CAD PROJEKT K&A

Differences between standard and professional rendering

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GENERAL INFORMATION

Our software offers two separate levels of rendering functionalities – standard and advanced. In both cases, the imaging features are based on the recent achievements in 3D computer graphics and highly technologically advanced. In the Professional Rendering Module, which is an additional module for CAD Decor 2.0 program, some really innovative functions are available, that guarantee a really appealing and natural look of designed interiors.

The main task of the Professional Rendering Module is to provide a perfect visualization quality in a relatively short calculation time. It was possible to shorten the time thanks to the introduction of a revolutionary solution of co-operation between the graphic card processor (GPU) and a central processing unit (CPU). It is nevertheless necessary to remember that the calculations are approximate, and that the main purpose of creating this module was to obtain an optimal calculation time with the best possible quality of visualization.

In this short comparison we provide you with tables, presenting features available on both levels of the rendering. The basic rendering functions (first table) are available for all users of CAD Decor 2.0. Those of our customers, who decide to purchase the Professional Rendering Module, will gain access to functionality presented in the second table. In the last part of this document we provide some illustrations, presenting differences between visual effects, possible to achieve in both levels of rendering in our software.

STANDARD RENDERING

The main difference between the previous visualization functionality, available in older versions of our software, and the new one, which is introduced in CAD Decor 2.0, consists of the fact that it is much easier to set the optimal parameters of lights and achieve incomparably better results. Even with a minimal effort it is possible to obtain very good results of visualization.

Using the **Ambient Occlusion** (global shading) function results in increasing the visual quality of the scene by adding an effect of a soft shadows and a natural depth to the picture. The range and intensity of the global shading can be freely modified, as well as the general **Brightness** of the scene, what helps to set the contrast and intensity of chiaroscuro accordingly to user's needs and preferences. Shades and shadows look much more naturally than ever before. Their quality can be additionally increased by using the **High quality** feature.

Another novelty is a special technique of texturing – **Bump Mapping**. The program detects brighter and darker fragments of textures and creates an illusion that they are 3-dimensional – concave or convex. As a result the texture of objects or materials on walls and floors gives a powerful impression of being rough, porous, embossed or smooth. Even if the economical feature of Simplified render is used to preserve operational memory and shorten the time of rendering, these effects are still visible (however without additional shading, what makes it look somehow flattened). It is worth mentioning that the databases of Polish well-know ceramic tiles manufacturer – Ceramika Paradyż, are prepared in a way that maximizes all advantages of this feature.

In the past the effect of basic own-light emission of various objects in the project was causing some problems. Even with the maximum level of this function, sometimes objects did not imitate the emission at a satisfactory level. In the new version of our software a new function has been added – **Show emission**, which results in a visible glow around the object attributed with basic emission (bloom

effect). In addition – but only for users who purchase the Professional Rendering Module – it is possible to attribute objects with a property of an advanced emission, measured in Watts per square meter, which makes them not only look as they do, but really emit their own light, influencing light distribution in a whole interior.

Standard rendering – description of functionality

Function	Description
Simplified render	• more economical version of render, uses less memory; • useful particularly with computers of weaker performance, with less processing power; • shorter time necessary to achieve the final effect; • worse appearance of the shadows – less realistic, more sharp, 'angular' and 'serrated'; • less visible bump mapping – 'flattened' and without shades;
Mirror effect	• displays attributed properties of vertical reflections for objects imitating mirrors; • all effects become visible when the lights are turned on;
Metal effect	• displays attributed properties of general reflections for objects imitating metal when the lights are turned on;
Show emission	• displays attributed properties of own light emission; • there are 2 kinds of emission available – basic and advanced; • the first one is available in standard and makes the objects look like they glow, but in fact they do not emit the real light; • the second one is available only with the additional module of Professional Rendering and gives an effect or a real light emission; • the Show emission function displays the basic emission (glow effect, also called light bloom, that creates an impression of the object glowing brightly with an intensive, white light); • as a result object which have been attributed the basic emission are surrounded by a halo that looks like they were emitting light;
High quality	• improves the quality of obtained effects of visualization, if only the processing power of the computer allows for it; • most significant changes regard the quality of shadows in the project; • they become softer and natural, and more gradual – like in the real world;
Bump mapping	• a specialist method of texturing, simulating even the smallest unevenness of the surface of objects; • gives an effect of a totally realistic look of the visualized surfaces, e. g. ceramic tiles, wood, printed wallpapers; • thanks to **Bump mapping** all protuberances of textures and tiles gain natural gloss and roughness; • feature available in the **Material properties** dialog box, in the **Advanced** tab (to open it, double left-click on the object to select it, then right click to open the context menu and select the **Material properties** position;
Vertex smoothing	• this feature can be used for additional processing of 3D models in visualization; • it smooths curves of selected objects, which were drawn in a way not ensuring a proper look of oval elements, or which lost their ideal shape during the conversion and grid minimization; • thanks to this option, is it possible to significantly diminish or totally remove sharp edges or corners in places, where objects should be smooth and rounded;
Ambient Occlusion	• a special method of shading spatial objects; • calculation of the degree in which the given fragment of the object's surface is expose to the ambient (diffused) light in the room; • gives the extra depth and perspective to the scene, increasing a reality of its look; • this option is responsible for a naturally looking shadows and shades, especially in the corners of the room and between the walls and the ceiling; • the level of the **Ambient Occlusion** can be regulated by changing its range, intensity and general brightness of the entire scene;
AO Range	• changes the scope of the shadows created by ambient occlusion; • when set to the minimum the shadows occupy the smallest space, and at maximum – stretch on a much wider area;
AO Intensity	• regulates the strength of the shadows; • at minimum they are pale and delicate, at maximum – dark and expressive;
Brightness	• defines the level of a general illumination in the scene and the contrast between light and dark objects;
Selection of the shape of the generated light field – IES files	• it is possible to choose and change the shape of a light-field generated by a particular light source in the project (a style of distribution of light by a given light fixture); • can be used to achieve original, unique and realistic effects of illumination of the scene; • IES files are a digital representation of an actually existing light sources - their intensity and geometry of light distribution; • IES data is provided by lighting manufacturers in the form of texts files; • there is 32 styles available to choose from in a standard version of CAD Decor 2.0; • users who purchase the additional Professional Rendering module can also download their own IES files, e.g. found in the Internet or created by them;

Creating animations and project presentation	• function of recording and saving animations in AVI format; • available in the **RenderPRO** tab -> **Presentation**; • animation is created on the basis of a freely defined path, at any angle and with changeable speed of the camera, which can be set before starting recording; • the speed and angle can be changed during recording; • many levels of resolution are available to choose from – form the current view resolution up to Full HD; • the number of frames per second can be changed (recommended: 15 frames for computers and 24 for TVs); • any codec can be selected; • in the result video the camera moves around the room with various speed and changes the view angle freely, and the scene in which it moves is rendered in the real time;
New Gallery	• an independent application for presentation of project illustrations and videos; • can be opened in any computer, without installation of CAD Decor 2.0, so it is possible for customers to see the results of designers work straight away (picture and AVI files can be send by e-mail together with the Gallery application).

PROFESSIONAL RENDERING

Two main processes performed by Professional Rendering module are:

- **Radiosity –** in other words a Global Illumination algorithm,
- **Raytracing** – a method of calculating the reflections and refractions of light rays.

Radiosity

It is one of calculation methods, responsible for achieving a total distribution of light in the scene. It takes into account indirect, diffused light (in contrast to local illumination models, which analyze only direct light, simulating the way of rays between the light source and the surface).

Indirect light (Global Illumination) is reflected from one surface to another. It is enough to look around to realize that the majority of light that reaches our eyes is indirect. Indirect light can be divided into two categories:

- light reflected in a diffusive way by rough surfaces (e.g. painted walls),
- light reflected in a mirror-like way by smooth surfaces.

Because the processing powers of computers are relatively low in comparison to processes taking place in our environment, some simplifications has been applied, so the calculations are performed in a acceptable time. In case of the Radiosity process the scene is divided into a mesh of small surfaces, and the calculations are performed for this divided scene – exactly – at the corners of the surfaces.

These calculations are a very complex process. If the processed scene consists of 100 000 little surfaces, then to calculate the exact light distribution in it the scene, the interaction of all 100 000 surfaces has to be analyzed, what gives 10 000 000 000 single operations to perform! As you can see – so many necessary calculations has to take some time.

The main advantage of our method and the reason why it is better than similar Global Illumination calculation solutions is, that once computed light distribution (at the corners of surfaces) is remembered by the program, so the scene can be viewed from any location and angle without any additional calculations. This characteristic is vital for creating videos, in which the camera moves freely in designed space. Unfortunately there is also one serious drawback – the accuracy of the calculations depends on how many surfaces the project contains of (the more – the better), what significantly influence the calculation time and program's requirements in regards to available operational memory.

Raytracing

Second of the two most important processes used by the Professional Rendering module. While Radiosity calculates the diffused light distribution and saves the results for the corners (vertexes) of surfaces in the project, Raytracing calculates reflections from mirror and glossy objects that reach the observer of the scene, as well as analyzes objects refracting light, such as glass and translucent plastic.

Because the analyze of refractions and reflections takes a relatively long time, there are 8 levels of Raytracing quality available.

- 1x1 – 1 ray send from the camera (the observer of the scene) goes through each pixel of the screen (this is the way the program analyzes the reflections – checks which rays go between the observer and the object – in reverted direction),
- 1x1 AA – through 1 pixel of the screen goes 1 ray from the camera and in places where there is not enough accuracy – the anti-aliasing (vertex smoothing) algorithm is used,
- 2x2 – through each pixel goes 4 rays,
- 2x2 AA – 4 rays per 1 pixel and anti-aliasing is used in case of lack of accuracy,
- 3x3 - 9 rays per 1 pixel,
- 3x3 AA - 9 rays per 1 pixel and anti-aliasing algorithm,
- 4x4 – the computations take 16 times longer then in 1x1 mode (to compute 1 pixel the program conducts 16 tries - 4 horizontal and 4 vertical),
- 4x4 AA - 16 tries and additional calculations on vertexes (adaptive anti-aliasing).

The 1x1 mode can be used for checking the initial results of Raytracing. It is also recommended to export illustrations using Raytracing, in the view resolution (it is a screen resolution diminished by the toolbars visible in the visualization window). In such case the view is ready for saving without any other additional calculations. If the illustration is to be exported in some higher resolutions, then the Raytracing calculations will be performed for a multiply time, what will significantly prolong the time of exporting the file.

Because the Raytracing algorithm's operation is based only on rays set by the user, it is possible to adjust the number of sent rays – both reflected and refracted. The reflected rays can be set from 1 to 10 and the refracted ones – from 0 to 20.

Standard settings is 1 reflected ray to 20 refracted rays. The bigger number of rays is set to be analyzed in the program, the longer the calculation time. It is recommended to perform calculations first on the standard settings and only in the final stage – just before saving the file as illustration – increase the number of analyzed reflections and refractions.

Professional rendering – description of functionality

Function	Description
Radiosity	• a method of calculating the indirect light in 3D scenes, the main Global Illumination algorithm; • takes into consideration reflection and absorption of light by different objects and colours; • parameters of Global Illumination calculated this way are remembered by the program and used for visualization in a real time; • improves the efficiency of the rendering and enables to attain a natural look of the scene; • effects are independent on the position of the observer; • the calculation process has two stages – in the first one the program prepares data for analysis, in the second one – displays the calculated illumination of the visualization in cycles (their interval can be adjusted by the user from 0 to 20 seconds); • the final look is obtained by the gradual improvement of the rendered scene; • edition of lights (in the **Scene** tab) can be performed after the beginning of Radiosity calculation – but the emission has to be attributed before they are started (emission cannot be changed during the calculation);

Scene diagnostics and repair	• each scene has to be prepared for calculations, and this is why this feature has been designed; • it repairs errors in the scene, this is: the reversed surfaces in 3D models, which can cause irregularities in the light distribution (objects with reversed surfaces are always much darker than they should after turning on the lights); • organizing all surfaces in the proper order is vital for the correct light distribution calculation and because of that this function is active by default;
GI Parameters	• available settings of global illumination are designed to adjust rendering to designer's preferences; • Global Illumination is a lighting model in which not only the direct light emitted by the light sources is taken into account (local light), but also beams reflected by objects such as walls, floors, furniture and equipment (indirect, global light); • ensures a realistic light distribution in the room;
GI Influence	• this function regulates the influence of the diffused light on the general light distribution; • when the slider is moved to the left, diffused light has no influence on the scene at all – only direct light is taken into account; • this parameter can be adjusted during the Radiosity calculations and after they are completed;
GI Contrast	• influences the way in which the number values are changed into components of RGB colours; • the contrast can be decreased during the Radiosity calculations, but the changes will be visible after the next refreshment of global illumination;
Ambient	• this term relates to the ambient light (light diffused in the scene), which illuminates the room evenly and without shadows; • ambient adds some white color to the scene, which makes it look brighter; • this function is useful in the scenes that should be bright but the current settings of light sources do not allow to attain such effect; • especially good results can be achieved when using both this parameter and functions of Ambient occlusion (in the Scene tab);
GI Colours	• increases the coefficient of light reflected by all surfaces in the scene (in other words: decreases the level of light absorption); • as a result the image gets brighter and at the same time there is stronger colour bleeding effect (this phenomenon takes place when the light reflects from a diffusive surface and takes over its colour); • this function determines the intensity of which the colors spread in the scene; • it is useful when there is a lot of dark materials used in the scene, that have a high level of absorption, and share little of their color with the rest of the scene;
GI Emission	• it is a multiplier of all emissive materials in the scene; • enables to quickly modify the intensity of advanced light emission of all emissive objects at once; • the scale for this factor is from 0 to 200% (with default level of 100%); • to change the properties of each element one after another would be time-consuming, so instead of that the level of emission for all objects can be changed with one movement of this slider; • when the slider is set at 0% all emissive objects have no influence on the light distribution in the scene;
Final Gathering	• the final calculation of the distribution of light for the chosen objects; • if some little object in the project does not look properly, it can be subjected to an additional treatment – the program will proceed some extra calculations of the amount of light beams reaching its surface; • particularly useful with objects consisting of a big number of little surfaces – they may be not properly illuminated by the indirect light; • to do so, select the object or objects and start the Final Gathering; • there more objects is selected, the more time is needed to achieve a final result; • it is recommended also while creating illustrations of the project with close-ups of some concrete elements of interior design;
Raytracing	• it is an algorithm analyzing reflections and refractions of light rays, which reaches the observer of the scene; • it calculates reflections and refractions of light rays generated on mirror and glass objects; • adds to the scene those light rays, which have been omitted by Radiosity, which takes into account light diffused in the whole scene; • creates lusters on metal surfaces, refractions on glass and – what is worth noticing – multiple reflections in mirrors; • adds reflected or refracted rays to the scene, which were omitted by Radiosity, which is taking into account only indirect, diffused light;
Quality (Raytracing)	• there are 8 levels of Raytracing quality available: 1x1, 2x2, 1x1 AA, 2x2 AA, 3x3, 3x3 AA, 4x4 and 4x4 AA (where AA stands for anti-aliasing); • anti-aliasing is a technique that minimizes distortion errors (aliasing), occurring while creating representations of the image of a high resolution in the lower resolution; • 1x1 mode is usually used to quickly see initial results of Raytracing; • the level of quality of Raytracing depends on the processing power of the computer – the better quality the higher memory consumption and a longer time of performing the operation;
Reflections (Raytracing)	• Raytracing works on the basis of rays defined by the user; • rays are sent from the item to the scene and analyzed and user can decide how many rays should be taken into account; • the program can analyze from 1 to 10 reflected rays; • a standard setting is 1 reflected ray and 20 refracted ones;

Refractions (Raytracing)	• the user can define how many refracted rays will be analyzed; • the level of this function greatly influence the look of transparent objects such as glass; • the program counts how many rays go through such objects, so the more rays we decide to analyze, the more realistic will be the picture; • the program can analyze from 1 to 20 refracted rays; • the user decides how to set this parameter, accordingly to current needs; • in this case the program analyzes the rays going through transparent objects; • if there are 2 glasses located one next to another and each of them has 4 sides (it is necessary that glass has defined thickness), then for the proper result Refractions should be set for 8 rays;

Advanced options	• calculation of the light distribution is done only for the corners of objects mesh;
	• the mesh for walls is by default established to fit the calculations and divided into faces of 100x100 mm;
	• the rest of the objects in the project is not divided automatically and they can require a modification of mesh density;
	• there are 2 options of mesh modification available:
	  • **adaptive mesh division** – changes the division of walls and platforms, to which other objects adjoin (e.g. kitchen cabinets) and cover some of the corners of the mesh (what artificially increases the range of the shadow); this function enables to automatically subtract such corners from the calculation and improves the distribution of indirect shadow on the border between the wall and the object;
	  • **scene mesh division** – thanks to this option You can choose by yourself the size of the mesh of the whole scene – from 40 mm to 200 mm (by default it is 100 mm) to improve the shadows distribution, the smaller size of a single face – the more faces and more memory and time needed to proceed calculations;

Diagnostics	• there are 2 features of scene diagnostics available:
	  • **show emissive objects** – marks these objects which hale been attributed an advanced light emission; function useful the modification of the light distribution in the room is necessary and it is not clear which objects are emitting the light;
	  • **show inverted surfaces** – shows those faces which hale been drawn in an opposite direction, what has a negative influence on the light distribution on the object; the surfaces can be drawn clockwise or counterclockwise and for the proper light distribution it is vital that all of them are drawn in the same way;
	• to repair a scene (meaning: to revert wrongly drawn surfaces) select the Scene diagnostics and repair in the Radiosity pane and start the Radiosity calculations (click <START>);

Statistics	• **Surfaces** – provides an information regarding the overall number of faces in the project, including faces of walls and all inserted objects (this number changes when the mesh division is modified); • **FPS** – the number of frames per second that can be generated; • **Calculation time** – time necessary for calculation of the direct light sources, and when the Radiosity is turned on – the time from the beginning of the calculation process; • **Memory** – current memory consumption (Radiosity calculations are not taken into account, because they are run in another process). If the consumption is below 1 GB the colour is of the caption is green, and when this value is exceeded, it changes the colour to red. It means that there may be not enough memory to perform new actions. Only occupied memory is shown, including CAD environment. The Radiosity calculations are performed in a separate process, so they are not included here. If the memory consumption is less than 1 GB the inscription **Memory** is green, and if it exceeds 1 GB - the inscription changes to red. This may mean a possible lack of memory to perform further tasks;
Downloading your own IES files	• the selection of a style of the light sources is available from the standard level of rendering; • the style (saved in a form of an IES file) determines the way the light is distributed by a light source, e.g. a halogen); • there are 32 ready-to-use styles for your disposition; • if you have a Professional Rendering module You can also download your own IES files, found in the Internet or created by you;
Advanced light emission	• in the Professional Rendering Module it is possible to attribute objects not only with a basic light emission, available on the standard level of rendering, but also with a property of an advanced light emission; • the difference between them is that objects attributed with advanced light emission have real and visible influence on the light distribution in the entire scene; • this feature is available in the **Material properties** dialog box – in the **Advanced** tab; • the power of emitted light is given in Watts per m^2, so the intensity of this light depends on the size of the emissive object; • another difference is that the light in advanced light emission can have any colour, not only white, as in basic emission – as shown in the illustration; • for best results, attribute both kinds of light emission to the object and use the feature **Show emission** in the standard rendering level, responsible for creating the glow effect;
Colour tones	• this function enables the user to quickly change the influence of the light distribution, calculated by the Radiosity process, on the overall colouring of the scene; • changes can be introduced during or after the completion of the Radiosity calculations; • the colour tones are filters that change the scene exposition, so it is worth it to set the lighting parameters to match the particular filter during the Radiosity calculations; • this feature gives the designer bigger flexibility in creating the final visualization.

STANDARD RENDERING:

To illuminate the scene below only 1 halogen has been used. It was necessary to additionally brighten up the scene (the **Brightness** function), because it was too dark. In both cases – this and the next illustration – the same set of ceramic tiles was used, and all differences in colours are caused by different light distribution.

PROFESSIONAL RENDERING:

Only 1 halogen was used to illuminate this scene, just as in the illustration above. As it can be clearly seen – despite the low level of **Brightness**, all details in the project are visible, and the light looks very naturally. The colours are an effect of the calculation method and the colour bleeding phenomenon.

STANDARD RENDERING:

There are 3 halogens in this scene and a material in the ceiling attributed with a basic emission, which simulates lights (bloom effect). The **Ambient occlusion** was used, as well as Brightness feature.

PROFESSIONAL RENDERING:

The same 3 halogens were used as in the illustration above, but the material in the ceiling is now attributed with advanced emission (so it emits real light, and not only simulates it). It can be seen on edges of ceramic objects. Please note the differences in the distribution of light and colours in both cases (the current and the previous illustration).

STANDARD RENDERING:

An example living room scene. Visualization was generated on the basis of the standard features, available on the basic level of rendering. The shadows look relatively soft - almost natural, but the general light distribution is not fully optimal.

PROFESSIONAL RENDERING:

The same interior after using algorithms of the advanced rendering. The look of shadows significantly increased – they look absolutely natural and very soft. Also the general light distribution in the scene looks realistic. The colour bleeding effect is clearly visible – the green colour from walls is transferred to white ceiling and furniture.

STANDARD RENDERING:

The scene is illuminated by 2 halogens over the washbasins, and a sunlight falling through the window. As you can see, the light reflected from washbasins and bathtub does not look fully naturally. The **Ambient occlusion** function was used, what added some depth to the scene.

PROFESSIONAL RENDERING:

The same scene as presented above, rendered with Radiosity method. The light is distributed naturally and softly on all objects in the bathroom, and the look of ceramics is now realistic and aesthetic. The window glass has been attributed with an advanced light emission, so it emits its own light, what can be seen on the suspended ceiling.

STANDARD RENDERING:

Light sources in this kitchen are: the halogen lamps and sunlight, coming through the window.

PROFESSIONAL RENDERING:

Despite turning the halogen lamps off, the scene is much brighter than in the illustration above, because the window has been attributed with a real light emission effect, so it sends light rays into the room and changes the look of the entire scene. Visible reflections – e.g. on stool legs.

STANDARD RENDERING:

This scene is visualized on the basic rendering level, and lighten up by the spotlight, located in the center of the room.

PROFESSIONAL RENDERING:

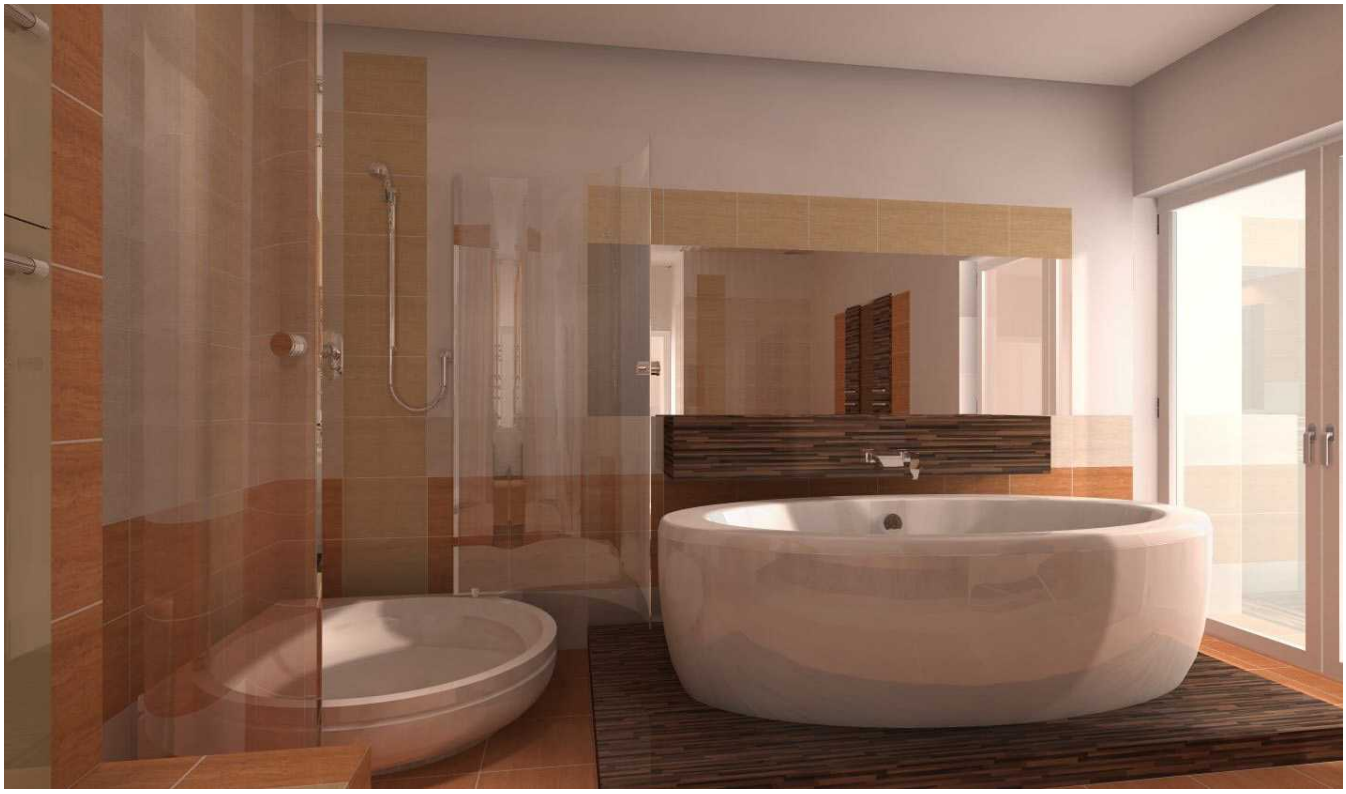
The only source of light in this project is sunlight coming through the window. To achieve this effect the sunlight beam has been set in a proper location, and the natural, warm colour and intensity were attributed to it. The window glass has been given the advanced emission property. This is why the light falling into the room has a real influence on the look of the entire scene.

PROFESSIONAL RENDERING:

Additionally some halogen lamps have been turned on in the project. Please note the natural look of the shadows and shades – their softness and tonal gradations.

PROFESSIONAL RENDERING:

An example of using the Raytracing algorithm, which analyzes reflected and refracted rays. The effect can be seen on the glass shower enclosure.



PROFESSIONAL RENDERING:

An example of a living room arrangement. Visualization created in the Professional Rendering module. The time of the Global Illumination (Radiosity) calculations for the presented scene was 60 seconds. It is worth mentioning, that it is not a rendering of this single view, but the rendering of a whole project. After the calculation, the room can be viewed from any direction and its look will be the same (rendering calculation results are remembered by the program). Therefore, it is possible to freely move in the rendered scene. The average time of rendering of a single frame is 0,7 second (and this is with the maximum number of details in the project). It means that using our software will enable you to create videos of the rendered interior of a very high quality and in a surprisingly short time.

The current scene is composed from over 100 000 surfaces. There are 6 halogen lamps and 3 objects attributed with an advanced light emission in it.

Computer parameters

- processor: Intel Core2 Duo E8400
- graphic card: GeForce 9600 GT
- RAM: 4 GB

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