White Paper Report

Report ID: 100819

Application Number: HD5113210

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Institution: Lower Eastside Girls Club of New York

Reporting Period: 9/1/2010-12/31/2011

Report Due: 3/31/2012

Date Submitted: 3/26/2012

NEH Office of Digital Humanities

Final Performance Report and White Paper
Grant HD-51132-10

The Lower Eastside Girls Club
Girl/Hood Project
(Domebase)

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The Lower Eastside Girls Club of New York

March 26, 2012

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INTRODUCTION

The Lower Eastside Girls Club Girl/Hood Project is an ongoing effort to produce local history programming for the East Village Planetarium, opening in early 2013. In advance of the construction of the full size dome, first steps included the creation of a low-cost digital dome authoring system for teaching and production. This mini-dome authoring system has been named Domebase.

The Girls Club is currently constructing a new community science, art, and environmental center in lower Manhattan. The Center for Community includes a 30 ft. fixed planetarium, media production studios, local history photographic archive, and a recording studio in a 1958 Airstream trailer.

The goal of Domebase is to create a community approach to content production for hemispheric projection that is appropriate for small dome operators in schools and science centers. It is also designed to foster the production of dome programs on humanities topics, including local history and personal narratives.

Initial funding for the creation of a mini-dome authoring system was provided by the National Endowment for the Humanities, through the Office of Digital Humanities, as a Digital Humanities Start-Up Grant, and as part of the "We the People" initiative. The final media products of this project include a virtual re-imagining, for the dome, of a Girls Club mural project - Women Who Change the World.

Resources

Lower Eastside Girls Club - Center for Community
http://www.girlsclub.org/building

NEH Office of Digital Humanities
http://www.neh.gov/odh/

Press
http://thevillager.com/villager_363/girlsclub.html
http://blog.makezine.com/2011/12/01/lower-east-side-girls-club-gets-airstream-trailer-on-the-second-floor/
http://www.nytimes.com/2010/09/11/nyregion/11metjournal.html

Planetarium dome fabricators
http://www.spitzinc.com/

Planetarium projection systems
http://www.elumenati.com/

PROJECT ACTIVITIES

BUILDING THE MINI-DOME

The mini-dome workstation was conceived as a production and teaching station, where we could learn about hemispheric projection while our planetarium was constructed. It became clear that anyone working in domes who did not have regular access to a full-size planetarium would have a use for such a tool, to preview perspective, lighting and animation.

While there are simulation domes, inflatable planetariums and partial hemispheres (sometimes called portals) that could be used as authoring stations, these systems generally cost between $25,000 and $100,000 and may not include computers and software in that price. The fisheye projection lens alone for such a system can cost over $10,000.

Our design goal was a system that could be assembled for $10,000 or less, including computer, software, projector, fisheye lens, and dome screen. Here is a rough breakdown of our final system costs:

Acrylic dome (with shipping)	800
Projector (used)	1000
Fisheye projection lens (DIY)	1100
MacBook Pro (17")	3000
Unity Pro software	1500
Canon 5D camera (used)	800
Other software, installation hardware	1200
TOTAL	$9400

The following pages describe the individual elements of the workstation, the steps to assemble it, and some possible improvements.

Resources

Center for Community weblog post
http://c4c.posterous.com/mini-dome-update-immersive-3d-authoring-with

Other mini-domes

http://www.wix.com/cosmi1/cosmix

http://geodome.info/systems/portal/

http://paulbourke.net/miscellaneous/domemirror/UnityiDome/

Acrylic Dome

The large acrylic dome came from a company that sells these as skylights for buildings and RVs. While they can be purchased as large as 96" in diameter, it is recommended that you measure all hallways and doorways before ordering.

Our dome measured 54" in diameter, and 27" from top to bottom, 1/4" thickness and came with a 1.5" flange around the edge. Shipping for the dome equaled the cost of the dome itself. As shipped, it had a split foam rubber tube around the flange to protect it. We had been warned about the possibility of cracking the dome by applying too much pressure on the edge mounts. As a precaution against that, and a protection against people hitting their heads on the edge, we left the foam protector on the dome, and loosely tightened the eyebolts that we mounted through carefully drilled holes.

One major difference between projecting on a flat screen and in a hemisphere is cross-bounce of light. On a flat screen, the most reflective surface is generally desirable to obtain the brightest image. In a dome, any bright element can reflect around other sides of the projection surface and wash out other images. For that reason, a darker, gray surface is preferable. We obtained a paint sample chip from the manufacturer of our full-size dome and made an effort to match it with a flat enamel. There is still a constant concern to keep program material at relatively low brightness, and compensate with higher color saturation to make the image "pop". But the mini-dome serves as a useful testbed for program material that will be shown later in a larger dome with a brighter projector.

Resources

Dome source
http://www.cleardome.com/

Larger acrylic domes
http://www.complexplastics.com/hemispheres/pricelist/

Fisheye Projection Lens

The fisheye projection lens is the crucial element in this workstation. Without a creative, DIY solution, a commercial lens would make the system too expensive for the applications we were targeting.

After a number of experiments with normal projection into hemispheres and projection using mirrors, it was clear that the distances required for straight projection and the difficulty of getting close enough to the hemisphere for a clear view would require a fisheye lens of some sort. A search on the Internet turned up a French planetarium

enthusiast, Yves Lhoumeau, who had assembled a projection lens out of two normal camera lenses in an unorthodox configuration. Lhoumeau's lens used a circular fisheye lens and a 50mm lens, placed in front of the projector. One advantage of this assembly would be that the 8mm fisheye lens could serve double duty as a normal fisheye lens on a full frame DSLR, for capturing 180 degree images that could be projected into the mini-dome. In fact, this is the simplest method for creating imagery that fits into a dome, and it is often combined with time lapse and long exposures to create dome programming (see the separate section on this site for Fisheye Photography).

Finding that we did not have the fabrication and lens assembly skills of Lhoumeau, we looked for an alternate way of connecting the lenses in a back-to-back configuration. A cheap macro bellows seemed to have promise, but it is normally used with a lens and a camera, not two lenses. A custom coupling was necessary for the second lens, and this was constructed using two lens caps with an opening cut through them, and then bolted together. Another solution would have been to use a commercial double-sided lens cap, made for storing and transporting two lenses. If this were to be used in another system, the opening between them would still have to be drilled and sawed out.

The first version of the lens mount was constructed out of wood, in imitation of Lhoumeau. It had to be mounted at an angle to the Optoma projector, since the projector had no controls to adjust the angle of the beam. When we upgraded the projector, a simple piece of thick plastic (from an Ikea lap table for a laptop computer) was cut to shape and screwed onto the bracket mounting holes in the bottom of the projector. It was found that the plastic flexed a small amount, and a set of small braces were added, attached with black duct tape. The final mount is limited in adjustability. Ideally, the lens would be adjustable in distance from projector as well as side-to-side, but between bellows movement, bellows pivot (around the normal tripod mount), projector focus, and the focus on each lens, good results can be achieved. A projected radial grid pattern is useful in aligning and locating the projector in relation to the dome.

Resources

Lhoumeau's projector
http://www.astrosurf.com/lhoumeau/planetariums/fr/realisation3.htm

More posts on the building process at C4C
http://www.domebase.org/building-the-mini-dome
http://c4c.posterous.com/diy-fisheye-projector-assembled-prototype-wit
http://c4c.posterous.com/mini-dome-theater-45-ft-dome-for-3d-and-plane

8mm circular fisheye lens
http://www.bhphotovideo.com/c/product/440665-REG/Sigma_485101_8mm_f_3_5_EX_DG.html

50mm lens
http://www.bhphotovideo.com/c/product/12142-USA/Canon_2514A002_Normal_EF_50mm_f_1_8.html

Macro Bellows
http://www.amazon.com/Fotodiox-macro-bellows-Canon-Cameras/dp/B003EDTG8W

Radial Grid for Testing
http://paulbourke.net/miscellaneous/domemirror/meshmapper/

Projector

Two projectors were used to develop this workstation. The first was an Optoma HD66, with 1280x720 resolution. It was chosen for its low cost ($600) and relatively high contrast ratio - important for achieving good black levels in the dome. At the time, most of the images we were projecting were circular dome masters from Domefest, a dome film festival organized by ArtsLab at the University of New Mexico. These programs are available online on Vimeo at 1280x720 resolution, too low for large dome projection but useful for study. The Optoma projector was suitable for early tests but it became clear as we started working on our own Unity-based scenes that a higher resolution would be desirable. That said, The Optoma is very good projector for the price in this application.

The projector we are now using is a Panasonic PT-AE3000U, with 1920X1080 resolution. It was purchased used for a low price, and has been discontinued by the manufacturer. The current model, PT-AE7000U, sells for around $3000. This projector has much better control of the direction of the lens projection, making it easier to mount the DIY fisheye lens onto it.

Due to the difficulties of dome projection, including light cross-bounce, any projector used in a mini-dome station will require some experimentation to find the best picture and color setting.

Resources

Optoma projector
http://www.bhphotovideo.com/c/product/654484-REG/Optoma_Technology_HD66_HD66_Home_Theater_Projector.html

Panasonic projector
http://www.bhphotovideo.com/c/product/823267-REG/Panasonic_PT_AE7000U_PT_AE4000U_HD_Home_Cinema.html

Domefest on Vimeo
http://vimeo.com/6988758

BASIC 3D MODELING

Though we would expand our imaging techniques as we went along, our basic approach to producing for the dome was to create 3D assets (characters and sets), import them into Unity, and then navigate through the environment, animating a third person character or moving a first person camera.

Since all of our graphic and media classes are based on the Mac platform, our first priority was finding an inexpensive and easy 3D modeling program to use. We were hesitant to start up with the industry standard Maya, as we were concerned about high licensing costs and a steep learning curve. Cheetah3D fit our requirements. We soon discovered that even the easiest programs for 3D require extended study and practice. This encouraged us to find other sources for 3D assets, both cheap and free, and to explore simplified environments and display techniques.

During our initial project start-up, several developments in entry-level 3D applications made our work easier. Pixologic, the makers of ZBrush, released a free sculpting program, Sculptris. Being able to sculpt a virtual ball of clay is a much more intuitive way to create 3D shapes than manipulating polygons. We found Sculptris very useful in introducing our students to 3D creation.

Resources

Cheetah3D

Cheetah3D website
http://www.cheetah3d.com/

Cheetah3D Training - Recommended ($29)
http://www.cheetah3d.com/training.php

Tips and Tutorials
http://www.mac3dsoftware.com/support.php

Tutorials, Links and Resources
http://www.cheetah3d.com/links.php

Sculptris

Sculptris website
http://www.pixologic.com/sculptris/

Sculptris-Unity Workflow
http://forum.unity3d.com/threads/49756-Sculptris-modeling-tool
http://up2dat3d.forumotion.com/t14-sculptris-vs-zbrush

ADVANCED 3D

When we began our project, we decided to avoid expensive 3D modeling software such as Maya since we knew we would not be able to afford licenses for all of our students. In fact, a full license for Maya would have used up most of the budget for our mini-dome workstation. We found that Autodesk had a program for educators that gave out free licenses, so we used that to evaluate the program and begin learning it. It is likely that as we continue our production work and expand our capability, we will use Maya more. It has already given us more flexibility to use a variety of 3D file formats, and allows us to exchange files with volunteer game designers and animators.

Similarly, ZBrush is commonly used in professional workflows but is too expensive for our current budgets. A donation by Pixologic of three copies of ZBrush allowed us to begin learning the program and trying it in our project. Within a few months, Pixologic released Sculptris, a free entry level sculpting tool that was adopted quickly by our students (see the Basic 3D Modeling page).

ZBrush is a professional 3D sculpting program that is widely used in character creation. It can result in figures with millions of polygons, making them unsuitable for use in real-time game engines, which require simpler digital assets in order to run with acceptable frame rates. In some cases, an operation called Decimation can reduce polygon count while maintaining the appearance of high detail.

However, most ZBrush workflows for Unity call for the creation of a low-poly version of a figure that is saved before further detail is sculpted. Once a more detailed version is created, a normal map is generated which, when applied to the low-poly version, gives the appearance of higher detail. This fairly complex workflow means that including ZBrush requires a much higher level of skill than construction using simple shapes and smooth surfaces.

Resources

Maya

Autodesk Maya Site
http://usa.autodesk.com/maya/

Maya Learning Path
http://usa.autodesk.com/adsk/servlet/index?id=9571510&siteID=123112&linkID=9242256

Maya tutorials (94 videos)
http://www.youtube.com/playlist?list=PLF3E8C00791AEC3F8&feature=plcp

Complete Maya to Unity Workflow
http://vimeo.com/10968593

ZBrush

Getting started - Pixologic
http://www.pixologic.com/zclassroom/

Getting Started
http://www.zbrushworkshops.com/sculpting-knife-tool.html

Pixologic ZBrush Youtube channel
http://www.youtube.com/playlist?list=PL247F5DF3A9F790C7&feature=plcp

Digital Tutors – Beginners guide to ZBrush
http://www.digitaltutors.com/11/training.php?pid=496

ZBrush on new 4R2 features (17 videos)
http://www.zbrushcentral.com/showthread.php?161537-ZBrush-4R2-ZClassroom-Movies.-Update-3

Making a vase
http://forums.3dtotal.com/showthread.php?p=693150

Ryan Kingslien - Sculpting the Face
http://www.youtube.com/watch?v=SzCBQoD55y8&feature=youtu.be

http://vimeo.com/28949284

Jason Walsh on 4R2
http://cgterminal.com/2011/09/25/zbrush-4r2-intro-to-dynamesh-tutorial/

Polypainting
http://www.pixologic.com/docs/index.php/Polypainting

ZBrush site on 4R2
http://www.pixologic.com/docs/index.php/Main_Page

ZBrush 4R3 introduction
http://www.zbrushcentral.com/showthread.php?166716

Tips and tricks
http://www.pixologic.com/docs/index.php/Tips_and_Tricks

Texture palette
http://www.pixologic.com/docs/index.php/Texture_Palette

Spotlight feature
http://www.youtube.com/watch?v=062jPkInTEk

Hard Surface Modeling – a list of tips and tutorials
http://learning3dfromscratch.blogspot.com/2009/09/hard-surface-articles-for-zbrush.html

Low-Poly Workflows (may not all apply)
http://www.youtube.com/watch?v=CcE0avDbHgU

http://www.youtube.com/watch?v=NQ09hkA54LY

ZBrush to Unity workflow (9 videos)
http://www.youtube.com/playlist?list=PLE3519744BD0B4DF2&feature=plcp

DIGITAL ASSET SHORTCUTS

Faced with steep learning curves and limited personnel, we looked for alternatives to creating all of our 3D environments and objects from scratch. We had two game industry professionals who donated time to create early prototypes of a girl character, and who provided tips and guidance. But soon we found other sources of 3D assets.

Established online stores such as Turbosquid and The 3D Studio offer a vast array of models, some of them free. The trick to using those assets is making sure you acquire them in file formats that your chosen software can handle. The best format for Unity is FBX, but it is also simple to import OBJ, .ma (Maya) and .max (3DS Max).

Unity Technologies introduced their own Asset Store early in our project, and it has expanded to include a wide variety of models, most of them free or inexpensive, as well as add-ons to Unity that make game mechanics and scripting easier. With the Unity Asset Store, you are assured that all models are compatible.

Other sources are attractive but more difficult to use. The Google 3D Warehouse has many models available for download, but the Collada format is more difficult to use with Unity. Sketchup Pro can convert Collada to FBX, as does a limited time evaluation copy of the program. In our project, the Emily Dickinson house, modeled by Beryl Reid, was found in the Literary Landmarks collection, a valuable resource for homes and places associated with authors.

One of the most difficult aspects of using a game engine is the modeling, rigging and animation of characters. Some digital asset stores carry rigged and animated characters, but Mixamo has pioneered a streamlined, online method for designing and animating characters. Some characters and animations are free, others are inexpensive enough to make it worthwhile in time savings. It is also possible to design your own character and then have Mixamo rig it through its website, and supply the animations.

A recent development with great potential is the rise of 3D scanners and other ways to record real world objects and convert them to meshes, for use in modeling programs and games. Autodesk, makers of Maya and AutoCad, entered the low-end and hobbyist market with the free 123D series of programs. 123D Catch allows a creator to take multiple photos of an object, upload them to the "cloud" and have Autodesk's servers return a 3D mesh. Other programs in the series provide 3D modeling and a connection to laser cutters and 3D printer services.

Resources

Digital Asset Stores

Turbosquid
http://www.turbosquid.com/

The 3D Studio
http://www.the3dstudio.com/

Unity Asset Store (integrated into the Unity application)
http://unity3d.com/unity/asset-store/

Character Modeling and Animation Services

Mixamo
http://www.mixamo.com/

Make Human
http://www.makehuman.org/

3D Scanning Tools

Autodesk 123D
http://www.123dapp.com/create

NextEngine Scanner
http://www.nextengine.com/

Other Low-Cost Resources

Mixamo's list of free resources
http://www.mixamo.com/c/articles/10-free-resource-2d

Google 3D Warehouse
http://sketchup.google.com/3dwarehouse/

Google 3D Warehouse "Literary Landmarks" collection
http://sketchup.google.com/3dwarehouse/cldetails?mid=f78f92c2d73bb4143b3255f750af3679

FISHEYE PHOTOGRAPHY

After the complexity of 3D production, fisheye photography for the dome seems very straightforward. It is the simplest way to acquire images that are pre-warped for hemispheric projection.

Using a full frame camera (a Canon EOS 5D) and a fisheye lens (Sigma 8mm) we learned to capture circular fisheye images. If the camera is held at the same tilt as the dome, the image when projected will appear to surround the viewer with the point of view of the photographer. Since the resolution of the dome is much higher than resolution of HD video, stills taken with a DSLR provide better visual quality than video. Those stills can be shot as a time lapse sequence from a fixed camera position, creating a dramatic sense of place, motion, and time when projected in the dome.

A 360 degree panorama can be stitched together from as few as six fisheye shots. We conducted a panorama workshop with Girls Club members on a trip to Mexico, using the PTGUI stitching software to easily create equirectangular photos. These odd looking photos can be mapped inside a sphere in the Unity game engine, and the viewer's POV moved inside that sphere to recreate the location of the photo series. We will explore this scene creation strategy further this year with a Coney Island time lapse project.

Resources

Pano head – Nodal Ninja
http://store.nodalninja.com/products/R1-Adjustable-Tilt-Ring-Mount-Package.html

Sigma 8mm fisheye lens
http://www.bhphotovideo.com/c/product/440665-REG/Sigma_485101_8mm_f_3_5_EX_DG.html

Canon 5D MK II
http://www.bhphotovideo.com/c/product/583953-REG/Canon_2764B003_EOS_5D_Mark_II.html

PTGui Stitching Software
http://www.ptgui.com/

THE UNITY GAME ENGINE

The Unity game engine was chosen as a production platform due to its ease of use, real-time navigation, and rapid prototyping capabilities. It proved to be an important element of our teaching strategy with teen producers, as they could instantly try their creations and navigate through 3D environments in real-time, without waiting for a rendering process.

Unity is a free download, although some features that we need for hemispheric projection require the paid Pro version. It is cross-platform, both in the systems that the program will run on (Mac and Windows) and in the platforms that your finished game or scene can play on (Mac, Windows, web browser, iOS, Android, and Flash.

One of the most useful, and free, utiilities is the iTween animation and path editing system for Unity. The "UFOMG" sample Unity project shows an object moving on a path, and the camera moving on a separate path. This has great potential for navigating an environment in a dome show, or creating cinematic camera moves for narrative purposes.

The key to using Unity in hemispheric projection is the Paul Bourke fisheye lens, created with a multiple camera rig in the Unity editor. This provides the circular, pre-warped image necessary for proper perspective in the dome. The first links in the resources section of this page provide the source of that camera rig and information on how to use it. A detailed tutorial will be posted on the domebase.org site.

Resources

Paul Bourke's fisheye camera implemented in Unity
Bourke's Page: http://paulbourke.net/miscellaneous/domemirror/UnityiDome/

Note: Link to Bourke's original Unity demo is here
http://paulbourke.net/miscellaneous/domemirror/UnityiDome/domedemos.zip

Bourke demo updated for Unity 3.5:
https://s3.amazonaws.com/domebase/Bourke_domedemos_2012.zip

Bourke fisheye camera, updated, as a Unity package:
https://s3.amazonaws.com/domebase/Bourke_Fisheye_Cam_35.unitypackage

Unity tutorial videos
http://video.unity3d.com/channel/1649856/tutorials

Student tutorials
http://www.unity3dstudent.com/

iTween animation and tracking utilities
http://itween.pixelplacement.com/index.php

iTween Visual Editor and iTween Path Editor
http://dkoontz.wordpress.com/itween-visual-editor/

Video Tutorials
http://www.youtube.com/user/cannedmushrooms/videos?query=Unity

Unity for Artists - Basics
http://adammechtley.com/tutorials/unity/basics/

Wiki list of tutorials
http://www.unifycommunity.com/wiki/index.php?title=Tutorials

Using Scripts
http://unity3d.com/support/documentation/Manual/Scripting.html

Newbie guide to Unity Javascript
http://forum.unity3d.com/threads/34015-Newbie-guide-to-Unity-Javascript-(long)

Arrays
http://www.unifycommunity.com/wiki/index.php?title=Which_Kind_Of_Array_Or_Collection_Should_I_Use?

Physics
http://unity3d.com/support/documentation/Components/class-PhysicsManager.html

Projector
http://unity3d.com/support/documentation/Components/class-Projector.html

Movie Texture
http://unity3d.com/support/documentation/Components/class-MovieTexture.html

3D Buzz - Custom character and camera control system
http://www.3dbuzz.com/vbforum/content.php?212

Mixamo – Prefab characters, animation, rigging
http://www.mixamo.com/

Unity Asset Store
http://unity3d.com/unity/editor/asset-store.html

A page turning utility (for in-game books) in development by Mike Renwick
http://www.youtube.com/watch?v=NQbha2tOY5Y

AUDIO AND MUSIC

Sound plays a big role in both game design and dome production. While we have just begun to integrate sound with Unity during the grant period, we are now concentrating on audio and music in our after school classes. With our students, we begin with Garageband for the basics. We have recently focused on Ableton Live as both a production platform for music and sound effects and a live performance tool that can be synchronized with Unity or operated independently. Ableton has a low-cost entry-level program called Ableton Live Intro that works well for us.

Unity has a very capable audio system, built around Audio Listeners (often attached to a navigating camera or game character) and Audio Sources (triggered when a collision is detected, or designed as 3D ambience in a space). Sounds can trigger once or loop, and the falloff of a sound with distance can be graphically determined. Unity allows both stereo and Surround sound design, which is a useful capability for dome production.

In the new Girls Club facility, audio production will center on the Airstream recording studio, a full-featured Pro Tools station for live recording of voice and instruments and mixing in both stereo and Surround sound. Several additional Ableton Live composing stations will be available for students to work on in classes or on their own.

Resources

Ableton Live

Ableton site
http://www.ableton.com/

Ableton Getting Started Series from Ableton.com
http://www.ableton.com/movies

A variety of Live tutorials
http://audio.tutsplus.com/category/tutorials/ableton-live/

Using the Looper
http://vimeo.com/32415551

Composing – 2 hr video
http://vimeo.com/30283458

Building a track with Live Intro
http://www.youtube.com/watch?v=8i5E0hrVPFI&feature=channel_video_title

Audio in Unity

AudioSource
http://unity3d.com/support/documentation/ScriptReference/AudioSource.html

AudioListener
http://unity3d.com/support/documentation/ScriptReference/AudioListener.html

Tutorial on using audio in Unity
http://www.unity3dstudent.com/2010/07/beginner-b10-audio-basics/

Encyclopedic resource of sound design in games
http://www.soundingames.com/

PROJECT RESULTS

The "invention" of the mini-dome workstation is the major result of this project. Allowing a producer to put months of study, environment creation, programming, and animation design into a dome environment, without the costs associated with operating a full-size planetarium, is a major accomplishment. This tool has enabled our work in the Unity game engine to result in new approaches to dome production. Some examples of the Unity work are linked below.

UNITY PROJECT SAMPLES

Project files are available for download in multiple file formats.

> Full Unity projects, which can be opened in the Unity game engine. Please note that the fisheye camera rig and some other features require Unity Pro.
>
> Compiled apps, for both OS X and Windows. Performance of these apps, including framerate, may be limited by your computer processor or its graphics card. Try a lower quality setting (available in the splash screen) if you have any problems running these apps.
>
> Webplayer versions. These will run in a browser, but if you do not have the Unity webplayer plug-in, you will be prompted for it.

All of the project file examples have been updated to run in Unity 3.5. Some of the samples are free-running animations. Others allow navigation through the 3D environment, using typical game controls of the WASD keys and the direction arrows. A mouselook feature may also be employed, allowing the viewer to look around and tilt up and down in the space.

The "History Jam" scene is an experiment based on our original goal for this project - to create an historical narrative based on the history of the site of the new Girls Club. This was a shipbuilding center when the first houses were built on the filled-in marsh nearby, and the Flying Cloud clipper ship reflects that. Later, the Civil War ironclad Monitor was built at foundries on both the Manhattan and Brooklyn banks of the East River. The Williamsburg Bridge now dominates the waterfront. Finally, the Maya temple from Palenque reflects our long term interest in Maya culture and our sister girls club in Chiapas, Mexico. The clipper ship was purchased on The 3D Studio website, saving us enormous time modeling the ship. Old New York buildings on te waterfront are purchases from the Unity Asset Store. For that reason we can't share the Unity project file. The Maya temple, Monitor ironclad, and Williamsburg bridge can be found in the Google 3D Warehouse.

The "Women Who Change the World" samples are recreations of a real life mural project, painted by local women artists on the tenement walls of a community garden.

Version 1 of the mural samples includes an animated girl figure, acquired from Mixamo, which can be navigated through the scene using WASD keys, and the mouse to orbit around the figure.

Versions 2 and 3 are a simplified approach, designed as a virtual gallery tool for other producers to use with their own murals or posters. They use an iTween-based camera tracking system to move the viewer from mural to mural.

The last fireworks sample is a study of a new Unity feature (the Shuriken particle system) and a celebration of the potential for creating inspiring work in the dome.

Resources

Studies and Experiments

Basic fisheye camera demo (modified Paul Bourke example)

- Project: https://s3.amazonaws.com/domebase/Simple_Fisheye_Project.zip
- App, OS X: https://s3.amazonaws.com/domebase/Bourke_Fisheye_Mac.app.zip
- App, Windows: https://s3.amazonaws.com/domebase/Bourke_Fisheye_Windows.zip
- Webplayer: https://s3.amazonaws.com/domebase/BourkeFisheyeWeb/BourkeFisheyeWeb.html

Emily's House (NEA "The Big Read" project on Emily Dickinson)

- Project: https://s3.amazonaws.com/domebase/Emily_House_Project.zip
- App, OS X: https://s3.amazonaws.com/domebase/Emily_House_Mac.app.zip
- App, Windows: https://s3.amazonaws.com/domebase/Emily_House_Windows.zip
- Webplayer: https://s3.amazonaws.com/domebase/EmilyHouseWeb/EmilyHouseWeb.html

UFO/Sci-Girls study (demo of iTween camera tracking, cloth physics, Maya vase recreation)

- Project: https://s3.amazonaws.com/domebase/UFOMG_Project.zip
- App, OS X: https://s3.amazonaws.com/domebase/UFOMG_Mac.app.zip
- App, OS X, (Fisheye): https://s3.amazonaws.com/domebase/UFOMG_Fisheye_Mac.app.zip
- App, Windows: https://s3.amazonaws.com/domebase/UFOMG_PC.zip
- App, Windows (Fisheye): https://s3.amazonaws.com/domebase/UFOMG_Fisheye_Windows.zip
- Webplayer: https://s3.amazonaws.com/domebase/UFOMG_Fisheye_web/UFOMG_Fisheye_web.html

Moonflower Animation (demo of ZBrush generated "flower", animated with NASA moon data and images)

- Project: https://s3.amazonaws.com/domebase/Moonflower_Project.zip
- App, OS X: https://s3.amazonaws.com/domebase/Moonflower_Mac.app.zip
- App, Windows: https://s3.amazonaws.com/domebase/Moonflower_Windows.zip
- Webplayer: https://s3.amazonaws.com/domebase/MoonFlower/MoonFlower.html

New York Waterfront Tests

History Jam (New York waterfront, clipper ship, ironclads, tenements, plus Maya pyramid)

- App, OS X: https://s3.amazonaws.com/domebase/History_Jam_Mac.app.zip
- App, Windows: https://s3.amazonaws.com/domebase/History_Jam_Windows.zip
- Webplayer: https://s3.amazonaws.com/domebase/HistoryJamWeb/HistoryJamWeb.html

Women Who Change the World, mural garden v1 (third person girl character)

- App, OS X: https://s3.amazonaws.com/domebase/MuralGardenV1_Mac.app.zip
- App, Windows: https://s3.amazonaws.com/domebase/MuralGardenV1_Windows.zip
- Webplayer: https://s3.amazonaws.com/domebase/MuralGardenV1_Web/MuralGardenV1_Web.html

Women Who Change the World, mural garden v2 (simplified, with camera track navigation, non-fisheye, click mural for info panel)

- Project: https://s3.amazonaws.com/domebase/MuralPanelsOnly_Project.zip
- App, OS X: https://s3.amazonaws.com/domebase/MuralGardenV2_Mac.app.zip
- App, Windows: https://s3.amazonaws.com/domebase/MuralGardenV2_Windows.zip
- Webplayer: https://s3.amazonaws.com/domebase/MuralGardenV2_Web2/MuralGardenV2_Web2.html

Women Who Change the World, mural garden v3 (simplified, fisheye)

- Project: (same as Mural Garden V2)
- App, OS X: https://s3.amazonaws.com/domebase/MuralGardenV3_Mac.app.zip
- App, Windows: https://s3.amazonaws.com/domebase/MuralGardenV3_Windows.zip
- Webplayer: https://s3.amazonaws.com/domebase/MuralGardenV3_Web2/MuralGardenV3_Web2.html

Fireworks - new Unity Particle System

WaterFireworks

- Project: https://s3.amazonaws.com/domebase/Unity_Fireworks_Project.zip
- App, OS X: https://s3.amazonaws.com/domebase/WaterFireworks1.app.zip
- App, Windows: https://s3.amazonaws.com/domebase/WaterFireworks1.exe
- Webplayer: https://s3.amazonaws.com/domebase/FireworksWeb/FireworksWeb.html

OUTREACH

Our primary goals during this start-up period were to build the mini-dome, develop workflows, and work with students in after school classes. But we knew that the project results would be of interest to 3D graphic artists, game developers, and small dome operators.

For outreach to these constituencies, we presented our work-in-progress to conference audiences, shared our work with Spitz, Inc. (dome and projection manufacturers, program producers), created a website (http://www.domebase.org/), and began developing a network of interested researchers online, through Google Plus.

For a repository of Unity project files, demos and apps (which can be large files), we chose Amazon S3. Links to sample Unity files can be found in the "Unity Project Samples" section of this document.

Presentations were made to the UNITE10 conference of Unity game developers, in Montreal, October 2010, and MacWorld 2012, in San Francisco. As of this writing we are waiting to hear about presenting to the Games For Change conference at New York University.

Links to conference presentation materials and online resources created by this project appear below.

Resources

MacWorld Presentation "No Place Like Dome"
https://s3.amazonaws.com/domebase/Dome_D_Pentecost.pdf

domebase.org website
http://domebase.org

Dave Pentecost Google Plus site (ongoing technology postings, community building)
http://gplus.to/davepentecost

Domebase Google Plus site (work-in-progress)
http://gplus.to/domebase

C4C (Center for Community) site - technology posts
http://c4c.posterous.com

LESSONS LEARNED

Despite our certainty going in that we could devise a simple workflow for dome production, we quickly discovered the limits of small teams in this area. Two occasional volunteers from game companies, a day a week each from one staff artist with 2D skills and one project manager: this was the extent of personnel devoted to the project. Staffing was determined by the limits of the startup grant and the project schedule.

Our goal - to create the simplest, cheapest possible workflow for animated dome productions - was not entirely achieved. We discovered some of the reasons that animated films and planetarium productions require many people and large budgets to produce. That said, we have successfully jump started our own dome production unit, created enthusiasm among our students, attracted new collaborators and found useful and affordable tools and strategies for small dome production.

Two conclusions were reached early on: our 2D artist, who creates all the graphic and promotional artwork for the Girls Club, would need more than one day a week to come up to speed on 3D modeling; and volunteers could advise and occasionally provide useful

digital assets, but had limited availability. The project manager devoted more than the anticipated one day a week to the project, in order to keep up with software developments in the field and begin building an appropriate workflow.

This sense of the labor-intensive nature of our effort was a useful finding. Other small dome production staff would likely face similar limitations in available personnel and budget. This sparked increased efforts to find ways to repurpose existing assets - archival, musical, textual, and photographic materials - in addition to the expected original 3D characters and sets.

From the "Trends in Fulldome Production" pdf linked below:

> A typical average of what most are spending for a 24-minute 3D animated program (4k x 4k resolution) is probably somewhere in the middle, between $300,000 and $600,000, or from $15,000 to $25,000 per finished minute.

Using Unity as our platform, we still anticipate being able to devise a lean, agile production method that will allow us to create appealing local programming, for a fraction of the costs in the above budgets. For our purposes, the Unity method provides a useful learning process for our youth production classes, introducing content and media production concepts in a rapid way, with quick feedback.

Resources

Trends in Fulldome Production and Distribution
http://extranet.spitzinc.com/reference/papers/Trends_in_fulldome_Show_Production_and_Distribution.pdf

NEXT STEPS

Our immediate next steps involve completing the construction of our new center, including the full size dome, and moving operations there. This will allow us to compare the preview quality of the mini-dome to the large dome, and adjust our approach to make it most useful in the production workflow.

There are a number of directions we plan to take in developing this workflow further.

- We will continue refining the hardware for the mini-dome.
- We will continue work on narrative strategies.
- We will develop more general purpose authoring frameworks. The “Women Who Change the World” simplified gallery navigation sample shows a useful direction for a framework that can be repurposed for other lessons and exhibits.
- We will expand our use of low-cost character animation systems such as Mixamo. Original character creation by small teams like ours may be inappropriate.

- We will acquire 3D scanning capability in the new building and use this to create virtual artifacts for historical productions. Our simple creation of Maya textiles and painted vases in experiments to date demonstrates the potential here.
- We will explore methods to incorporate other media in the dome, such as video and photography. Our cloth physics tests show that a rippling screen can be compelling in a 3D environment.
- Music will play a growing role in our work to evoke mystery and wonder in the dome. Minimal objects and dramatic lighting combined with surround sound may be the best strategy for the immersive environment. This is an approach that may be feasible and effective for small teams.

Our work so far has touched on new ways to interact with dome shows, navigate through 3D scenes, and combine music with visuals. Below is a list of some interesting possibilities for future work.

Future Developments and Resources

iPad control of the "Women Who Change the World" scene through OSC
- http://hexler.net/software/touchosc
- http://forum.unity3d.com/threads/16882-MIDI-or-OSC-for-Unity-Indie-users/page2
- uScript version http://uscript.net/forum/viewtopic.php?f=21&t=1089
- PlayMaker version http://hutonggames.com/playmakerforum/index.php?topic=1087.0

iPad control of Ableton Live
- With TouchOSC http://vimeo.com/17018938?ab
- With LiveControl http://livecontrol.q3f.org/

OSC control of Music from Unity
- Sender scripts from this thread http://forum.unity3d.com/threads/16882-MIDI-or-OSC-for-Unity-Indie-users/page2

Processing generative art code, displayed in Unity
- http://syphon.v002.info/
- http://code.google.com/p/syphon-implementations/

Quartz Composer in Unity
- http://syphon.v002.info/

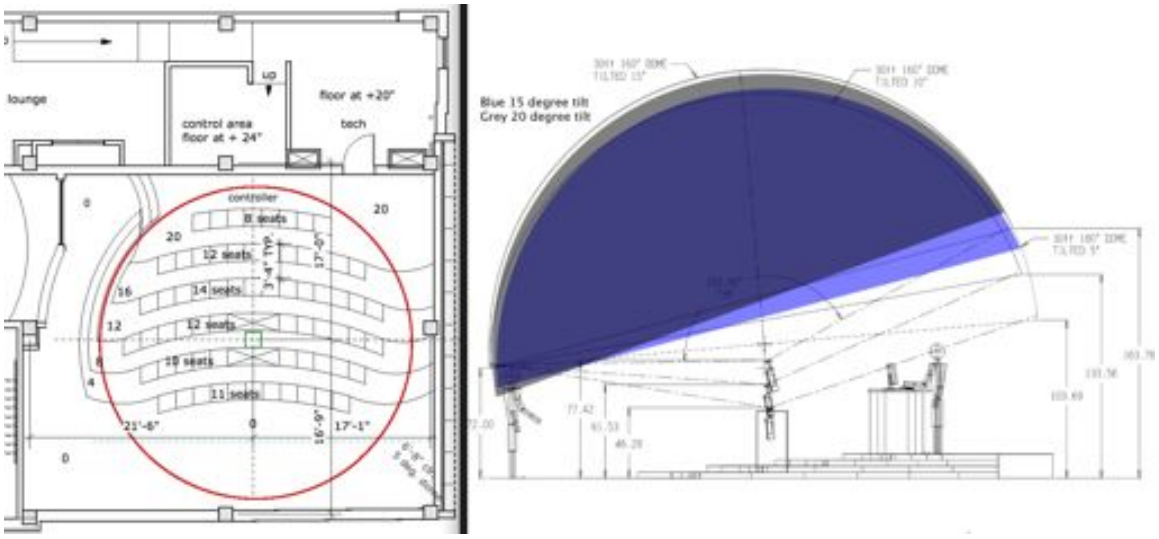
Web pages in Unity
- Paid ($200) solution http://mythoslabs.com/uwebkit/features
- Community plug-in http://www.unifycommunity.com/wiki/index.php?title=HtmlTexturePlugin

Kinect control of Unity
- Easiest deployment (free basic package) http://zigfu.com/

Audio reactive visuals in Unity (including spoken word)
- Paid ($50) add-on http://www.alteredr.com/visualizer-studio/visualizer-studio.html

More work on camera path control
- http://pixelplacement.com/2010/12/03/visual-editor-for-itween-motion-paths/

APPENDIX



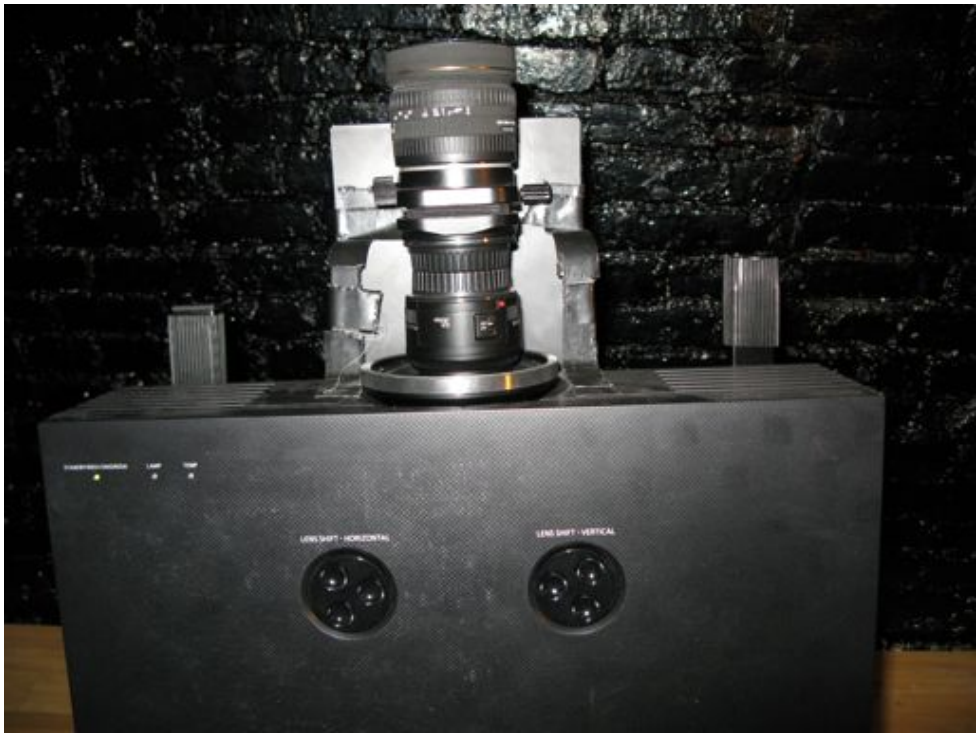
Full size dome under construction at the Center for Community

Mini-dome workstation

Acrylic dome at the Girls Club

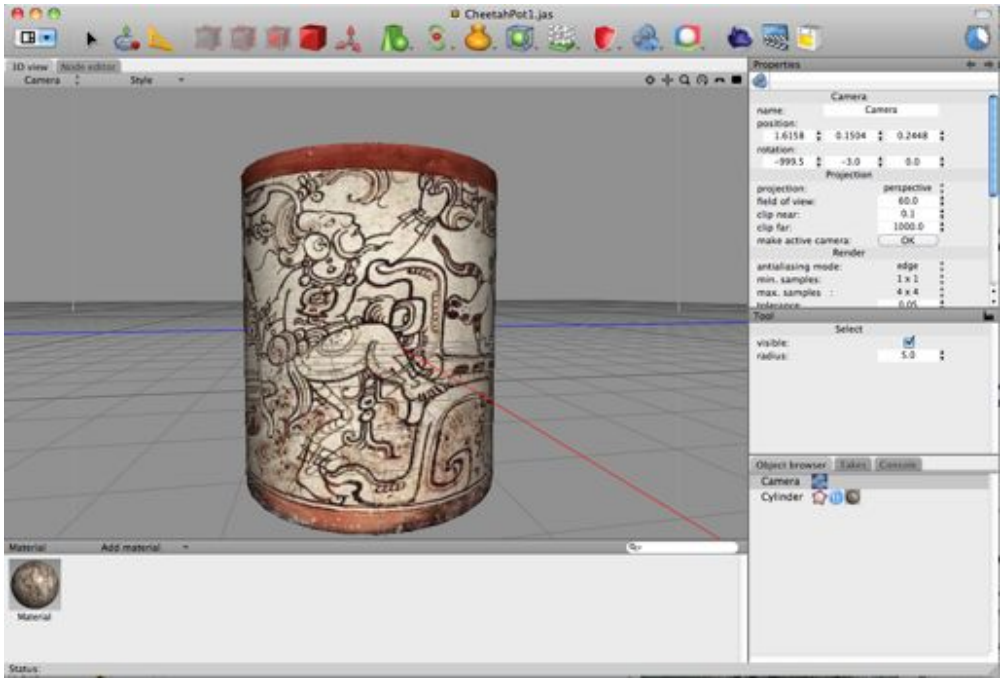
Lhoumeau projection design

Domebase fisheye lens assembly – 50mm lens on the left, 8mm fisheye on the righ



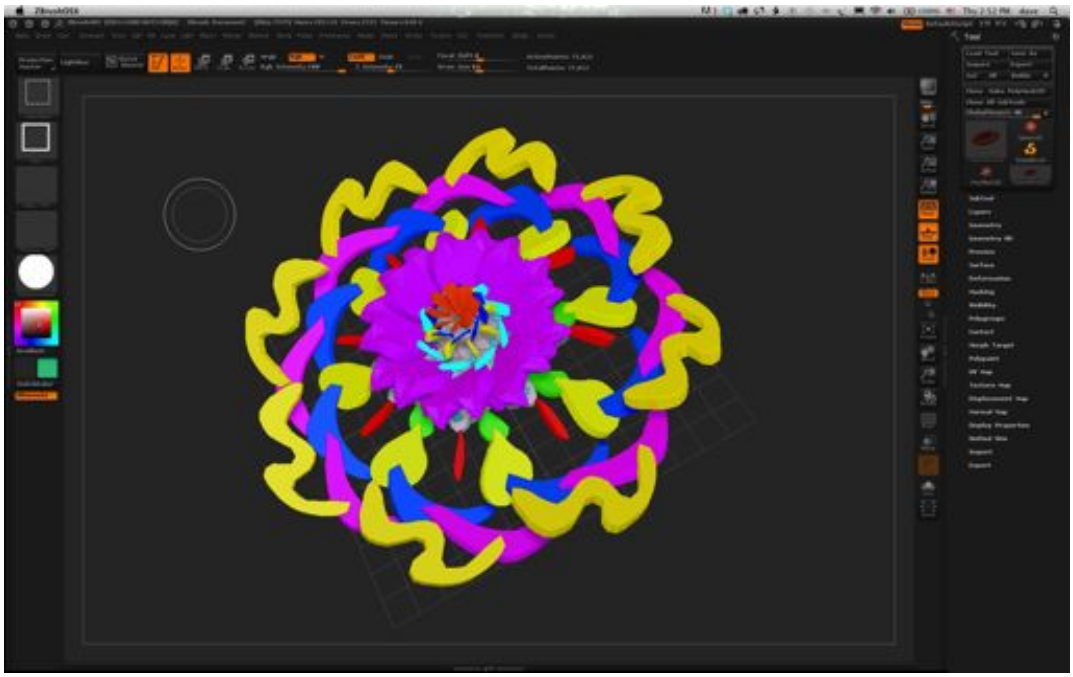
Final projection assembly on the Panasonic PT-AE3000U projector

“Women Change the World” mural garden in Unity on the mini-dome

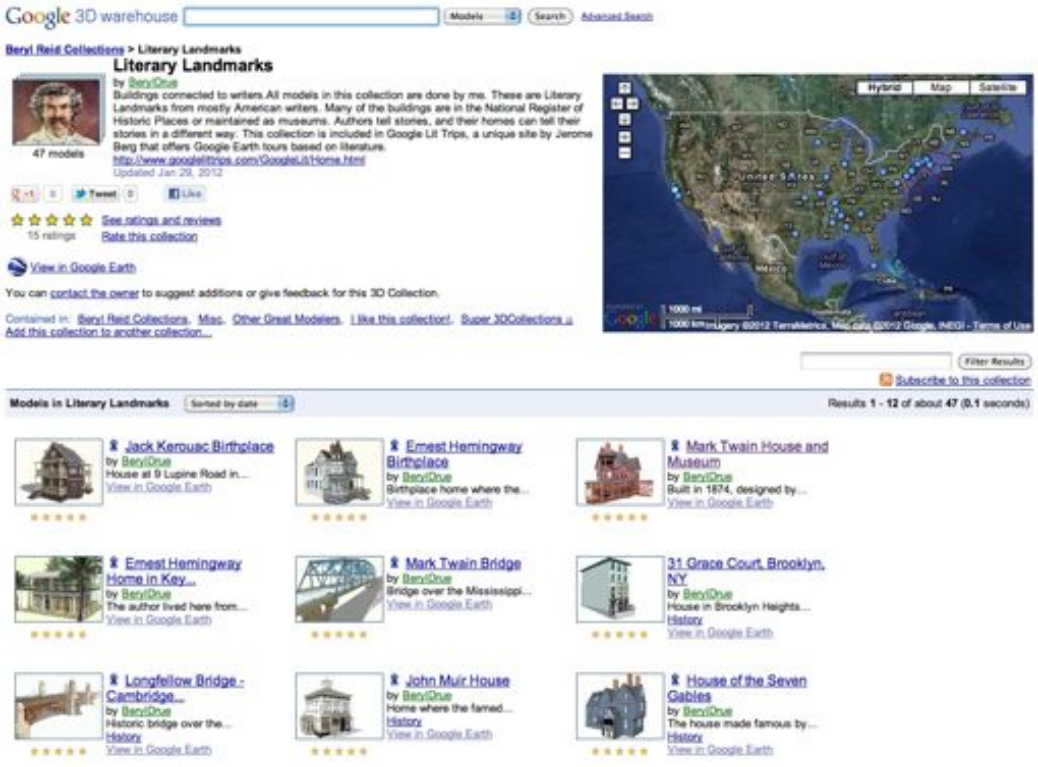


Maya Vase recreation in Cheetah3D

Student work in Sculptris



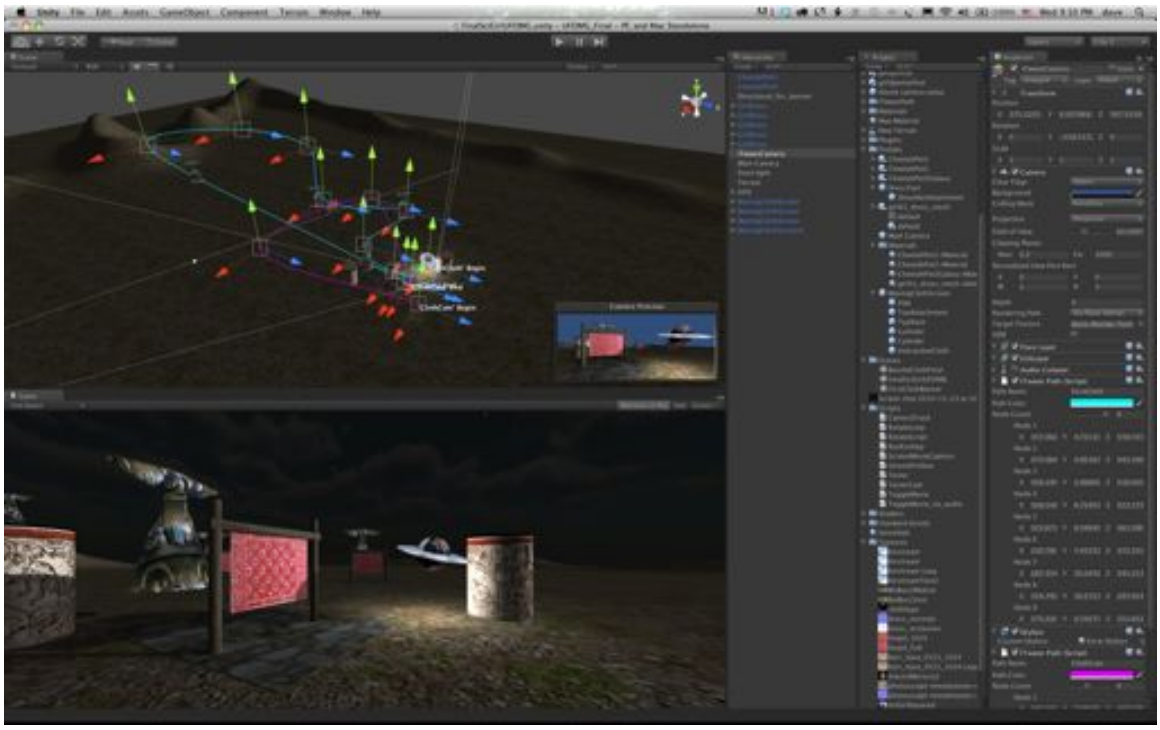
Moonflower sculpt in Zbrush



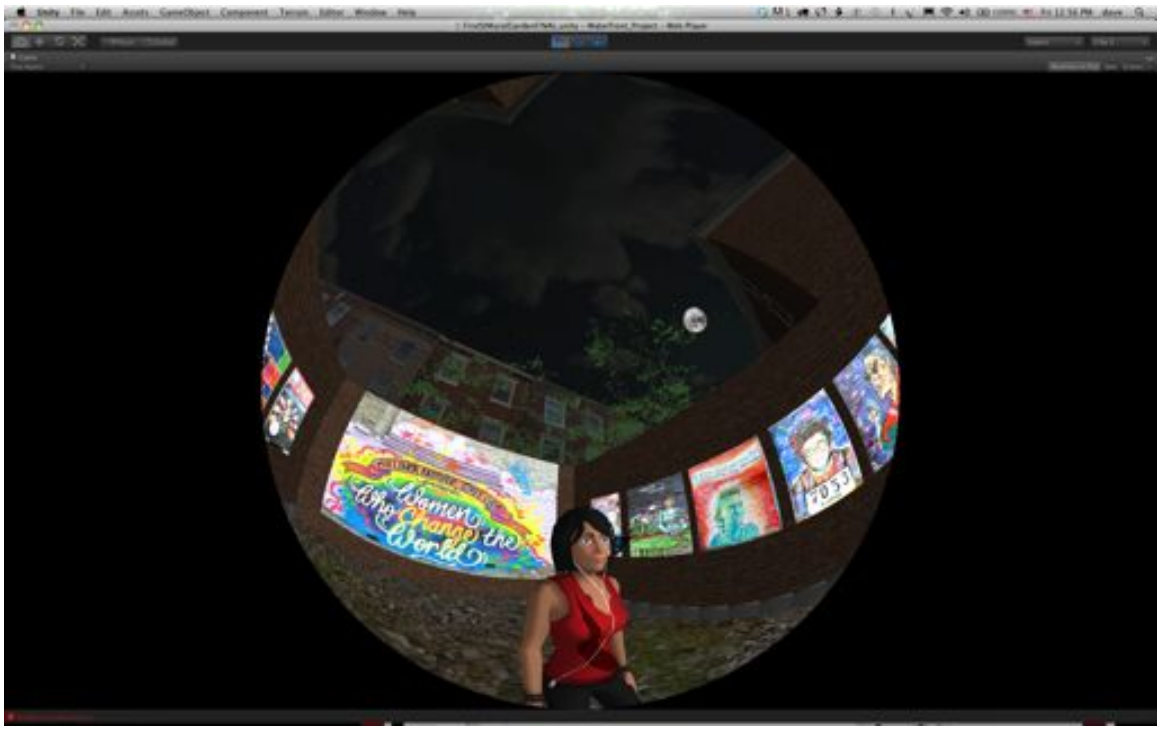
Literary Landmarks Collection by Beryl Reid, Google 3D Warehouse

Six fisheye shots

360 degree Equirectangular photo, stitched from the six shots above



"UFOMG" animation in Unity, with iTween path editor camera and object tracking



"Women Who Change the World" mural garden, with Mixamo girl character, fisheye view