 a week (US$8,000/week plus shipping)

Q: What opportunities are there to supply content to existing dome installations?

All Australian dome providers contacted for this pilot expressed interest in exhibiting the virtual orchestra. Scitech is keen to exhibit the live orchestra in conjunction with its planetarium stars themed show.

A slideshow from 2008 shows trends in fulldome show production and distribution (including revenue projections)
http://www.slideshare.net/bloonetwork/trends-in-fulldome-show-production-distribution

There are opportunities to install content in planetariums (the only obvious venues containing fixed domes) but as such, astronomy-themed content remains the most popular.

Recommendation: register the project in the upcoming DomeLab event, as an opportunity to network with dome content creators and

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explore distribution opportunities further for the virtual orchestra

Type 3: non–dome

Q: What technology, expertise and budget is required to tour the installation to locations to be performed in buildings?

The Dome App, or regular video files, can be provided to AV operators internationally for projection on flat surfaces. The main variable cost for a professional is the on-site AV technician's rate and the quality of AV equipment required (e.g. to project a longer distance requires a more powerful projector). The virtual orchestra imagery can be split across multiple video channels (different projectors) to cover a wider area. This option was not tested in any great detail in the pilot but can be supported by the Dome App and stand-alone non-interactive videos.

The Dome App can be refined into a consumer friendly DVD-ROM or digital download product. Connection of any computer running the Dome App to a video projector and sound system can serve as the basis of a non-dome exhibition.

Recommendation: use the Stakeholder demo event as an opportunity to assess the real-world cost of staging the virtual orchestra in a non-dome context.

AUDIENCE EXPERIENCE

Q: Is it amazing?

Audience experience needs further evaluation with defined target markets. Anecdotal evidence (from LittleISkies) suggests that exhibition in school halls and shopping malls via the CosmoDome inflatable theatre could be very compelling to new and younger audiences. Classical concert-goers may find the inflatable theatre experience less enjoyable.

Evaluation should include questions to ascertain marketing, educational and artistic benefits.

Q: Will presenters (eg. galleries, festivals) want to display this content? Will they want to pay for it?

Fulldome projection is a growing market. Word-of-mouth for this as-yet-unreleased project has been high (fielding calls from PR agents and artists working with other ensembles).

There is an international calendar of fulldome events and notable dome content creators such as this year's Sydney Film Festival Peter Rasmussen Innovation Award recipient, Peter Morse.

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MirrorDome inventor, Paul Bourke recently filmed the Borosan Orchestra in Turkey with the Ladybug camera.

The Melbourne International Film Festival in 2010 had a fulldome programme for the third year at the Melbourne Planetarium. Tickets were $26 full / $21 concession

Recommendation: register project in DomeLab event to research commercial opportunities

Source: Paul Bourke

CONCLUSION

The Virtual Orchestra pilot was successful in terms of audience interest and technical achievement. Michela Ledwidge and the MOD Productions team welcome opportunities to take the project to the next phase - staging of a stakeholder demo and subsequent filming of the full orchestra.

CREDITS

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Julian Thompson	Cello

iCINEMA CENTRE, UNSW

Research collaboration for creation of prototype dome display interactive
software application.

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THANKS

Paul Bourke	University Western Australia
Fee Plumley	Australia Council for the Arts
Peter Morse	Australia Council for the Arts
Prabhjot Singh	Iskies
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