

# Computer Graphics in Practice: **Beyond Games and VFX**

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# Overview

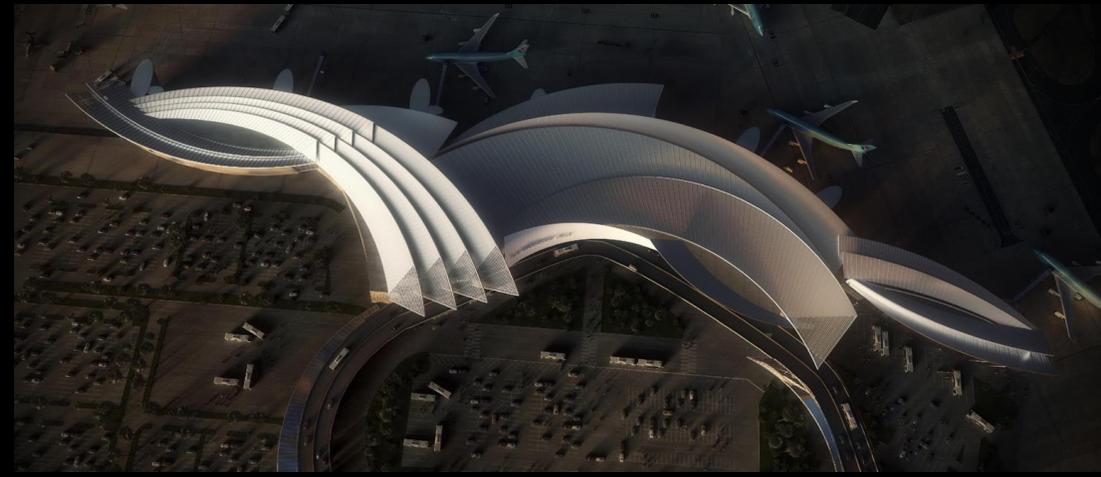
- VIZ exists
- It is important
- Rendering requirements for different industries
- Some thoughts on the future

# WE ARE CHAOS GROUP

We create powerful rendering and simulation technology to help you visualize anything imaginable.

- Global leader in computer graphics, over 20 years experience
- V-Ray is the industry standard for top design studios, architectural firms, advertising agencies, and visual effects companies
- 92 out of the top 100 architecture firms use V-Ray
- V-Ray portfolio includes V-Ray for 3ds Max, Maya, MODO, Nuke, Katana, Rhino, SketchUp and Revit, Corona
- Other products include VRscans, photoreal scanning technology and material library, Phoenix FD for fluid dynamics and PDPlayer
- Our R&D division is shaping the future of creative storytelling, virtual reality and digital design

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# Our mission

Solving hard problems so you don't have to

- Includes constantly looking into new technologies that may help our customers
- Also searching for hard problems that need solutions

# Computer graphics in practice

- When I mention computer graphics, students typically imagine
  - Games
  - Visual effects for film and TV
- These are the most famous applications of CG
  - They are great!
- However most of our users render visualization projects
  - Interior design
  - Arch Viz
  - Product Viz

# Why visualization is important?

- Architecture is important
  - You literally live your life in it
- Product design is important
  - You use those products every day

# Computer graphics products

- Many products, especially renderers, are specialized
  - Realtime renderers for games
  - Renderers for film VFX/TV work
  - Renderers for arch viz
  - Renderers for product viz
- The different applications have [slightly] different requirements
  - These requirements are very starting to converge somewhat

# V-Ray is unique because it is used in all areas

- V-Ray as a renderer, has been widely used in all areas of CG
  - And even in newer areas like training AI
- We've had the opportunity to observe the different requirements and attitudes of users in all CG areas
- Being based exclusively on raytracing is what made it all possible
  - Even for realtime - project **Lavina**

# DCCs and different integrations

- VFX-oriented DCCs
  - Maya, Houdini, Katana, 3ds Max
- ArchVIZ-oriented DCCs
  - SketchUp, 3ds Max, ArchiCAD
- Others
  - Cinema4D, Rhino, etc

# Rendering requirements

- Different industries have slightly different rendering requirements
- It is interesting to explore them in a bit more detail

# Data size

- Film renderers
  - Large amounts of geometry (often subdivided/displaced)
  - Large amounts of textures (usually tiled .tx files) - thousands of files
    - Generating large amounts of textures is very easy these days, even if it is not strictly necessary for the project
  - Data resides on a network location to be consumed by the render farm
    - Could be a large bottleneck
- ArchViz renderers
  - Relatively less textures
  - Varying file formats (JPG, PNG etc)
  - Data is often local on artists' workstation
- Proxies turned out to be particularly useful for both areas
  - A way for the renderer to directly load geometry bypassing the DCC

# Scene organization

- Film renderers
  - Tightly controlled pipeline, mostly split into different stages
  - Modeling, texturing, lighting, compositing are done by different people
  - The renderer must allow data to come in and out of the renderer
    - Support for common and standard file formats - Alembic, .tx, OpenEXR etc
  - Object properties, overrides, shader controls based on scene data is important
    - Often different versions of the same shot need to be rendered - for masks/holdouts, shadow extraction etc.
    - It is useful to be able to do those overrides without changing materials - f.e. through object properties
- ArchViz renderers
  - Scenes can be built from publicly available models
  - Varying model quality
  - Varying input texture file format and shaders
    - Materials specifically used to be a problem before because of material quality settings (sampling) embedded in materials instead of being handled automatically by the renderer
  - Not much need to move data in and out of the renderer, in fact staying in the renderer even for post

# Project duration

- Film renderers
  - Projects take a longer period of time, usually months
  - There is time to research how to solve specific problems or issues (usually, less so nowadays)
- ArchViz renderers
  - Projects usually have a relatively quick turnaround
  - There isn't a whole lot of time to spend on rendering itself

# Renderer output

- Film renderers
  - Sequences of frames (shots)
    - Lots of animated stuff going on in each shot - characters, explosions, vehicles, destruction etc
  - Many thousands of frames in a project
  - Render elements to separate various components of the scene for adjustment/compositing in post
    - World positions, extra textures etc.
  - Deep output support might be needed
  - Usually post-processing happens in a dedicated compositing application like Nuke or Fusion
- ArchViz renderers
  - Sometimes there are animations
    - Usually walk-throughs or other presentation formats, not a whole lot of moving things
    - Animations are increasingly moving over to realtime engines these days
  - Mostly the results are still images
    - Sometimes very large stills - distributed rendering is useful
  - Render elements to adjust scene in post
    - Usually masks
  - Post-processing happens either in the frame buffer, or in PhotoShop

# Additional tools

- A renderer is sometimes expected to provide additional tools
  - Scattering tools
  - Variation tools (texture randomization etc)
- Landscaping is a large part of ArchVIZ
  - Creating the natural environment around a building
  - Trees, grass, flowers

# Lighting

- Lighting in VFX
  - The goal is often to match the look of a given background plate as a reference
  - IBL is used all the time
  - More artistic control required in order to match a given background plate or to achieve a specific look
    - Separate control over diffuse and specular contributions, light linking, light filters/blockers
  - Artistic light units (f-stops and exposure)
- ArchVIZ requires more exact tools
  - There is no reference - the renderer must say what the scene looks like, without any references
  - Sun & Sky system for daylight scenes
  - IES lights and area lights with prescribed intensity
  - Physical light units (lumen, lux, candela etc)

# Global illumination

- GI in VFX
  - Was avoided for a long time due to restrictions of the tools
  - Only relatively recently VFX moved to raytracing exclusively
  - Usually one or two bounces are enough when you render a character against a plate
  - Tricks to suppress fireflies are allowed with less regard for physical accuracy
  - Brute force strategies work well
- ArchVIZ
  - ArchVIZ users were pioneers here
    - Starting with radiosity solutions for lighting analysis
    - Moving to raytraced GI in the beginning of the 21st century
  - Accurate light distribution is important - one or two bounces are not enough
  - Specialized algorithms must be used to handle large number of bounces efficiently
    - Light cache in V-Ray
    - UHD cache in Corona

# Materials

- Materials in VFX
  - Skin, hair materials are important
  - Programmable shaders might be important (OSL, shading SDK)
    - Could be a burden to the performance, or the development (keeping compatibility), but very helpful to customize the renderer
  - Artistic control might be important
  - Shading networks can be very complicated
    - Lots of blend materials, masks, color correction textures etc
  - Driving shaders through scene data or metadata is important
    - User attributes, bitmap file name tags etc.
- Materials in ArchVIZ
  - Physical accuracy is important
  - Materials for vegetation (foliage, grass), curtains etc
  - Prebuilt material libraries might be important
  - Programmable shading is not important
  - Procedural shading, variations might be important

# Some features are used differently

- Hair primitives
  - Used for characters in VFX - hair, facial hair, peach fuzz, animal fur
  - Used for carpets, rugs, blankets, grass in ArchViz
- 2D displacement
  - Used for skin and fine character detail in VFX
  - Used for stone and brick walls, roof tiles, pavement etc
- Frame buffer
  - Used for previewing the output and explore render elements om VFX
  - In ArchVIZ, also used as a post-processing tool, sometimes final post-processing is done there without post
  - Sometimes this leads to concept clashes like LUT files

# Renderer setup

- A bit more time is available in VFX for setting up a renderer
  - Different settings per shot might be required
  - There are multiple iterations over a shot that allow settings to be fine-tuned
  - Non-adaptive (fixed) sampling is acceptable, with manual control over every sample
    - Takes a while to find the right settings, but the time is amortized over hundreds of animation frames
- There is less time available in ArchVIZ
  - The renderer must be able to handle many different types of projects with minimal settings
  - Automatic/adaptive sampling is preferable, with only quality/max time specified as input

# Render farm resources

- In VFX, usually whole frames are distributed
  - Hundreds or thousands of machines
  - Render farm can spill to the cloud if needed
  - Occasionally DR is used for iterations during lighting
  - Software for render farm management is used
- In ArchVIZ, often a single frame is distributed
  - DR is often used for final results (stills)
  - A few machines only available, sometimes office workstations (no dedicated render farm)
  - Commercial render farm services handle the rest
  - Cloud is less used because of complicated setup
    - V-Ray Cloud aims to change that

# Workflows move between industries

- VFX workflows leaking into ArchVIZ
  - OpenEXR
  - Cryptomatte
  - LUTs and post-processing
  - Lots of research is done initially for VFX and then trickles down to ArchVIZ
    - Accurate BRDFs (f.e. GGX)
    - Volume rendering
    - Hair/fur shading
    - PBR-style materials
- And the other way round
  - Scattering tools for environments
  - Global illumination
  - Physical materials/lighting

# Real time rendering

- Real time rendering in VFX
  - Previz, playblasts
  - Occasionally for final frames or parts of final frames
    - Recently entire short films/TV series are rendered in real time engines
- Real time rendering in ArchVIZ
  - Walk-throughs
  - Space exploration/VR
  - Interactive experiences
- Real time engines
  - Game engines repurposed for specific workflows
    - Game-specific workflows might get in the way
  - Specialized real time engines for arch VIZ

# Virtual reality

- Doesn't work too well for entertainment
  - Difficult to keep the attention of the viewer at the right spot
  - Not very comfortable for longer viewing
- Very popular for ArchVIZ
  - Shows off a space much better
    - Still images - stereo panoramas
    - Walk-throughs
    - Interactive experiences

# Final thoughts

- Can one rendering solution cover everything?
  - VFX
  - ArchVIZ
  - Realtime

**Questions?**