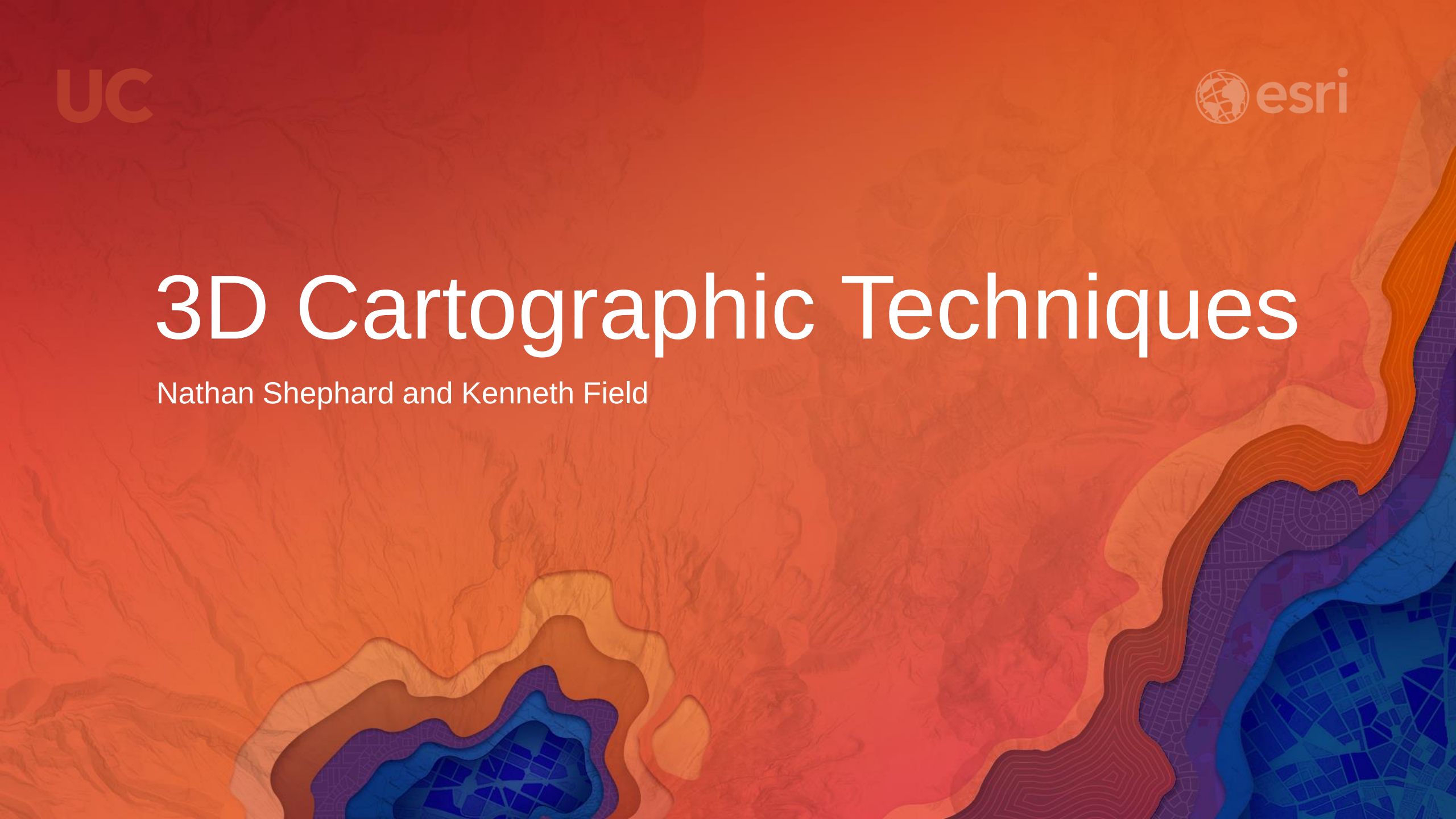
3D Cartographic Techniques

Nathan Shephard and Kenneth Field



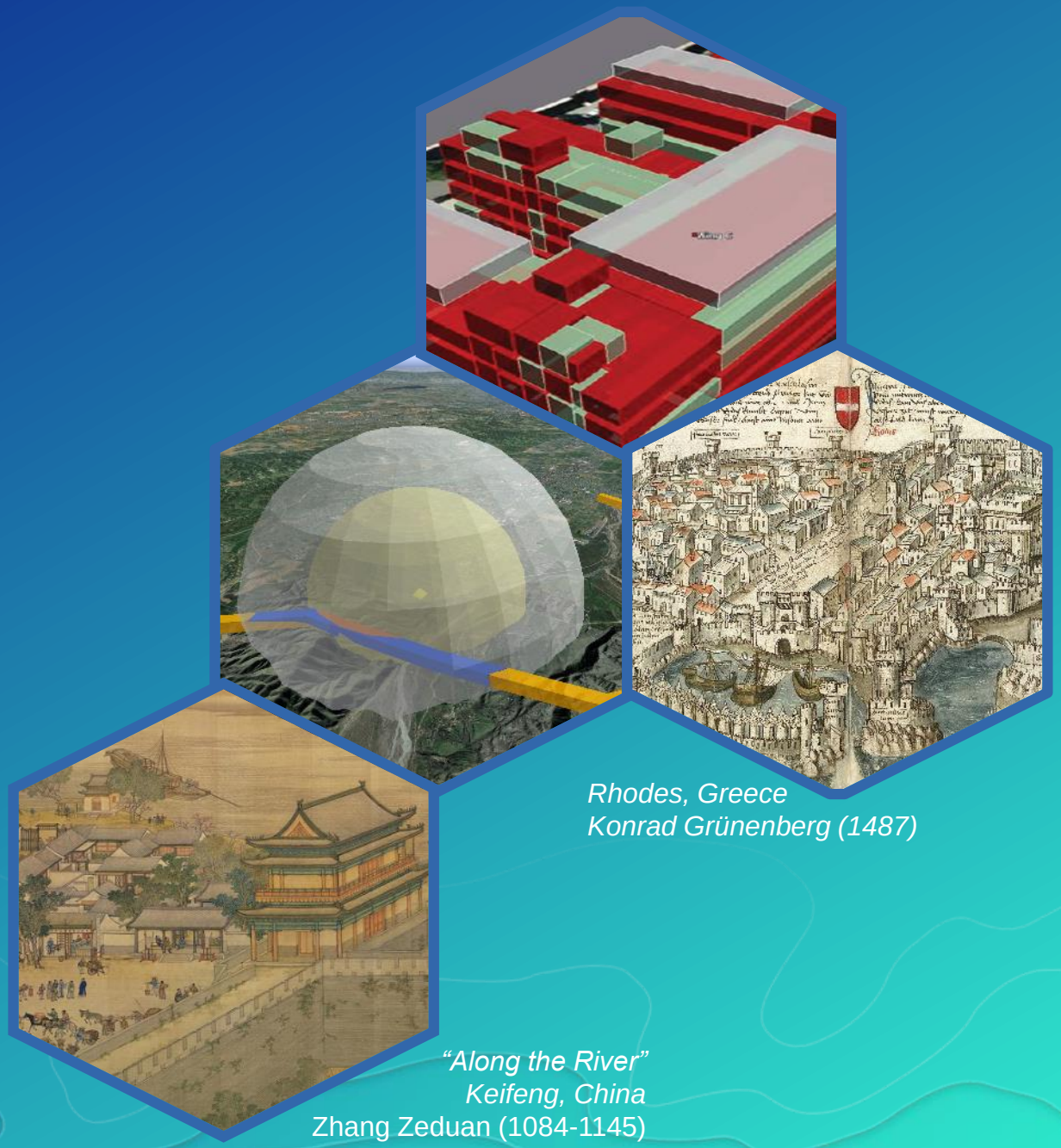
Why create 3D views?

“It’s cool, man!”

Which really means…

- See vertically stacked content
- Show data in an easy-to-understand form
- Invite imagination and understanding

3D is *how humans see the world*



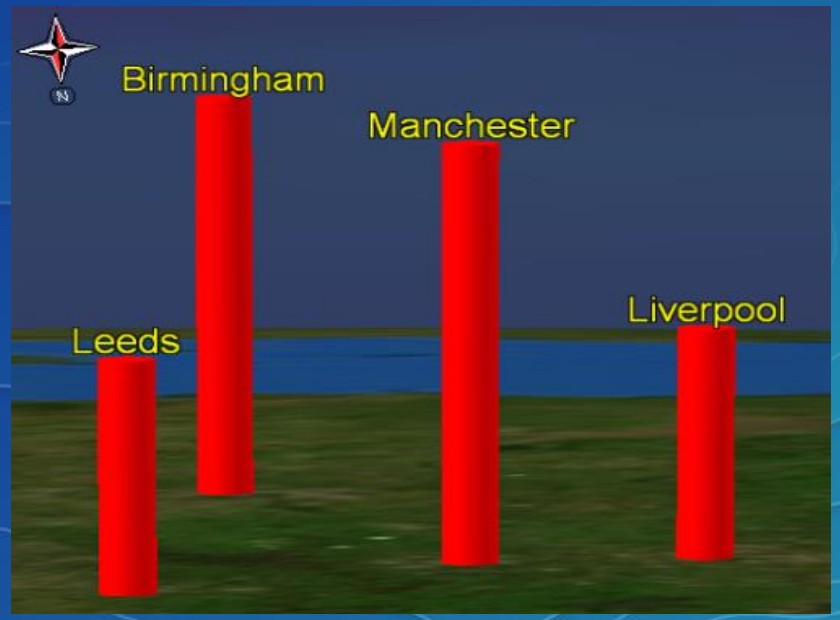
Rhodes, Greece
Konrad Grünenberg (1487)

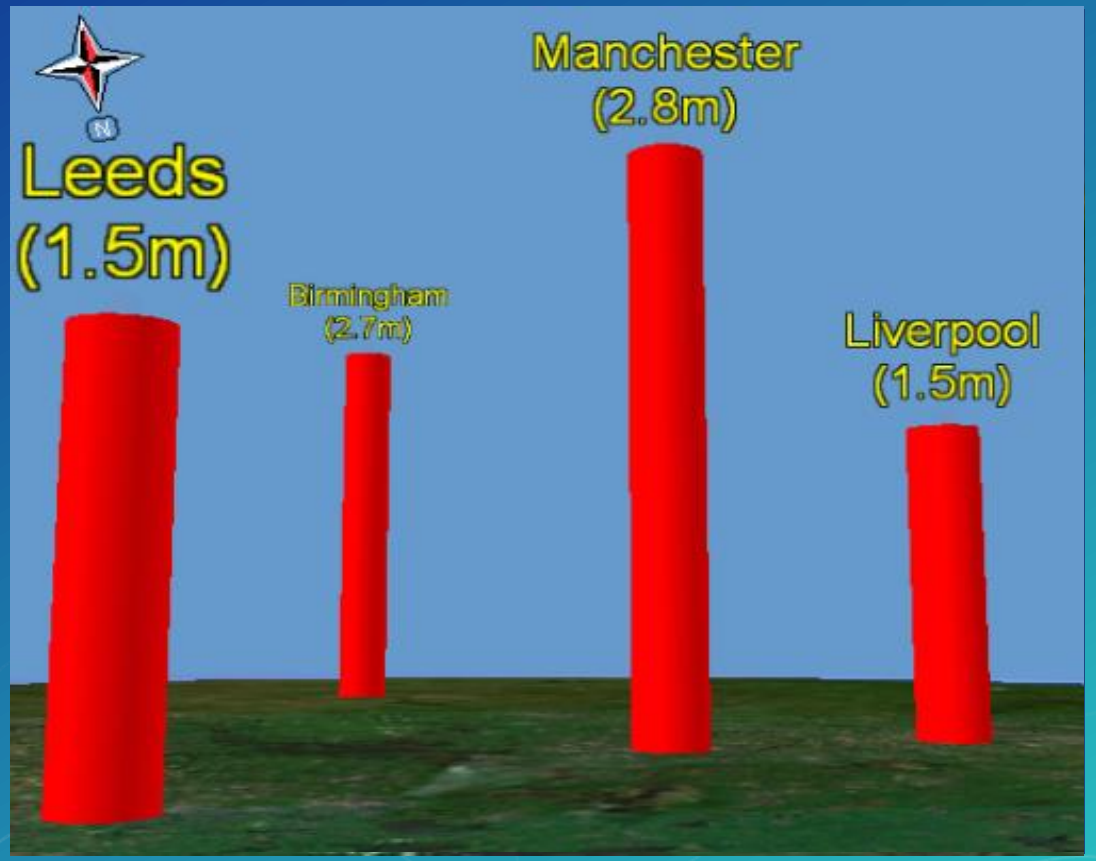
“Along the River”
Keifeng, China
Zhang Zeduan (1084-1145)

Classic first attempt at 3D symbology…

Population sticks

- *Manchester : 2.8m*
- *Birmingham : 2.7m*
- *Liverpool : 1.5m*
- *Leeds : 1.5m*





← Use a isometric / axonometric view

~~No useful information~~

~~Bad information~~

Labels

Real-world size symbols

3D View: Four Main Elements

Surfaces

- A ground (primary) surface
- Plus optional other surfaces

Textures

- The “cover” on top of the surfaces

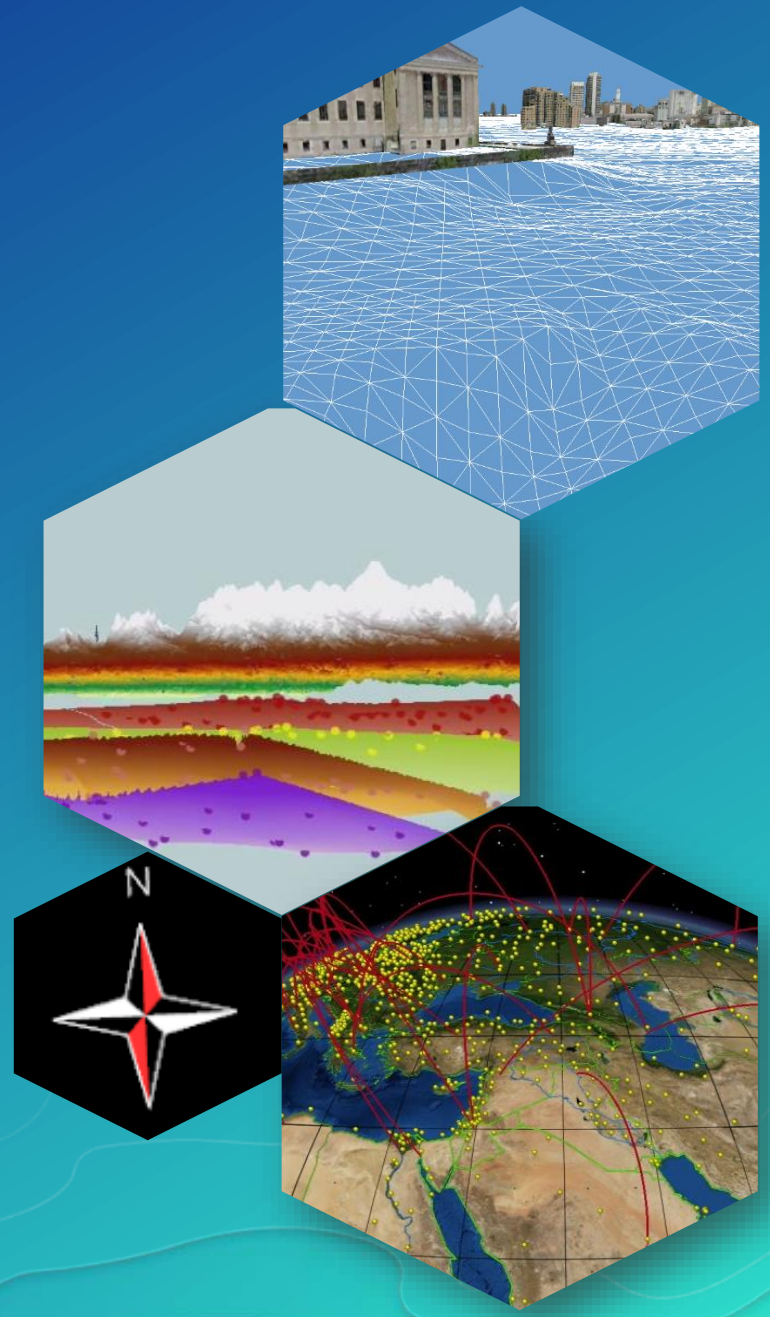
  (eg: aerial imagery, cartographic maps, etc)

Features

- That live on / relative-to the ground
- That know their own absolute z’s

Marginalia and effects

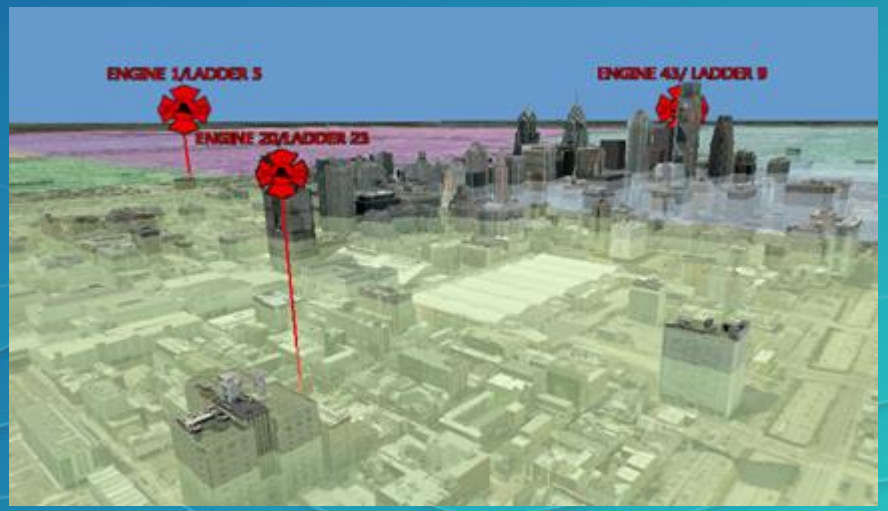
- Reference aids (eg: north arrow, TOC, …)
- Atmospheric effects (eg: lighting, fog, rain, …)



Styles of Scenes

Photo-realistic
(Real-World)

Augmented Reality



Cartographic
(Representative)

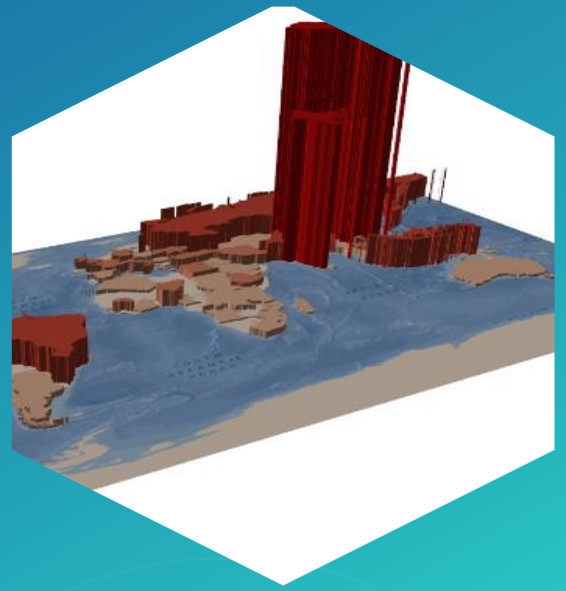


Photo-realistic Scenes

For 3D cartographers…

…they're kind of boring

…it's not really cartography

DESIGN REQUIREMENTS?

→ Look outside

USEFULNESS?

→ Changes to the status quo

AUTHORING OPTIONS?

→ Mood effects (lighting, rain, fog, …)

Beautiful, ray-traced Cityscape for Rotterdam, showing proposed new buildings with a setting sun and water reflections

Cartographic Scenes

For 3D cartographers…

…it's cartography

DESIGN REQUIREMENTS?

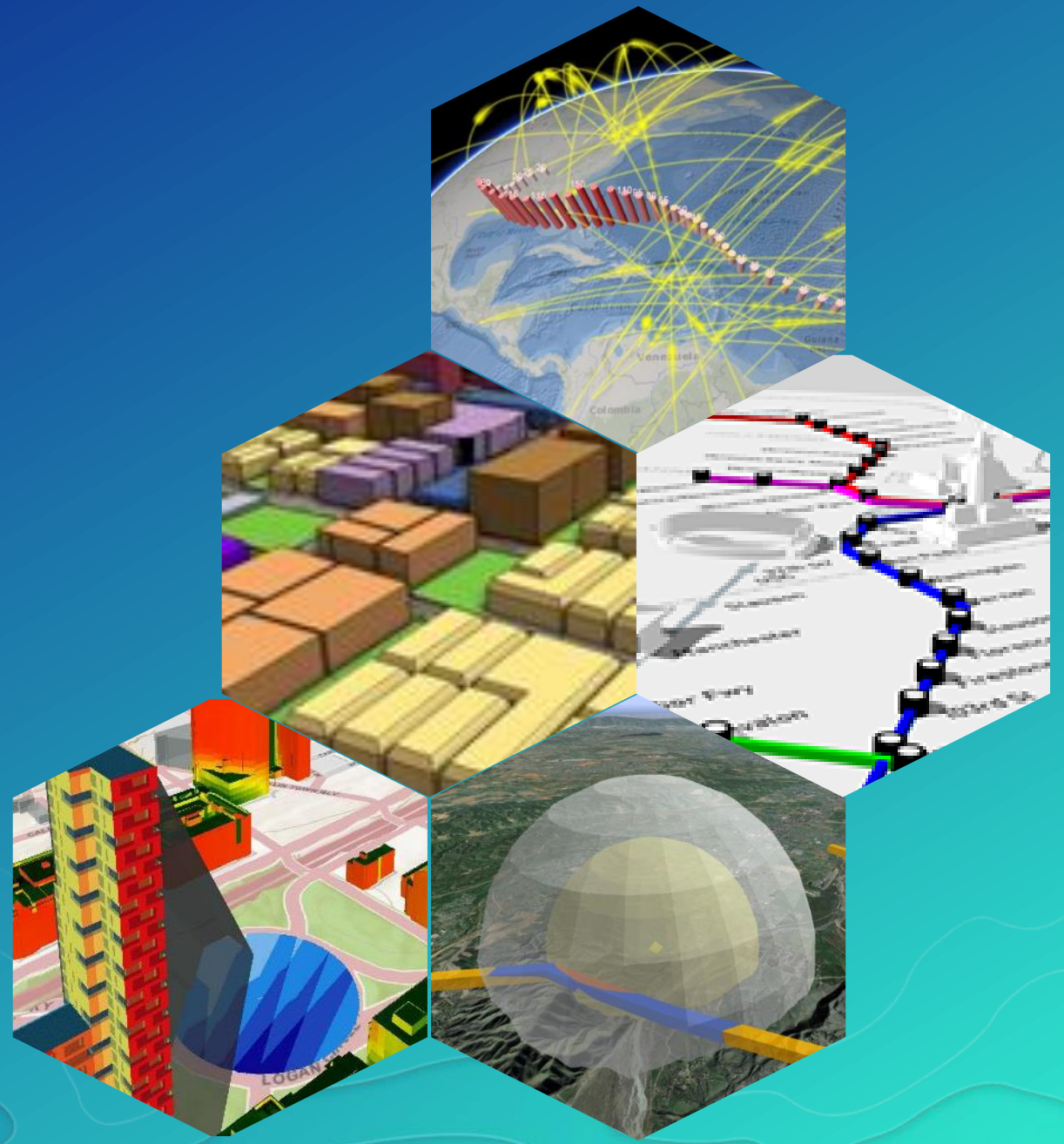
→ As rich / full as for 2D maps

USEFULNESS?

→ Powerful, eye-catching, immersive

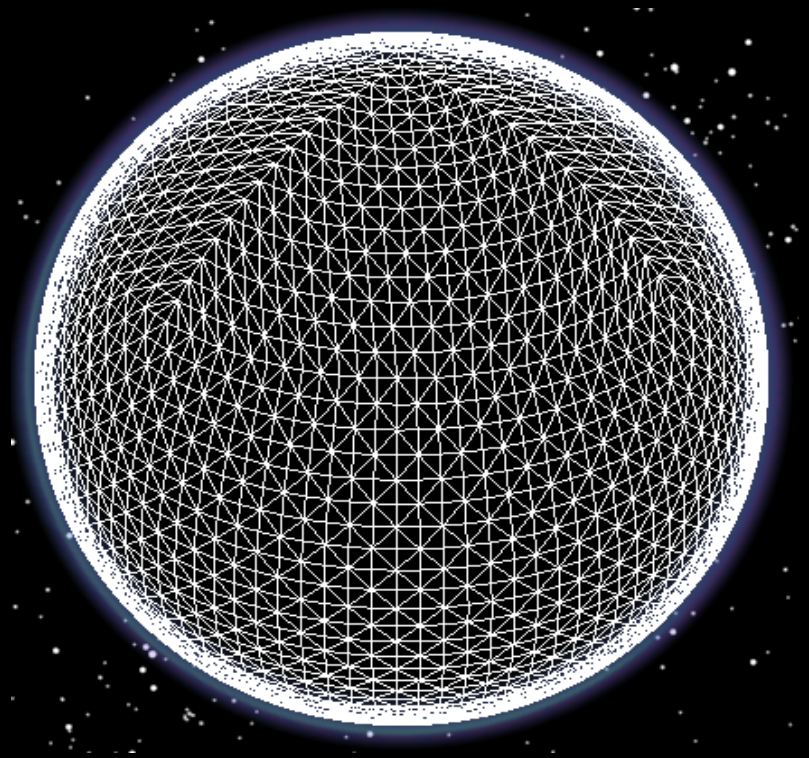
AUTHORING OPTIONS?

→ Size, Shape, Offset, Textures, Text …



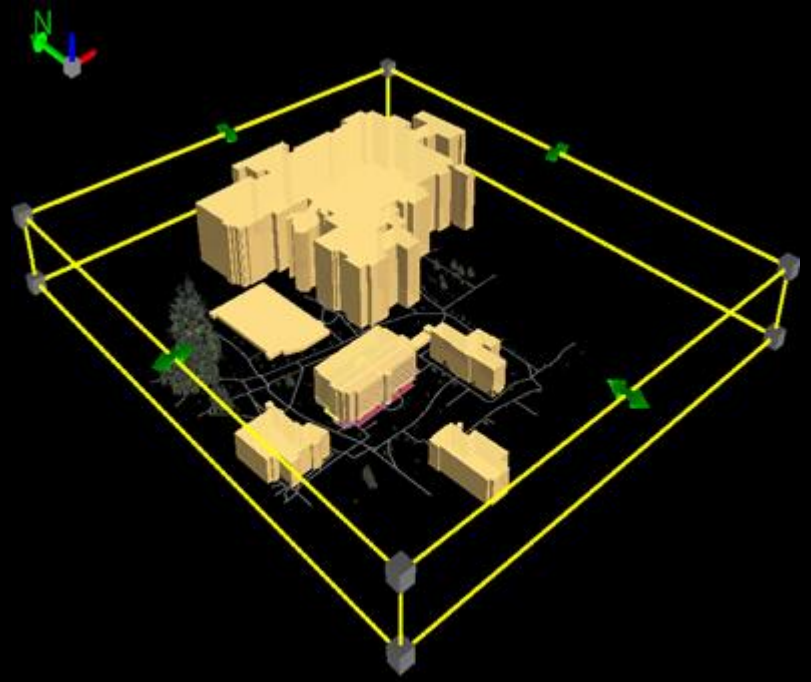
Types of 3D Worlds

Global



Global Coordinate System (WGS84)
Curvature of the earth
‘Global’ context

Local



Projected Coordinate Systems
Fishtank area-of-interest
‘Relative’ context

Beware, 3D can be evil…

Perspective distortion = lying

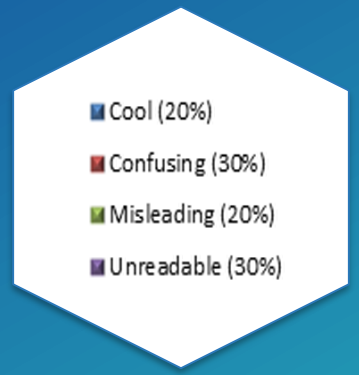
Content can be hidden = lying

Continuous scale = symbols change across scales

Easy to get disoriented = annoying

Large amounts data = slow

Hard to author = scary



+ Major Roads

+ Minor Roads

+ POI's

+ Building Footprints

SCALE

3D View: Familiar Symbols

Objects

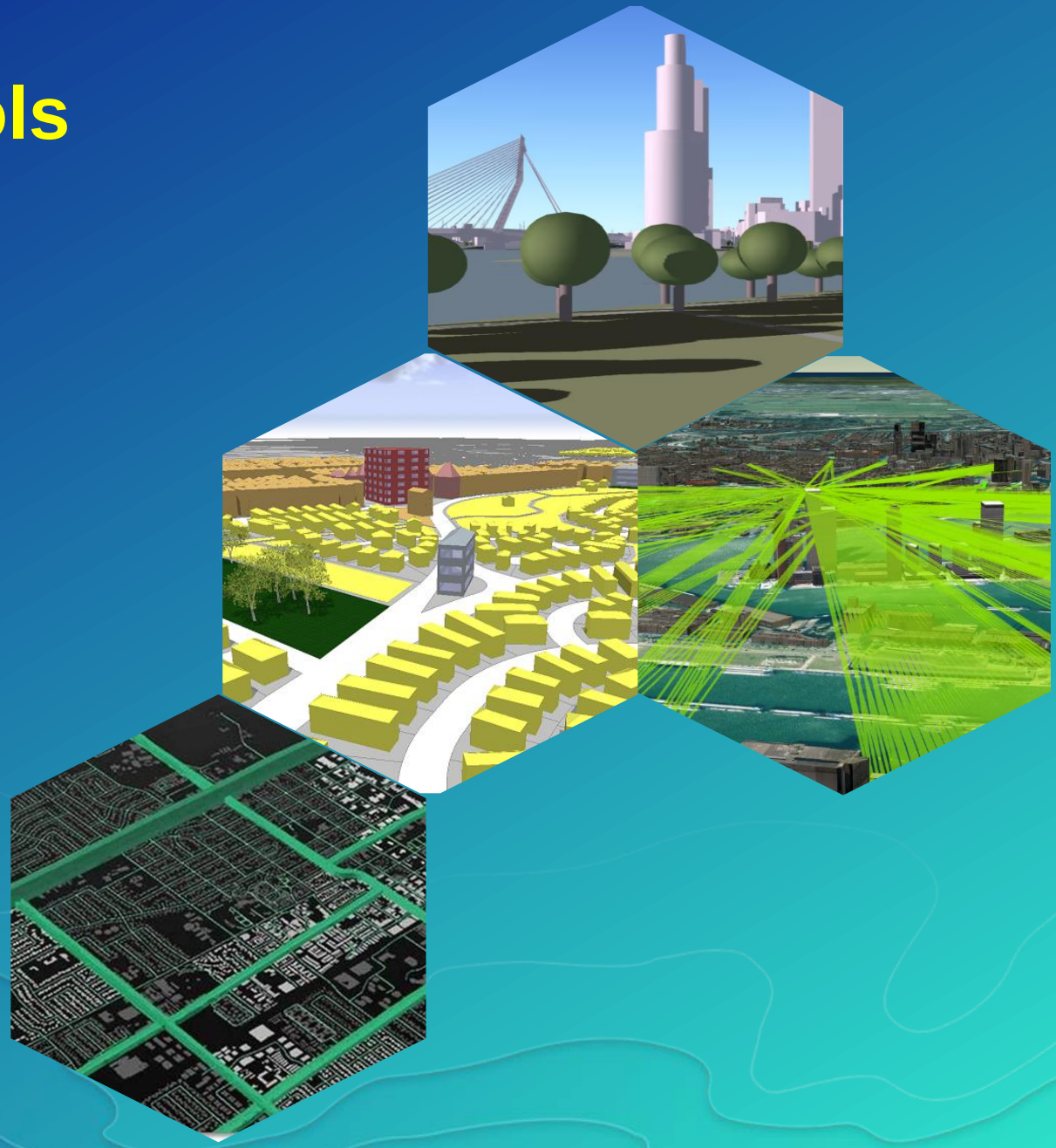
- Trees
- Stylized shapes

Colours

- Green is good

Use realistic elements

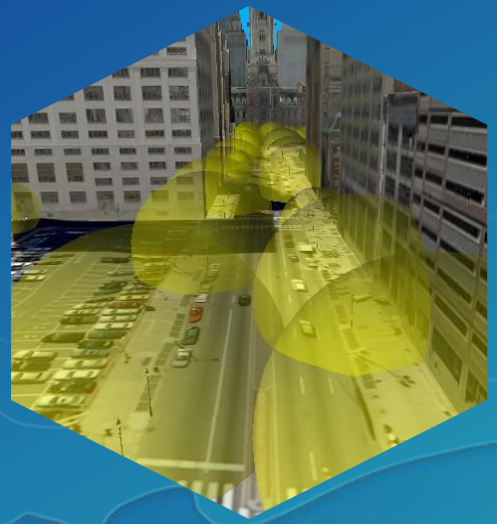
- “Walls” as barriers



3D View: Attribute-driven symbols

Change symbols based feature information

- **Size**
- **Color**
- **Transparency**
- **Rotation**
- **…**



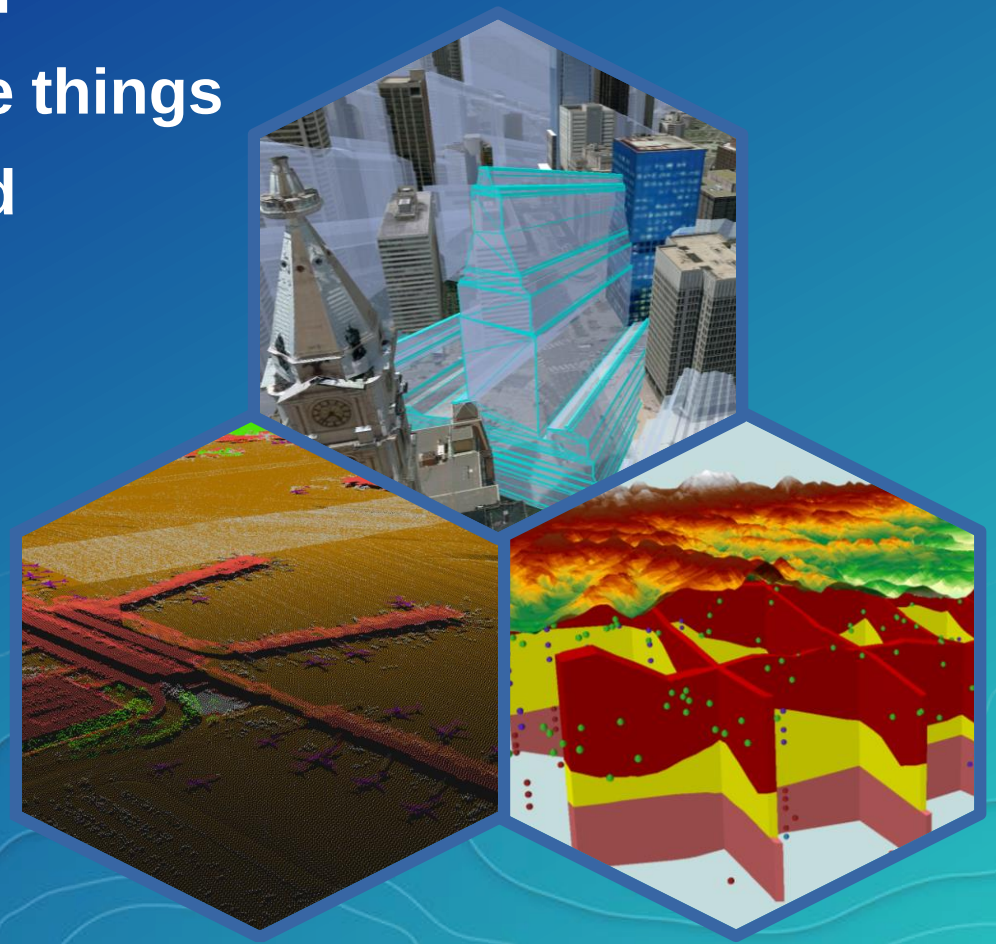
Street light coverage

Video removed

Wind vectors through a proposed development

3D View: Super Powers

- Fly around
- Use X-ray vision
- Expose invisible things
- Go underground
- See using radar

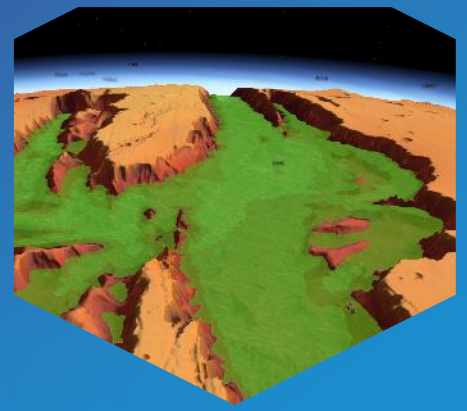


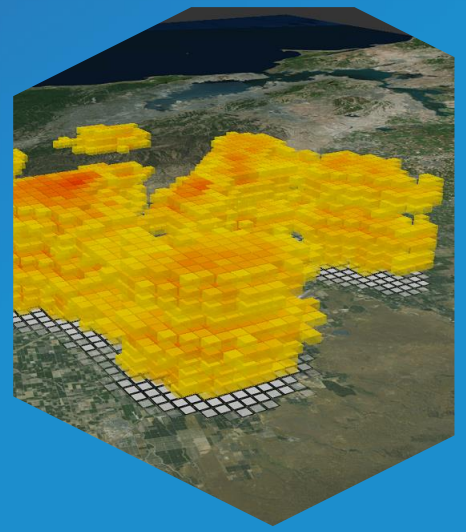
Video removed

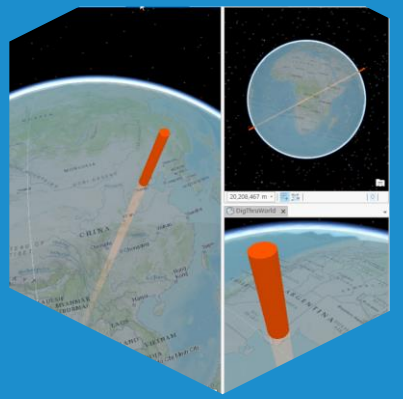
EXAMPLES

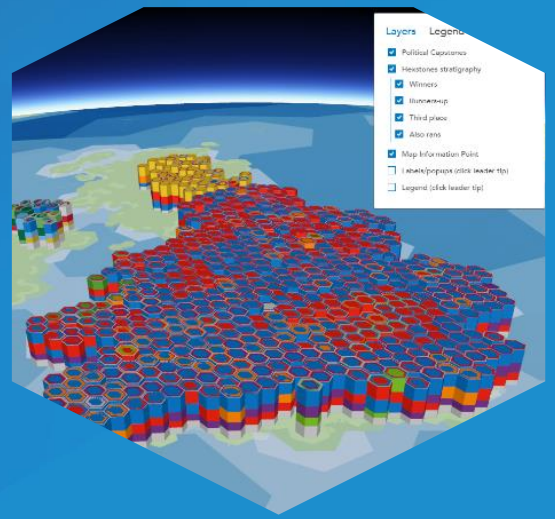
(Presented and explained)

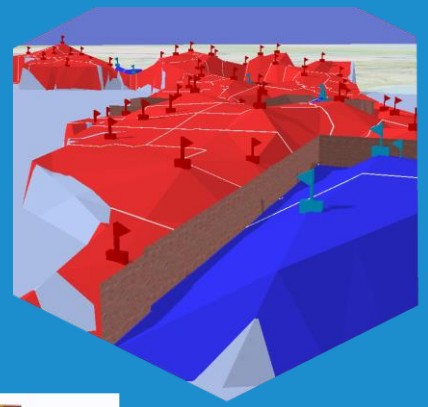
- JFK Crime Scene
- Minard’s Map 3D
- Typhoon Nabi
- Isometric Prisms
- Water Usage (Space-Time Cube)
- 3D Cartograms
- Views of Mt Fuji
- 3D Fun with Lego
- Dig to China
- Exaggerated Mars
- Partisan Hilltops
- Extruded people
- Historical Ship Race
- Shape Shifting

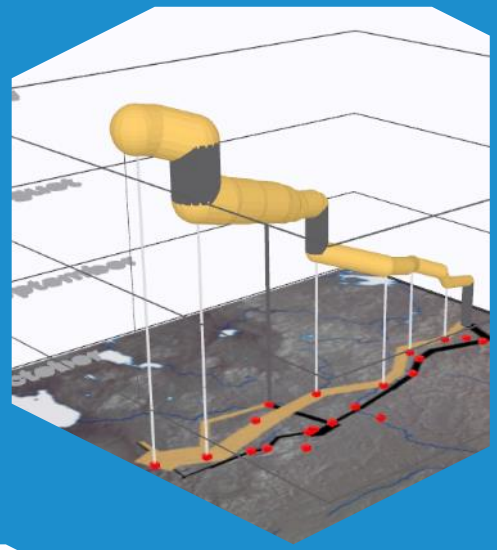


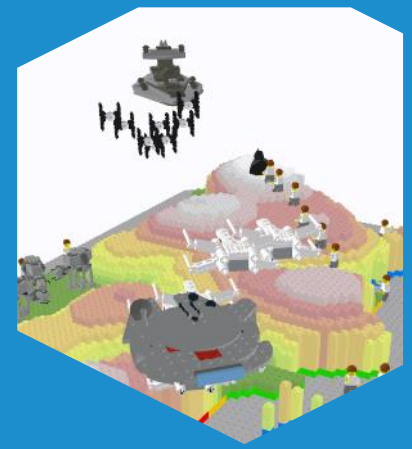


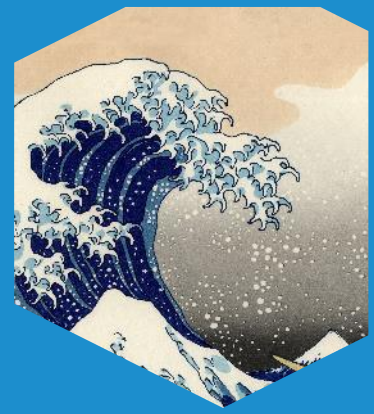












Checklist for authoring better 3D scenes

- **Message** – what should the viewer see / learn?
- **Delivery** – pictures, videos, interactive scenes?
  - Occlusion, measurements, before/after, …
- **3D canvas type** – global, or local?
  - Is an Axonometric / Isometric representation required?
- **Symbology** – realistic, thematic, augmented reality?
  - Size, Shape, Color, Textures, Transparency, …
- **Mood** – Scene propeties, such as shadows, lighting, haze
  - Gotham versus Pasadena
- **Guide users** – bookmarks, labels, popups, fly-throughs, voice-overs, …
- **Be creative** – the z-axis does not have to be only for ‘z’ or ‘time’

3D Guidelines (review at your leisure)

- Use dictates structure - Promotional maps require less structure. Thematics require more structure
- Impact - 3D can be powerful, eye-catching and immersive. Use to support attention-grabbing needs
- Content - Simplification and Generalisation have never been more important. Clean. Simple. Functional
- Texture - Avoid flat colours…add textures
- Natural realistic not photorealistic
- Symbols - Mimetic symbols support easier recognition
- Typography - Still important but don’t overload. Rotate with scene if possible but not to be overbearing
- Projection - Use axonometric where possible to maintain scale particularly for analytical map functions

3D Guidelines (review at your leisure)

- Sky and haze – avoid sky but include haze which aids depth cue perception
- Space-Time Cubes - Good for linear data, OK for point, poor for area…try not to overload or stack (beware of ‘inner holes’)
- Z value does not have to depict height or time, use it to show ‘what’s important’
- Scene control - Avoids occlusions by supporting multiple views but avoid too much rotation
- Bookmarks - supports easy camera reposition, highlight key view points
- Interaction - Allow data to be recovered, overcomes measurement limits
- Narration - Guides and improves interpretation

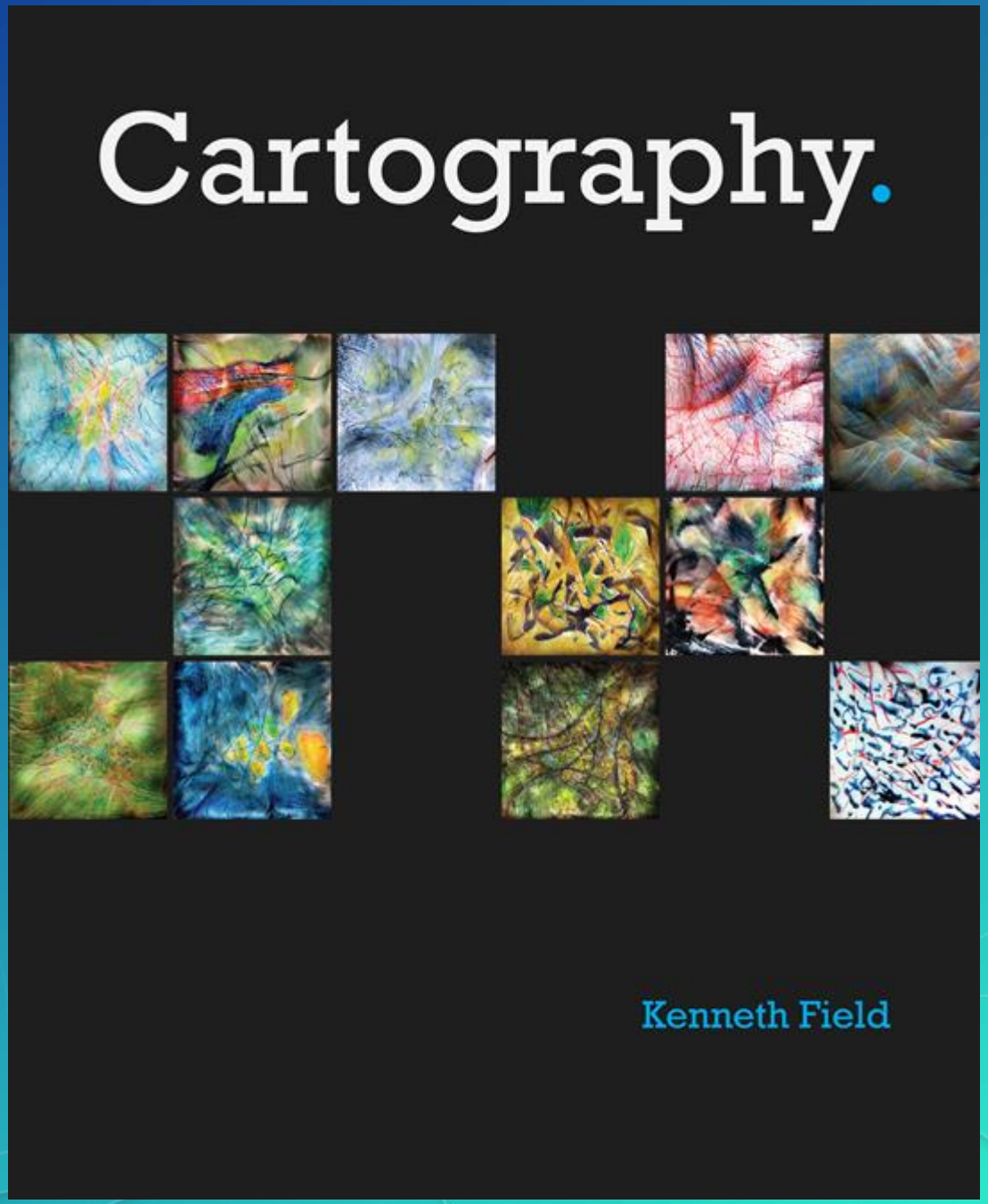
One more thing

Actually…a few more things

Cartography.

The book (Nov 2017)

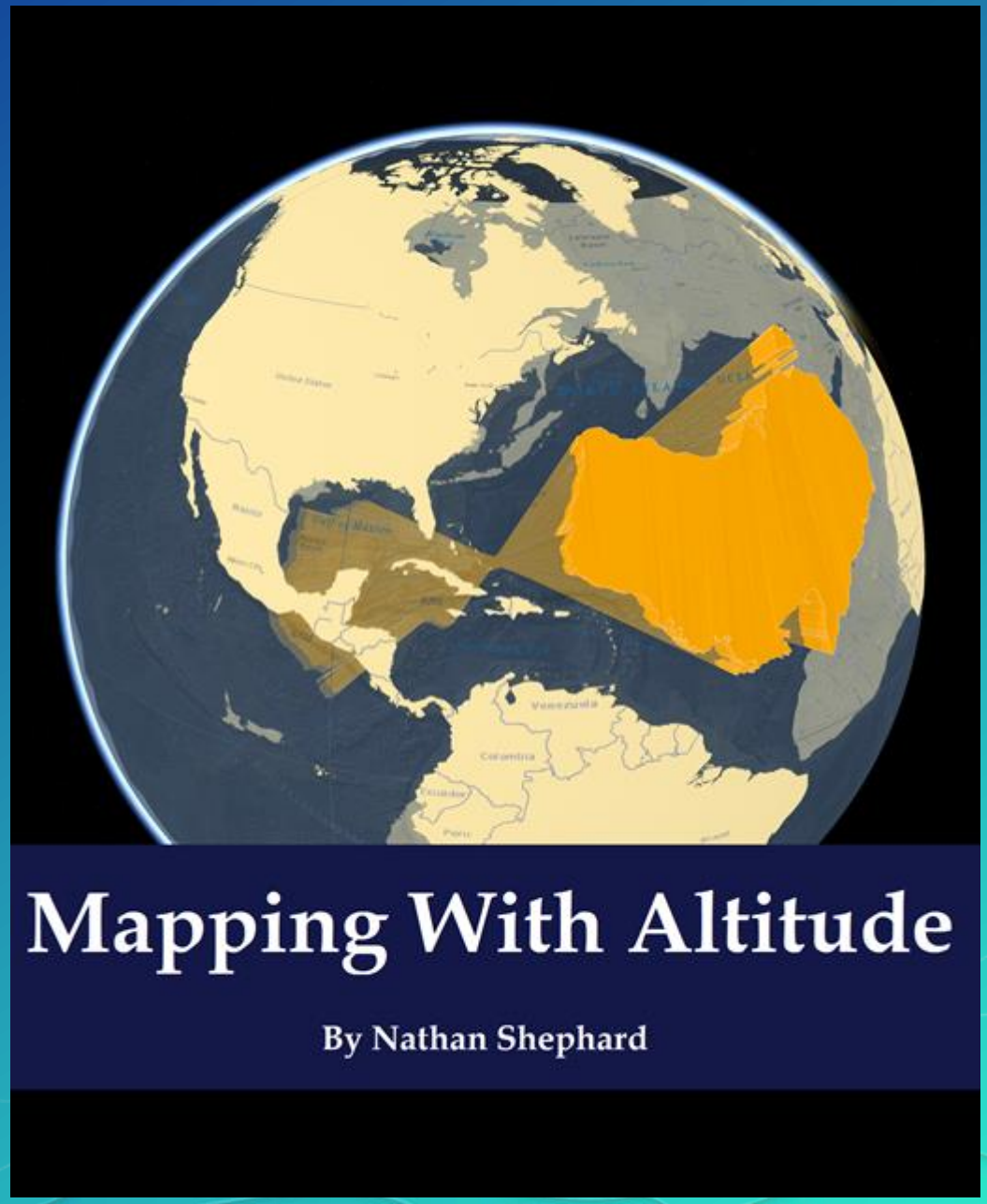
esripress.esri.com



Mapping With Altitude

(Still in progress… Hopefully 2018)

By Nathan Shephard



** Working Title*

Cartography.
The MOOC
esri.com/mooc/cartography (Nov 2017)

carto.maps.arcgis.com

cartonerd.com

adventuresinmapping.com

mapdesign.icaci.org

Other sessions

How maps work (KF/WJ)	Tue 15:15 | Thu 13:30
Amazing and Inspiring maps (KF/JN)	Tue 08:30 | Wed 10:15
Thematic map design (KF/JN)	Tue 13:30 | Fri 09:00
3D in ArcGIS Pro (CA/NS/SH)	Wed 08:30 |
3D Cartographic Techniques (NS/KF)	Wed 13:30 | Thu 15:15
Map Design for relief representation (KF/JN)	Wed 08:30 | Thu 10:15
Designing Story Maps to Change Hearts & Minds (JN/JB)	Tue 10:15
Designing Esri's Vector Tile Basemaps (WJ/AS)	Tue 14:00 | Wed 12:00
Styling Vector Basemaps (WJ/AS)	Thu 10:15

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