

Rendering and animation

Rendering involves the creation of a 2D image (or still) from a 3D object in a virtual space. This can be a time-intensive and resource-heavy task, and it is important not to underestimate the time and resources needed to complete renders. Renderfarms with networks of computers able to render each frame and cloud rendering may speed-up this process. In some software engines you can strip the image – dividing one image into parts and allocating each strip to different computers.

Rendering times are very dependent on the lighting and material choices as well as the settings chosen to work through. Strategies in the modelling process should take account of the final form of output for these works, whether print graphics or motion and effects (Smith, 2011). The range of rendering engines is extensive, with discipline-specific preferences and intentions. Rendering is the summation of the 3D modelling workflow and the choices and range of tools for these outputs are extensive. It is advisable to create a simple interior and exterior terrain to test and explore the dynamics between geometry, materials, lighting and environments and render settings to fully gauge each tool's possibilities. The following typology refers to common elements in the rendering process, though is not exhaustive.

Rasterisation – a method of rendering which can produce motion effects and converts vector images into raster images.

Material override – applies one material to every element; this is especially useful to evaluate the lighting design in the 3D model as you can source the colours that lighting choices provide.

Cached geometry – useful if no further geometrical changes take place as it allows a quicker computation time.

Raytracing – this enables indirect illumination, depth of fields, refractions and shadows.

Placeholders – boxes that surround your geometry as empty boxes to speed processing time and navigation until rendering takes place.

Radiosity – calculates indirect light and is a process that is part of global illumination.

Indirect illumination – bounces light around the scene.

Final gather – adds indirect illumination to landscape scenes. You may cache the final gather for reducing high-resolution render time.

Global illumination – this can be a separate setting or part of indirect illumination.

Photons – closer to what occurs in nature, photons are RGB separated colours which react in different ways to permeable and opaque surfaces.

Caustics – indirect illumination of concentrated light from transparent objects; refraction and the scattering of light from reflective surfaces (O'Connor, 2010, pp. 220 – 226).

Ambient occlusion – adds naturalism to surfaces through soft shadows and is the opposite of ambient light or global illumination.

[Strategies for Landscape Representation: Digital and analogue techniques](#), Routledge. ©2017 Paul Cureton.

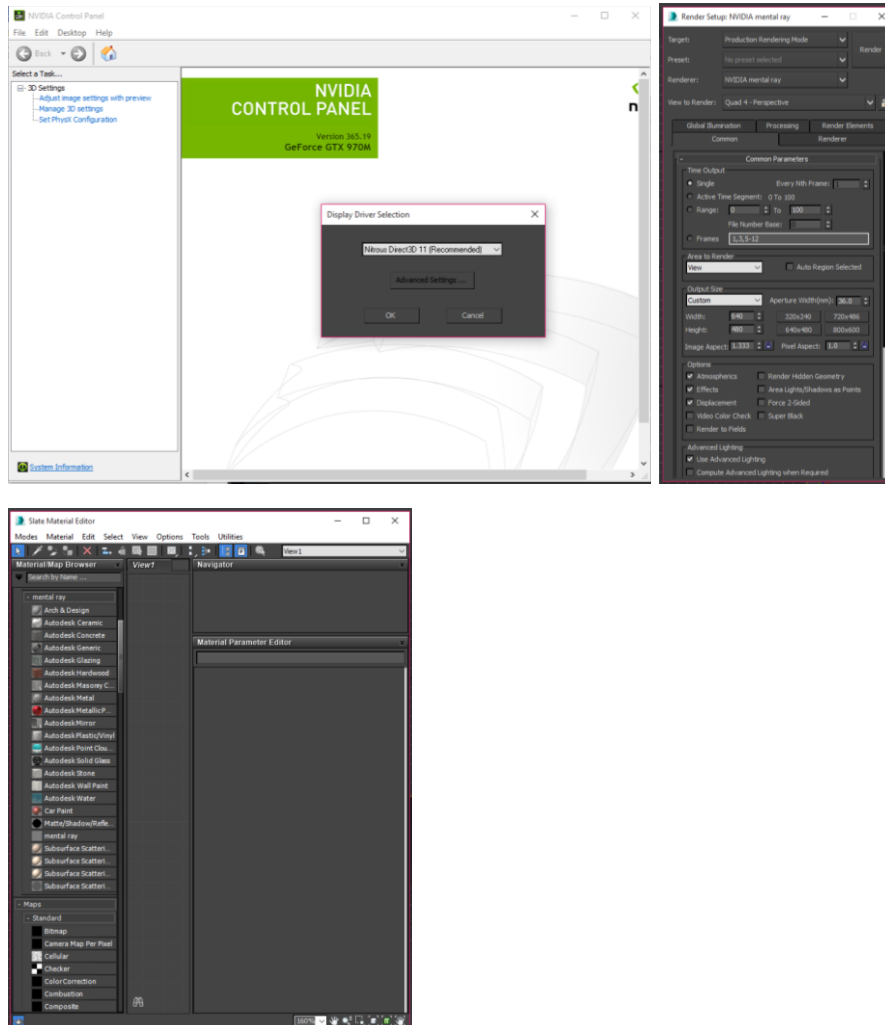
Material to be used for educational purposes and with book companion.

Importons – these merge together and remove any unnecessary photons.

Irradiance particles – these fire importons into the viewport that locate a surface for their placement. From this point indirect and direct illumination is stored within the particle. This is a useful tool for naturalised objects.

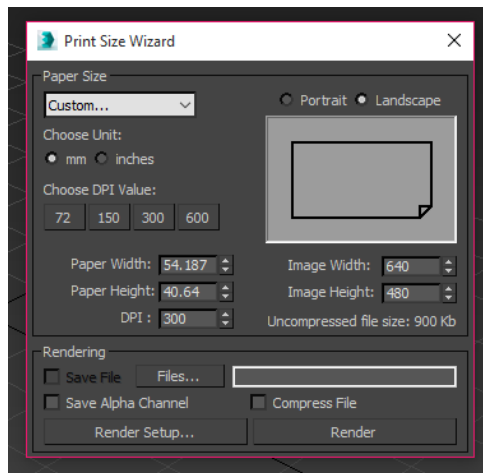
Setup

Setup may vary across software programs; the tutorial below discusses Mental Ray. Rendering can be a time-intensive task, so batch renders and renderfarms set-up through a network may provide time-saving in production and thus has a cost implication for practice management. This companion site does not discuss network settings and render pipelines.



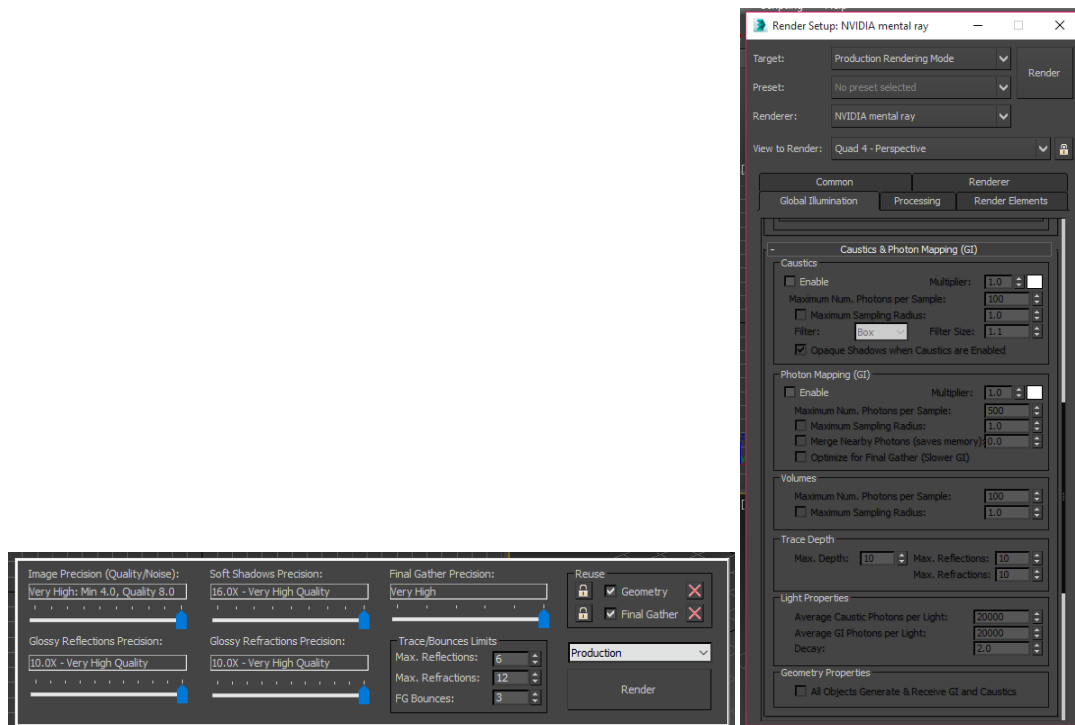
1. If possible, use the *Change graphics* mode of 3DS Max to check the drivers available prior to loading. Load 3DS Max and open a new file. Press F10 on the keyboard to bring up the *Render setup* window. Changing the render also changes the *Material editor* and allows use of photometric lights and camera specific to Mental Ray.

Note: Mental Ray shaders can be applied as materials and maps; shaders can also be used for the render setup, lights and cameras. See <http://help.autodesk.com/view/3DSMAX/2016/ENU/?guid=GUID-484B095B-1229-4CB9-BC53-952AC40F67C2>



2. You may also wish to consider the output of your work. An under-used asset in 3DS Max, beneath the *Render* tab is a *Print assistant* which can help determine dpi and page size.

Global illumination: photons, caustics, radiosity



- Mental Ray and other engines simulate light strikes (photons) on a surface; each surface will behave differently and bounce light around an environment. This information is stored in a single file. Raytracing behaves differently and traces the light from a surface to the original light emitter.

Global illumination is a universal term for the description of a scene in which all aspects of light have been considered as bounced, reflected and refracted light. Rendering algorithms that calculate the way light travels between surfaces of objects are called global illumination algorithms. The two most important global illumination algorithms are raytracing and radiosity. Radiosity is used by the scanline renderer, whereas Mental Ray uses raytracing. (van der Steen 2007 p.7).

Radiosity is thus a global illumination technique to provide more realistic renders of natural light phenomena. It can work with photometric lights (IES, etc.) to simulate real-world lighting and thus inform design decisions. Both radiosity and raytracing in 3DS Max have comparative advantages and disadvantages, as shown in the table (created by Autodesk) below. Various other render engines have similar offerings as well as material sets; it is worth experimenting via software trials to find the most suitable product.

Extract from Autodesk, 3DS Max Help Documentation, 2016

Lighting Algorithm	Advantages	Disadvantages
Ray-Tracing	Accurately renders direct illumination, shadows, specular reflections, and transparency	Computationally expensive. The time required to produce an image is greatly affected by the number

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	effects. Memory Efficient	of light sources. Process must be repeated for each view (view dependent). Doesn't account for diffuse interreflections.
Radiosity	Calculates diffuse interreflections between surfaces. Provides view independent solutions for fast display of arbitrary views. Offers immediate visual results.	3D mesh requires more memory than the original surfaces. Surface sampling algorithm is more susceptible to imaging artifacts than ray-tracing. Doesn't account for specular reflections or transparency effects.

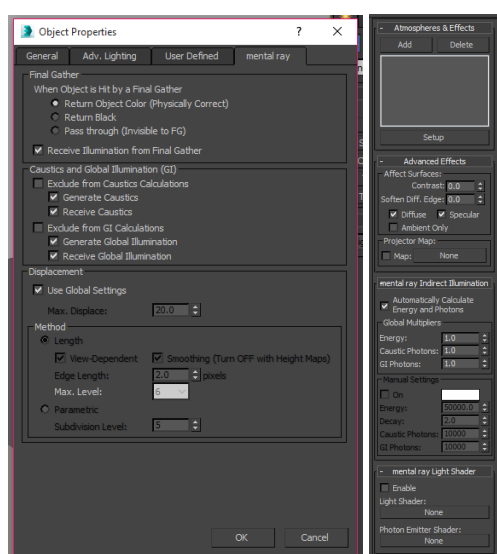
Final gather shoots out light points to a surface from a particular view or scene. Go to the *Global illumination* tab and scroll downwards in the render setup to view the caustics and photon mapping settings.

Additional links

Caustics and photon mapping: <https://knowledge.autodesk.com/support/3ds-max/learn-explore/caas/CloudHelp/cloudhelp/2017/ENU/3DSMax/files/GUID-C88F47C4-7825-4307-ADCE-5E5B5A9E2DB8-htm.html>

Radiosity workflow: <http://help.autodesk.com/view/3DSMAX/2016/ENU/?guid=GUID-616259FB-EDCB-4497-8A59-13A0C79455D6>

Interoperability note: materials and lighting defined in a Revit model can speed the production time if exported as an FBX file and imported through 3DS Max.



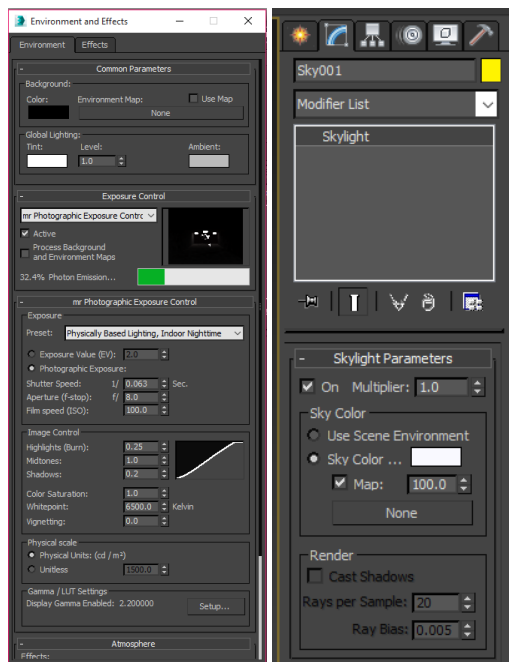
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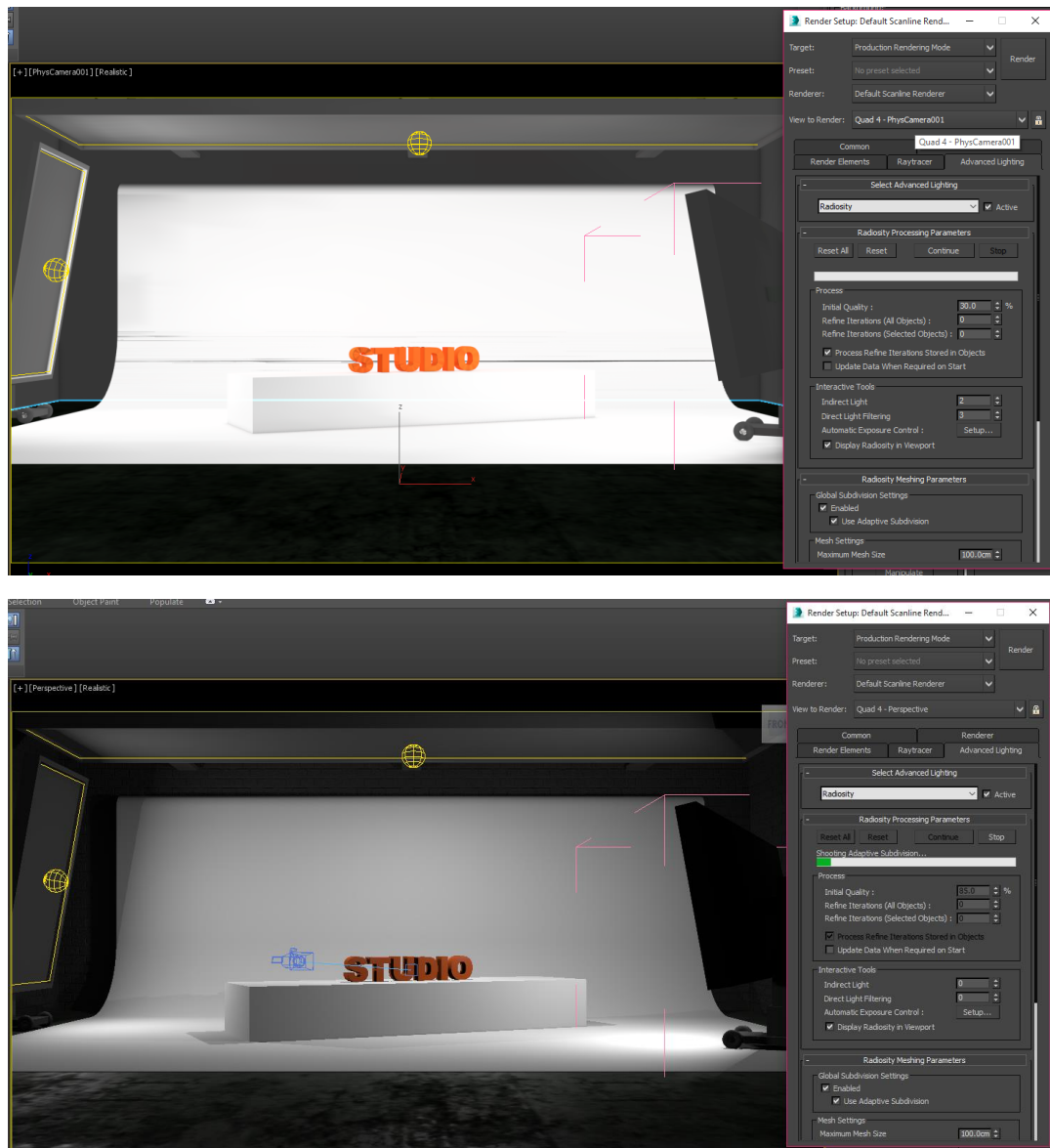


4. Load the Sponza model. Photons are useful for interior scenes, though can be skipped for exterior models. Choose the Mental Ray render engine (F10 on the keyboard). Enable caustics and photon mapping. You can specify that all objects receive photon and caustics in the scene or specify at an object level by right-clicking, *Object properties* and selecting the *Mental Ray* tab. Select the two scene lights. The specification can be adjusted in the *Modify* tab, in this case a 50 W halogen bulb. A torus knot has had a glass Mental Ray material applied and a spotlight placed above. Photon mapping requires objects to be sealed – that is, areas enclosed so that no light particulates can escape. The number of photons used can either result in a large paintballed surface or a smooth surface in which reflected colour and light are not visible. Change the GI photons in the *Light properties* window. Increasing photons brings out the caustics.

These effects can be simulated in the Cornell Box:
www.graphics.cornell.edu/online/box/history.html



5. Change the exposure control by pressing 8, and assigning mr photographic exposure control. Use the *Preview* button and test the exposure pre-sets such as outdoors, daytime. Experiment with the various settings; iteration is key to learning the best parameters for your own models.

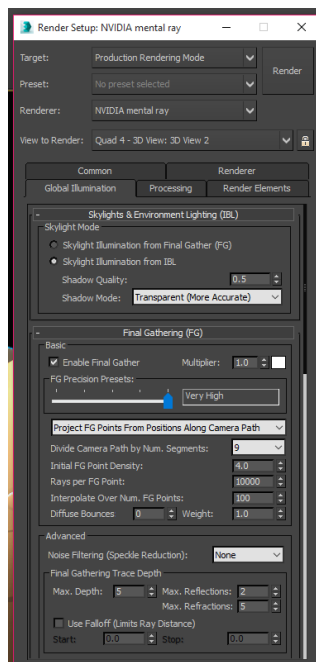


6. Load the Light Studio default model in 3DS Max. Load the *Render setup* (F10 on the keyboard) and select the default scanline raytracer, go to *Advanced lighting* and enable radiosity. Select *Advanced lighting solution* and choose *Radiosity*. Set the initial quality to 30 percent under the radiosity processing parameters. Press *Start*. Ensure *View radiosity* is enabled in the viewport. This simulates a rough view of the radiosity. The light levels are stored with the geometry and you can navigate the model without reprocessing. Next, enable global subdivision settings. Change the interactive tools *Indirect light* to 5 and *Direct light filtering* to 2. Adjust the upper studio lighting to a photometric 50 W halogen by selecting and clicking the *Modify* tab. Click the re-use direct illumination from radiosity solution in the render parameters.
7. Go to *Environment control* and set the exposure control to logarithmic (automatic is also an option). Change the exposure value to around 3.0. Click to render. 3DS max also has a lighting assistant to create lighting reports from photometric lights.

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Final gather



8. Final gather uses precise calculations of global illumination and averages these samples. Final gather can slow down the rendering process and can be completed without the need for photon mapping. Photons and global illumination and FG give “light depth in the shadows and soft tonal variations in the illuminated areas” (van der Steen, 2007 p. 12).

Reusing the final gather by ticking the *Geometry cache* in the render window will reduce render time. Using falloff will also assist final gather as it limits the final gather to the scene, not continually into space in an outdoor scene. The more final gather bounces, the more light travels around the room, and thus more luminance.

Add a skylight in the *Create* tab, standard lights icon. Click *Modify* and specify a sky colour. The skylight creates light in all directions depending on its pointer and gizmo shape. Press F10 for the render setup, ensure project final gather points for stills is selected in the final gather settings. Test a draft render of this global illumination.

Additional links

Material override: <http://docs.autodesk.com/3DSMAX/15/ENU/3ds-Max-Help/index.html?url=files/GUID-E444F273-E9A6-4E8E-9305-E06E062FF04D.htm,topicNumber=d30e390143>

Ambient occlusion: <https://knowledge.autodesk.com/support/3ds-max/learn-explore/caas/CloudHelp/cloudhelp/2016/ENU/3DSMax/files/GUID-88D3C277-BEFA-4742-B953-3CB377809FA6-htm.html>

Pbrt: www.pbrt.org/scenes.html

Structure Synth: <http://structuresynth.sourceforge.net>

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Source Forge: <https://sourceforge.net>

Plant Ecosystem Rendering: <http://dl.acm.org/citation.cfm?id=280898>

Poly Count: <http://polycount.com>