DV15437 – Revit to 3ds Max Workflows for Realistic Rendering with NVIDIA Iray

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Class summary

Back by popular demand! Learn how to maximize productivity between designing in Revit software and rendering in 3ds Max software with NVIDIA's Iray rendering engine. Discover all the settings and tricks you can use to properly set up a Revit model to make the transition into 3ds Max software as effective as possible. Once in 3ds Max software, all the work done in Revit software will transfer over, enabling more time for rendering and less time spent worrying about the design. The simplicity, accuracy, and speed of Iray will help the user create believable-looking renderings in the same way that a photographer would photograph a physical space. In the end, users will gain the knowledge of how to set up a seamless pipeline between Revit software and 3ds Max software in order to help streamline the rendering process across any scale of a project. This session features 3ds Max and Revit Architecture.

Key learning objectives

At the end of this class, you will be able to:

- Effectively set up models in Revit for transfer to 3ds Max.
- Set up a direct link between Revit and 3ds Max.
- Manage lighting, cameras, and materials inside of 3ds Max.
- Render “Photo-Realistic” renderings with NVIDIA Iray.

Chapter 1: The Digital “Digital” Photographer

Playing Photographer

Images provided by NVIDIA

CG

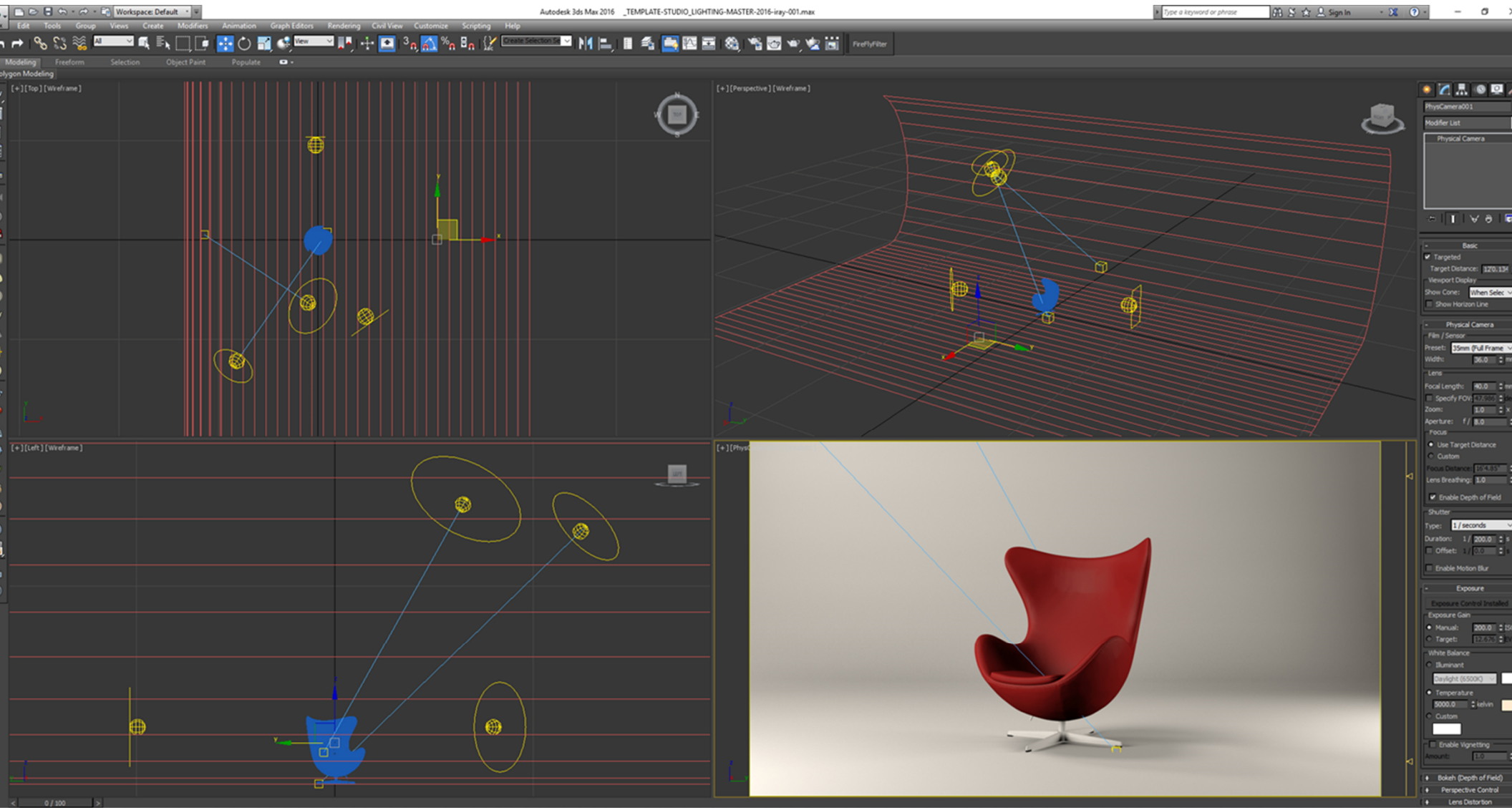
Photo

Images provided by NVIDIA

NVIDIA Iray Overview

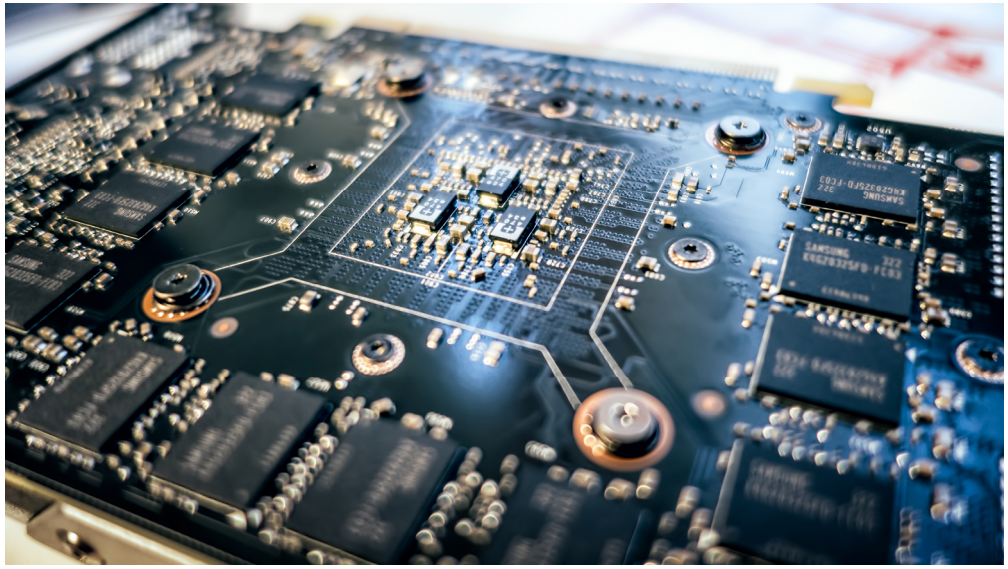
- **Photo-Real 3D Render with a strong parallel to Photography.**
- **Built for Designers**
  - It just works!
- **Progressive Rendering (Develops like a Polaroid)**
- **Physically based**
- **Unbiased**
- **Interactive**
- **Floating Point (32-bit)**
- **GPU rendering is extremely dependent on RAM.**
  - If you cannot load the entire scene on to the card, it will not render. Make sure you get the biggest card you can!
  - You are only as good as the weakest card in your system!


Gensler
DESIGN
EXCELLENCE
AWARDS


Autodesk 3ds Max 2016 _TEMPLATE-STUDIO_LIGHTING-MASTER-2016-iray-001.max
[+][Top][Wireframe]
[+][Perspective][Wireframe]
[+][Left][Wireframe]
[+][Physical]

GPU Recommendations

- **GTX 1070 ($)**
  - Entry Level
- **GTX 1080 ($$)**
  - Best Bang for the Buck
- **Titan X – Maxwell ($$)**
  - Super Fast
- **Titan X - Pascal ($$$)**
  - Stupid Fast
- **P5000 ($$$)**
  - Best Quadro for Price/Speed
- **P6000 ($$$$$)**
  - Top Card



GTX Vs Quadro

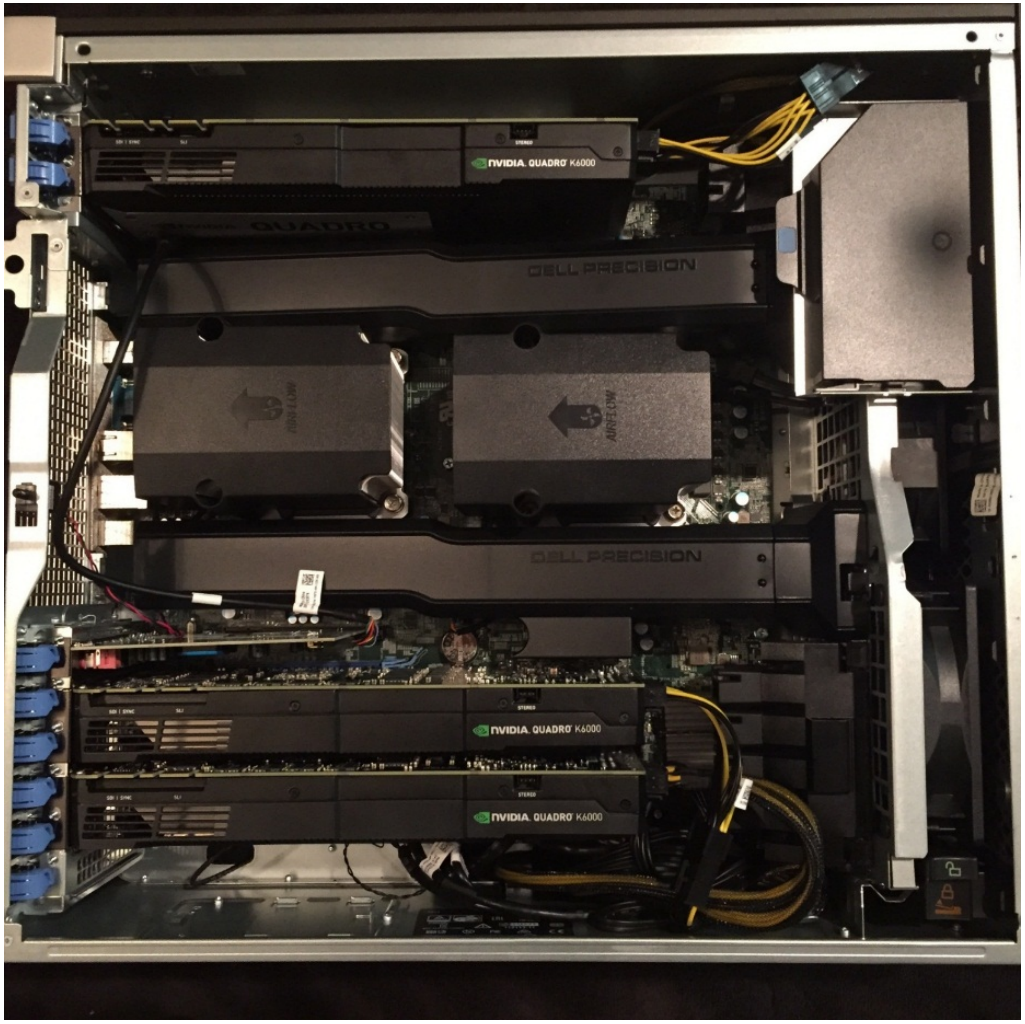
- **GTX**
  - Built for gaming
  - Run SUPER HOT
  - HIGH Power Consumption
  - Decent Viewport Performance
  - Cheaper than Quadro

- **Quadro**
  - Built for CAD Applications
  - More Energy Efficient
  - Excels Viewport Performance
  - More dependable than GTX
  - Lots of RAM
    - P6000 @ 24GB
  - NVLink

GPU Configurations

- **It is recommended to have at least 2 GPUs for interactive rendering.**
  - Interactivity will need one GPU set for Windows only.
  - Do **NOT** put GPUs in SLI Mode for rendering.

- **Optimal Configuration:**
  - GPU 0 – Windows (Titan X, P4000, P5000, P6000)
  - GPU 1 – Rendering (Titan X, P5000, P6000)
  - GPU 2 – Rendering (Titan X, P5000, P6000)


NVIDIA QUADRO K6000
QUADRO
DELL PRECISION
AIRFLOW
DELL PRECISION
NVIDIA QUADRO K6000
NVIDIA QUADRO K6000

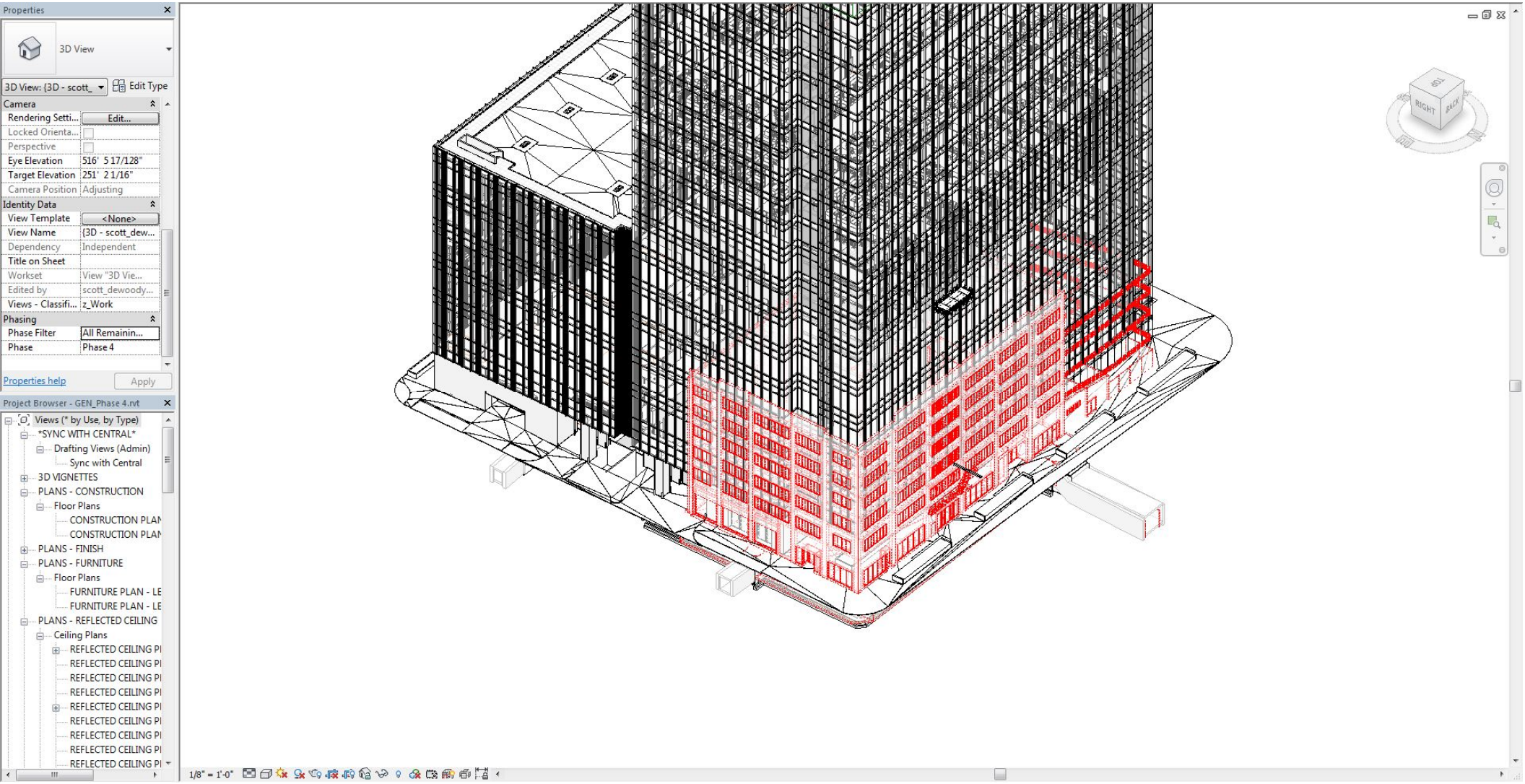
Chapter 2: Revit Setup

View Setup

- **View Classifications:**
  - **Visualization – Scene (Simple Workflow)**
    - This view is one export, and is best for speed. It can be ideal for those who want to do as little work in 3ds Max as possible.
  - **Visualization – Export (Advanced Workflow) (Recommended)**
    - A little more complex, but offers the most flexibility with the model. Ideal for those who want to work more in 3ds Max, but those who want to work in Revit more can still benefit from this workflow.
- **Hide objects not seen for rendering for optimization:**
  - Views will only export what is visible.
  - Not everything will be needed. This will be up to the user and what is being render.
  - Reducing information that is not needed, will help optimize RAM and file size.

View Setup

- **Watch for the “Phase Filter” in the View Properties under the Phasing section.**
  - Exporting a 3D-View with the “Phase Filter” enabled will result in all the objects that are included in the filter to have a material override applied to them. This means when using this workflow, these objects will all be combined in to one massive object.
  - It is recommended to export the phased options in their own FBX files if they are required for rendering. This will give full control over their materials as well.
  - Phases will need to align with the view you are looking to render. If geometry overlaps on top of each other, this will cause rendering issues and will not look correct. The pieces need to fit like a puzzle, which is how the rest of this workflow works.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Floor Plans
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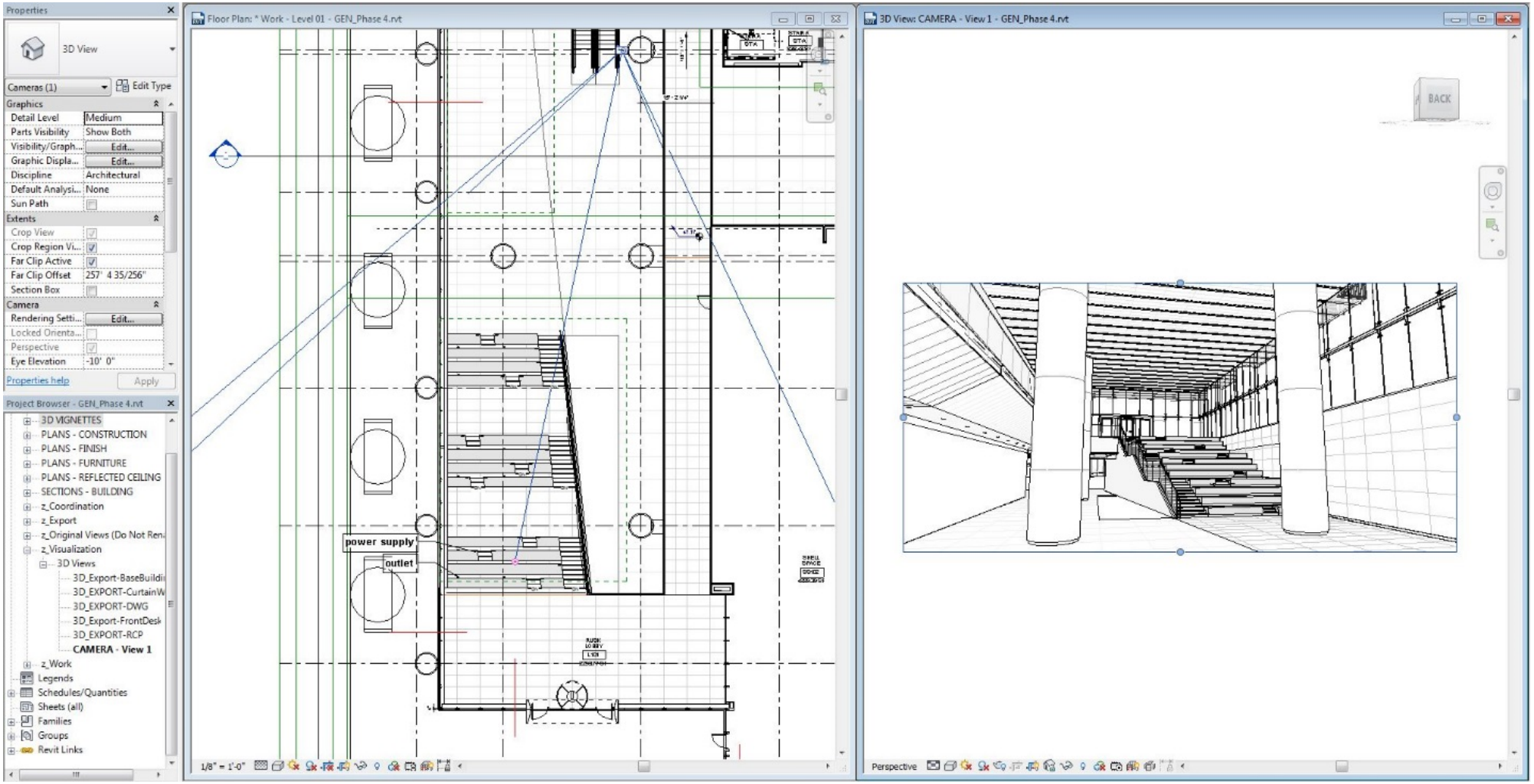
BACK
1/8" = 1'-0"

Visualization – Scene (Simple Workflow)

- **View Setup:**
  - Place a Camera for the view you want to render.
  - Make sure lights are visible and turned on.
  - Make sure elements that are not needed are hidden.
    - Use a section box or disable categories in Visibility Graphics.
  - Make a duplicate of the same view, and hide everything but Railings and any additional curved objects.
    - Do this only if the scene has extensive amounts of railings and curved objects.
    - Must export the
    - This view is one export, and is best for speed. It can be ideal for those who want to do as little work in 3ds Max as possible.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PLANS - FINISH
PLANS - FURNITURE
PLANS - REFLECTED CEILING
SECTIONS - BUILDING
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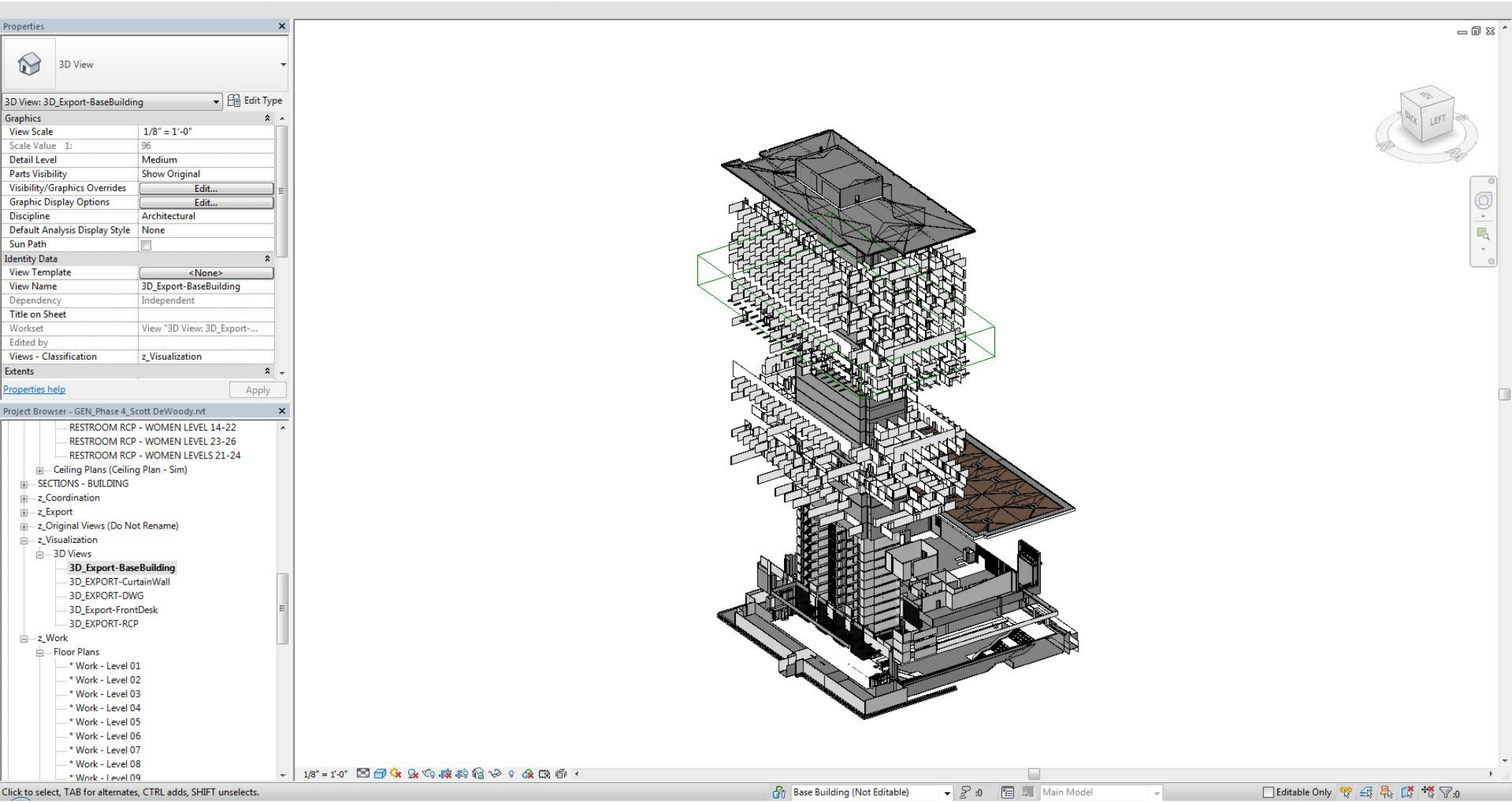
3D_EXPORT-CurtainW
3D_EXPORT-DWG
3D_Export-FrontDesk
3D_EXPORT-RCP
CAMERA - View 1
z_Work
Legends
Schedules/Quantities
Sheets (all)
Families
Groups
Revit Links
Floor Plan: * Work - Level 01 - GEN_Phase 4.rvt
power supply
outlet
1/8" = 1'-0"
3D View: CAMERA - View 1 - GEN_Phase 4.rvt
BACK
Perspective

Visualization Export (Advanced Workflow):

- **View Setup:**
  - **Multiple** Views for Export
    - **RVT/FBX:** Base Building, Interiors, Core, etc
    - **RVT/FBX:** Curtain Wall and Mullions (Must Filter Out Walls)
    - **RVT/FBX:** Furniture
    - **RVT/FBX:** RCP + Lighting Fixtures
    - **DWG:** Railings and other curved objects
    - **RVT/FBX:** Site and Entourage
  - **Make sure unneeded elements are hidden in all views.**
  - **Make sure elements are not visible in more than one view.**
    - Use a section box, or disable categories in Visibility Graphics.

Why do the Advanced Workflow over Simple?

- **File Organization:**
  - Able to “archive” exported versions of your project.
  - Able to organize large projects inside of 3ds Max easier.
- **Protect against File Corruption**
  - By splitting exports you can reduce losing all your work when 3ds Max decides it doesn’t want to work on a Saturday.
- **Multiple people working on the project at once.**
  - This can be done by loading the multiple exports into their own 3ds Max files, and Xref them into a “Master” 3ds Max file. This is explained later in the document.
- **Best way for 3ds Max to handle large scale projects.**
  - 3ds Max can handle millions of polygons, just not millions of objects. The multiple exports help consolidate the model.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Scale Value 1: 96
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RESTROOM RCP - WOMEN LEVEL 23-26
RESTROOM RCP - WOMEN LEVELS 21-24
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3D_EXPORT-DWG
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1/8" = 1'-0"
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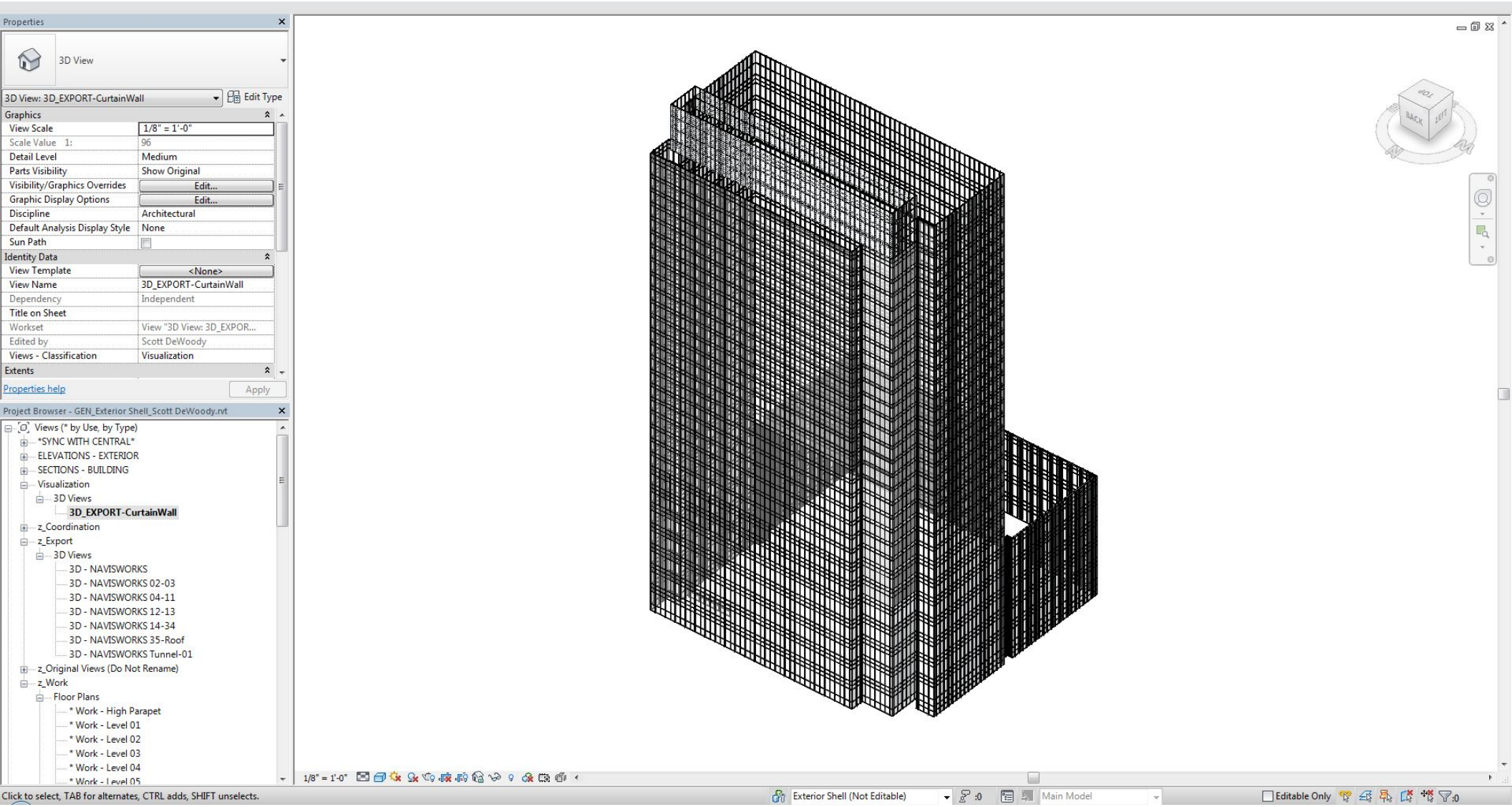
Base Building (Not Editable)
Main Model
Editable Only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Exterior Shell (Not Editable)
Main Model
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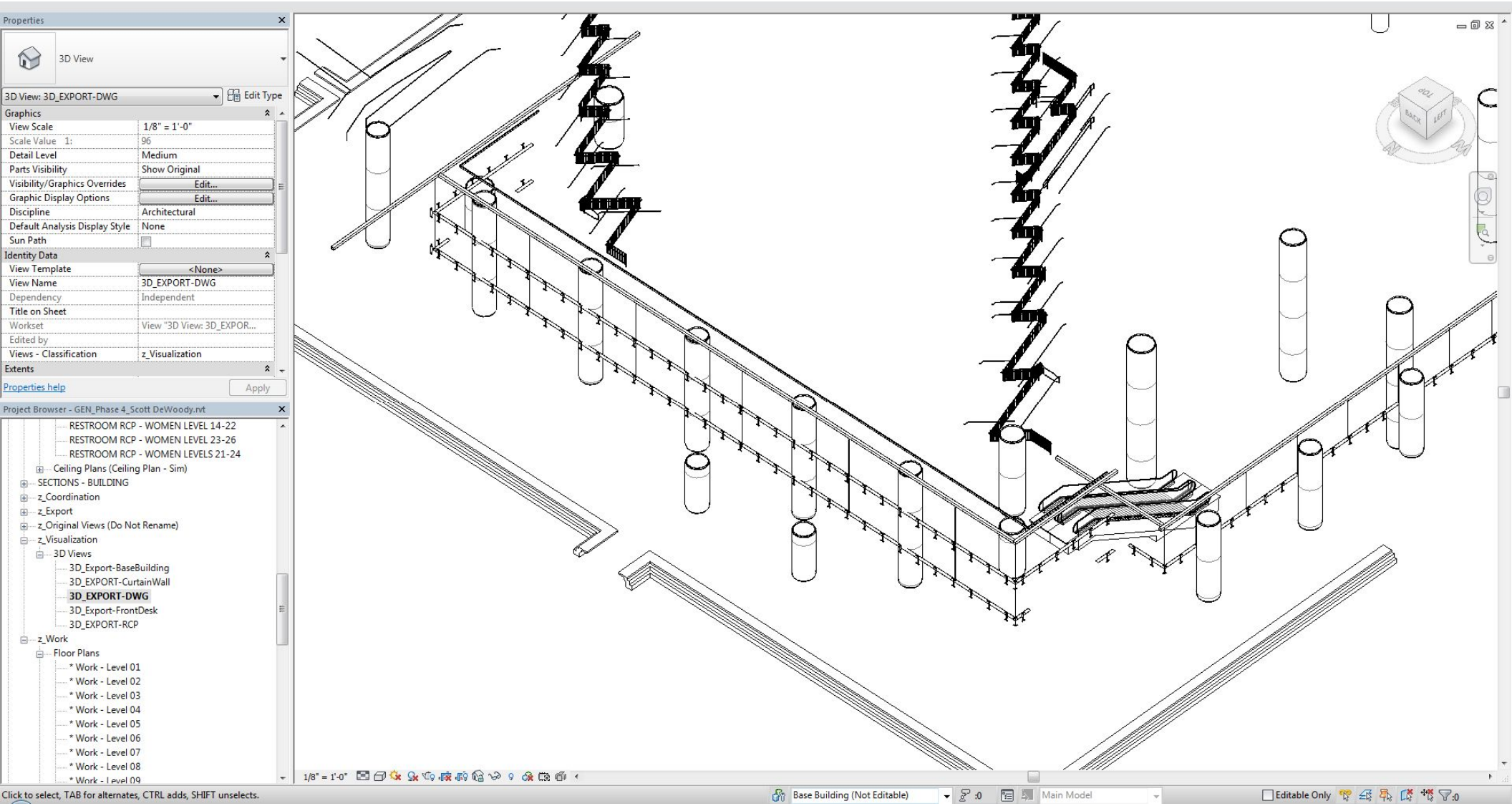
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Ceiling Plans (Ceiling Plan - Sim)
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Base Building (Not Editable)
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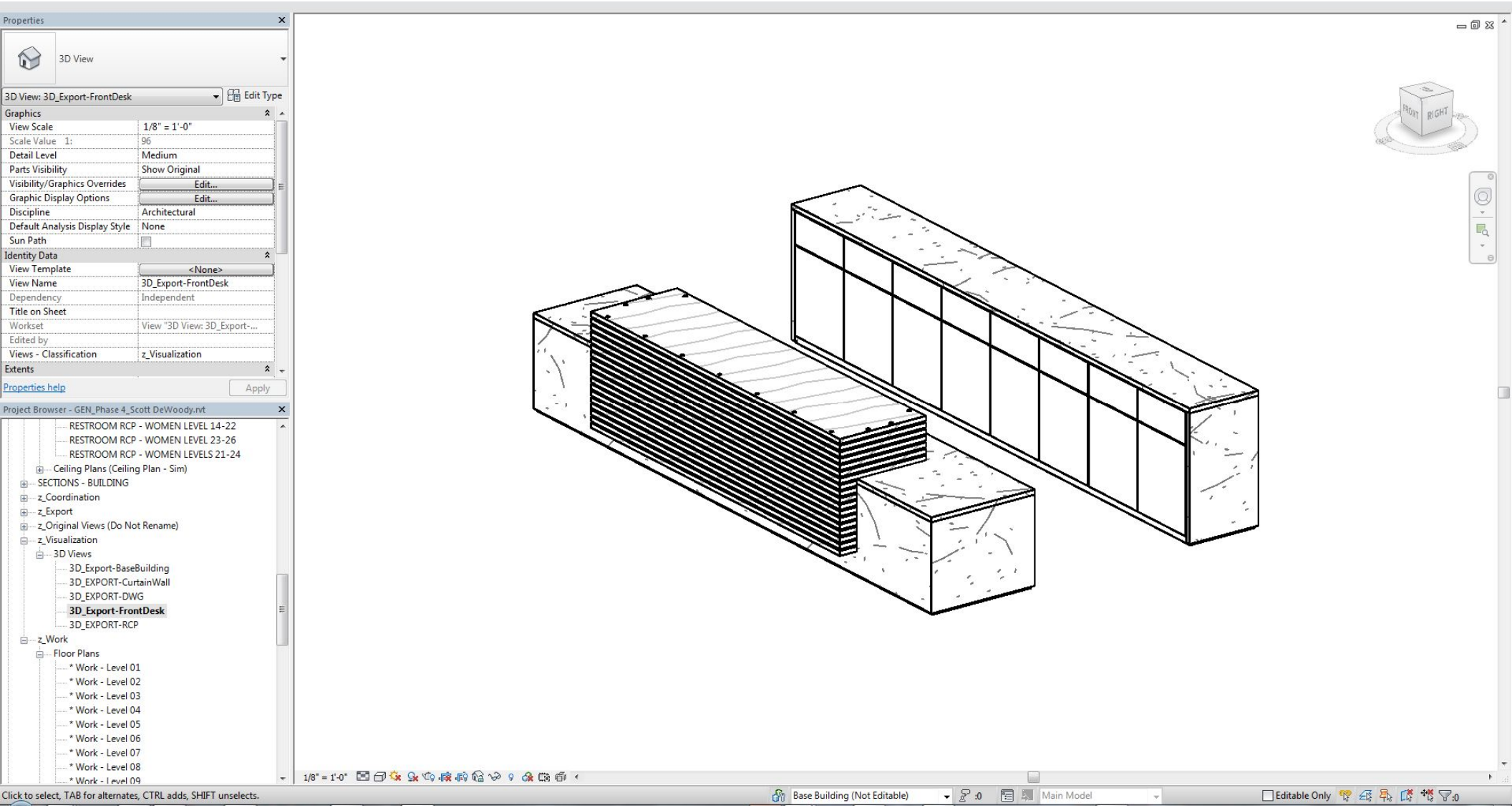
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RESTROOM RCP - WOMEN LEVELS 21-24
Ceiling Plans (Ceiling Plan - Sim)
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Base Building (Not Editable)
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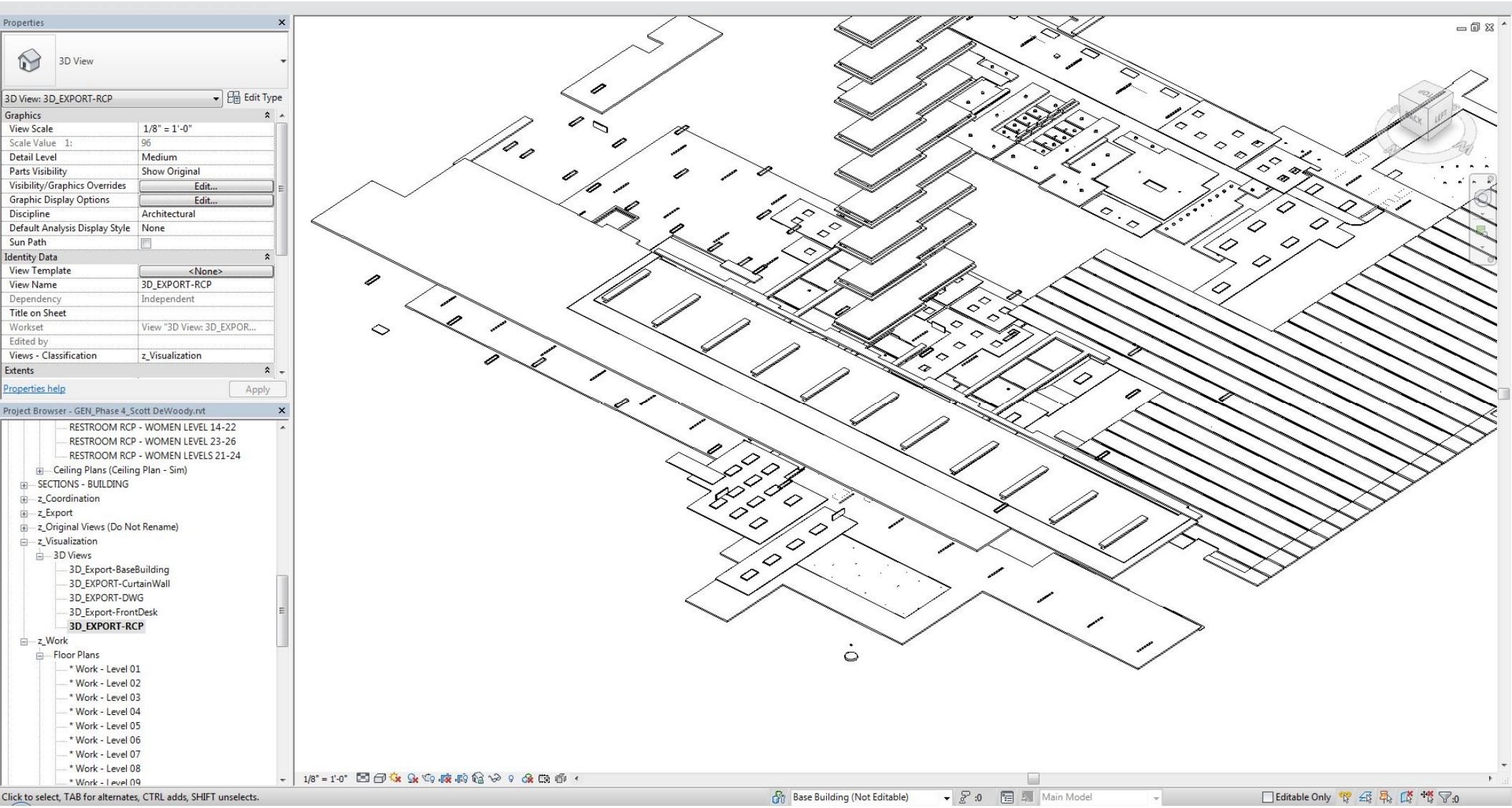
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Ceiling Plans (Ceiling Plan - Sim)
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1/8" = 1'-0"
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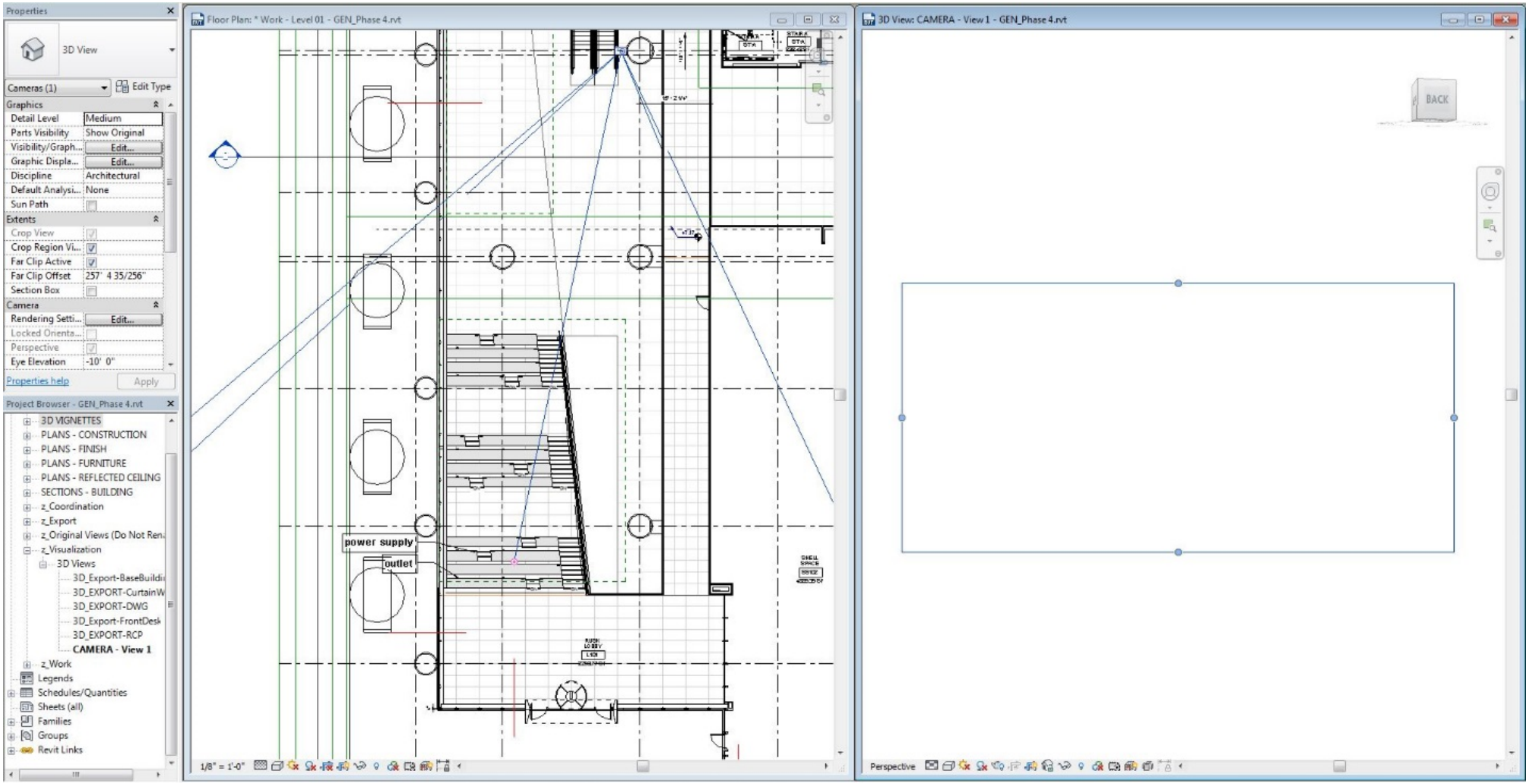
Base Building (Not Editable)
Main Model
Editable Only

Cameras (2015 and below + FBX Workflow)

- **Set a View for each desired camera to bring into 3ds Max.**
  - If using the Simple Workflow, only one view should have everything visible that is needed to be rendered in 3ds Max.
- **All Camera views should have everything hidden.**
  - Do this by disabling everything in Visibility Graphics (VG).
- **Each View is then exported via FBX.**
  - Create a naming convention for the view, and name the FBX the same.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3D VIGNETTES
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SECTIONS - BUILDING
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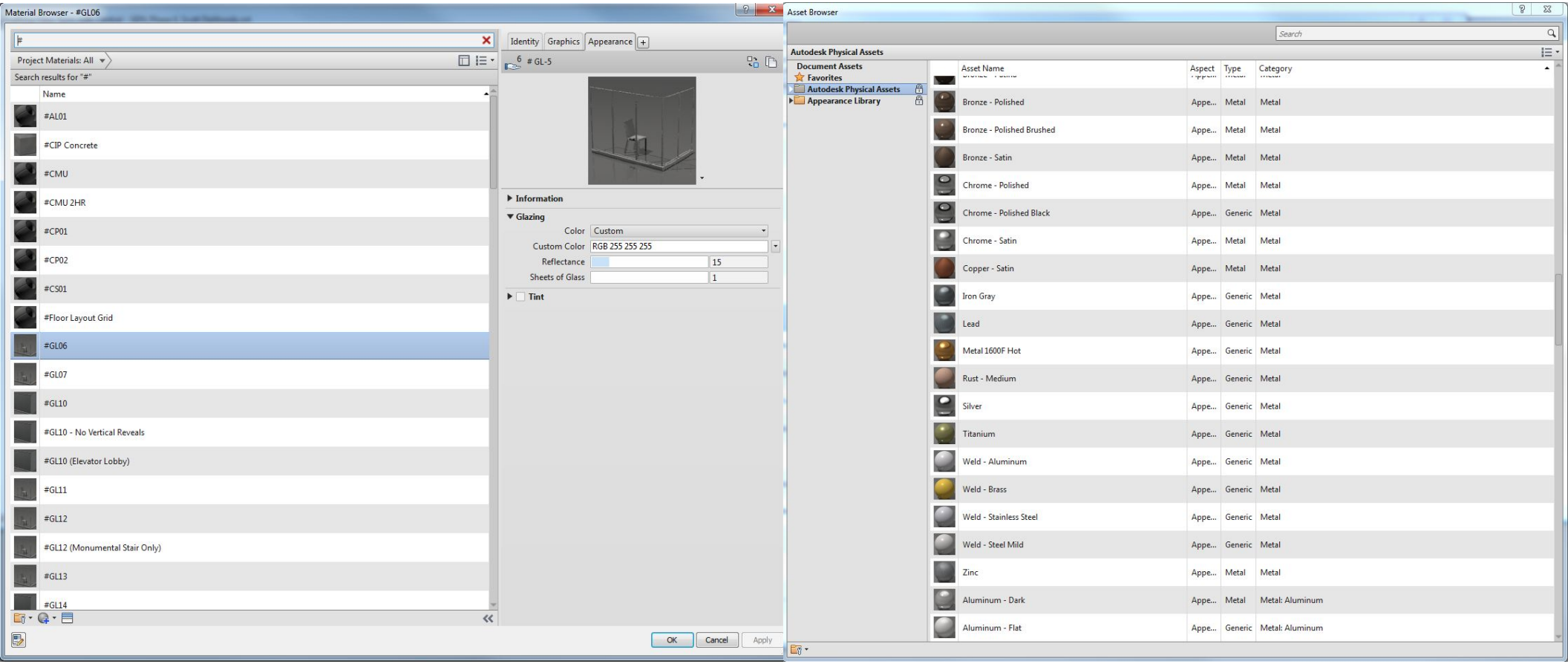
Groups
Revit Links
Floor Plan: * Work - Level 01 - GEN_Phase 4.rvt
power supply
outlet
1/8" = 1'-0"
3D View: CAMERA - View 1 - GEN_Phase 4.rvt
BACK
Perspective

Cameras (Revit Link Workflow 2016+)

- **Linking any view into Revit will bring in every camera placed in the Revit file regardless of the view linked.**
- **It is best to create two presets, one with cameras enabled, and the second with cameras disabled.**
- **More on this in a few slides!**

Materials

- **Name your materials!**
  - Consider using a naming convention for all your materials for optimal organization. Try following the drawing codes that the project specifies for materials. This helps greatly when coordinating with other designers on the project. If the code does not work, try something along the lines of: [MATERIAL TYPE]-[SUB-TYPE]-[DESCRIPTION]
  - Just use something that works best for the project, and then stick with it. It can be very painful to change this later.
- **Make sure all objects have materials.**
  - Review imported families from 3rd parties. They can sometimes not have any materials applied, or their own names.
  - Objects without materials can cause rendering artifacts in the render process.
  - All objects without materials will receive a material called Generic inside of 3ds Max.
- **Set material properties in Revit.**
  - Use materials from the Autodesk Physical Asset library as a good place to start!
  - Only needed if you want to edit materials in Revit instead of doing it inside of 3ds Max.
  - Add more detail to materials by adding reflection and bump maps.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Project Materials: All
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#CMU
#CMU 2HR
#CP01
#CP02
#CS01
#Floor Layout Grid
#GL06
#GL07
#GL10
#GL10 - No Vertical Reveals
#GL10 (Elevator Lobby)
#GL11
#GL12
#GL12 (Monumental Stair Only)
#GL13
#GL14
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Graphics
Appearance
GL-5
Information
Glazing
Color
Custom
Custom Color
RGB 255 255 255
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1
Tint
OK
Cancel
Apply
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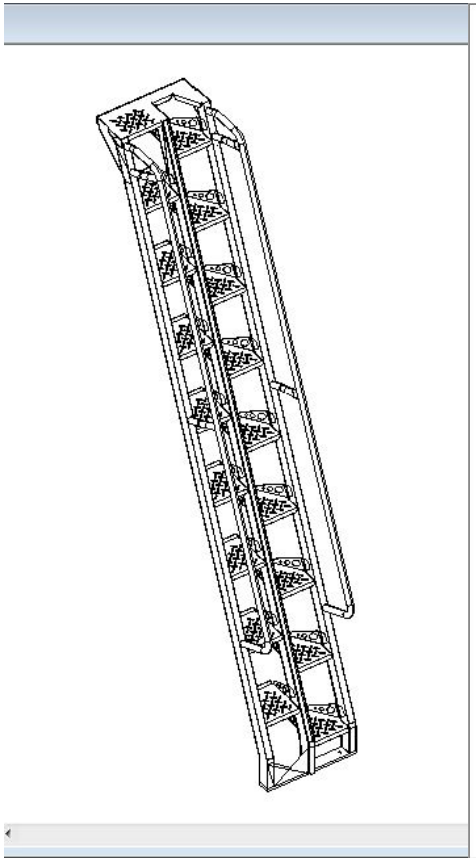
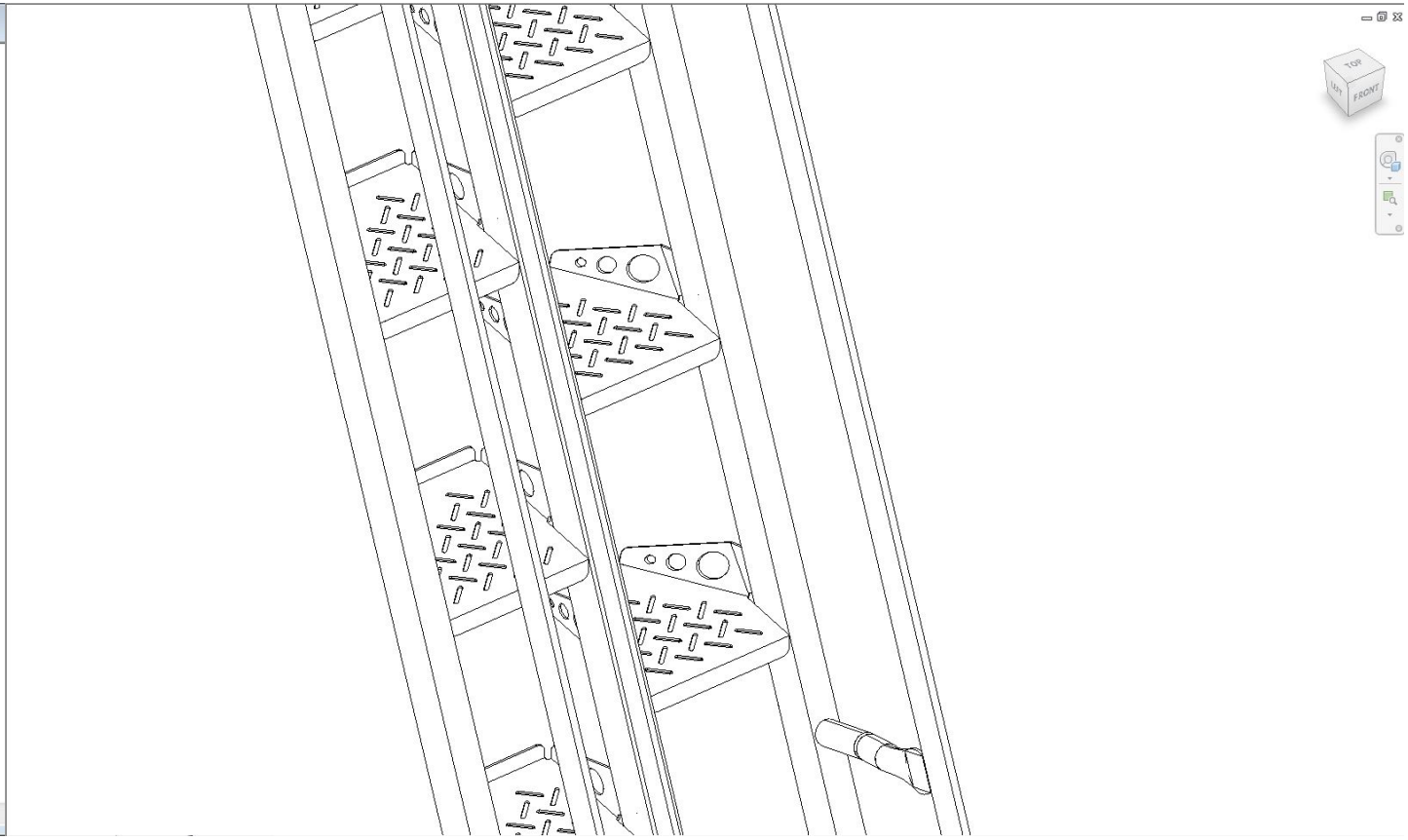
Search
Autodesk Physical Assets
Document Assets
Favorites
Autodesk Physical Assets
Appearance Library
Asset Name
Aspect
Type
Category
Bronze - Polished
Bronze - Polished Brushed
Bronze - Satin
Chrome - Polished
Chrome - Polished Black
Chrome - Satin
Copper - Satin
Iron Gray
Lead
Metal 1600F Hot
Rust - Medium
Silver
Titanium
Weld - Aluminum
Weld - Brass
Weld - Stainless Steel
Weld - Steel Mild
Zinc
Aluminum - Dark
Aluminum - Flat

Families

- **System Families**
  - Make sure floors, walls, ceilings, are all properly aligned. This will help close any gaps in the model that could introduce light leaks.
    - This includes modeling areas around dropped ceilings and soffits.
  - Be careful of overlapping surfaces. Geometry that is right on top of each other will creating rendering artifacts. Hiding one of the elements from view will eliminate this.
    - This issue is seen a lot with structure slabs and floors, and in some situations certain wall elements.
- **Make sure Families are optimized for Revit**
  - Poorly created families can have bad performance in Revit, and crash 3ds Max during Iray rendering.
- **Keep track of families with lots of curves**
  - Curved objects need to be exported via DWG.
  - This only applies to curved objects that are created natively in Revit.
- **Name Families for organization**
  - Use a naming convention that works for you.
  - Add and Remove any meta-data in the families that you need.

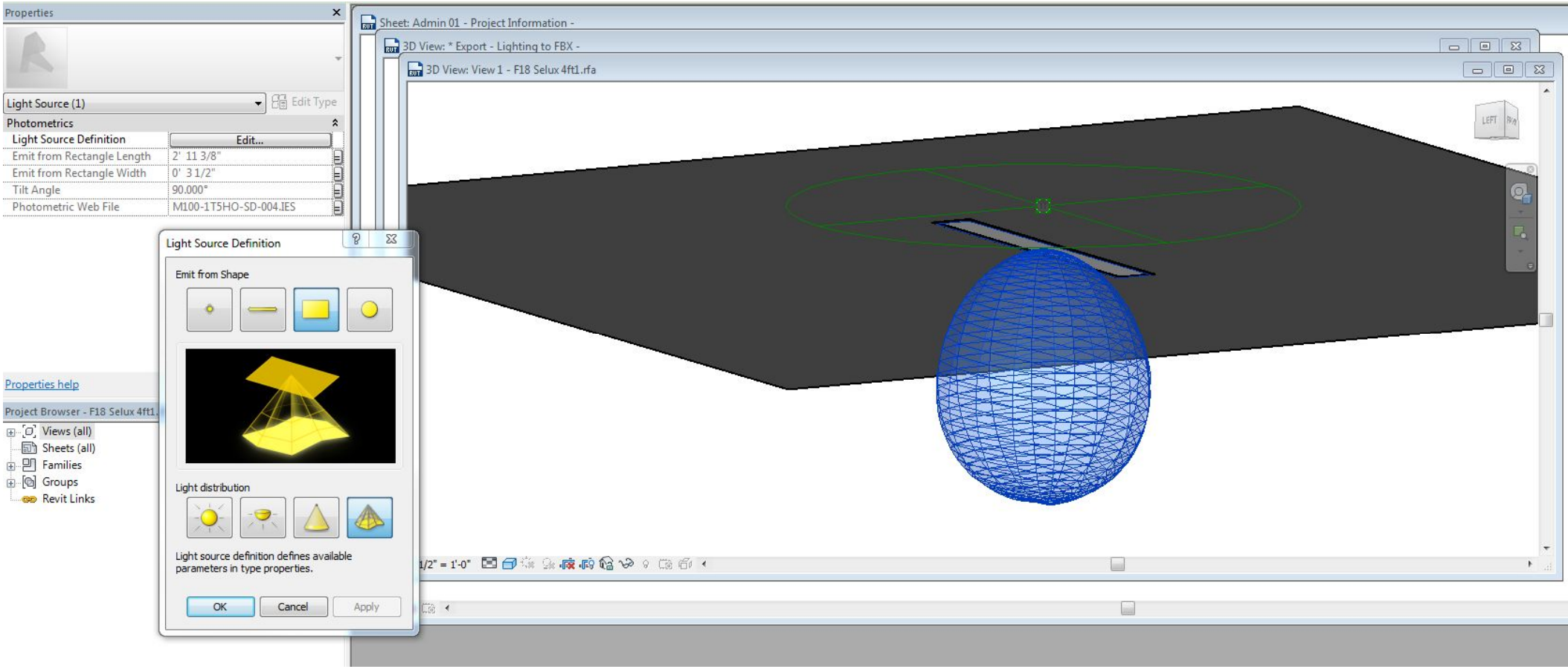
Poorly Created Family Example





Lighting Fixtures

- Add Lighting Objects to Lighting Fixture Families.
  - Make sure not to place Lighting Objects inside of the family. Place them just slightly below the light.
- Add IES files to the Lighting Objects.
  - This will mimic real-world fixtures, and will add a higher level of realism to your renderings.
  - Make sure to set a proper lumens value to the light, if no IES file is available.
- Use a naming convention to organize lights.
  - Add/Remove any meta-data that you might need.


Properties
Light Source (1)
Edit Type
Photometrics
Light Source Definition
Edit...
Emit from Rectangle Length
2' 11 3/8"
Emit from Rectangle Width
0' 3 1/2"
Tilt Angle
90.000°
Photometric Web File
M100-1T5HO-SD-004.IES
Properties help
Project Browser - F18 Selux 4ft1...
Views (all)
Sheets (all)
Families
Groups
Revit Links
Light Source Definition
Emit from Shape
Light distribution
Light source definition defines available parameters in type properties.
OK
Cancel
Apply
Sheet: Admin 01 - Project Information -
3D View: * Export - Lighting to FBX -
3D View: View 1 - F18 Selux 4ft1.rfa
LEFT
1/2" = 1'-0"

Chapter 3: Export and Link to 3ds Max

File Link Benefits

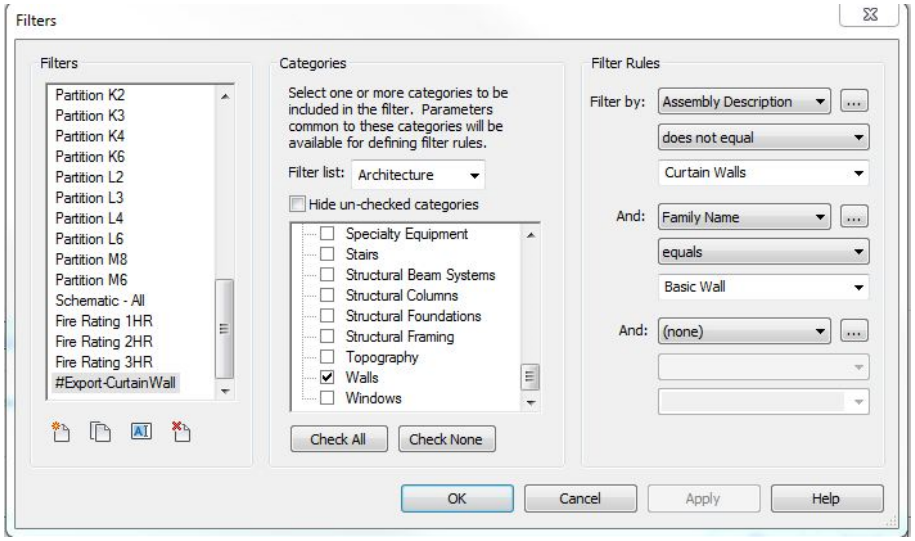
- **All changes done in Revit update to 3ds Max**
  - Super-fast and easy! Just save your files and hit “reload”!
  - Editing geometry in 3ds Max is not advised with linked objects
    - This can cause issues when updating the link
- **Materials can be edited in either Revit or 3ds Max**
  - ***Note*: You can only edit materials in either Revit or 3ds Max**
  - 3ds Max has more advanced Materials for better realistic looking results.
- **People working in Revit and in 3ds Max can work together almost seamlessly.**
  - Communication between team members is the key!

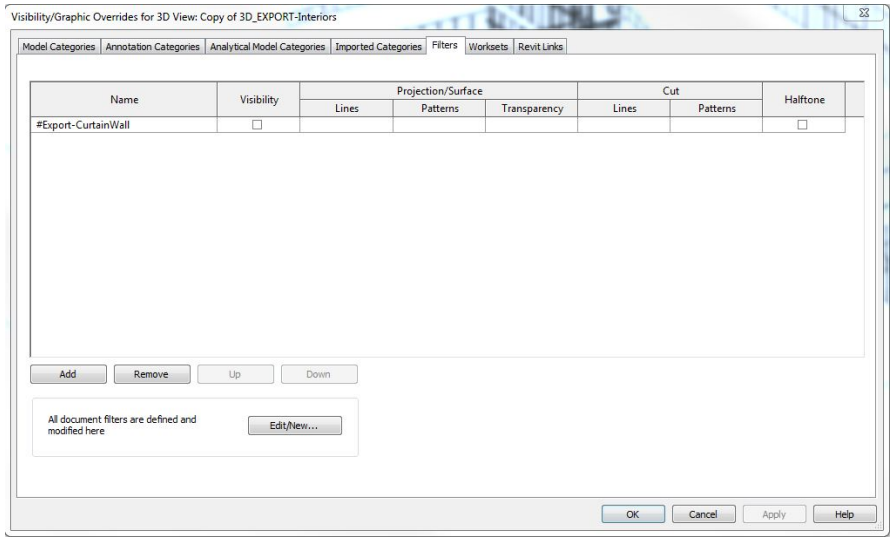
Export File Formats

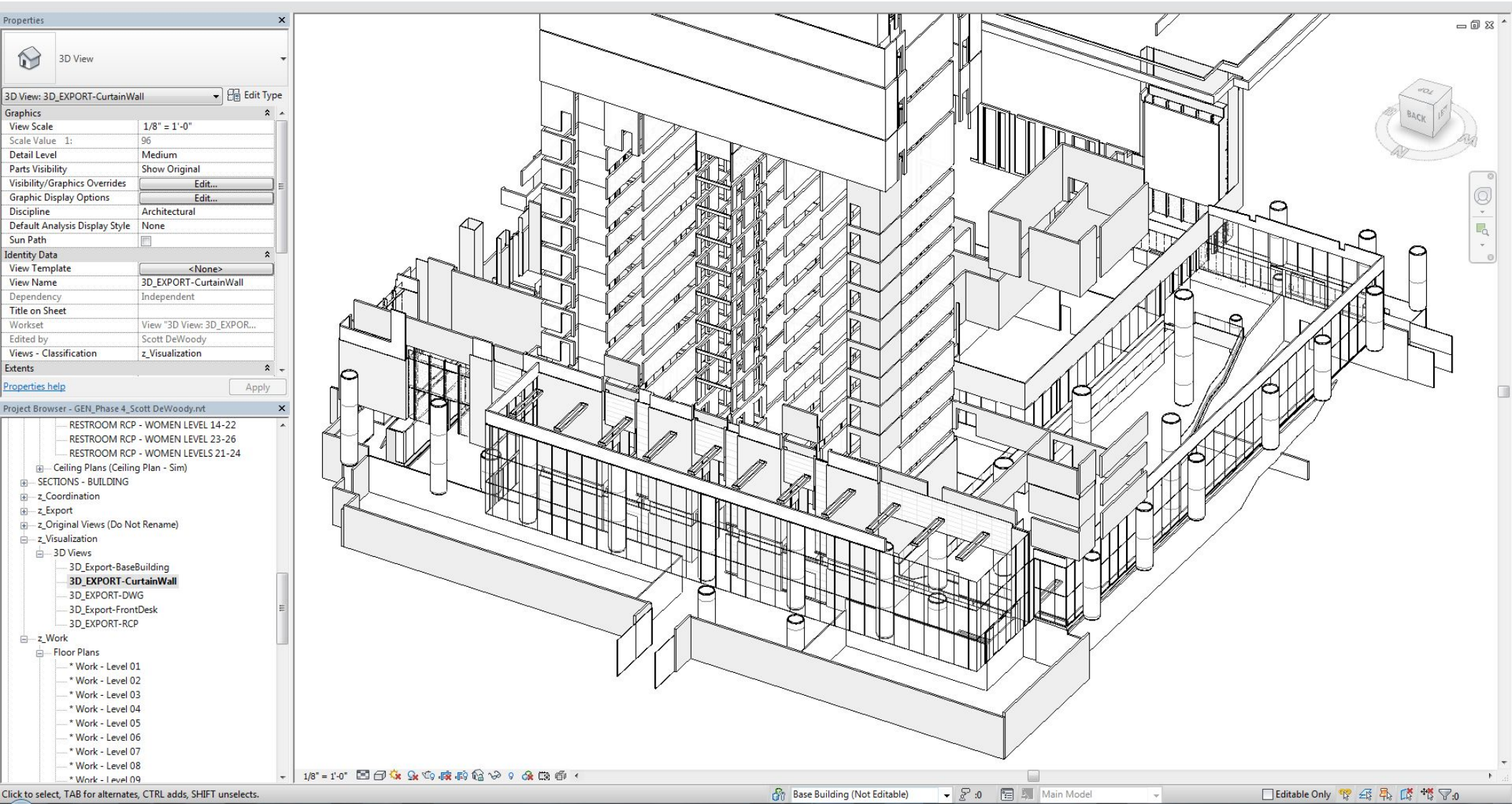
- Export as FBX
  - Base Building/Interiors
  - Curtain Wall and Mullions
  - RCP
  - Lighting Fixtures
  - Furniture
  - Site and Entourage
- Export as DWG:
  - Railings
  - Anything with curved surfaces.
    - Example: Cylindrical Columns, Louvers, etc.
    - Objects created outside of Revit will retain their topology.

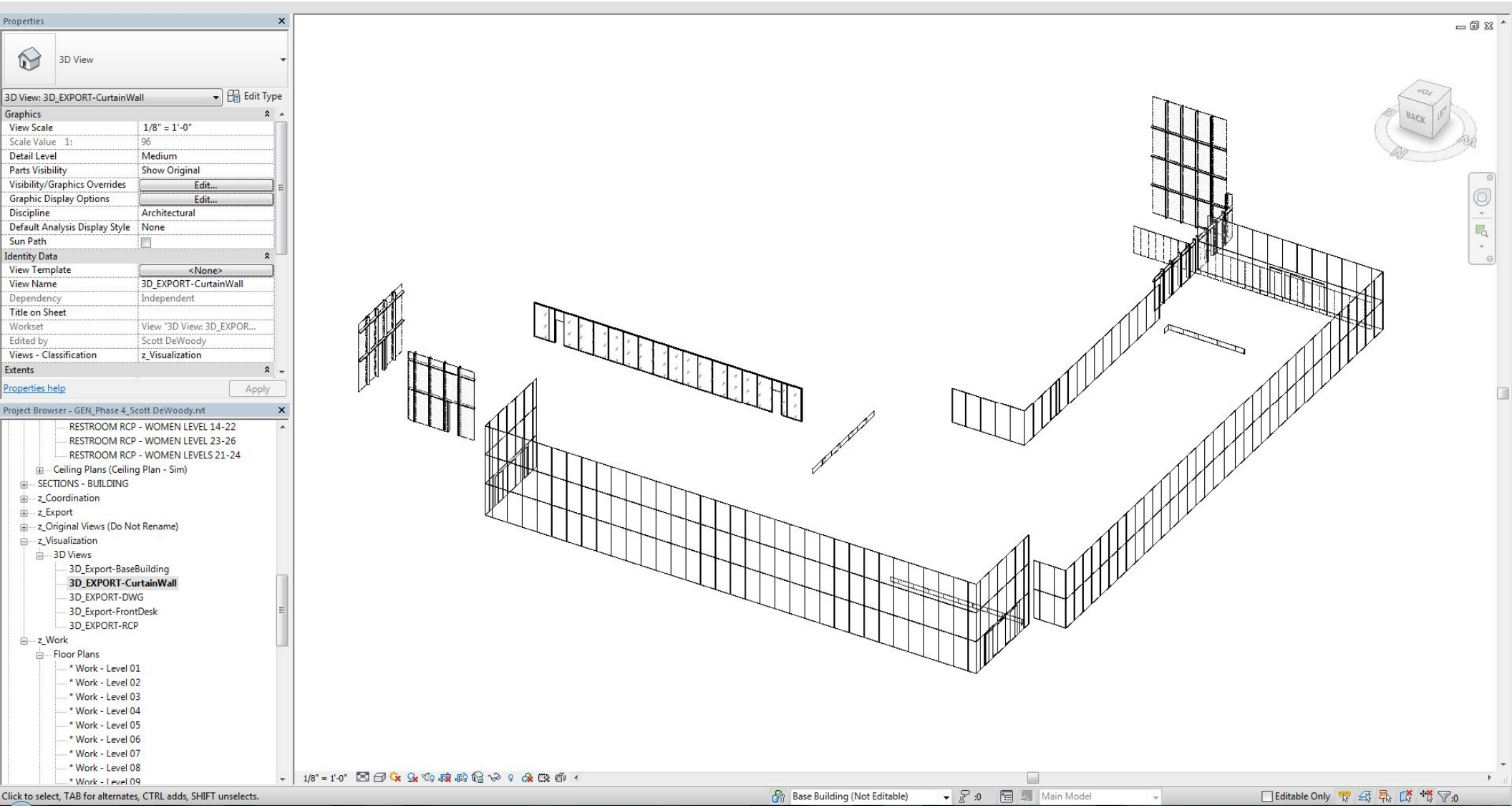
Filter Curtain Wall and Mullions Only

- You need to use a filter to only see Curtain Walls and Mullions in their own view.
  - This is applied in the Visibility Graphics Settings under “Filter”.
    - You do not need to do this in Revit 2013 and below.



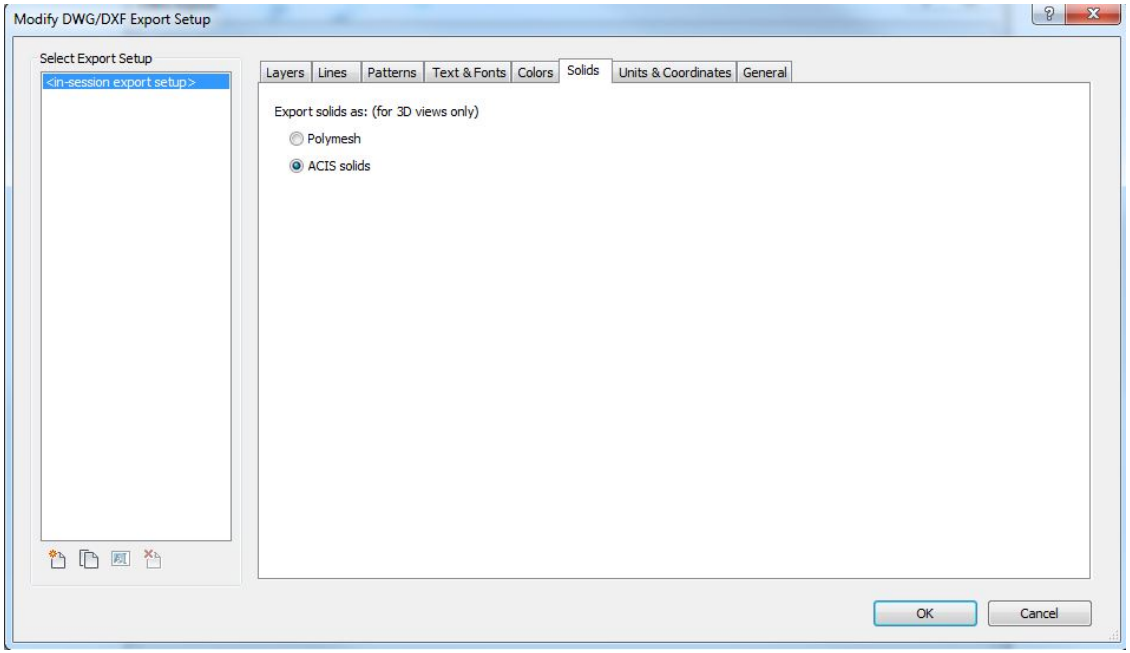



Properties
3D View
3D View: 3D_EXPORT-CurtainWall
Edit Type
Graphics
View Scale 1/8" = 1'-0"
Scale Value 1: 96
Detail Level Medium
Parts Visibility Show Original
Visibility/Graphics Overrides Edit...
Graphic Display Options Edit...
Discipline Architectural
Default Analysis Display Style None
Sun Path
Identity Data
View Template <None>
View Name 3D_EXPORT-CurtainWall
Dependency Independent
Title on Sheet
Workset View "3D View: 3D_EXPOR...
Edited by Scott DeWoody
Views - Classification z_Visualization
Extents
Properties help
Apply
Project Browser - GEN_Phase 4_Scott DeWoody.rvt
RESTROOM RCP - WOMEN LEVEL 14-22
RESTROOM RCP - WOMEN LEVEL 23-26
RESTROOM RCP - WOMEN LEVELS 21-24
Ceiling Plans (Ceiling Plan - Sim)
SECTIONS - BUILDING
z_Coordination
z_Export
z_Original Views (Do Not Rename)
z_Visualization
3D Views
3D_Export-BaseBuilding
3D_EXPORT-CurtainWall
3D_EXPORT-DWG
3D_Export-FrontDesk
3D_EXPORT-RCP
z_Work
Floor Plans
* Work - Level 01
* Work - Level 02
* Work - Level 03
* Work - Level 04
* Work - Level 05
* Work - Level 06
* Work - Level 07
* Work - Level 08
* Work - Level 09
BACK
1/8" = 1'-0"
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.
Base Building (Not Editable)
Main Model
Editable Only

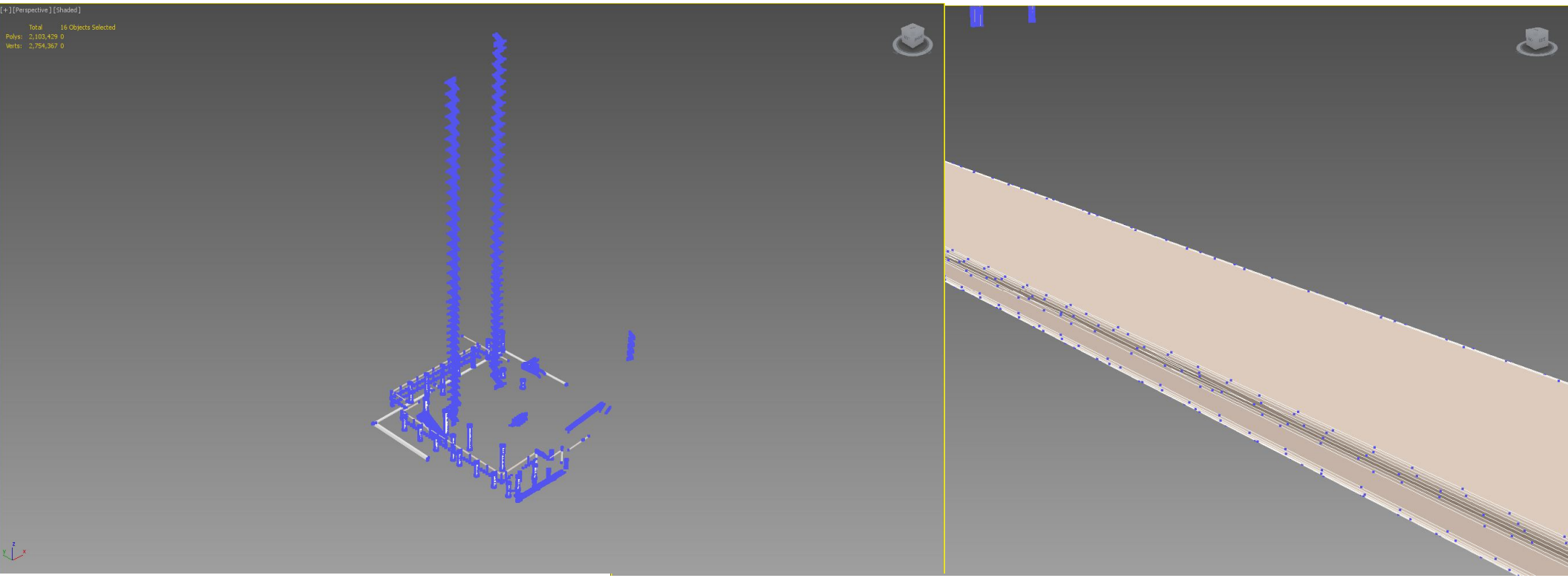

Properties
3D View
3D View: 3D_EXPORT-CurtainWall
Edit Type
Graphics
View Scale 1/8" = 1'-0"
Scale Value 1: 96
Detail Level Medium
Parts Visibility Show Original
Visibility/Graphics Overrides Edit...
Graphic Display Options Edit...
Discipline Architectural
Default Analysis Display Style None
Sun Path
Identity Data
View Template <None>
View Name 3D_EXPORT-CurtainWall
Dependency Independent
Title on Sheet
Workset View "3D View: 3D_EXPOR...
Edited by Scott DeWoody
Views - Classification z_Visualization
Extents
Properties help
Apply
Project Browser - GEN_Phase 4_Scott DeWoody.rvt
RESTROOM RCP - WOMEN LEVEL 14-22
RESTROOM RCP - WOMEN LEVEL 23-26
RESTROOM RCP - WOMEN LEVELS 21-24
Ceiling Plans (Ceiling Plan - Sim)
SECTIONS - BUILDING
z_Coordination
z_Export
z_Original Views (Do Not Rename)
z_Visualization
3D Views
3D_Export-BaseBuilding
3D_EXPORT-CurtainWall
3D_EXPORT-DWG
3D_Export-FrontDesk
3D_EXPORT-RCP
z_Work
Floor Plans
* Work - Level 01
* Work - Level 02
* Work - Level 03
* Work - Level 04
* Work - Level 05
* Work - Level 06
* Work - Level 07
* Work - Level 08
* Work - Level 09
BACK
1/8" = 1'-0"
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.
Base Building (Not Editable)
Main Model
Editable Only

Exporting Railings and Curved Objects

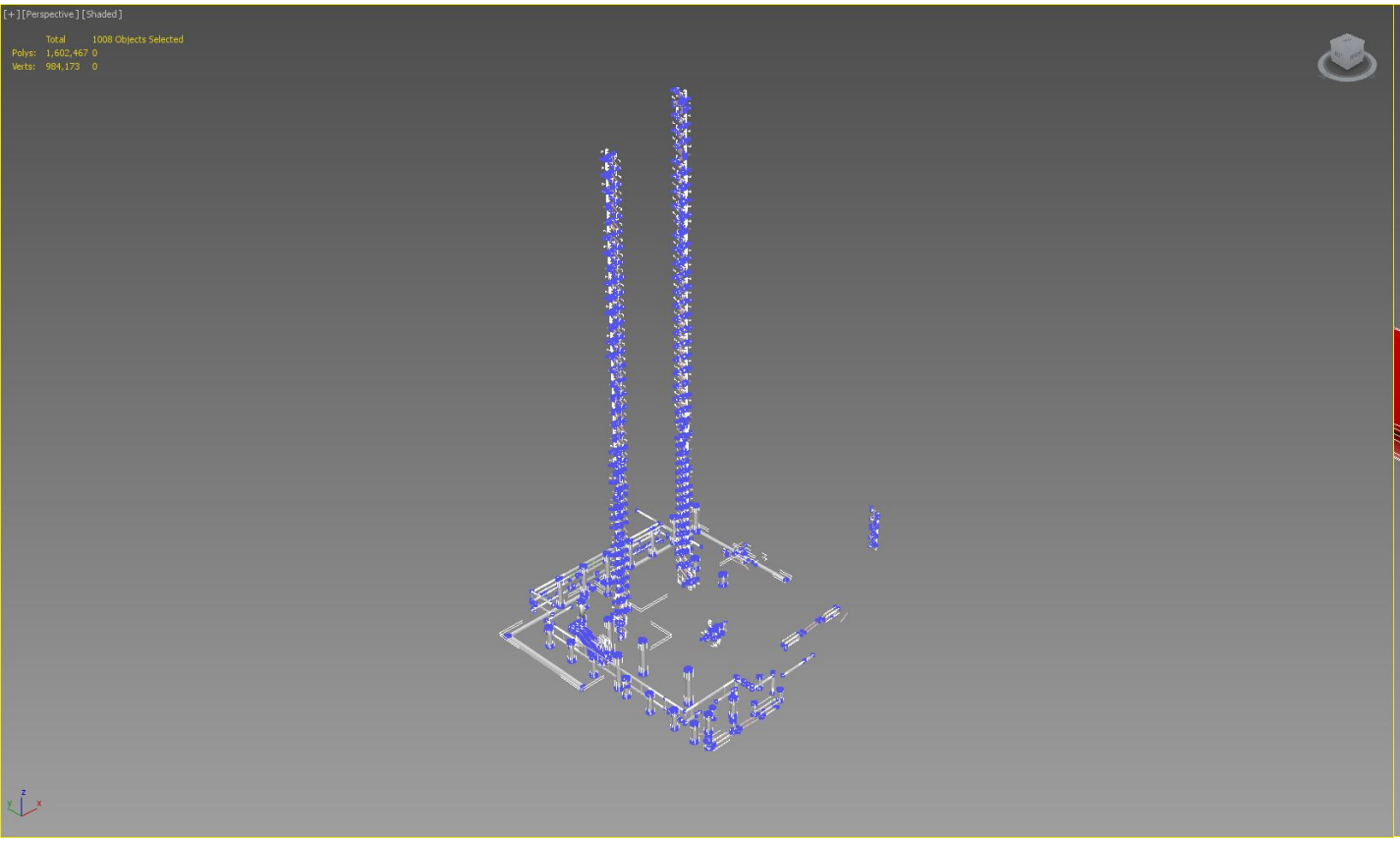
- Export DWG as ACIS.
  - This is located in the export DWG settings under the “Solids” tab.

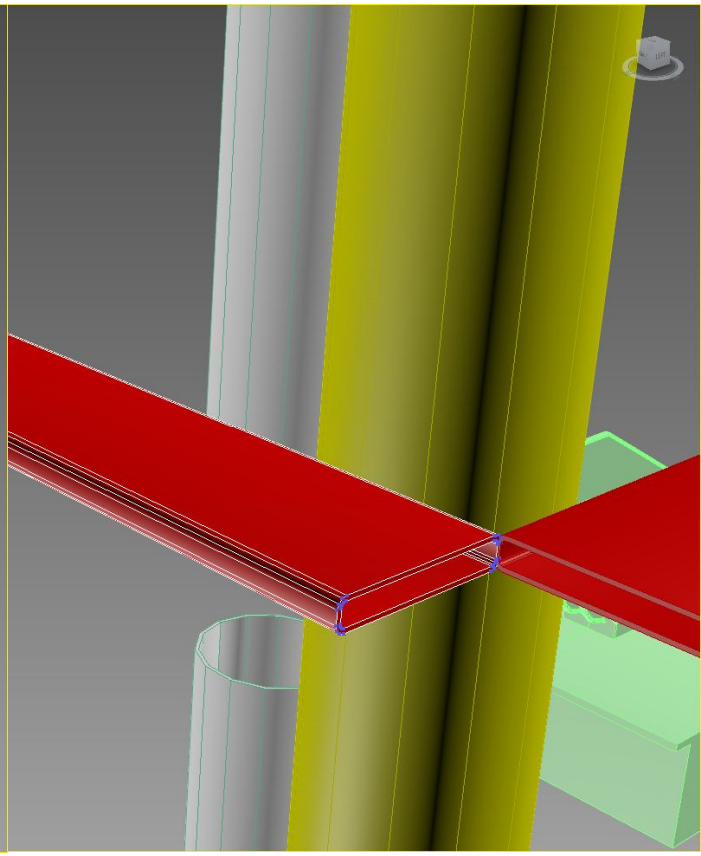


Exporting Railings and Curved Objects



DWG ACIS Export of Curved Objects





System Units and Import Tips (3ds Max 2015)

- **3ds Max system units need to be set to Feet.**
  - FBX exported from Revit only comes in properly when you use Feet.
    - You will experience issues with modifiers and UVW if you do not.
- **DWG Files export by default in Inches.**
  - This can be changed in the export settings in Revit. If you forget, all you need to do is rescale the DWG on import.
- **If directly importing FBX, use the Entertainment Preset when importing for more import options.**

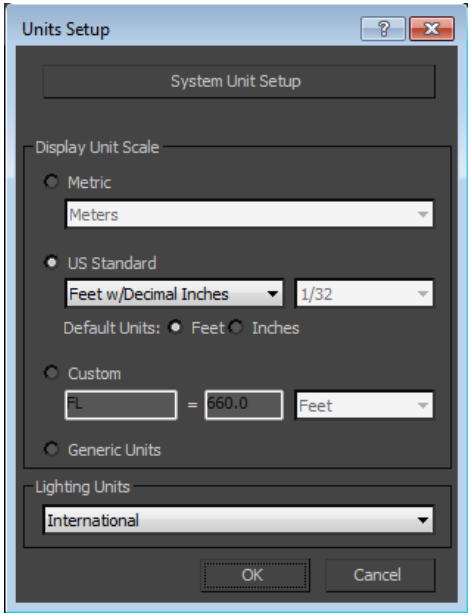
System Units and Import Tips (3ds Max 2016 FBX Workflow)

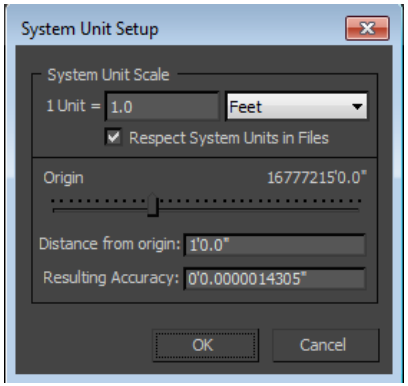
- **Work-Around #1: Change System Units**
  - Set System Units in 3ds Max to Centimeters.
    - Not Ideal if different units are required for the project.
- **Work-Around #2: The FBX Import Trick**
  1. Set 3ds Max to the System Units required for the project
  2. Go to File > Import
  3. Select the FBX File
  4. In the Import Options go to Advanced Options > Units
     1. If you do not see Advanced Options dropdown, switch the preset at the top to **Autodesk Media & Entertainment**
  5. Uncheck “Automatic”
  6. Pick the Units required for your project from the dropdown list.
  7. Import the FBX.
  8. Delete everything Imported
  9. **DO NOT CLOSE OR RESTART MAX**
  10. Go to File > Import > Link FBX
  11. Link FBX File

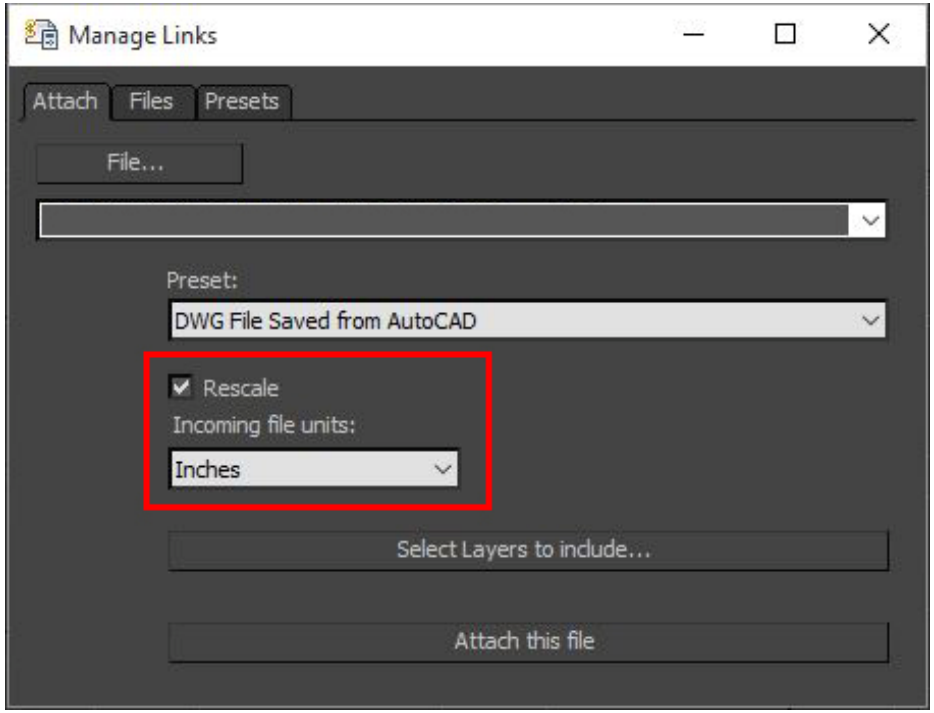
System Units and Import Tips (3ds Max 2017 SP2+)

Everything is fixed in 3ds Max 2017 SP2!

- **3ds Max system units need to be set to the same units as Revit.**
  - FBX exported from Revit will need to match for project continuity!
- **DWG Files export by default in Inches.**
  - This can be changed in the export settings in Revit. If you forget, all you need to do is rescale the DWG on import.
- **If directly importing FBX, use the Entertainment Preset when importing for more import options.**


Units Setup
System Unit Setup
Display Unit Scale
Metric
Meters
US Standard
Feet w/Decimal Inches
1/32
Default Units: Feet Inches
Custom
FL
660.0
Feet
Generic Units
Lighting Units
International
OK
Cancel

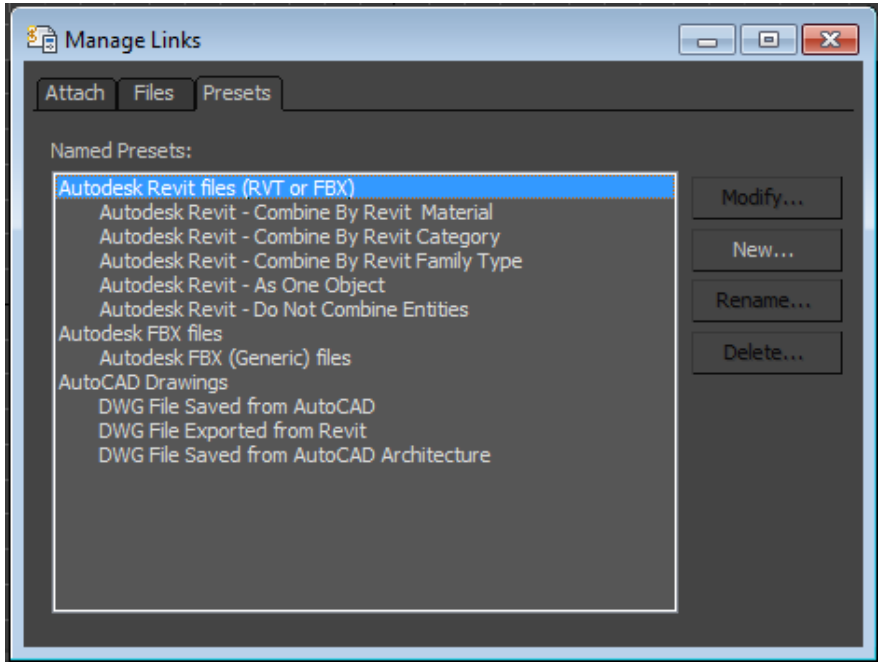

System Unit Setup
System Unit Scale
1 Unit = 1.0
Feet
Respect System Units in Files
Origin
16777215'0.0"
Distance from origin: 1'0.0"
Resulting Accuracy: 0'0.0000014305"
OK
Cancel


Manage Links
Attach
Files
Presets
File...
Preset:
DWG File Saved from AutoCAD
Rescale
Incoming file units:
Inches
Select Layers to include...
Attach this file


[+] [Front] [Shaded + Edged Faces]
Imported DWG in Inches
Correct scale in feet

FBX/Revit Link Settings

- **Combine By Materials:**
  - Base Building / Interiors
  - Curtain Wall and Mullions
  - RCP
- **Do Not Combine (Optional):**
  - Furniture
  - Site and Entourage
  - Railings and Curved Objects
  - Lighting Fixtures

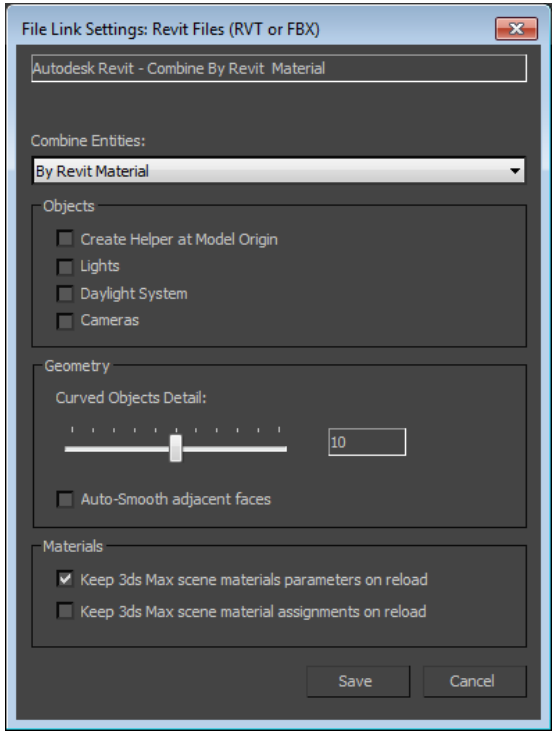


Material Linking

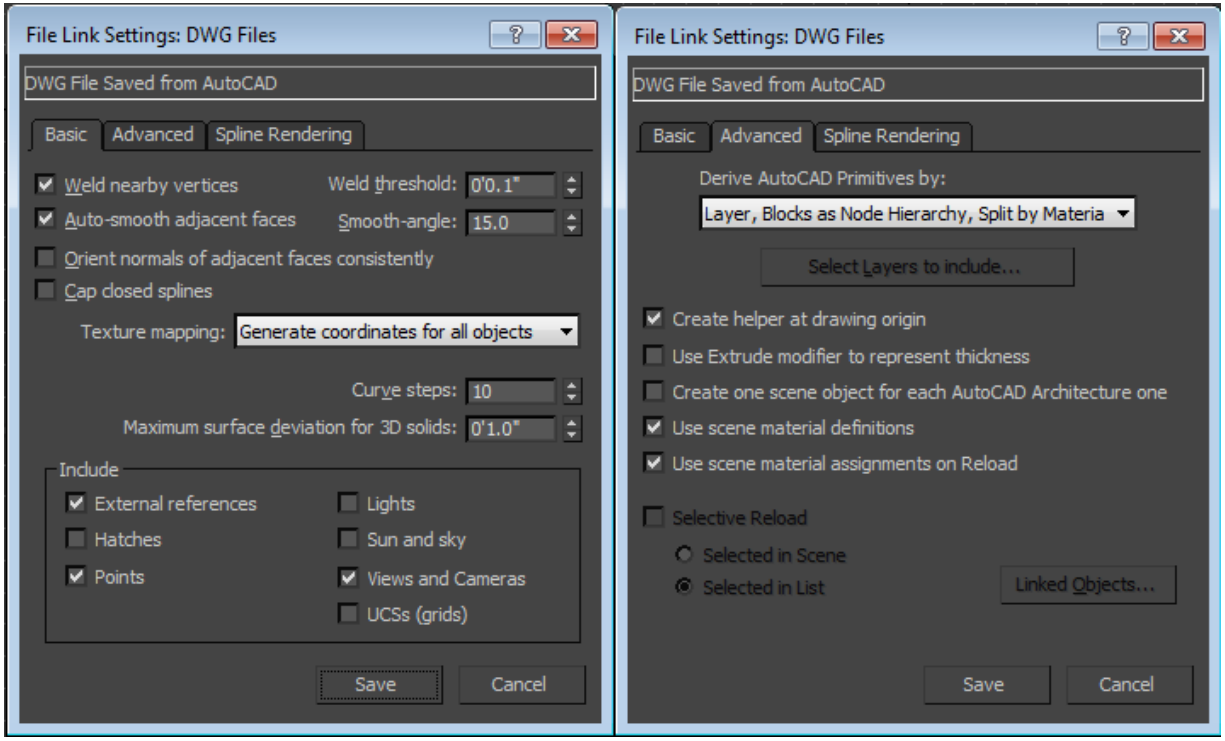
- **Keep 3ds Max scene materials parameters on reload.**
  - This is recommended if adjustments to the material properties will happen inside of 3ds Max. If the name of the material stays the same, the material will not be overridden when reloading the file. If left uncheck, the material will be overridden and replaced with the latest version from Revit.
  - Converting materials to another format is ok, as long as the material name stays the same.
- **Keep 3ds Max scene material assignments on reload.**
  - This is recommended if new materials will be created and applied inside of 3ds Max. Since a new material have been created, 3ds Max will not replace the newly created material with the latest version from Revit when this is enabled. This checkbox is highly recommended for DWG imports, as they do not bring in any materials to begin with.

FBX/DWG Link Preset Settings

FB

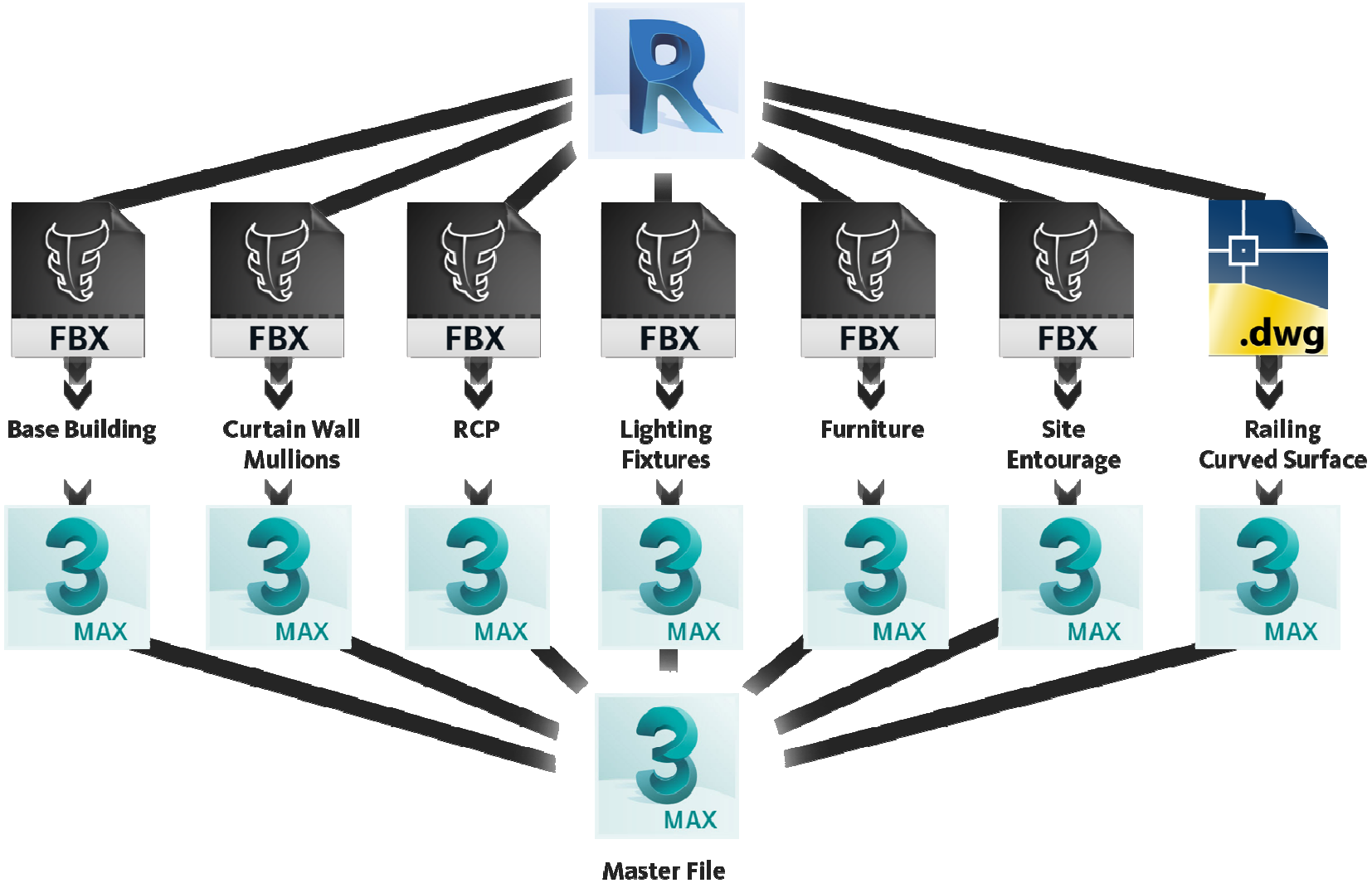


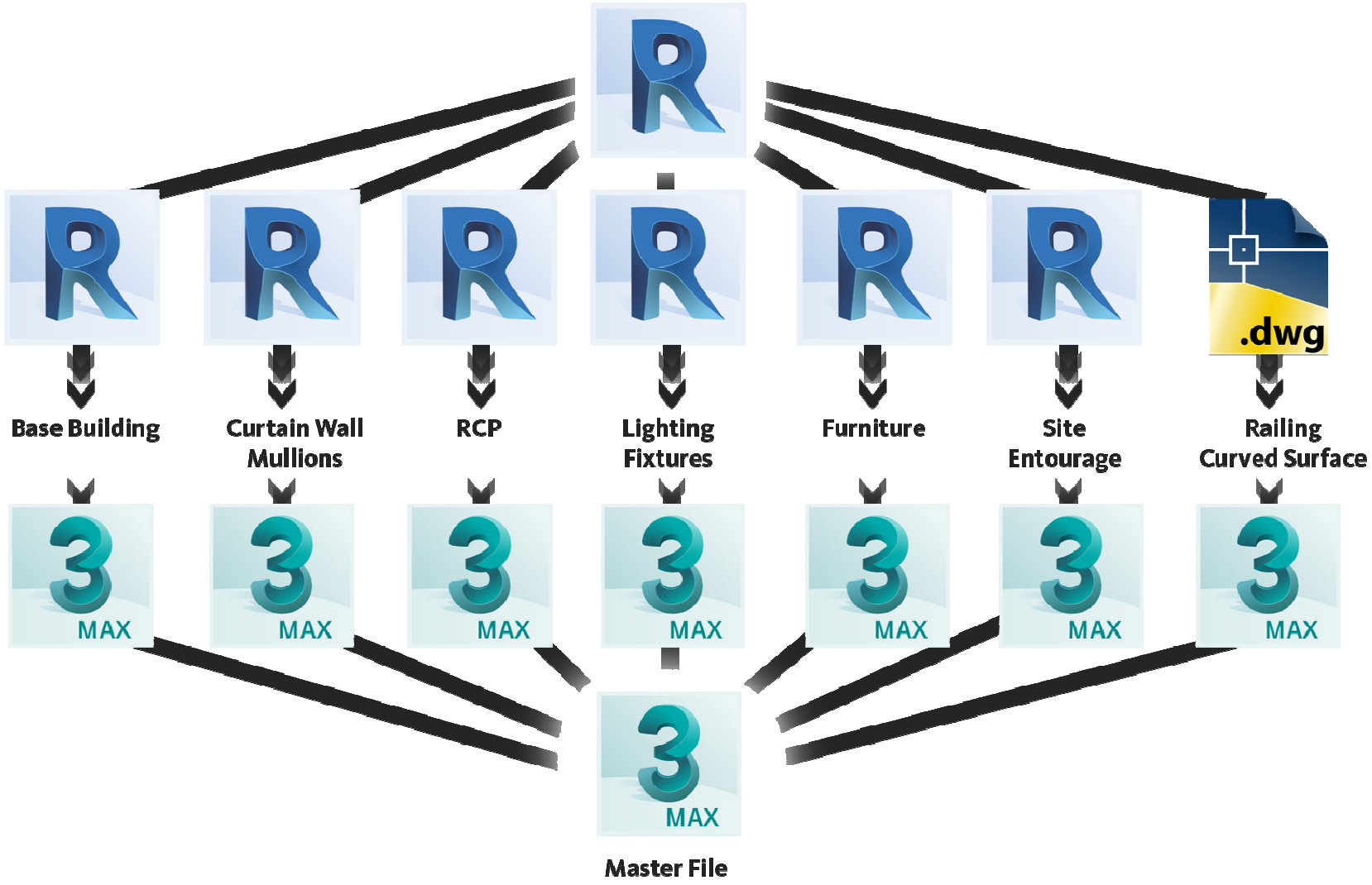
DWG



Xref into a “Master” file

- **Import your multiple FBX and DWG files into their own 3ds Max Files**
- **Xref all the files into one main “Master” file**
  - Less chance of losing all your work
  - Easier to swap parts in and out
  - Allows multiple people to work on the same project
  - Multiple “Master” Files can be created for different scenarios
  - “Testing” materials and lighting is a little more tedious
    - Create a test file for faster testing, then apply to the main model


FBX
FBX
FBX
FBX
FBX
FBX
.dwg
Base Building
Curtain Wall Mullions
RCP
Lighting Fixtures
Furniture
Site Entourage
Railing Curved Surface
MAX
MAX
MAX
MAX
MAX
MAX
MAX
MAX
Master File

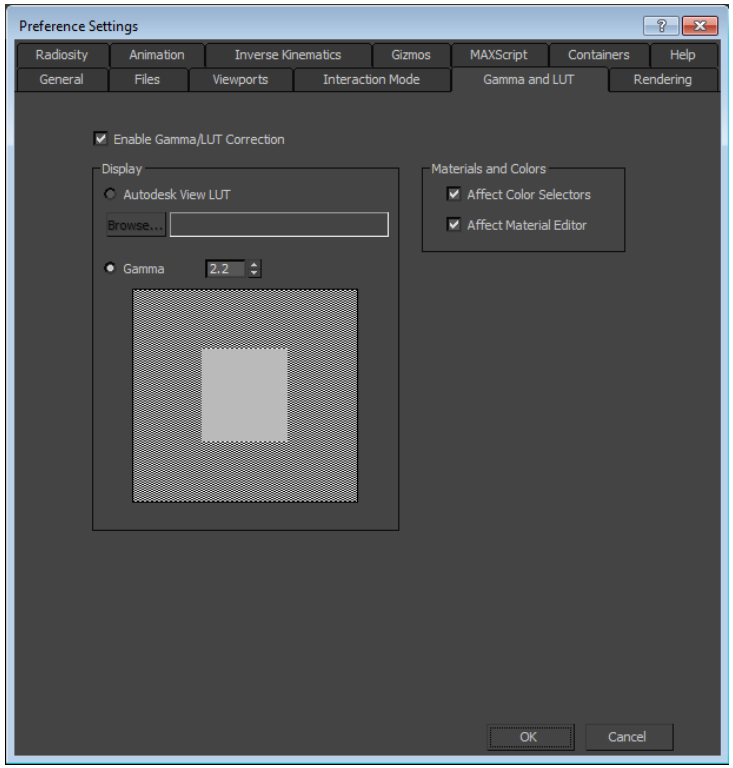

.dwg
Base Building
Curtain Wall Mullions
RCP
Lighting Fixtures
Furniture
Site Entourage
Railing Curved Surface
MAX
Master File

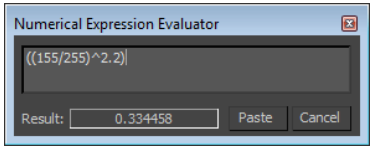
Chapter 4: 3ds Max Settings

Make sure to install NVIDIA Iray and Mental Ray with 3ds Max 2017!

Gamma Settings

- **Make sure Gamma is enabled and set to 2.2.**
- **Use the following equation to convert RGB Values into linear values for 3ds Max and Iray.**
  - ((rgb/255)^2.2)
  - 255*((rgb/255)^2.2)
    Use this for sRGB



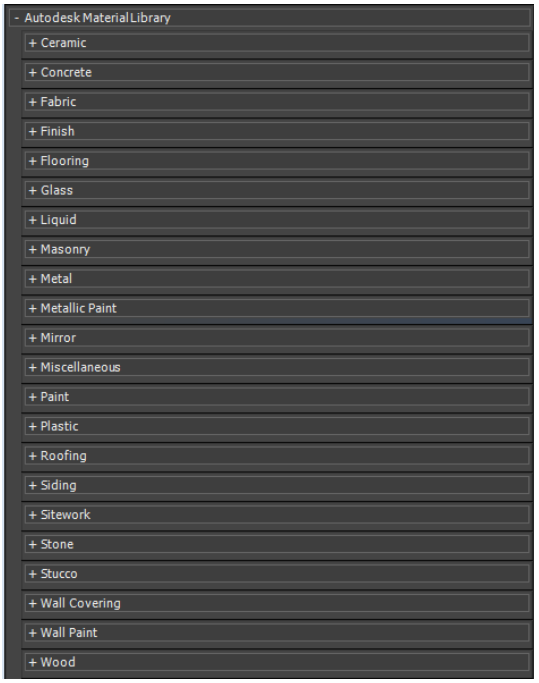


Materials

- **Compatible Shaders:**
  - Autodesk Materials
  - Arch & Design
  - Iray Shader
  - MDL (3ds Max 2016+)

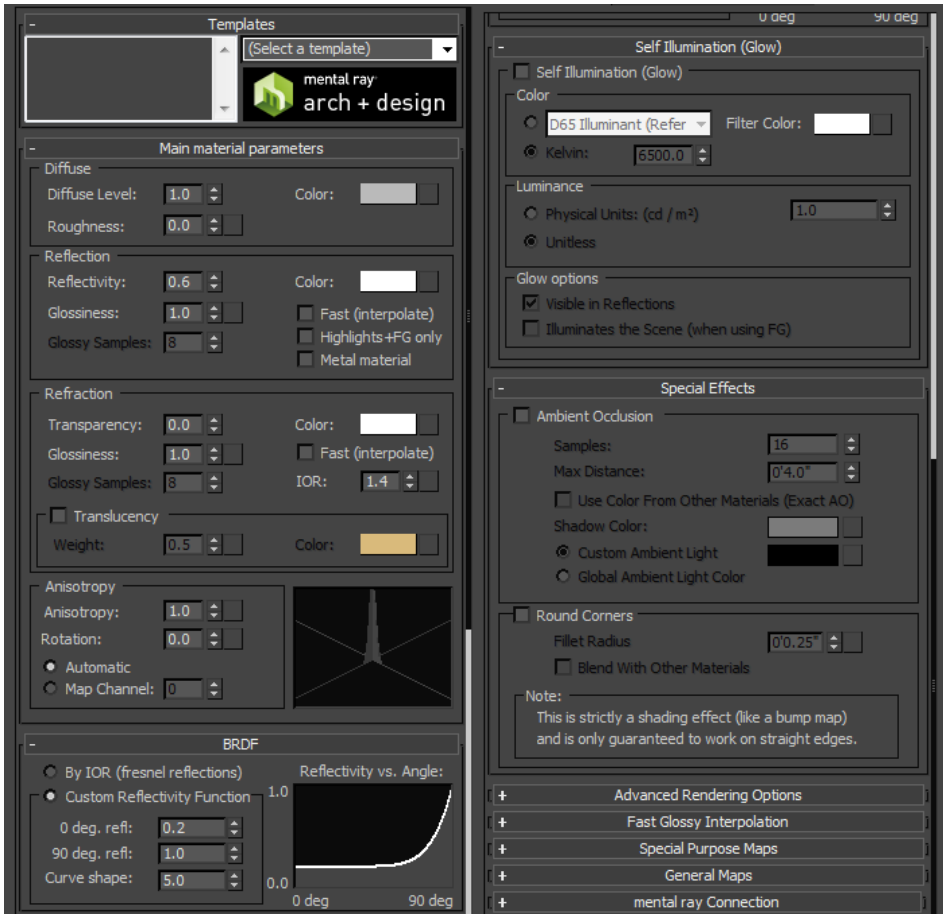
Autodesk Materials

- If you set your material properties in Revit, these will be good to go!
- Quick and Easy!
- Hundreds of presets to mimic a wide range of architectural materials!



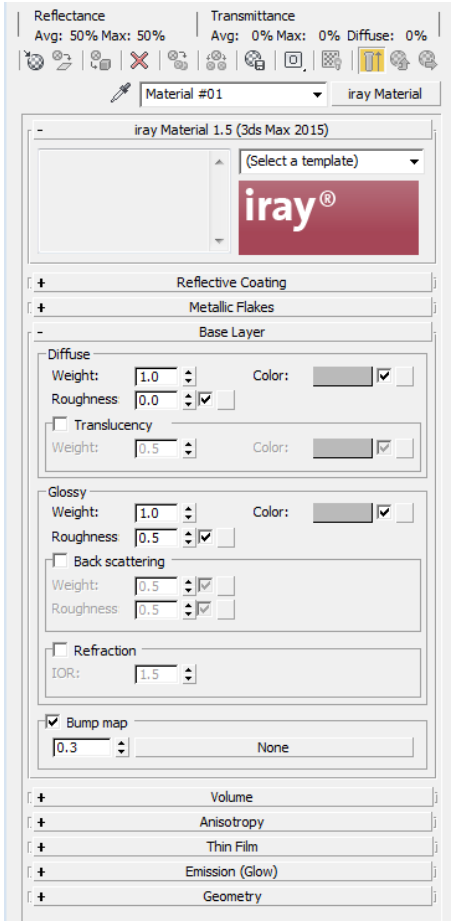
Arch & Design

- **Extremely Powerful, Flexible, and Customizable!**
- **Lots of Presets!**
- **Special Functions!**
  - Curved/Beveled Edges



Iray Shader

- **Optimized for use in Iray**
- **Must download from NVIDIA directly. Not supported by Autodesk.**
  - Download Free at http://blog.irayrender.com
  - You will also have to install this on all of your render nodes.
- **Amazing quality and presets.**
- **Powerful and easy to use.**
- **Multiple “Coats” for complex, reflective, materials.**



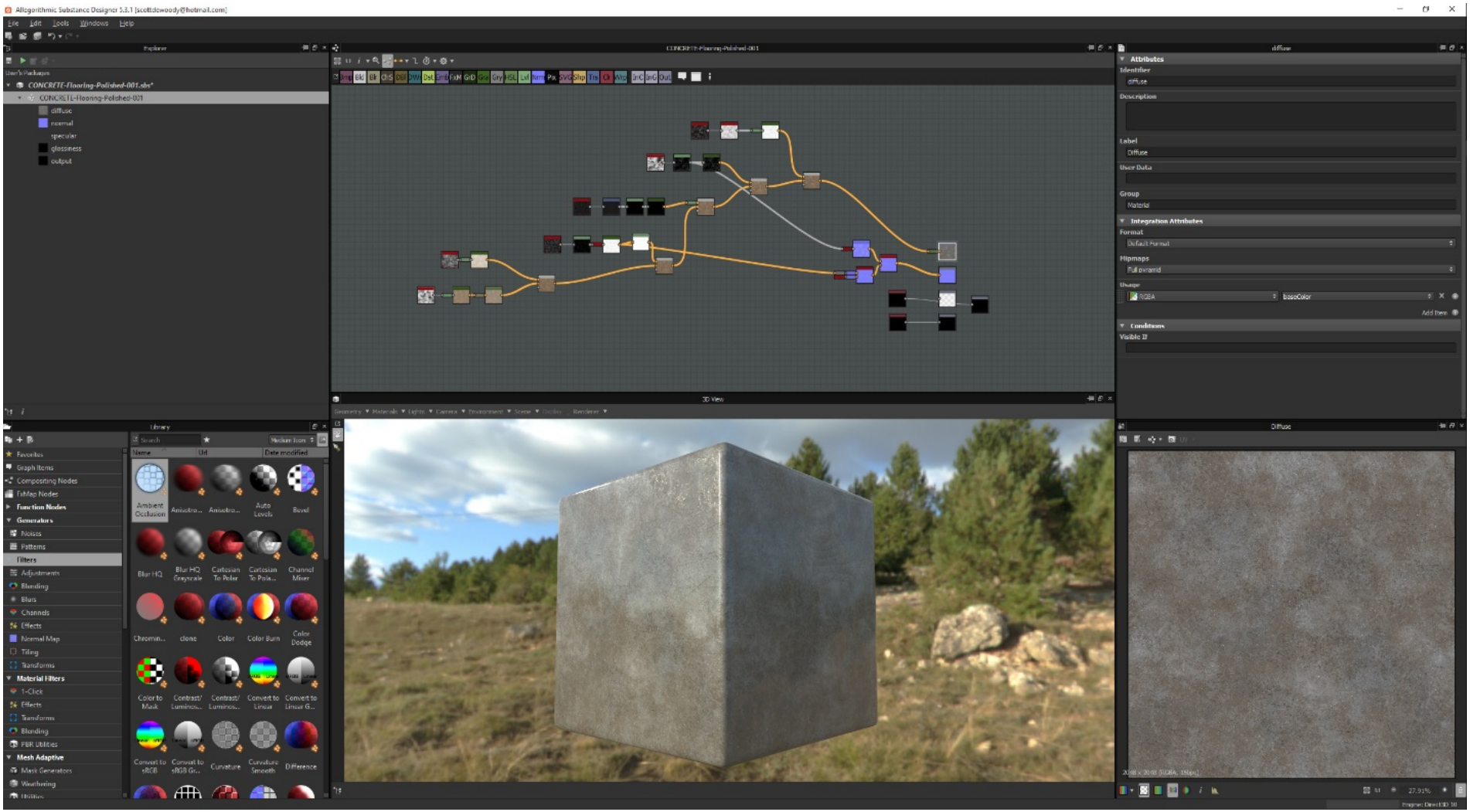
MDLs

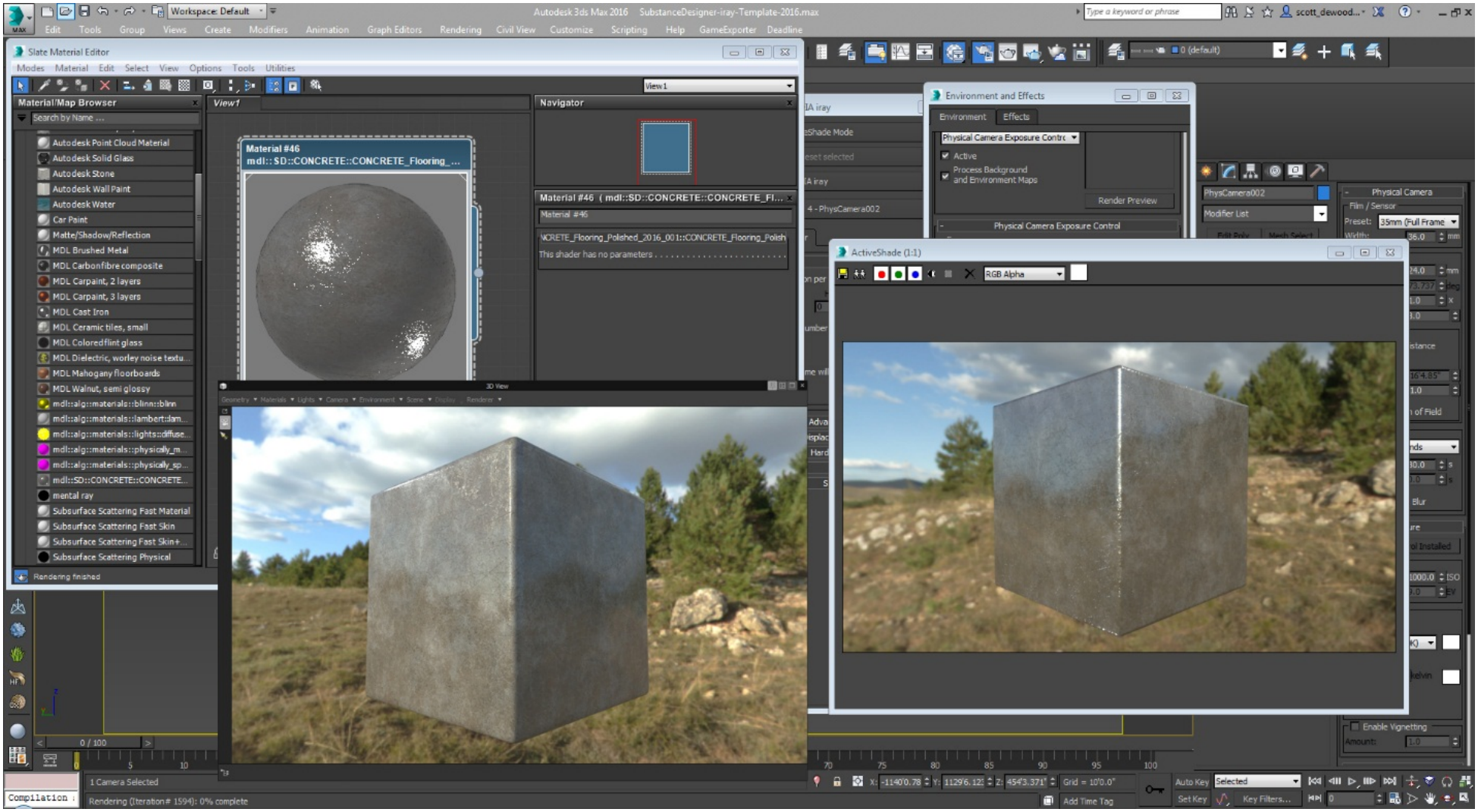
- **Key Features of MDL**
  - **Designed primarily for GPU Rendering with Iray as the main platform.**
  - **Can define extremely complex materials through multiple parameters and additional layers and coatings.**
  - **Parameters can be added for custom-built material libraries.**
    - This allows for a base material to be set, and additional customization of that material for specific instances.
  - **Is designed to be adopted by other render engines.**
  - **MDL Libraries be easily packaged and distributed across any series of renderers that support MDL.**
    - This allows a single unified look for materials across all platforms! There is only a need for one single material library in a production environment.
  - **Supports traditional rendering techniques that work well with conventional rendering pipelines.**
- **Enable MDL inside of 3ds Max follow the steps at the Mental Ray Blog**
  - http://blog.mentalray.com/2015/05/08/using-mdl-with-mental-ray-in-3ds-max-2016/
- **Current Limitations inside of 3ds Max 2016**
  - Editing MDL materials can only be done on the parameter level inside of 3ds Max after loading external MDL code.
  - Parameter connections to other MDLs or other Shaders are currently not supported.
  - Measured Materials are not yet handled by Mental Ray 3.13.
- **More technical information can be found here**:
  - **http://www.nvidia-arc.com/products/Iray/mdl-materials.html**
  - **http://www.mdlhandbook.com/**

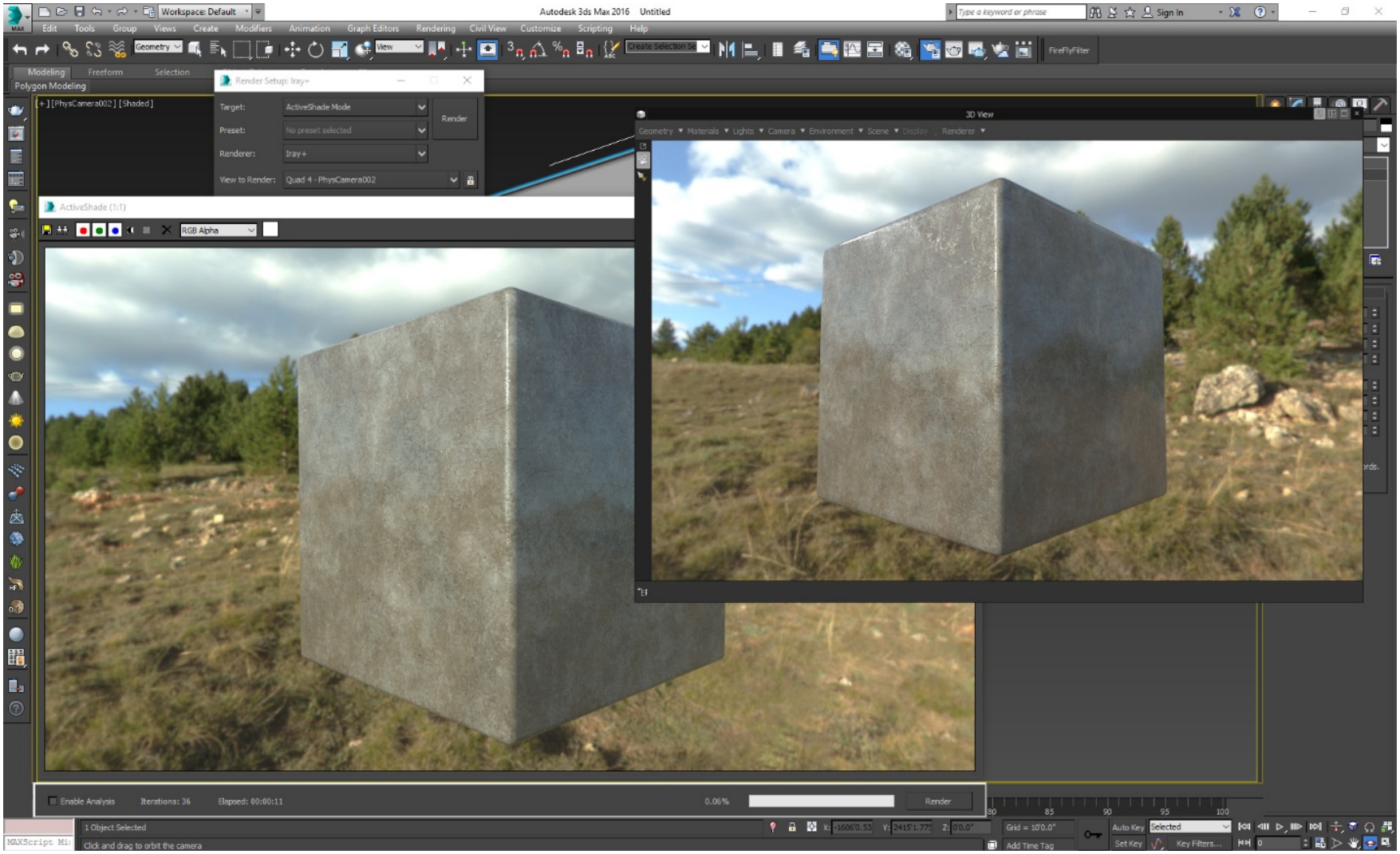
Substance Designer 5.5

Created by Allegorithmic, and can be found at: www.allegorithmic.com

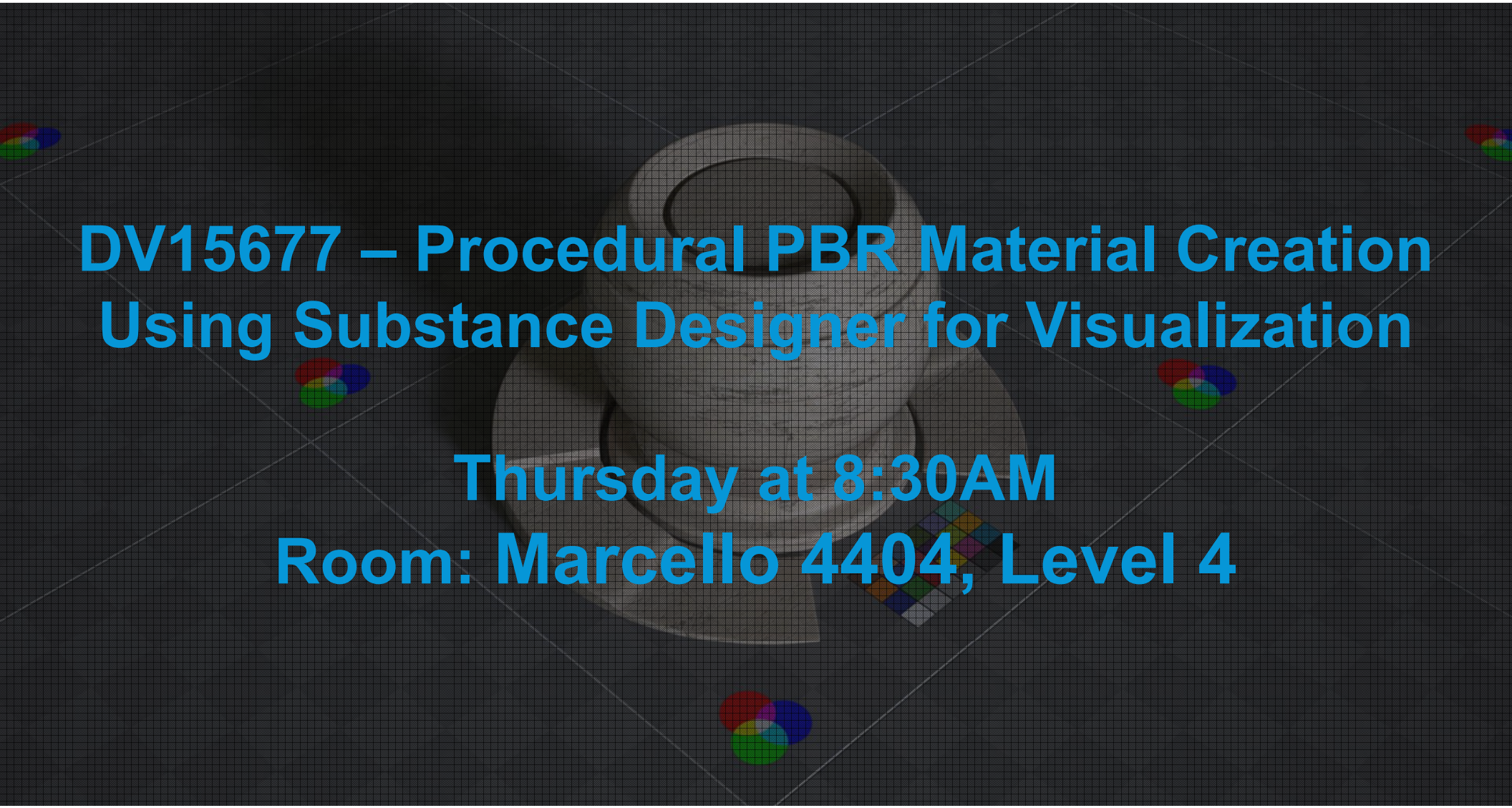
- **Key Features:**
  - Procedurally generate an infinite amount of Materials and Variations
  - Render with Iray directly inside of Substance Designer for a 1:1 Material preview of what would appear inside of 3ds Max
  - Export MDL files to use directly with Iray and Iray for 3ds Max
  - First full node-based MDL Editor


Explorer
CONCRETE-Flooring-Polished-001
diffuse
normal
specular
glossiness
output
Attributes
Identifier
Description
Label
User Data
Group
Integration Attributes
Format
Mipmaps
Usage
Conditions
Visible If
3D View
Library
Favorites
Graph Items
Compositing Nodes
FxMap Nodes
Function Nodes
Generators
Noises
Patterns
Filters
Adjustments
Blending
Blurs
Channels
Effects
Normal Map
Tiling
Transforms
Material Filters
1-Click
Effects
Transforms
Blending
PBR Utilities
Mesh Adaptive
Mask Generators
Weathering
Utilities
Ambient Occlusion
Auto Levels
Bevel
Blur HQ
Blur HQ Grayscale
Cartesian To Polar
Channel Mixer
Color
Color Burn
Color Dodge
Color to Mask
Curvature
Curvature Smooth
Difference
Diffuse


Autodesk 3ds Max 2016 SubstanceDesigner-iray-Template-2016.max
Slate Material Editor
Material/Map Browser
Material #46
mdl::SD::CONCRETE::CONCRETE_Flooring_...
Navigator
Environment and Effects
ActiveShade (1:1)
RGB Alpha
Rendering finished
1 Camera Selected
Rendering (Iteration# 1594): 0% complete


Autodesk 3ds Max 2016 Untitled
Render Setup: Iray+
Target:
ActiveShade Mode
Preset:
No preset selected
Renderer:
Iray+
View to Render:
Quad 4 - PhysCamera002
Render
ActiveShade (1:1)
RGB Alpha
3D View
Enable Analysis
Iterations: 36
Elapsed: 00:00:11
0.06%
Render
1 Object Selected
Click and drag to orbit the camera

See Handout on How to import Substance Designer MDLs into 3ds Max 2016 and 2017

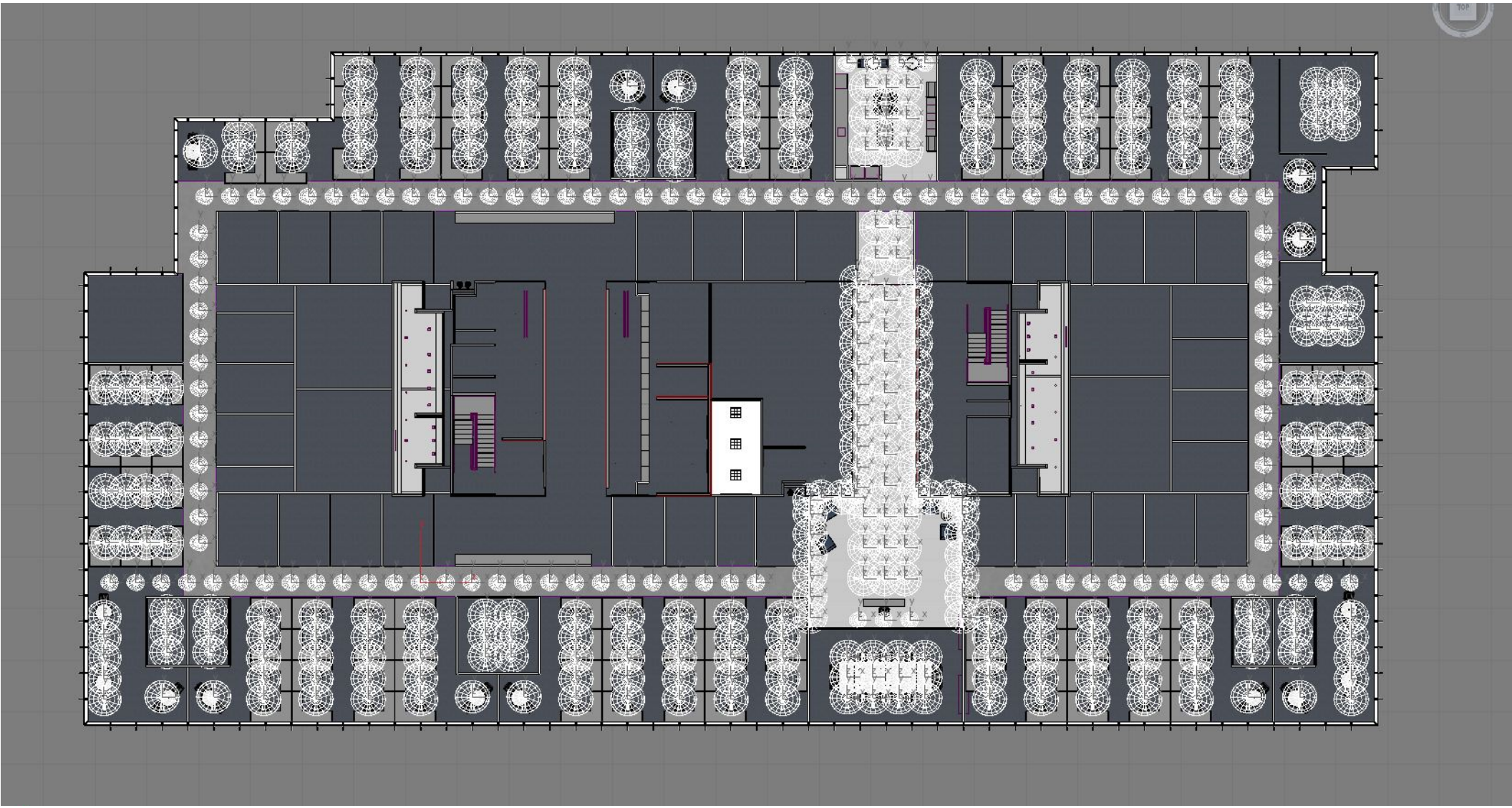


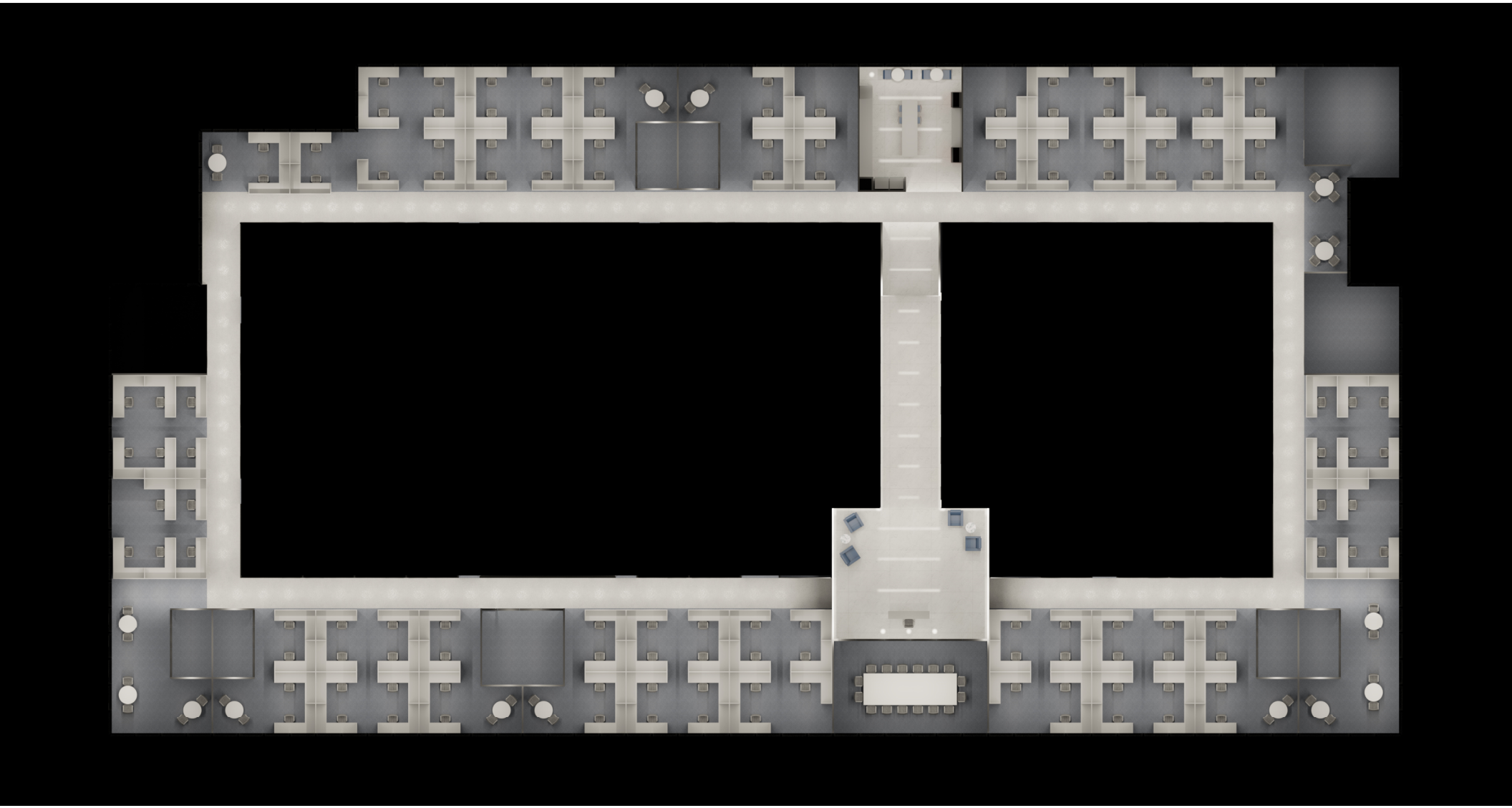
DV15677 – Procedural PBR Material Creation Using Substance Designer for Visualization

Thursday at 8:30AM
Room: Marcello 4404, Level 4

Lighting

- **Use the Daylight System for Sunlight and Skylight**
  - Make sure to add mrSky into Environment Map slot
  - Control Sun Location and Time via the Motion Tab
- **Use Photometric Lights for optimal quality and performance**
  - Standard lights not fully supported
  - Lights added in Revit will transfer in as Photometric Lights
- **Use color temperature for a more realistic look**
  - Setting the light's color to "White" will look boring
  - Artificial lights should not go above 5000K in most cases
- **Number of Lights does not affect performance**





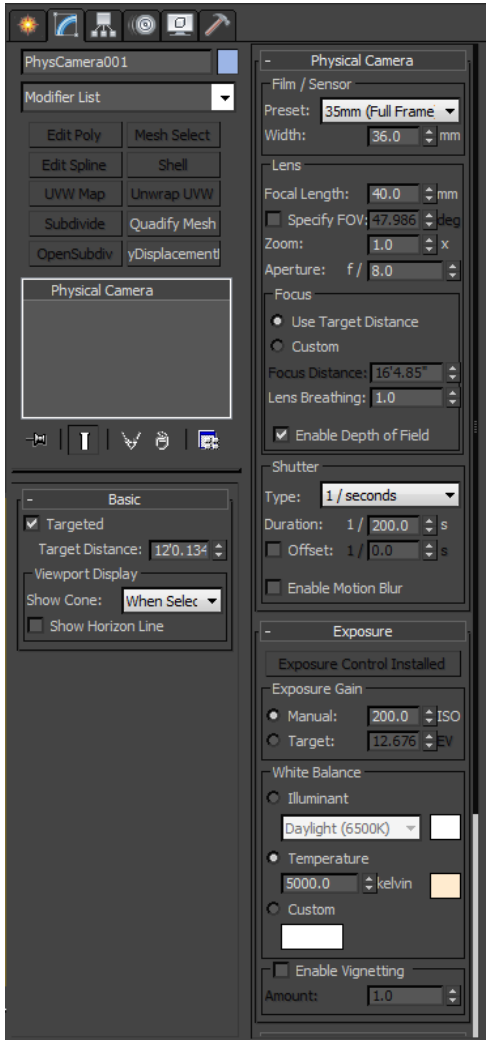
mrPhotographic Exposure Control (3ds Max 2013-2015)

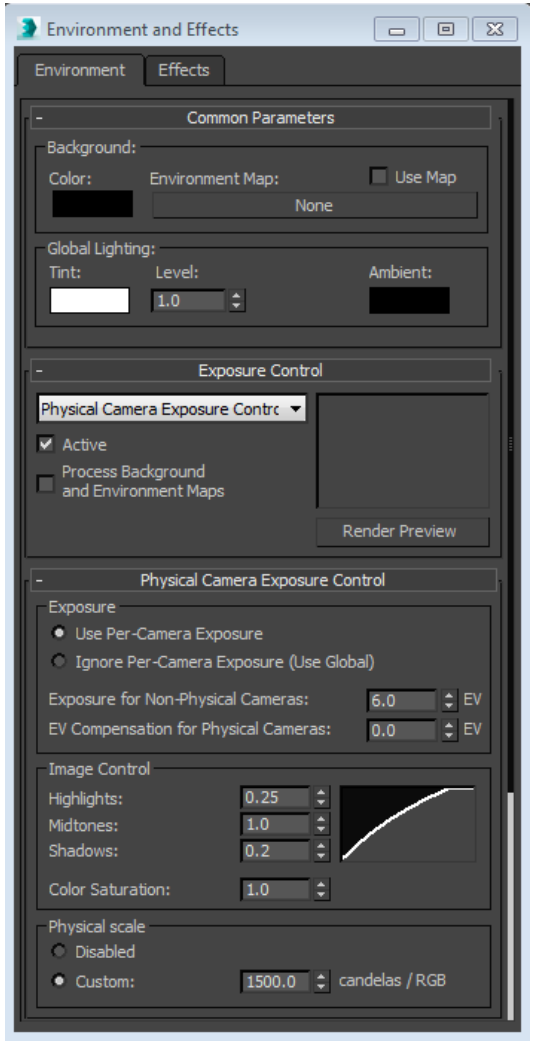
- **Enable this under Environment.**
- **Use the EV scale for quick and easy settings.**
- **Use the Camera Settings for more advance control.**
  - Try to use real world exposure values for more realistic quality.
- **Set Highlight and Shadow settings to 0.**
  - Better to crush these settings in post, and not the render.
- **Make sure to set the White Balance to match your lighting.**


[Camera004] [Shaded]
Environment and Effects
Environment
Effects
Common Parameters
Background:
Color:
Environment Map:
Use Map
Map #14 (mr Physical Sky)
Global Lighting:
Tint:
Level:
1.0
Ambient:
Exposure Control
mr Photographic Exposure Contrc
Active
Process Background and Environment Maps
Render Preview
mr Photographic Exposure Control
Exposure
Preset:
(Select a preset)
Exposure Value (EV):
10.0
Photographic Exposure:
Shutter Speed:
1/
16.0
Sec.
Aperture (f-stop):
f/
8.0
Film speed (ISO):
100.0
Image Control
Highlights (Burn):
0.0
Midtones:
1.0
Shadows:
0.0
Color Saturation:
1.0
Whitepoint:
6500.0
Kelvin
Vignetting:
0.0
Physical scale
Physical Units: (cd / m²)
Unitless
1500.0
Gamma / LUT Settings
Display Gamma Enabled: 2.200000
Setup...
Atmosphere

Physical Camera (3ds Max 2016-2017)

- **Physical Camera Features**
  - DSLR Camera Settings for each Physical Camera in the scene
  - Film/Sensor settings that mimic real-world sensors
  - Ability to change Shutter Speed to different types
    - Recommended **1/seconds** to mimic DSLR
  - Enable Motion Blur for each Physical Camera in the scene
  - Can use EV Scale or Specific ISO Value
  - White Balance for each Physical Camera in the scene.
  - Enable Depth Of Field which is controlled by Aperture, Film Width, and Focal Length
    - Settings for Bokeh Effect
  - Physical Camera Exposure Control enables global exposure with exposure for each individual camera in the scene.
  - Under the Physical Camera Exposure Control, leave the setting “User Per Camera Exposure” Enabled.
  - Use “Exposure for Non-Physical Cameras” to properly expose the Perspective and Orthographic views. This value is based on an EV Scale.


PhysCamera001
Modifier List
Edit Poly
Mesh Select
Edit Spline
Shell
UVW Map
Unwrap UVW
Subdivide
Quadify Mesh
OpenSubdiv
yDisplacement
Physical Camera
Basic
Targeted
Target Distance: 12'0.134
Viewport Display
Show Cone: When Selec
Show Horizon Line
Physical Camera
Film / Sensor
Preset: 35mm (Full Frame
Width: 36.0 mm
Lens
Focal Length: 40.0 mm
Specify FOV: 47.986 deg
Zoom: 1.0 x
Aperture: f / 8.0
Focus
Use Target Distance
Custom
Focus Distance: 16'4.85"
Lens Breathing: 1.0
Enable Depth of Field
Shutter
Type: 1 / seconds
Duration: 1 / 200.0 s
Offset: 1 / 0.0 s
Enable Motion Blur
Exposure
Exposure Control Installed
Exposure Gain
Manual: 200.0 ISO
Target: 12.676 EV
White Balance
Illuminant
Daylight (6500K)
Temperature
5000.0 kelvin
Custom
Enable Vignetting
Amount: 1.0


Environment and Effects
Environment
Effects
Common Parameters
Background:
Color:
Environment Map:
Use Map
None
Global Lighting:
Tint:
Level: 1.0
Ambient:
Exposure Control
Physical Camera Exposure Contrc
Active
Process Background and Environment Maps
Render Preview
Physical Camera Exposure Control
Exposure
Use Per-Camera Exposure
Ignore Per-Camera Exposure (Use Global)
Exposure for Non-Physical Cameras: 6.0 EV
EV Compensation for Physical Cameras: 0.0 EV
Image Control
Highlights: 0.25
Midtones: 1.0
Shadows: 0.2
Color Saturation: 1.0
Physical scale
Disabled
Custom: 1500.0 candelas / RGB

Physical Camera – Image Control

- **These settings will apply tone-mapping adjustments to the rendering, and can be found under the Physical Camera Exposure Control That will help with the contrast of the Highlights and the Shadows of the rendering.**
  - Leave these settings at default. It will give really good results from the start.
  - Set Highlights and Shadows to 0 to remove any tone-mapping.
    - Leave Mid-tones set to 1.0.
    - Doing this will allow Tone Mapping to be applied in Post Production.
    - Save the output in 32-bit EXR for best Dynamic Range.


Image Control
Highlights: 0.25
Midtones: 1.0
Shadows: 0.2
Color Saturation: 1.0
Physical scale
Disabled
Custom: 1500.0 candelas / RGB


Image Control
Highlights: 0.0
Midtones: 1.0
Shadows: 0.0
Color Saturation: 1.0
Physical scale
Disabled
Custom: 1500.0 candelas / RGB


Image Control
Highlights: 1.0
Midtones: 1.0
Shadows: 1.0
Color Saturation: 1.0
Physical scale
Disabled
Custom: 1500.0 candelas / RGB

Real-World Camera Settings – Aperture (f-stop)

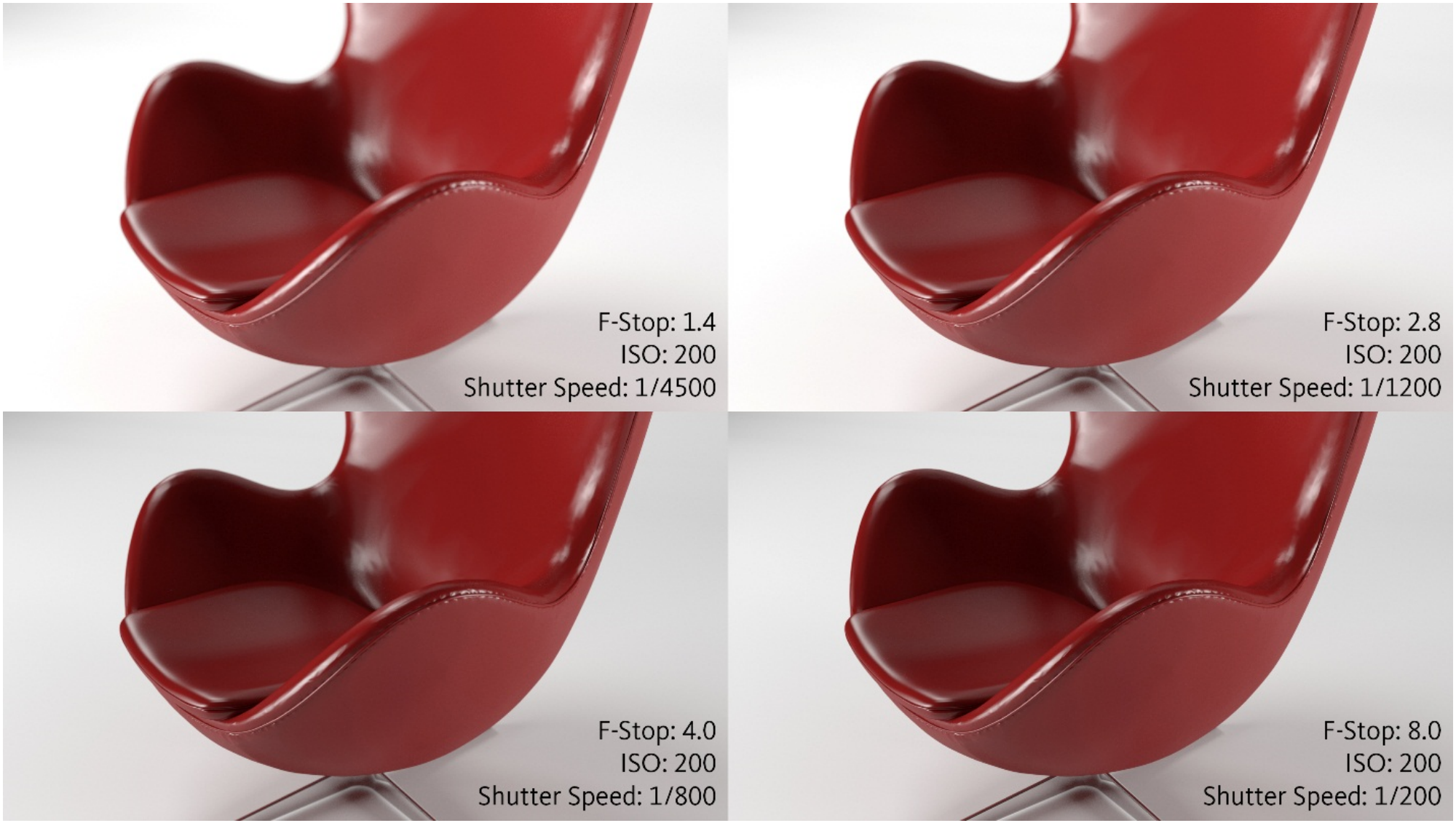
- **This setting will control Depth Of Field (DOF) in the camera.**
  - Usually **f/8.0 – f/11.0** is the sweet spot for most cameras, and is the ideal setting for shooting **Architecture** and **Landscapes**. This is due to how sharp the images come out, and results in **very little DOF**
  - **Decreasing** the Aperture will **increase** the **brightness**, and **increase** the DOF effect
  - **Increasing** the Aperture will **decrease** the **brightness**, and **decrease** the DOF effect
  - Depth of Field needs to be **enabled** to take effect

F-Stop: 4.0
ISO: 200
Shutter Speed: 1/200

F-Stop: 6.0
ISO: 200
Shutter Speed: 1/200

F-Stop: 8.0
ISO: 200
Shutter Speed: 1/200

F-Stop: 11
ISO: 200
Shutter Speed: 1/200


F-Stop: 1.4
ISO: 200
Shutter Speed: 1/4500
F-Stop: 2.8
ISO: 200
Shutter Speed: 1/1200
F-Stop: 4.0
ISO: 200
Shutter Speed: 1/800
F-Stop: 8.0
ISO: 200
Shutter Speed: 1/200

Real-World Camera Settings – Shutter Speed (1/seconds)

- **This setting will control Motion Blur in the camera. The Shutter Speed will determine how fast the shutter of the camera closes.**
  - The **higher** this setting, the faster the shutter will shut. This results in **freezing objects in motion**, and will also **decrease** the **brightness** of the image
  - **Lowering** the Shutter Speed will allow objects in motion to become **blurry**, and will **increase** the **brightness** of the image.
  - Motion Blur needs to be **enabled** to take effect.


F-Stop: 8.0
ISO: 200
Shutter Speed: 1/100
F-Stop: 8.0
ISO: 200
Shutter Speed: 1/200
F-Stop: 8.0
ISO: 200
Shutter Speed: 1/400
F-Stop: 8.0
ISO: 200
Shutter Speed: 1/800


F-Stop: 13
ISO: 200
Shutter Speed: 1/40
F-Stop: 8.0
ISO: 100
Shutter Speed: 1/150
F-Stop: 8.0
ISO: 300
Shutter Speed: 1/250
F-Stop: 13
ISO: 1000
Shutter Speed: 1/1000

Real-World Camera Settings – ISO (Film Speed)

- **This setting controls how much light hits the sensor in the camera. In the Real World, this would also control how much noise would be visible in the photograph.**
  - **Decreasing** the ISO value will **darken** the image, but create **less noise** in the photograph.
  - **Increasing** the ISO value will **brighten** the image, but create **more noise** in the photograph.
  - **Note:** Since the renderings are completely digital, the **ISO setting will not create any noise in the rendering**. However, it is recommended to add some noise back in Post Production to help mimic the effect. This will help the renderings look more like a photograph when it is finished.


F-Stop: 8.0
ISO: 200
Shutter Speed: 1/100


F-Stop: 8.0
ISO: 200
Shutter Speed: 1/200

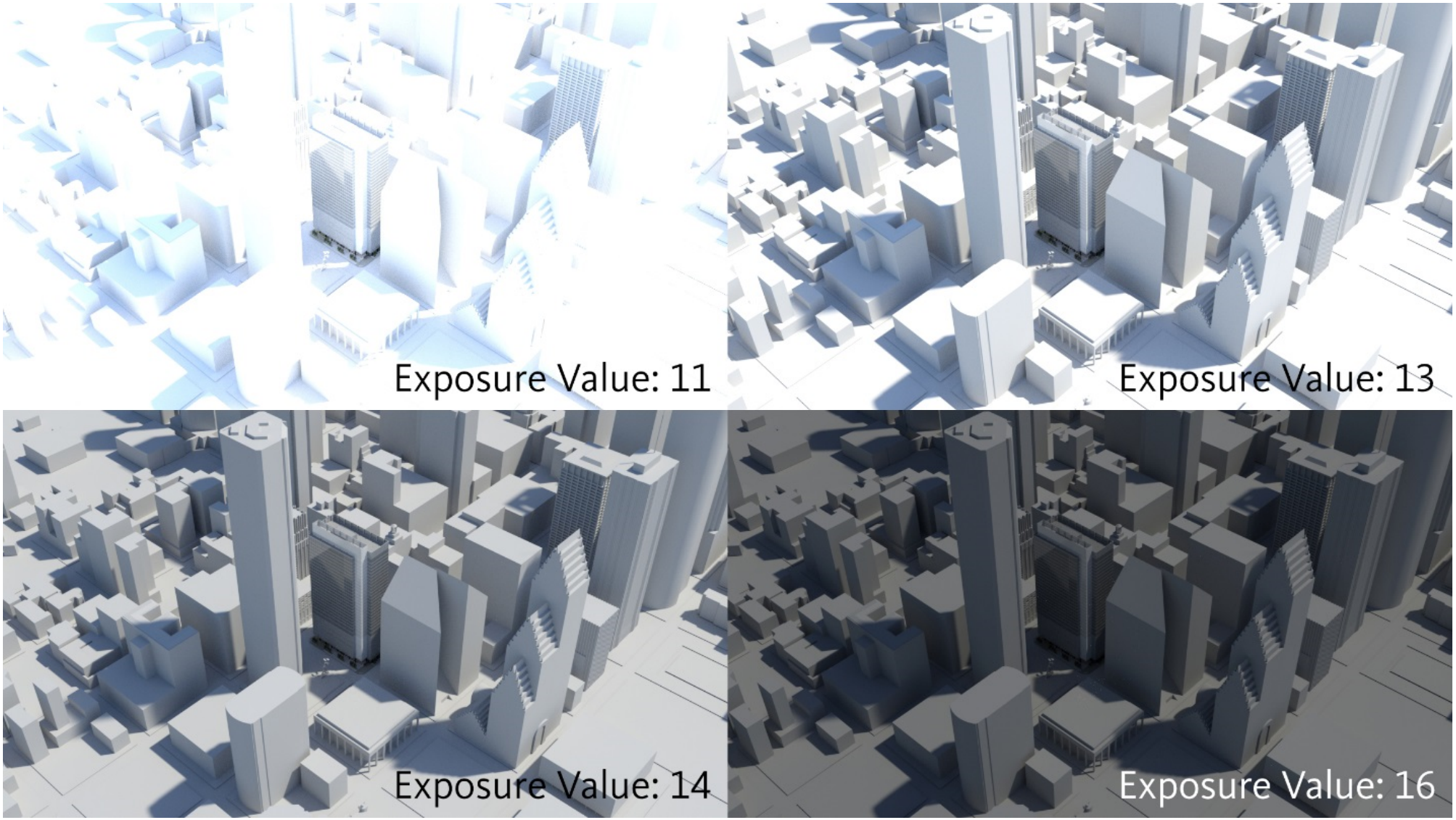

F-Stop: 8.0
ISO: 200
Shutter Speed: 1/300

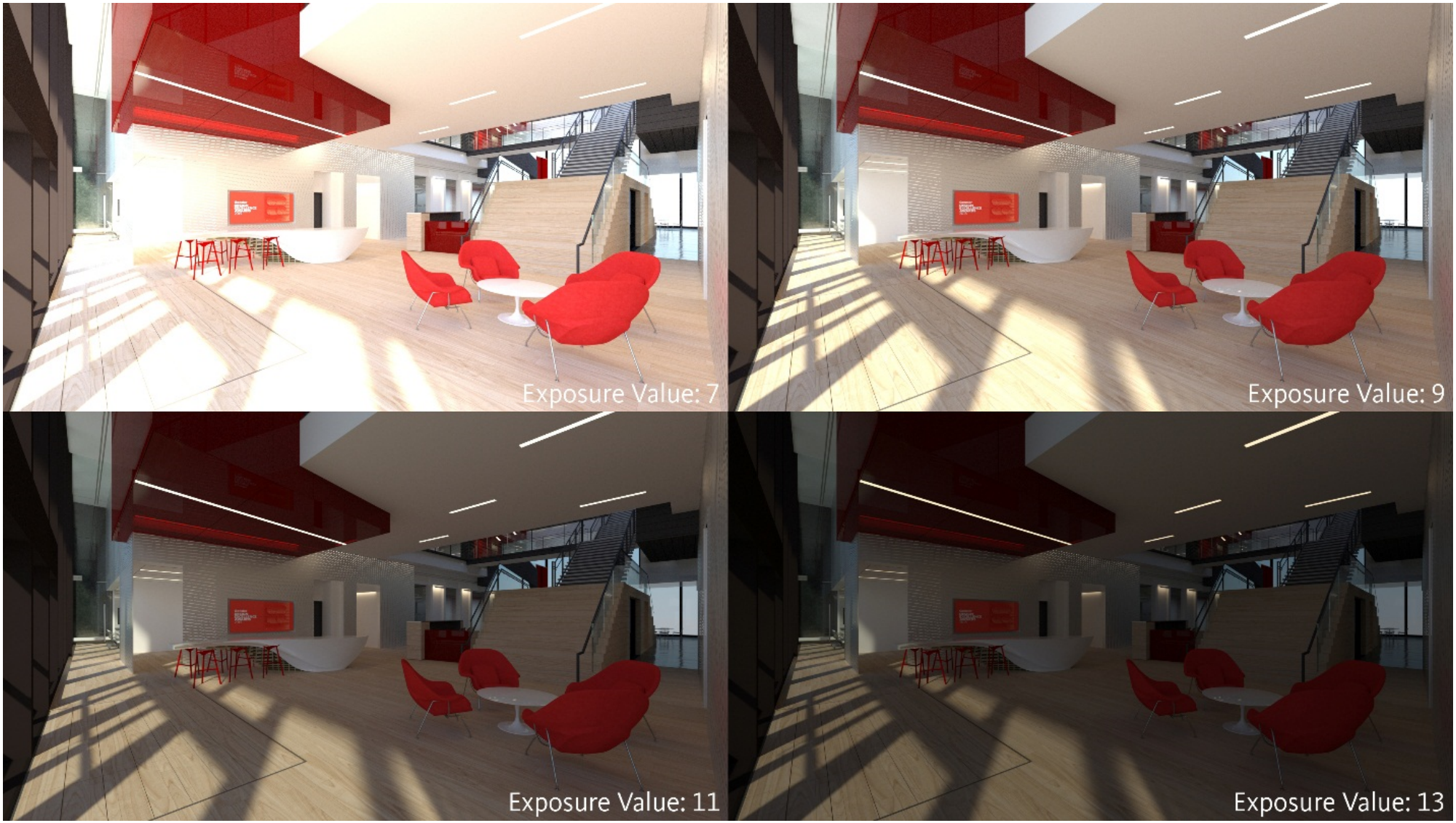

F-Stop: 8.0
ISO: 200
Shutter Speed: 1/400

Real-World Camera Settings – Exposure Value (EV)

- This is a value that combines the **Exposure Triangle** of **Aperture (F-Stop)**, **Shutter Speed**, and **ISO** into one **single value**. All the various combinations will always yield the same level of exposure for the set **Exposure Value**. This can be a **quick** way to set the **Exposure** for the scene, especially if **Depth of Field** and **Motion Blur** are **not required**.

Daylight Settings	
Full Sunlight	**EV 13-14**
Hazy Sunlight	**EV 12**
Cloudy Bright	**EV 12**
Overcast	**EV 11**
Open Shade with Clear Sunlight	**EV 11-12**
Interior Lighting	
Galleries	**EV 7-10**
Office and Work Areas	**EV 6-8**
Home Interiors	**EV 5-7**


Exposure Value: 11
Exposure Value: 13
Exposure Value: 14
Exposure Value: 16


Exposure Value: 7
Exposure Value: 9
Exposure Value: 11
Exposure Value: 13

Real-World Camera Settings – White Balance

- **This value is based off of the Kelvin Temperature Scale, and will determine what color value will be considered white by the camera. For instance, if the temperature of a light is 5000k, and the White Balance is set to 5000k, the light will appear white in the rendering.**
  - The **higher** the number, which results in a **cool temperature**, the **warmer** the rendering will look.
  - The **lower** the number, which results in a **warm temperature**, the **cooler** the rendering will look.
  - A value of **6500K** is perfect for exterior daytime renderings.
  - A value of **4500-5000K** is a good starting point for interior renderings.

Color Temperature	Light Source
6500K	Daytime / Cloudy
5500K – 6500K	Daytime
5000K	Camera Flash or LED
4000K – 5000K	Fluorescent Light
3000K – 4000K	Sunrise / Sunset
25000 – 3000K	Incandescent Lighting
2000 – 3000K	Tungsten Bulbs


White Balance: 3500K


White Balance: 4500K


White Balance: 5000K


White Balance: 6500K

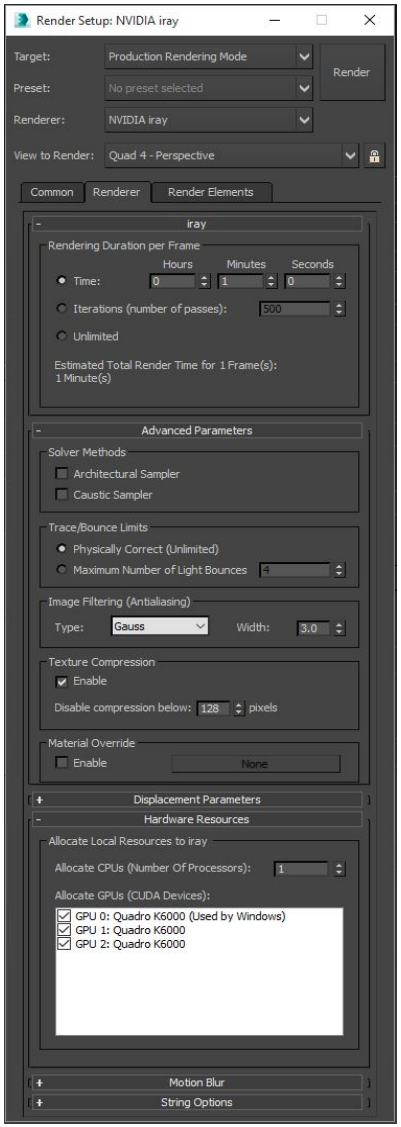
Chapter 5: Iray Settings

Render Settings Overview

- **Enable Iray in both Production and Active Shade**
- **Setting Rendering Calculations:**
  - Time – How long to render (Best to control time)
  - Iterations – How many calculations (Best for consistent quality)
  - Unlimited – Go until I say stop. (Best in Active Shade)
- **Set Hardware Resources:**
  - Set the number of CPU Cores to render with
  - Set which GPUs will do the rendering
    - Disable GPU-0 (Windows) in ActiveShade for better performance

Iray Production Mode

- **Enable all CPUs and GPUs.**
- **LPEs are only available during Production Rendering.**
- **Best for rendering animations.**
- **Optimal Iterations for quality:**
  - Exterior: 3,000 – 5,000 Iterations
  - Interior: 10,000 – 15,000+ Iterations



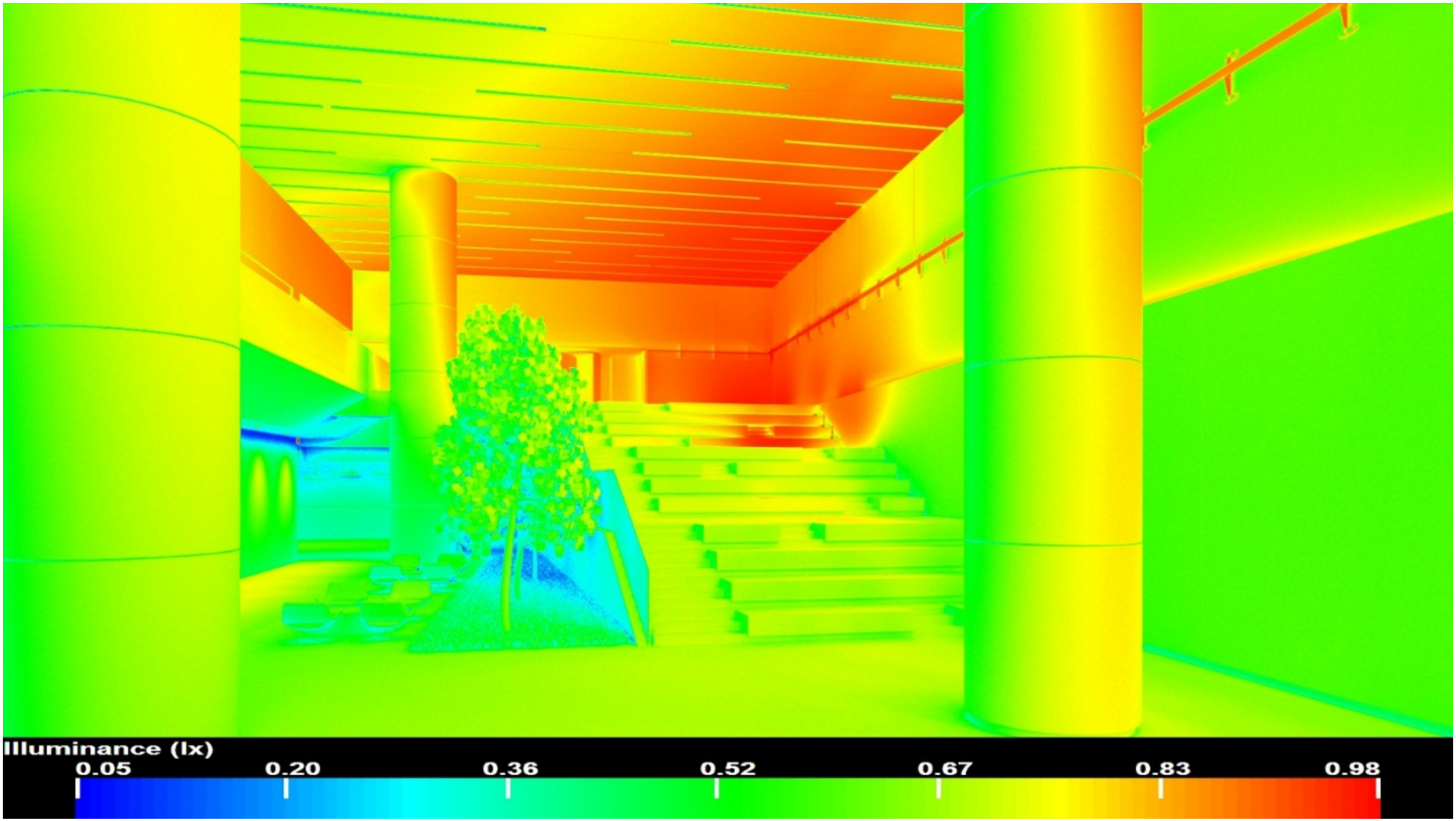
Iray Active Shade

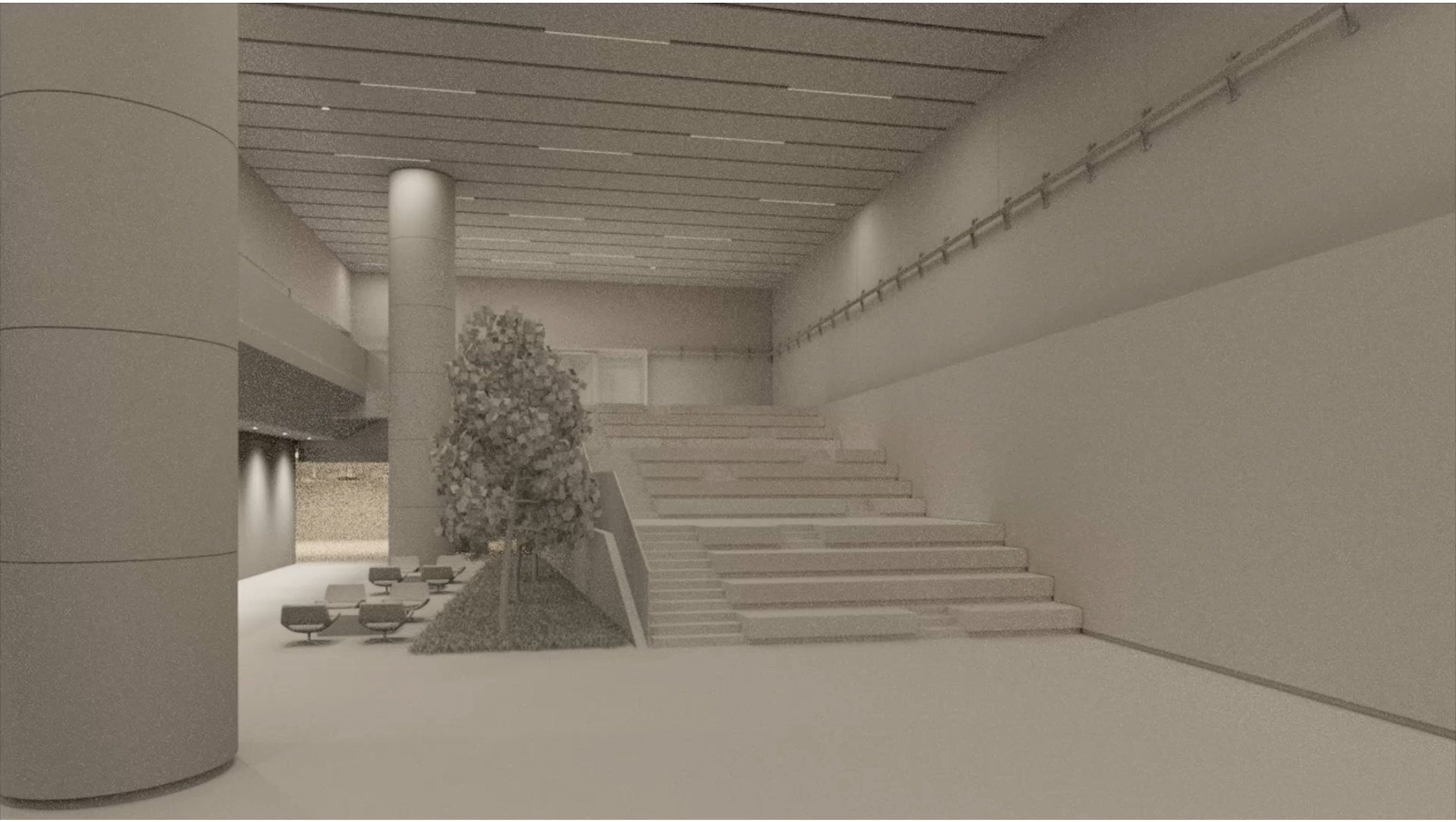
- **Interactive Features:**
  - Material Changes
  - Camera/Perspective Changes
  - Exposure Changes
  - White Balance Changes
- **Non-interactive Features:**
  - Creating Lights
  - Changing Light Intensity
  - Moving Lights*

Chapter 6: Irradiance Mode (2016 & 2017)

Irradiance Mode (3ds Max 2016-2017)

- **Enable Irradiance under the Render Elements**
  - This is found only in the Production Rendering Mode for Iray
  - The main rendering will be completely white. The Irradiance will show up after the rendering fully completes.
- **For best accuracy use the following**
  - IES files that are the correct specification to the lighting fixtures in the project.
  - Use the 3ds Max Daylight System for the mrSun and mrSky.
- **The following will reduce the accuracy of the Irradiance Render:**
  - Photometric Lights without IES files
  - IBL (HDRI) used for the environment light and sunlight.


Illuminance (lx)
0.05
0.20
0.36
0.52
0.67
0.83
0.98



Chapter 7: LPE and Post Production

LPE (Light Path Expressions)

- Mathematical Equations that can pull specific elements out of the buffer for compositing in post
- Known as A Regular Expression Language (REGEX)
- Can write your own LPEs
- Visit NVIDIA's blog for ongoing discussions
  - blog.irayrender.com

LPE Example: Beauty Pass

- Beauty Pass = L .* E

LPE Example: Area Lights

- Area Lights = La .* E

LPE Example: Indirect Illumination (2+ Bounces)

- Indirect Illumination = L {2,} E

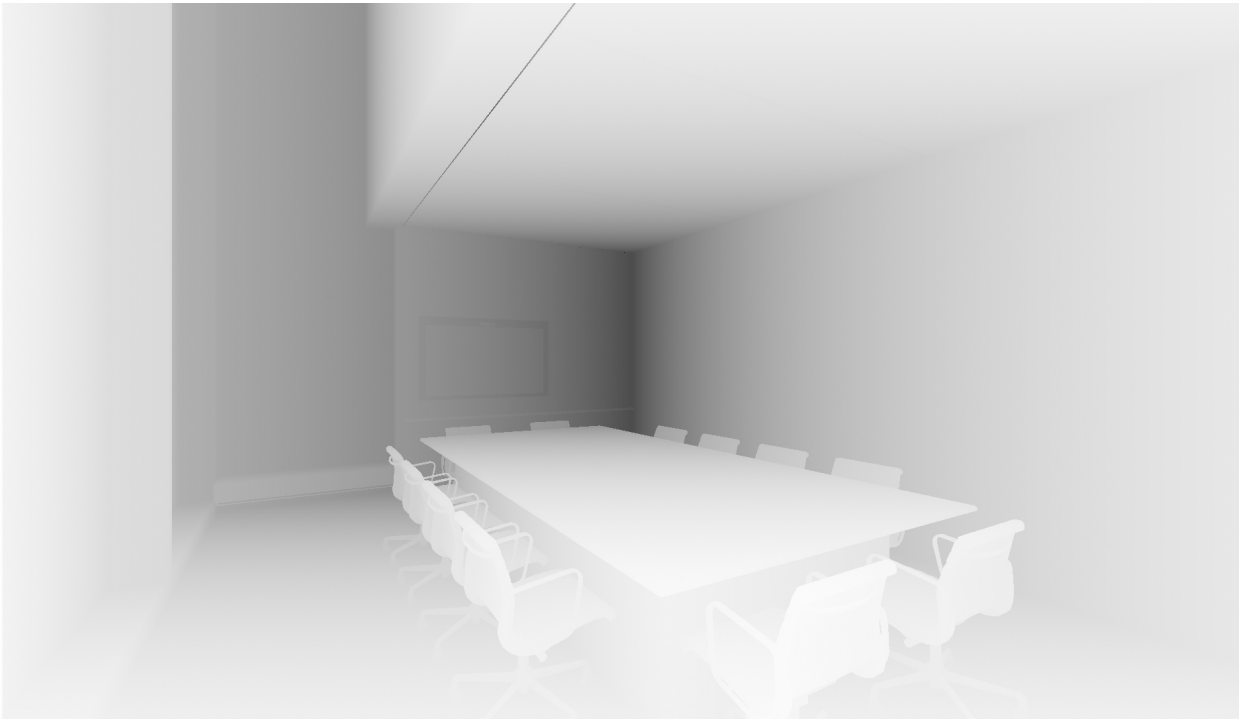
LPE Example: Adding Passes Together


+

=


LPE Example: Standard Preset Render Element

- Z-Depth and a few others



The Elements of LPEs

- **Eye Event**
  - E – Eye/Camera/View

The Elements of LPEs

- **Eye Event**
  - E – Eye/Camera/View
- **Light Event**
  - L – All Lights
  - Lp – Point Lights
  - La – Area Lights
  - Le – Environment/Background Lights
  - <L ‘handle’> - Light Source Defined by a Handle
    - Set by Layer Name

The Elements of LPEs

- **Light Interaction Events: < t m h >**
  - **Type (t)**
    - R – Reflection
    - T – Transmission
    - V – Volume

The Elements of LPEs

- **Light Interaction Events: < t m h >**
  - **Type (t)**
    - R – Reflection
    - T – Transmission
    - V – Volume
  - **Mode (m)**
    - D – Diffuse
    - G – Glossy
    - S – Specular

The Elements of LPEs

- **Light Interaction Events: < t m h >**
  - **Type (t)**
    - R – Reflection
    - T – Transmission
    - V – Volume
  - **Mode (m)**
    - D – Diffuse
    - G – Glossy
    - S – Specular
  - **Handle (h)**
    - Set by Layer Name

The Elements of LPEs

- **Symbols**
  - **.**
    - Defined as a ‘Wild Card’
  - *****
    - Defines any number of Set Light Source Events
  - **< >**
    - Defines a Light Interaction Event
  - **[ ]**
    - Defines a “Set” within a Light Interaction Event
  - **^**
    - Excludes, or inverts, an element from a Light Interaction Event.

The Elements of LPEs

- **Operands Symbols**
  - **Quanifiers**
    - **?**
    - *****
    - **+**
    - **{ }**
  - **Concatenation**
    - **A** – First Event or First LPE
    - **B** – Second Event or Second LPE
  - **Alternatives**
    - **|** - Shows one or the other

The Elements of LPEs

- **List of Operands**
  - **AB**
    - Set A first, then B
  - **A | B**
    - Sets A or B
  - **A?**
    - Might set A, if A is present
  - **A***
    - Sets any occurrences of A in sequential order, including zero

The Elements of LPEs

- **List of Operands**
  - **A{n}**
    - Sets exactly *n* consecutive occurrences of A
  - **A{n,m}**
    - Sets from *n* to *m*, inclusively, occurrences of A
  - **A{n,}**
    - Sets *n* or more occurrences of A
  - **NAME: expression**
    - Sets a name for the expression for reference in another expression
  - **$name**
    - References another named expression
  - **^expression**
    - Creates and inverse of the expression

Deconstructing LPE's

Deconstructing LPE's

Deconstructing LPE's

L.* <R[GS]> E

"Reflection" Pass LPE

Deconstructing LPE's

L.* <R[GS]> E

Light Event

Deconstructing LPE's

L.* <R[GS]> E

Light Interaction Event

Deconstructing LPE's

L.* <R[GS]> E

Eye Event

Deconstructing LPE's

'chairs'

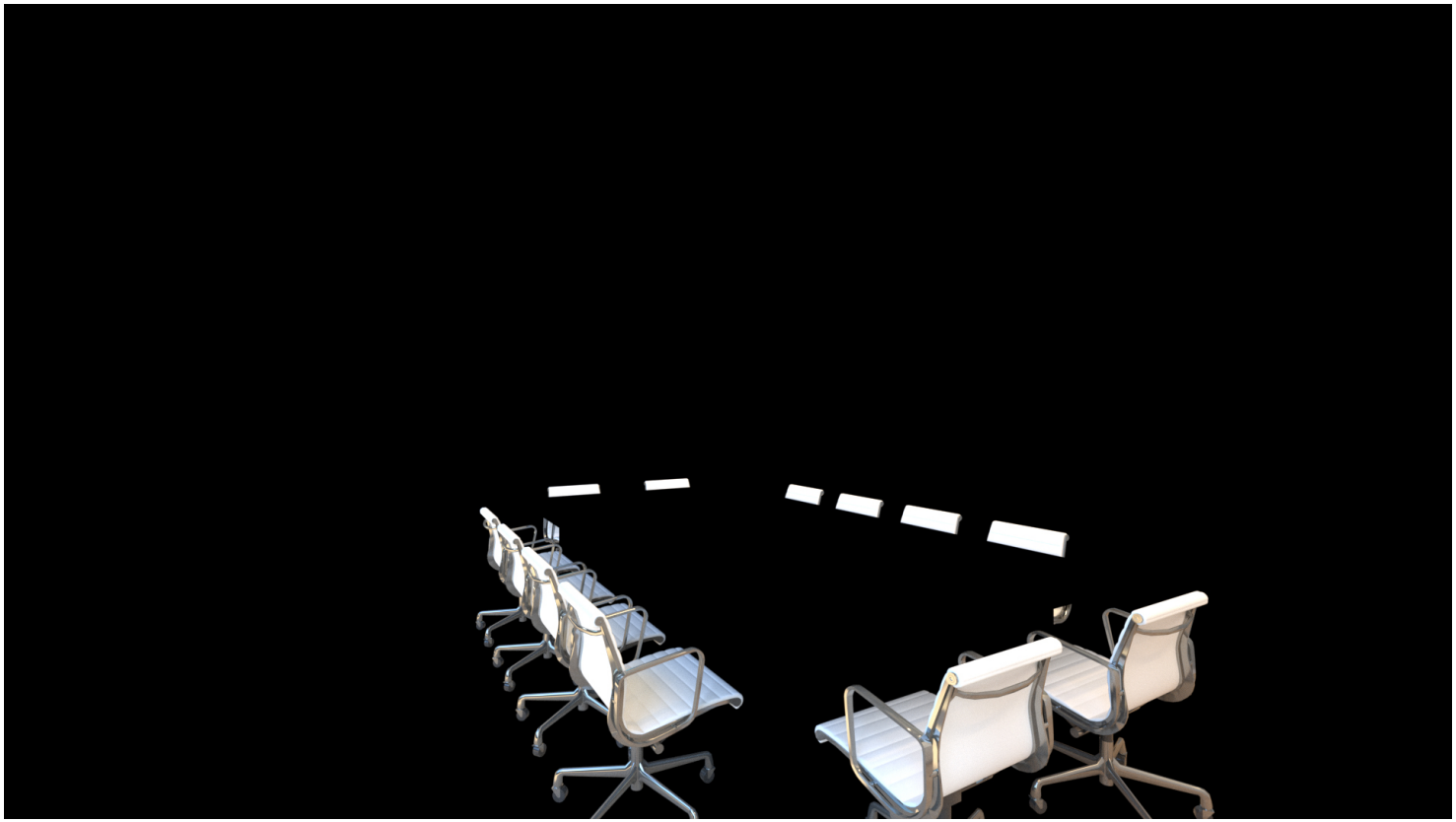
This is a handle for the 'chair' objects in the render.

Deconstructing LPE's

L.* 'chairs' E

All Direct Events on the "chairs" objects

Deconstructing LPE’s



Deconstructing LPE's

L.* 'chairs' .*E

All Events everywhere that effect "chairs" objects

Deconstructing LPE's

Deconstructing LPE's

L.* <RD'chairs' .*E

All Reflective Diffuse Rays everywhere that effect "chairs" objects

Deconstructing LPE's

Deconstructing LPE's

L.* <RG'chairs' .*E

All Reflective Glossy Rays everywhere that effect "chairs" objects

Deconstructing LPE’s

Let’s study some color options!

LPE in Post Production – Fabric Wrapped Panels

- L .* ‘fwp’ .*E

LPE in Post Production – Chairs: Diffuse Pass

- L .* <RD'chairs'> .*E

LPE in Post Production – Chairs: Glossy Pass

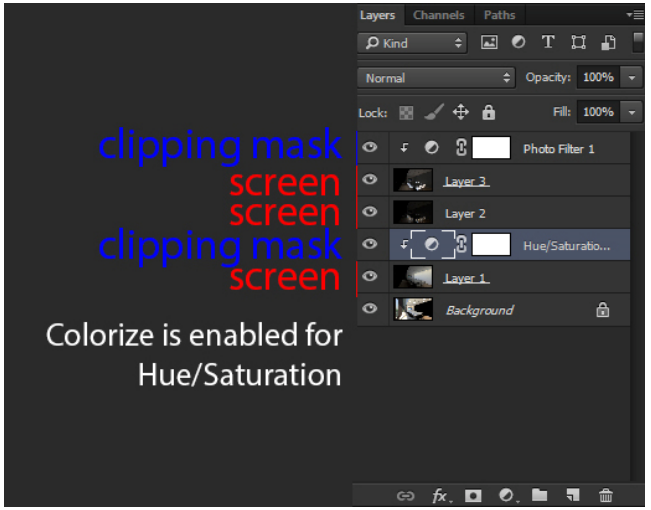
- L.* <RG'chairs'> .*E

LPE in Post Production – Fabric Wrapped Panels

- ^(L.* (‘fwp’ | ‘chairs’) .*E)

LPE in Post Production – Photoshop Set Up

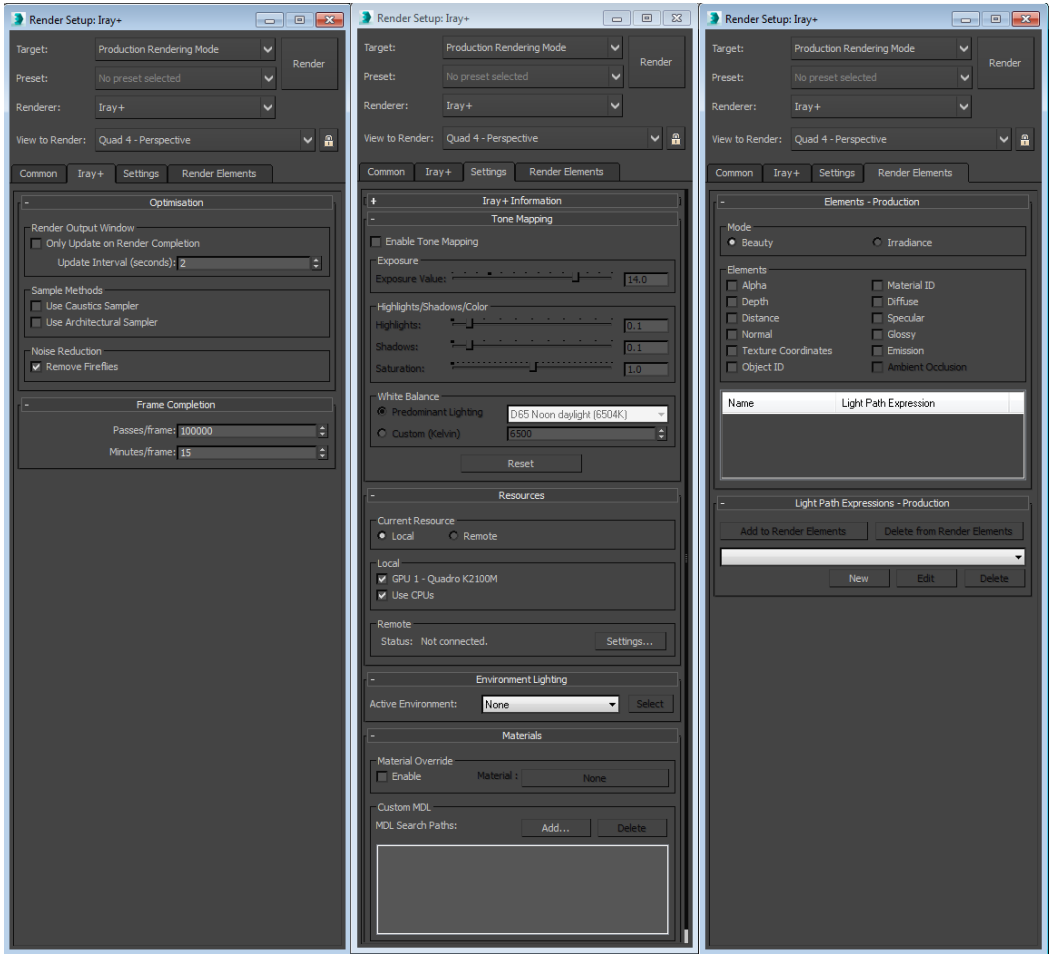
Beauty Pass = L .* E



Chapter 8: Iray for 3ds Max

Iray for 3ds Max Features

- **Convert Iray from 3ds Max to Iray for 3ds Max with a few clicks through an included converting tool.**
  - Iray for 3ds Max does not support Shaders other than the Iray for 3ds Max Shaders, so scenes will need to be converted.
  - Iray for 3ds Max does not fully support the 3ds Max 2016 Physical Camera at this time.
- **Direct MDL Support**
  - Import MDL through the Iray for 3ds Max Shader
  - Supports “Measured Material” MDLs
- **Fully Interactive in Active Shade**
  - Every change in the scene will be updated in Active Shade buffer
- **Two Flavors**
  - Iray for 3ds Max
    - Used for Photorealism
  - Iray for 3ds Max Interactive
    - Super-fast, but limits ray bouncing to achieve the speed.
- **NVIDIA VCA Support**
- **Iray Server**


Render Setup: Iray+
Target:
Production Rendering Mode
Preset:
No preset selected
Renderer:
Iray+
View to Render:
Quad 4 - Perspective
Render
Common
Iray+
Settings
Render Elements
Optimisation
Render Output Window
Only Update on Render Completion
Update Interval (seconds): 2
Sample Methods
Use Caustics Sampler
Use Architectural Sampler
Noise Reduction
Remove Fireflies
Frame Completion
Passes/frame: 100000
Minutes/frame: 15
Iray+ Information
Tone Mapping
Enable Tone Mapping
Exposure
Exposure Value: 14.0
Highlights/Shadows/Color
Highlights: 0.1
Shadows: 0.1
Saturation: 1.0
White Balance
Predominant Lighting
D65 Noon daylight (6504K)
Custom (Kelvin)
6500
Reset
Resources
Current Resource
Local
Remote
GPU 1 - Quadro K2100M
Use CPUs
Status: Not connected.
Settings...
Environment Lighting
Active Environment:
None
Select
Materials
Material Override
Enable
Material :
None
Custom MDL
MDL Search Paths:
Add...
Delete
Elements - Production
Mode
Beauty
Irradiance
Alpha
Depth
Distance
Normal
Texture Coordinates
Object ID
Material ID
Diffuse
Specular
Glossy
Emission
Ambient Occlusion
Name
Light Path Expression
Light Path Expressions - Production
Add to Render Elements
Delete from Render Elements
New
Edit
Delete

NVIDIA Iray VCA

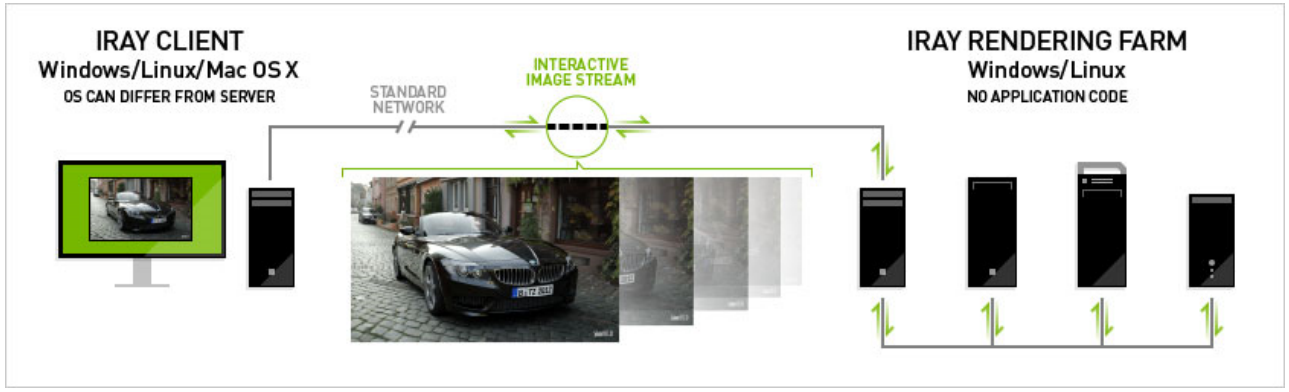
The NVIDIA VCA is a server contains 8 Quadro M6000s and can be linked together with other VCAs through InfiniBand technology. Iray for 3ds Max will allow a direct connection to the VCA, enabling users to have access more GPUs than their desktops could ever hold. When the VCAs are linked, the number of GPUs that are available to render with go up exponentially.

- 8 Quadro M6000s per VCA
- Linked VCAs through InfiniBand
- Direct Connection to VCA through Iray for 3ds Max Interface
- Can reduce rendering times drastically

Images provided by NVIDIA

Iray Server

- Supports any version of NVIDA Iray Plugins
- Can run on either Windows or Linux machines
- Cache Management minimizes submission times
- Flexible queue management system
- Entire cluster can coordinate together for rapid image creation
- Custom scripting allowed when jobs are completed
- Streaming behaves identically to local interactive rendering



Images provided by NVIDIA

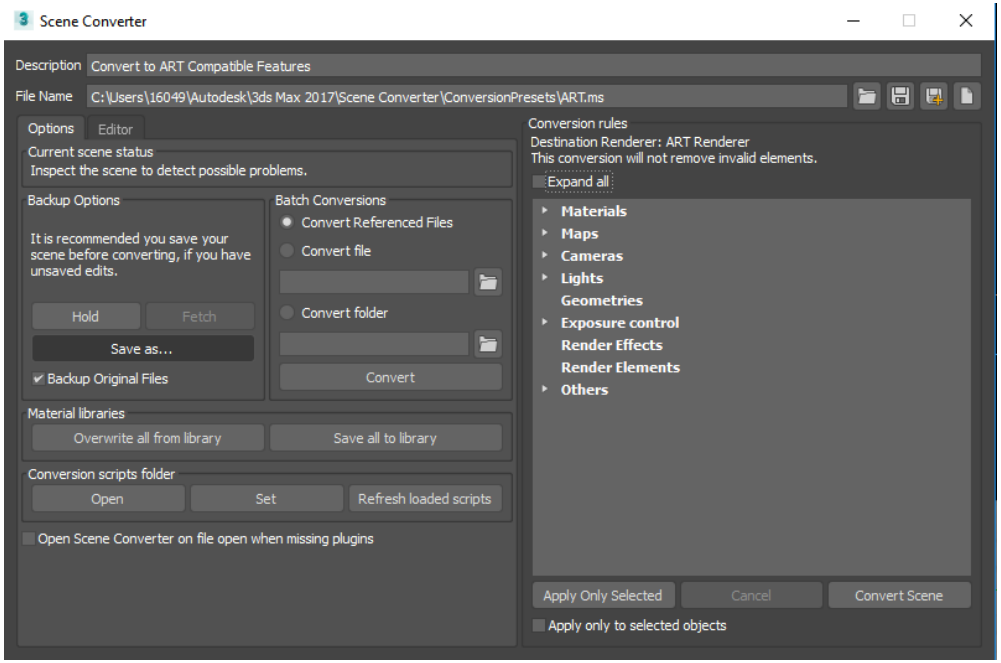
Chapter 9: Other Render Engines

Key Things to Change

- **Materials**
  - Depending on the engine you are using, Materials will need to be converted from the Autodesk Materials to the ones supported by your rendering engine of choice.
- **Lights**
  - Some engines support the Photometric and Standard 3ds Max Lights, but some require users to use lights specific to the engine. This will require users to replace all lights in the scene with lights that are supported by the Engine
- **Cameras**
  - The new Phsyical Camera inside of 3ds Max isn't widely supported by most engines yet. Some engines will still support the Standard Camera, but others will require users to use Cameras that are specific to that engine.

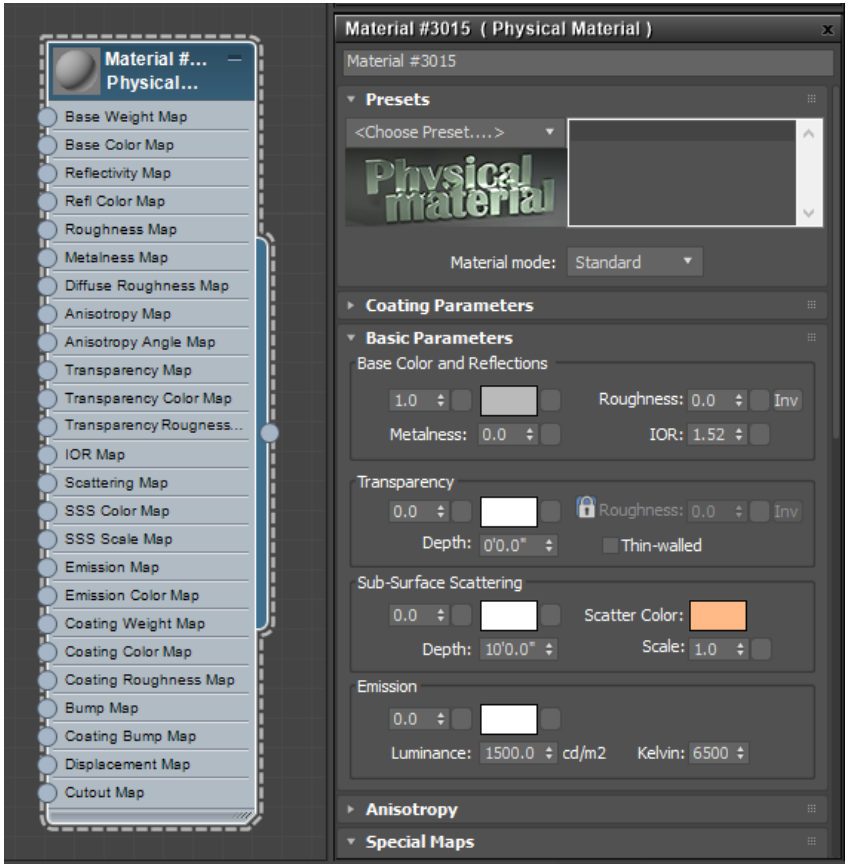
Scene Converter – 3ds Max 2017+

- Designed to help convert scenes from one rendering engine to another.
- Only supports converting scenes from Revit to Autodesk Raytracer (ART) out of the box.
  - Requires support from 3rd Parties, or the community, to create the conversion scripts to run with the tool.
- Will help create back-ups and other workflows to ensure if a scene breaks, it can be fixed.

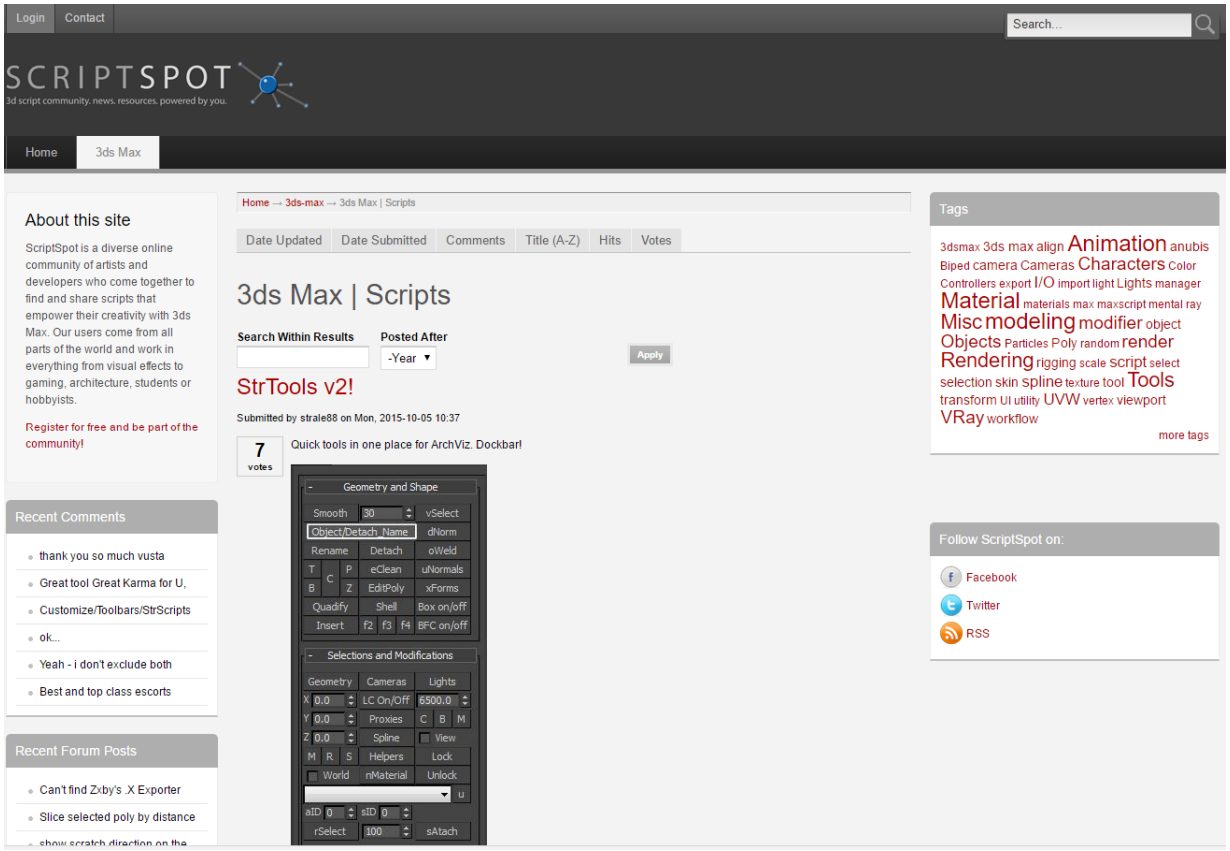


Physical Material

- Designed to be a single material that can work across multiple engines. Support is open for 3rd parties to adopt.
- Uses the Metallic/Roughness workflow that can be currently found in Unity or Unreal. But it also supports typical Reflectivity/Glossiness Workflows for backwards compatibility with “old” materials.
- Recommended to use this Material when using Autodesk Raytracer (ART)
- Not much 3rd Party support yet, but expected to grow in the upcoming releases.



Max Scripts can help!



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