AZ-LIVE's Sketch to 3D Immersion Completed in a Day

By: Steven Eiselen, Amanda Chesher, and Chris Deer

Building a Visualization Project

The popularity of data visualization rises as it becomes increasingly important in modern research. The Arizona Laboratory for Immersive Visualization environments (AZ-LIVE) has visualized countless projects for faculty, staff and student across all academic departments. AZ-LIVE's visualization breaks down into two main project types. One type focuses on chemical and biological structures, generally classified as scientific visualization. The second main type, referred to as architectural visualization, encompasses landscapes and architectural buildings. Past examples of architecture projects range from virtual cities to landscaping improvements in downtown Tucson to recreations of historical places. This article will be specifically focusing on architectural visualization.

AZ-LIVE Lab Coordinator Marvin Landis and architecture specialist Steven Eiselen are the developers who construct these visualization projects. These projects can be completed in a day, sometimes as quickly as fifteen minutes even. But that doesn't mean this is a simple process. The process can be broken down into three main parts. The first part relies on getting the project from its initial form to a completed model in a prepared virtual environment. The second part takes the prepared virtual environment and visualizes it with conventional methods such as pictures and videos, AZ-LIVE's Mechdyne Flex Cave Autonomous Visualization Environment (CAVE) for virtual reality immersion, or the University of Arizona Creative Coding Lab's Oculus Rifts. While Steven Eiselen usually receives the client data in the form of a completed 3D model, this article will start from a pen and paper sketch and work up from that.

Making the Model

Assuming things from the client's perspective, the first step of this process is to sketch a concept onto paper. After the pen and paper drawing of the complex building is completed, it can be brought to Steven Eiselen. The client will generally want their sketch modeled. This is where Steven Eiselen comes in. Upon receiving the sketch, Eiselen will transform the sketch into a 3D model. Eiselen generally prefers using SketchUp, an excellent 3D modelling program which excels at making rapid pace models of 3D architectural designs and models. This portion of the article will focus on making the 3D model using SketchUp.

The first step in this process is generally adding some form of surrounding terrain or real world location for a reference. There are four main options for adding this terrain. One option is to use a Google Earth screenshot or some other image of a site, scale it, and then use a flat 2D surface. This method is most common for rapid prototypes where speed is the top priority, as well as concepts for fictional terrains such as space colonies. Another option is to use the SketchUp sandbox feature to craft a custom made 3D terrain; however this can be done better in other 3D modelling programs and even the Unity3D game engine. A third option is to get a heightmap from GIS / LIDAR data, convert it into a 3D mesh or model using other programs, and import the model into SketchUp. A heightmap is a special image type in which the pixels correspond to elevation, and often includes a corresponding image map which provides visual data. AZ-LIVE used this methods for the Catalina Mountains, the Grand Canyon, the Mars Domoni Crater models, and a project done in conjunction with Pima Association Governments.

Finally, the most used method is SketchUp's geo-location tool. This allows for a direct import from anywhere in the world with a varying level of 3D height accurate quality depending on how large the site is. While the terrain and image map are not high quality, the model is sized accurately and works well for the conceptual stage of a project. The benefit of the geo-location tool is that it allows for the ability to position the model at the location specified. This means that once geo-located, you can use SketchUp's 'Preview in Google Earth' tool alongside an installed copy of Google Earth to actually view your model in its real world location to scale in Google Earth. Yet another major benefit is that it is also possible to, in the components window, select 'nearby models' to import surrounding buildings, which is great for comparing concepts with surrounding architecture.

At this point all that's left is detail work. The building will need modeled and textured, as well as any custom props added such as light posts, signs, etc. For the purpose of this article, the details on how to model the building itself will be skipped. Additional props may be needed, and SketchUp works well for this. It has access to the Trimble 3D Warehouse, which has models of everything from cars to furniture to streetlights to other buildings. Just be sure to check the Trimble 3D Warehouse License Agreement before using the models for future projects. At this point, the complex building drawing is now a 3D model. Textures can be added, detailed landscaping can be added. At this point, the model can be sent to AZ-LIVE for processing.

Preparing the Model

When AZ-LIVE's Steven Eiselen and Marvin Landis receive a model, it is most frequently in the form of a SketchUp model, as discussed before. Those are the easiest models to process and work with. However, the lab receives other models such as Autodesk Suite Revit, 3DS Max and Maya models, as well as Blender and Lightwave files. For SketchUp models, the 3D space that the model is in is typically called a 'scene' or an 'environment'. Many models have multiple structures and components, and even entire high detail blocks of buildings with props and landscaping. Afterward the model is processed the model with a few touch ups based on the client specification. Some clients request no corrections, such as architecture class professors when referencing student projects. Other projects will require more extensive touch ups. Touch ups include things such as optimizing polygon counts[1], resolving Z-Fighting[2], setting up component

[1] Polygon count refers to how many polygon shapes are used to create a model. Lower polygon models look more 'box-like' with sharper corners, whereas higher polygon models look smoother with more rounded corners. Polygon optimization refers to lowering the polygon count within acceptable parameters for better performance.

[2] Occurs when two polygons intersect with each other and cause a flickering effect where each is "fighting" to be rendered over the other.

and group hierarchies[3], and preparing billboard objects[4]. Once the touch ups are complete, the model is exported to Unity, almost always as an FBX file. Per the export: exports are typically in centimeter units with the 'Y' axis facing up, and will sometimes export 2 sided faces, especially if the models texture mapped but the face is oriented the wrong way.

Importing the Model

The AZ-LIVE uses the Unity3D game engine. The main reason for this is that the creator of the University of Arizona's CAVE, Mechdyne Corporation, has a program called GetReal3D which allows an easy workflow for using Unity3D with the CAVE via a special Unity package and Daemon program (TrackD) which creates a synchronized Unity Executable for the CAVE. At this point, our Sketchup model, which was just exported as an FBX[5], catches up to the same position as other 3D model types - and the following steps are universal for every 3D model type. Then a new Unity Project is created along with new folders for the models, scripts, and other parts of the project. Then the model that was just exported from SketchUp is imported into Unity. Depending on the unit's scale the import scale will be changed until it matches the base scale. This is almost always a base 10 change. SketchUp comes with an 'auto generate colliders' option and, depending on how simple the polygons are, this may be all that is necessary. When auto generating the colliders, Unity tries to create colliders from the model's mesh. Sometimes these colliders are not sufficient; in these instances the AZ-LIVE team goes in and makes their own colliders to better match the mesh. There are options to turn on walkable surfaces, buildings, and interiors so the user can bump into a surface and not go through a wall. This is especially important for visualizations utilizing physics and gravity. More basic colliders will be created for

[3] Making each set of objects their own group.
[4] 2D representations of props which are always facing the camera in order to mimic a 3D effect.
[5] While SketchUp is free for nonprofit and evaluation use, the FBX export option is only available in the pro version after the initial evaluation period has ended.

spheres and boxes, especially objects which can be interacted with, dynamically moved and or tossed around such as AZ-LIVE's Interactivity Room and Human Organs simulations.

With the models scale and colliders set up, the next step is to create a basic lighting scheme for the Unity scene, usually by increasing the ambient light and adding a directional light to simulate sunlight. As the CAVE projects a darker image than a desktop running the same program the lighting is intensified in order to compensate. Shadow settings can be added to objects and lighting. A skybox can be added if the client requests one, although generally the default blue skybox is kept. Some projects require the application of special materials and shaders, such as for transparent, self-lit, specular and reflective textures. At this point, the billboard objects still need some processing by the use of several scripts. The first script added places the mesh into world coordinates as opposed to the coordinates of their local space so that they will rotate in place around the user. The second script makes the mesh face towards the player but casts a static shadow relative to the position of the directional sunlight. The last step for scene preparation is to code out and implement any special features and parts of the environment. These are things such as interactivity, physics, and gravity with objects, proximity triggers, audio, animations, GUI's, and other things you would find with interactive software. The scene is then completed.

Interfacing with the Model

If the goal is to do a video or screenshots, typically nothing else is needed except to use a static or scripted camera depending on the implementation and taking screen and video grabs.

If the goal is a desktop-based, screen based "game," then a character controller and several scripts to allow interactivity with a mouse and keyboard or with a controller will be added. The project will then be exported as a regular Unity executable and run wherever it is needed to be run. For example, there is an executable for the Belle Isle Commonwealth[6], which provides an

[6] http://rc.arizona.edu/az-live/in-house-projects#Belle

interactive fly-through of the Belle Isle Concept Model. There is also a working version of the Foot Model available in this format that was produced by Christopher Deer[7]. When using the Oculus Rift, the process is approximately the same except that there is an Oculus Unity Plugin for the character controller and cameras.

If the goal is to work with the CAVE, more work is required. First, the GetReal3D package is needed. Then a basic character controller prefab object is added into the scene and the settings are modified. These modified settings include disabling gravity, whether or not a wand will be used for interactivity and what purpose, as well as the wand movement type and movement speed. Movement speed is related to the size of the model and is set accordingly. Finally, the Unity scene is exported as an executable and a test run is done in the CAVE. During the test run, it may become apparent that changes need to be made; these changes are often lighting, object scale, and movement speed. After that works, there is only one final pre-appointment inspection needed. After that, the project is finished and the client is ready to be immersed in their project.

[7] Graduate Student in Applied Biosciences, also works for the AZ-LIVE