Introduction to Design Visualization Concepts

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AC5408

Are you new to design visualization? Are you having a hard time understanding the language needed to communicate or produce the daily requests for images or videos? Do you not know how a photorealistic image is constructed from a software perspective?

Through various software examples, you will learn the basics of design visualization. This lecture will help you understand the language used to create images or videos that will communicate your designs. Get an overview of the Autodesk design visualization portfolio.

Learning Objectives

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

- Understand techniques needed to create a photorealistic 3D rendering and how they are used in various Autodesk products

- Understand the language and terminology used in context of design visualization projects

- Understand the principles behind the creation of images and videos, and choose the right output for different presentations

- Get an overview and comparison of various Visualization Solutions in the Autodesk products portfolio

About the Speakers

Marion Landry

Marion Landry has over 18 years of experience in Architectural Visualization, working with a range of software including Autodesk® 3ds Max® Design and Autodesk® Showcase™. She has worked for various architecture firms in Vancouver, BC and on numerous projects from concept design to high-end visualization.

As a Technical Marketing Manager for Autodesk, she focuses on the creation of technical demonstrations and workflows with Autodesk® 3ds Max® Design and Autodesk® Showcase™. She also contributed in the writing of multiple white papers including: Daylight Simulation in 3ds Max Design 2009 (Getting started and advance), Using the Autodesk Civil Visualization Extension for 3ds Max Design and AutoCAD Civil 3D and more recently Easier mental ray rendering for designs workflows.

You can follow Marion's technical advice and tips & tricks publication on her YouTube channel and on twitter. She also answers technical questions and offer supports on The Area Autodesk Showcase forum.

Pierre-Felix Breton

Pierre-Felix Breton is a product designer who specializes in the field of physically-based lighting simulation and rendering.

Currently employed by Autodesk, he participates in the creation of core rendering technologies that are embedded into applications such as Autodesk® Revit®, Autodesk® AutoCAD®, Autodesk® Fusion360® and Autodesk® 3ds Max®.

As his professional background includes electrical engineering, computer programming, and theatrical lighting, Pierre-Felix consults regularly on various architectural lighting design projects as a designer, technical coordinator, and simulation specialist.

# <u>Fundamentals of Photorea**li**stic Rendering</u>

In order to obtain an image that is as realistic as possible, the laws of physics must be respected by all aspects of the rendering process.

This is also referred as "*Physically Based Rendering*".

This is based on three fundamental elements:

- Materials
- Lighting
- Camera/viewing

Each one represent the leg of a tripod: if one element is setup wrong, the tripod falls down - the resulting image will look incorrect.
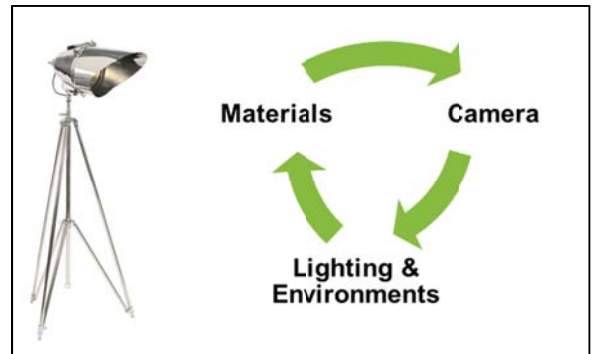
Fortunately, the general trend in computer graphics is to move towards a physically based rendering and get all those aspects "right".

As a result, the workflow is similar to "point and shoot" cameras and rendering has become accessible to anyone.

Materials (or *Appearances)*

Real materials have physical characteristics that alter how light is reflected. In 3d software the principles are the same: users have to define how light interact with materials. The bulk of the work involves defining color, micro deformations and roughness.

Base Color & Texture Wrapping

The most important aspect of a material is its base color.

Although uniform finishes such as painted wood or plastics can be defined by a solid color, the appearance of many materials (such as ceramic tiles or fabrics) varies along their surface.

To accomplish this, we need to use digital pictures (called "*textures[1]*" in the rendering jargon) as if they were "gift wrappers".

Autodesk products offer various ways to "wrap"



Its like wrapping a gift….   …on geometry

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[1] "*Texture*" is generally confusing for people who are not specialists in computer graphics as it often relates to how a surface feels when you touch it (i.e. a glossy ceramic which is smooth or a rough stone)

images around geometry. AutoCAD, Fusion and Revit for example, offer basic image placement methods while 3ds Max offers more advanced placement methods. The scale and orientation of the texture map is controlled by what we call "UV coordinates" or "UV mapping" - UV being equivalent to X and Y coordinates for regular geometry.

Importance of seamless images (tiling)

A critical aspect of texture mapping relates to how the image is tiled across the surface of the 3D object. If an image is used as a gift wrapper without modifications, the edges of the image will become visible and the result will look unnatural.

Images used as textures must be modified (typically in Photoshop or other specialized software) to become seamless and usable for photorealistic result.
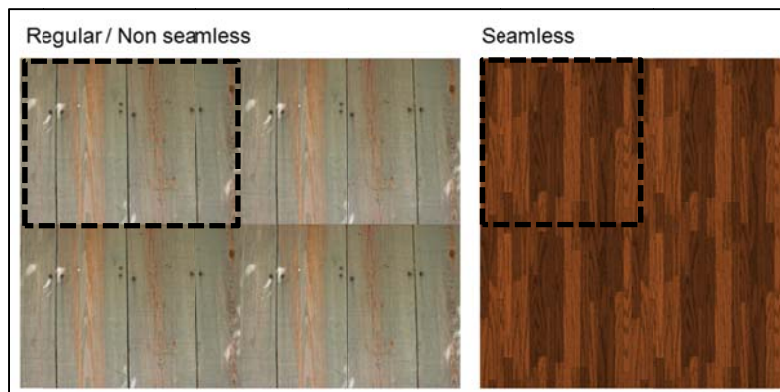
Reflectivity, falloff & roughness

Materials will reflect more light when viewed at grazing angles than when they are viewed straight-on. With a physically based renderer, this is built-in.

Then comes the amount of "roughness", or how smooth / rough a material is (micro deformations). Polished materials will have fewer irregularities than rough materials, and therefore reflect light in a more focussed way (reflections are sharp as opposed to blurry).
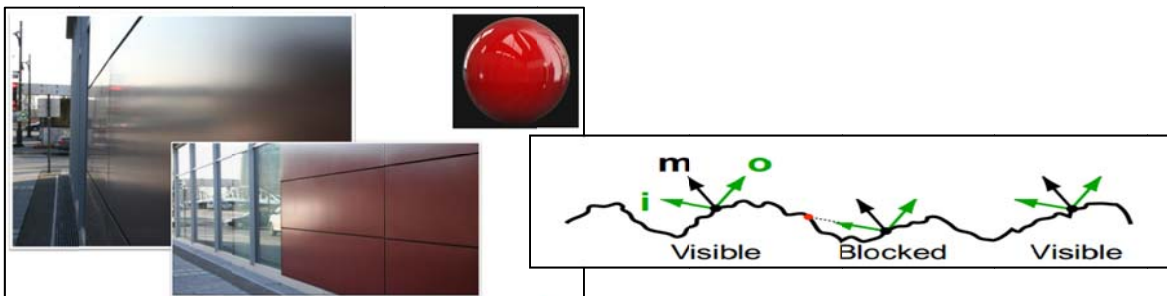
Bump & Relief

To add irregularities without having to model them, we use images (texture maps) defining height and deformation information.

We call these special images "*height maps*" or "*normal maps*".

The principle is the same as regular texture mapping used for color information; the only difference is that "height maps" and "normal maps" define how surfaces are embossed or deformed.
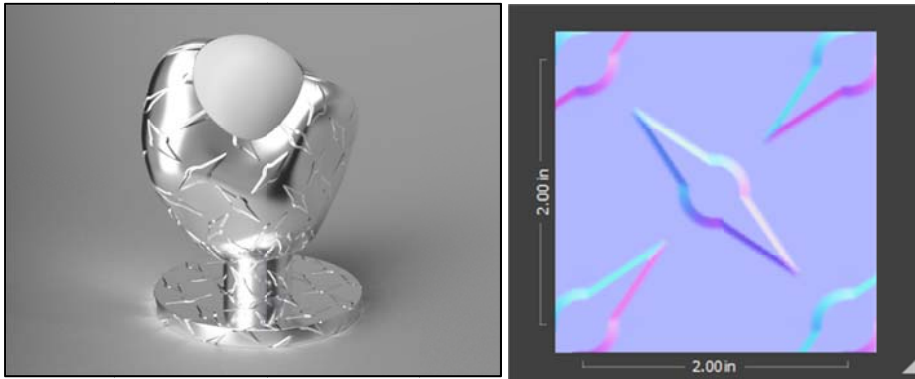
Checker plate bumps achieved with a *normal map*

"*Normal maps*" (which typically look purple/green) are generated with specialized software and cannot be modified in photo editing programs such as Photoshop without dedicated plugins.

On the other hand, "*height maps*" (which are typically black and white) can be edited in Photoshop and are simpler to deal with as they only store elevation data.
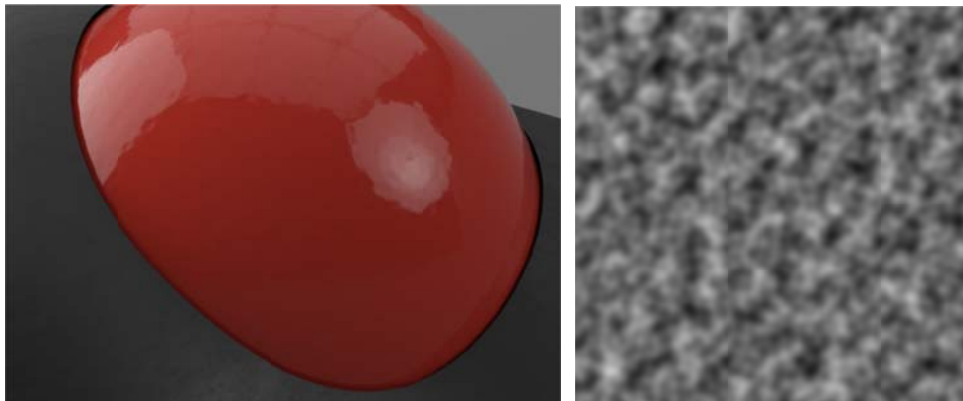

Orange peel slightly deforming reflections achieved with a *height map*

Holes and cut-outs

Similarly, holes don't have to be modeled as geometry. Special images – mapped on the object surface - can indicate to the renderer where to punch holes and where to stay solid.

Holes and cut-out maps are black and white images as they only need to give "*see-thru*" information to the renderer.

For example, a metallic mesh surface will looks very realistic when *cut-outs* patterns are combined with a matching *bump* pattern.
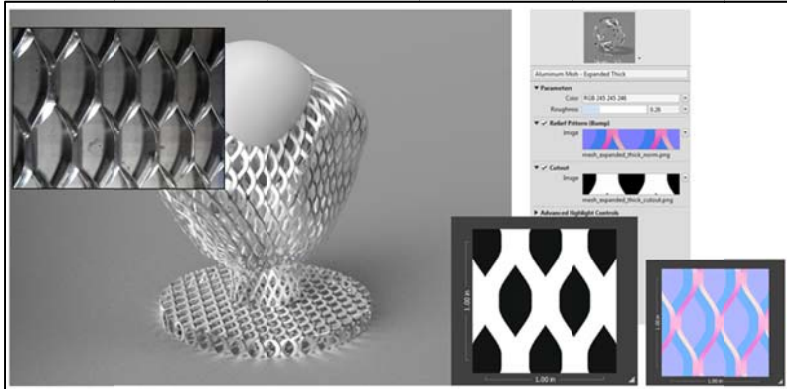

Metallic mesh holes with a cutout map combined with a normal map

Translucency

Another layer of "effect" found in material definitions is called "*translucency*".

Incoming light rays are internally scattered at various depths and wavelengths as opposed to be simply blocked out.

Marble, plastics, porcelain typically need *translucency* to give highly photorealistic results. Keep in mind however that *translucency is computationally intensive.*
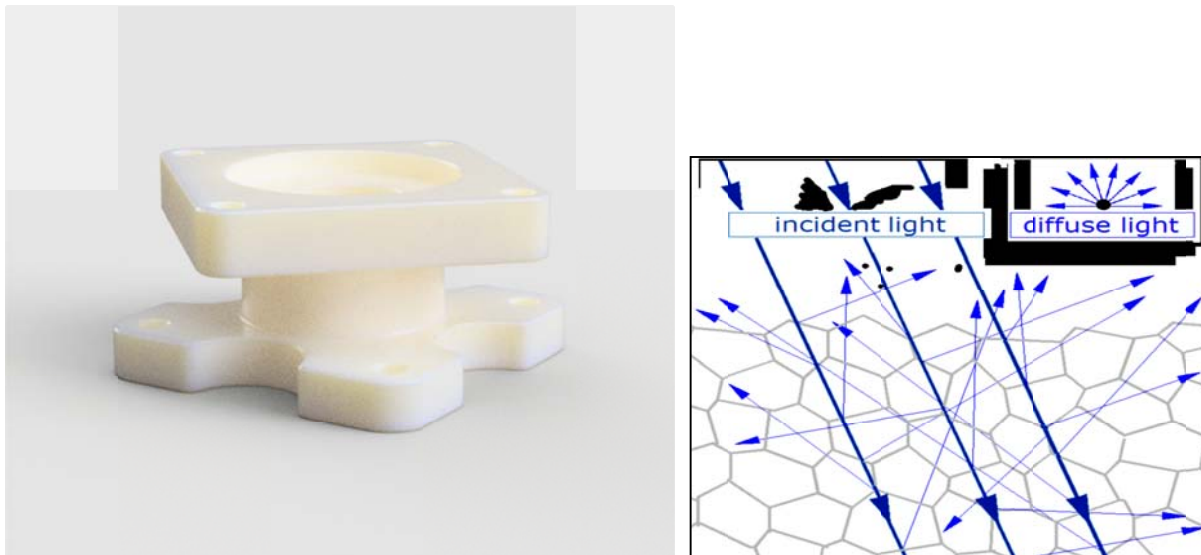

Translucent plastic with internal light scattering

Transparency

On the other hand, as opposed to *translucency*, *transparency* will let light rays through without scattering.

The directionality of the light rays is also affected by the "roughness" of the material. For example, acid etched glass has a high amount of "*roughness*", thus spreading light rays by a large amount, creating a blurry effect.
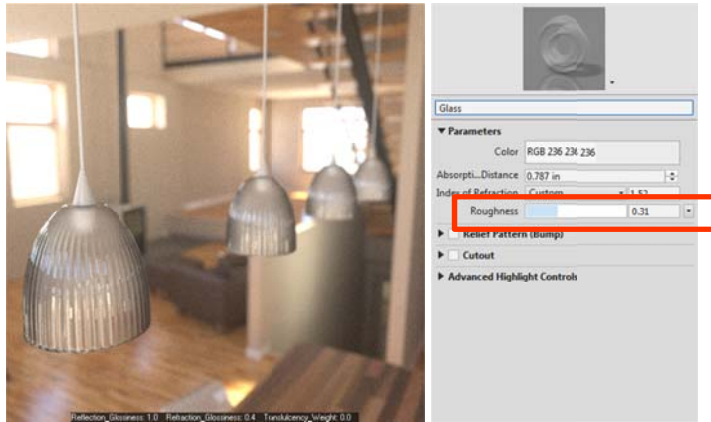
Transparent lamp shade with slightly rough reflections and refractions makes a soft blur

Complex materials

By stacking up effects (roughness, translucency, cut-outs etc.) and changing their contribution with a combination of several *texture maps* we can achieve visually rich materials.
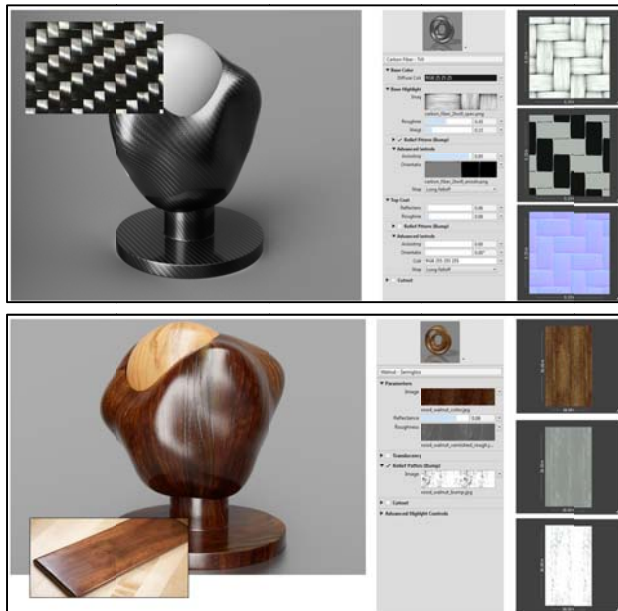
Carbon fiber and wood requires several layers of textures to look good.

Lighting & Environment

The next aspect to consider for photorealistic rendering is lighting. This part is often overlooked.

If the lighting or environment is poorly defined, the render will look flat and unrealistic even with perfect material definitions,

Since the environment is reflected by materials and contributes to the overall illumination of the model, the 'look' of final image will be tremendously affected.

Here are examples where the same object (with the same material) where rendered with different environments:
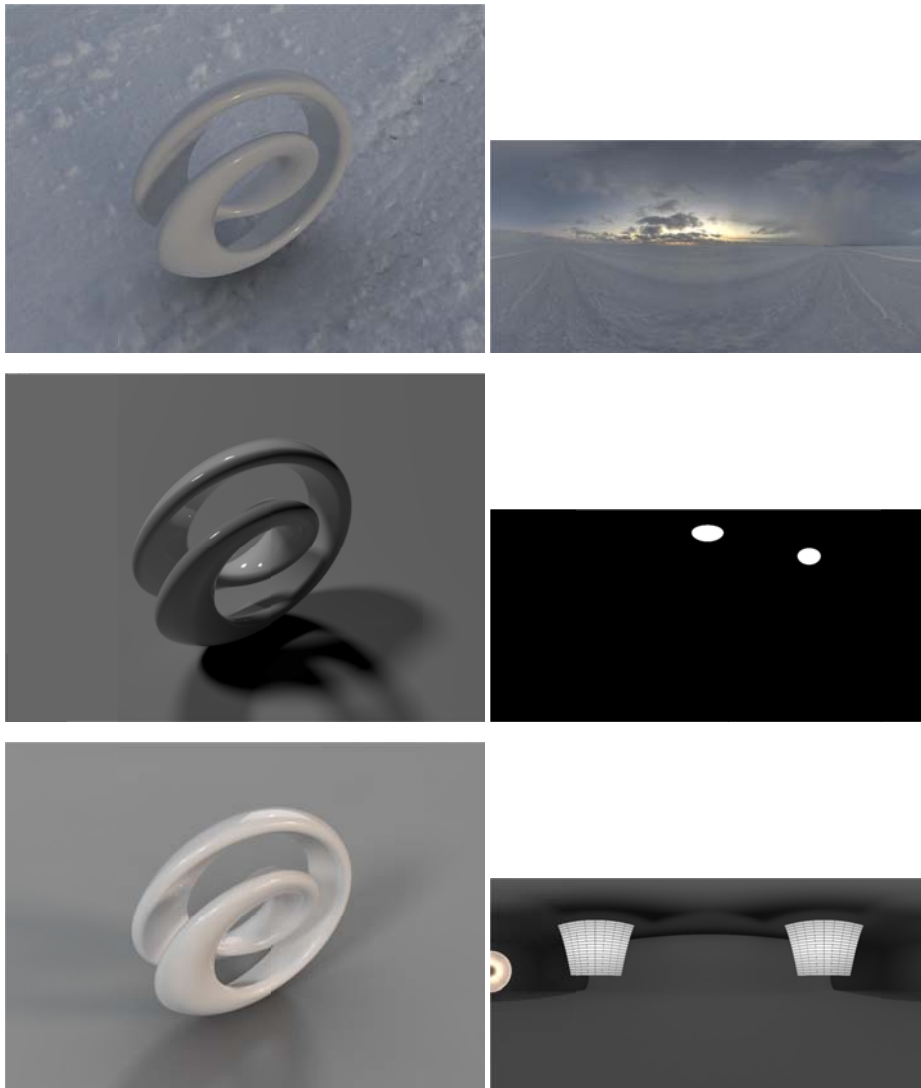
Different environments for the same model drastically change the look of the image

With rich and detailed environments, reflections and lighting become much more alive. For "mechanical" objects, you will get good results if there are noticeable and recognizable details in the environment.

In the following example, note how the horizon line or the grid-like pattern enhances the curvature of the car body:

Subtle details in the environment enhance curvature of objects (source: Fusion 360 gallery)

For architectural scenes, Sun/Sky backgrounds - one of the popular techniques used in today's renderings - contributes largely to the perception of space and forms as it helps modulating reflections and shadows inside the space.

Additionally, a mix between a cool/bluish exterior environment and a warm/yellowish interior lighting will help creating an eye pleasing image and mood:

(Source: Render 360 gallery)

Camera

Exposure

Physically based renderers compute light according to the law of physics so cameras must take into account a wide range of brightness values. Just like in real life, virtual cameras implement the notion of "*exposure*", which will let you adjust the relative brightness of the image independently from the lighting conditions of the 3d model.

A scene photographed with different exposure settings: although the lighting of the scene did not change, the exposure of the camera affected the brightness of the image.

Depth of field & lens distortion

Physically based renderers can also simulate depth of field and other lens attributes (optical defects) to help increasing the realism of an image or convey an emotion.

Depth of field

Other effects such as fish eye lenses, chromatic aberration etc. add great impact and realism to your renders.


Lens distortion, chromatic aberration and other special effects

Introduction to Photomontage/ post rendering processing

Alpha Channel

Photomontage implies the use of image compositing software such as Photoshop to make changes to the rendered image without having to re-render the originating scene.

For example, one of the most typical tasks that you may want to accomplish is to change the uniform background of an exterior rendering and replace it with a dramatic sky.
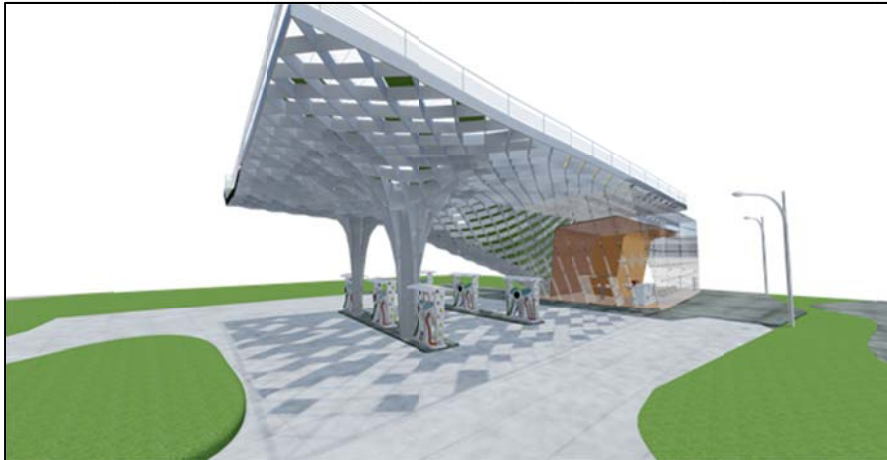
Original rendering

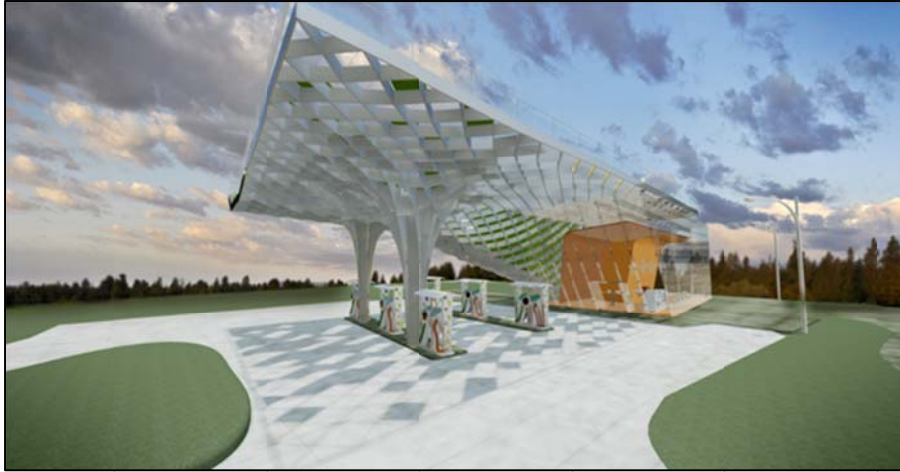This is made possible with the use of what is known as "Alpha Channel".

The "Alpha Channel" is additional information stored with an image file used to define transparent and opaque areas.
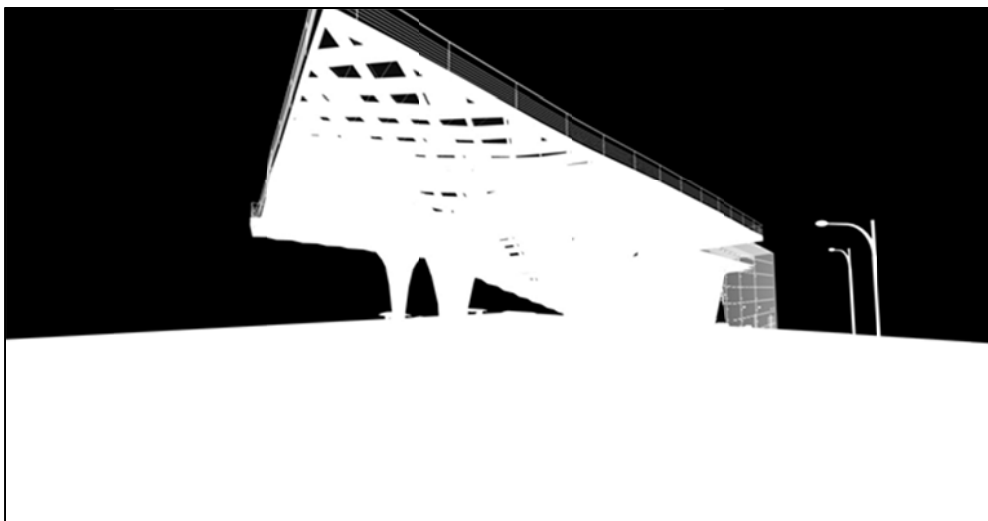
Alpha channel stored in the image

The "Alpha Channel" will then be used in an image editing software to easily select areas to be replaced.

Background replaced with a dramatic sky in Photoshop with the use of the Alpha Channel as a selection tool

Recommended file formats for photomontage

Format	Alpha Channel Support	Recommendation	Comments
PNG	Yes	High	Lossless compression. Good for a lot of projects, including web and mobile native display.
TIF	Yes	High	Industry standard for high quality imagery, but not read by all devices (web, mobile etc.)
BMP	No	Avoid at all cost!	Native windows format. Uncompressed, low bit depth.
JPG	No	Low	Good for quick web / email / PowerPoint work. No Alpha Channel, Compression artifacts

Application examples

Photomontage can be done with various levels of complexity / flexibility depending on the capabilities of the renderer.

For example, with Revit you can use views with different display styles to later composite them together in a final image.

In Showcase, you can output a PSD file which will separate the background environment, the objects and the shadow in 3 distinct layers.

In 3ds Max you can output an image with an Alpha channel as well as several other elements in distinct images (ex: a chair can be rendered separately from a room).

Different Revit views (diffuse, ambient occlusion, outline, shadows) with different styling blended together in Photoshop

Rendering still images

Image Resolution for printout

The number of pixels in an image defines what we call the "*image resolution*". This has a direct impact on the quality and size of your printouts.

To calculate the appropriate image resolution to be rendered, you need to take into account two things:

- The size of the image you want to print (ex: 8 x 11 inches)
- The dots per inch (DPI) of your printer (ex: 300 DPI)

DPI is a measure of spatial printing or video dot density, in particular the number of individual dots that can be placed in a line within the span of 1 inch.

The amount of pixel needed to print a certain image size will depend on the desired DPI. Your render times will also depend on the desired output size.
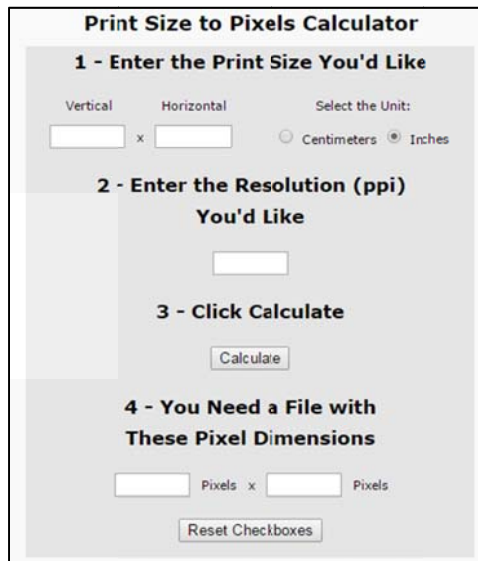
Example

8.5 x 11 inches printed @ 72 DPI will require an image rendered at 612 x 732 pixels, will render fast.

8.5 x 11 inches printed @ 300 DPI will required an image rendered at 2550 x 3300 pixels, will render longer.

Tip: an image size calculator can be found here:

http://www.photokaboom.com/photography/learn/printing/1_calculators.htm#Print

Print Size to Pixels Calculator

1 - Enter the Print Size You'd Like

Vertical   Horizontal   Select the Unit:

[   ] x [   ]   ○ Centimeters ◉ Inches

2 - Enter the Resolution (ppi)
**You'd Like**

[   ]

3 - Click Calculate

[Calculate]

4 - You Need a File with
These Pixel Dimensions

[   ] Pixels x [   ] Pixels

[Reset Checkboxes]

Image Resolution for screen presentation

For screen presentation, the image resolution needs are easier to understand as pixels usually get displayed at a 1:1 scale on display devices.

Application	Typical Resolution	Typical Render Time
Power Point Presentation	1920×1080	Medium
IPad	1920×1080	Medium
HD Video	1920×1080	Medium
Gallery on a webpage	800 x 400	Fast
Email	800 x 600	Fast
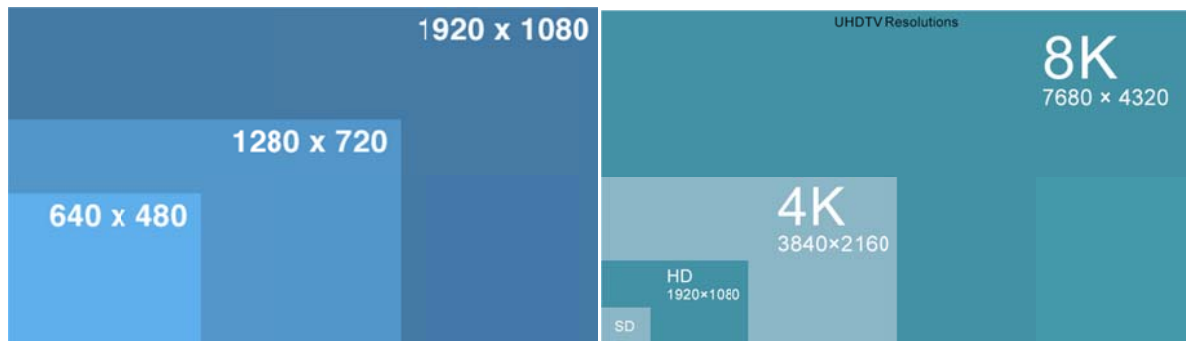
Standard resolutions for computer and television screens

<u>Rendering Animations</u>

Predicting rendering time

When rendering animation, the rendering time increases substantially compared to still images.

Before pressing the 'render' button for your animation, it is a good idea to run a quick mental calculation of how long this animation should take to render.

Example

15 seconds movie @ 30 images per second = 450 images total

450 images @ 2 minutes render time per image = 900 minutes = 15 hours render time

Recommended file formats for animations

| Player	Formats
YouTube	.MOV .MPEG4 .AVI .WMV .MPEGPS .FLV
iPad	.m4v .MPEG4 .MOV (H.264 codec)
PowerPoint	.mov .AVI .MPEG4 .MPEG2 .mpeg .WMV .SWF

Visualization with the Autodesk product line

	In-software rendering	Walkthrough or fly-by	Workflow to 3ds Max Design	Workflow to Showcase	Interactive Presentation	A360 rendering	Aggregation + Props + Animated objects
AutoCAD	✖	✖	✖	✖		✖	
Inventor	✖		✖	✖			
Showcase	✖	✖		---	✖		✖
Revit	✖	✖	✖	✖		✖	
3ds Max Design	✖	✖	---	✖			✖

Summary of workflows related to visualization for major Autodesk products
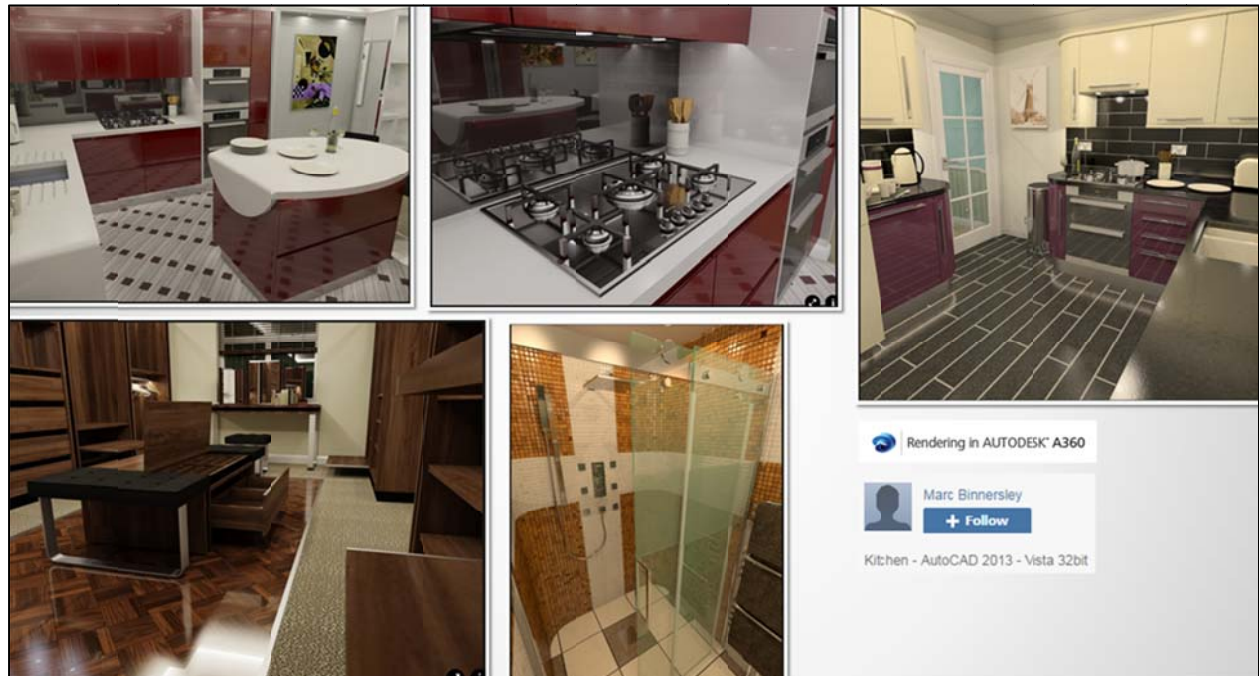
Rendering on the cloud with Autodesk 360, based on AutoCAD files
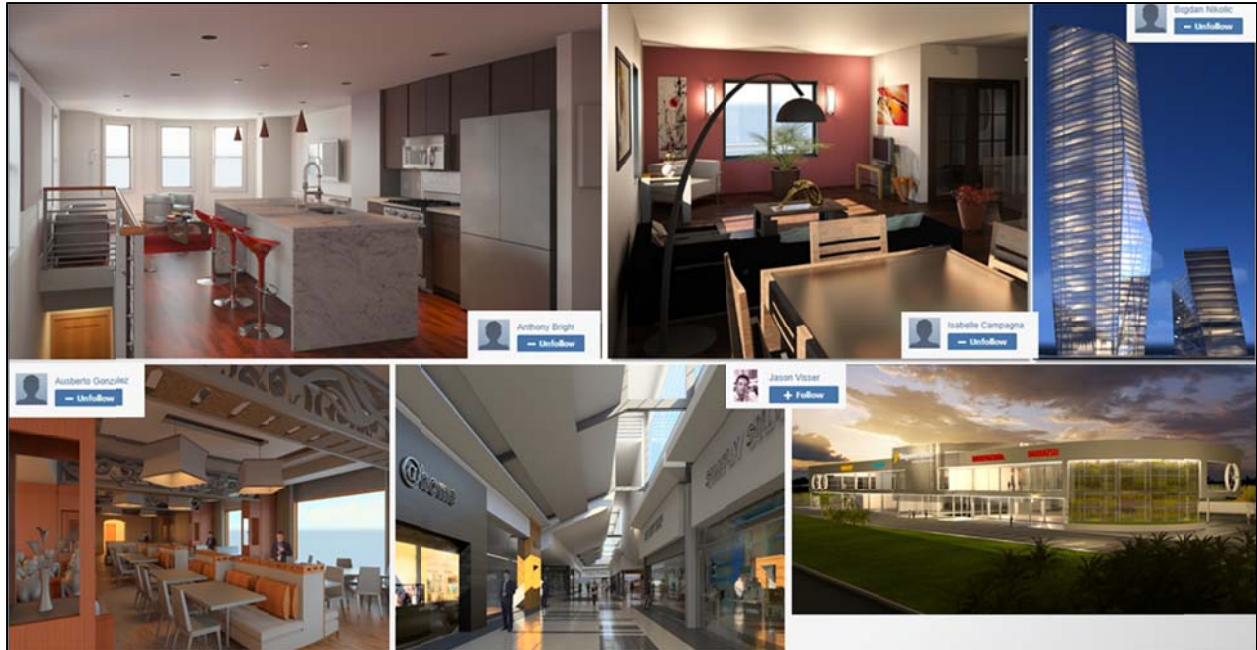
Rendering on the cloud with Autodesk 360, based on Revit files
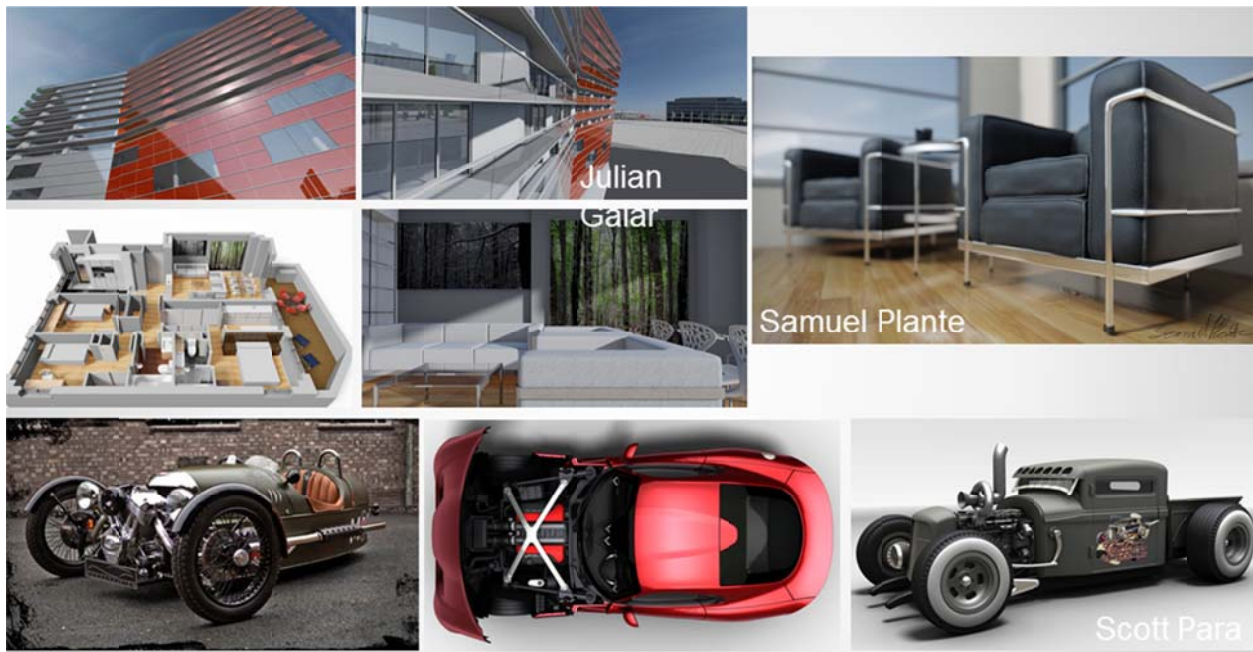
Autodesk Showcase renderings (modeled in various sources)

Autodesk 3ds Max renderings