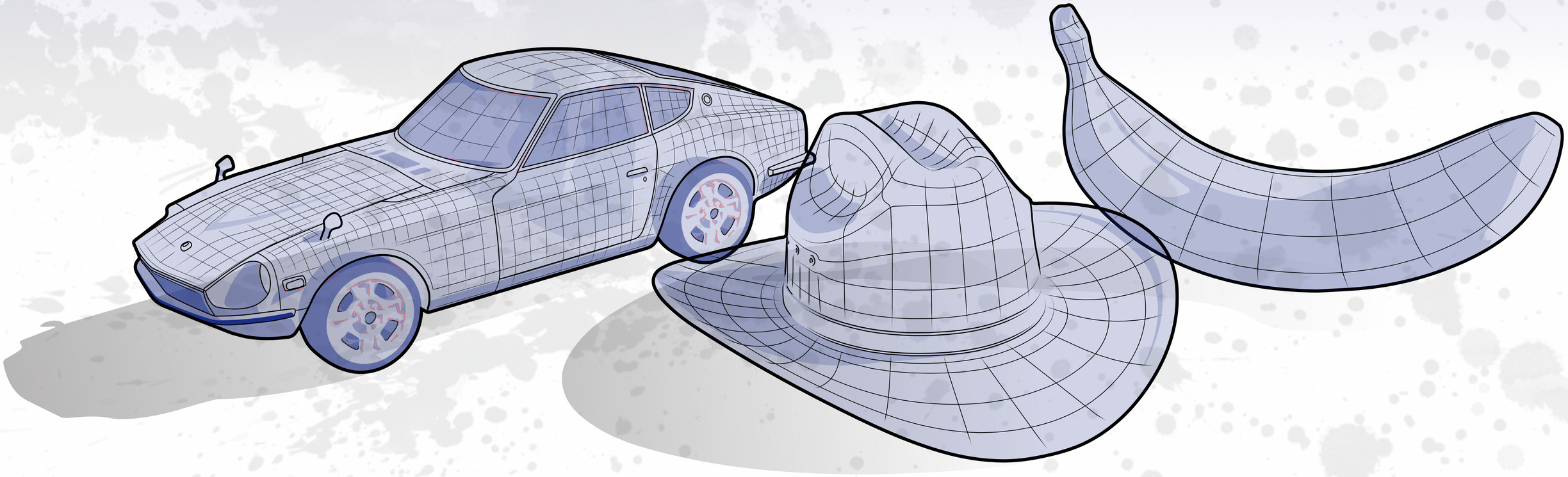
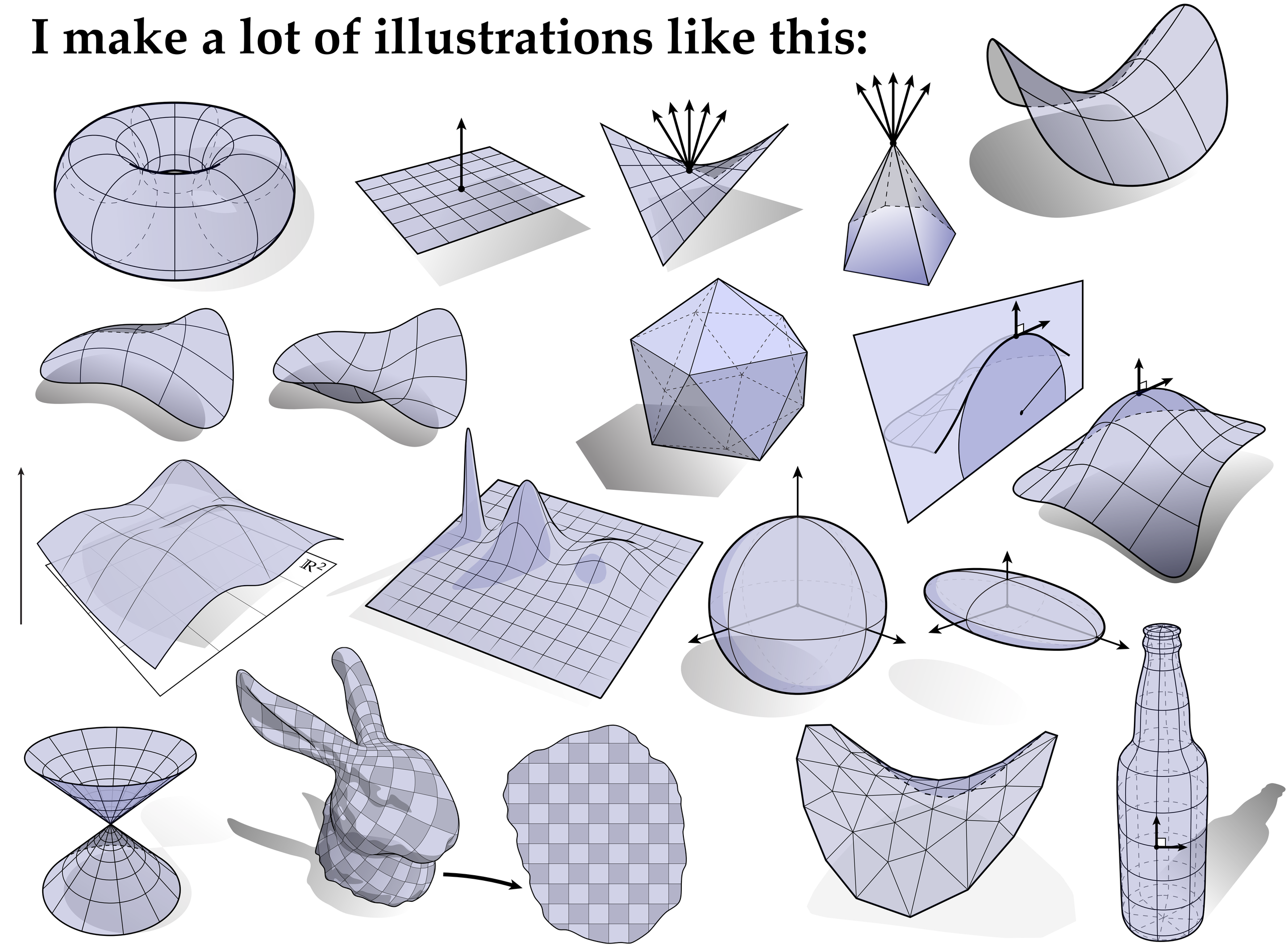


Illustrating Geometry

Keenan Crane

I make a lot of illustrations like this:



And I get a lot of email like this:

Thesis Renders - taught myself Modo last > week, thank you for the recommendation

How do you make your diagrams? - for creating figures is fairly labor intensive. I >> s

cs177 CS 177 - for the figures, it's unfortunately not as easy as writing some TikZ c

Question from a Ph.D. student - creating these figures is fairly labor intensive. Right n

A barrage of comments, questions, and unsolicited advice - typesetting, figures, and

Great Notes - for creating figures is fairly >> labor intensive. Right now I start out in a

How to draw beautiful figures in papers? - for creating figures is fairly labor intensive.

Tools that you use? - the geometry figures, I start out in a 3D modeler (Luxology's mo

Diagrams for your papers - awesome! - trying to figure out > where the best fit for the

(4) Siggraph course - for the figures, sadly there is no automatic tool. Right now I start >

About images in your thesis / Discrete Differential Geometry course - making these fi

How do you create awesome illustrates in your thesis and SIG course notes? - makin

You have been thanked! - . The figures look great :) --Hossein On Fri, Jun 7, 2013 at

excellent notes on DDG fa11 - The figures are generated using a couple different so

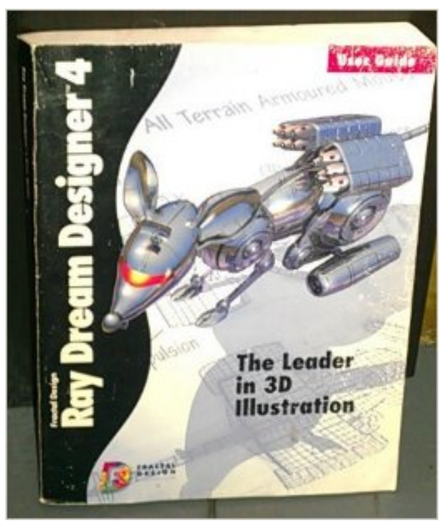
What everybody wants to know:

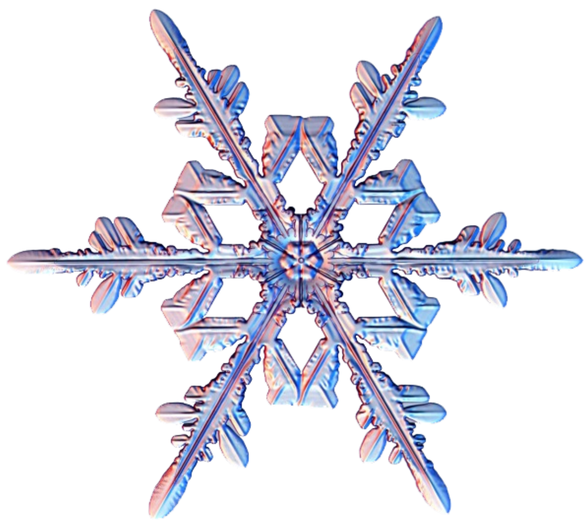
"WHAT PROGRAM DO YOU USE TO MAKE YOUR FIGURES?"

Unfortunately, not that easy!

- *have been using Adobe Illustrator since ~1994*
- *modo/Lightwave since ~1997 ("RayDream" before that)*
- *lots of drawing/painting/photography classes*
- *differential geometry since ~2004*
- *have drawn 200+ figures in this particular style*

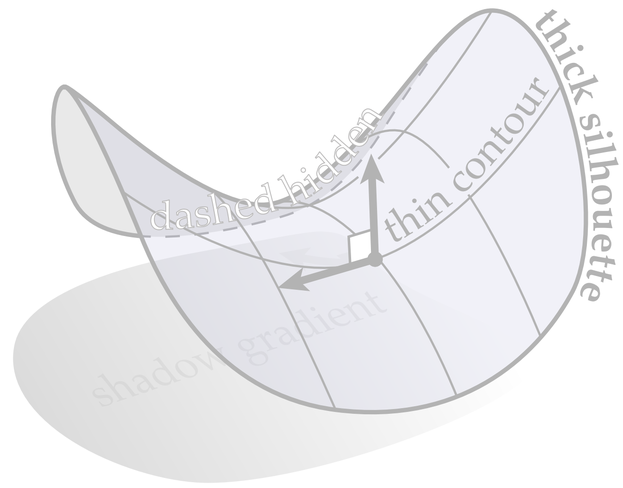
- *also, I am a unique snowflake*
- *…would like to think that some of these factors contribute.*





\usepackage{mathpazo} *Pall*

Goals of this talk:



- show examples of figures I've made
- show *how* they're made
- discuss workflow

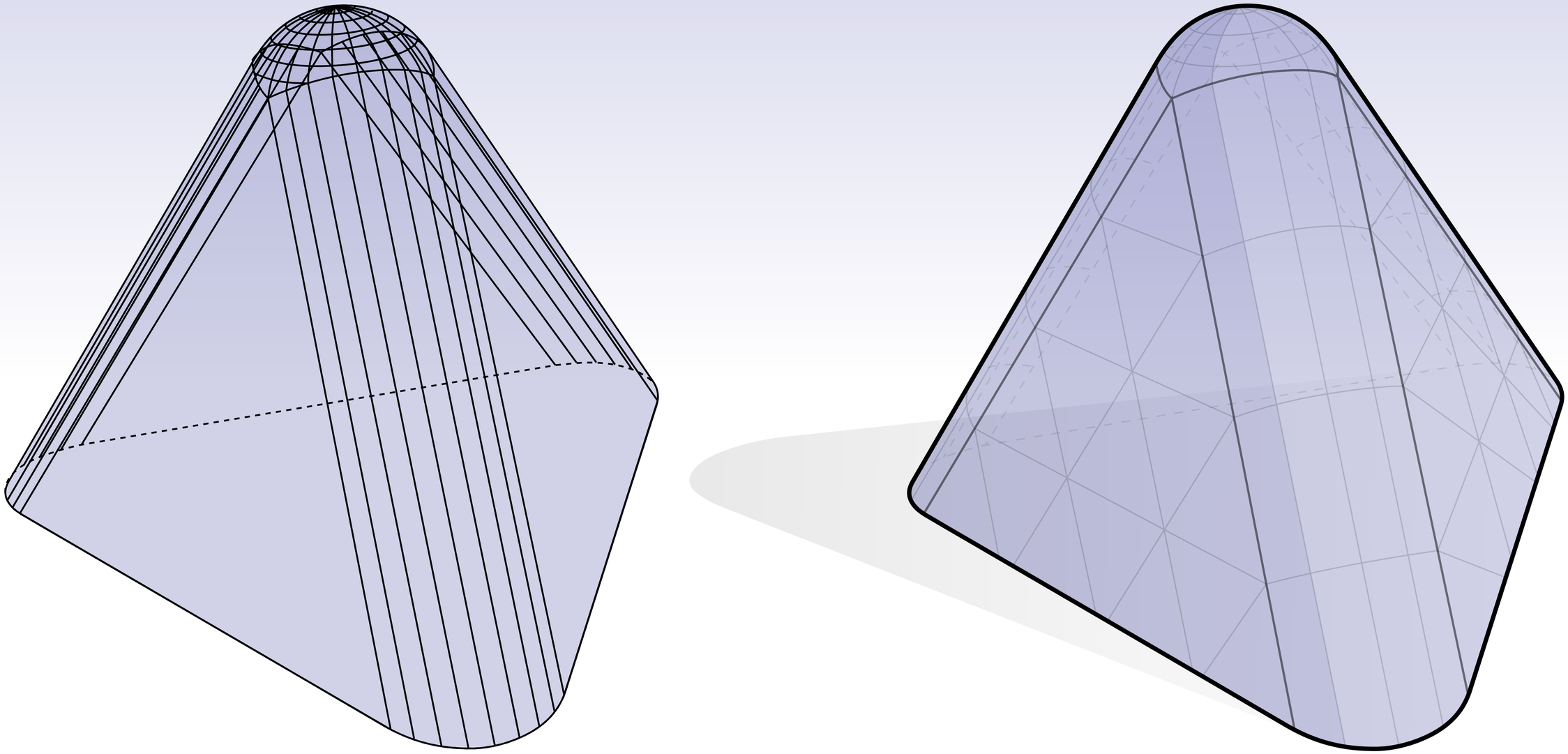
1b1f8a

20% opacity

  - even if Keenan is a snowflake, *can't it be automated?*
    - what design aspects are easy to formalize?
    - what's difficult to formalize?
    - where do current tools (unnecessarily) fall short?
  - general discussion about design & technology

(Show More Examples!)

“People don’t notice the things you do...



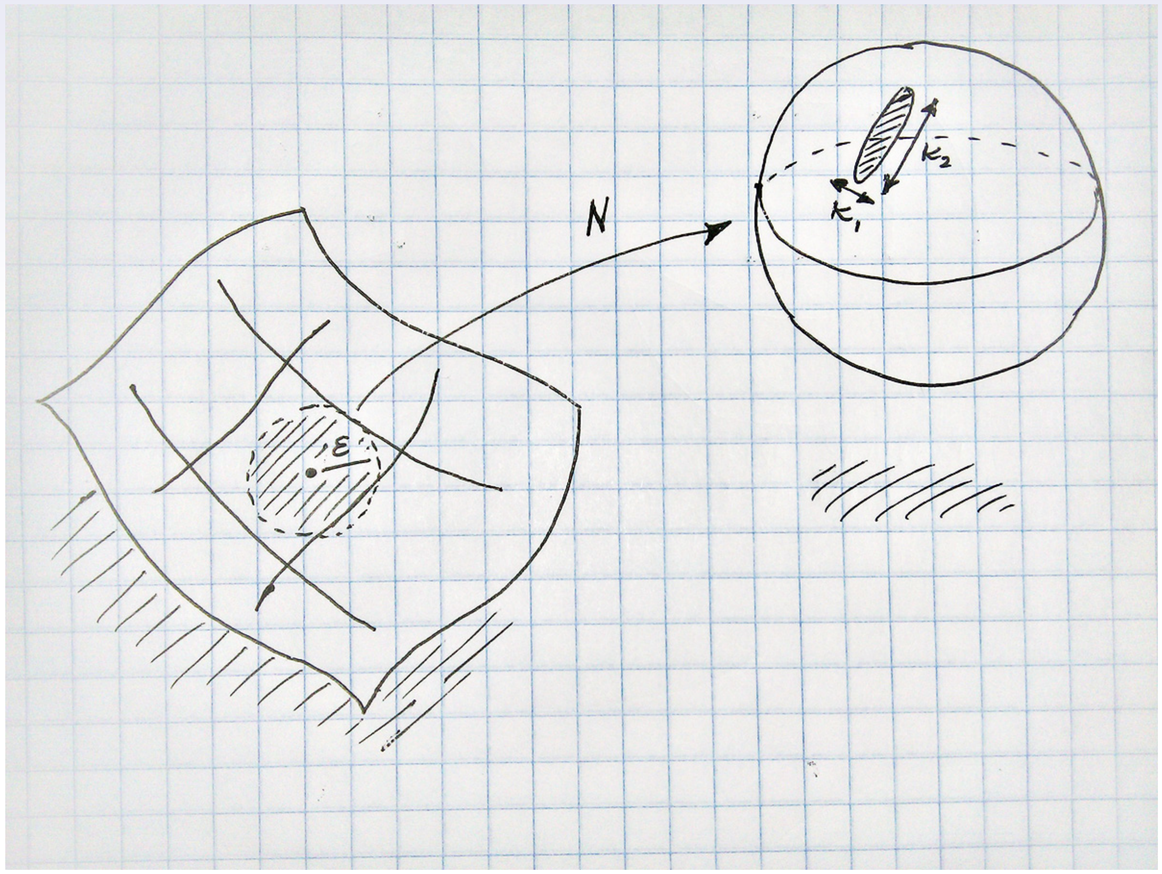
...until you stop doing them!”

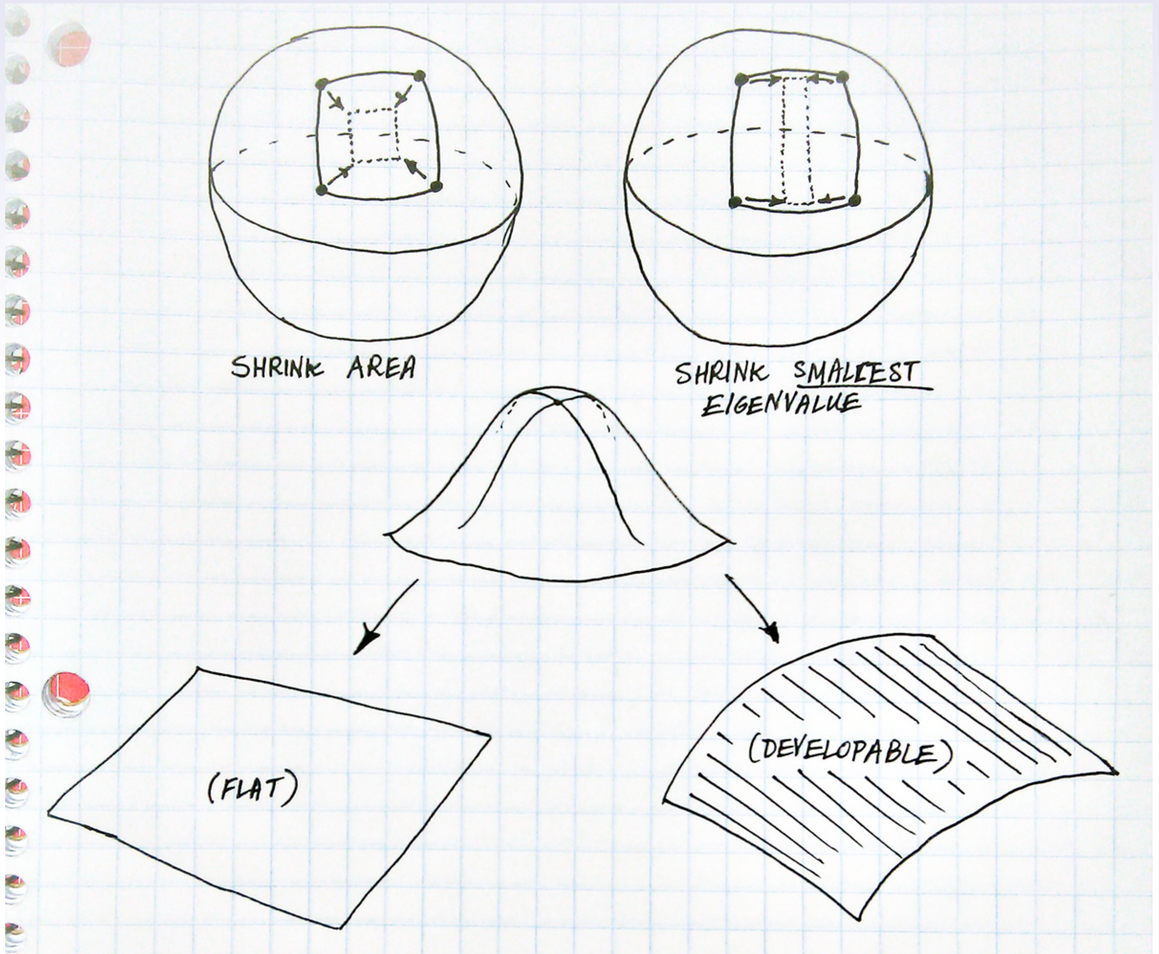
Common Decisions

What's the geometry?
Where does the camera go, and what's the focal length?
Where's the light/shadow?
  Do we want to include shading?
  Do we want a separate light for the shadow vs. the shading?
Which "geometric" lines should be included?
  Always the silhouette.
  What about other contours?
Which "combinatorial" lines should be included?
  E.g., grid lines.
Should we automatically trace contours, or do it by hand?
Are there any components that can be algorithmically generated?
What's the line thickness, for various classes of lines?
What's the line style for hidden lines?
What's the line style for partial lines?
What's the fill color for various regions?
  Should we use different colors/brightnesses to indicate lighting?
  Should we use gradients for shading?
  How should we color occluded regions?
  How dark is the shadow?
  What direction does the shadow gradient go?
How do we label the figure?
  What gets labeled?
  Where do labels go? (How) should they occlude/be occluded by geometry?

What's the Geometry?

Most important question... and hardest to answer!

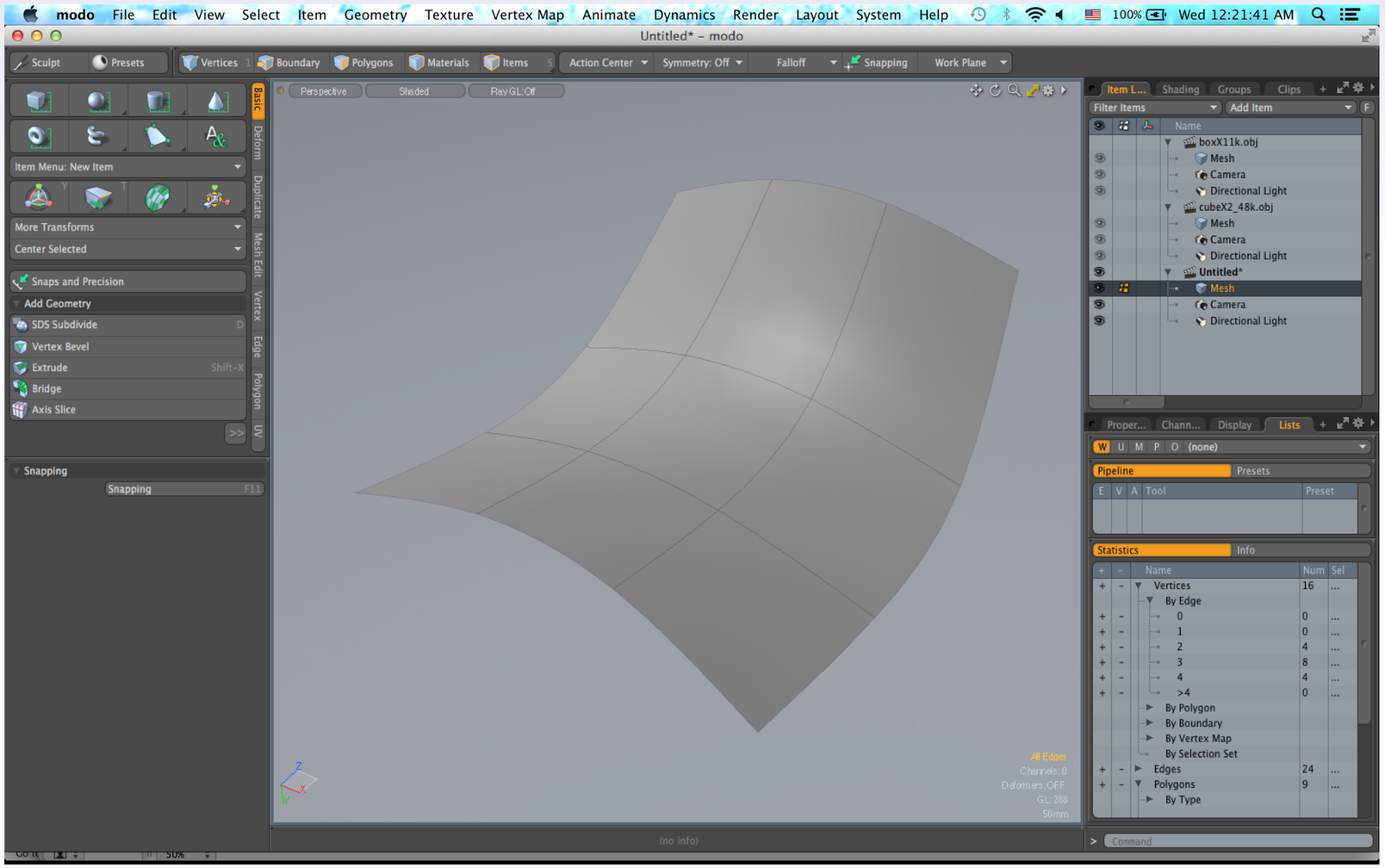




Often starts with a sketch (or two or three).

Create the Geometry

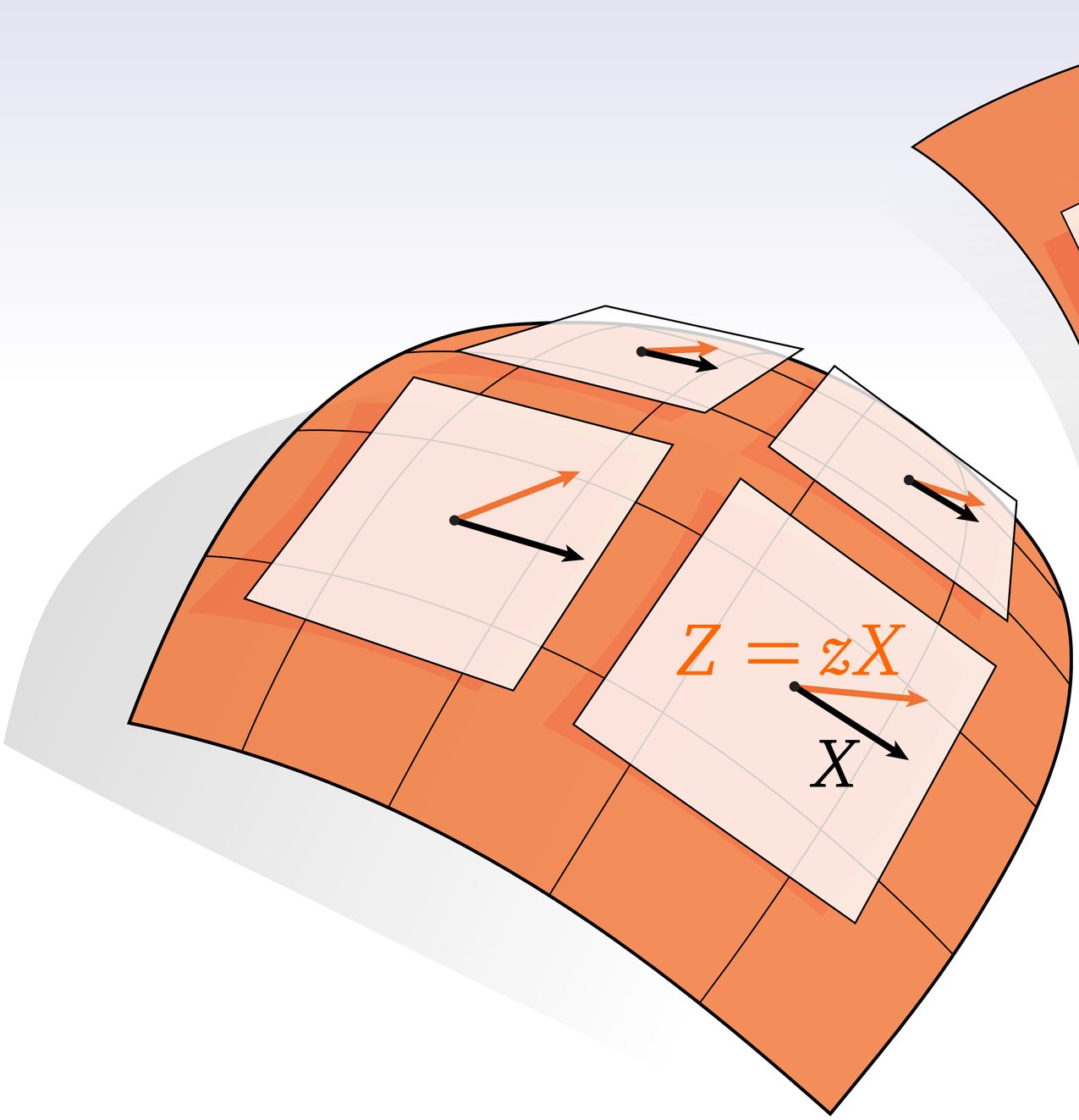
Playing in 3D often gives you new ideas / forces you to change your initial idea.

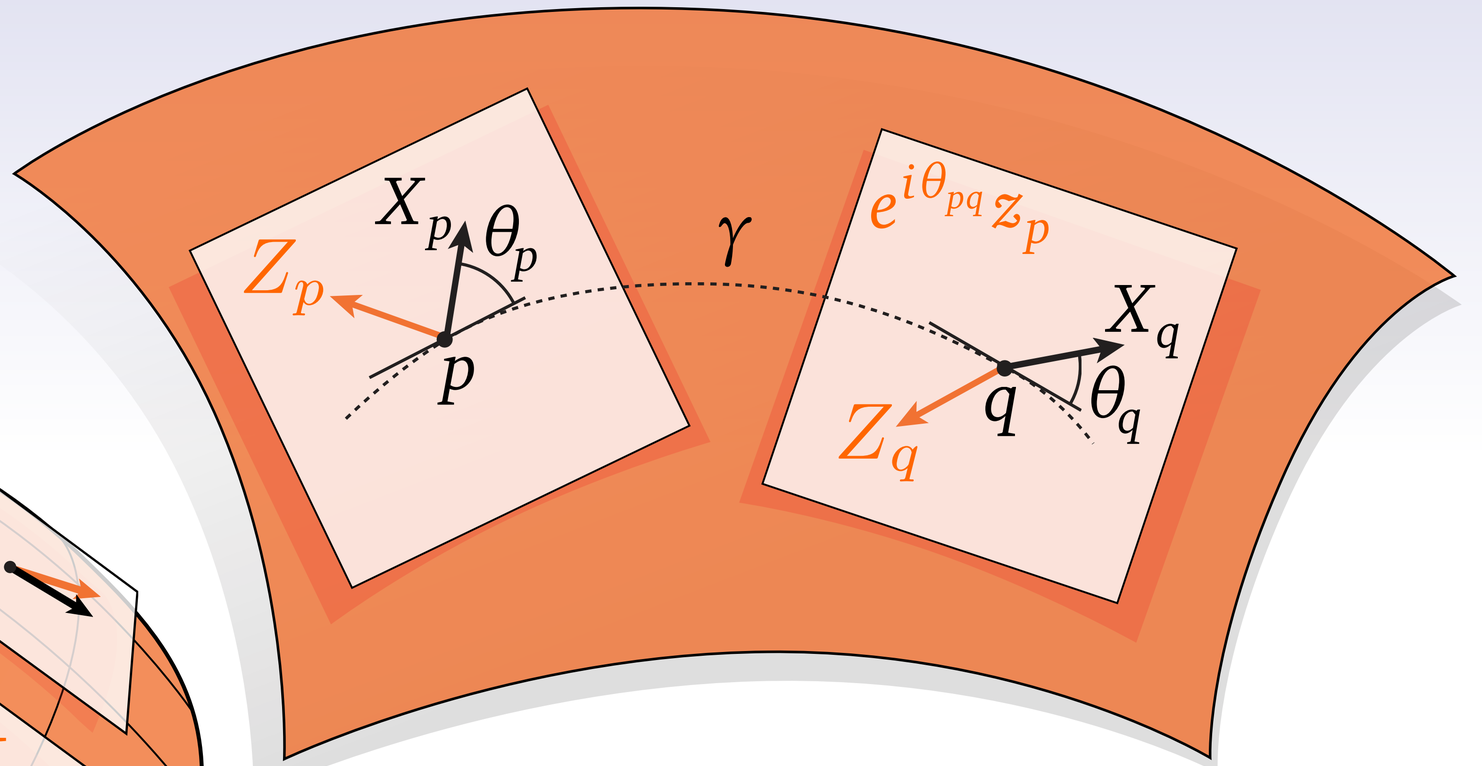


I use “modo,” mostly because I know how!

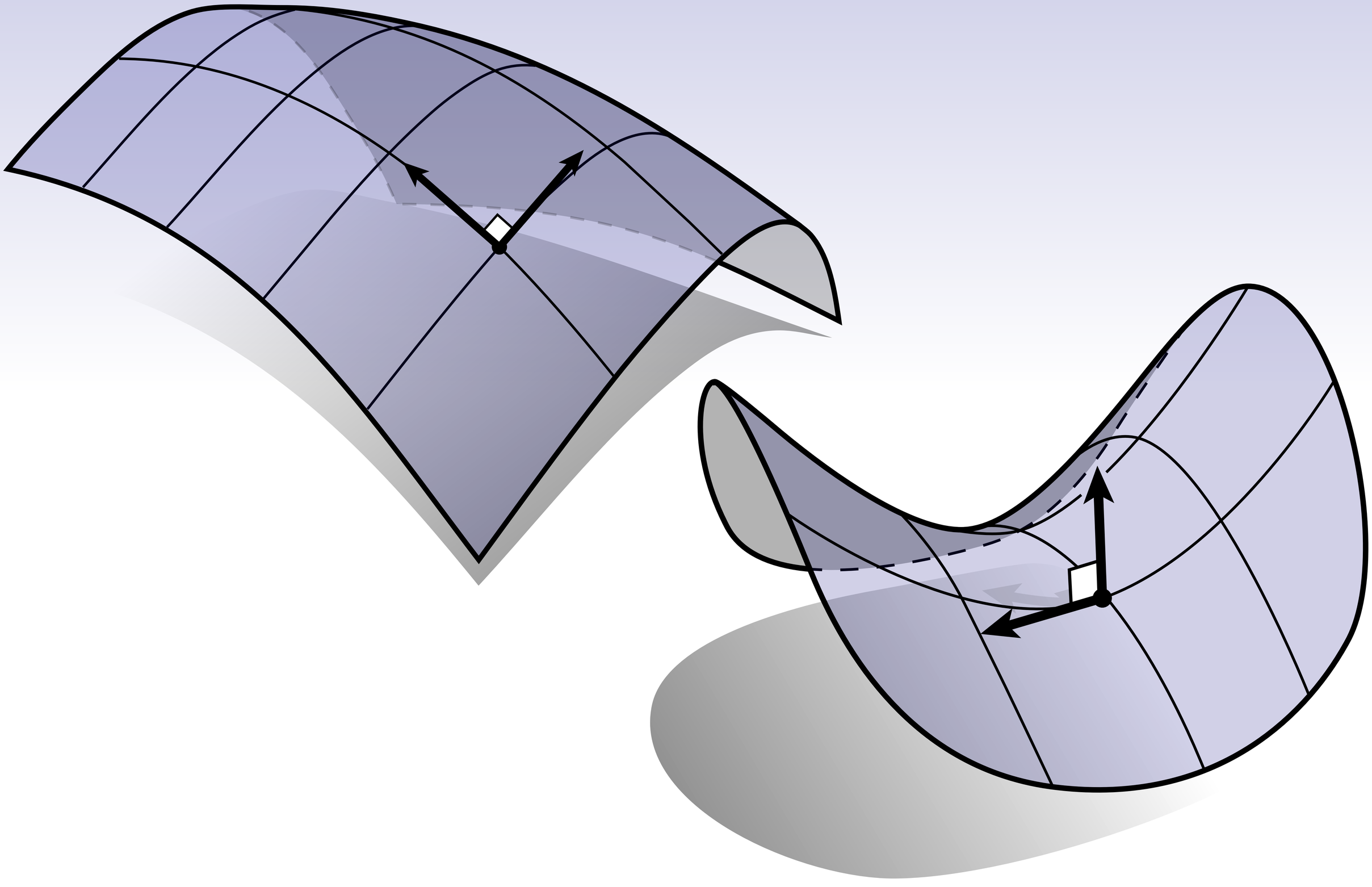
Really, Create the Geometry!

Really do it in 3D. Faking it ***never*** works.

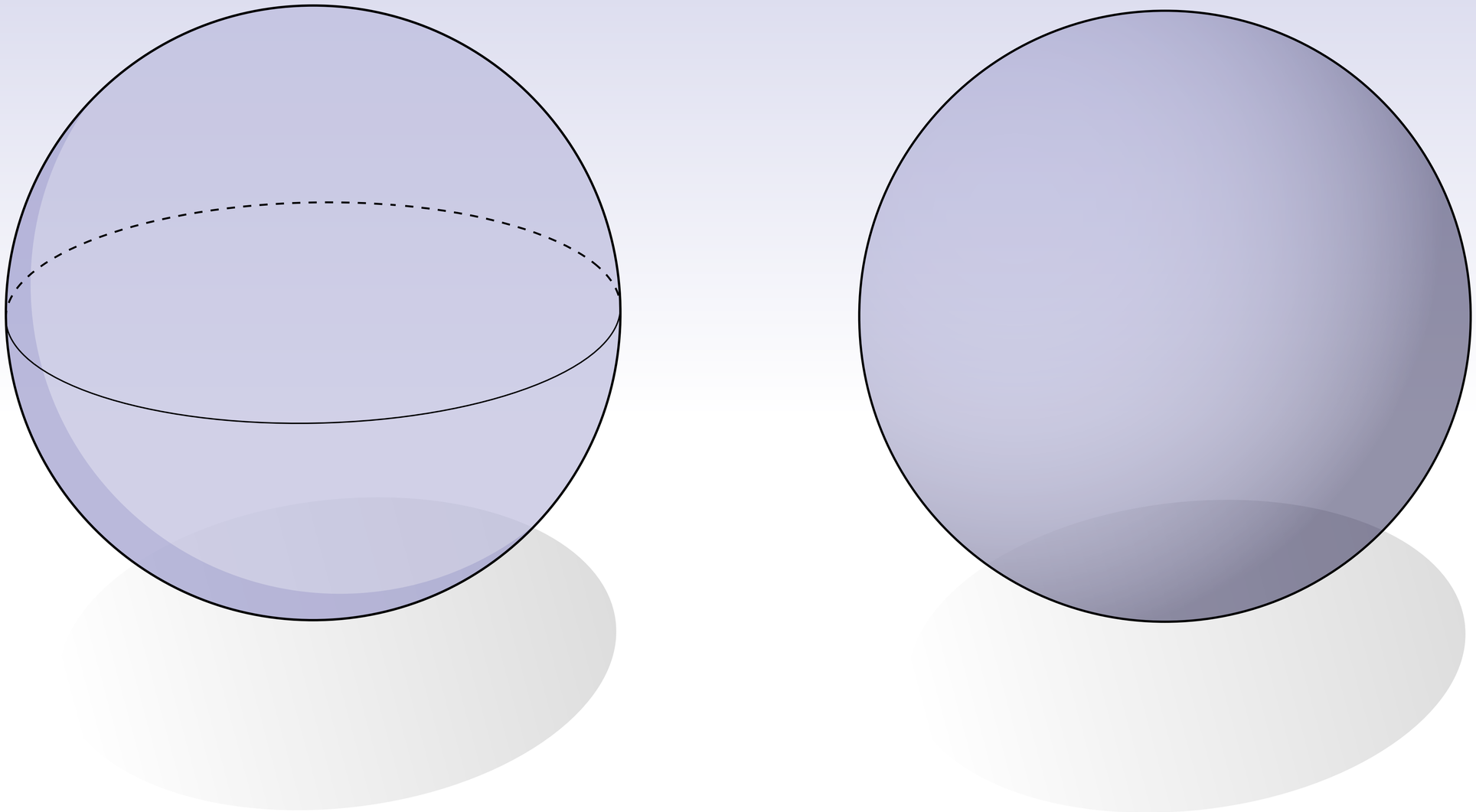




Cheating the Light

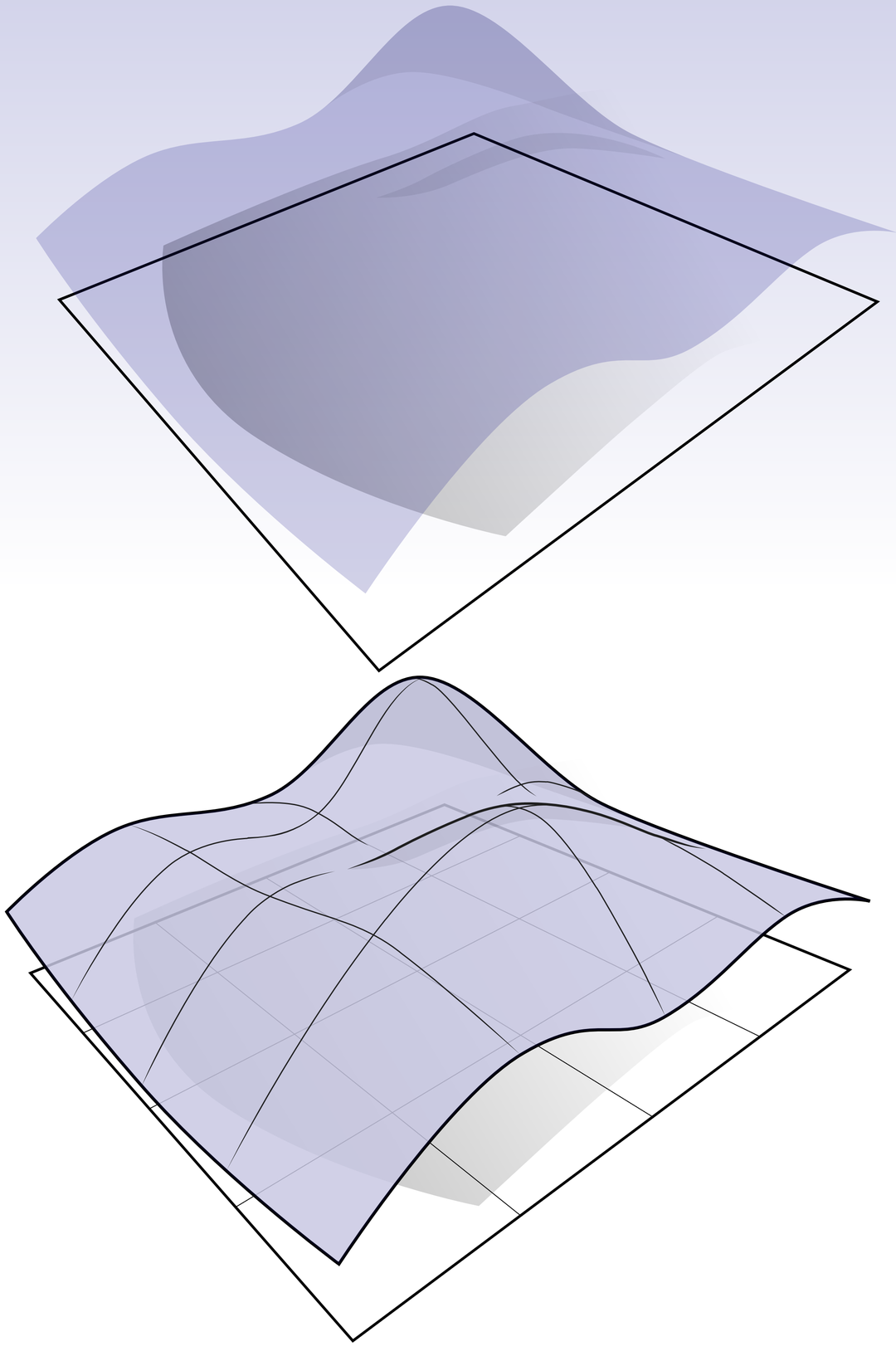


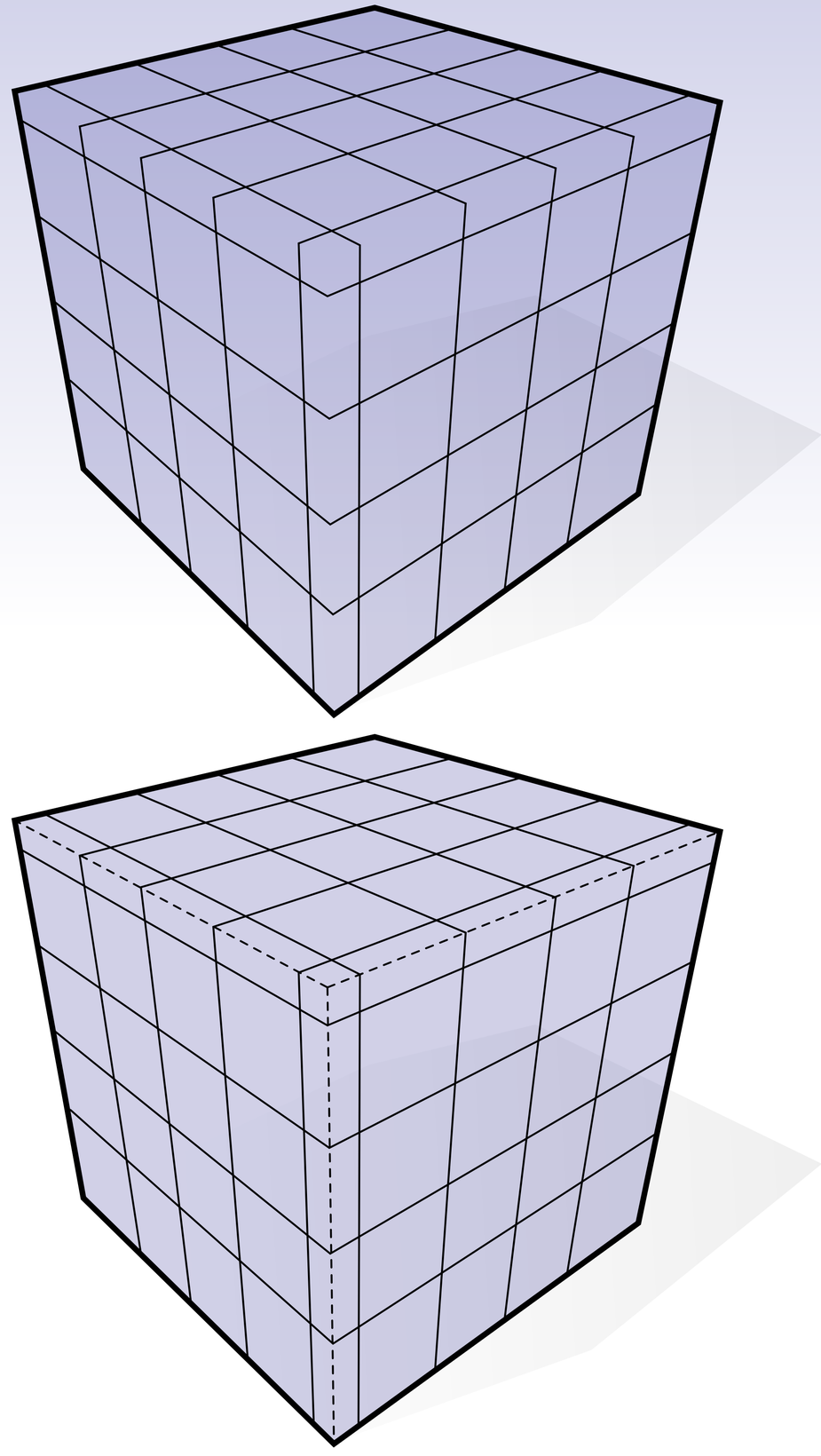
Shading?



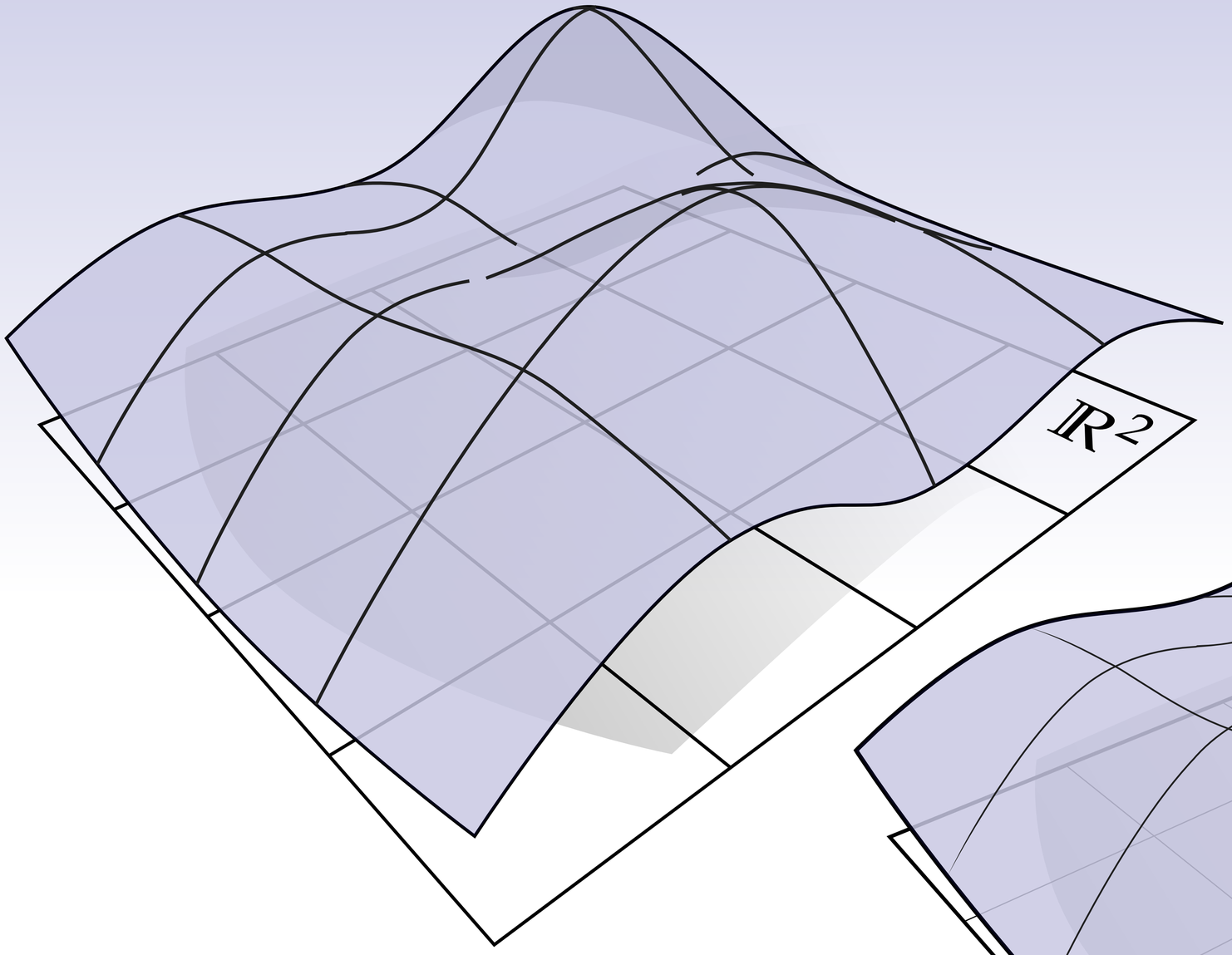
interaction of style & technological limitations

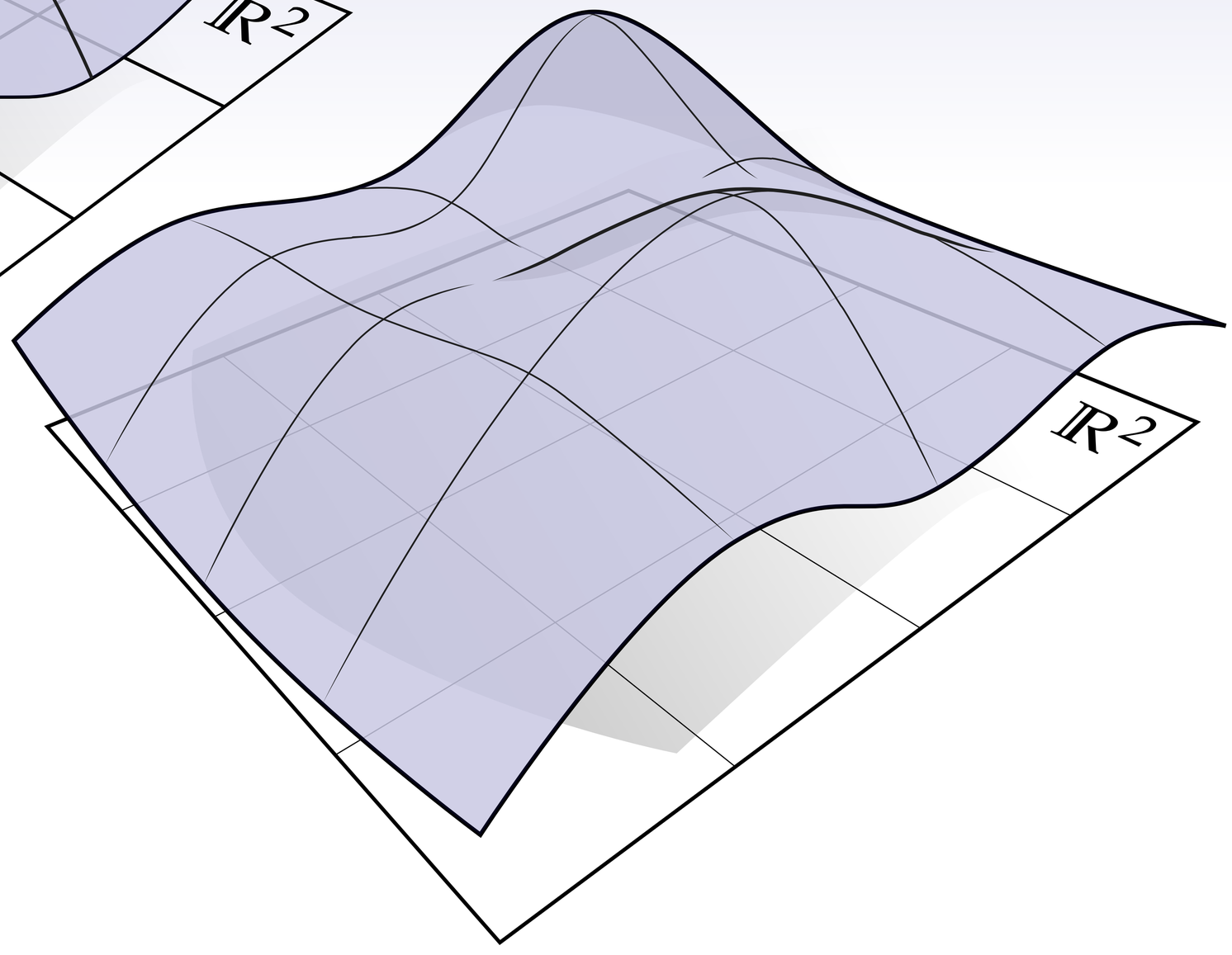
The Importance of Lines



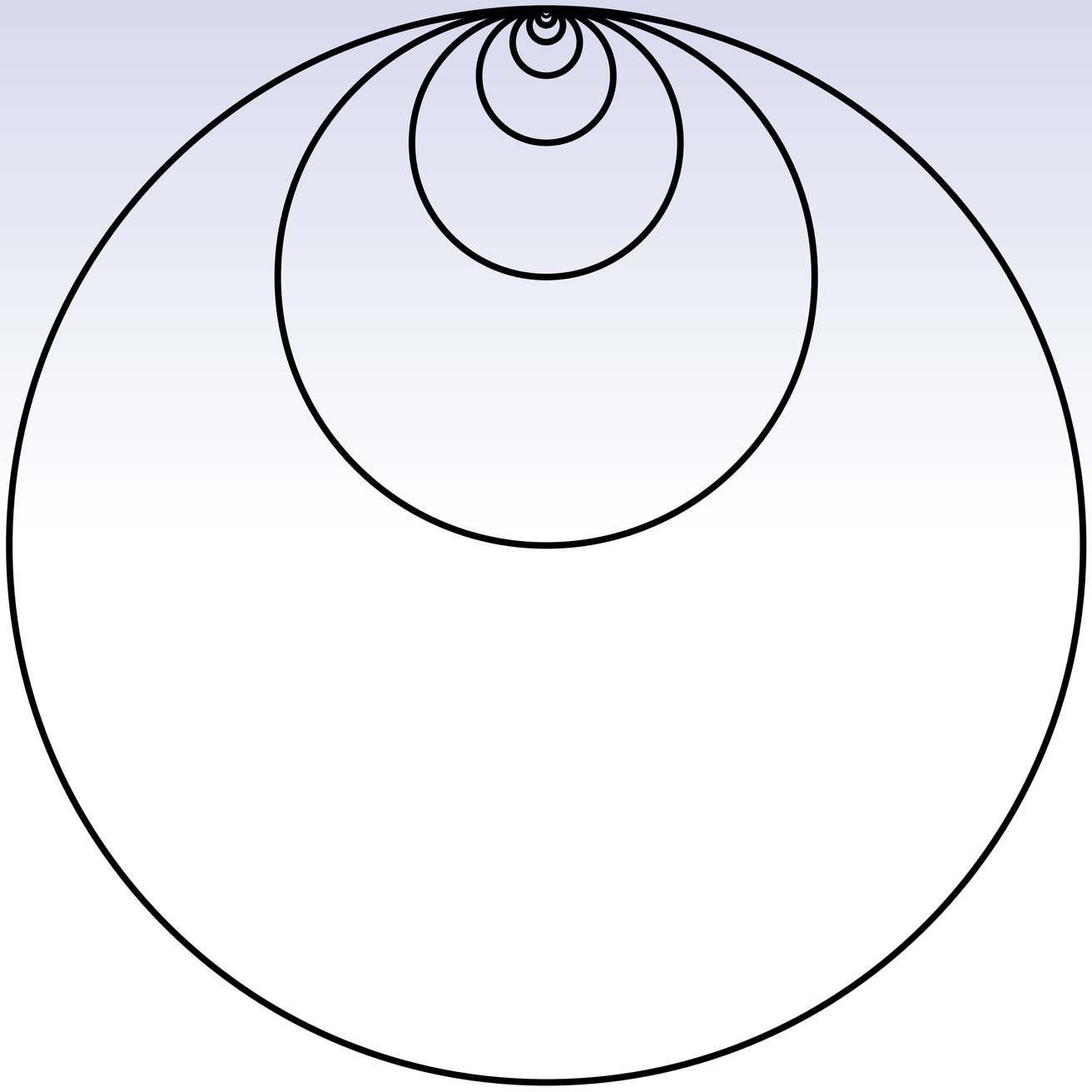


The Importance of Line Width



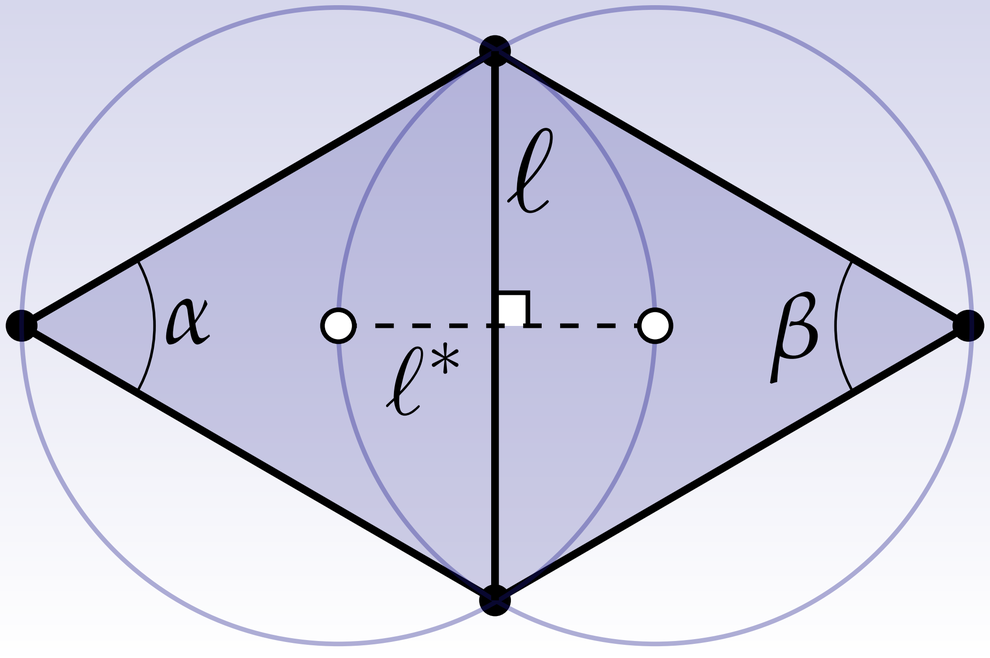


Abstraction vs. Accuracy

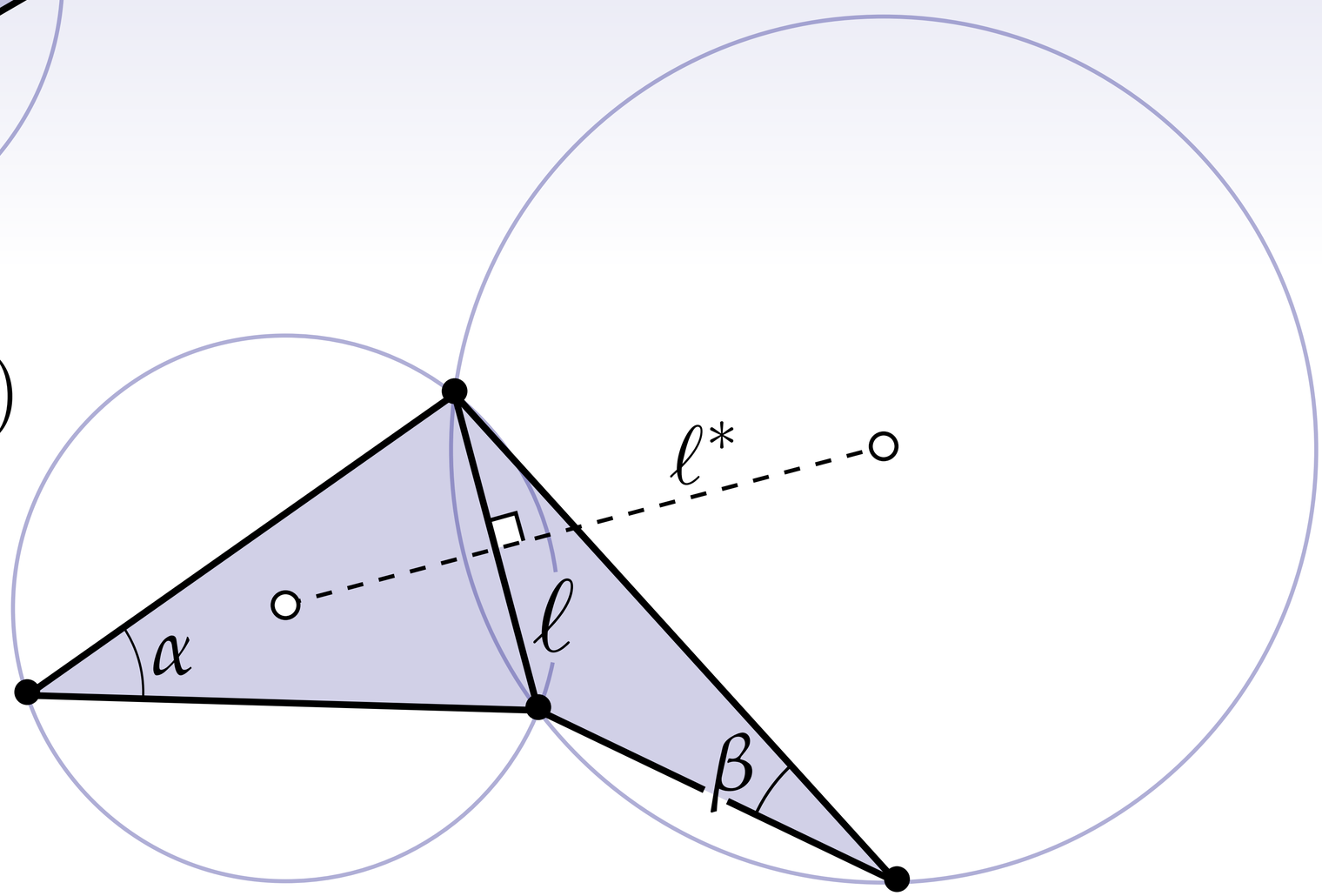


topological space

Is This Figure Misleading?

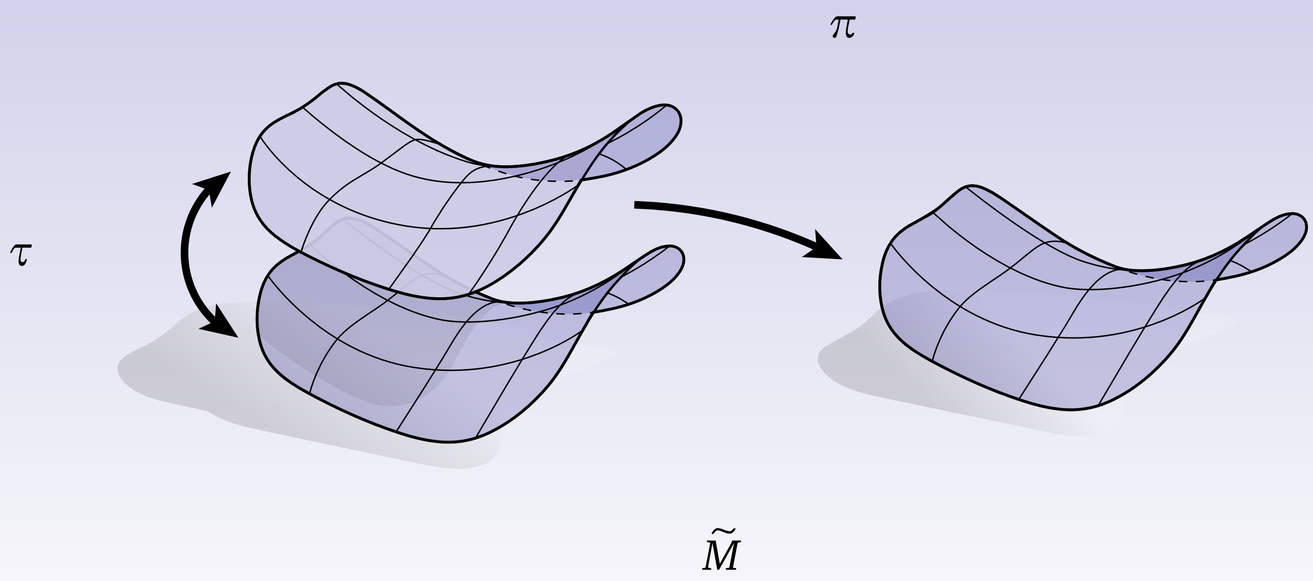


$$\frac{\ell^*}{\ell} = \tfrac{1}{2}(\cot\alpha + \cot\beta)$$

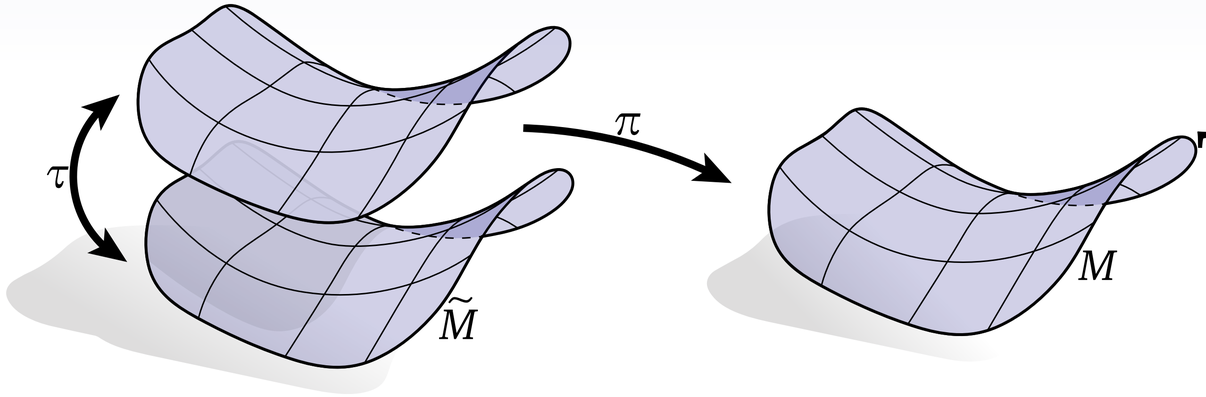


$$\frac{\ell^*}{\ell} = \tfrac{1}{2}(\cot\alpha + \cot\beta)$$

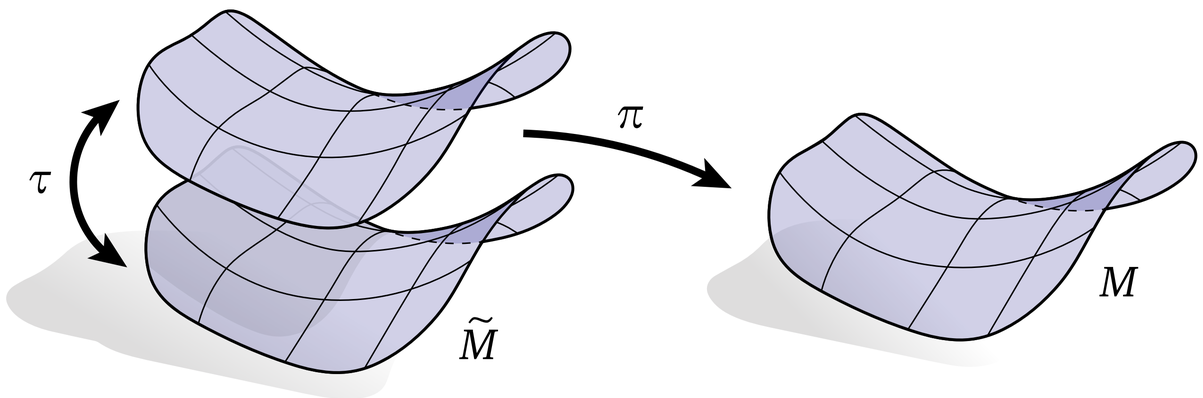
Labeling - Local



Too far.

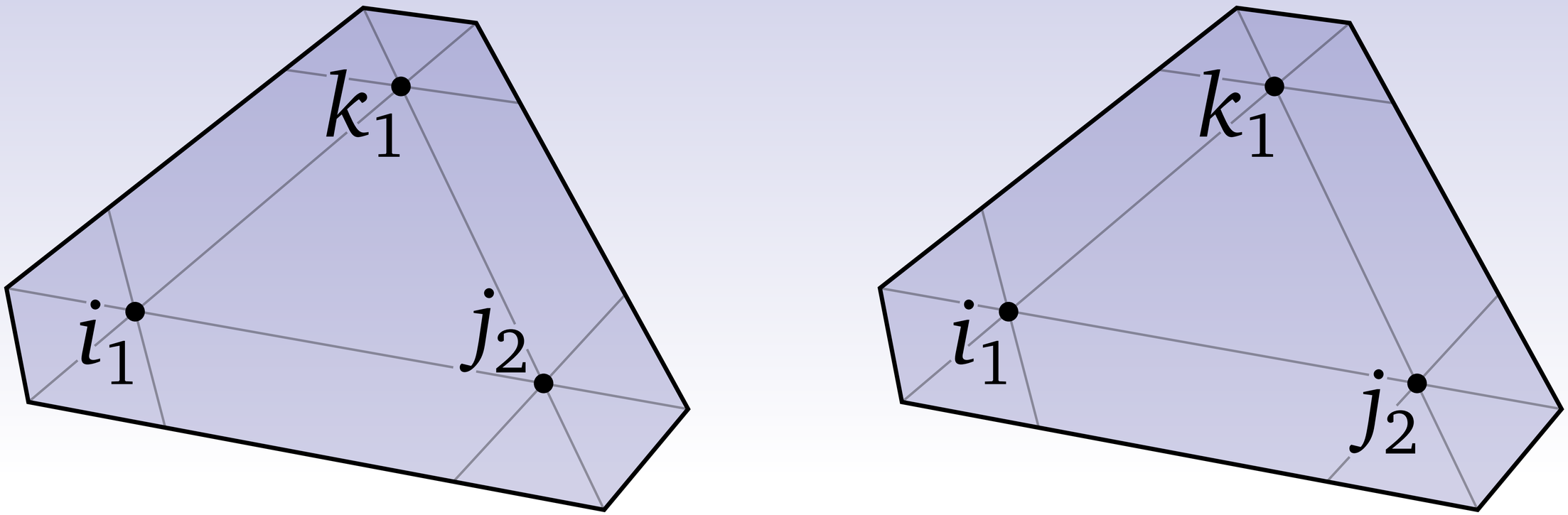


Too close!

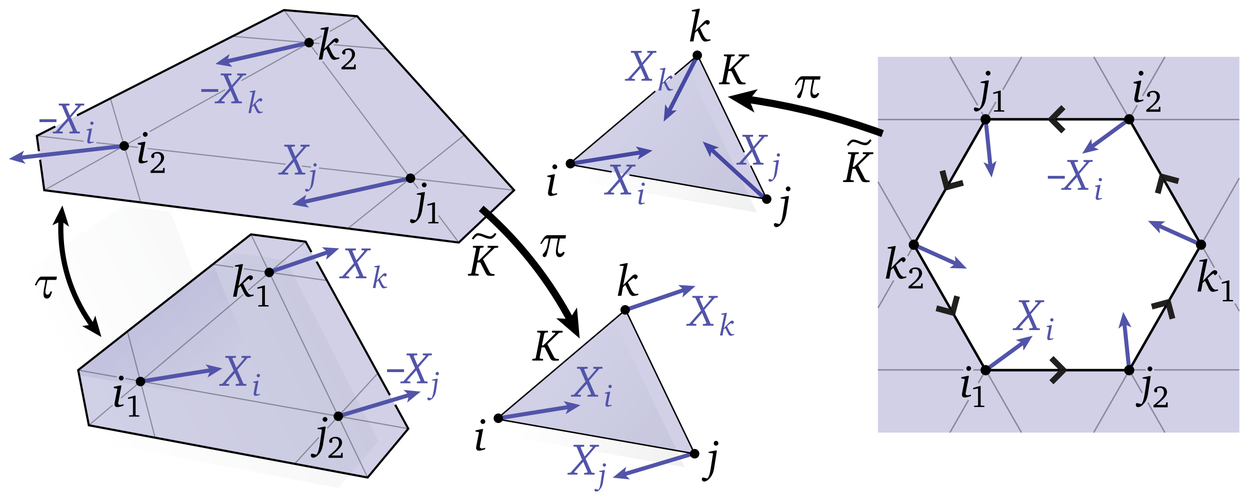


Just Right?

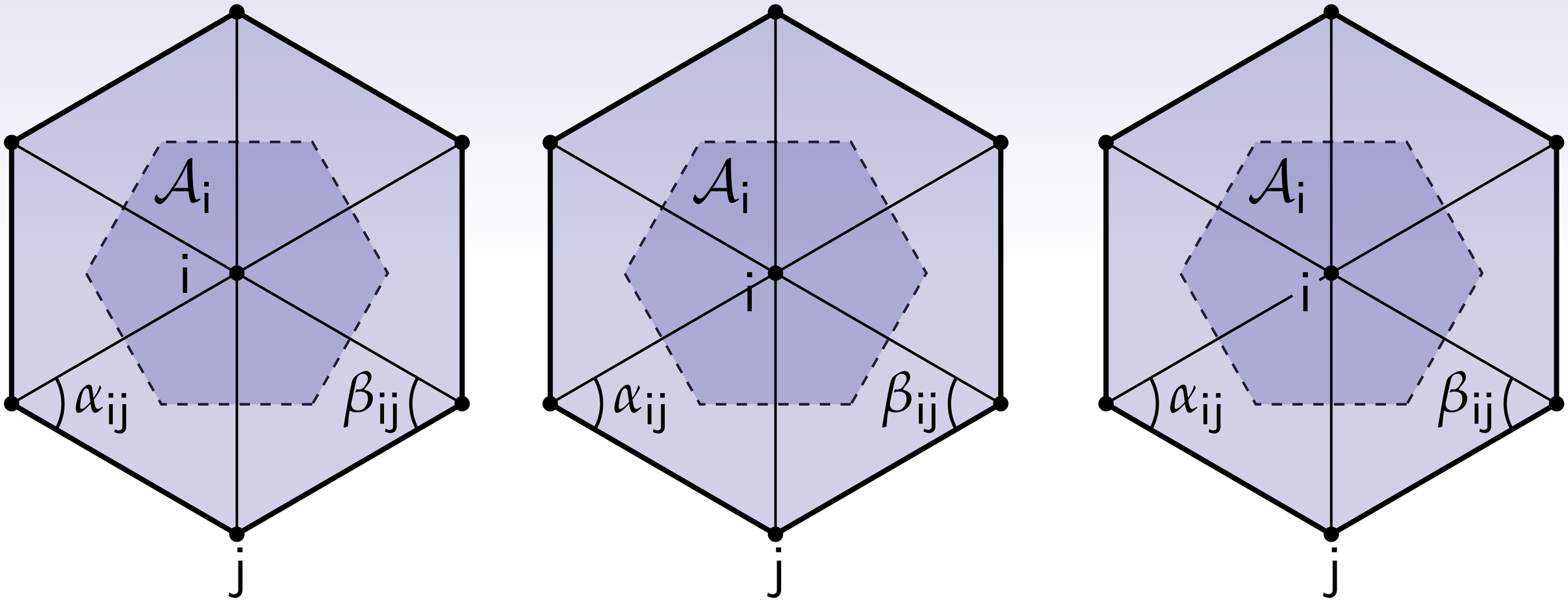
Labels - Global Placement



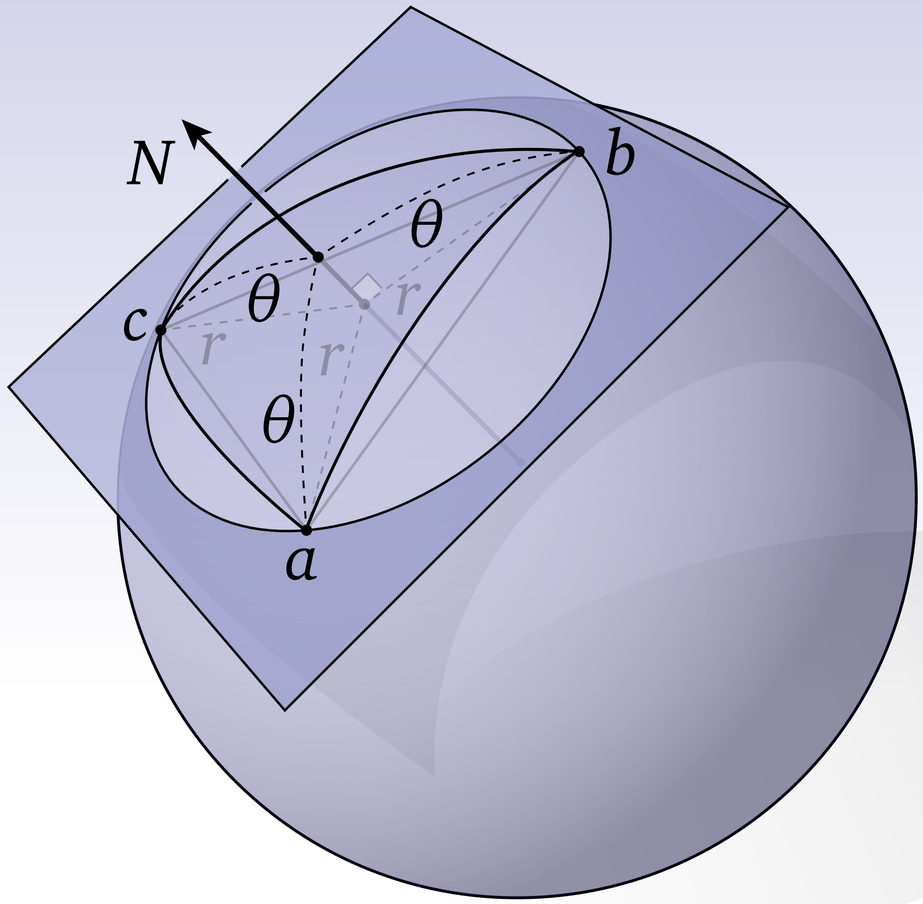
...In context, lots of constraints!

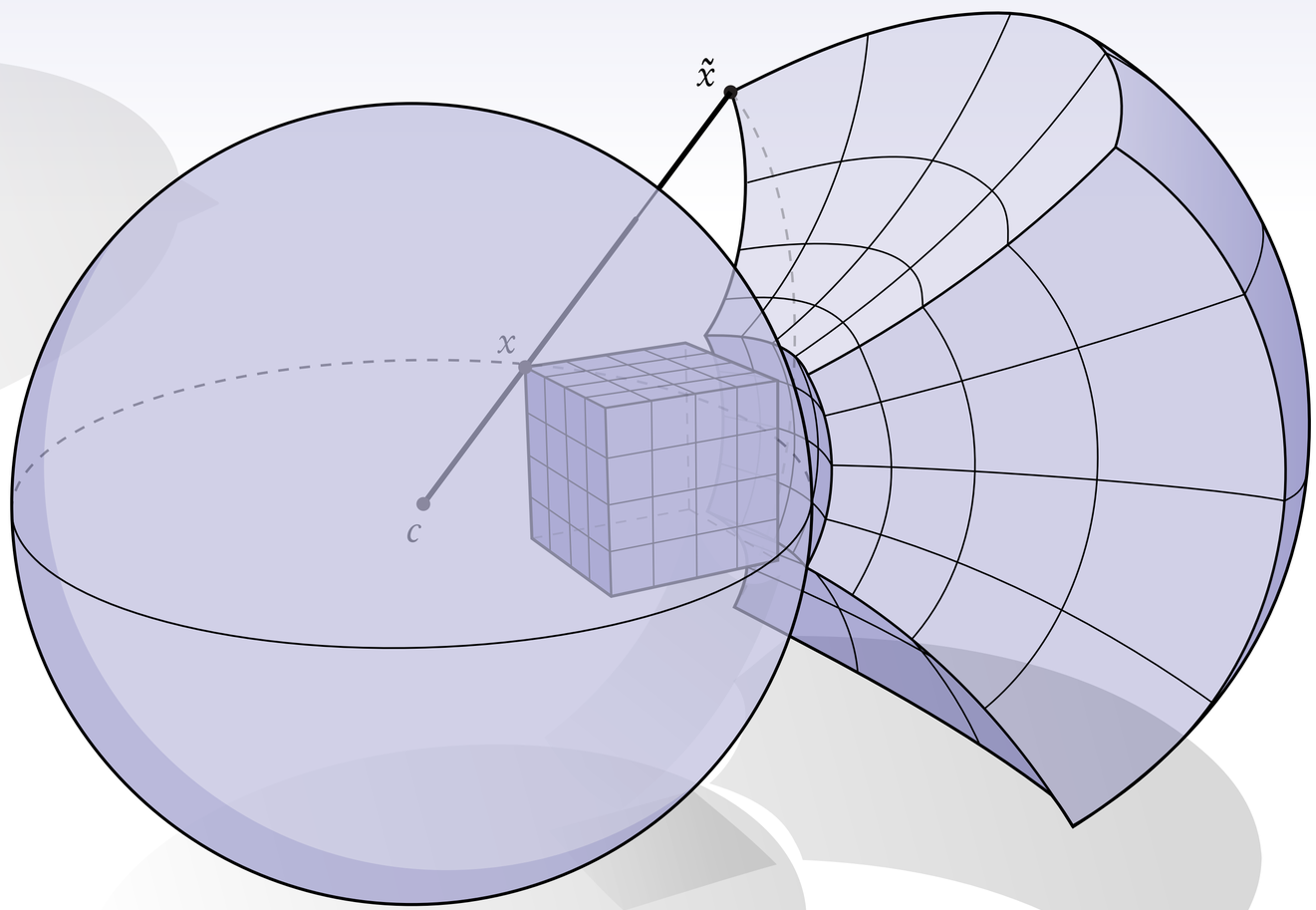


Labeling - Hidden Lines

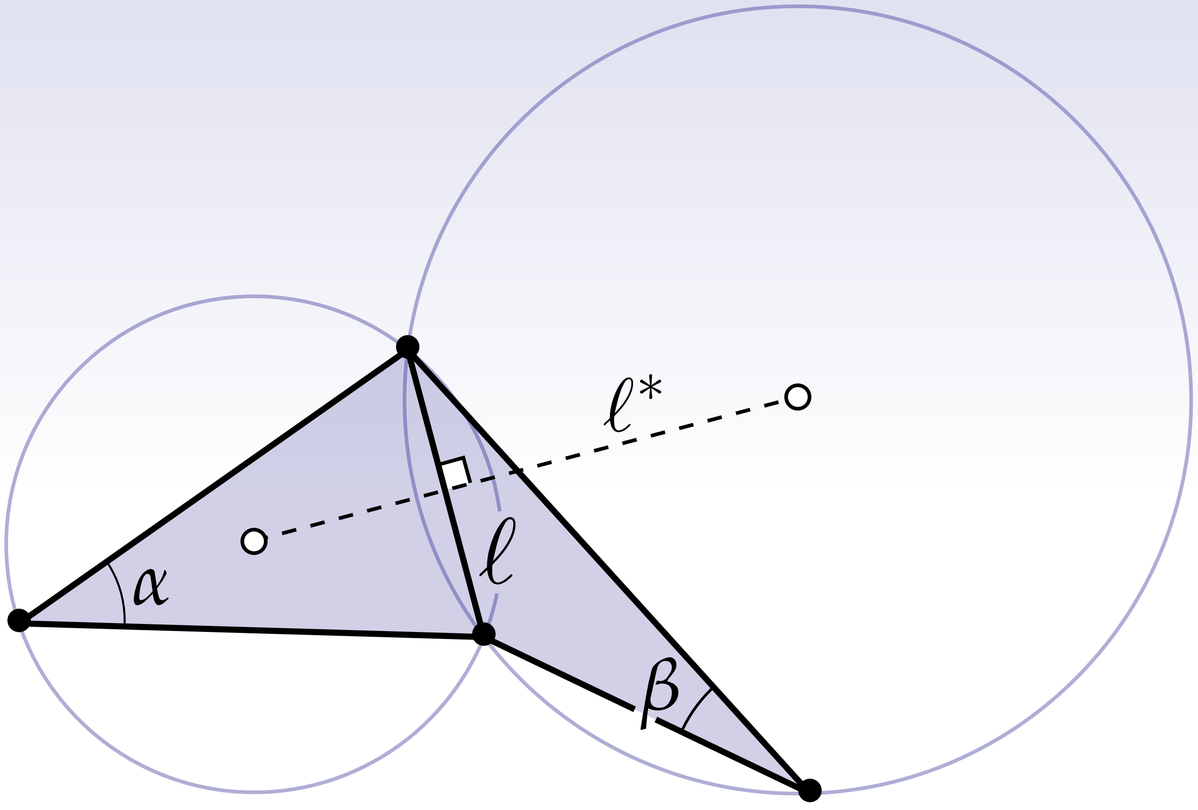


Labeling - Occlusion

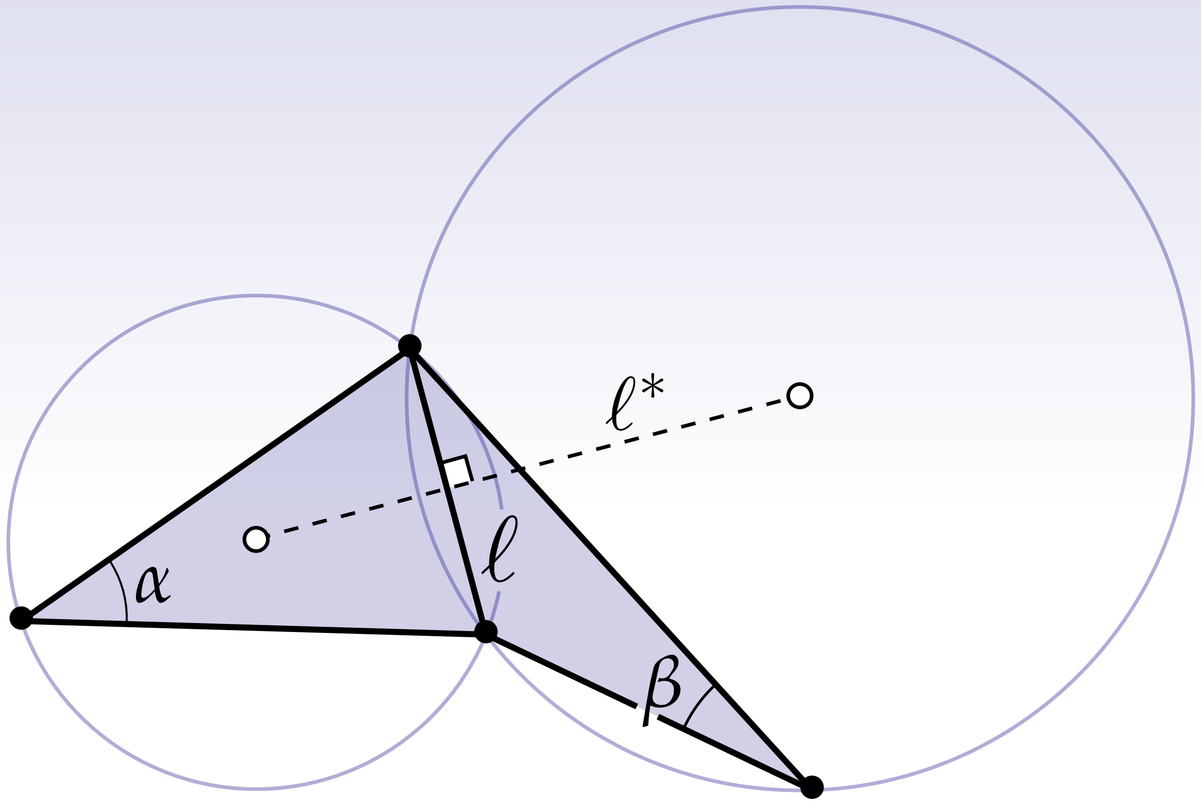




Labeling - Which One is Centered?

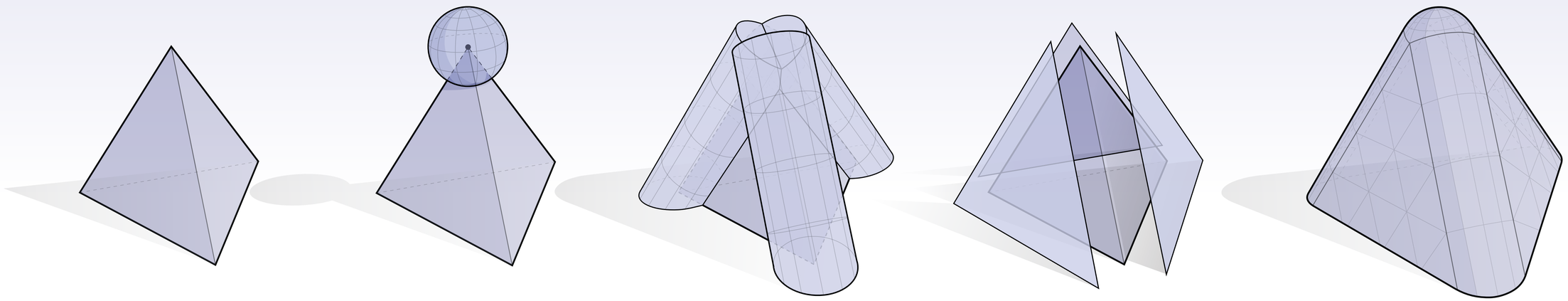


$$\frac{\ell^*}{\ell} = \tfrac{1}{2}(\cot\alpha + \cot\beta)$$



$$\frac{\ell^*}{\ell} = \tfrac{1}{2}(\cot\alpha + \cot\beta)$$

Instead of more slides...



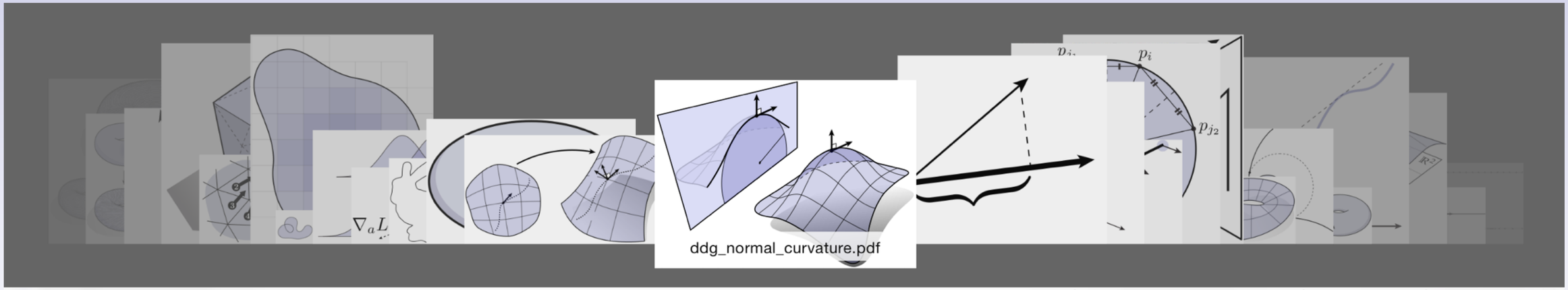
...Why not just show you how this really happens?

(Note: *not* real time! ~6 hours)

Future Opportunities?

- **"Easy"** — 3D Illustrator
  - *convert 3D geometry into 2D strokes*
  - *opens the door to animation*
- **"Medium"** — TeX for mathematical illustration
  - *codify best practices of professional illustrators*
- **"Hard"** — automatic generation of figures from text
  - *start with very narrow domain? (e.g., set theory)*
  - *potential to change the world*

Bonus Question: Search?



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ddg_half_turn.pdf	Apr 21, 2013, 6:37 PM	255 KB	PDF Document
ddg_harmonic_generator_single_face.pdf	May 9, 2013, 4:06 PM	212 KB	PDF Document
ddg_harmonic_generator.pdf	May 9, 2013, 4:18 PM	272 KB	PDF Document
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Glass Blowing Demo