MASTERING TOPOLOGY & HARD SURFACE MODELING

An ebook by ThomasColin3D

INTRODUCING

WHO AM I ?

I'm Thomas Colin, a **professional 3D Hard Surface Modeler**, a **Motion Designer** and a **Video Editor**. I started learning 3D in 2013 in a famous 3D/VFX school in Paris called Isart Digital and I have a Master's degree in 3D and Visual Effects. I'm known as **ThomasColin3D** on YouTube for my 3D Modeling skills, my ability to fix complex topology problems.

Since I began my professional career, I worked in **10 studios**. I've had the opportunity to work in all areas of 3D, such as TV shows, animated films, advertising, real estate, luxury, and video games.
I worked for big companies such as **Meta**, **Instagram**, **Xiaomi**, **Red Bull**, **Rolex**, **L'Oréal**, **Snapchat**, and many others.

In this ebook, you are going to learn all the **best industry standard Hard Surface Modeling techniques used by professionals**, tips & tricks, and useful shortcuts to **speed up your work**. I gathered all my knowledge to help you to become a better 3D Modeler. I tried to keep it beginner friendly as much as possible.

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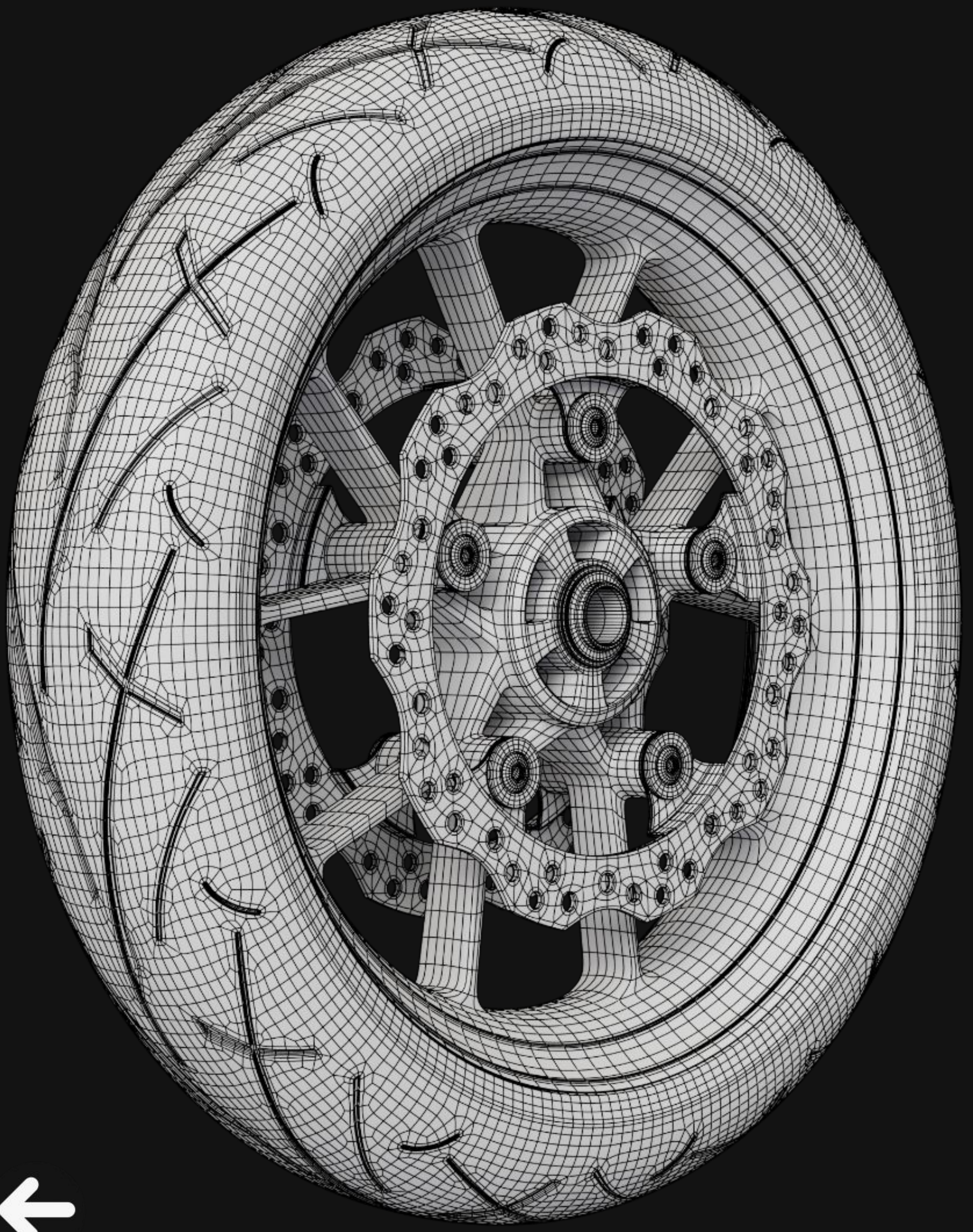
WELCOME

AND THANK YOU FOR PURCHASING MY EBOOK

If your goal is to be able to **create complex models** like mine, then buying this ebook was the right choice. In this book you're going to learn all the techniques that I use in my daily work : **Industry standard techniques**, **tips and tricks to improve your workflow and your understanding of topology**. You'll also learn how to **fix beginners mistakes**.



CHAPTER 1

A LITTLE BIT OF THEORY

←

SUB-D MODELING VS BOX MODELING

WHAT'S THE DIFFERENCE ?

Both **subdivision (Sub-D)** modeling and **box modeling** are approaches used in 3D modeling, but they're not the same thing. In practice, 3D modelers use **both methods together**. We could say that box modeling is a way of building the base, and Sub-D modeling is a way of refining/smoothing it. Here's the difference :

SUB-D MODELING

Sub-D modeling is a modeling workflow where you start with a low poly "control mesh", and apply subdivision surfaces (like Catmull-Clark). The software **smooths and adds detail by dividing faces into smaller polygons**.
This modeling technique is the hardest to master because it requires a **strong topology knowledge**. It requires **bevels** and **support loops** to avoid heavy polygons/textures stretching. Your mesh needs to have an **even polygon density**, and the faces have to be **squared polygons**. Your topology **MUST be as perfect as possible** to avoid pinching and shading issues. The polygons have to be **all quads**, but you can use tris and n-gons sometimes on **flat surfaces ONLY**, **never on curved surfaces**.
Sub-D is mostly used for close-up shots, product visualization, film/VFX assets, and for meshes that needs to be deformed. The polycount doesn't matter that much if you use it.

BOX MODELING

Box modeling is a modeling workflow where you start with a simple primitive shape (most commonly a cube), but it could also be a sphere, cylinder, or any other primitives, and then refine it step by step into a more complex model.
It's mostly used for the **blocking step**. (This is the step where you try to get the right proportions before adding more details with loop cuts, knife tool, etc.)
With this method, the topology is **less important**. You can use **tris** and **n-gons** as much as you want if your mesh is not meant to be subdivided/deformed.

LIST OF USEFUL SHORTCUTS

Ctrl + **A** : Apply menu
Ctrl + **1,2,3...** : Subdivision surface modifier
Ctrl + **B** : Bevel (**A** to change the size, **P** to change the shape, **V** to bevel a vertex)
Ctrl + **R** : Loop cuts
Ctrl + **A** on a modifier : Applies the modifier
Ctrl + **T** : Triangulate
Ctrl Numpad + or **-** : Grow or shrink the selection
Shift + **A** : Add objects
Shift + **S** : Pie menu
Shift + **R** : Repeat latest the latest command
Shift + **E** : Crease (**Shift** + **E** + **1** = crease value of 1)
Shift + **Tab** : Snapping button
Shift + **G** : Select similar menu
Shift + **N** : Flip normals
Shift + **Right click** : Move the 3D cursor
Shift + **C** : Reset the 3D cursor
Alt + **Shift** + **left click** : Select an edge loop
Ctrl + **Alt** + **left click** : Select an edge ring
Alt + **Shift** + **S** : Spherify (like a cast modifier)
Alt + **E** : Extrude menu
Alt + **j** : Tris to quads
Alt + **V** : Rip and fill
V : Rip an edge or a vertex
J : Connect
K : Knife tool (**C** to cut through, **A** to enable angle constraint)
GG : Slide a vertex along an edge
S + **Shift** + **Z (or X**, **Y)** : Scale in every axis except the Z axis (or X, Y)
R + **Shift** + **Z (or X**, **Y)** : Rotate in every axis except the Z axis (or X, Y)
G + **Shift** + **Z (or X**, **Y)** : Move in every axis except the Z axis (or X, Y)

L : Select linked
A : Select everything
U : Unwrap menu
P : Separate menu
M : Merge menu
Q : Quick favorites
O : Proportional editing
1, **2**, **3** : Vertex mode, edge mode, face mode

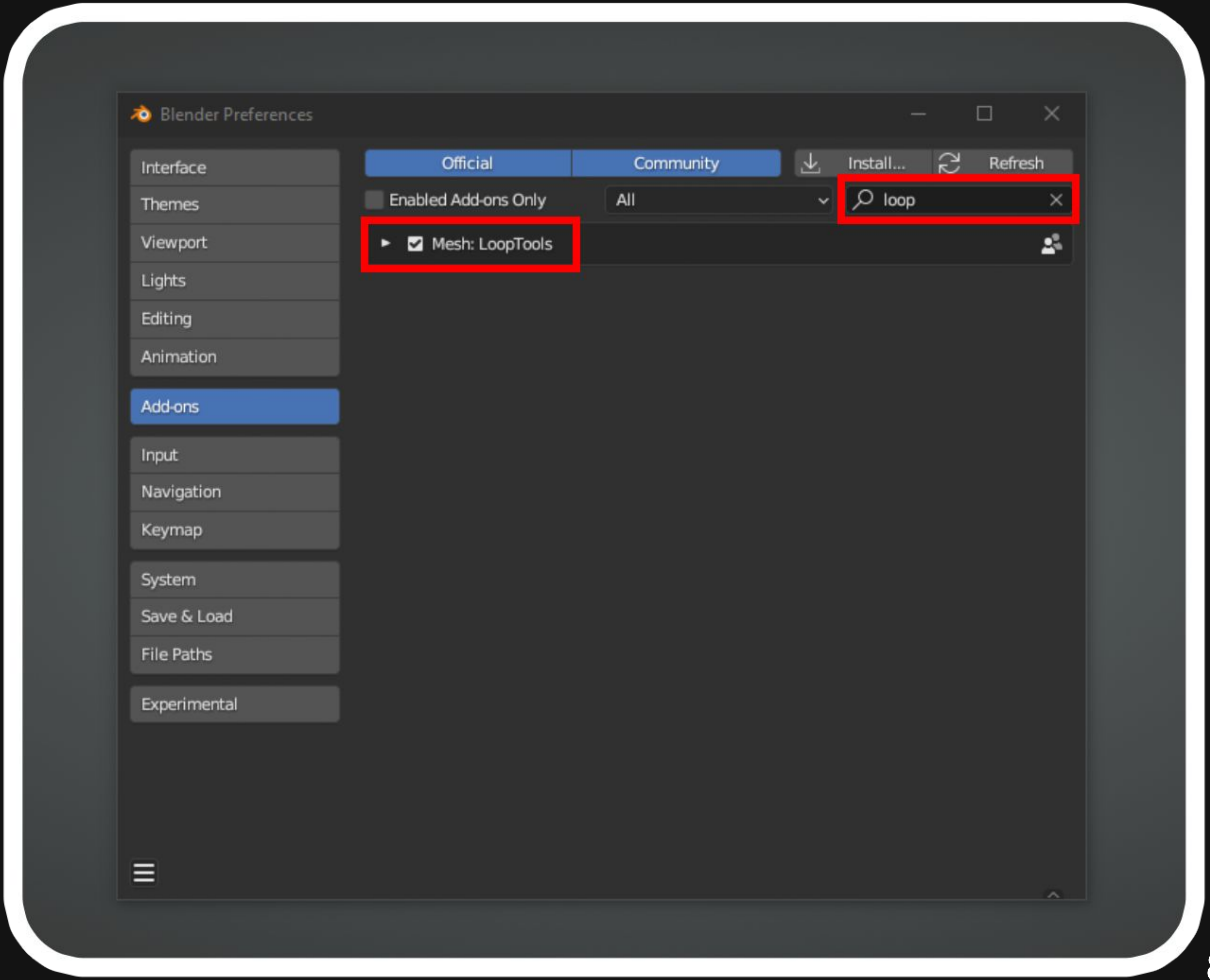
BEFORE GETTING STARTED

INSTALL THE LOOP TOOLS

LoopTools is a native addon that is disabled by default. To enable it, open the preferences menu (edit > preferences) and in the Addons tab, write “loop”. Check the box to activate it, and don’t forget to save your preferences by clicking the three lines at the bottom left of the window.

LoopTools provides some of the best modeling features for creating high-quality hard surface models. It’s incredibly useful for maintaining good edge flow and clean, organized topology.

The ones I use the most are: Circle, Space, Gstretch, Relax, and Curve. You’ll find some use cases later in the book.



loop

☑ Mesh: LoopTools

TOPOLOGY

WHAT IS TOPOLOGY ?

In Hard Surface Modeling, **topology** refers to how the polygons (quads, triangles, n-gons) are **arranged** and **flow across the surface** of your 3D model.
It's not just about the shape of the object, but about the **structure of the mesh**. it makes your model **easier to modify** later and it looks better when you **subdivide/render** it. And lastly, it also **avoids artifacts** when adding bevels, booleans, or subdivision surface modifiers.

QUADS, TRIS AND N-GONS

- **Quads** (4-sided faces) are preferred because they **subdivide predictably** and keep **surfaces smooth**. They are very important on **deformable meshes**.

- **Tris** can be used in **flat** and **non-deforming areas**.

- **N-gons** (5+ sides) are usually avoided because they can cause **shading issues** or **artifacts**. However, they are perfectly **fine on flat surfaces**.

Tris and N-gons are **automatically turned into quads when you subdivide them**. (Example on the next page)

SHADING AND SMOOTHING

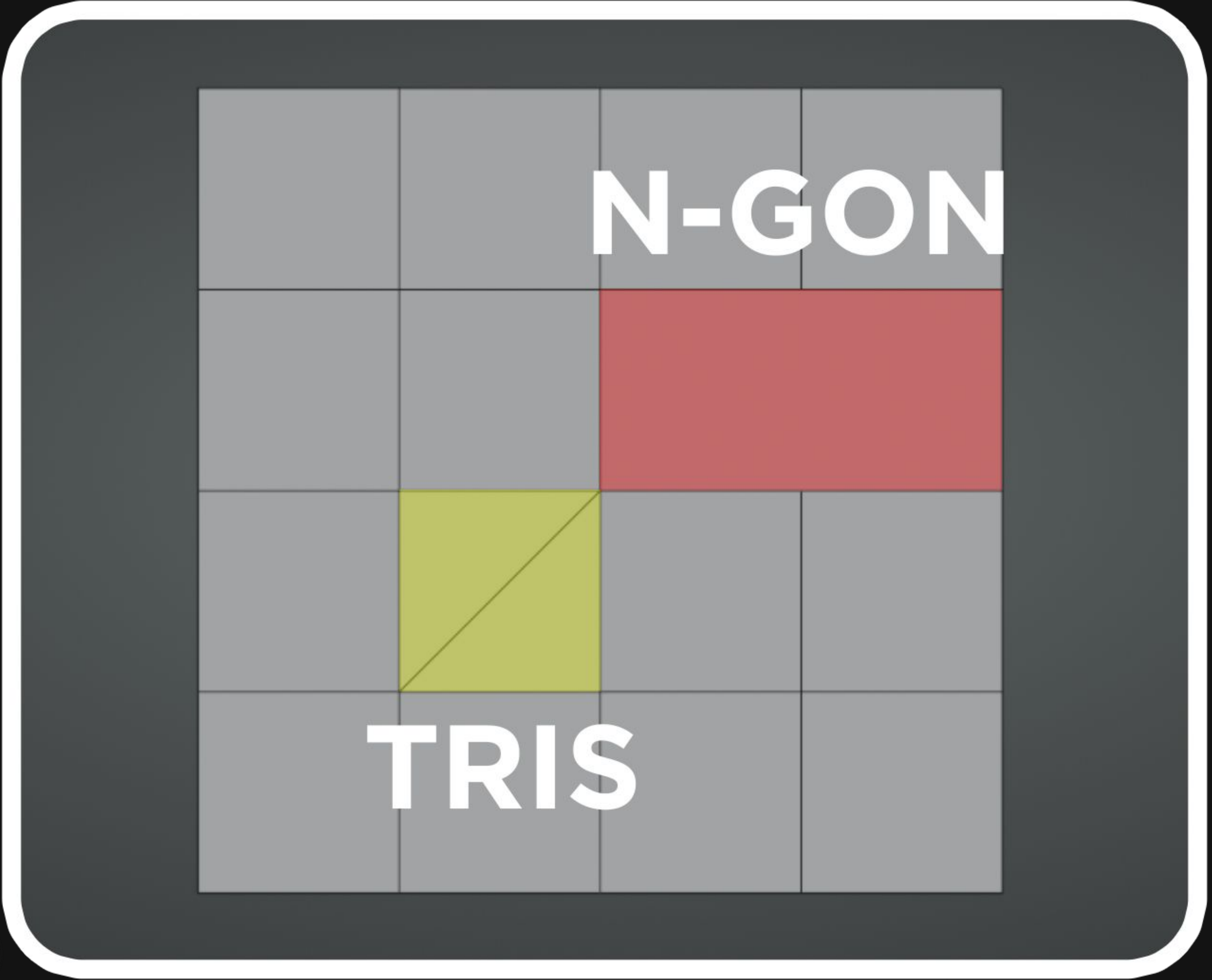
Clean topology avoids weird shading artifacts like **dark spots** or **pinching**. (We will see some examples in the next pages)

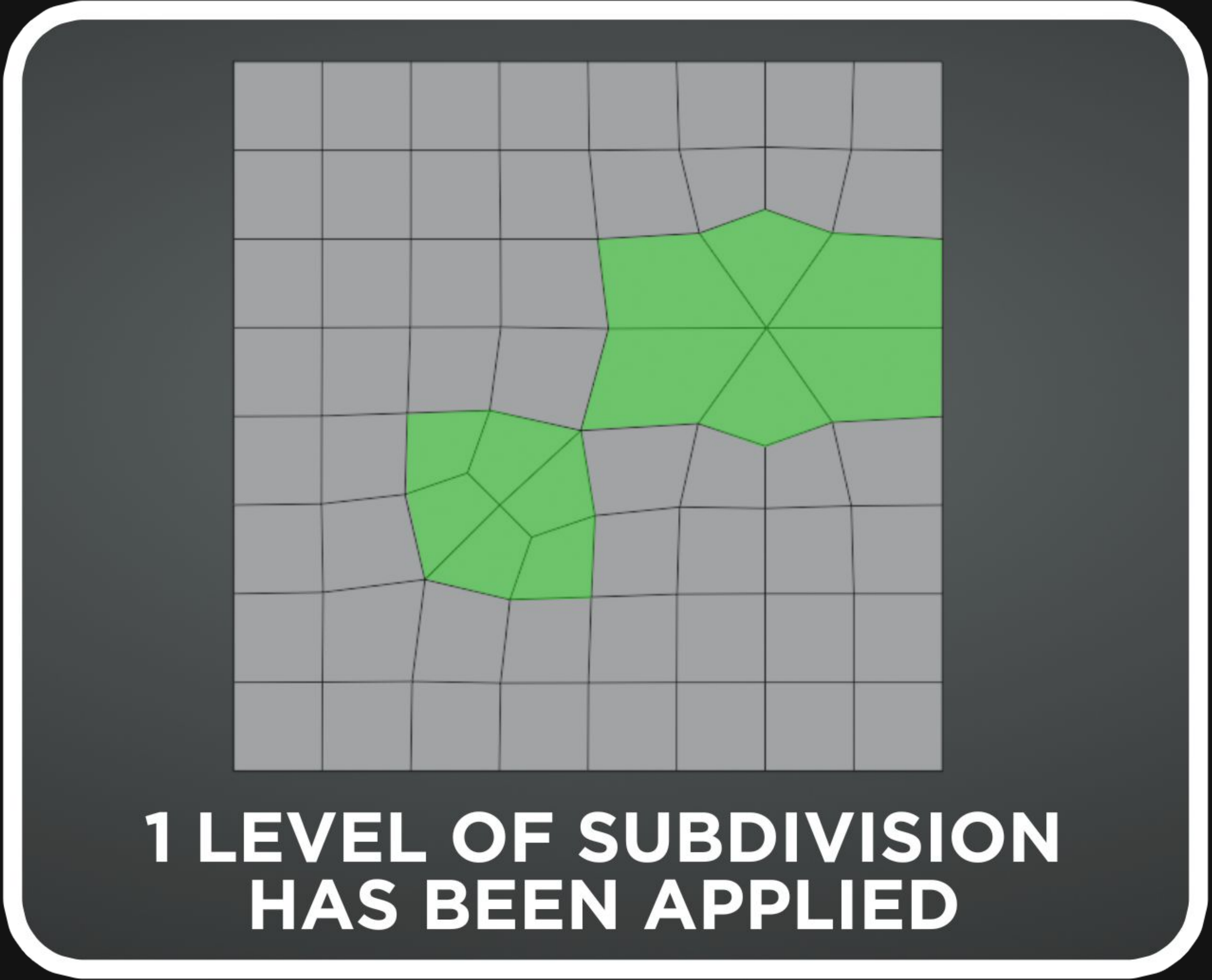
TOPOLOGY FUNDAMENTALS

TRIS & N-GONS TO QUADS

In this picture, we have 2 tris and 1 n-gon. We can easily turn them into quads by adding a Subdivision Surface modifier and applying it.

I applied 1 level of subdivision, and now all the polygons are quads. In this example, you could remove the diagonal edge to get rid of the tris and connect the 2 vertices of the n-gon, but this was just a very simple way to demonstrate what I mentioned.





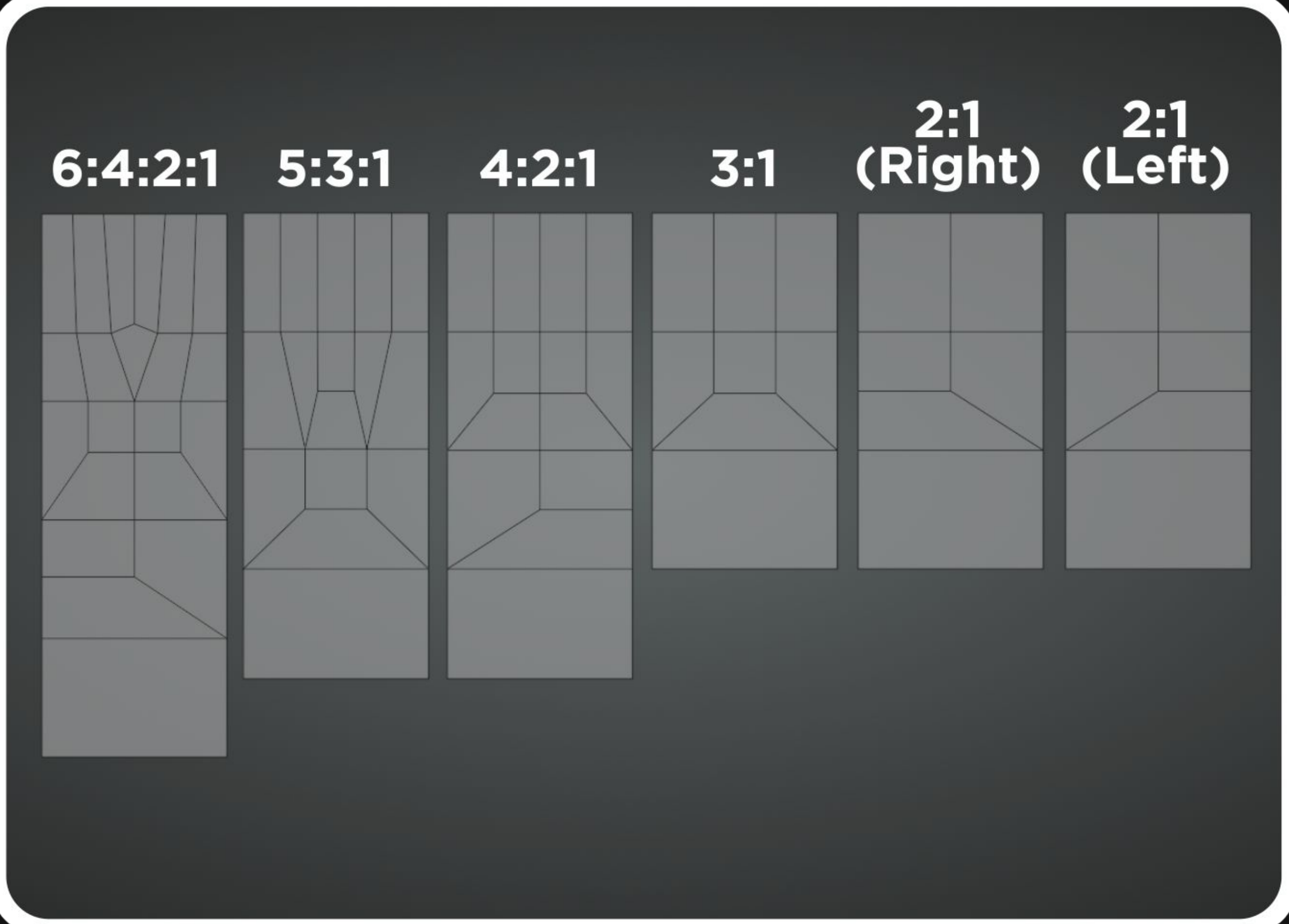
TOPOLOGY

REROUTE, REDUCE, TERMINATE EDGE LOOPS

This is the **most important fundamental skills** to master in order to create good topology.

Instead of adding too many loops on your model, you need to know how to **reroute**, **reduce**, or **terminate edge loops**. This method allows you to reduce your polycount significantly!

It's especially useful when you're working with **localized topology** (example on the next page).



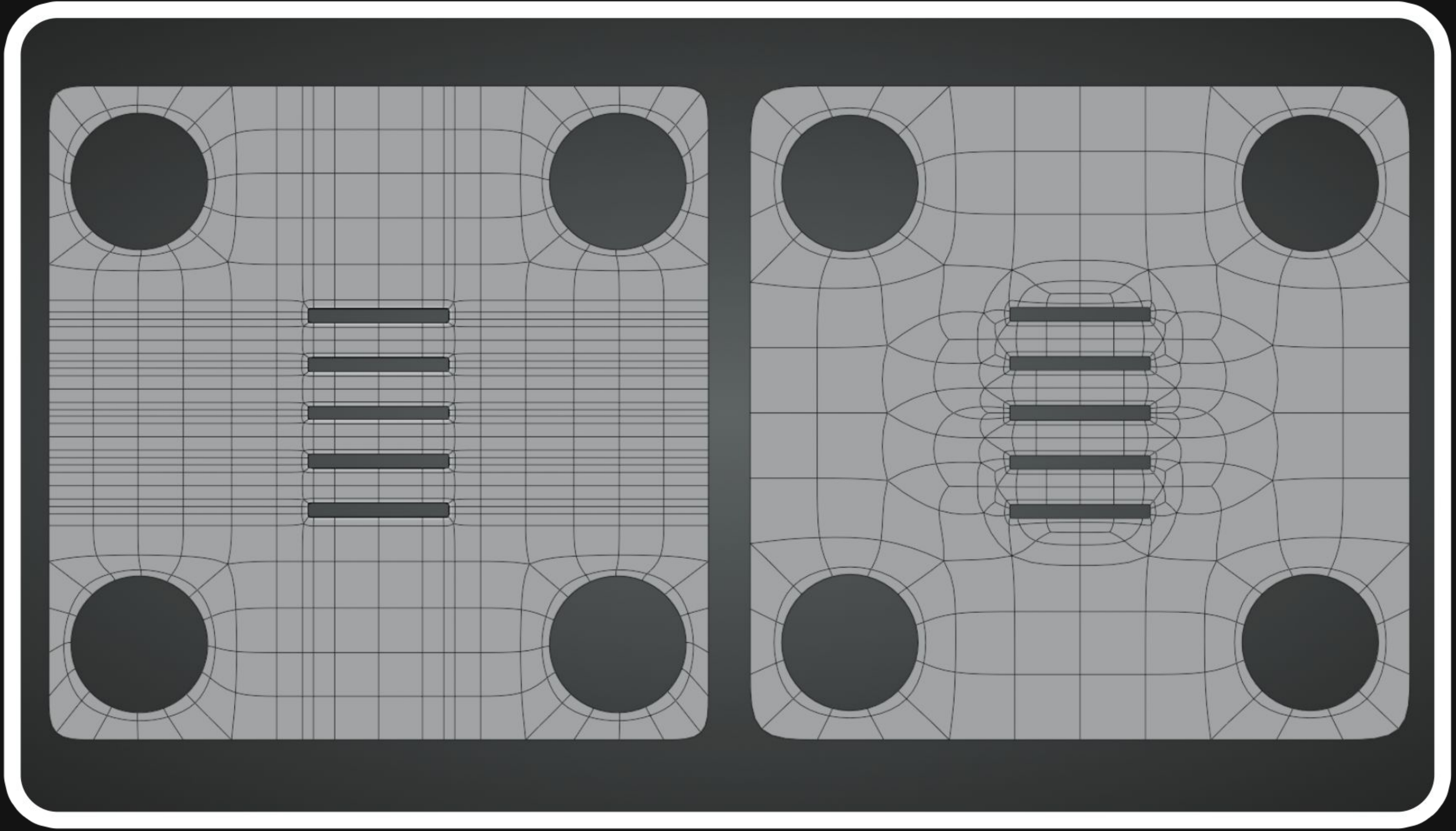
TOPOLOGY

LOCALIZED TOPOLOGY

As I mentioned in the previous page, localized topology is very important.

If you take a look at the first model, I added a lot of small details in the center. **The more details you add, the more edges you create**. And as you can see, the sides of the model become **heavily subdivided (and the polygon size becomes uneven).**

To fix that, I reduced the number of edges. Doing this allows you to add more details without introducing a huge amount of unnecessary edges. It also keeps the polygon size even on the sides.



POLES (E-POLES & N-POLES)

WHAT IS A POLE ?

In Sub-D modeling, a pole is a vertex where a “**non-standard**” number of edges **meet**. In other words, a pole is any vertex connected to **more or fewer than 4 edges**. In a clean quad-based topology, every vertices ideally connects to 4 edges. However, poles are **inevitable**. But they are not a bad thing if you know how to deal with them.

Poles are a great way to **redirect your edge flow**. They are impossible to avoid when modeling complex shapes.
Poorly placed poles can cause pinching, unpredictable deformations, and shading artifacts.
The good thing is that they have no effect on flat surfaces. You can connect an infinite number of edges to a single vertex without causing any problems.

3 TYPES OF POLES

- **N-poles (3 edges)** : often used at corners or to end edge loops cleanly. (N-pole = Nose-pole)
- **E-poles (5 edges)** : common in curved surfaces where loops converge. (E-pole = Extrude-pole)
- **6+ edges** : usually more problematic, they can cause more pinching or shading artifacts.

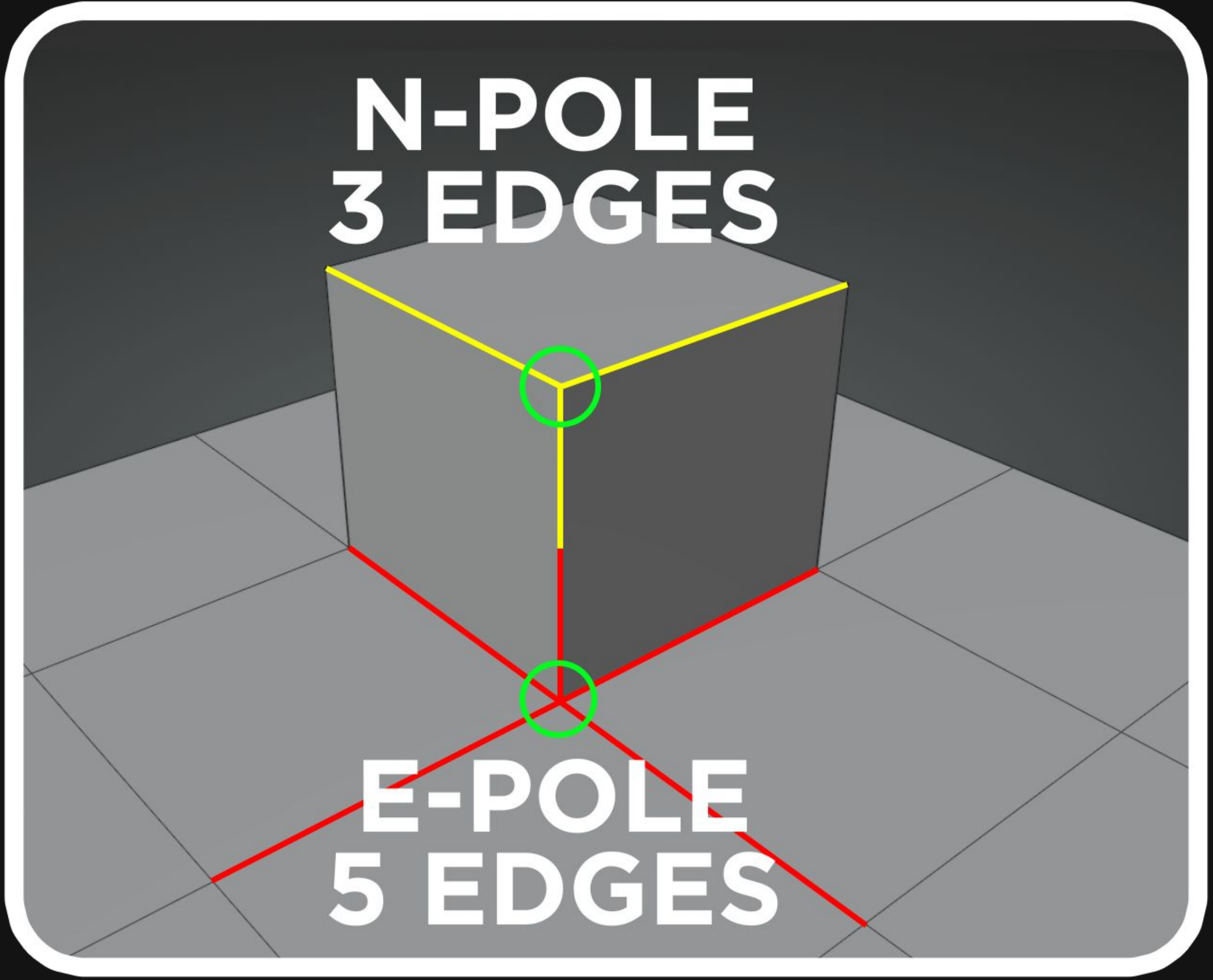
BEST PRACTICES

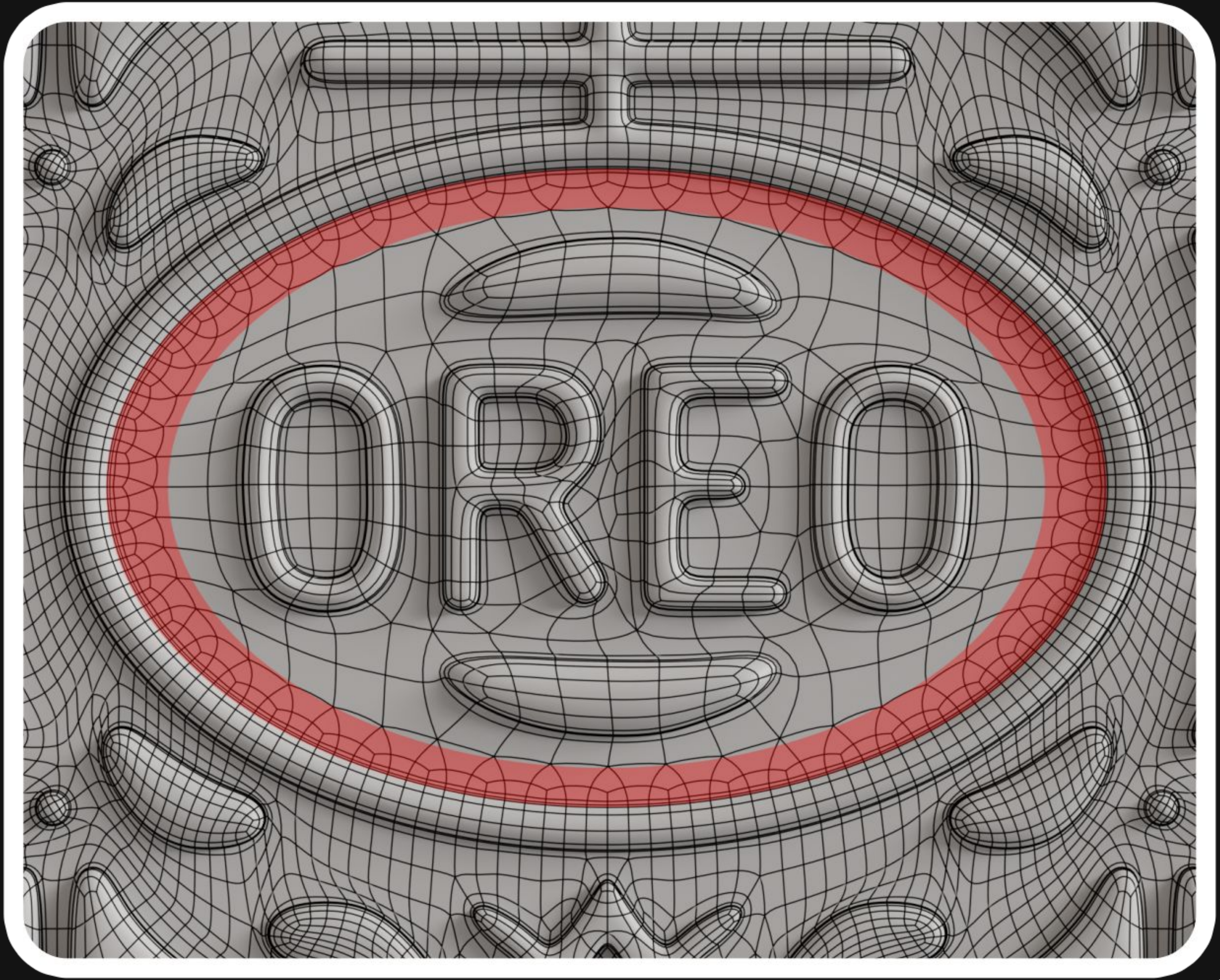
- Try to keep poles away from areas that deform or from curved surfaces if it’s possible.
- Place them in flat or hidden areas.
- Minimize poles that have 6+ edges connected.

POLES (E-POLES & N-POLES)

EXAMPLES

As you can see in the red area of this picture, there are dozens of E-poles. They are great for **reducing the polygon density** of a mesh. And as a said on the previous page, **they don't matter on flat surfaces**.





CONVEX & CONCAVE ANGLES

WHAT'S THE DIFFERENCE ?

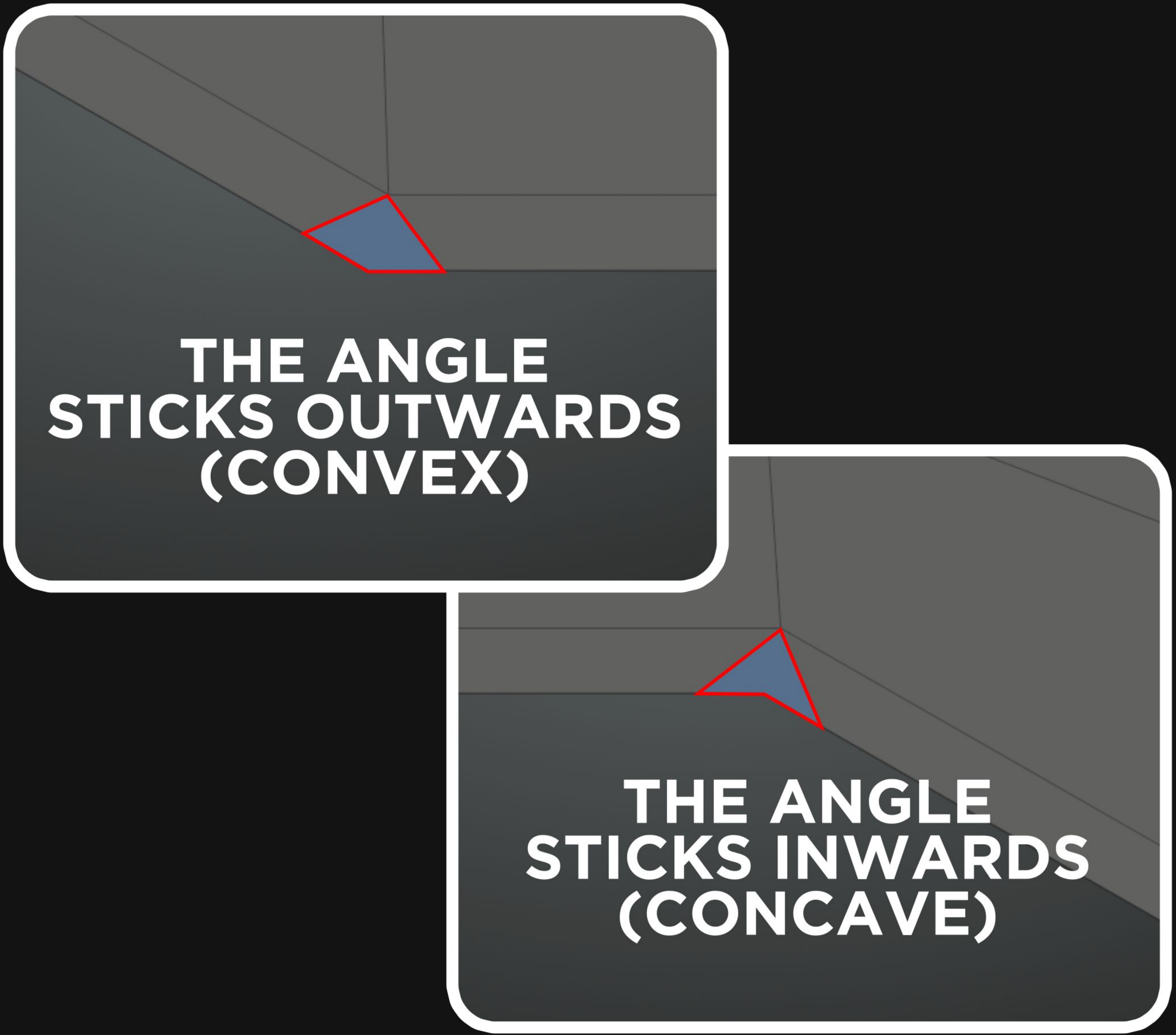
In 3D, a **convex** angle occurs when 2 faces (or edges) meet in such a way that the angle between their outward normals is less than 180°. The angle sticks **outwards**.

A **concave** angle occurs when the faces meet and form an interior cavity, so the angle between their outward normal is greater than 180°. The angle sticks **inwards**.

Example :

- **Convex** : Think of the outside of a cube corner.
- **Concave** : Think of the inside of a box corner.

The method for beveling a concave angle is not the same as beveling a convex one. The vertices of a concave angle must be connected differently. You will find an example on the next page.



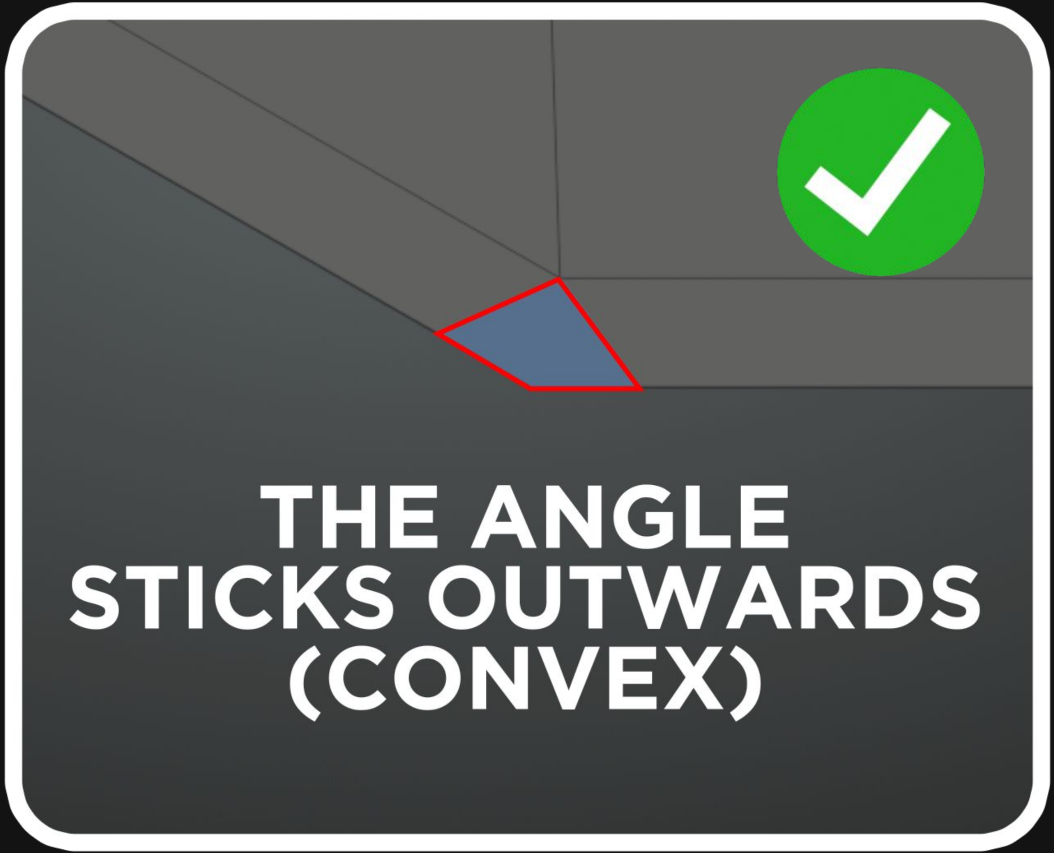
THE ANGLE STICKS OUTWARDS (CONVEX)

THE ANGLE STICKS INWARDS (CONCAVE)

CONVEX & CONCAVE ANGLES

HOW TO BEVEL THEM ?

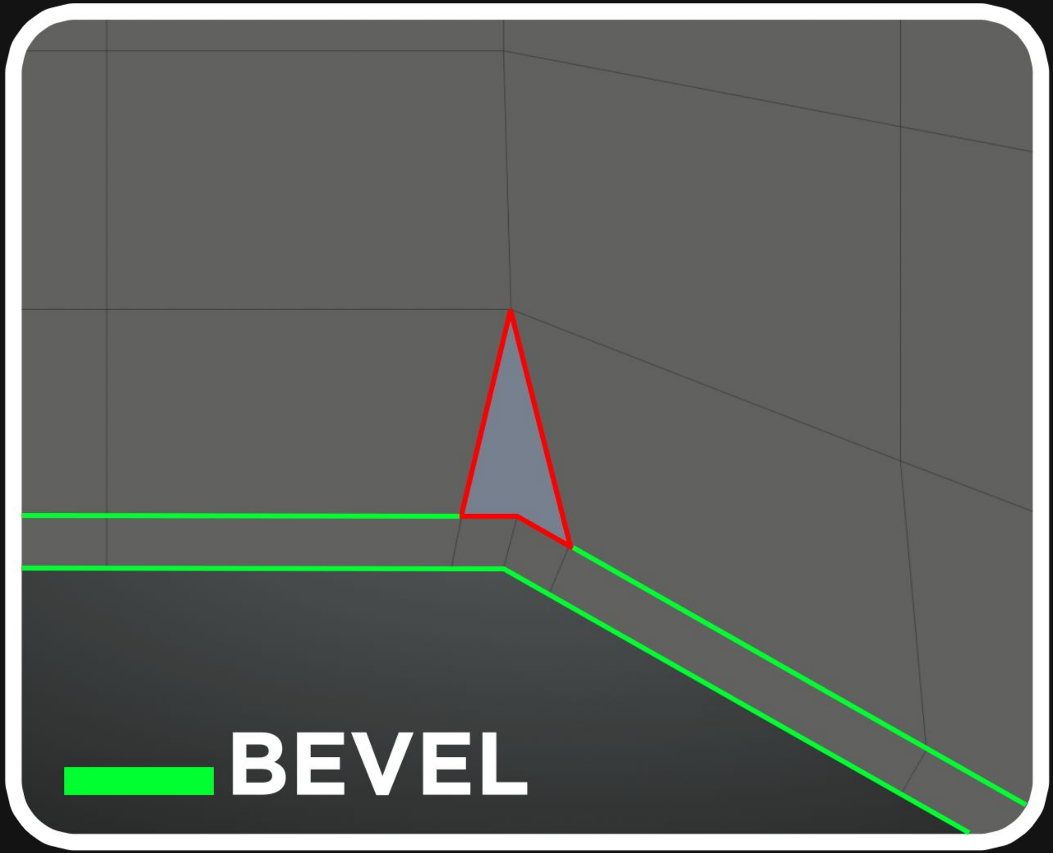
Convex angles don't need any extra work when you bevel them. They turn into **diamond polygons** and they subdivide nicely.

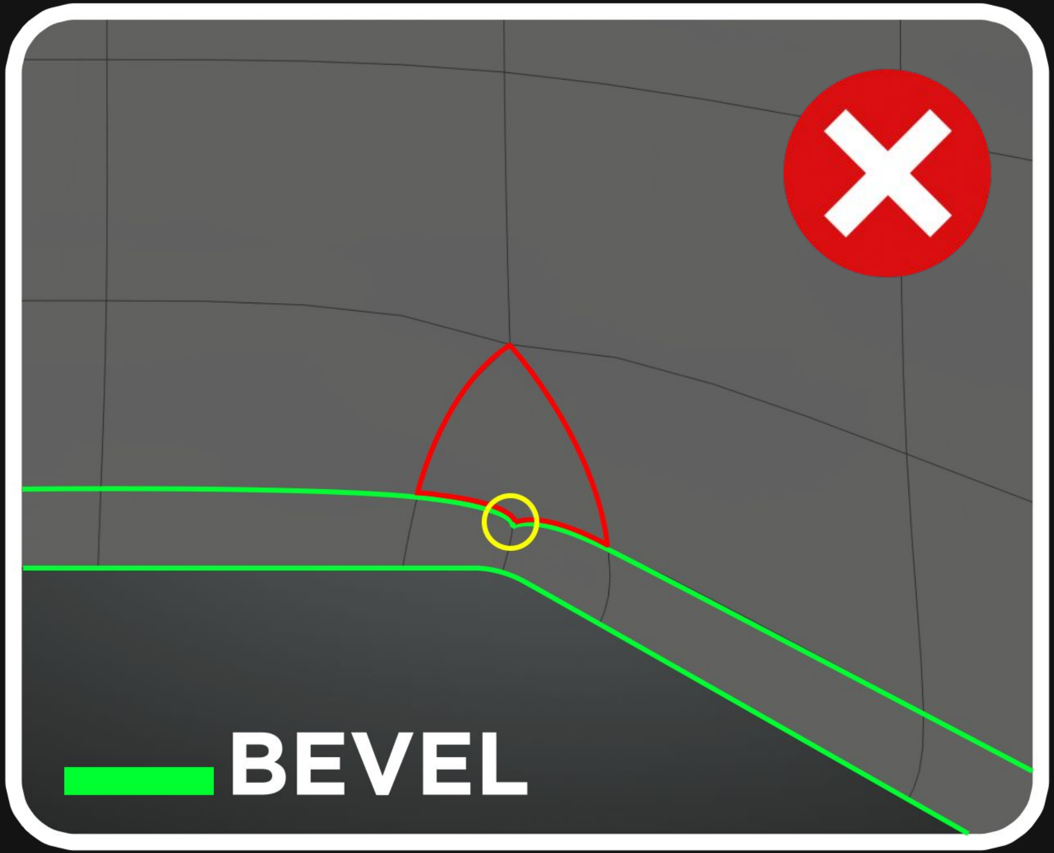


CONVEX ANGLE

When you bevel a **concave angle**, you need to connect the vertices in a specific way to avoid distortions. For example, let's connect the vertices as shown.

We can clearly see that **the bevel is distorted**. You must avoid this if you don't want your **textures to stretch**. There are 2 ways to fix this issue.



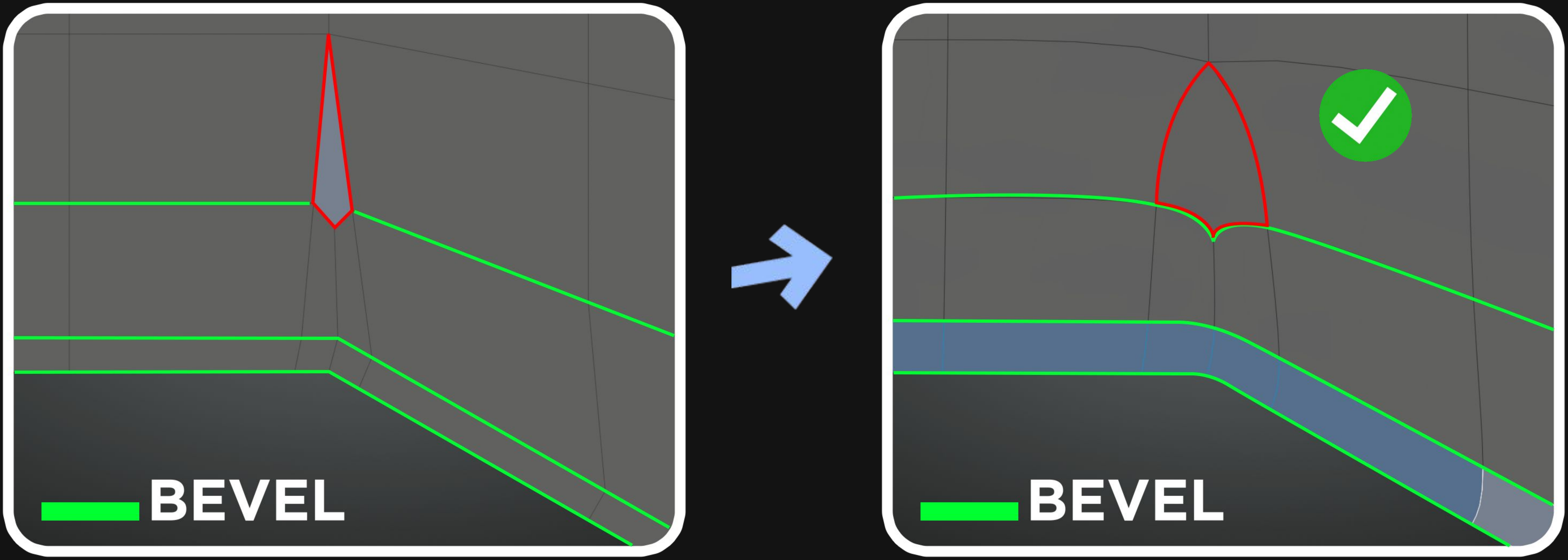


CONCAVE ANGLE

CONVEX & CONCAVE ANGLES

2 METHODS TO FIX CONCAVE ANGLES

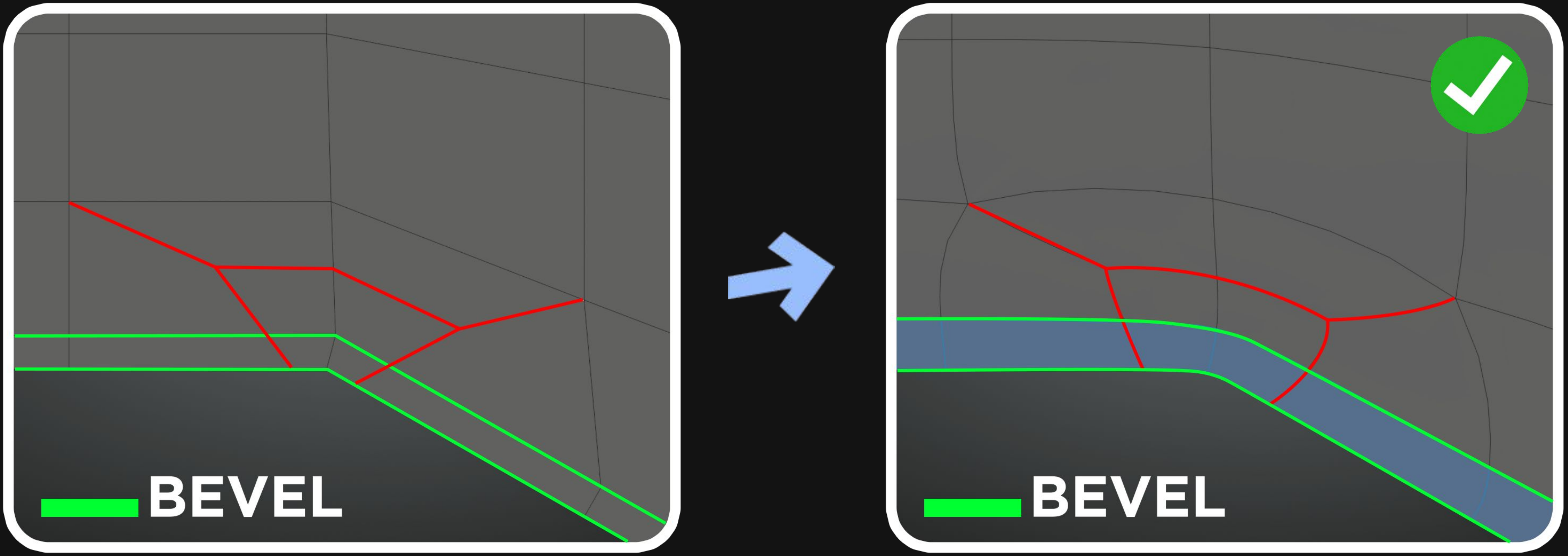
First method : connect the vertices **behind the bevel**. The angle now forms a **diamond shape**, with the angle pointing outward. As you can see, when using a subdivision surface modifier, the bevel's shape is **no longer deformed**. The distortion is absorbed by the **support loop** behind it.



CONVEX & CONCAVE ANGLES

2 METHODS TO FIX CONCAVE ANGLES

Second method : This is another good way to connect your vertices. The bevel's shape is protected, and any distortion is handled by the **support loop** behind it. The edge flow is slightly different, but both methods work well. It's it's up to your personal preference. On flat surfaces, it doesn't matter whether you choose the first or the second method, but on curved surfaces, it can create **pinching** and/or **artifacts**. Try both and see which one works best for your models.



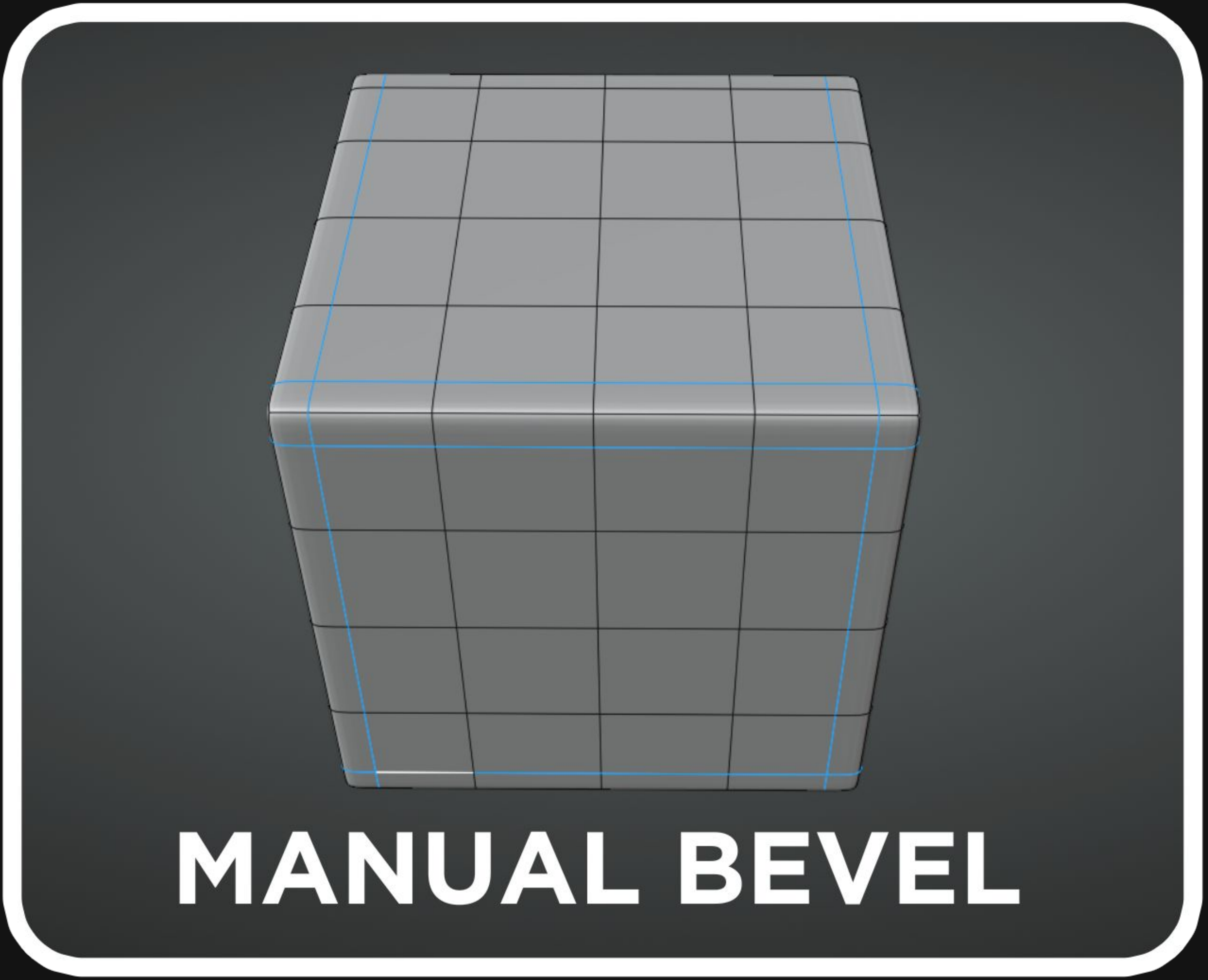
3 TYPES OF BEVELS

1. MANUAL BEVEL

In real life, nothing is perfectly sharp (90°). Bevels are used to create smoother corners. They catch the light better and make your model look more realistic.

Pressing Ctrl + B is the most common way to add a bevel. It generates actual geometry / support loops on your model. This method is the best if you plan to export your model, as manual bevels can be read by any other 3D software.

However, be careful to set the shape value to 1, otherwise, the bevel can be destructive. (An example is shown on the next page.)



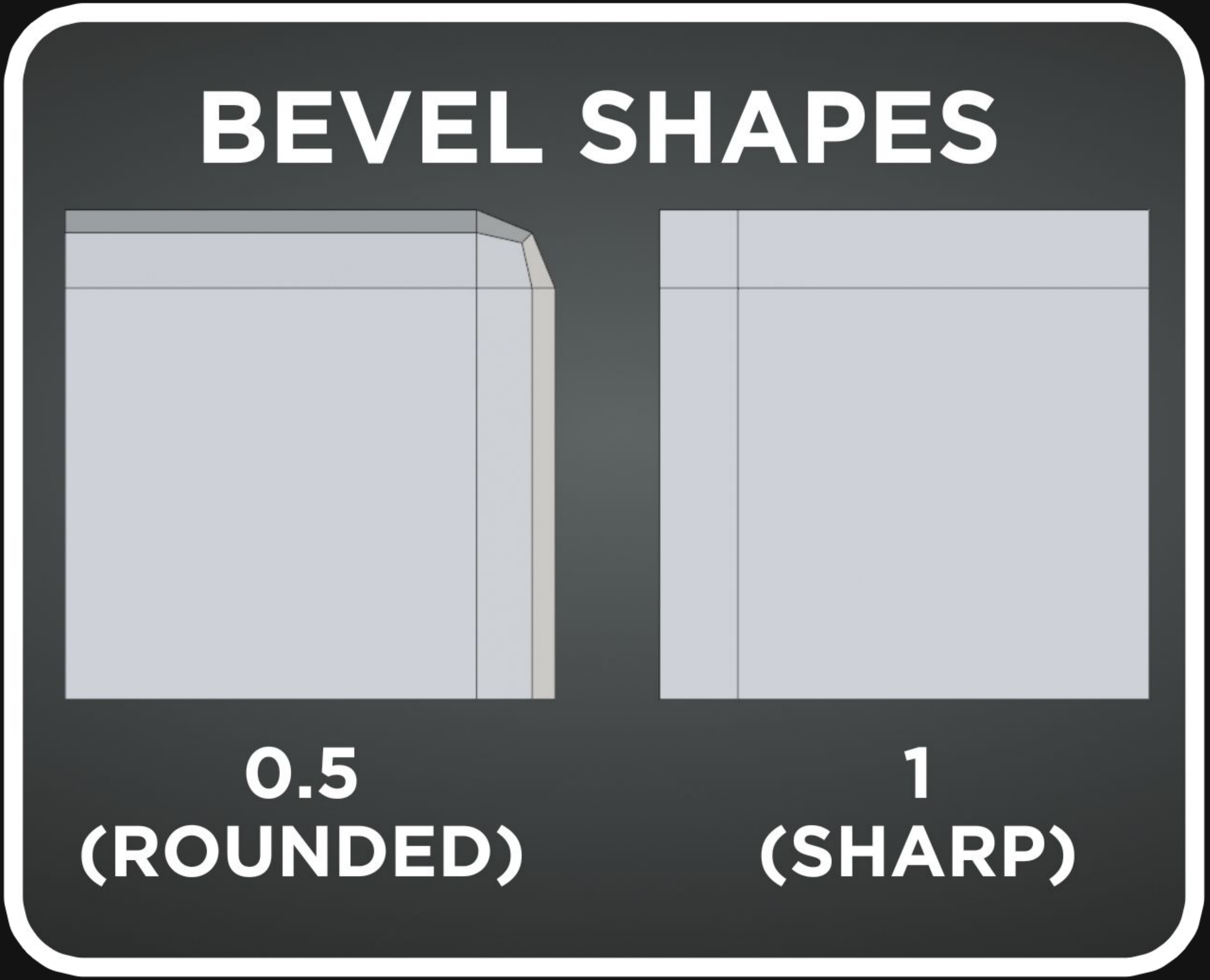
BEVEL SHAPES

0.5 VS 1

The shape of your bevel is **very important**.
To work **non-destructively**, it is recommended to always set the shape value to 1 in order to **keep the corners sharp** (90°).

By default, the shape is set to 0.5, which rounds the corner (45°).

If you're wondering "why?", let me show you an example that is easy to understand.


BEVEL SHAPES
0.5
(ROUNDED)
1
(SHARP)