

# An Immersive Interactive Experience of Contemporary Aboriginal Dance at the National Museum of Australia

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## ABSTRACT

This paper is a description of a walk-through experience of Aboriginal dance in the Welcome area of the Gallery of First Australians (GFA) at the new National Museum of Australia (NMA). The experience is an immersive multimedia environment with a perceptual user interface that extracts footstep features in real-time from 32 square metres of vibration sensitive carpet. Six network synchronised PC workstations process the footstep features and render the interactive 3d graphics and surround sound effects over six data projectors and thirty speakers mounted in the gallery.

The experience is based on a cycle of six dances that reflect cultures from different parts of the country - a men's dance, a women's dance, a fishing dance, a drumming dance, a rainbow serpent story, and an urban dance. The six dancers are projected life-size onto the walls of the gallery - three on each side. Images from the GFA collection of paintings by aboriginal children are integrated with the dance and music. The image of a snake sculpture from the GFA collections circles the room in the period between dances.

We present the design and outline of the system, experiences gained in developing the software and producing the media, and observations of visitor responses to the installation, some of

which will be shown on video at the conference.

**KEYWORDS:** immersive, interactive multimedia, perceptual user interface, surround sound, Aboriginal and Torres Strait Islander culture.

## INTRODUCTION

The glass front of the museum cabinet has been replaced by the glass screen of a computer monitor that we can reach through with the mouse to explore the exhibit further. Although the interaction has advantages the virtual object on the small screen never seems as interesting and impressive as the real thing, and only one person can use the mouse at a time. Projecting the computer screen up large can give a better impression and allows more than one person to see the exhibit together. Dialogue, music, and sound effects attract attention and increase the engagement with the exhibit. Room-size virtual environment productions that combine multiple large projections with surround sound have been used for Museum exhibits that immerse the visitor in the scene to give the illusion of having jumped right through the glass into the cabinet with the objects [1]. However this illusion is easily shattered when you have to use a mouse or keyboard to explore the exhibit. The alternative to the conventional graphic user interface

(GUI) is a Perceptual User Interface (PUI) that allows more natural styles of interaction by voice, gaze, gestures and bodily movements [2]. A PUI can allow a group of people to collaborate on equal footing – for example by singing together [3], because the sensors such as cameras or microphones do not require individual manual operation.

We combined an immersive environment with a PUI interface in an interactive exhibit for the Gallery of First Australians (GFA) at the new National Museum of Australia (NMA). This installation provides the possibility for a flow of people to experience the exhibit in a physical and playful way, rather than having to study distant objects and text through the glass.

The following sections introduce the Museum and describe the brief for the GFA Welcome area. Next we describe the design, media production, software development and equipment installation. Finally we discuss the process of realization along with observations of responses from focus groups that have toured the Museum recently.

### **The Museum**

The National Museum of Australia (NMA), slated as Australia's premier 'next-generation' museum [3], will open in March 2001 as a part of the celebrations of Australia's centenary as a federated nation. Just as museums around the world are rethinking their role and purpose in society as they face the new millennium, the new National Museum of Australia cannot simply be the same old museum concept with new technology. Both educational and entertaining, the Museum will employ a fresh and exciting approach to Australian history, culture and the environment - presenting its varied subject matter through the blending of exhibits, technology, media, live

performances and hands-on activities within dynamic architectural and landscape spaces. The NMA is located on Acton Peninsula, a spectacular and prominent location on the foreshore of Lake Burley Griffin, with expansive views to the city, the parliamentary zone and farther afield to the National Botanic Gardens and the Brindabella Ranges. Before construction began in 1999 an Aboriginal smoking ceremony was performed on the site to lay to rest the spirits of those who have died in the area and announce a new beginning. The traditional owners of the area, the Ngunnawal people, constructed a ground design of three circular sites linked with lines to represent their three clans. Indigenous people from around the country joined them in smoking the site by lighting a fire inside the ground pattern from special local wood and leaves to create a vale of smoke over the site. During the ceremony the participants covered themselves in smoke, discussed the reasons for the ritual, and performed dances and songs. The NMA has 3 main galleries containing 5 permanent exhibitions. The North Gallery contains 3 exhibitions called Tangled Destinies: Land and People in Australia, Eternity: Stories from the Emotional Heart of Australia, and Horizons: The peopling of Australia since 1788. The South Gallery contains Nation: Symbols of Australia. The third gallery - the GFA - explores Aboriginal and Torres Strait Islander cultures and histories with focus on the 60,000 year long attachment to land and sea and the recent history of contact with later settlers. Between the South Gallery and the GFA is a corridor-like transition zone some 8m wide by 20m long. At one end there is a lift, toilets, and a seating area where people can arrange to meet, wait for each other, take a breather, and chill out for a while

between major exhibitions. At the other end is the entry to the GFA where the first exhibit is a video of the Ngunnawal smoking ceremony that occurred on the site in 1999.

#### **The Brief**

The Director of the Museum, Dawn Casey, felt that visitors entering the GFA exhibition should have an impression that Aboriginal culture is not just part of past history but a lively part of contemporary Australia which will continue to contribute to our future society. The brief was to present Aboriginal culture in a hi-tech interactive experience for around 300 people passing through this area per hour. The experience should be a change of mood rather than explicitly informative, a positive and lively feeling of welcome, entertaining as well as educational.

#### **The Concept**

The smoking ceremony is a part of traditional Aboriginal culture that has become familiar to most Australians through contemporary performance – perhaps most famously at the opening of the Sydney 2000 Olympics. The concept for the GFA Welcome area is based on the smoking ceremony and leads very naturally into the first exhibit about the Acton Peninsula smoking ceremony shown on video at the entrance of the GFA.

The idea is that visitors walking through the transition area walk right through the middle of an interactive multimedia experience of a smoking ceremony and welcome dance. The smoking is a symbolic cleansing and invitation to enter into the gallery. Contemporary dancing and music draw on and highlight the variety of aboriginal cultures around the country. Objects and paintings from the museum collections

are integrated with the music and dance. A feeling of immersion is generated by hi-tech computer generated special effects that surround the visitors on all sides as they move through the area.

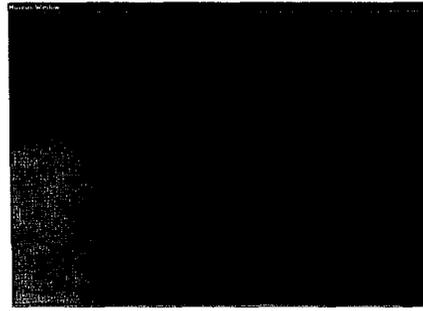
#### **THE EXPERIENCE**

The experience is designed for a flow of up to 300 people per hour moving through the transition zone between major exhibitions. You can sit at one end and just watch the dancing, listen to the music, and observe other people interacting. You can walk through it quickly on your way to or from the exhibitions. Or you can stay and play and dance for as long as you like. When you enter the area from the South Gallery you hear the music and looking down toward the entry to the GFA see six life-size dancers on the walls – three on the left and three on the right. Each dancer is dressed and painted to reflect a different aspect of Aboriginal and Torres Strait Islander culture – a grass skirt contrasts with a suit, a traditionally patterned dress with a modern skirt. The dancers are surrounded by smoke that wafts around and behind them as they move. On the floor in front of each dancer is an illuminated circle pattern from a Ngunnawal ground painting used in the Acton Peninsula smoking ceremony on this site. As you walk through the middle of the dancers and over the circles your footsteps generate ripples that distort the dancers and smoke, cutting through to hidden layers of imagery that tell a story. You also generate specially composed sound effects that circle around you in the space. Each dancer has a different sound effect in front of them so that different aural textures build depending on where people are moving in the area. The experience consists of 6 dance scenes choreographed and composed specifically for this installation - a

women's dance from the desert, an urban welcome, a fishing song from Torres Straits, a story about the bat and the rainbow serpent, a drumming song from the north, and a men's dance. Each scene contains layers of smoke, an image from the NMA collection of aboriginal children's paintings, interactive visual effects, and an interactive sound designed for the music in the scene. The paintings were collected in a several year long project on the Aboriginal Children's History of Australia that involved 70 Aboriginal schools around the continent in the 1970's [4]. The interactive sounds were drawn from the music compositions and natural sounds such as waves or thunder. The integration of elements in each scene is described in the following sections.

#### **Women's Desert Dance**

The Women's dance is a mystical scene where the dancers mimic kangaroo movements against a red backdrop. The music was composed by Jan Preston to reflect the central desert. The snapshot in Figure 1 shows a dancer against a finger-painting of snake and lizard shapes that drift slowly past as smoke swirls around. The video is motion-blurred to enhance the timeless feel of the scene. The interactive visuals are subtle magenta waves that cause the snake and lizard shapes to ripple. The interactive sounds are short vocalizations from the music which reverberate as though inside a cave.



**Figure 1: Women's desert dance**

#### **Urban Walk**

The Urban dance is based on a song composed by Geoff Dunn to reflect the culture of aboriginal people living in the city. The snapshot in Figure 2 shows a dancer against a collage of colourful paper squares that form a cityscape with a highway through it. The video smoke and parts of the dancers bodies are pixelised to give a computerized feel. Transparent interactive ripples cut through the smoke to reveal the backdrop and the interactive sounds are vocalizations sampled from music soundtrack.



**Figure 2: Urban dance**

### Torres Straits Fishing Song

The fishing song composed by Jan Preston and sung by Helen Aanu conveys the culture of the Torres Straits people. The snapshot in Figure 3 shows a dancer dressed in traditional clothing holding a fishing spear against a painting of fishing boats dragging nets off the shore of an island. The interactive waves ripple through a dot-pattern that moves like a school of fish. The interactive sounds are percussive singing chirps and vocalizations from the music.



Figure 3: Fishing dance

### Rainforest Story

The rainforest story is based on a song that was composed by Geoff Dunn to suggest the rainforest regions. The snapshot in Figure 4 shows a dancer in front of a nighttime image of a bat flying out from the trees toward a rainbow serpent sleeping at the bottom of the picture. The painting by Suzanne Chalmers (nee Hayes) is from *Djugurba: Tales from the Spirit Time*, written and illustrated by young Aborigines training as teachers at the Kormilda College in Darwin [5]. The ripple effect is a rainbow that colours the black and white image as it moves through it. The interactive sounds include samples of thunder, rain and wind as well as percussive instruments from the musical composition.



Figure 4: Rainforest dance

### Northern Drumming

The Northern drumming music composed by Jan Preston drives a high energy percussive dance. The snapshot in Figure 5 shows a dancer against a bright oil-pastel image of the sun smiling down on dancers and ceremonial burial sticks on a beach scene. The video is processed to give an energetic stroboscopic effect. The interactive ripple cuts through to a spinning disc of sun-rays that changes speed as you stroke the carpet. The interactive sounds include samples of waves and footsteps on the beach as well as percussive sounds from the music.

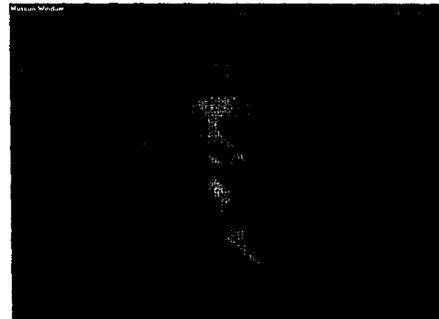


Figure 5: Drumming dance

### Men's Fire Dance

The music for the Men's Dance is a deep throb of several didgeridoos blended together by Geoff Dunn. The snapshot in Figure 6 shows a dancer in a business suit holding a boomerang. The imagery is minimal to emphasise the smoke and the rippling cut through to a brightly coloured painting of men dancing around a fire. The interactive sounds are vocalizations sampled from the music.



Figure 6: Men's fire dance

### Rainbow Serpent Transition

Between each dance there is a transitional fade in and fade out that takes 10 seconds or so. During this transition an image, shown in Figure 7, of a rainbow serpent appears circled around the six screens. The head is on one screen, the neck on the next and so on, around to the tail on the last screen. After each dance the snake has moved by one screen so that it travels around the gallery once every dance cycle. The image is a photograph of a snake sculpture from the NMA collection that has been manipulated so that the background colour matches the painted colour of the walls to give the impression that the serpent is actually crawling on the wall surface rather than just a projection.



Figure 7: Rainbow serpent transition

### THE SYSTEM

The Welcome area installation is on public show all day all year round. The system has been designed to be robust and reliable using an architecture of identical modules where there are no specialty servers, masters or slaves. A failure in any module will not compromise the installation and new modules can be swapped into place while the other modules continue to function. Modules automatically synchronise and sequence so that any number can be active at any time and more can be added as required in future.

### Equipment

Each module is a PC connected to a sound system, floor sensor, and video projector. The PCs each have a 933Hz Pentium III processor with 256 Mb RAM, 20 Gb disc, Sound Blaster Live! Soundcard and Nvidia GeFORCE2 video-card. The 4 output channels of the soundcard are connected to a Bose home theatre surround sound system, and the piezo cable floor sensor is connected to the mic-in socket. The video-card output is connected to a Sony Mx20 LCD video projector. The components of each module are laid-out in a 2.8m square as in Figure 8.

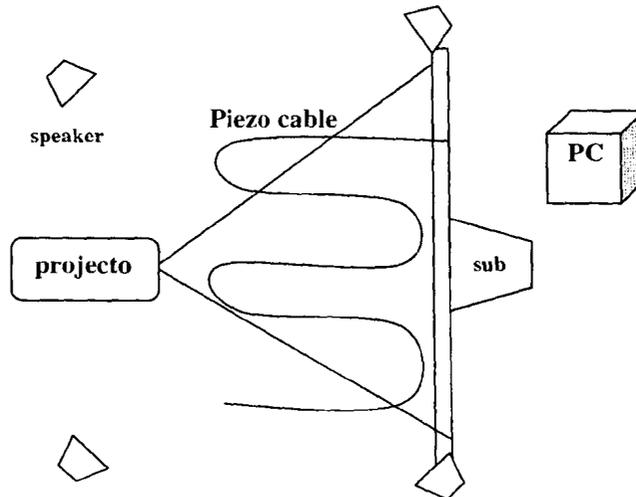


Figure 8: Module equipment layout

The projector is mounted on the roof front-projecting onto a white wall, four satellite speakers are mounted on the roof on gimbals, the sub-woofer is hidden in the roof, and 9m of piezo cable is layed under the carpet to form a 2x3m interaction area in the center. The components are cabled back to the PC rack in a comms cupboard. The PCs, audio amps and video projector can be remotely monitored and automatically powered on/off over network connections.

**The Software**

The software is designed around the sequencing of scenes with transition periods in between. The scenes are in separate directories named dance0, dancel, etc that contain the media elements that are integrated in each scene. The media are loaded and synchronised across the networked modules during the transition period.

Scenes can be configured on an overall level across all scenes and on a local level within scenes. The software was custom written in C++ to create unique real-time audio-visual special effects using a combination of DirectX video [6], OpenGL graphics [7], DirectSound3d spatial audio [6] and EAX environmental audio [8]. These high performance application programming interfaces (APIs) take advantage of hardware-accelerated algorithms on the video and sound cards. The software consists of four software subsystems that run in separate threads with local communication via shared memory and network communication over broadcast tcp/ip.

The four subsystems called the PUI floor for user input, the Ripple graphics for video effects, the WillyWilly audio for surround sound, and the Peer synchronisation for distributed

networking are described in the following sections.

#### PUI floor

The PUI floor extracts features generated by people walking over the carpet in the gallery. The signals are read from the piezo cable connected to the microphone input of the soundcard. The short term power and long term average power of the signal is monitored for transients that correspond with footfalls, and longer pressures that correspond with rubbing or stroking the carpet. The features are calculated in relative terms to reduce the effects of background noise and variation in levels due to physical characteristics in different components and regions of the installation. A normalized level for each feature is calculated at real-time rates. Features are time-stamped and written to a log file which can be used to debug, calibrate and analyse the response of the system. The PUI floor has configuration parameters for setting the sensitivity to footstep transients, amplifying the signal level, setting the length of the signal processing buffer for real-time response, setting a refractory period to prevent multiple triggering from single events, and setting the minimum size of the ripple feature sent to the graphics engine.

Floor

```
float Trigger; // sensitivity
to trigger a ripple
float Mag; // signal
magnification factor
int FrameLength; // samples
per processing buffer
int Refractory; // refractory
frames before retriggering
float Min; // minimum
size of ripple
End
```

There is potential to develop a wide range of feature detectors to recognize

more complex gestures such as a double tap, or a rhythm, or a count of the number of footsteps in a certain period. The data in the log files could potentially be used to gain insights into visitor behaviour, traffic and flow through the gallery.

#### WillyWilly audio

The WillyWilly audio subsystem generates a circle of moving sounds around a central listening position using real-time spatial sound processing on the soundcard and the surround sound speaker system. The sounds can be samples in files named sample0.wav, sample1.wav etc. in the scene directory or direct audifications of signals from the piezo sensor connected to the mic-in. Transient features detected by the PUI floor are mapped to spatial location of the sound which moves a fixed step angle with every footstep. The level of the transient affects the reverberation so that a very heavy footstep causes a large echo effect. The number of samples and audifications can be configured on a scene by scene basis.

Revolve

```
int SampleNum: //number
of samples in this scene
int FootstepNum: //number
of samples per footstep
end
```

The levels of the audio mixer can also be configured at the overall level with the following parameters

Mix

```
int MasterOutLevel: //main
audio output level (0..~65k)
int MasterInLevel: //main
audio input level (0..~65k)
int MicOutLevel: //mic
output level (0..~65k)
int WaveOutLevel:
//sample output level
```

```

        (0..~65k)
    int SampleVolume:
    //volume   mdB-10000 to
    10000)
    int FootstepVolume: //mic
    (piezo cable) volume mDB
    end
    
```

**Ripple graphics**

The Ripple graphics subsystem generates the interactive visual scene for each module. The scene has 5 layers that can be arranged in any order by depth with different transparencies rendered from back to front. The layers are called the ripple layer, the flat layer, the scrolling layer, the rotating layer, and the gradient layer. The ripple layer is a 3d surface that ripples in response to features detected by the PUI floor. A video or image with varying transparency can be placed on this layer. The other layers are 2d surfaces. The flat layer can also show video or images placed on it. The scrolling layer can only show images but can be configured to move in the horizontal and vertical directions at fixed speeds. The rotating layer shows images that rotate at a configurable base speed but it also responds to the stroking feature parameter from the PUI by speeding up or slowing down. The gradient layer is an overlay on the front of the scene to lower the lighting levels towards the bottom of the screen to prevent eye hazards due to the front projection. The gradient layer can also be used for software edge fade effects which are otherwise difficult to achieve with LCD projectors. The layers can be configured at overall or scene levels as shown:

```

    ripple_layer
    string texture: //(VIDEO
    or IMAGE)
    float alpha_min: //ripple
    alpha at max ripple height
    
```

```

    float alpha_max: //ripple
    alpha at rest
    float multiplier: //scale
    factor for ripple amplitude
    float frequency: // ripple freq
    Hz (higher = finer ripple)
    int ripple_lifetime: //duration
    of ripple in seconds
    int patchSize: //resolution
    of ripple mesh
    end
    flat_layer
    float depth: // depth of
    layer
    int texture: // texture on flat
    layer (VIDEO or IMAGE)
    float alpha: //transparency (0
    to 1.0 opaque)
    end

    rotating_layer
    float depth: //depth of
    rotating layer
    float alpha:
    //transparency (0 to
    1.0 opaque)
    float speed: //base speed
    of rotator
    end

    scrolling_layer
    float depth: //depth of
    scrolling layer
    float alpha:
    //transparency (0 to
    1.0 opaque)
    float x_speed: //speed of
    texture in x direction
    float y_speed: //speed of
    texture in y direction
    end

    gradientLayer
    bool enabled: //draw frame
    end
    
```

**Peer synchronisation**

The Peer synchronisation keeps the distributed dance scenes in sync with each other and allows modules to be swapped in and out without affecting the rest of the installation. The synchronisation occurs by TCP/IP broadcast messages to a group IP address. The modules respond to the messages by alternating between a transition state and a play state. A module entering the transition state schedules a 'play' message for broadcast at some configurable time in the future. During the transition period the video and image data are preloaded behind a transition image screen with the sound turned off. Modules respond to the first 'play' message they receive from the group. The tightness of synchronisation depends on the network latency which is typically of the order of milliseconds. This is short enough to be unnoticeable to a human observer. If the disparity between modules increases to more than 10ms it becomes noticeable as a blurring and echoing of beats in the music. More than 100ms causes a visible desync between the movements of dancers in the videos. In experiments we found the network delay was negligible compared with delays introduced by other parts of the system – for example the video system takes hundreds of milliseconds Sync

```

    ipaddress MulticastAddress:
    // ip:port, in dotted quad
    notation
    int      TransitionTimeMs:
    //duration of transition in
    milliseconds
    int SequenceTimeMs: //duration
    of sequence in milliseconds
end

Sequence
    int StartSequenceId: //index of
    the first sequence

```

```

    int SequenceNum: //number
    of sequences

```

```
end
```

**Discussion**

The development and realisation of the GFA Welcome has been a year long process that has involved many people who contributed in many different parts. The development of the scenes began with a meeting of the composers Geoff Dun and Jan Preston with the choreographer Marilyn Miller to identify regions and influences for each scene. Once the 6 general regions had been decided upon the composers each drafted up 3 short 1 minute musical pieces over a period of a month or so. The choreographer used these drafts to then develop the dances and to rehearse a group of six dancers. Each dancer was dressed in a different clothing to reflect different aboriginal cultures and they were filmed against a blue-screen at the Australian Film and Television School studios by Chili Film in a day long shoot. The filming required 3 takes of each of the 6 individual dancers performing each of the 6 dance scenes by themselves. The best take of each scene was then selected during post-production. The drafts of the music were recorded onto the film during the shoot and then replaced with final versions of the music during post-production. Rough versions of the videos were digitized and used for developing the integrated scenes with various image layers in the software. Film of smoke from a smoke machine was shot against a black screen on another occasion and also digitized. After some computer trials we decided to composit the smoke behind the dancers during video post-production rather than do it using computational resources which were needed for the other interactive effects. The final set of

36 one minute long dances with music and smoke were delivered on CD in MPEG I format at PAL resolution.

The interactive software was designed and developed by Stephen Barrass and Bodhi Philpott at the CSIRO Virtual Environments lab, in parallel with the media production. Some of the challenges in the software design included the need to develop a natural and intuitive multi-person interface without keypads or intrusive terminals, the need to develop a robust system that would work reliably all day long, and the need to enable a system administrator to quickly and easily find and correct any software faults that might occur. We solved the problem of the interface with the concept of the PUI floor which also proved a robust solution since the piezo cable has been widely used in industrial applications such as traffic counting. Although we had tested the piezo cable in the lab and were confident it could work well, we did not know how the characteristics might change once it was glued to the concrete slab, surrounded by underlay and covered in carpet. To deal with this uncertainty we parameterised the PUI floor subsystem and tuned it on site to maximize the recognition of footstep features. The software was built on Windows, rather than a more exotic multimedia operating system like BeOS, so that it could be maintained by a system administrator without requiring particularly specialized knowledge. The robustness of the system was tested over progressively longer periods to track down memory leaks, until it proved able to run reliably for a week at a time.

Versions of the media and software were regularly reviewed by a group from the NMA that included the Director, curators, exhibition designers and other staff. These reviews raised a

range of issues that were addressed during the development. Early concerns about the potential hazard for visitors who might look directly at the projector were addressed by a shaded gradient layer that reduces the brightness toward the bottom of the screen. The original concept to use silhouettes of the dancers changed with feedback from early reviews to a warmer and more personal look. The curators suggested the idea to use the children's pictures to provide a lively and colourful feeling. The idea to use a rainbow serpent was also raised during the review process.

We are now in the final stages of installing the Welcome area in preparation for the opening of the NMA in six weeks time. In recent weeks we have observed the response of several focus groups who have been shown through the galleries. The first group included fifty children from the 'school of the air' who live in remote regions and do their classes over the radio who were shown through in two subgroups. The first subgroup very quickly grasped the connection between jumping on the carpet and the ripple effects and many of them played with it together for five or ten minutes before being lead to the rest of the exhibits. From casual conversations it was clear that they easily understood what was going on and thought it was good fun. The second subgroup did not become so actively involved or seem to understand the interactive nature of the installation. We surmise that this may have been because the Women's Dance scene was playing when they arrived and the effects in this scene are quite subtle and harder to notice than in the other scenes. Even after some demonstrations and explanations they were not so interested to play with it and moved on after only a couple of minutes. From these observations we realized that children

probably require very obvious interactive response during the initial experience in order to become interested to interact. The second focus group was made up of 50 local school teachers who were shown into the Welcome area en-masse. They listened attentively to an explanation and watched a demonstration but only a few stepped forward to tentatively tap the carpet in the interactive area. Once the main group had moved on five or six remained behind to try it for themselves and were clearly delighted. It seems that adults may be reluctant to interact in front of other adults, or perhaps in front of a professional peer group. However in general conversation there was a positive response to look and feel of the installation. It also became clear that the curators showing the groups through need to be able to talk about the content of the installation and its relation to other parts of the exhibition rather than the technology itself. For example the Welcome provides an opportunity to talk about the collection of children's painting collection which is not on show anywhere else in the permanent exhibitions. The installation has the advantage that it can be continuously and incrementally developed and enhanced even after the opening day. This will allow us to respond to longer term observations of visitor behaviour and reaction to the GFA Welcome area.

### **Summary**

The GFA Welcome is a walk-through dance video experience designed for a flow of 300 people per hour moving to and from the Gallery of First Australians at the National Museum of Australia. This high technology interactive media experience presents a contemporary and future oriented impression of aboriginal culture to visitors entering the gallery. The

experience is based on a cycle of six contemporary dances - a men's dance, a women's dance, a fishing dance, a drumming dance, a rainbow serpent story, and an urban dance. Six dancers are projected life-size onto the walls of the gallery - three on each side. Behind each dancer is an image from the NMA collection of painting by aboriginal children. As you walk through the gallery your footsteps generate ripples that reveal hidden layers in the video, and your footsteps kick up a willywilly of sounds that revolve around you. The image of a traditional snake sculpture circles the room in the period between dances.

The installation combines an immersive audiovisual environment with a perceptual user interface in a large scale interactive group experience. The experience is presented using six video projectors and 30 speakers driven by six network synchronised PCs each configured with 3d graphics and surround sound equipment. The user interface is 32 square metres of vibration sensitive carpet connected to the computers for real-time signal processing and feature detection.

The GFA Welcome is unique for its multi-person footstep interface, its large scale immersive quality, and the integration of music, dancing and special effects with artifacts from the collections to produce a novel, entertaining and educational experience.

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#### REFERENCES

1. Göbel M., Barrass S., Eccles J., Eckel G., Hasenbrink F., Lechner U., Mostafawy S., Toth S., Unnützer P. Digital Storytelling - Creating Interactive Illusions with AVOCADO. In *Proceedings 9th International Conference on Artificial Reality and Teleexistence*, Waseda, December 16-18, 1999.
2. Turk M. and Robertson G. (eds) Perceptual User Interfaces, In *Communications of the ACM*, 43 (3), March 2000.
3. National Museum of Australia [www.nma.gov.au](http://www.nma.gov.au)
4. Barrass S. Immersive Interfaces for Music, Stories and Games. In *Proceedings of the Workshop on the Future of VR and AR Interfaces*, IEEE Conference on Virtual Reality VR2001, Yokohama, March 13-17, 2001.
5. *The Aboriginal Children's History of Australia*, written and illustrated by Australia's Aboriginal children, Rigby in assoc. with Island Heritage, Adelaide, 1977.
6. Wilson M.R. and others. *Djugurba: Tales from the Spirit Time*, ANU Press, Canberra, 1974.
7. DirectX API [www.microsoft.com/directx](http://www.microsoft.com/directx)
8. OpenGL API [www.opengl.org](http://www.opengl.org)
9. EAX API [www.eax.creative.com](http://www.eax.creative.com)

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