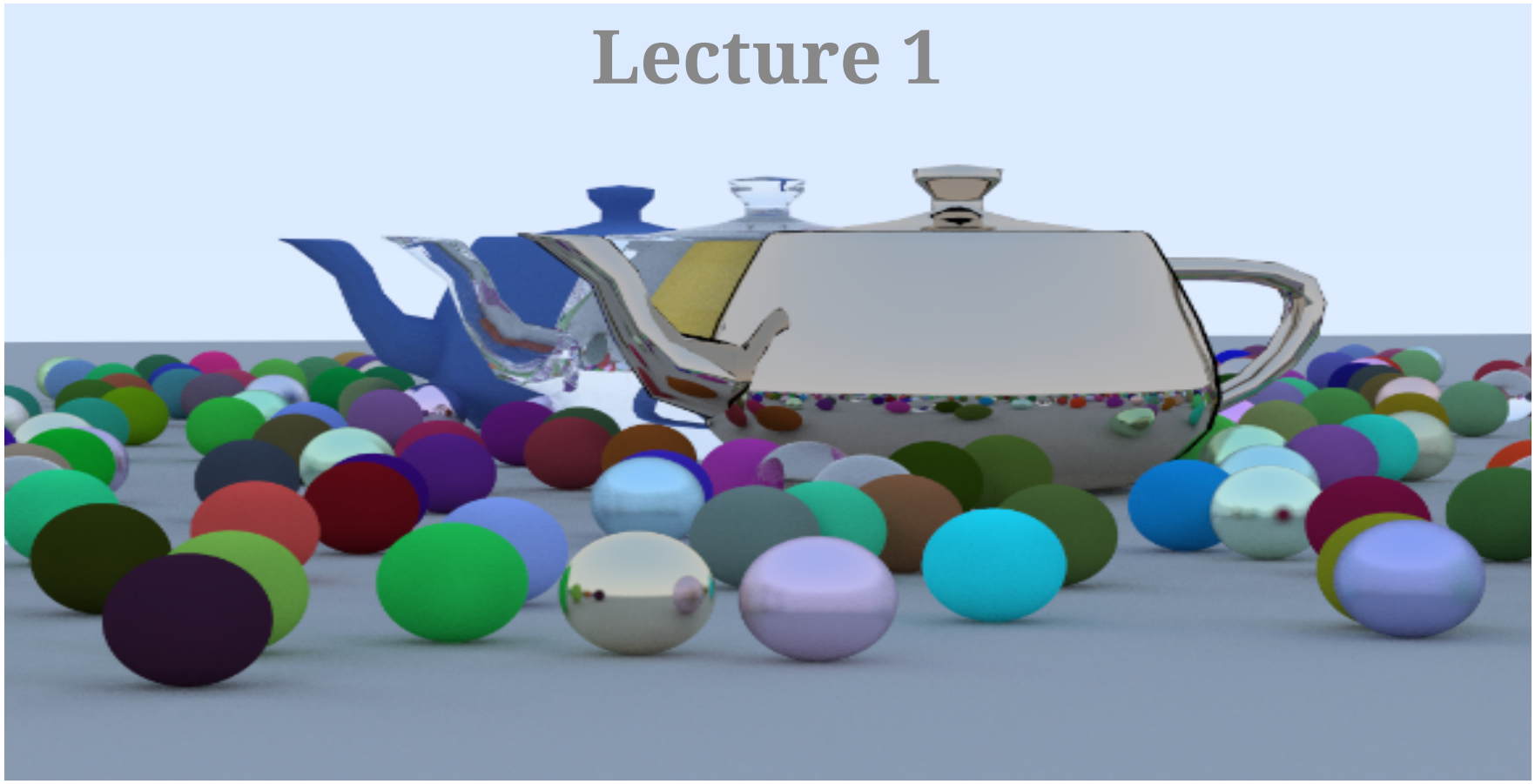
Computer Graphics

Lecture 1



Computer Graphics

- Computer graphics deals with all aspects of creating images with a computer
  - Hardware
  - Software
  - Applications

Introduction to CG

- **Computer graphics** is the display, storage & manipulation of images and data for the visual representation of a system.
- A typical graphics system consists of host computer, fast processor, large memory and frame buffer along with display devices, input devices, and output devices.

Use of Computer Designed Pictures

- Art, Entertainment and publishing
- Movie production, Animation and special effects
- Computer Games
- Browsing on world wide web
- Paint System
- Monitoring a process
- Displaying simulations
- Computer aided designs

Computer Graphics & Image Processing

- **Computer Graphics->**
  - create pictures and images
  - Synthesize(create) them on basis of some description(Model)
- **Image Processing->**
  - Improve or alter the images
  - Processing can remove noise or enhance contrast
  - Enhance certain features.

Applications of Computer Graphics

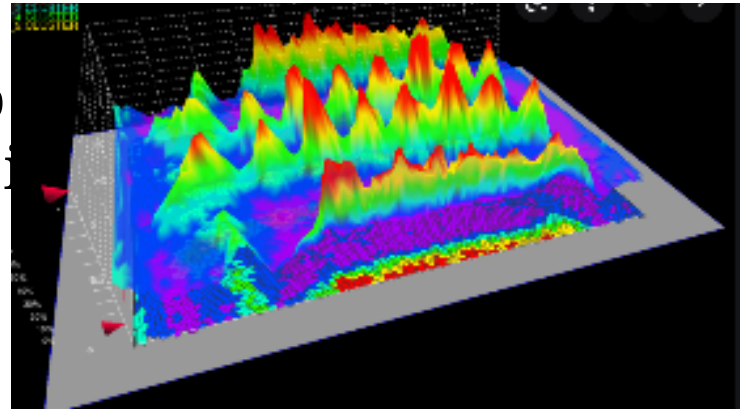
- GUI
- Scientific Visualization
- Entertainment
- Architectural scenes
- Medicine
- Virtual world
- Education

GUI

- Menus, icons, cursors, dialog boxes, scrollbars, grids, 3d interface

Scientific Visualization

- Also known as SciVis, is the representation of data graphically as a means of gaining understanding and insight into the data.
- Also known as visual data analysis. This allows the researcher to gain insight into the system that is studied in ways previously impossible.
- **What it is not-** It is important to differentiate between scientific visualization and presentation graphics.
- **Presentation graphics** is primarily concerned with the communication of information and results in ways that are easily understood.
- **Scientific visualization**, we seek to
  However, often the two methods are i



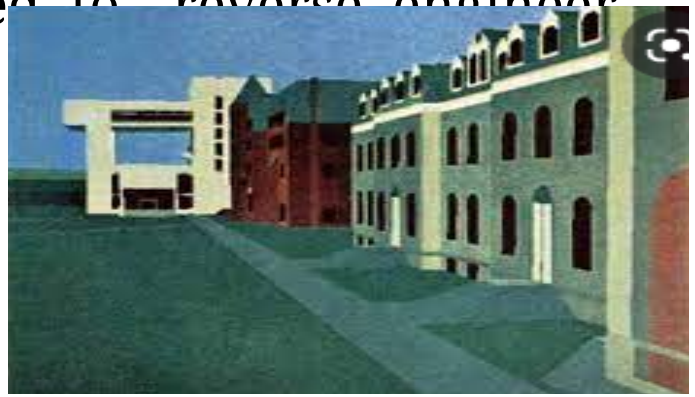
- From a computing perspective, SciVis is part of a greater field called visualization.
- This involves research in computer graphics, image processing, high performance computing, and other areas. The same tools that are used for SciVis may be applied to animation, or multimedia presentation, for example.
- As a science, scientific visualization is the study concerned with the interactive display and analysis of data.
- Often one would like the ability to do real-time visualization of data from any source. Thus our preview is information, scientific, or engineering visualization and closely related problems such as computational steering or multivariate analysis. The approaches developed are general, and the goal is to make them applicable to datasets of any size whatever, while still retaining high interactivity. As an emerging science, its strategy is to develop fundamental ideas leading to

Entertainment

- One of the main fields of application of computer graphics is the entertainment industry, in particular computer games and movies.
- First film, which began to use computer graphics, was the Throne
- First feature-length film created completely using computer was Toy Story.

Architectural scenes:

- Modern architects use 3-dimensional models for both customers and builders
- More accurate computer generated models
- Architectural animations are used in :
  - Showing relationship of a building, environment and its surrounding buildings
  - rendering architectural spaces without the use of paper and pencil tools
  - creation of interactive environments to visualize the system before it is created
  - computer-generated images are used to "reverse engineer" historical buildings



Medicine

- Computer graphics is used in medical diagnosis as it provides:
  - ability to visualize measure and evaluate structures in a non-interfering manner.
  - Is used in training and provide new methods for learning, as professionals can test their skills in simulators and evaluate their performance in a virtual environment
  - More accurate and better than traditional training that involves great number of dissections in order to correctly learn about the human anatomy/ structure
  - provide 3D models that allows the professional not only to use a 3D model as a biography plans but also interact with it to perform surgery rehearsals

Virtual worlds

- Gaming environments, ‘Prince of Persia’ had Turkey’s streets in it.

Education

- Computer Graphics leads to introduce new computer-based programs and applications, for teaching specific concepts included in the school curriculum.
- The application of new technologies is starting to produce good results in the education and intervention process.
- Useful applications for teaching and training specific concepts (such as academic, social or communicative skills) seems to be of interest to all associations and special schools
- Other areas where CG is being actively applied are courtrooms, Supermarkets, Apparel stores, Vehicle's navigation etc.

Elements of pictures Created in Computer Graphics

- Basic objects are
  - Poly line
  - Text
  - Filled regions
  - Raster images

Elements of pictures Created in Computer Graphics

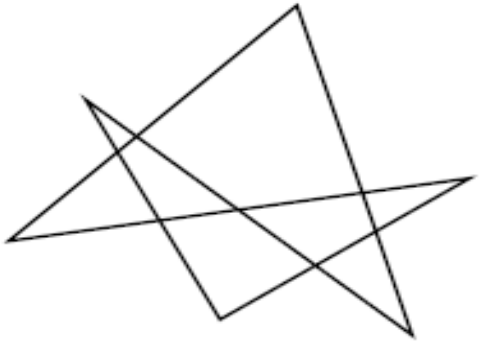
Poly Lines

- Connected sequence of straight lines
- **Line Drawings** Pictures made up of poly lines
- If several lines in polyline the each line is called an edge
- Two adjacent lines meet at vertex

Polygon:

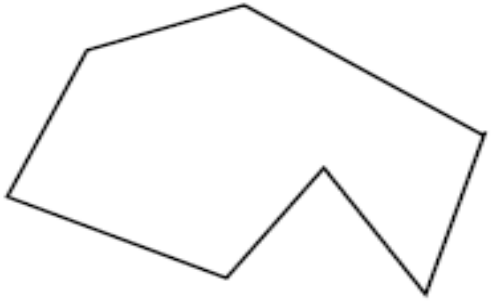
A polyline is closed if it ends where it starts called **polygon**

- It is simple if it does not self-intersect
- **Simple polygon(Jordan polygons)**
  - Well-defined two regions(inside and out side)

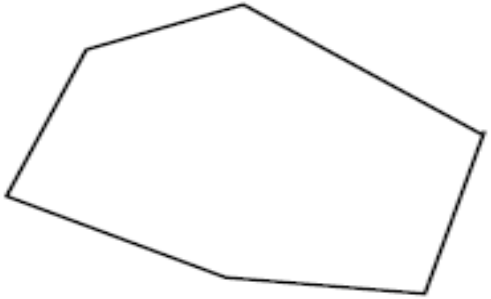


Closed polyline

Simple polyline



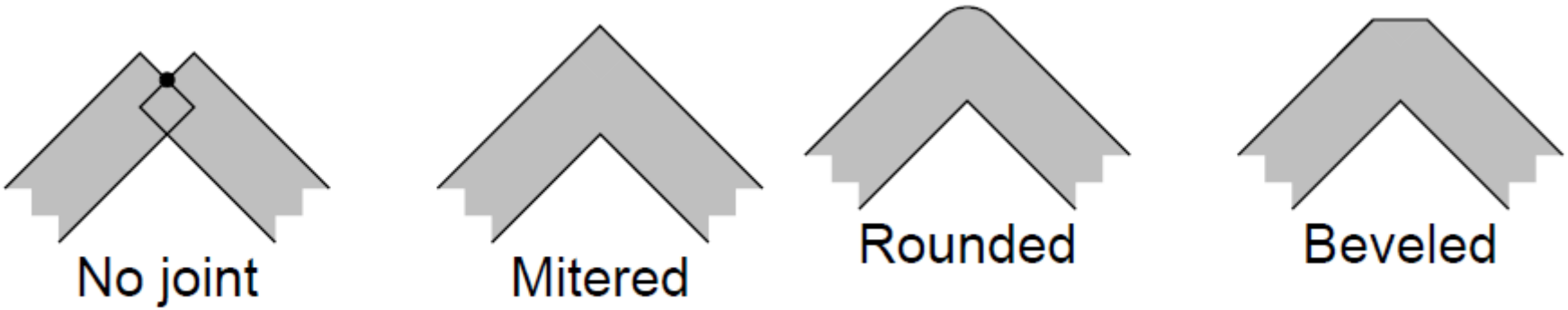
Simple polygon



Convex polygon

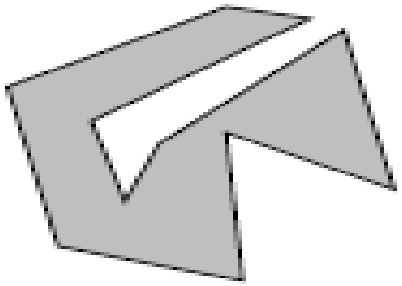
Attributes of Lines & Poly Lines

- Color
- Thickness
- Type(dashed, solid, dotted)
- Manner in which thick edges are blend



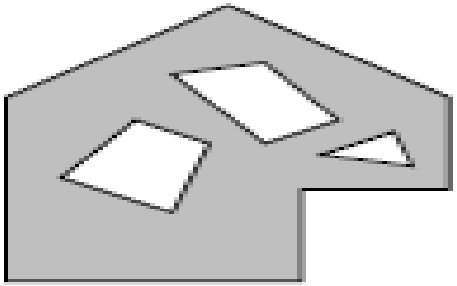
Filled Region

- Shape filled with some color or pattern.
- Boundary of filled shape is a polygon
- **Attributes**
  - Enclosing border
  - Pattern
  - color

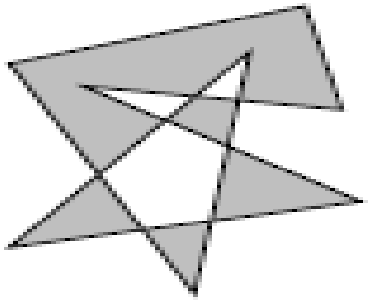


with boundary

without boundary



with holes



self intersecting

Text

- Text can be thought of as a sequence of characters in some *font*.
- Some Graphic devices has two modes
  - **Text Mode:**
    - Use for simple input & out put Characters to control operating system or edit code in program
    - Built in character generator
    - Capable of drawing Alphabets, Numeric & special characters
  - **Graphic Mode:**
    - Richer set of character shapes
    - Characters can be placed arbitrarily

Raster Images

- Image is made up of many cells, in different shades.
- Each cell is known as **pixel.**
- Stored in memory as 2-dimensional array of square/ rectangle cells
- pixel maps/bitmap

4 Major areas of Computer Graphics

- Display of Information
- Design and modeling (Represent Real world in a simpler more abstract form)
- User Interface
- Simulation.

Types of Graphics Systems

- **Active**: The user interacts with the system using some input device like the mouse etc. eg Games, Flight Simulators etc
- **Passive**: The user cannot interact with the system, eg TV

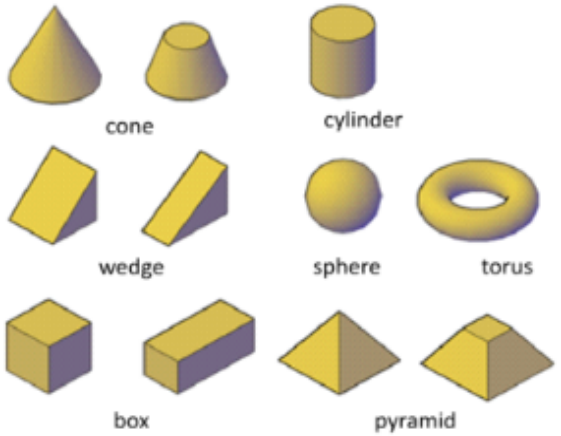
Computer graphics are present in almost every field of life these days.

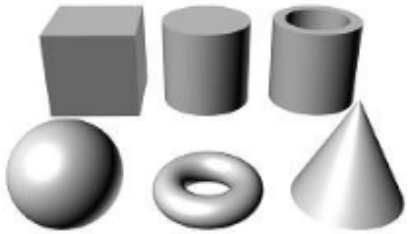
Examples: Wireframe model of a sphere using the sweep representation.

This sphere can be rotated around its axis.

It is stored in the form of the intersection points.

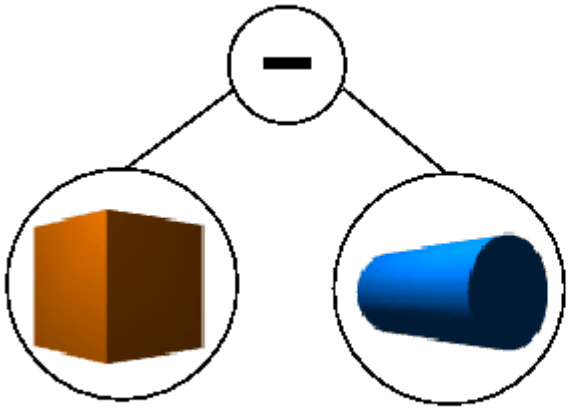
- Simple 3d objects:
  - A shaded pyramid.
  - Simple 3d Shaded Objects (Sweep Representation or wireframe)
  - Primitive 3d objects shaded



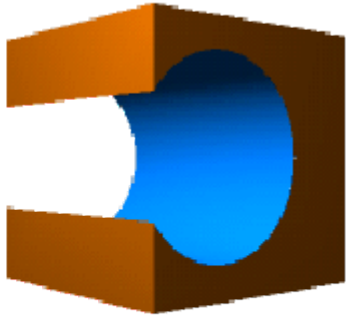


CSG

- Create a hole with the help of CSG or **constructive solid geometry:**
- First create a cube and then pass a cylinder through it. Then you take out the cylinder i.e. we subtract the object.

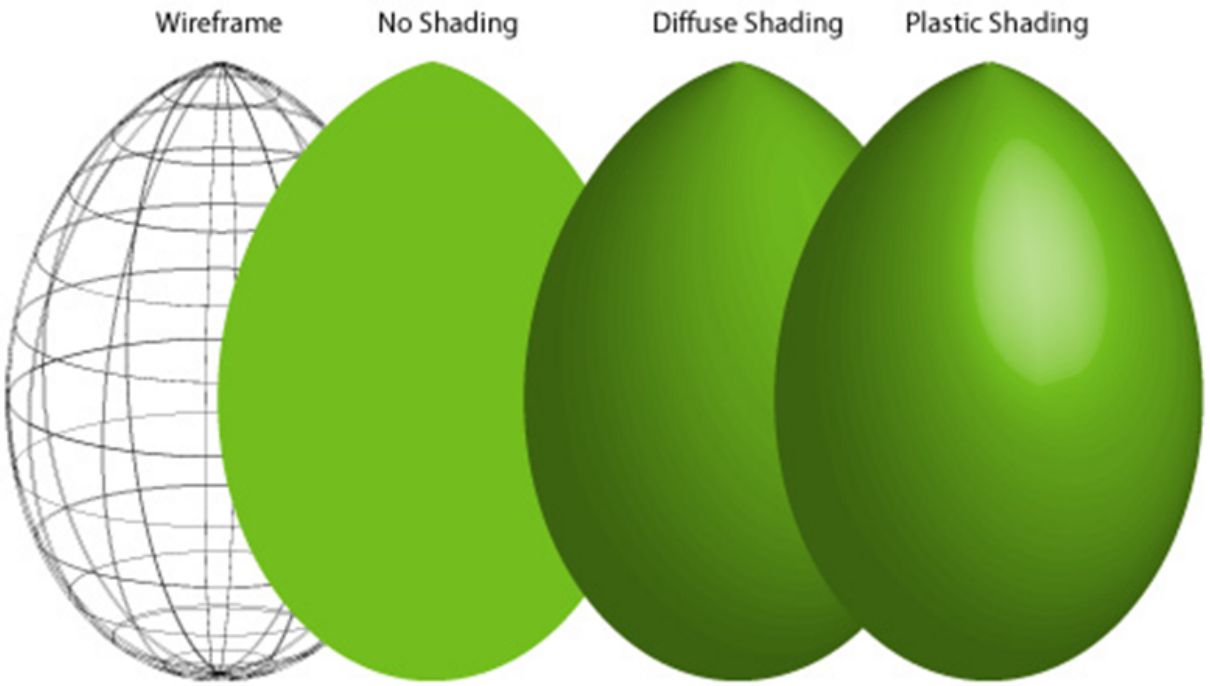


CSG Tree

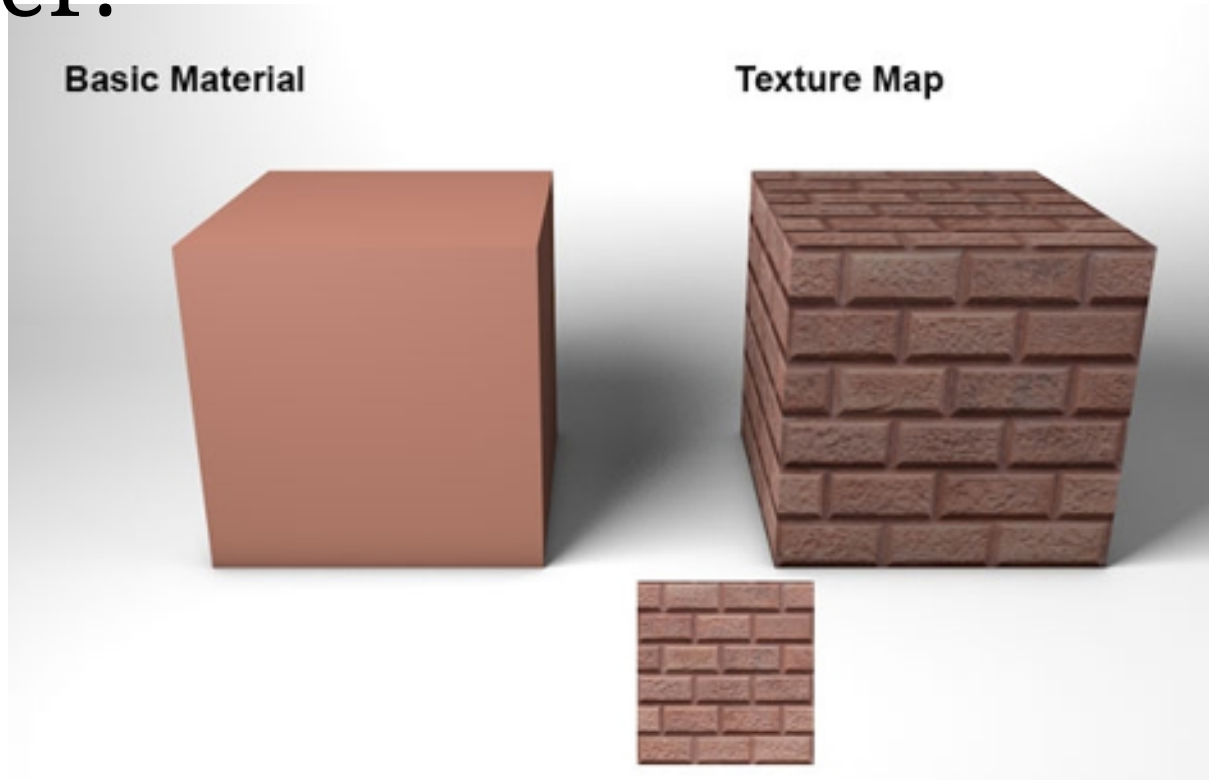


The Resulting Solid

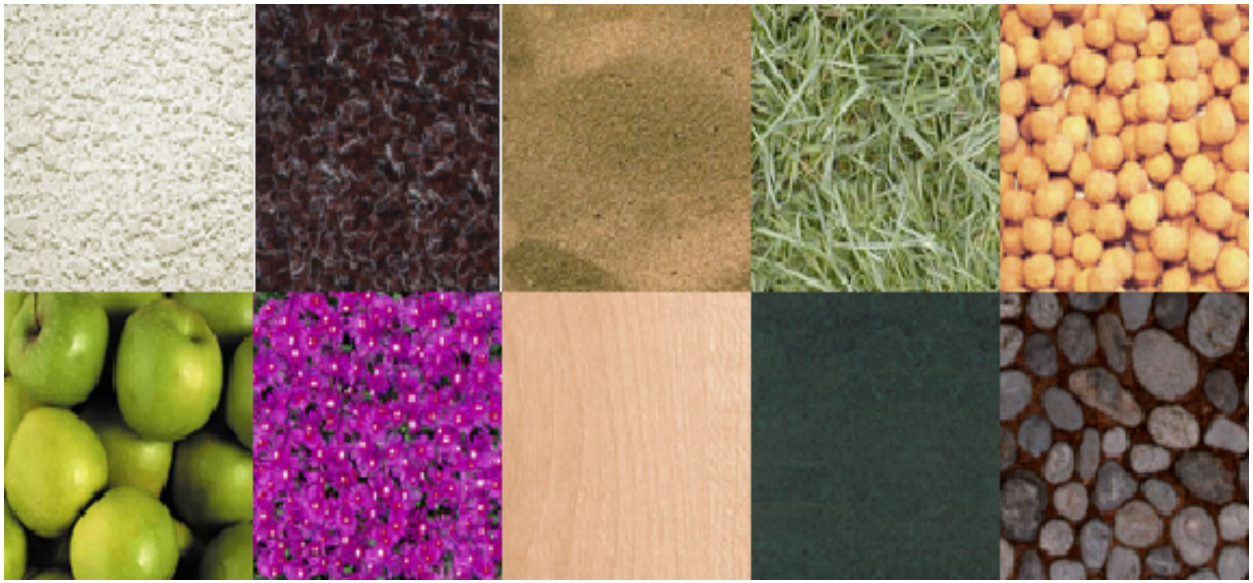
- Shading effects, Texture mapping and shadows. Sometimes using a texture is better than using the normal shading.



Texture Image mapping, textures are used to add depth to the image so the user can perceive the depths better.



Stochastic Textures (Real world Textures), they are random so they are difficult to create using the computer. Visual Realism: Trying to create the visual effect of real world.



Standards graphics packages

- **GKS**: Graphics Kernel System: First standard by ISO and OSI, Introduced in 1977.
- **SRGP**: Simple Raster graphics Package
- **PHIGS**: Programmer Hierarchical Interactive Graphics System (till late 90).
  - An (API) standard for rendering 3D computer graphics, considered to be the 3D graphics standard for the 1980s through the early 1990s.
  - Subsequently, a combination of features and power led to the rise of OpenGL, which became the most popular professional 3D API of the mid to late 1990s.

Open GL:

- Current standard, quiet Popular, available on Windows and LINUX, device independent
- Most languages or compilers have their own built in graphics libraries and APIs or support for 2d and 3d Graphics.
- **Open Graphics Library (OpenGL)** is:
  - a cross-language, cross-platform application programming interface (API) for rendering 2D and 3D vector graphics.
  - The API is typically used to interact with a graphics processing unit (GPU), to achieve hardware-accelerated rendering.
- **Device independent:** OpenGL, X11
- **Device Dependent:** SOLARIS, HP-AGP Applications built using these systems could not run on any other device but the one they supported (hardware device).