A PRIMER: GRAPHICS, RENDERING, AND VISUALIZATION

Kathedrale by Martin Geupel | www.racoon-artworks.de

rendered with Corona Renderer using the Embree Ray Tracing Kernels

Visualization is Foundational to Insight

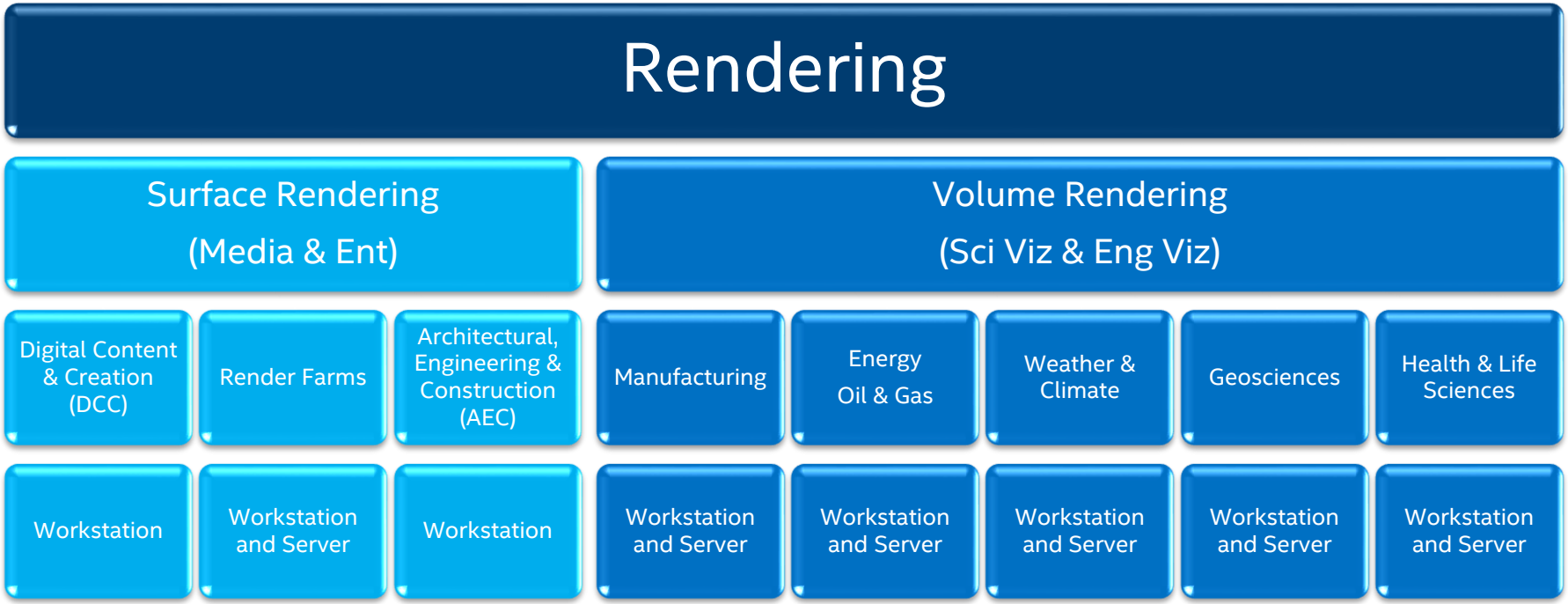
- Roughly 30% of the human brain is devoted to vision.
- Visualization is the dominant way of acquiring information.
- Visualization makes complex data comprehensible and meaningful.

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.

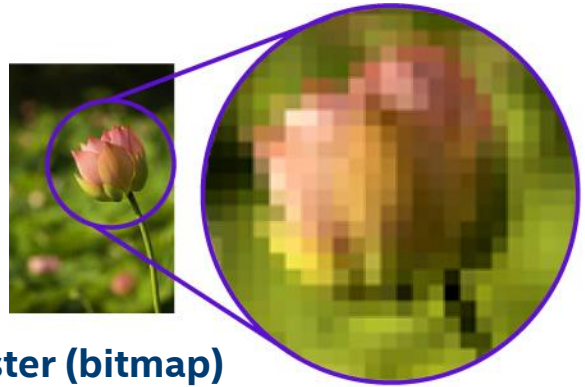
Rendering **Markets**: Workstation and HPC



The Basics: Graphics

VECTOR	RASTER
FORMED BY VARIOUS SHAPES	COMPRISED OF PIXELS
SCALABLE	LOSES QUALITY WHEN SCALED
CAN CONVERT TO RASTER	CAN'T CONVERT TO VECTOR
SVG, CGM, EPS, XML	BMP, JPG, GIF, PNG

- **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.



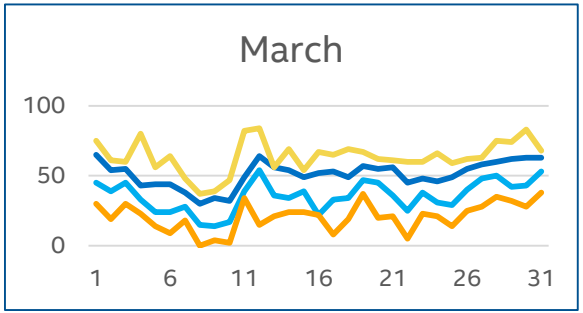
Raster (bitmap)

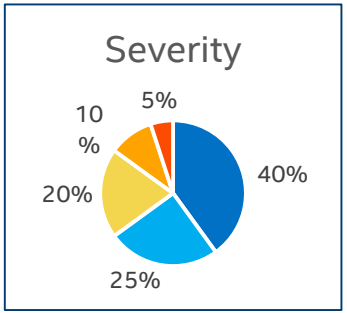
Source: https://vector-conversions.com/vectorizing/raster_vs_vector.html and https://www.corporate3design.com/blog/112/

The Basics: Visualization

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

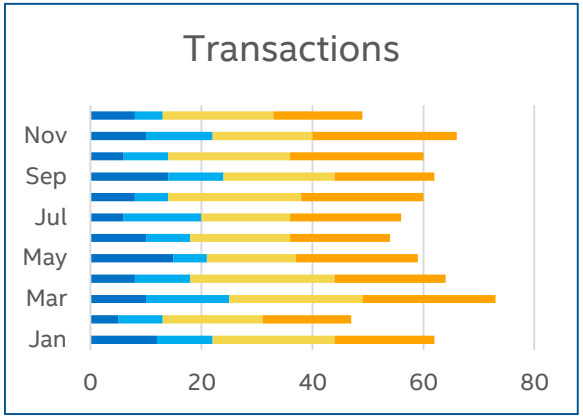
- **Data Visualization**
- **3D Visualization**

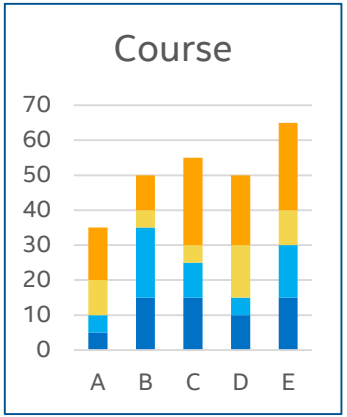




Data Visualization:

- Data visualization is the process of displaying data/information 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.





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

Performance

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

Interactive
5-10 frames/second
Scientific Visualization

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.

Jaguar F-type by Jeff Patton, www.jeffpatton.net.
Rendered with Corona Renderer using Intel's Embree Ray Tracing Kernels.

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.

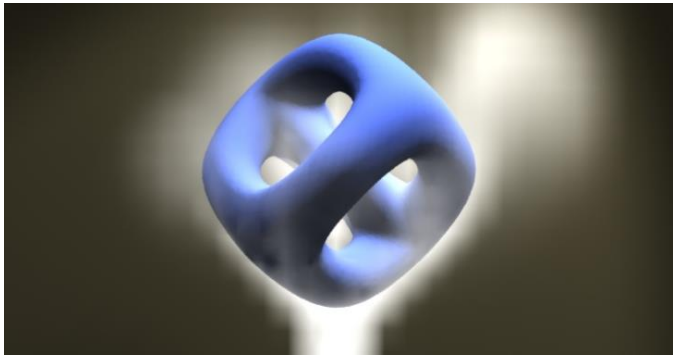
Luxurious Living Room by Eduard Caliman (www.eduardcaliman.com). Rendered with Corona Renderer.

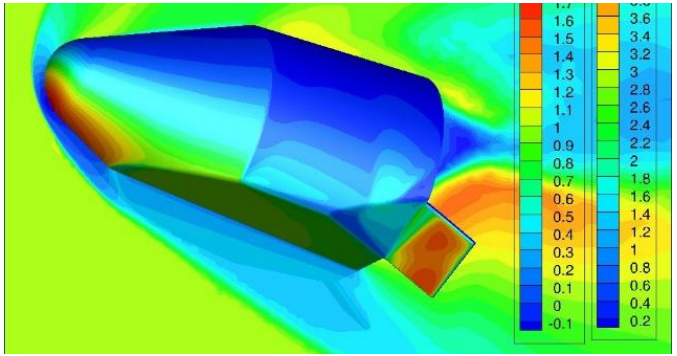
The striking difference between **real-time** and **offline rendering** lies in the speed at which the computation and finalization of images takes place. Speed vs quality. Think speed in real-time rendering and photorealistic quality in offline rendering. The goal would be to render images fast at the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

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*

*Other names and brands may be claimed as the property of others

Rendering in a Scientific and Engineering Workflow

Modeling and Structure Prep → Structure Changes and Alterations → Preparation of Simulation System → Simulation Run → Analyze and Visualize

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

Simulation

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

Post-processing includes Rendering

Rendering of simulations

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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

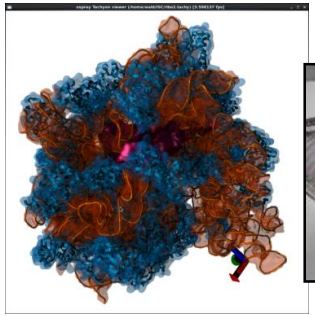
1. https://www.theverge.com/2014/8/29/6083309/ikea-product-images-are-now-75-percent-cg

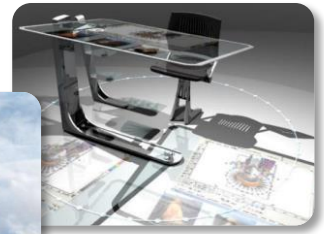
Supporting a Broad Range of Visualization Needs

One-on-Many

Many-on-One

Scientific Visualization | Professional Rendering | Video Transcode | Visual Understanding | Media & Gaming | Client & Productivity





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://newsroom.intel.com/news/intel-artificial-intelligence-helps-bring-the-meg-mega-shark-big-screen/#gs.75qfm8
- https://insidehpc.com/2018/10/cpu-based-photorealistic-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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Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more complete information visit www.intel.com/benchmarks.