Visualization is Foundational to Insight

- Roughly 30% of the human brain is devoted to vision.
- Visualization is the dominant way of acquiring information.
- Visualization makes complex data comprehensible and meaningful.
THE BASICS: WHAT’S THE DIFFERENCE BETWEEN GRAPHICS, RENDERING AND VISUALIZATION?
So, in summary, what’s the difference between graphics, rendering, and visualization?

• Most people use all the terms interchangeably

• In the visual effects and animation domain, the terms graphics and rendering are often used while in science and engineering, the term visualization is more commonly used.

• Graphics is used to describe the images generated from a computer, while rendering is about a 2D or 3D image created from an application, and finally, visualization is often used to describe a graphical representation of a 2D or 3D image.
Rendering Markets: Workstation and HPC

Surface Rendering
(Media & Ent)
- Digital Content & Creation (DCC)
- Render Farms
- Workstation

Volume Rendering
(Sci Viz & Eng Viz)
- Architectural, Engineering & Construction (AEC)
- Energy Oil & Gas
- Weather & Climate
- Geosciences
- Health & Life Sciences
- Workstation and Server
- Workstation and Server
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The Basics: Graphics

- **Graphics**: Images generated from a computer
  - **Types** of graphics/images
    - **Raster graphics** – Images that use bitmaps (a single pixel that corresponds to a memory bit).
    - **Vector graphics** - Graphical representations of mathematical objects such as lines, curves, polygons. Shapes are based on mathematical calculations and spatial relationships.

<table>
<thead>
<tr>
<th>VECTOR</th>
<th>RASTER</th>
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<tbody>
<tr>
<td>FORMED BY VARIOUS SHAPES</td>
<td>COMPRISED OF PIXELS</td>
</tr>
<tr>
<td>SCALABLE</td>
<td>LOSES QUALITY WHEN SCALED</td>
</tr>
<tr>
<td>CAN CONVERT TO RASTER</td>
<td>CAN'T CONVERT TO VECTOR</td>
</tr>
<tr>
<td>SVG, CGM, EPS, XML</td>
<td>BMP, JPG, GIF, PNG</td>
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**The Basics: Visualization**

**Visualization:**
The graphical representation of data as a means of gaining understanding and insight into the data.

- **Data Visualization**
- **3D Visualization**

**Data Visualization:**
- Data visualization is the process of displaying datainformation in graphical charts, figures and bars.
- Used to deliver visual reporting.
- Think of financial dashboards for execs like Tableau* or Qlik* or IT dashboards for network health.

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The Basics: Visualization

**3D Visualization:** A 2D representation of a digital model that has been given properties such as *texture, color, and material*. A model might be a simple wire-frame object or scene. In order to give these shapes real form, they must be introduced to texture maps, artificial light sources, and a number of other filters.

Source: https://techterms.com/definition/rendering
Rendering

Quality

Offline
Minutes/hours per frame
Professional Studios (Animation films)

Interactive
5-10 frames/second
Scientific Visualization

Performance

Real-time
30-100 frames/second
Video games
The Basics: Rendering

**Rendering**: The process involved in the generation of a two-dimensional (2D) or three-dimensional (3D) image from a model by means of *application programs*.

**Real-time rendering**
The prominent rendering *technique* used in interactive graphics and gaming where images must be created at a rapid pace. Dedicated graphics hardware (GPUs) and pre-compiling of the available information has improved the performance of real-time rendering.

The Basics: Rendering

**Offline rendering**
Used in environments where speed is not a concern and the image calculations are performed using multi-core cpus rather than dedicated graphics hardware. This rendering technique is mostly used in animation and visual effects (think cinema and Hollywood), where photorealism needs to be at the highest standard possible.

The striking difference between **real-time** and **offline rendering** lies in the speed at which the computation and finalization of images takes place. Speed vs quality. Think speed in real-time rendering and photorealistic quality in offline rendering. The goal would be to render images fast at the highest quality and photorealism possible.

Luxurious Living Room by Eduard Caliman (www.eduardcaliman.com). Rendered with Corona Renderer.
Volume Rendering: Gaining Insights through Data Exploration and Features

- **Volume rendering** is essential to scientific and engineering applications that require visualization of three-dimensional data sets.

- Distinct from volume rendering, **surface rendering** refers to the generation of a 2D or 3D image from a model's surfaces, as opposed to drilling down into a section of that model, beyond the surface.

- In scientific visualization and computer graphics, volume rendering is a set of techniques used to display a 2D projection of a 3D discretely sampled data set.

Volume Rendering provides Scientific and Engineering Visualization for HPC Users
Rendering in a Visual Effects (VFX) Pipeline (Media & Entertainment)

Storyboarding & Art, PreVis
Surfacing, Modeling, Shading and Texturing
Layout, Animation, Lighting
Rendering, Computation
3D Compositing and Finishing

Content Creation
Applications: Houdini*, 3DS Max*, Maya*, Blender*, Cinema 4D*

Characters and Scenes
Pixar Renderman*, Autodesk Arnold*, Chaos VRAY*, Moonray* from DreamWorks*, Hyperion* from Disney, Bender*

Final Stage
Flame*, Lustre*

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Rendering in a Scientific and Engineering Workflow

Phase 1: Modeling and Structure Prep

Pre-Processing includes Rendering
Manufacturing: CAD tools like Catia*, NX*, PTC*, SolidWorks*
HLS: Molecular Modeling tools like Amber* and CHARMM*
Oil & Gas: Reservoir modeling s/w from Landmark/Halliburton, Schlumberger

Phase 2: Structure Changes and Alterations

Simulation Run
Simulation
Manufacturing: Fluent*, Simulia*, Star CCM+*, OpenFoam*, Altair*
HLS: GROMACS*, LAMMPS*, NAMD*
Oil & Gas: Typically proprietary

Phase 3: Preparation of Simulation System

Analyze and Visualize
Post-processing includes Rendering
Rendering of simulations

*Other names and brands may be claimed as the property of others
Why is 3D Visualization/Rendering Important?

- Makes it easier to communicate our ideas, especially complex ideas and relationships
- Enhances and improves visual communication
- Provides greater engagement and interactivity
- Easily marketable and shareable
- Greater insight because of more precise information – “scientifically accurate models”
- It's cheaper and more cost effective than creating physical models
- Allows total control over the final look (75% of IKEA's catalogues are now renders and not real photos)¹
- Poor visualizations can hinder the analysis, the science, or the understanding of the problem

Supporting a Broad Range of Visualization Needs

One-on-Many
Scientific Visualization
Professional Rendering
Video Transcode

Many-on-One
Visual Understanding
Media & Gaming
Client & Productivity

Iris™ Pro Graphics

Intel XEON® inside
Visual Cloud

DECODE

INFERENCING

RENDER

ENCODE

FOUR CORE BUILDING BLOCKS, FIVE MAJOR WORKLOADS, INFINITE INNOVATION OPPORTUNITY
More Training

To learn about the different rendering techniques such as rasterization and ray tracing, please take the Visualization 201 course.

Here is a list of use cases in which Intel has played a significant role in rendering:

• https://corona-renderer.com/features/proudly-cpu-based
• https://www.easterngraphics.com/pcon/en/2016/06/01/rendering-in-pcon-planner-7-3-new-interface-new-strengths/
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