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EDITORIAL:
CHRYSALIS IN CRISIS

by **Aaron Ellis**

When FACET Monthly first hit the presses in January, 2020, most Americans had never heard of wet markets and probably couldn't tell the difference between surgical masks and N95 respirators. But now, just a few weeks later, millions in the U.S. and billions around the world are acutely aware of the particulars of pandemics.

The way we interact with others has changed and will, perhaps, remain in this new normal for years to come. The threat of sudden, invisible death from a force that rides on winds and lingers on surfaces has transformed personal habits, the nature of work and what it means to be free in the relative blink of an eye.

In response to the SARS CoV-2 germ, San Antonio College is now operating primarily in an online capacity. In just two weeks, this imperceptible crowned invader has forced our faculty, staff and students to huddle together, separately, in front of laptop computers' tiny web cams as our forever-changing physical campus now stands eerily vacant.

Such a profound metamorphosis in such a short span of time cannot come without risks of its own. As we retreat to the safety of our homes and the familiar shorthand of Internet social exchange, we encounter, anew, the old concerns in different guises.

As always, protecting student data is of paramount importance. But how can we follow FERPA guidelines when said data transits unsecured lines on apps that play it fast and loose with digital security? New news of hacks and cracks and virtual-gate crashing flood our feeds on a daily basis. New York City public schools abandoned the Zoom telecommunications platform mere days after teachers and students migrated en masse to the system.

And in other disciplines, doctors now offer the modern miracle of remote diagnosis through telemedicine, but with very real risks to patient privacy. In governance, the topic of virtual voting is making headlines as legislators rush to pursue remote elections without soberly considering the dangers from within and without.

Undoubtedly, this will be a year of transformation. Transformation for our nations, our institutions, and for ourselves. But this time doesn't need to be a moment of unrestrained and unguided mutation. We can all play a part in how we change. We decide what to discard and what to retain. The choices we make and positions we take matter both for now and for our collective future.

So how will our landscape look by the Fall of 2020? Will our classrooms ever refill? Will our jobs ever return? Will our economy ever recover? We ask these these questions inside a cloud of uncertainty amid the fog of war with a microscopic foe.

Our answer comes in every decision we make. Where will we go? Who will we cherish? What will we learn? In this moment, in this season, in this life we all get the vote – with our choices.

FACET Monthly will continue delivering 3D technology news and information for as long as possible in these interesting times.

PROJECTS:
SHIELD FORCE

by **Aaron Ellis**

Many of the 3D projects the FACET team pursues are of an educational or research nature. It is rare if any of our work truly has life-or-death implications. However with the advent of the novel coronavirus SARS CoV-2 and the Covid-19 disease associated with it, we find ourselves challenged to find ways to make a difference in the midst of this pandemic.

Responding to national and local requests for face shield equipment for medical professionals on the front lines of the war against Covid-19, and specifically a call for 3D-printed parts, our team set about identifying the appropriate digital object files to meet the need and then printed the first copies of those designs to test their suitability.

Each of the resulting prints took more than six hours to complete. Due to the lengthy print times, the fact that our best printers are stationary resources confined to campus, and the official lock-down currently in place, the prospect of 3D printing large numbers of face shield bands to meet demand was and remains impossible to attain.

In light of these realities, we proposed an alternative option that involved using traditional fabrication techniques to supplement these 3D printed prototypes.

The basic idea follows modern manufacturing practices. In the real world, 3D printers are used to create the "positive" or master version of a shape. Once made, an aluminum or silicone mold or "negative" is built around it. After that, hot ABS plastic or two-part resins are injected into the mold to create near-identical duplicates of the original.

This process requires quite a bit of setup time along with a lengthy trial-and-error cycle of development. However, once perfected, each new copy of a master shape can be produced in seconds or minutes instead of the many hours it takes to build just one 3D-printed object.

Some companies and institutions have hundreds of idle 3D printers and millions of grams of printer material to put to work toward this noble cause, but not San Antonio College. We just have a handful of machines and limited access to them at this time. A hybrid high/low tech approach seems to be our best option.

After building our first prototype, then the mold and cast, we discovered that the original design we downloaded, while great for production on certain types of 3D printers, was not suitable for molding and casting duplicates. The walls of the parts simply proved to be too thin for that process.

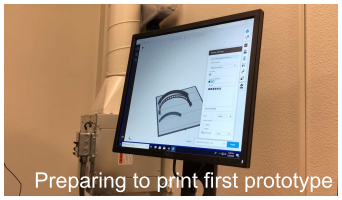
Recognizing the trial-and-error nature of the project, we began a re-design of the face shield band object and started the entire process anew. This time the band walls would be double the thickness, while maintaining the correct positions of the all-important anchor points for the face shield.

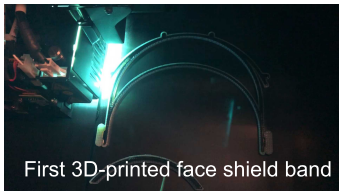
At the time of this issue's publication, we are awaiting print completion of the re-configured band, to be followed soon after by another mold-making cycle and eventually, hopefully, the casting of a working and durable part.

If all goes well and the cast face shield band meets requirements, additional molds will then be created from the new master prototype and those duplicate molds will star in the production of working casts for as long as our material supplies hold out.

This is where the project stands so far. We hope to have a positive update on this potentially life-saving endeavor in the next issue of FACET. ▲

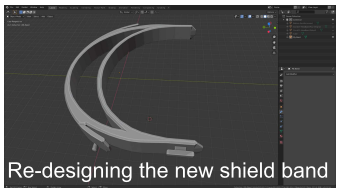
Note: videos of this project can be found at: https://www.youtube.com/playlist?list=PL6YmfWUv1k1WlqIuqRm0o_gE4OqqBgheZ


Preparing to print first prototype


First 3D-printed face shield band


Removing the first print


Pouring the first silicone mold


Re-designing the new shield band

NEWS:
SAC 3D PRINTER SET UP AND READY TO GO?

by **FACET Staff**


America Wilson moving Connex 3

In the January issue of FACET, the impending trade-in and upgrade of San Antonio College's most powerful 3D printer was the featured news article. This transition was expected in early February, but due to logistical complications, the printer was not delivered until the end of the month and could not be set up until mid-March.

By the end of Spring-break, global and national conditions had made it clear that SAC's campus would be closed for the foreseeable future, leaving the fate of our newest printer in question.

Fortunately, this new Stratasys Objet 260 has since been used to build prototype face shield bands with the potential to help meet current needs for such gear during the Covid-19 virus outbreak. See the article above for more details on this ongoing project.

As San Antonio College and other educational institutions around the world transition to all-online classes, heavily hands-on curricula will, by necessity, change. What this will mean for our 3D Printing and Fabrication class is, for now, TBD. ▲

IDEAS:
TENACIOUS 3D

by **Aaron Ellis**

An object at rest tends to stay at rest. And an object in motion tends to stay in motion. At least that's what we've been told. But often in life, circumstances accumulate around us to slow our roll forward. In this battle between progress, regress, and stasis, tenacity is a powerful tool if we have a bit of it – and if we put it to work.

I've said before in this space that 3D isn't easy. But it gets easier the more we do it. Every day, in some way, is the reliable path forward. Of course this technology isn't for everyone, but for those who need it – or those who soon will – 3D is a vehicle to amazing possibilities. But it only works for us if we maintain our fluency with it.

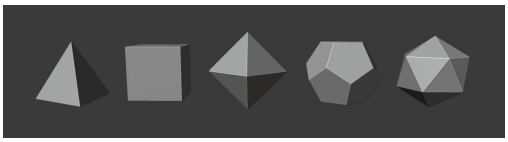
I've been teaching 3D technology skills to adults and children since 2010. In that time, my students have used a variety of tools to complete their assignments and craft some of their dreams. But even though the hardware is more powerful now and the software is easier to use than ever before, former students still come to me and mention that they've forgotten how to do some of the tasks that once came naturally to them.

How does that happen? It occurs a little bit every day. Some skills are perishable and 3D is definitely one that is. How can we combat this tendency? By choosing to make something each morning. That something doesn't always have to be new. We can simply remake old things in different ways. If we continuously look around for design challenges we will find exercises to stretch our skills.

The federally-funded Title-III grant that is at the heart of FACET Monthly and the 3D technology classes we offer at San Antonio College has been titled "Tenaces." This strange Spanish word is a call to persevere amidst difficulty and push through the obstacles ahead of us. It's something we all need in life, especially in these trying times. ▲

3DIVERSIONS:
ROLLING THE BONES

by **Aaron Ellis**



Note: Due to disruptions from the Covid-19 pandemic, this month's planned conclusion to America Wilson's Miniature Madness series of articles is postponed. A related topic is featured instead.

The previous two 3Diversions articles revealed some of the processes involved in making customized miniature figurines for tabletop role-playing games. This article will explore a high-tech update to the design and production of randomized gaming tools used by millions of people for thousands of years.

If you've ever played a board game, then you've probably bounced a cube or some other multi-faceted object on a table a few times in your life. It might surprise you to learn that dice have been around for a very long time and that they come in a variety of shapes and sizes.

The Athenian philosopher Plato described a series of multi-sided shapes that we now call platonic solids, but even then, he wasn't the first to notice their perfect geometric forms. These shapes consist of a tetrahedron (4 sides), a cube (6 sides), an octahedron (8 sides), a dodecahedron (12 sides) and an icosahedron (20 sides). These shapes have been employed in various games over many centuries as dice. Building these shapes in 3D is easy – and especially so in Blender. In fact, the software typically starts up with a cube in each new scene. Generating the other platonic shapes is nearly as quick – if we know the right design techniques.

Egyptian 20-sided die

Starting with the default Blender cube, we can simply move it to the side as that die is ready to go. That was simple enough! But we're not done with cubes just yet. The octahedron can be built almost as easily by adding a modifier to a standard cube. Specifically, the modifier we should use is called Bevel. Normally, this handy tool softens up sharp edges a bit, but this modifier has an Offset or Width value that transforms a lowly cube into the mighty octahedron.

Technically, this is not a completion of the shape due to a hidden overlap of vertices (or points) that occurs during an extreme beveling procedure. Some of those vertices will need to be merged with their closest neighbors. But for now, we can call it a day for the eight-sided die. But we're not quite done with modifier tricks.

The next platonic solid in our lineup is the dodecahedron. Or is it? You might think that, again, a cube would be the best starting place for making a dodecahedron. But in fact it's the twenty-sided shape we need instead. So let's skip ahead for now and make an icosahedron first.

In Blender all we need to do to make a 20-sided die is locate the Add menu item and select Mesh, then click on the Ico Sphere option from the drop-down sub-menus. As soon as it's done, a golf-ball shape pops into the scene and a teeny-tiny panel appears in the lower-left corner that's labeled "Add Ico Sphere." That panel has an enticing triangular arrow suggesting that it might expand to show more options.

Once that triangular arrow is clicked, the panel enlarges and reveals an option called Subdivisions. By default, Ico Spheres start at 2 subdivisions, but if we drop that value down to 1, we will have transformed our Ico Sphere into a perfect icosahedral platonic shape.

With that lesson learned, we can now bounce back to making the dodecahedron we skipped earlier. Building that shape can be accomplished by employing the same strategy we used when transforming a cube into the octahedron. We simply apply a Bevel modifier to an icosahedron with an extreme Offset or Width value. In doing so, those perfect twenty facets then become twelve. Again there will be extra vertices that probably should be merged, but we won't bother with those for now.

You may be thinking that we left out a shape. And if so, you're right. We still haven't gotten around to making the tetrahedron, or four-sided die. This platonic solid with the fewest number of facets is also super-easy to make. Again we will need to locate the Add menu option and select the Mesh sub-option and then select the Cone primitive object type. The conical shape that next appears on the screen doesn't quite look like the pyramidoid we need. But if we can notice the Add Cone panel in the bottom left of the screen, and expand it, showing that the Vertices amount is set to 32. We can change that value all the way down to 3 to give us the correct number of sides and also set the Depth option of the cone down to 1.41 to ensure that all of those sides have the same surface area.

That's all it takes to make Plato's solid forms. Additional dice shapes are possible and numbers are still needed. Let's save those for later.

Note: video example available at https://youtu.be/OKMCy5BYA1I ▲

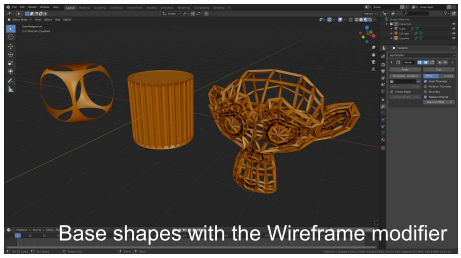
TECHNIQUES:
REBUILT FROM THE WIRES UP

by **FACET Staff**

In this, our last Techniques article in the series on using Modifiers in Blender 3D to easily transform objects, we take a look at a few modifiers and learn how they can work together to create interesting new shapes.

Specifically, we will be working with the Subdivision and Wireframe modifiers. These tools can be stacked to turn simple objects into complex forms. Modifiers typically apply their processes to an entire model, with options for some degree of filtering those effects.

The Subdivision modifier splits all polygonal surfaces into four separate, but co-planar facets. Imagine a stained-glass window with many different pieces arranged on the same flat area, but each shard has a unique shape. This modifier changes large single faces into multiple smaller facets. Our next tool works a bit differently. This Wireframe modifier replaces all of the edges in a 3D model with a holey version of the original shape. The resulting new model vaguely resembles a wicker basket or a fishing net made of thick cord.


Base shapes with the Wireframe modifier

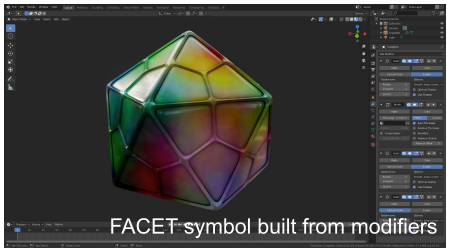
As mentioned earlier, multiple modifiers can be stacked onto an existing model and can even be repeated for different effects. The order in which these modifiers are added matters as much as the parameters within each one. Don't worry about that detail yet.

The shape we will attempt to make today is really a recreation of the FACET Monthly symbol. You have no doubt seen it in the pages of this publication. In fact, it's on the cover of every issue. This symbol looks like a blocky stained-glass marble. It's just a slightly more complex variation of a simple icosahedron (or twenty-sided die).

Since an icosahedron is our starting object for this exercise, we should learn how to place one in our scene. The first step toward this goal in Blender 3D is to select (by right-clicking with the right mouse button) and delete (by pressing the delete key on the keyboard) the default cube. Next, we should locate the Add menu option and select Mesh and then Ico Sphere from its sub-menus. With that done we should find and expand the Add Ico Sphere panel in the lower left corner of the screen and then change the Subdivisions option from 2 to a value of 1. This will give us the proper icosahedral shape upon which we will perform all subsequent processes.

With the icosahedron in place and selected, we are ready to add modifiers. Let's locate the Modifiers tab on the middle-right of the Blender window. The icon should look like a small blue wrench. Once in the modifiers panel, click on the Add Modifier button and then locate and click Subdivision Surface near the bottom of the second column of options. This immediately quadruples the number of facets on the shape and rounds out all of the surfaces by default using organic subdivision processes. That's not quite what we need for the moment, so let's click on the Simple button to the right of the Catmull-Clark option on the new Subdivision modifiers listing instead. While it may not seem like the object has changed much, trust me, it has.

Now we can add our next modifier. This time when we click Add Modifier, we should select the Wireframe option from the very bottom of the second column list. Our once normal-looking icosahedron now suddenly becomes a wire mesh version of itself. That's great, but it's looking a little too thin, so let's bump up the Thickness setting to .075 or maybe a bit more if you want. This is looking good, but in order to truly duplicate the FACET symbol, we should take care of one more setting. Locate and un-check the Replace Original option in the Wireframe modifier panel to bring back the missing volume from the original shape. Now it's looking more like our inspiration.


FACET symbol built from modifiers

If we want, we could stop right there. However, it wouldn't hurt to touch it up a bit more. Let's follow the first set of instructions and add two new instances of the Subdivision Surface modifier. On the first one, we can set it to Simple subdivision, as before. But for the last subdivision operation, let's leave it at Catmull-Clark and set Viewport Subdivisions to 2 to smooth out the angular forms a little.

That's it for the overall design, but your object will still need some color. Next month starts a new series on Materials. Don't miss it. ▲

Note: a video example can be found at https://youtu.be/_hdBM-uLsZk

CLASSES:

San Antonio College has offered non-credit 3D Technology classes every month since September of 2018. Most of our classes met in person once a week for three hours on Fridays and met for two, three or four weeks, depending on the discipline. Class costs were low and our 3D Visualization class was always free of charge. However, things have recently changed. New classes are planned but course delivery will now occur online using video streaming and other technologies. Contact us for more information about our classes. E-mail: aellis43@alamo.edu.