



CS 543 - Computer Graphics: Introduction

by

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(with help from Emmanuel Agu ;-)

What to Expect

- ❑ This course is mainly about how to create ***pretty pictures***
 - Algorithms, mathematics, data structures
 - Over 30 years of research
- ❑ Today, a big chunk is available off the shelf
 - Just make **OpenGL** or **DirectX** library calls
- ❑ We want you to learn what is *inside* that library
 - We use OpenGL as one example of how things could be done
 - In industry, you may only use OpenGL
 - The ***really interesting*** jobs will ask you to extend it.

What to Expect (cont.)

- ❑ This course is about Computer Graphics, not OpenGL
 - How would one *build* OpenGL?
 - Focus on underlying methods
 - Other methods besides OpenGL
- ❑ This course is heavy on
 - Coding
 - C/C++
 - Efficiency (speed & space)
 - Pretty pictures

Summary of Syllabus

- ❑ 2 Exams (50%), 5 Projects (50%)
- ❑ Projects will use OpenGL
- ❑ **Project 4:** Extend home-grown library, miniGL
- ❑ Write code on any platform that has OpenGL
 - Encouraged to use MingGW (www.mingw.org)
- ❑ Must run on CCC machines
- ❑ Program in C/C++
- ❑ Can discuss with others, turn in unique project
- ❑ All material on class Website
(www.cs.wpi.edu/~emmanuel/courses/cs543/)

Assignments

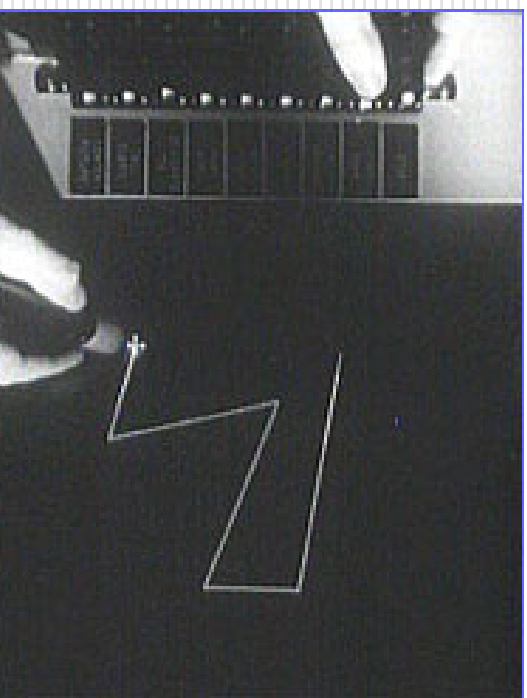
- ❑ Many phases to homework:
 - Understand/design/code/debug/test/eat/test some more
 - Encouraged to discuss approaches
 - Must hand in your own work only
- ❑ Cheating:
 - Many reasons *not* to do it!
 - Immediate 'F' in the course
- ❑ Advice for doing well:
 1. Do the assigned reading
 2. Come to class
 3. Ask questions (class, office hours, MyWPI discussions)
 4. Make sure you understand before coding
 5. Don't share your code with others!

What is Computer Graphics?

- ❑ Use computer resources to generate pictures
- ❑ Started in early 1960s
 - Some Pioneers:
 - ❑ Ivan Sutherland - Overall vision of CG/VR
 - ❑ Jim Blinn - Computational models
 - ❑ Ed Catmull - Animation and surface descriptions
 - ❑ **MANY OTHERS!**

Ivan Sutherland
demonstrates Sketchpad
(1961)

Image: www.pbs.org



What is Computer Graphics? WPI (cont.)

- ❑ ACM SIGGRAPH Conference
- ❑ CS types create *tools* that artists use to create *compelling content*
- ❑ Many programs are for artists. Here we focus on *CG tool smiths*.

Related Areas to CG

- ❑ Modeling: Shape of objects in a scene
- ❑ Shading & Lighting: Surface & Environmental effects
- ❑ Post Production: Tweaking the images
- ❑ Computer Vision: Extracting info from images
- ❑ Scientific Visualization: Making sense of data
- ❑ Animation: Making things move over time and space
 - Take animation course after CS 4731!
- ❑ HCI: Incorporating user interaction

CG Tools

- ❑ Hardware tools
 - Output devices
 - ❑ Monitors, projection systems, VR helmets, print
 - Input devices
 - ❑ Mouse/trackball, pen/tablet, keyboard, other
 - Graphics accelerators
- ❑ Software tools
 - Editor (emacs)
 - Compiler (g++)
 - Debugger
 - Graphics libraries
- ❑ Your eyes

What is a CG Library?

- ❑ Low-level routines
 - Points, lines, circles, text, etc.
- ❑ High-level routines
 - Pull-down menus, window management, etc.
- ❑ Some of this has traditionally been device dependent
 - Difficult to port, error prone
- ❑ Now we have device/platform independence (almost)
 - OpenGL, DirectX, Java3D, etc.
 - XBOX, PS1/2/3/P, Revolution, GB Advance, etc.

Motivation for CG

- Appealing pictures produced
- Humans respond better to pictorial information
- Human brain recognizes visual patterns
- "If it looks right, it is right."
 - Jim Blinn, CG Pioneer

Reasons You Are Here

- ❑ Want to work in CG field
 - Games, film, Web
- ❑ Instant gratification
- ❑ New medium for artistic expression
- ❑ Communicate your ideas
- ❑ Take advanced graphics or visualization course
- ❑ Do research in graphics
- ❑ Get a grade (just one of your MS courses)
- ❑ Gluttons for punishment!

2D vs. 3D

□ 2D Graphics

- (x, y) color values on screen
- Orthographic: objects have no depth or distance from viewer

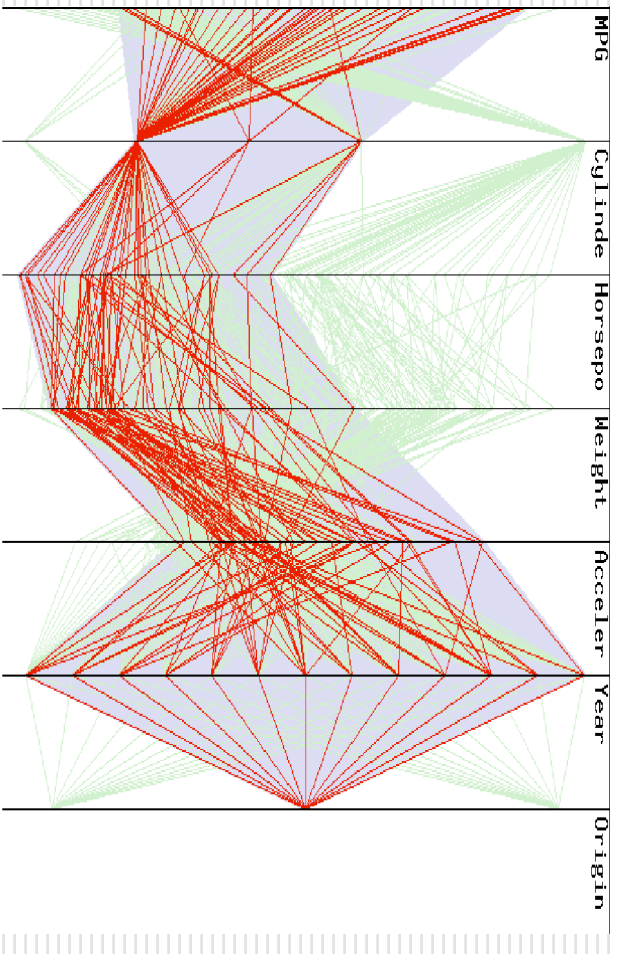


Image: Matt Ward

□ 3D Graphics

- (x, y, z) values on screen
- Perspective: objects have distances from viewer

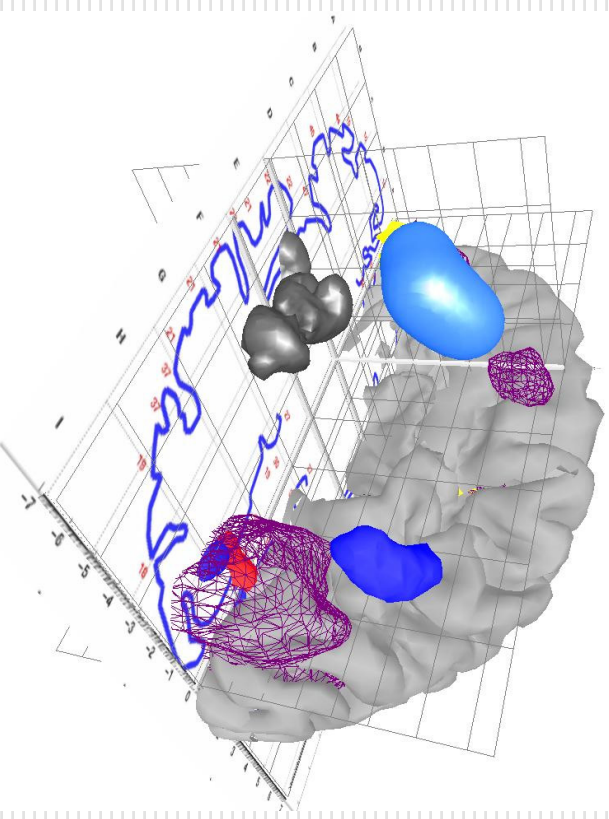


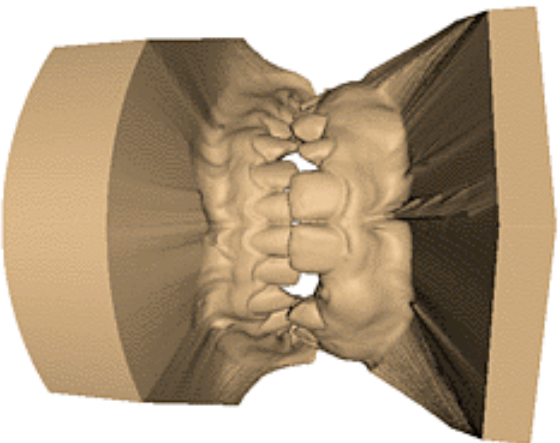
Image: Human Brain Project, Denmark

3D Content Creation

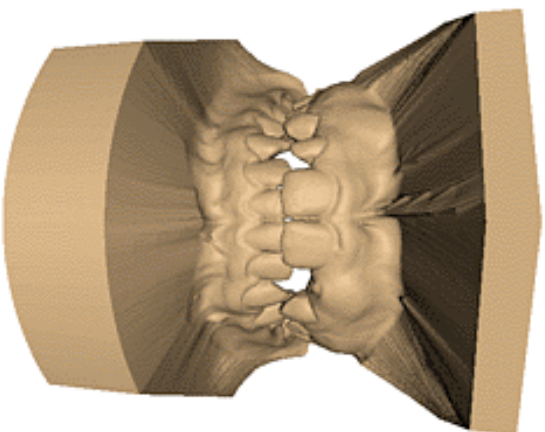
- ❑ Create 3D objects in the scene (modeling)
 - Basic shapes (cube, sphere, etc.), meshes, etc.
 - Scale them (may also stretch them)
 - Position them (rotate, translate, etc.)
- ❑ Then, generate the picture (rendering)
 - Perspective
 - Color and shading
 - Shadows
 - Texture mapping
 - Environment mapping (e.g., fog)
 - Transparency and blending
 - Anti-aliasing
- ❑ Numerous packages to help do these!

Modeling Example

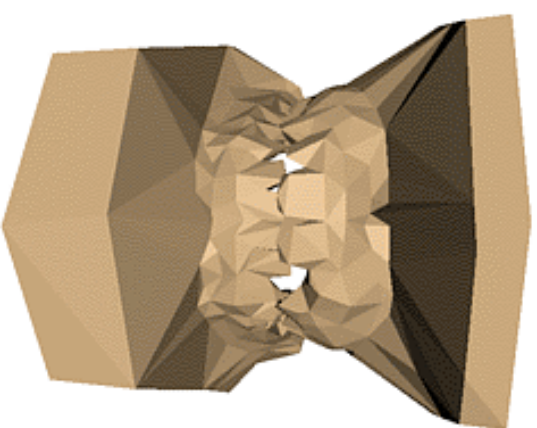
- Why might we need multiple object representations?



Original: 424,000 triangles



60,000 triangles (14%)

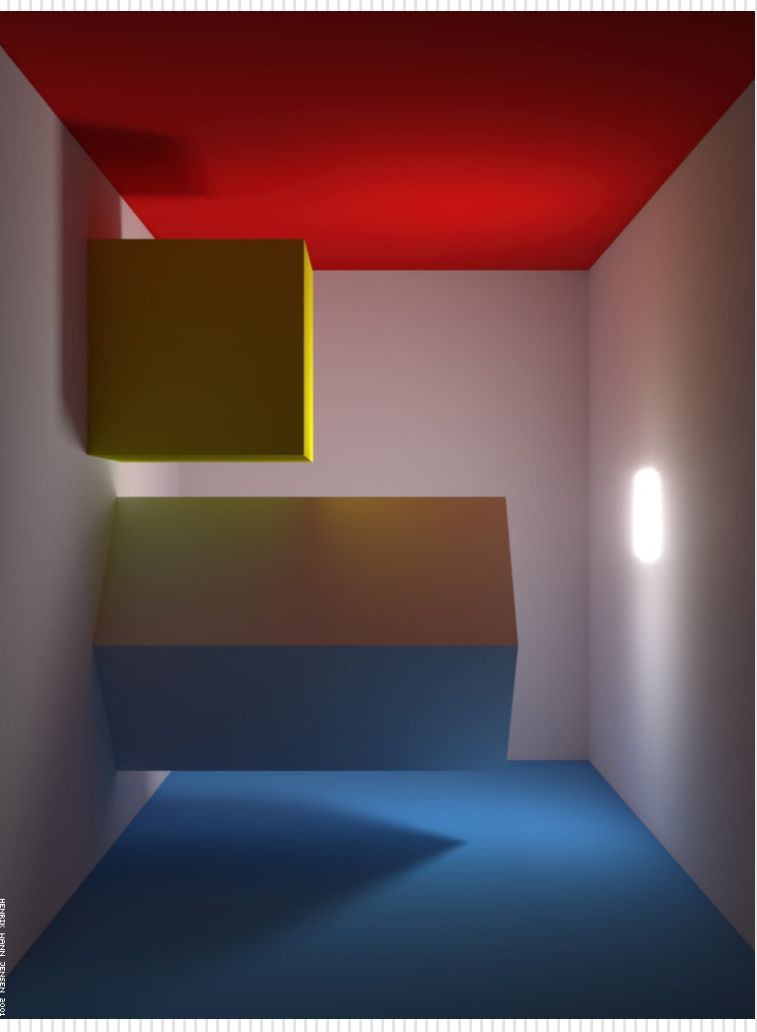
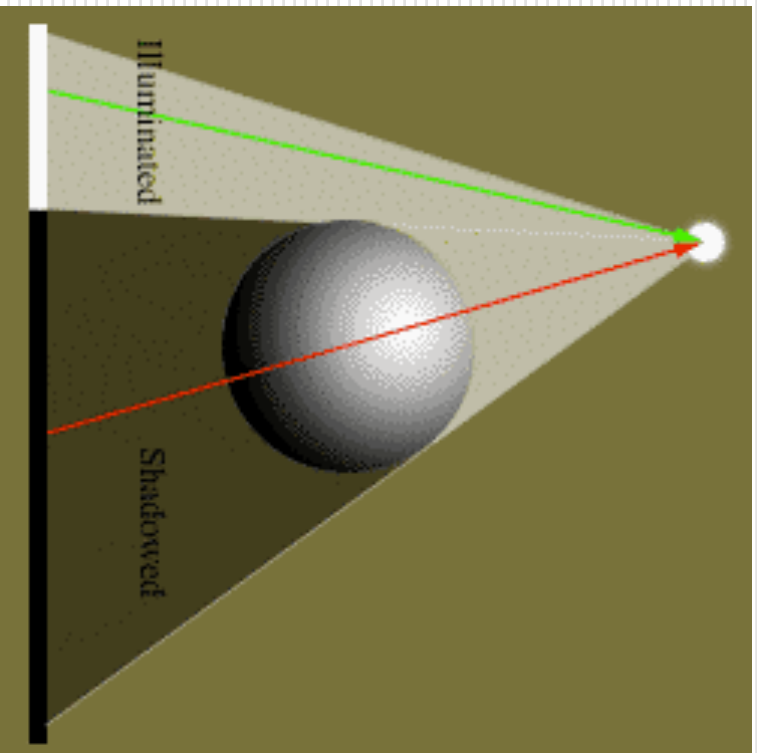


1,000 triangles (0.2%)

(courtesy of Michael Garland and Data courtesy of Iris Development.)

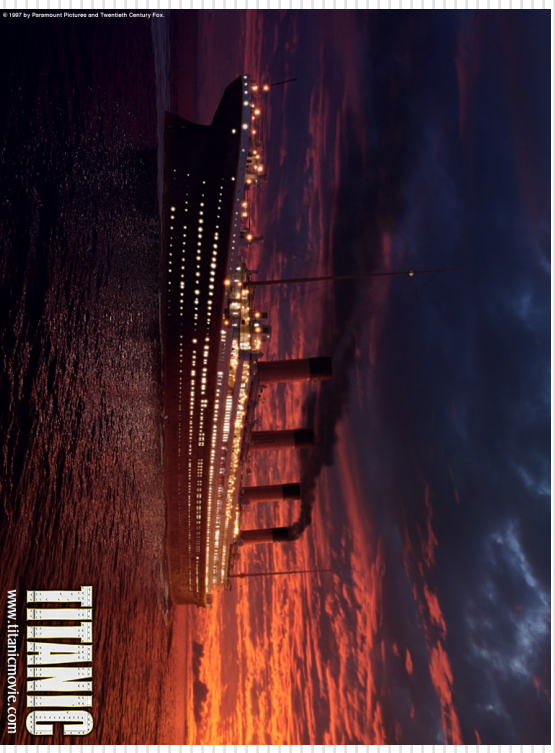
Shadows and Lighting

- ❑ Need to simulate the movement of light in a scene.



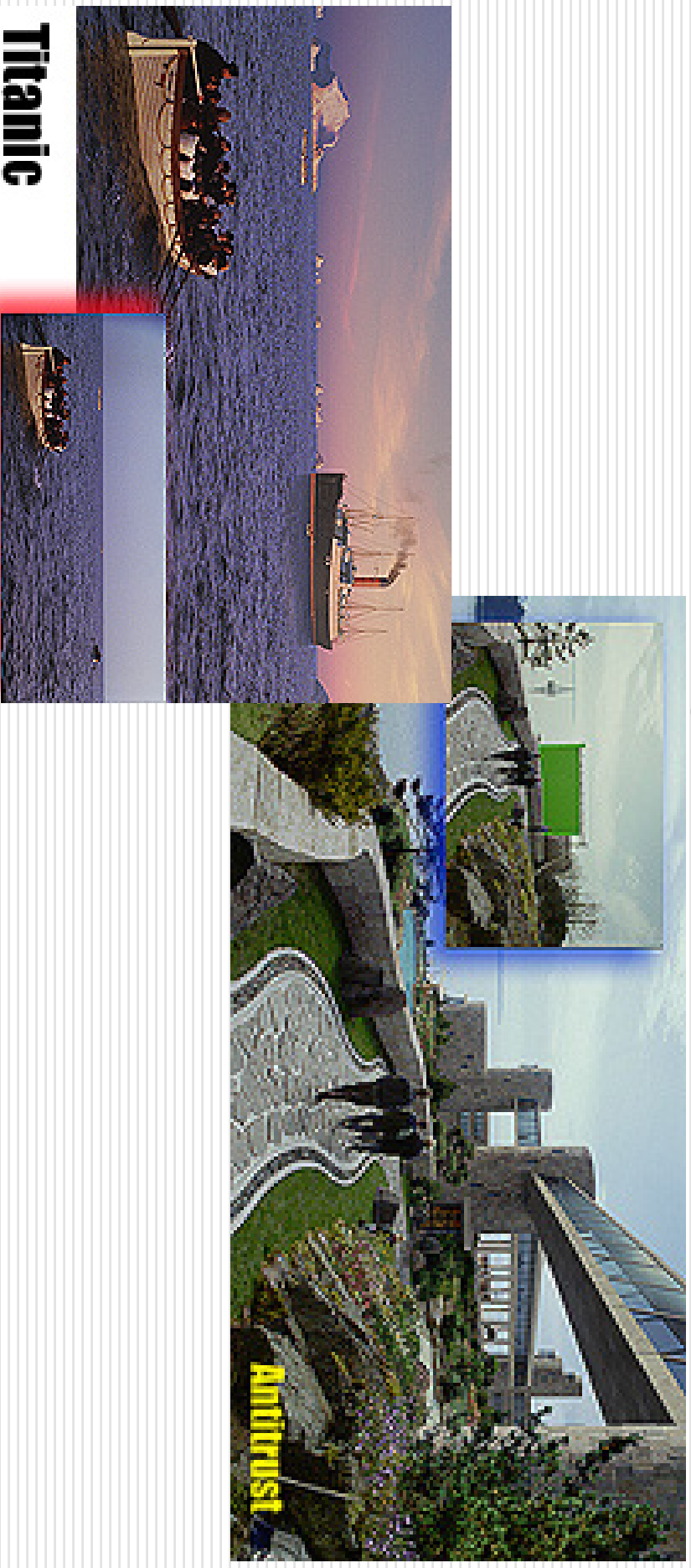
Uses of Computer Graphics

❑ Post-Production



Uses of Computer Graphics (cont.)

- ❑ Post-Production (green screens)



Titanic

Images: http://www.nuvein.com/archived_cinnews_site/cinnews12/digitaldesignart.html

Sample CG: Environments



Image: www.doom3.com



Sample CG: Fractal Mountains

No atmospheric
correction

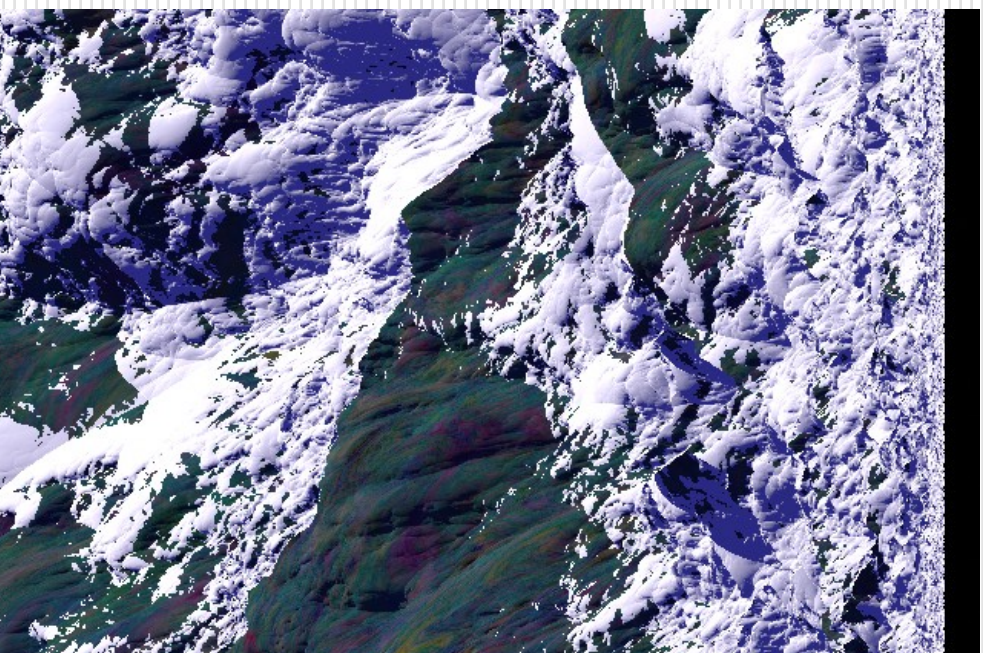


Image: Ken Musgrave -
www.kenmusgrave.com

Sample CG: Fractal Mountains (cont.)

Atmospheric
correction only

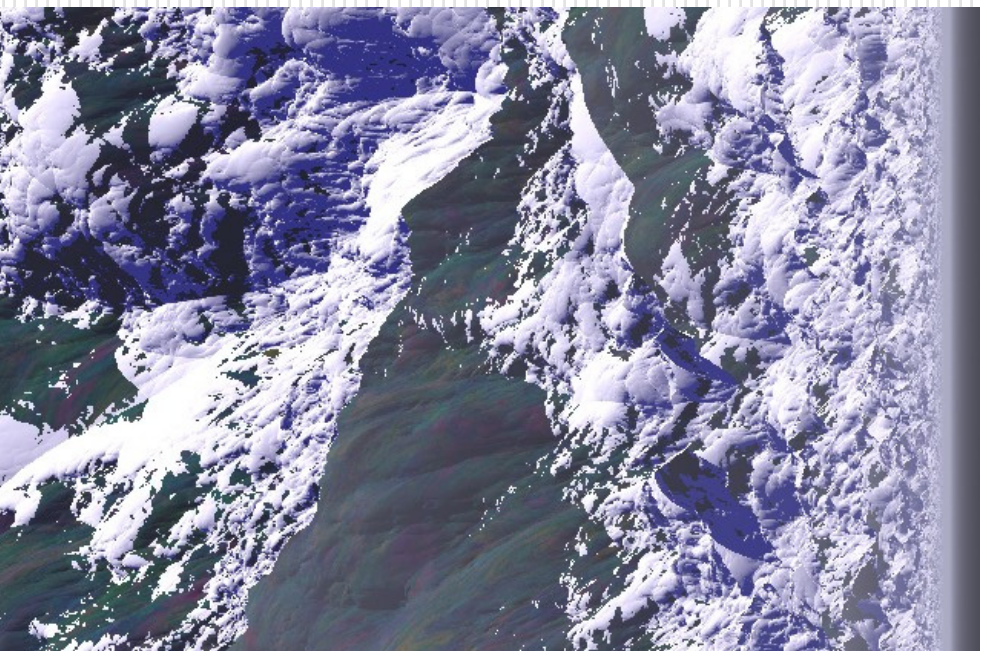


Image: Ken Musgrave -
www.kenmusgrave.com

Sample CG: Fractal Mountains (cont.)

Atmospheric and
color correction

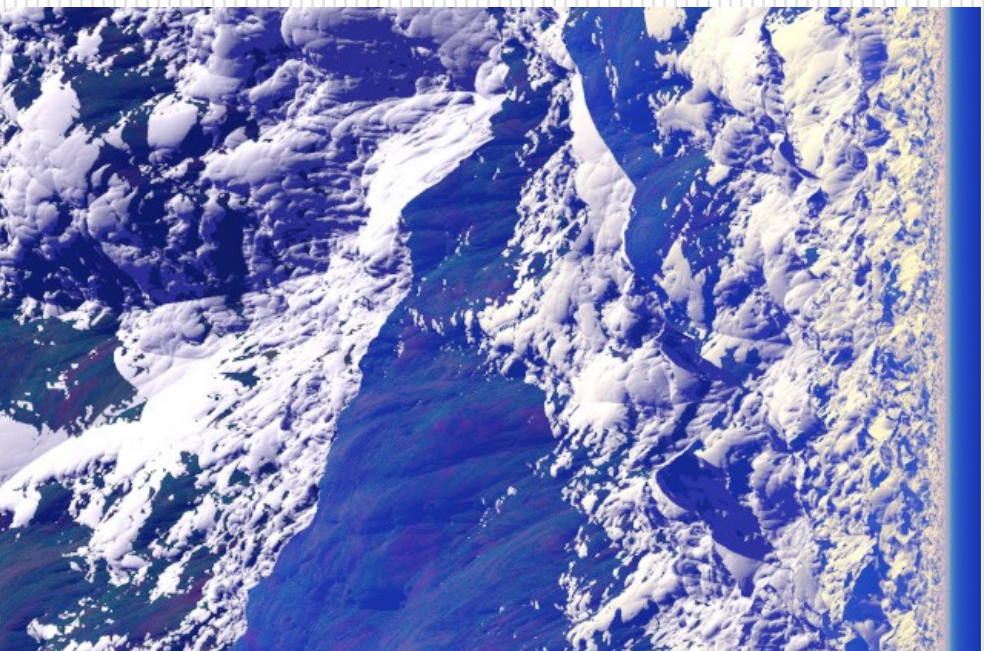


Image: Ken Musgrave -
www.kenmusgrave.com

Fractal Mountains - No Atmospheric Correction

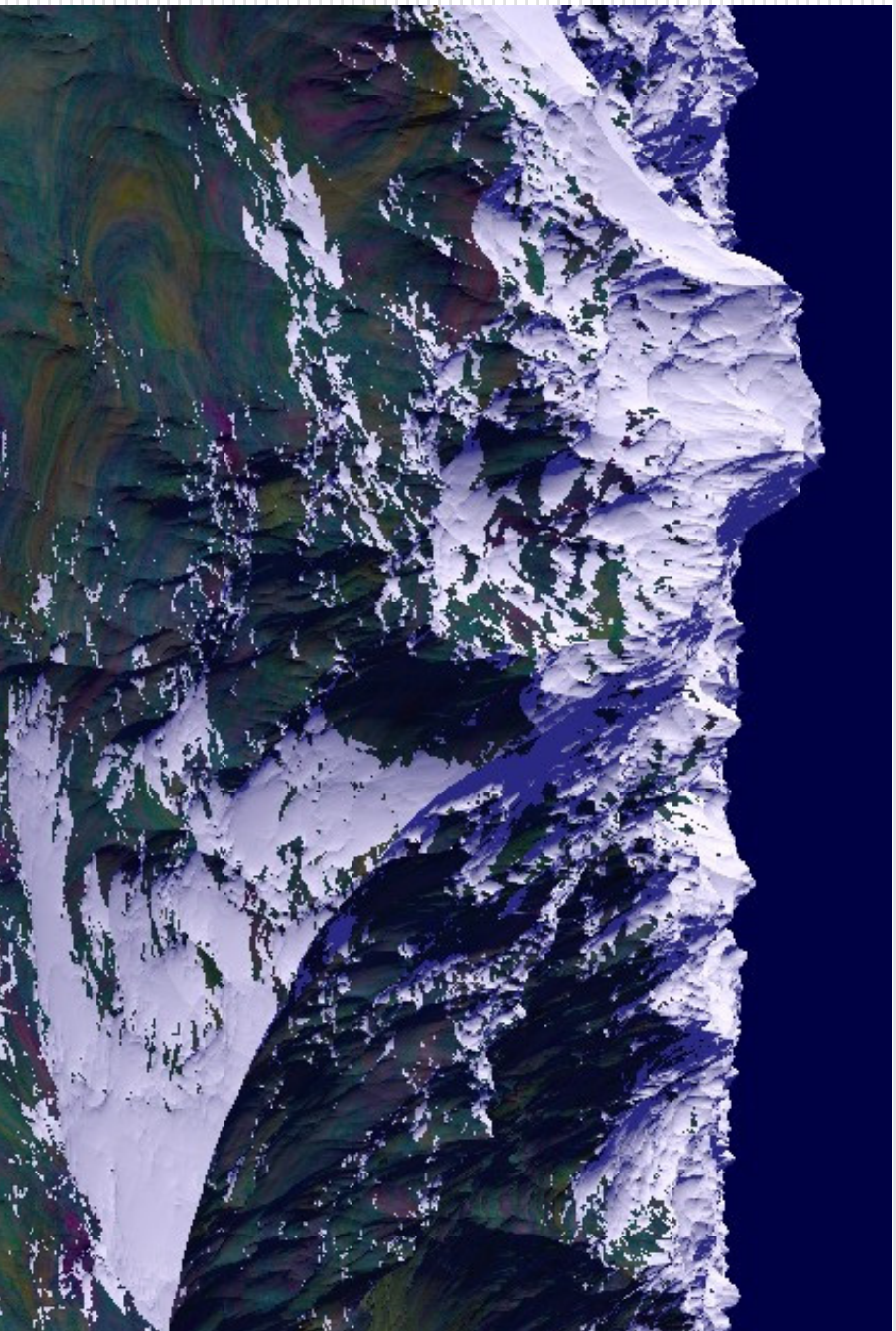


Image: Ken Musgrave - www.kenmusgrave.com

Fractal Mountains - After Atmospheric Correction

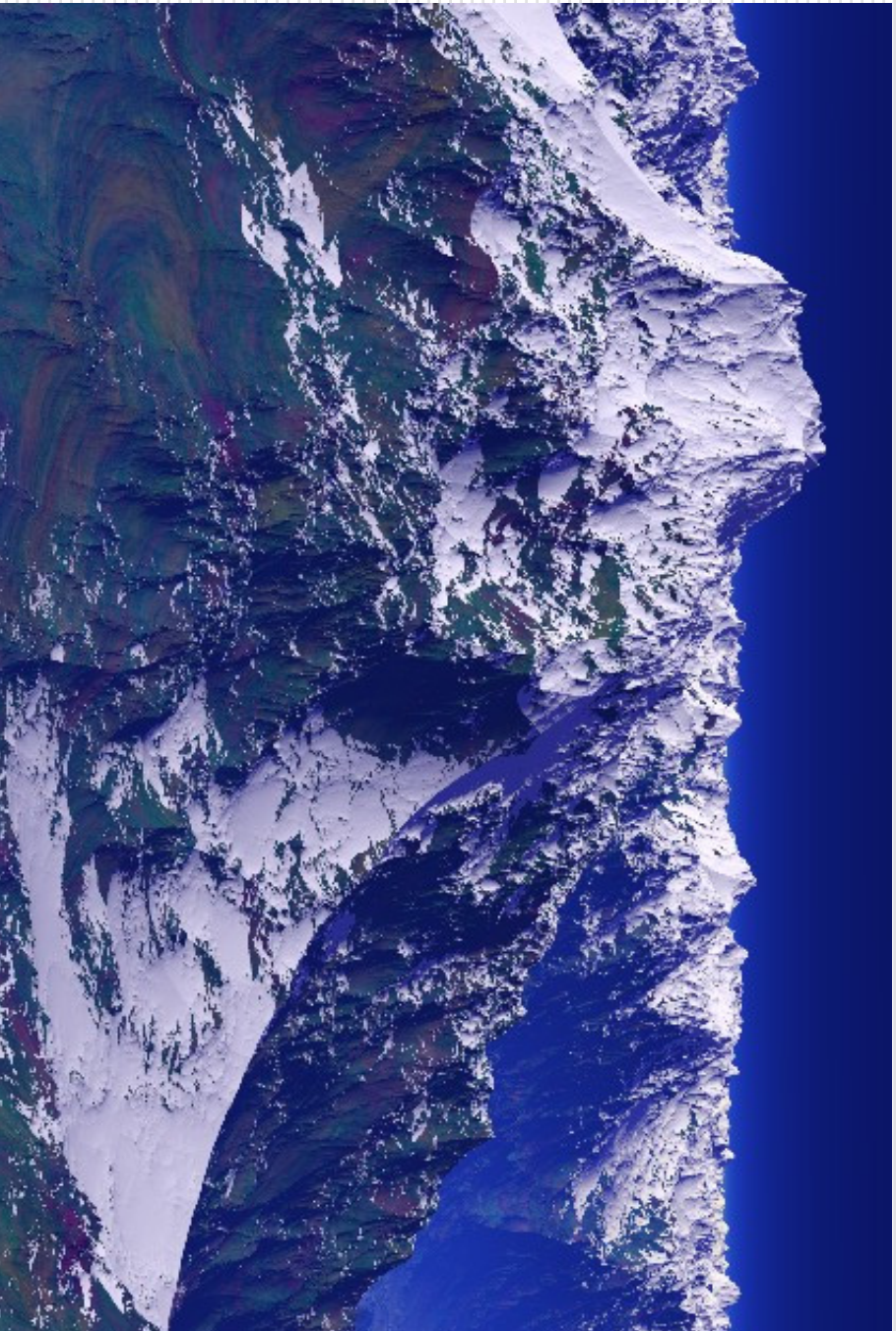


Image: Ken Musgrave - www.kenmusgrave.com

Sample CG: Characters



Sample CG: Objects

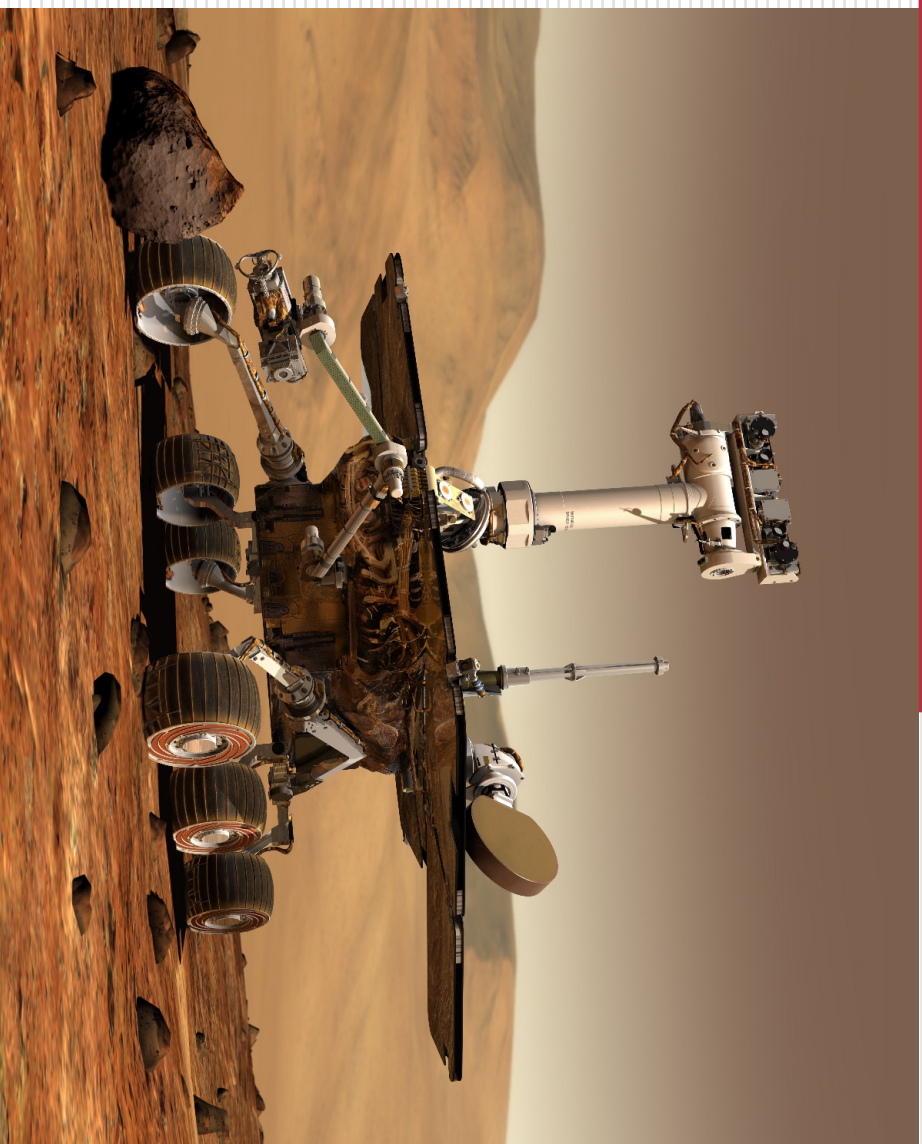


Image: marsrovers.jpl.nasa.gov/gallery/artwork/

