ALAMO COLLEGES DISTRICT
San Antonio College

FACET Monthly
3D Technologies @ SAC

Volume 1, No. 1

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Funding:
FACET is funded through a U.S. Department of Education Title III HSI grant. (#P031C110039)

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EDITORIAL:
TOWARD SPATIAL EQUITY IN ACADEMIA

by **Aaron Ellis**

Whenever our team travels for outreach events in the community, we often hear the statement, "I didn't know SAC did that." Even among faculty, staff and students at San Antonio College, many people are unaware that this institution has been applying 3D technologies toward solving practical, academic, and research problems for the better part of this decade.

This shouldn't be as surprising as it is. Many colleges and universities have engineering and architecture departments. Some even have academic programs dedicated to film or game development. Of course, all of these disciplines benefit from 3D hardware and software.

If someone wants to build bridges as a career, that person might start by enrolling in a civil engineering program at an institution and begin working through the curriculum over several years. In today's world, such a student would soon encounter CAD software and be expected to master the related tools.

Despite the difference in subject matter, aspiring game developers might follow a similar path and find themselves using similar software.

That's great for engineers, architects, game, film and television developers. But what about everyone else? What about the paleontologist who wants to accurately scan dinosaur footprints or fossilized leaf impressions? What about morticians tasked with constructing realistic prosthetic applications for decedents with facial injuries?

Are there any colleges that teach the professional application of 3D for those not pursuing careers in engineering or entertainment? The answer is a disappointing "kind of, but not really."

Digital 3D has been around for decades and like many advanced technologies that eventually migrate beyond their initial industries into completely unrelated fields, 3D is becoming increasingly visible in the corporate world. Costs continue to drop and ease-of-use improves. For example, end-users can now scan their own faces and insert fairly accurate digital sculptures into online video games with little more than a cell-phone.

Unfortunately, academia has been slow to catch up to these changes or to even acknowledge 3D as a disruptive technology. While many institutions of higher learning in the U.S. offer a Biology for non-majors class, very few provide 3D technologies classes to students outside of narrow technical fields.

Johns Hopkins School of Medicine is just one that now offers a first-year Medical Sculpture course utilizing both traditional and digital sculpting methods. Other institutions around the country have a few scattered, not-for-credit offerings as well.

But similar educational opportunities in Texas are largely unavailable. In response to this, in late 2018 San Antonio College began offering 3D technology training to the community. These classes are not part of an academic department. They don't count for college credit, or even CEUs. However, these classes do provide short, focused, and inexpensive skills-training in six key disciplines; modeling, sculpting, visualization, terraining, scanning and printing.

PROJECTS:
DINOSAUR DOCUMENTATION

by **Aaron Ellis**

If you've lived in or around Bexar County for a while, you may have heard of Government Canyon State Natural Area. GCSNA is a 12,000 acre recharge zone that serves the city of San Antonio as part of the Edwards Aquifer and is home to ancient hidden treasures.

GCSNA has experienced many localized floods over the years and each event displaces lots of soil and rock. Well over a decade ago, after one such flood, Texas Parks and Wildlife staff, John Koepke and Niki Lake, discovered an extensive dinosaur trackway newly-exposed in the limestone canyon floor along the Joe Johnston trail route.

After a few years searching for the right partners to properly document the find, TPWD signed an agreement with the Witte Museum and San Antonio College in which SAC would provide 3D scanning services for dinosaur footprints at the site.

Most of the dinosaur tracks remain under water for much of the year and are typically covered with algae and debris even when dry. But for four weeks each August over a period of three years, SAC faculty, staff and students converged on the canyon along with TPWD natural resource officers, Witte staff, and local volunteers. This group worked together to clean and prepare each of the trackways for documentation, analysis, and 3D scanning.

The SAC team scanned fifty of the most impressive dinosaur footprints using an Artec Eva 3D scanner to quickly capture all of the surface and textural details. The dinosaur trackways are located roughly two-and-a-half miles from the nearest power source, so we had to provide our own portable power for the scanner and laptop.

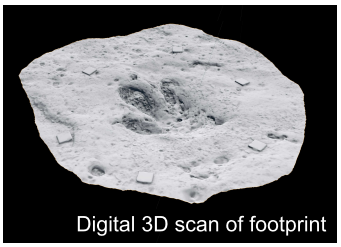
After completing the high-resolution scans, we then brought in Sean Ryan from SAC's Department of Creative Multimedia to film the three major trackways using an aerial drone for the low-res scans. Once that video footage was captured, our team uploaded 300 of the best still images into Agisoft MetaScan. Processing such a large photoset took over 24 hours to complete using a powerful computer and resulted in a virtual replica with over 120 million polygonal surfaces.

In spite of the blazing August temperatures, numerous technical challenges and the constant nagging of biting insects, this project was a great success. It is gratifying to see that the work our team contributed is now part of permanent physical and interactive displays in the Witte Museum's main hall. ▲

Note: a video example on YouTube at:
https://youtu.be/zXjByuCO72c

Aaron Ellis and Anne Dietz scanning sauropod footprint

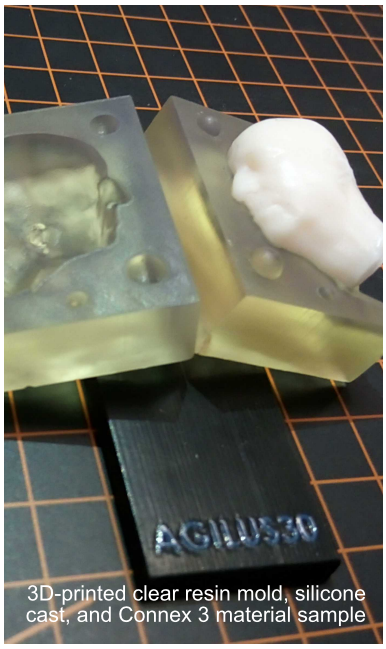
Theropod footprint in limestone at GCSNA



Digital 3D scan of footprint

NEWS:
SAC TO UPGRADE HIGH RESOLUTION 3D PRINTER

by **FACET Staff**



3D-printed clear resin mold, silicone cast, and Connex 3 material sample

In 2014, San Antonio College received its first high-resolution 3D printer. The device is a Stratasys Eden 260 VS printer that uses Polyjet technology. The Eden was funded through a U.S. Department of Education Title V grant for $99,902.00 for the printer, a control computer and a water-jet parts-cleaning station.

Recently the 3D technologies staff at SAC learned about a trade-in opportunity to upgrade the single-material Eden 260 with a multi-material Objet 260 Connex 3 printer. The Connex will finally offer us the chance to mix various colors, including clear, together in a single object and to print fully-assembled prototypes with both rigid and flexible materials. By using multiple material cartridges, the new printer will be able to generate objects with as many as 85 different resin combinations. In contrast, the Eden 260 printer supports only one material per print job.

The Connex 3 printer has the same build-area, resolution and uses the same software and resin cartridges as our older printer. This will allow faculty, staff and students who are already trained with the Eden to transition their 3D printing projects to the new platform with little additional instruction.

3D printing projects that we've worked on in the past include replica skulls of early hominids for the Anthropology department, human embryonic development models for the Biology department and simulated prosthetic facial features for the Mortuary Science department.

One of the project ideas that has been out of reach to date is a series of clear resin models with colorized bones, muscles and organs suspended within to highlight the appropriate structures and their placement inside the human body. Our team has created interactive virtual versions of some of these models but with the Connex, we will be able to replicate them with physical models as well.

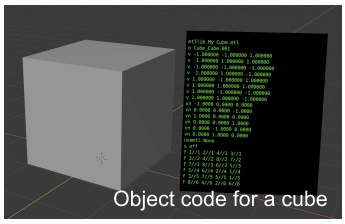
The new printer will be integrated into our program of study early in the new year with February's 3D Printing & Fabrication class. ▲

IDEAS:
OPEN SOURCES

by **Aaron Ellis**

One of the reasons that FACET exists is to de-mystify some of the secrets behind 3D technologies. 3D printing is a cool topic that frequently pops up in the news. It sounds easy enough – download a file, plug it into a printer and wait for a physical object to pop out. Yes, it can be that simple. But only if a valid digital object already exists.

But everything in 3D, even a plain cube, must be built by someone. A cube has six sides, twelve edges and eight points. To a 3D software program, that same cube is just an organized collection of vertex coordinates in an XYZ world and is defined by digital code. That code is the DNA of 3D.


Object code for a cube

It takes a lot of data to make just a simple cube. But what about something more complex? How about a five-horned rhinoceros beetle? SAC student Jamila G. and I sculpted one from scratch after several hours of work over a handful of days.

Just one high-quality replica of an insect contains more than a million tiny triangular faces called polygons. If we were to display the code for such an object, it would fill thousands of pages of printed text.

Needless to say, a lot goes into making customized virtual objects. While there are very few "easy" buttons when it comes to building 3D content, the FACET team is dedicated to making it accessible to all. ▲

3DIVERSIONS:
MINIATURE MADNESS, part 1

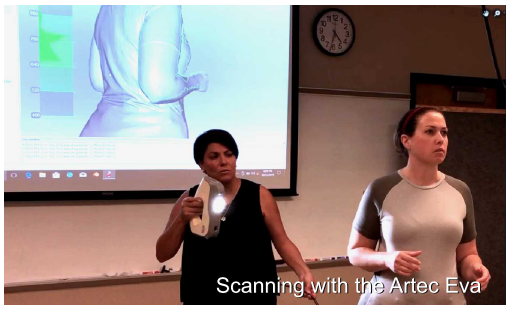
by **America Wilson**

The same technology that aids in the study of prehistoric artifacts and the production of wearable prosthetics can also be applied to projects that are less serious. Over the next three issues, I will detail a fun project that starts with scanning a real human subject and ends with printing a tabletop gaming figurine.

So, what is 3D scanning? It is the process of analyzing a real-world object to collect data on its shape, often using a technology called photogrammetry. Jackie Black, who is an avid gamer and Architecture student at SAC requested a customized game piece. The initial strategy was to do a full-body 3D scan of Ms. Black and use that data to make the figurine. This project was to be my first attempt ever to 3D scan anything and the idea of scanning a full six-foot-tall human subject was daunting.

To scan Jackie, I used an Artec Eva 3D scanner. This is the same scanner model that was used to produce the first 3D portrait of an American President – President Barack Obama. The scanner is handheld and lightweight, featuring three sensor eyes and twelve strobe lights around the central camera.

To prepare for the session, I rehearsed my intended scanning track – keeping in mind that I needed to cover every surface of my subject. The device is not wireless so it must be attached to a laptop with cables. Moving completely around a subject with a digital scanner and keeping the required sensor distance can be a real challenge with short cables.


Scanning with the Artec Eva

Thankfully, the 3D Technologies lab at San Antonio College is outfitted with a digital projector, an articulated arm for the laptop and an overhead retractable power outlet. This combination allowed me to see the data the scanner was collecting even when I moved away from the laptop and also helped keep me from tripping on cables and cords.

Jackie was an excellent scanning subject. Her outfit was form-fitting with a neutral pattern and muted colors. She pulled her hair back and powdered her face so the scanner would not pick up any shininess. One of the first things I learned in this process was that the scanner "likes" some surfaces better than others. It hates reflective or refractive objects. Also, the distance from the scanner to the subject greatly determines the quality of a scan. And sometimes it needs a different angle to fill-in any holes the scanner leaves due to incomplete data. Holding the device steady and making slow movements is imperative to allow the scanner time to process all of the images. Go too fast and the scanner has the potential to lose track of the object, forcing the operator to return the device back to the last point it "remembers" had usable data. Overall, the Artec Eva 3D scanner is easy to use, and captures shapes with incredible speed and precision. And it will only set you back $20,000.

Scanning Ms. Black was the easy part. She held mostly still for over 14 minutes before her muscles objected. Even so, she moved ever-so-slightly a couple of times, creating a few spots of bad geometry. These errors typically present as scars or extra body parts and occur when a feature is scanned twice, but in different locations. The software doesn't realize that new data coming in is still the same object.


Incorrect scan data

Fixing bad geometry and cleaning up 3D scans can be a long and frustrating process. So far, I have invested about 16 hours in cleaning up Jackie's scan data to get the model ready for printing but that's another story reserved for next month's article. So, stay tuned for the next chapter in the odyssey to make a tabletop gaming mini-fig in 3D. ▲

Note: a video example can be found at https://youtu.be/L67s7K4QtNg

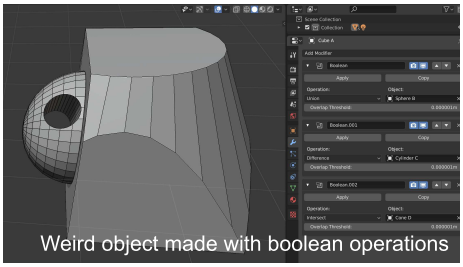
TECHNIQUES:
EASY 3D MODELING FOR NON-ENGINEERS?

by **FACET Staff**

There are many different ways to create 3D objects. Most of these methods require several complex steps and a fair degree of advance planning. Fortunately, some great-looking and functional models can still be built quickly and painlessly using a handful of tools called modifiers. Over the next few articles in the Techniques section of FACET, we will be taking a look at various modifiers and how they work to make the process of making things easier.

Modifiers belong to a class of tools that performs frequently-needed tasks. Those tasks include beveling object edges to make rounded corners, spinning profile contours into wine glasses, etc. Today, however, we will learn how to use boolean modifiers in Blender 2.81 to make representational models of buildings and other structural shapes.

Boolean modifiers might best be thought of as geometric math utilities. With booleans, there are only three mathematical operators; addition, subtraction and intersection. A boolean "Union" operation might be to merge a sphere onto the side of a cube. Then a boolean "Difference" operation might cut a cylindrical hole in the side of that sphere. After that, a boolean "Intersection" operation could discard parts of the cube that don't fall within an overlapping cone.


Weird object made with boolean operations

Only a few geometric math operations are needed to make an exceptionally useless object like the one described above. Evidence of the originating shapes should be noticeable both in the final model and in the stack of boolean modifiers affecting the initial cube.

With that quick introduction to booleans out of the way, let's get started. A default Blender 3D scene typically contains a cube. And a cube is one example of a "primitive object." Other object primitives are planes, circles, cylinders, spheres, cones, and torii. For this activity, we are going to keep it simple and just use cubes in our scene.

We can add these new objects quickly by clicking the Add, Mesh, Cube menu options in Blender. This will add and place a new object of the chosen type into the scene at the position of the 3D cursor. Repeating the process will add more cubes in the same virtual space.

For now, let's just add two extra cubes to the starting cube in the default Blender scene. Once we have three overlapping cubes in our workspace, we can then begin manipulating those objects in relation to each other to prepare for boolean operations.

The three spatial transformations we can perform on any object in a 3D scene are Move/Grab, Rotate and Scale. Blender 2.81 has dedicated buttons for each of these tasks, but for this example, we will just use keyboard shortcuts instead. To move a cube straight up, select the object so that it is highlighted in a yellow outline, then tap the G key on the keyboard, followed by a tap of the Z key, and then punch in a number – let's say about 1.7 for this cube. After moving the cube upward (in the Z-axis) we can scale the still-selected cube by tapping the S key on the keyboard and then type in 0.9 to shrink it by 10%. We can do something similar to one of the other full-sized cubes as well by selecting it, then Grabbing/moving it in the Z-axis by -0.2 and then Scaling it down 0.9.

If you followed those steps you should have three stacked and intersecting cubes. The next step is to select an unmodified cube, then locate and click the Modifiers tab in the Blender 2.81 side panel (the icon looks like a blue wrench). In the Modifiers panel, click on the Add Modifier button and select the Boolean option on the third row of the second column of options. This adds a new boolean entry in the modifier stack. The default option should be set to Difference (subtraction) but it will not yet have a target object or cutting tool assigned until you click the empty field to the lower right and select one of the other listed cubes. Click the Apply button to make the cut. Then repeat the process for the other scaled-down cube. The result should be a building with a hollow interior and a roof ledge. Cutting windows and doors follows all the same processes but requires a few more steps.

Office building cut with boolean modifiers

Now try to complete your own office building using boolean difference, union and even a few intersection operations. ▲

Note: a video example can be found at https://youtu.be/b4g3B2eLndA

CLASSES:

San Antonio College offers 3D Technology classes every month. Most of our classes meet once a week for three hours on Fridays. Most classes meet for a total of two, three or four weeks, depending on the discipline. Class costs are low and priced for the entire class (not per session). Our 3-4 week 3D Visualization class is always free of charge. Off-schedule classes can be arranged for groups of five to ten students and include all of our offerings. Contact us about registration details or for more information by e-mail at aellis43@alamo.edu or call (210) 486-1223. ▲

COURSE TITLE	DAY	TIME	LOCATION	START DATE	END DATE	PRICE
3D Sculpting and Design	Friday	9:30 AM – 12:30 PM	SAC/MLC 651	01/10/20	01/31/20	$35.00
3D Printing and Fabrication	Friday	9:30 AM – 12:30 PM	SAC/MLC 651	02/07/20	02/21/20	$35.00
3D Visualization	Friday	9:30 AM – 12:30 PM	SAC/MLC 651	03/06/20	03/27/20	FREE
3D Modeling	Friday	9:30 AM – 12:30 PM	SAC/MLC 651	04/03/20	04/24/20	$35.00
3D Sculpting and Design	Friday	9:30 AM – 12:30 PM	SAC/MLC 651	05/01/20	05/29/20	$35.00