3D Modeling and Animation

Comp3351

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3D games

➢ The video game industry enables artists to use 3D software to create virtual worlds and characters that will be played in a video game engine.

➢ 3D games animation, which creates the actual game world that players are immersed in while playing the video game.

3D Vs 2D

3D Vs 2D

- ➢ Full 3d (top pic)
  - 3D games usually make use of three-dimensional geometry, with Materials and Textures rendered on the surface of **GameObjects** to make them appear as solid environments, characters and objects that make up your game world.
  - The Camera can move in and around the **Scene** freely, with light and shadows cast around the world in a realistic way.
  - 3D games usually render the **Scene** using perspective, so objects appear larger on screen as they get closer to the camera. For all games that fit this description, start in 3D mode.

3D Vs 2D

➢ Full 2D (down pic)

- Many 2D games use flat graphics, sometimes called sprites, which have no three-dimensional geometry at all.

- They are drawn to the screen as flat images, and the game's camera has no perspective. For this type of game, you should start the editor in 2D mode.

Orthographic 3D vs 2d Game with 3D Graphics

Orthographic 3D (top pic)

➤ Sometimes games use 3D geometry, but use an orthographic camera instead of perspective.

➤ This is a common technique used in games which give you a bird's-eye view of the action, and is sometimes called "2.5D".

➤ If you're making a game like this, you should also use the Editor in 3D mode, because even though there is no *perspective*, you will still be working with 3D models and **Assets.**

➤ You'll need to switch your Camera and Scene view to Orthographic though.

2D gameplay with 3D graphics (down pic)

➤ Some 2D games use 3D geometry for the environment and characters, but restrict the *gameplay* to two dimensions. For example, the camera may show a side-scrolling view, and the player can only move in two dimensions, but the game itself still uses 3D models for the obstacles and a 3D perspective for the camera.

➤ For these games, the 3D effect may serve a stylistic rather than functional purpose.

➤ This type of game is *also* sometimes referred to as "2.5D". Although the gameplay is 2D, you are mostly manipulating 3D models to build the game, so you should start the editor in 3D mode.

2D GamePlay with Perspective Camera

2D gameplay and graphics, with a perspective camera

➤ This is another popular style of 2D game, using 2D graphics but with a perspective camera to get a parallax scrolling effect. This is a "cardboard theater"-style scene, where all graphics are flat, but arranged at different distances from the camera.

➤It's most likely that 2D mode will suit your development in this case.

➤However, you should change your Camera's projection mode to Perspective and the Scene view mode to 3D.

➢Information can be communicated through images

➢Images come in many different formats

➢Using the best format can help the viewer

- Understand a concept
- Understand complex relationships
- Gain new perspectives
- Efficiently communicate ideas

Why 3D Images

➢ Adds realism to images

➢ User can manipulate object views for a full 360 degree perspective

➢ 3D images can help simplify complexity when displaying graphical relations

➢ Adding a third dimension to data can improve pattern recognition.

What is a 3D Model?

➢ A 3D Model is a bunch of data (vertices, normals, texture coordinates, color etc) which *usually* represents an object in the 3D world

Uploaded By: 121han

2D Graphics

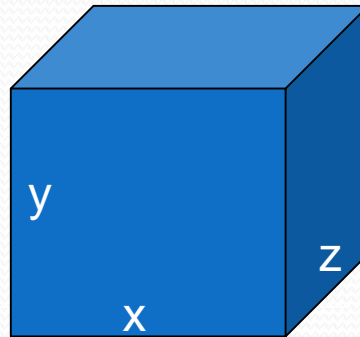➢ 2 dimensional images are comprised of x and y dimensions

y

x
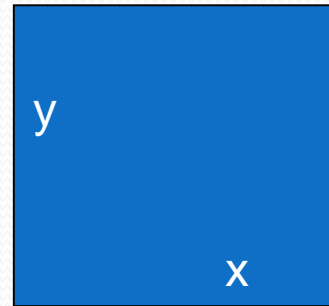
2D rectangle

➢ Note the image is flat, with no depth

3D Graphics

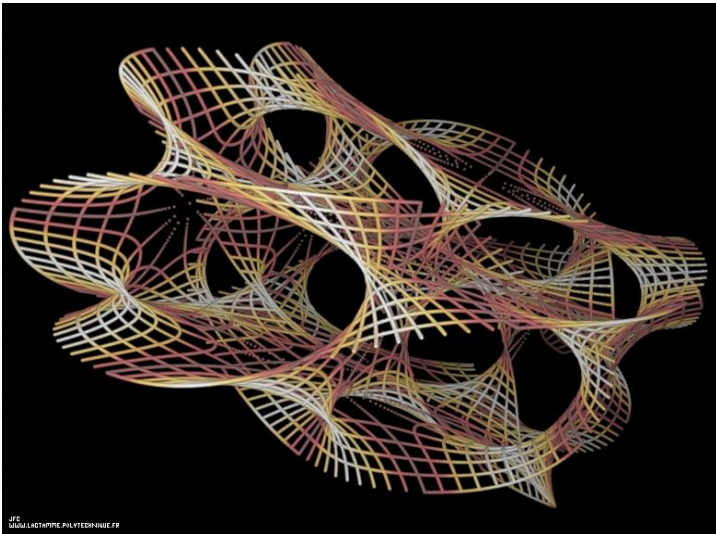➤ 3 dimensional images include x and y dimensions as well as a z dimension

3D cube

➤ Using the z axis in images adds depth to the image as demonstrated by the 3D cube.

Activity

Activity 1.1	**Title:** Understand the role of 3D modeling in the video games industry
Type:	Individual or group activity – research work
Goal:	Familiarize students the importance and the usability of 3D models in serious games ILO P1
Outline:	During this activity, students should: • Play during a certain time (a week for example) at home some given serious games (proposed by the teacher or the students) • Write a brief synthesis about how can utilize 3D models in serious games. This synthesis should contain some statistics about 3D video games industry, some examples of 3D serious games and the point of view of students about the impact of 3D modeling on the video games industry
Timeline	A week
Assessment	Assess the synthesis prepared by each student

N Dimension Graphics

➢ Images can be created beyond 3 dimensions. Generally used in math and sciences.

http://www.lactamme.polytechnique.fr/Mosaic/images/CAYA.61.0129.D/display.html

➢ Objects beyond 3 dimensions are of interest to scientists and mathematicians

3D computer graphics

Definitions and history

➤ 3D : three-dimensional

- Width
- Height
- Depth (length)

➤ 3D Computer Graphics

- Computer graphic: producing images using a computer
- 3D computer graphic: using a three-dimensional representation of geometric data

➤ History

- 1961: Computer graphics (William Fetter, Boeing)
- 1976: First computer animation (Futureworld, Edwin Catmull and Fred Parke)
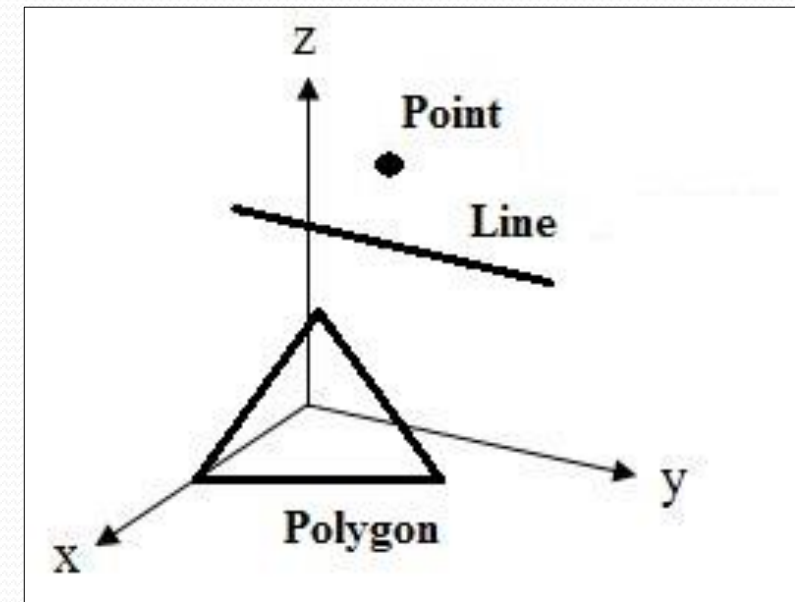
3D modeling concepts and tools

3D modeling basic concepts

- **Scene:** when modeling work on a scene at a time

- **3D space:** a geometric three-parameter model of scene
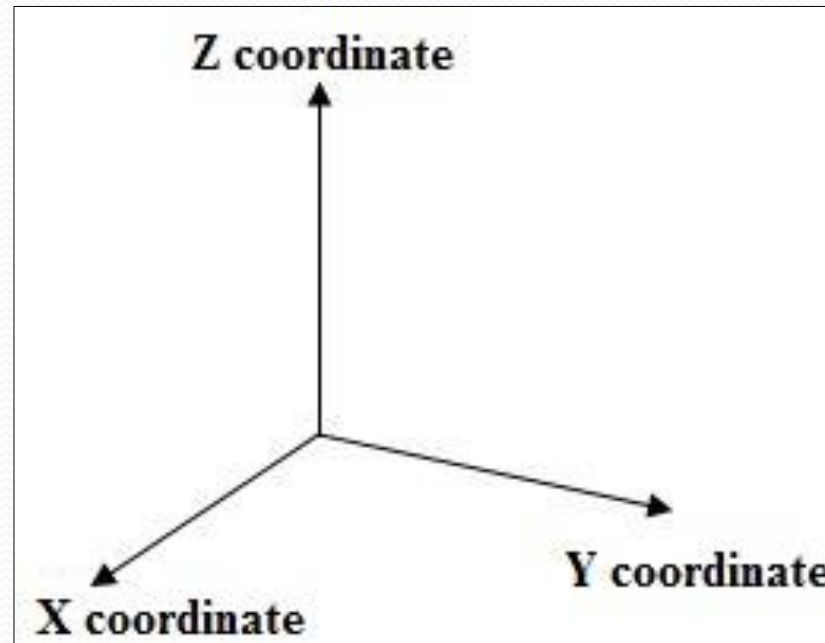
# 3D modeling concepts and tools

3D modeling basic concepts

➤ **Point (vertice):** Every point in three-dimensional space is described by means of **three coordinates**.

➤ Line : is defined using two points

➤ Edge : two adjacent surfaces

➤ Polygon : is composed by a list of vertices and lines and which has color/texture

3D modeling concepts and tools

3D modeling basic concepts

- **Object:** is the primitives used to build 3D model. It is made up of sets of polygons
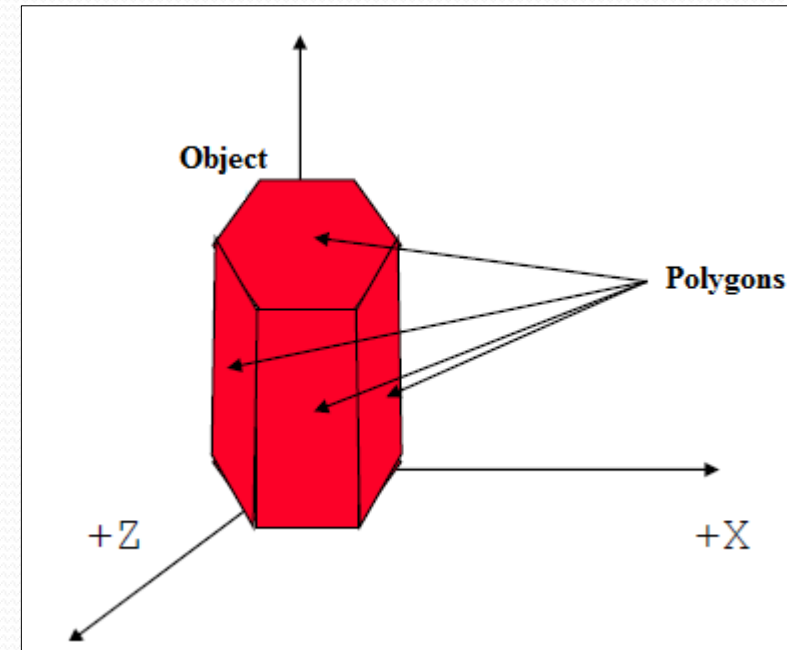
- **Structure:** is combination of objects
- **Operator:** Tools to build structures from objects

3D Computer Graphics

➢ 3D computer graphics are rendered on a computer display – don't need 3D glasses

➢ 3D images are created by drawing in a 3 axis environment

➢ Texture, lighting and shading add realism

➢ Translation and scaling create a realistic experience for the viewer when manipulating objects or moving through the 3D world

The 3D Graphics Pipeline

Modeling Transformation   Orientation and arrangement of objects in 3D world

Lighting   Objects and scene is lit based on light source locations

Viewing Transformation   Create the 3D scene from the "camera" point of view

Projection Transformation   Transform 3D scene to 2D

Clipping   Discard unnecessary objects that fall outside the camera's view (**Why?**)

Rasterization   Convert image into pixels

Texturing   Assign colors to each pixel

Display   Display images or scene onto a computer display

3 Basic 3D Graphics Operations

- Translation
- Rotation
- Scale

Translation

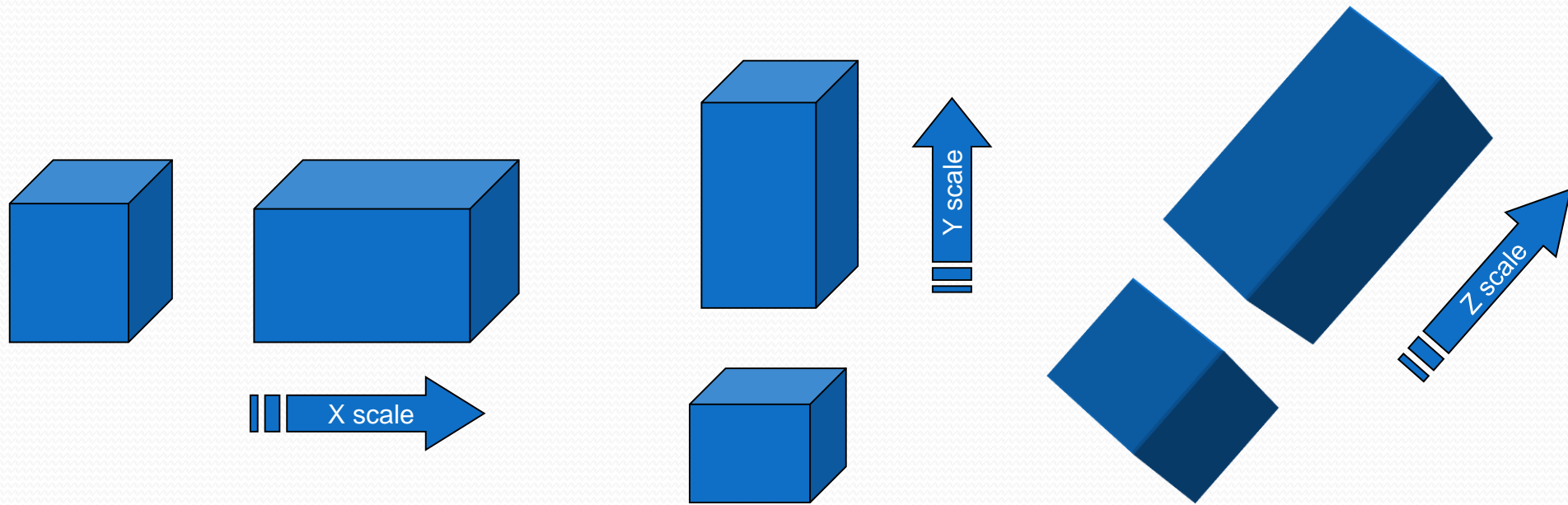➢ When you move a 3D object in one of 3 dimensions(x, y, z) you are performing translation
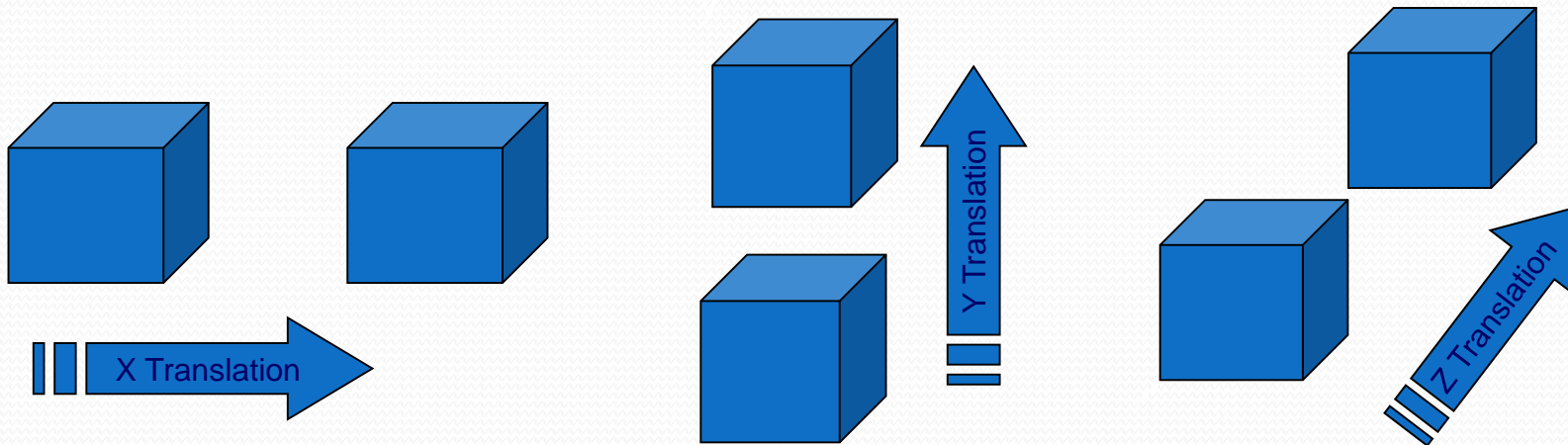
Rotation

➢ When an object is spun on its axis, an object is
rotated
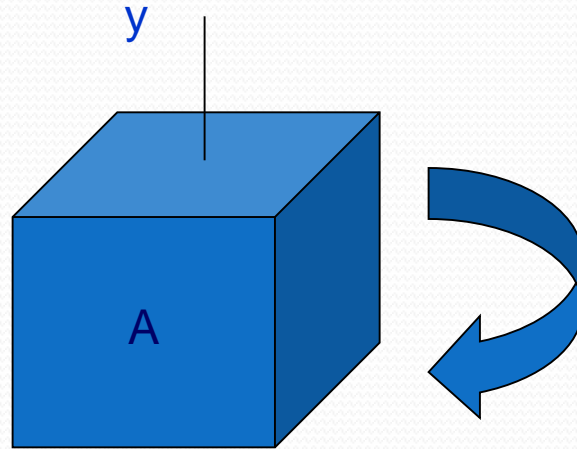
Scale

➢ Scaling changes the number of pixels in an image, in other words, make it larger or smaller.

3D Graphics Creation

➢ **3D modeling**: forming a computer model of an object's shape

➢ **Scene layout setup** and **animation**: the motion and placement of objects within a scene

➢ 3D **rendering**: generating an image from a 3D model
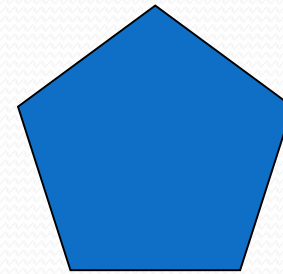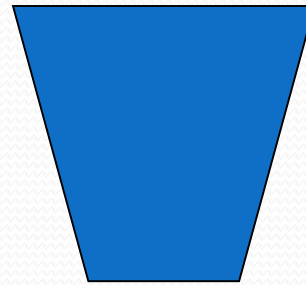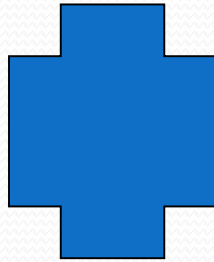
Modeling

➢ Modeling is the task associated with creating and shaping individual objects that will be used in a scene

➢ May also specify materials (textures, types of reflections)

➢ Describe object physical behavior

Modeling

➤ Complex shapes are built from primitives such as triangles or polygons.
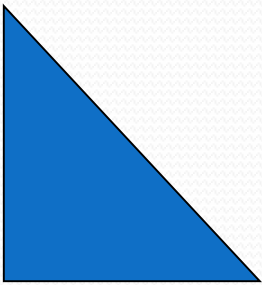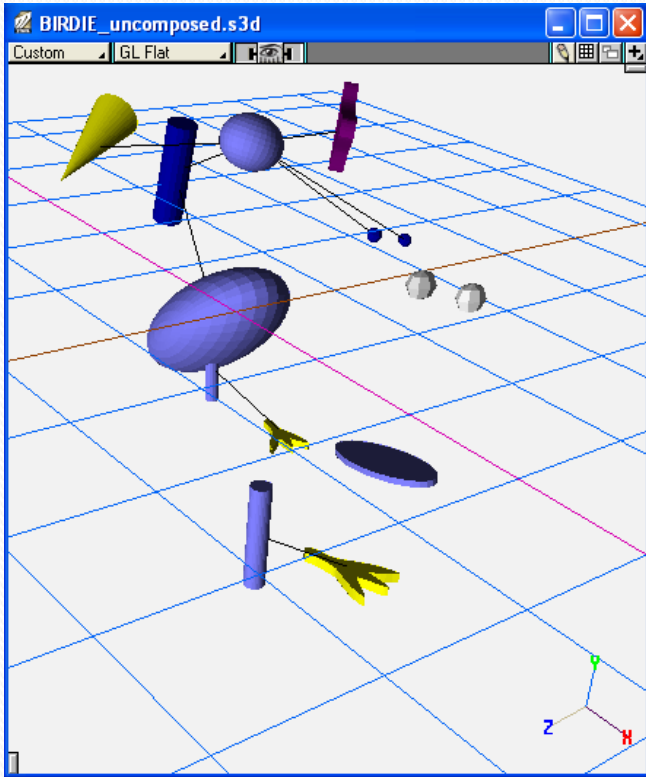
Triangle

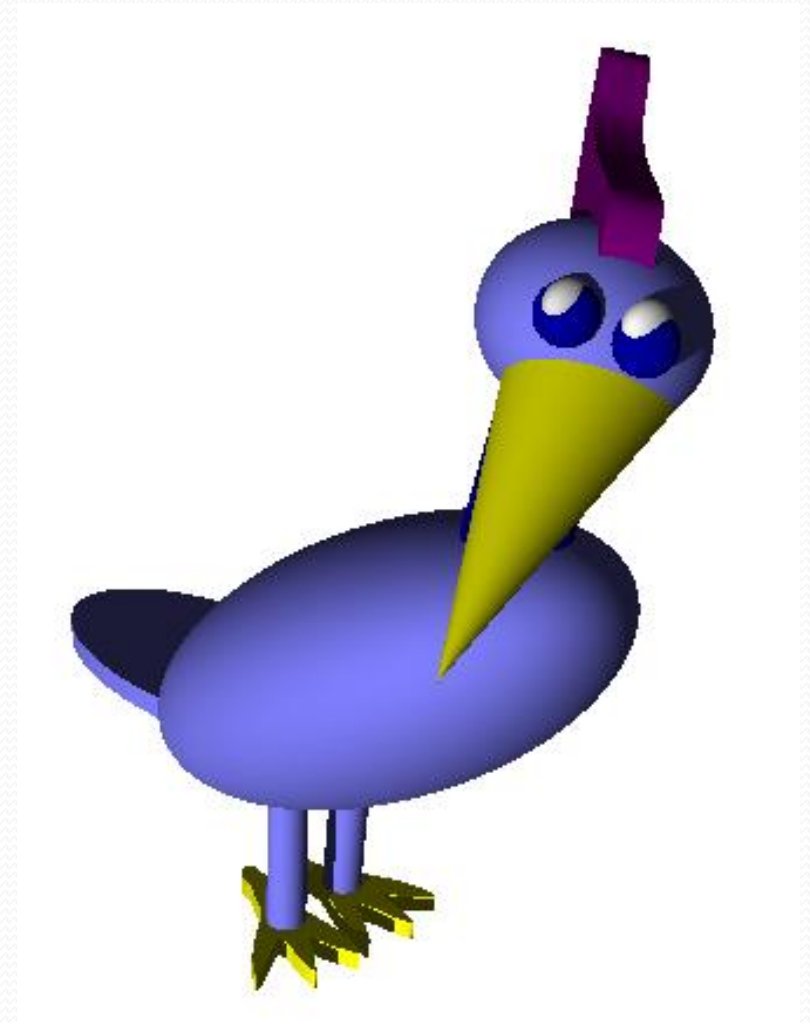Polygons

Modeling

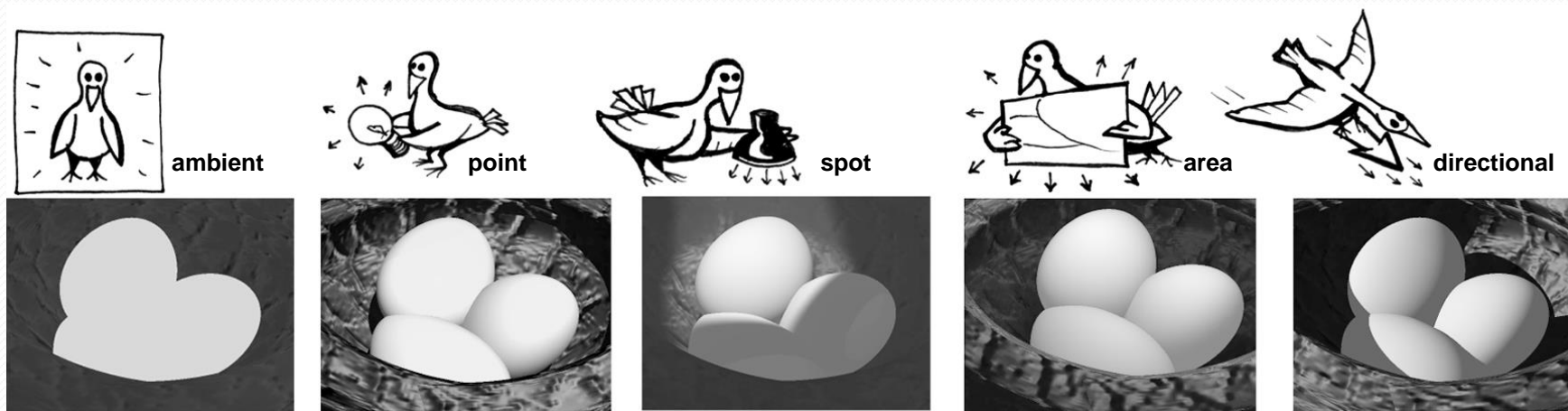
Individual objects are created and then assembled into final image

Scene Layout

➢ Scene layout requires positioning objects and lighting for desired effect.

➢ Lighting can enhance the visual quality of the scene and create different moods.

ambient   point   spot   area   directional

Rendering

The automatic process of generating a photorealistic or non-photorealistic image from a 2D or 3D model (or models in what collectively could be called a scene file) by means of computer programs. (Wikipedia):

➢ Ray Tracing

➢ Radiosity

➢ Shading

➢ Texture

Ray Tracing

➤ Ray tracing is a mathematical algorithm that:

- Plots the path of light from the viewers perspective onto an image

- Can represent reflective and refractive properties of light

- Adds realism to the scene

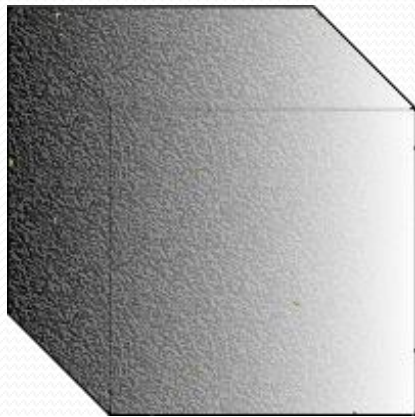- requires a large amount of computer processing power
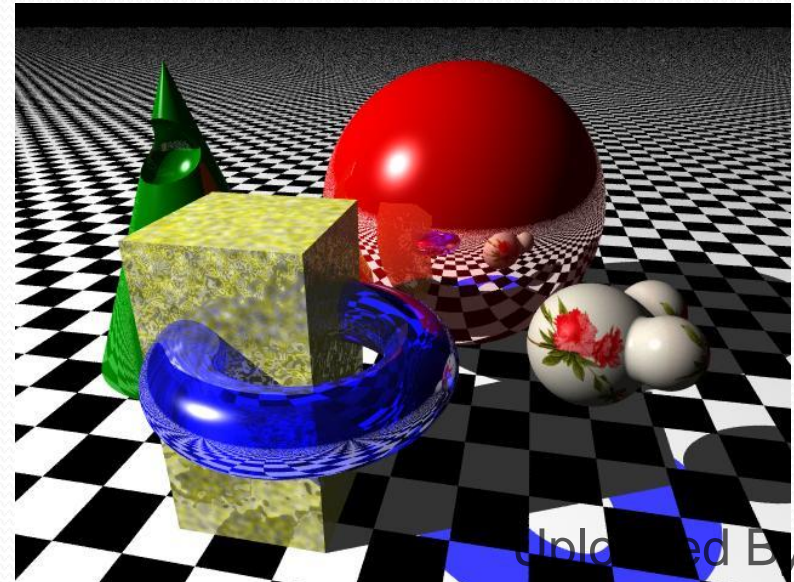
Radiosity

➢ Illumination algorithm that models multiple light reflections, resulting in a softer image



Radiosity Factory

Shading

➤ Shading results when the color of an object is adjusted to simulate light angles and distance from light sources. This adds realism to a 3D scene.
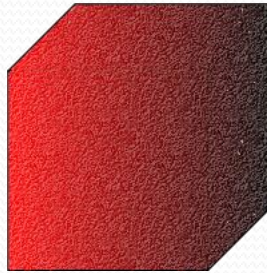
Texture

➤ Add detail to the surface of a 3-D shape

➤ This adds detail and improves the realism of a displayed image.

➤ Texturing can be a very simple texture simulating wood grain for example or can be another image as demonstrated in the picture where a 2D map of the earth is added to a sphere
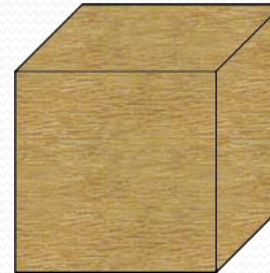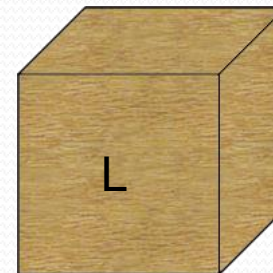
Putting it all Together
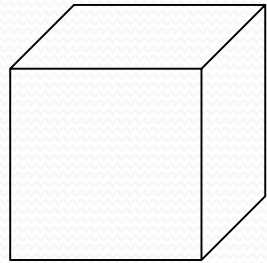
Model

Shading

Texture

D

V

L
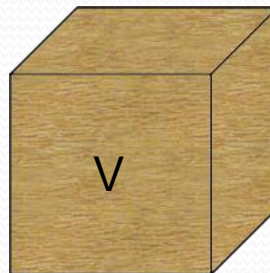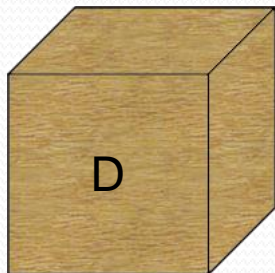
Scene Layout

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3D Graphics Use and Applications

➢ Movie industry (real-life motion scenes)
➢ Video game industry
➢ Entertainment
➢ Computer Assisted Drafting (CAD)
➢ Medicine
➢ Security
➢ Commerce
➢ Science and research sector (chemical compounds, molecular engineering...)
➢ Architecture industry (buildings and landscapes through Software Architectural   Models)
➢ Engineering community (designs of new devices, vehicles and structures ...)
➢ Earth science (3D geological models)
➢ Physical devices (3D printers or CNC machines)

Games

➢ Most recognizable 3D application

➢ Requires a number of types of programmers

- Graphics
- Physics
- Sound
- Artificial Intelligence (AI)
- User Interface (UI)

Entertainment

➢ Animated **movies** are a popular form of 3D entertainment

➢ Combines movement with 3D graphics

➢ Movement can be achieved through motion capture or avars

- Motion capture – actual person or object performs movements with markers tracked by a video camera

- Avars- a computer instructions are used to control object movement.

Medicine

Medical industry
(models of organs of the
human body).

can help in:
 - the understanding
and analysis of anatomy
 - medical diagnosis
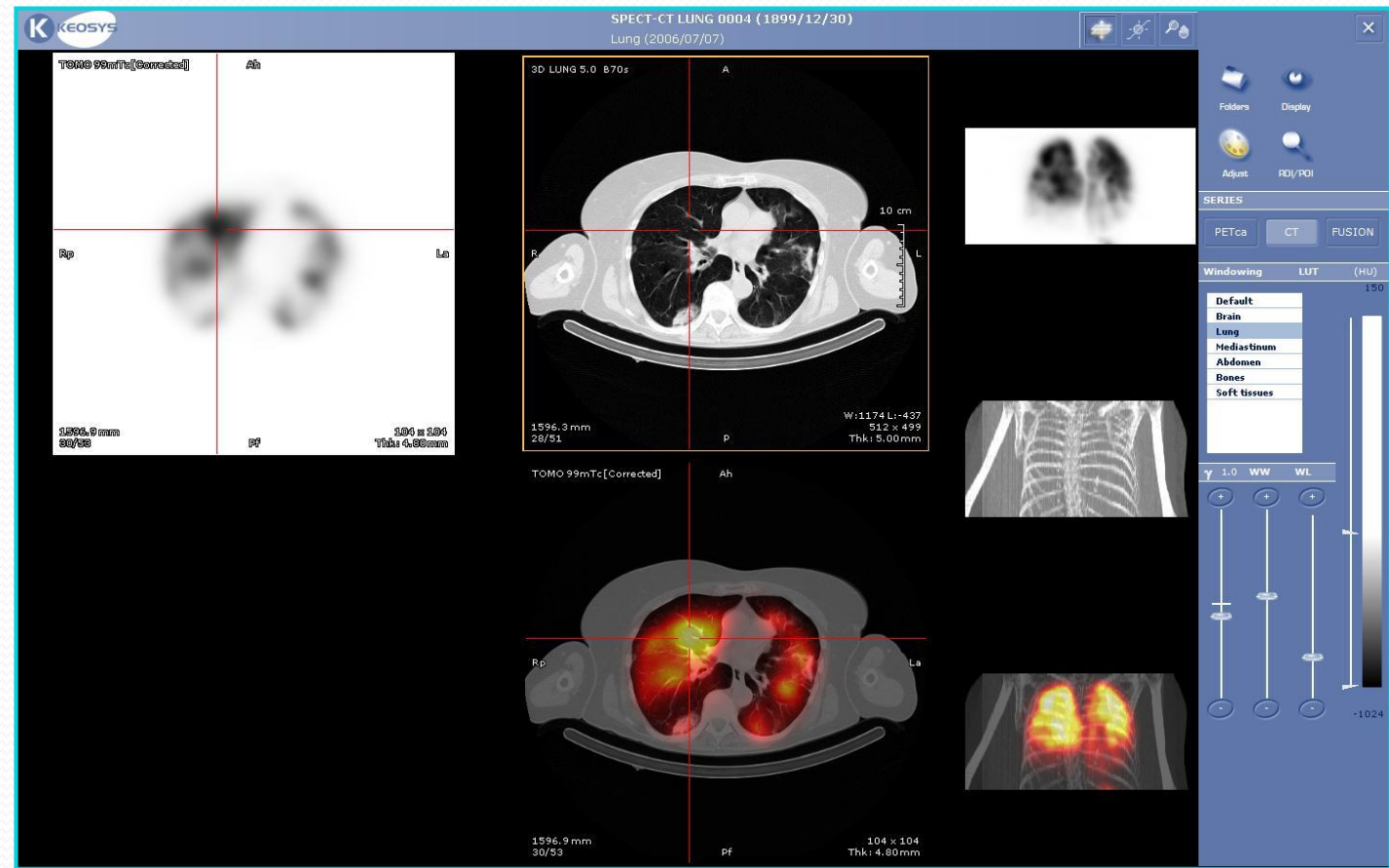
Security
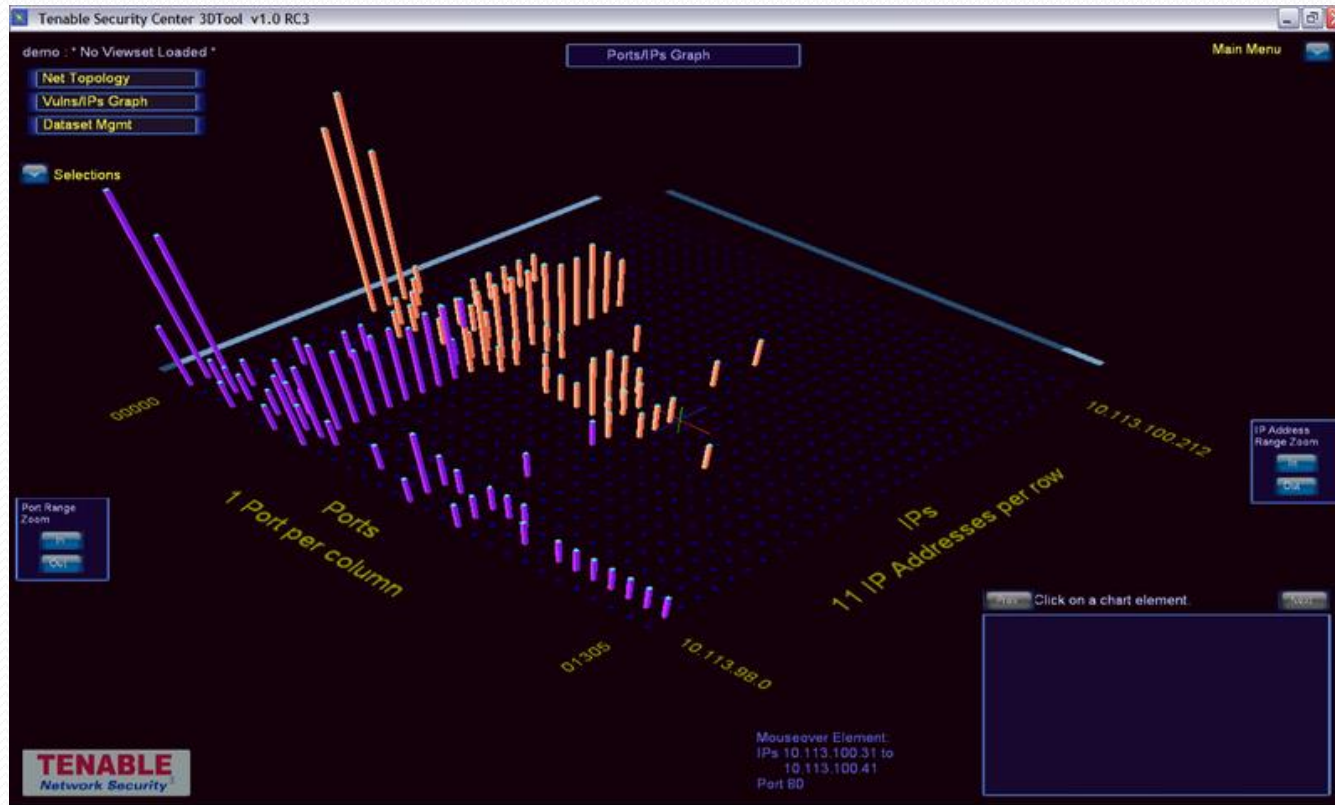
3D graphic security tool that can help computer system administrators identify weaknesses in network security.

Commerce

- Real Estate
- Business Intelligence
- E-retail
- Maintenance, Training, Documentation

Real Estate

3D graphics can be used by a user to view a specific location in 3D. Note that the tool displayed here permits the user to navigate through a city in 3D but also has a 2D map displayed as a reference.

Business Intelligence

Business Intelligence is the collection of data, processed into information that managers can use to make business decisions. Displaying data in 3D helps decision makers gain insight into complex relationships.

E-Retail
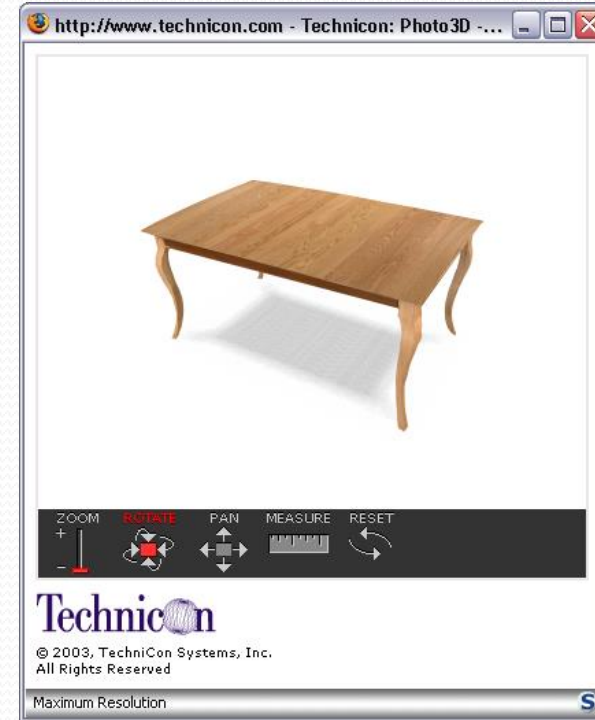
➤ 3D images can be manipulated, viewed and measured before purchase

Maintenance, Training, Documentation
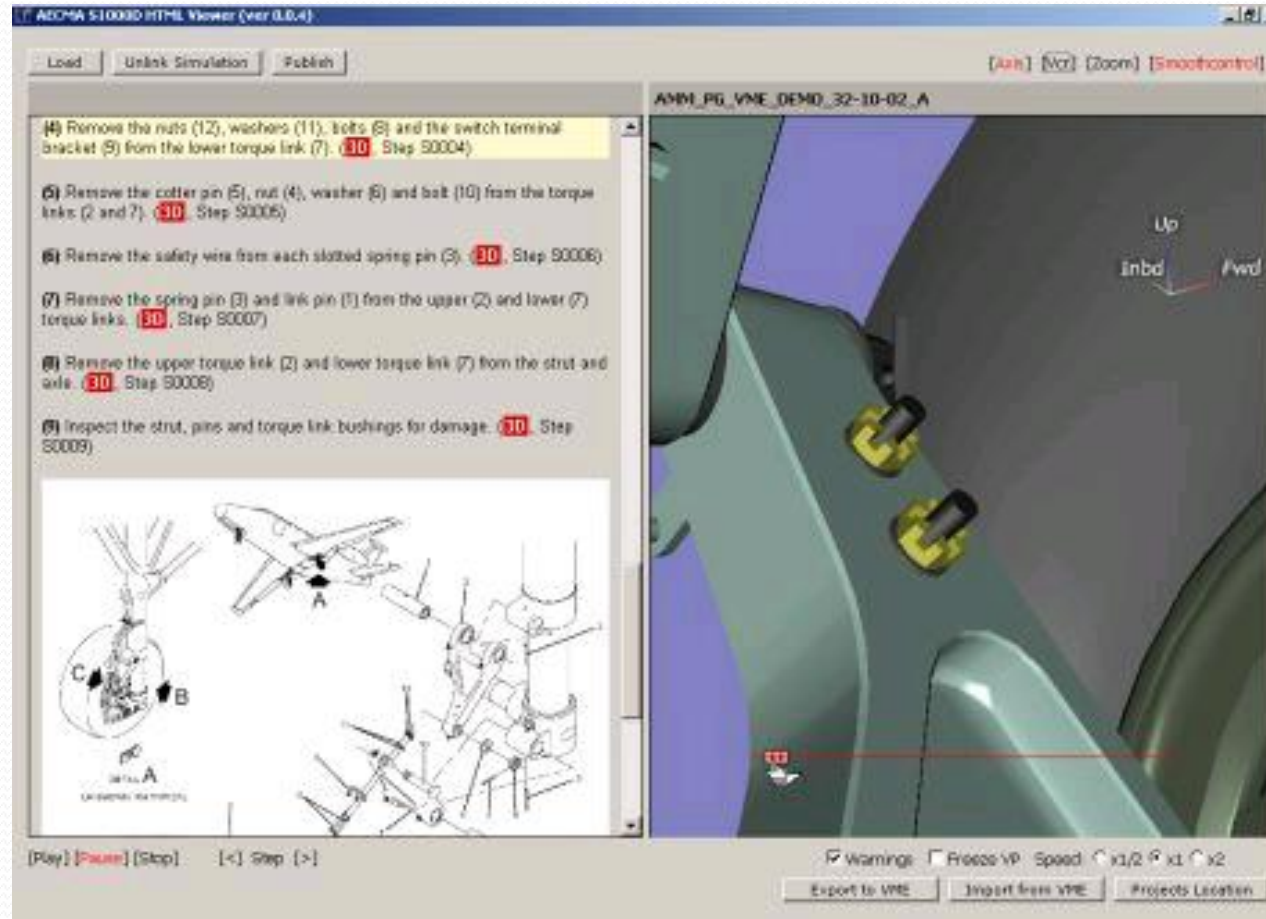
3D graphical application applied to a practical application of airplane maintenance, training and documentation

3D Graphics Use and Applications

➢ Movie industry (real-life motion scenes)
➢ Video game industry
➢ Entertainment
➢ Computer Assisted Drafting (CAD)
➢ Medicine
➢ Security
➢ Commerce
➢ Science and research sector (chemical compounds, molecular engineering…)
➢ Architecture industry (buildings and landscapes through Software Architectural   Models)
➢ Engineering community (designs of new devices, vehicles and structures …)
➢ Earth science (3D geological models)
➢ Physical devices (3D printers or CNC machines)

3D Graphics Benefits

➤ Adds realism

➤ 3D images can help simplify complexity when displaying graphical relations

➤ User can manipulate object views for a full 360 degree perspective

➤ Adding a third dimension to data can improve pattern recognition and increase business decision speeds

3D Graphics Challenges

- Requires specialized skills to develop 3D applications
- Requires higher performance computer hardware
- Web adoption has been slow, no mainstream applications

3D Graphics Tools

➢ 3D designers use powerful software tools to create the images we see in games, movies and other applications. The tools include:

- Maya
- 3ds Max
- Lightwave
- Softimage
- Sketchup

3D modeling concepts and tools

3D modeling tools

Title	Developped by	License	3D Rendering Support
CINEMA 4D	MAXON Computer	Commercial software	Yes
Maya	Autodesk Media and Entertainment	Commercial software	Yes
LightWave 3D	NewTek	Commercial software	No
3ds Max	Autodesk Media and Entertainment	Commercial software	Yes
Blender	Not a Number Technologies (NaN) and NeoGeo	Free and open-source	Yes

Activity

Activity 1.2	**Title:** Compare some 3D modeling tools
Type:	Group activity – research work
Goal:	Familiarize students to 3D techniques, concepts and tools ILO P1
Outline:	During this activity, students should: • Conduct a bibliographic research about three modeling tools : Blender, Maya and 3ds Max • Compare these tools using the following metrics: – Usability in the 3D industry – Performances – Functionalities – Documentation – ... • Prepare a presentation
Timeline	A week
Assessment	Assess the presentation of each group

Activity

Activity 1.1	**Title:** Understand the role of 3D modeling in the video games industry
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Timeline	A week
Assessment	Assess the synthesis prepared by each student

Summary

➢ 3D graphics used extensively in games and entertainment

➢ Industrial 3D graphics applications

➢ Some use of 3D in Business Intelligence and e-commerce.

➢ Challenges

Thank you for your attention!