

Best Practices for Photorealistic Rendering



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Feature Article

More feature-filled and easier-to-use than ever, photorealistic rendering solutions have become a 'must-have' in product design. By following these four best practices, engineers can use today's applications to create more realistic images more quickly.

Technically speaking, photorealistic rendering is the art and science of using computer algorithms to produce images that imitate real-life scenes as realistically as possible. While the most high-profile photorealistic renderings are found in animated movies, such as WALL-E®, Ratatouille®, and The Incredibles®, engineers are now increasingly employing these tools to create highly realistic views of their products.

The most common uses for photorealistic renderings in engineering include:

- **Design reviews**—When submitting a product for a design review, or when showing a design proposal to the marketing department, engineers are now using photorealistic renderings to simulate, more precisely, what the product will look like, early in the design process.
- **Product packaging**—When developing product packaging that includes a picture of the product, engineers now use photorealistic renderings of their model on the packaging mockups, instead of building a prototype and taking it to a photo studio.
- **In-situ design placement**—When designers want to show the placement of a product in a particular real-world setting—such as a new faucet installed on a bathtub or sink—they are using photorealistic renderings to illustrate exactly how it will appear in that real-life setting.

In each of these applications, photorealistic rendering eliminates the many costs of first building a prototype, then taking it to a photographic studio and spending time (and money) setting up a background, positioning the lighting, taking photographs, and performing multiple adjustments and iterations to make the images look just right.

Photorealistic rendering also helps reduce time-to-market by allowing design teams, early in the design process, to gain a more accurate understanding of how a finished product will appear, and by enabling companies to produce packaging in parallel with the product, rather than waiting for a prototype.



By creating a photorealistic image from a 3D CAD model, manufacturers can save the effort of building a physical prototype and taking it to a photo studio.



The time- and cost-savings of photorealistic rendering is even more impressive for manufacturers who build large and more complex products.

Best Practices



These are just a few examples of the effects that can be realized with modern photorealistic rendering tools. To download a free screensaver with more examples, visit PTC.com/go/screensaver.

While photorealistic rendering applications for engineers aren't new, they are more advanced and easier to use today. Additionally, some applications are being fully integrated into standard CAD/CAM/CAE packages. This seamless integration between 3D design and rendering applications allows engineers to use their existing models to create photorealistic images within the same design environment, rather than having to export models from their CAD/CAM/CAE system and import them into the rendering system.

As a result, more engineers now have the opportunity to take advantage of these capabilities, along with their many benefits. However, engineers that have little experience with lighting, surfaces and other aspects of photorealism will face a learning curve.

Below are four best practices that can help engineers, with all levels of experience, to start using photorealistic rendering to create highly realistic renderings more quickly and easily.

Best Practice #1: Use Image-Based Lighting

One of the most difficult and time-consuming aspects of rendering, for those who are not lighting experts, is positioning the lighting in a realistic manner, which can be a highly iterative process. A capability called image-based lighting (IBL) takes the guesswork out of lighting for novices. Using IBL, the user wraps a high-dynamic range (HDR) image around the model. HDR is an image format used for settings such as rooms or courtyards, and includes the correct lighting and color to generate the right reflections. The HDR image becomes the background for the model, which eliminates the need for users to manually position light sources. By using an HDR image, novices can instantly take advantage of expert lighting for use in their renderings. HDR images are easy to find, as there are millions of these images available for purchase or download via the Internet.

Best Practice #2: Check Out an Appearance Library

Another time-consuming aspect of creating a photorealistic image is building up the materials on the surface of the model, so the model has the right texture and light-reflectance properties. For example, glass, stainless steel, wood, or injection-molded plastic all require a different set of appearance parameters, which can include reflection, glossiness, and color texture (e.g., wood grain). By selecting from a library of appearances and placing them on the model, engineers can quickly and easily ensure that their models have the right surface properties every time.

Best Practice #3: Physically Correct Lighting and Global Illumination

Advanced users who want to set up their own lighting for their renderings can gain a better understanding of the impact of lighting on the model by using physically correct lighting and global illumination.

Physically correct lighting includes two pre-set characteristics—intensity and color temperature—for every light used in the image. Intensity is represented by lux or wattage, and the color temperature of the light is the color that the light gives off. For example, incandescent light gives off a yellow tint, while fluorescent light gives off a blue tint. Physically correct lighting applies the right intensity and color values when users select a lighting type, rather than requiring users to set these parameters manually. This approach allows users to set up lighting more quickly, and increases accuracy by reducing the likelihood of errors. When the system uses standard terms for preset values (e.g., watts instead of lux), users will find it more intuitive, and usability will improve.

Physically correct lighting should be used in conjunction with global illumination capabilities, which calculate the impact of both the light that comes directly from the light source and the indirect lighting that bounces off surfaces. Another aspect of global illumination is caustics, which show how light rays, which are reflected or refracted by a curved surface or object, appear on another surface. Together, physically correct lighting and global illumination enable engineers to see the full impact of illumination on both the scene and the model.

Best Practice #4: Create Realistic Shadows

Shadows have subtleties that, if rendered properly, can make images look more realistic. However, since shadows do not have hard edges, users of photorealistic rendering software should first remove any sharp edges from their models by using rounds and fillets.

Also, users should incorporate transparent shadows, where appropriate. If a light shines on a solid object, the shadow will be grey. But if it falls on a transparent object, the shadow will pick up the color of the object through which the light is shining. Using the transparent shadow capability in the software will incorporate the color of the transparent object in the shadow.

Getting Started: Choosing the Right Photorealistic Rendering System

In order to follow the above best practices, your photorealistic rendering system should include a number of capabilities, including:

- Support for HDR images
- A library of pre-defined realistic surfaces that can be applied to a model, such as bump maps that illustrate how a bumpy surface texture interacts with light in the environment
- Physically correct lighting, global illumination, and caustics to determine the impact of lighting on models
- Realistic shadow capabilities that permit soft or blurred edges and transparent shadows

Bringing Models to Life with Pro/ENGINEER®

Engineers wishing to take advantage of these photorealistic rendering capabilities can find them in Pro/ENGINEER's photorealistic rendering module, the Advanced Rendering Extension (ARX). These rendering capabilities are fully integrated into Pro/ENGINEER. Thus, if users make a change in their model, they can simply re-render it, without having to re-translate all of the underlying information and re-import it into a second rendering application.

Faster Time-to-Market and Lower Costs

With modern photorealistic rendering packages, such as the Advanced Rendering Extension for Pro/ENGINEER, engineers—with and without lighting experience—now have the best practices-based tools they need to render highly realistic models. These models enable engineers, clients, managers, and marketers to see exactly what a product will look like, earlier in the design process, so they can make changes and develop packaging more quickly, speeding time-to-market. At the same time, engineers can eliminate the need to use photographic studios, also saving time, money and effort.



Photo or drawing? Modern photorealistic rendering engines make it hard to tell the difference.