SMOOTHING AND HOW TO AVOID IT

DAVID ARANGO

INTRODUCTION

I was modeling an asset for *Stick to Manual* one day, doing my standard process of extruding, rearranging, and adding edge loops just as I'd done for ages. One thing I noticed while I was working is that my model, a control panel/console with hard edges, had way too many edge loops going around it and the mesh looked, well, pretty ugly. I went to delete a bunch of them and clear up the mesh, but then I realized that all of these loops were necessary- not for the mesh's shape, but for the smoothing that was going to come later.

Smoothing a mesh in Maya requires two things: edge loops to support your primary edge and clicking on the "Mesh Smooth" command to finalize the process. Try smoothing a random model that hasn't been prepped. You'll be treated to the wonderful sight of a squashed, melted looking abomination that barely looks like what you modeled, depending how complex it was. Mesh Smooth is a wonderful tool, but it has the power to turn a cube into a sphere if it's not prepped. Sometimes, though, the prepping leaves your model looking dirty and in need of fixing.

In this paper I'm going to go over how to (and when to) smooth using Mesh Smooth, but also give you an alternative method, beveling. This all comes with a caveat, though. Before you go off and read/skim/throw this paper away, I want you to keep in mind that I'm only talking about hard edge modeling. For organic modeling, absolutely do not use beveling! I'll explain more in the next segment.

IMPORTANT STUFF

Let's get some definitions defined so there's no confusion later. What do I mean with organic modeling? Organic doesn't just mean living/natural stuff like characters, apples, croissants, etc. It also means things that have natural curves to them or tubes, like for example, test tubes and grenades. What do I mean with hard edge modeling? Simple, everything else. From desks to computer screens to cricket bats, these guys are simple meshes in comparison because they generally use straight lines and don't have a lot of fancy curves in their design. Of course, there will be things that don't fall perfect within these guidelines, like guitars. They have curved bodies and yet they also have straight edges in parts. You'll simply have to use your judgement when it comes to these objects and see what smoothing method works best not just for you, but for your art directors.

THE IMPORTANCE OF GOOD TOPOLOGY

No conversation on smoothing and bevels would be complete without first talking about how important good topology is. First off, what do I mean with topology? Topology is the organization, flow, and structure of faces in your mesh. If you have good topology, then your mesh is neat and organized and wonderfully efficient. If your mesh has bad topology, it'll give your modeling lead an aneurysm trying to navigate it. If you're a modeler, good topology is now your goal at all times, no exception. Having bad topology gets more serious than just being kind to your modeling lead, it can really mess up your production based on how bad and extreme it is. You're always going to want to have uniform, clean topo so that your mesh deforms evenly if it's meant to deform; save memory since the more polys you have, the more it takes to process and draw; and

finally, any modifiers or nurbs that you apply to your mesh will work better the cleaner your topology.

Essentially, this is what encapsulates good topology:

Rule 1: Try to make all your faces quads. Triangles are sometimes acceptable if the mesh isn't deforming, but under no circumstances should you have ngons in your file. You won't even be able to UV it without fixing them!

Rule 2: Use the least amount of polys to tell your story. There's no need to use a hundred polys for a cube, 6 works just as well.

Rule 3: Make all your faces as even and uniform as possible. Erratic and random face sizes will cause you to have artefacts and weird out your renderer.
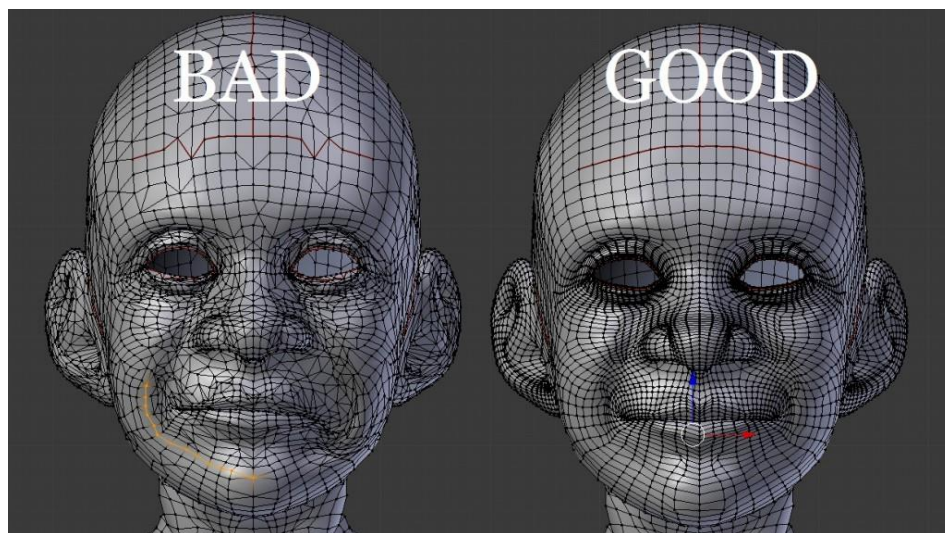

The last point I have to make about topology is that you're not doing this for yourself. You're making a clean model not just for the UV artist (which usually ends up being you), but for the texture artists, for the animators, and for the render team. If your mesh is clean and pristine, their jobs will be that much easier. Teamwork makes the dream work.

TRADITIONAL SMOOTHING
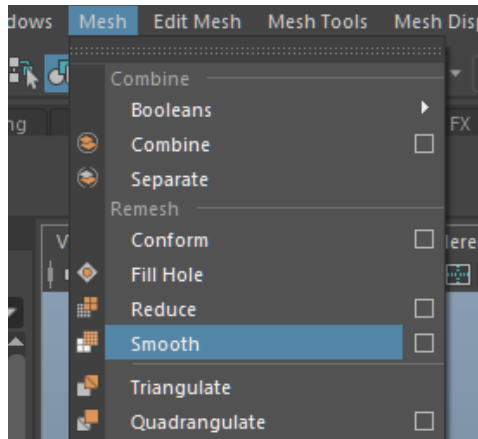
Smoothing is a pretty simple process. Maya takes a mesh and softens it based on the edge loops, which is why your cubes will turn to spheres and your prisms into long potatoes if they're not properly prepped with supporting loops. Everyone should know how to do regular smoothing just based on principle, since it's the easiest way to get a curved look and will also be your best friend if you're modeling organic objects like characters. A cool thing about smoothing is that you don't have to hit Mesh->Smooth to see what your model will look like. Simply hit 3 on your keyboard to activate the smooth preview and press 1 to go back to your regular view.
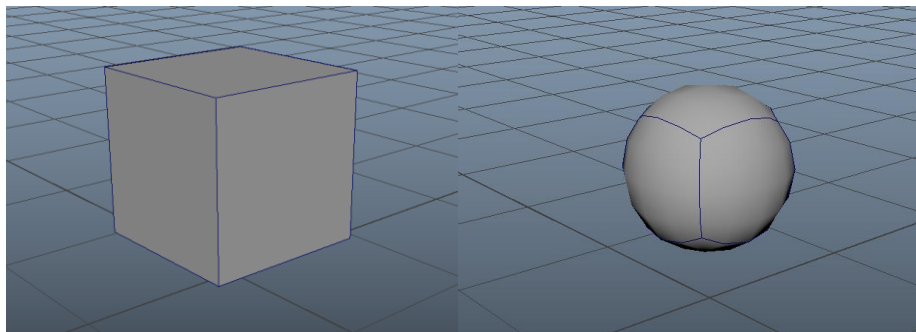
*Behold the humble, unprepped cube in its' transition toward a sphere!*
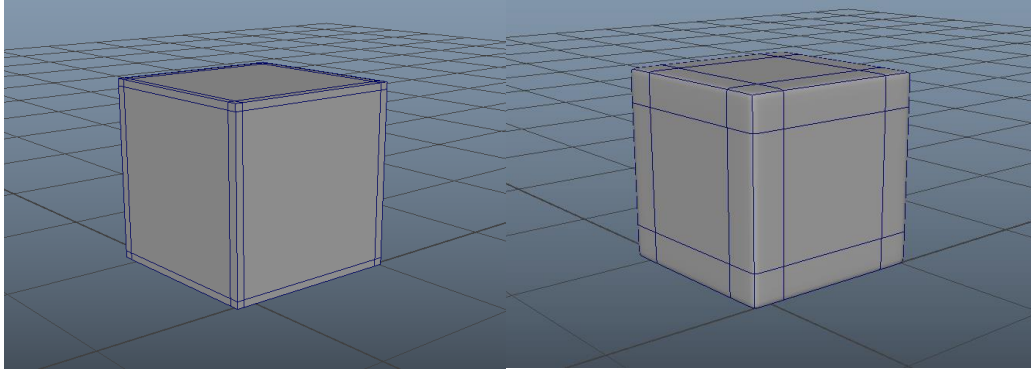
Once edge loops are added, smoothing turns the cube from a sharp cube into a softer, more realistic one. Perfect!

The basics on how this process are pretty intuitive, basic concepts. The edges belonging to the original cube mesh will be called the *primary edges*. These form the shape itself and are crucial to its structural integrity. The loops I added in the second step are called *support loops*, and these serve to tell the smooth command where it should tighten up its curves. Notice how the cube with edge loops isn't a sphere? Consider support loops like markers that sharpen whatever edge they're put next to.

WHY SMOOTH?

Smoothing is absolutely necessary with organic modeling and with meshes that contain curves. Look at your hand right now. It's obviously not some polygonal mesh, but rather a smooth shape, full of curves and wrinkles and fastidious little details. Mesh Smooth helps you get your mesh to look organic and, well, smooth. You won't be able to get the curves and roundness of an organic object like, say, a plant or a character's face without it, nor simulate a convincing curve that doesn't have weird segmentation if you don't use this tool. Going back to the example of the console, there are a couple organic parts to the asset- mainly the buttons and lights. They'd look

weirdly segmented if I were to leave them like that, but after smoothing they look normal.
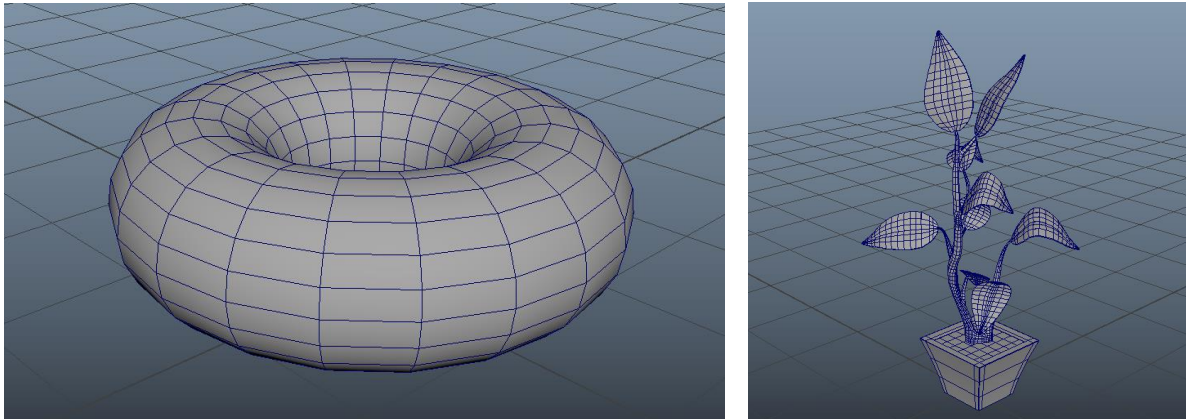
These shapes would be exceptionally hard to smooth using beveling, which is why

Mesh->Smooth exists!

PROBLEMS WITH MESH SMOOTH

For all the praise I've heaped on Mesh Smooth, it is not without its numerous faults. For one, smoothing leaves your topology pretty messy if you're not careful, and sometimes even if you are. Slapping edge loops with wild abandon around your entire model will have that effect, and also have the unfortunate downside of creating a ton of unnecessary faces. It may not be a big deal in that single model you're working on, maybe a difference of 300-500 polys, but when you bring every single model in your production into your environment for layout and animation, it'll be noticeable.

Adding support loops means adding an edge loop around the entire object, which means splitting a lot of polys you don't need to and adding to your poly count. Too many polys can lead to a number of fun problems, from slowing down your processing and making Maya stutter and sometimes even crash in the most extreme of cases, to making your render times longer. Remember Rule 2?

Another inconvenience of using edge loops is that if you're not aware while modeling, it's entirely possible to add edge loops far too close to each other. A single stray click can accidentally stack them basically on top of each other without you noticing, and during UV'ing meshes like this can be complicated since the UV pieces are so small. Sometimes, it's impossible to select a polygon face just because of how small it is. This might not be a problem for you, but it's going to be a headache and a half for the people down the pipeline.

Modeling with smoothing in mind is sometimes tricky because you'll need to go back and forth between subdivision preview modes to see if what you're modeling is even looking like what you want. Remember, don't ever work on 3! That may look fine when you're looking at the model in the viewport, but the UV's will be ruined since your topology isn't technically modeled well.

One last problem with using edge loops to smooth your model is that following Rule 3, keeping your topology uniform and consistent, is exceedingly hard. Sometimes you'll find yourself having to move edges around and rearranging them, even having to add extra loops in order to keep consistency. The importance of having a consistently uniform mesh will not become readily apparent, but rather reveal itself later down the road during rendering when it's pretty late to fix anything. If you have a mesh that has faces of alternating sizes, your renderer could freak out and cause these faces to flicker thanks to the way that light behaves. Nothing is more rewarding than rendering that awesome house you've been working on for ages, and then have half of it turn black during the render because your topology is terrible.
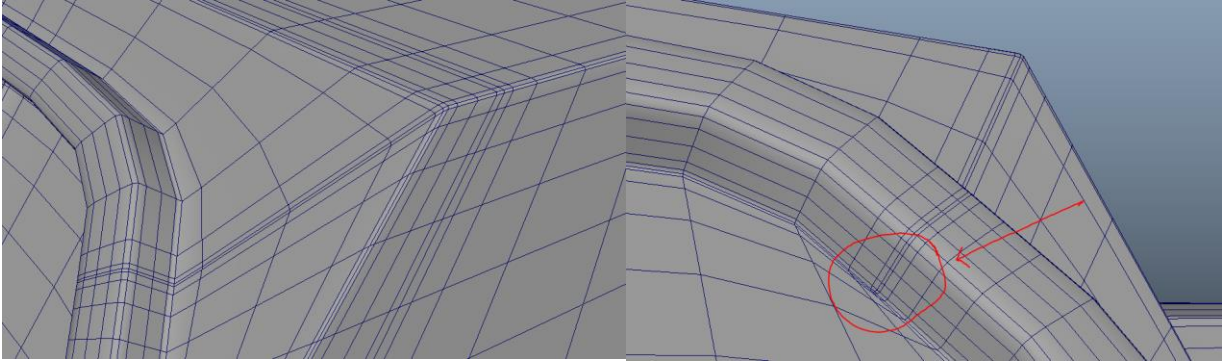
Here we see one of the unintended consequences of sticking edge loops in a high-poly model

without being careful. The supporting edge loop is necessary for the upper corner of the model

*to remain rigid, but it loops over to this corner and creates a weird piece of geometry.*
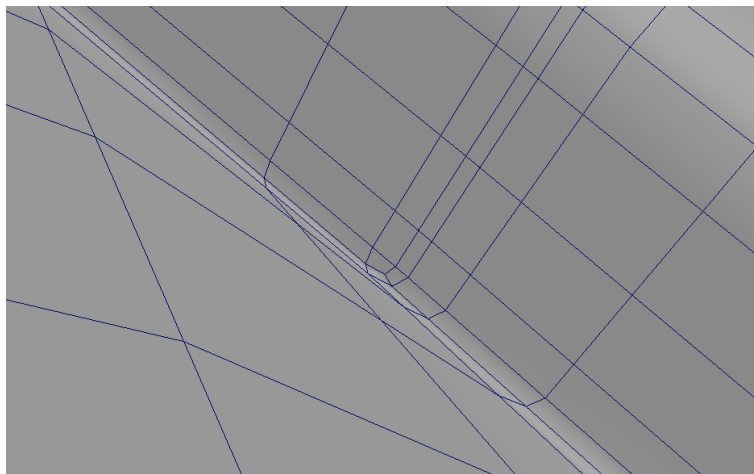
And of course, once we zoom in, we discover that this little edge loop managed to break quite a

couple rules of good topology. Super tiny polygon faces, nonuniform polys, higher poly count,

and I can personally assure you that this little bit will be a pleasure to UV.

Long story short, using Mesh Smooth on a hard edge mesh might not be a good idea if you want

to keep your topology clean and easily navigable. Of course, just like how we could theoretically

move every vertex by hand instead of using soft select to move a group of vertices, you could

avoid any issues with Mesh Smooth by being real careful and rearranging your topology and edge

loops, but why put yourself through that much work? If you can save the production time, do it!

The future you will be grateful, trust me.

<div align="center">BEVELING</div>
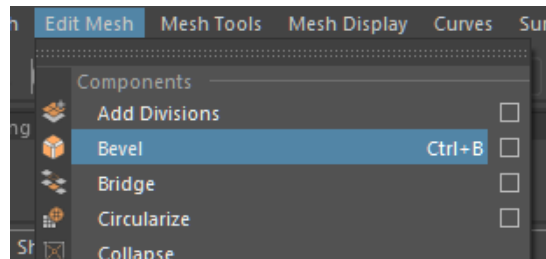
Finally, we get to beveling, the whole point of this paper. Beveling is unfortunately a more

complex beast than smoothing, but any issues you might have with it can be easily resolved.

Beveling is different from smoothing in that it doesn't affect the whole mesh, but rather only the

edges you've selected, splitting them into fractions and curving them as well as it can. In this way,

you can give a rigid object rounded corners.
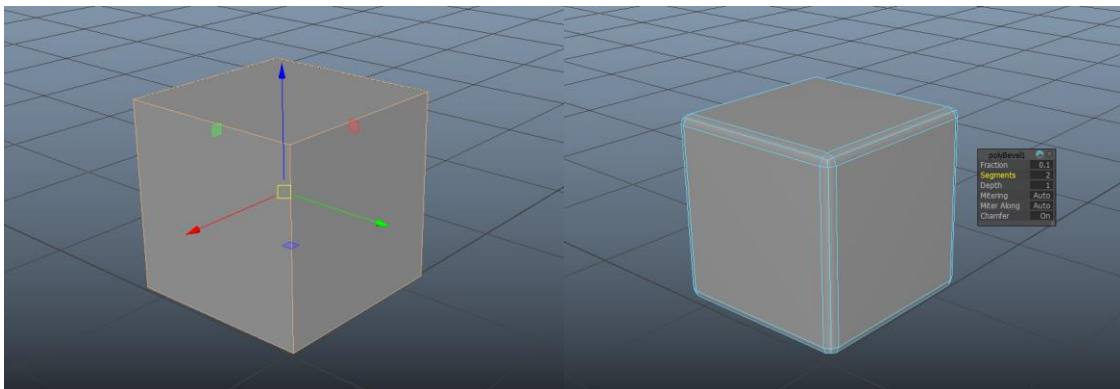
First, select the edges you want to bevel. Then, click bevel, and voila! Instant soft edges.

The way that bevel works is it creates geometry where these edges used to be. The amount of

geometry and its size will be entirely dependent on the settings you've selected. For example, for

this cube I've selected two segments at a fraction level of 0.1. If I were to increase the fraction

size, the bevel would be much thicker, and if I were to lower the fraction size, the bevels would become thin. The fraction size is up to your needs- do you need a thick, rounded edge? Perhaps consider raising the fraction value and the number of segments. For a sharper edge, lower the fraction value.

<div align="center">WHY BEVEL?</div>

Barring organic models and some cylindrical shapes, bevels can do everything mesh smooth can, with practice and some fiddling, and save you a lot of the issues that smoothing gives you. For one, you have complete control over your edge loops and the topology of your model, since you're selecting just what you want to affect. Therefore, as you're not creating random polygons halfway through your model, you're keeping your poly count down and your topology looking clean. It also gives you history to go back and fix the divisions and size of the bevel should you need to. If you check the mesh's history, you'll be able to mess with the bevel's values directly after the fact, which is perfect for if you made a mistake or if you're testing out to see how hard or soft to make an edge.

Essentially, if you want to have soft edges but your object is too high poly that adding edge loops would create a huge headache, go with beveling. This tool gives you the maximum amount of control over your model, and will allow you to have a cleaner mesh as a result.

Lastly, beveling is typically used the most in the industry, so it's good to start practicing now!
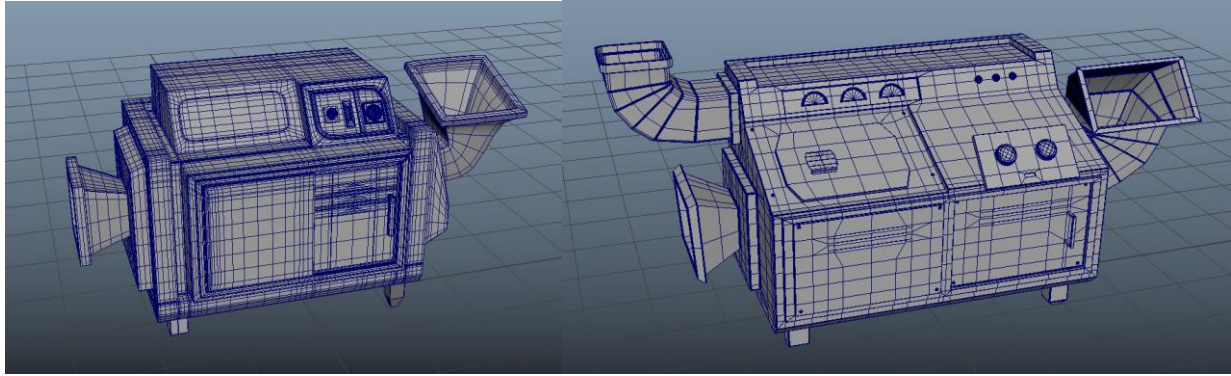
Here are two versions of Stick to Manual*'s console. The left one was smoothed with edge loops, and the right one used beveling exclusively. Notice how despite being bigger and having far more surface area, the second console looks cleaner and a lot less busy than the first one.*

PROBLEMS WITH BEVELS

Beveling isn't perfect, and as I mentioned before it is also a tricky tool to use sometimes. The main issue with beveling is that it is very easy to create a good amount of ngons in your mesh, since creating fractional edges where there previously was only a single vertex is a great way to make Maya scream. Luckily, these are incredibly easy to fix. Simply use the Multi-Cut tool to create edges as necessary to cut up the offending ngon and make some quads.
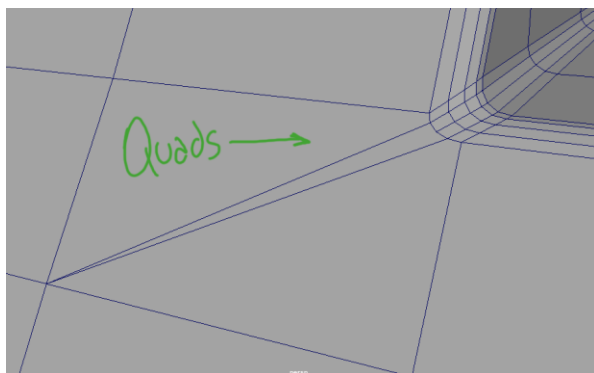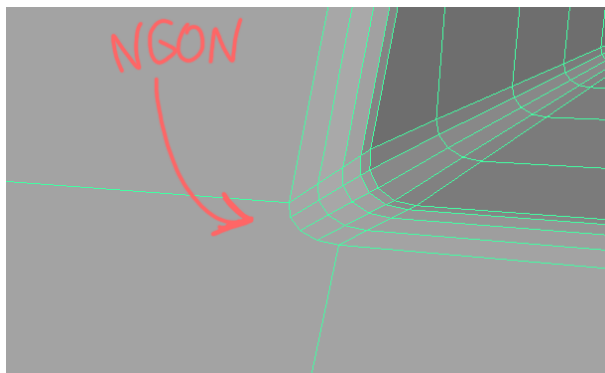

Be sure that you check your asset with Mesh Cleanup to sniff out any last ngon you might have missed. Remember, you won't be able to UV without resolving ngons!

Another issue with beveling is that it might freak out and not understand how you want elbows and corner pieces to be resolved. In the above example, everything went well, but this isn't often the case.
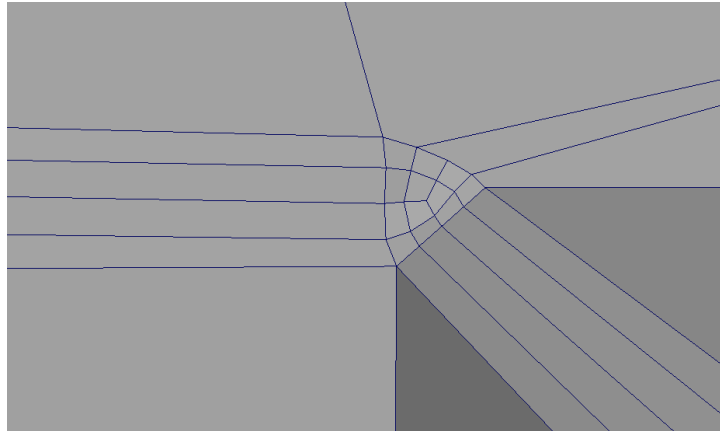

This elbow's normal are askew and all sorts of nasty. Unfortunately, there isn't much to be done except manually making a connection and straightening out the verts so the normals look like they're supposed to. It's a small price to pay for complete control over your mesh but be aware that you will have to do additional cleanup while beveling that you likely won't have to when using the Mesh Smooth command.

One last inconvenience with using bevels is that you must bevel everything at once, otherwise the tool will misconstrue what fractional levels you're trying to use and give you different results when you bevel adjacent edges.
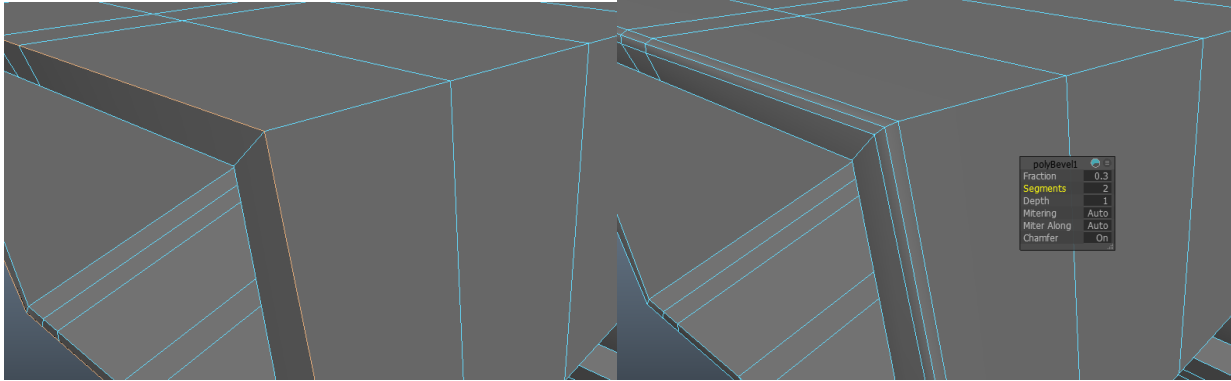
In this example, one edge loop is selected and beveled. The values for this bevel are 0.3 (fraction) and 2 (segments). The resulting bevel is looking fine!
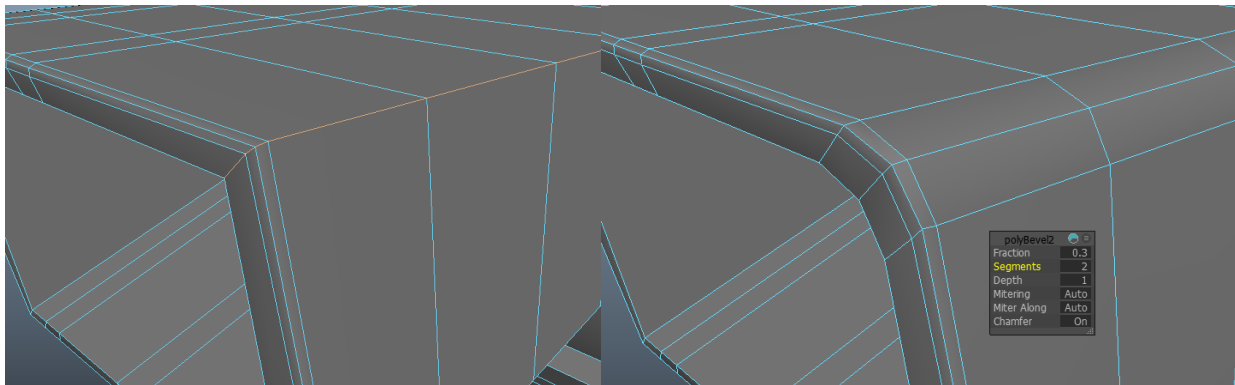
However, if we do the same exact thing to the intersecting edge loop, using the same 0.3 and 2 values, we get a monstrosity that's far too thick. This is the bevel tool freaking out because both bevels were done at separate times.
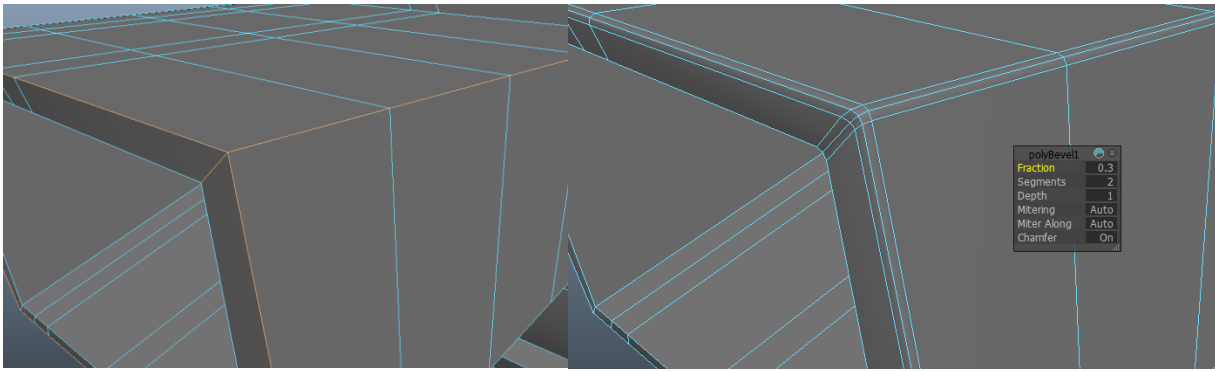
The correct way to go about having bevels with equal fractions in relative space is to do them all at once. This time, I've selected both sets of edge loops and slapped a bevel on them, using the same values as always. The bevels work great now, and the end product is what I was looking for!

CONCLUSION

Beveling is a tool that takes some time to understand, but once you do it will save you a lot of time and effort in the future and help your team down the line when they're handling your model. It's not a perfect tool and it has its' caveats, but we put up with it for the sake of good topology and low render times.

Contrary to this paper's title, you don't actually want to avoid Mesh Smooth. At least, not all the time, since it's a very useful tool that will give you great results if you know what to use it for. However, I'd like you to be aware that the Bevel command exists, if only to broaden your toolkit and give you options: does this table really need edge loops, or can I get away with beveling? Can I save a couple hundred polygons here? Is my mesh clean enough? These are questions that you will hopefully ask yourself as you model your next assets.

Last but not least, don't forget that *you* are the modeler. Just as the definitions of organic and hard edge modeling are fast and loose, so too should you be with your models and modeling philosophy; the whole point of this paper is that beveling is cool, yes, but also that you shouldn't limit yourself to a single tool. There's an entire arsenal for you to play with, so go out and explore!