MASTER OF LIGHT AND SHADOW

BY MICHAEL J. HUSSMANN
PHOTOS: CLAUS-PETER DUDEK

High Dynamic Range Imaging (HDRI) is designed to show all the tonal values in a picture, from the brightest lights to the darkest shadows. The potential that HDRI, in combination with panorama photography and 3D modeling, opens up for a new kind of photography is shown by the work of Claus-Peter Dudek for his clients in the automobile industry.

Photography means "to write with light", but photographic techniques can only register a small percentage of light values between the brightest daylight and the darkest night. Print film can reproduce a contrast range of approximately 10 aperture stops, i.e. a relationship of about 1 to 1000; slide film has an even lower dynamic range. In this matter, the image converters of digital cameras are not, as often suggested, handicapped; a digital camera can reproduce about twelve f/stops, thus a relationship of approximately 1 to 4000. This dynamic range is sufficient for most applications, but even the most everyday subject can overwhelm a digital or analog camera with the richness of its contrasts.

This includes the view looking from inside a room to the outside, as well as the view from outside into the comparatively dark interior, subjects in which the sun or artificial light sources are visible in the picture, or simply subjects that are partly in the dark, partly in bright sunlight. Whenever a subject is not illuminated homogeneously and there are contrasting light conditions in different parts of the picture, the contrast can easily surpass the camera's dynamic range; a tonal spectrum from one to several million is not a rare thing. Photographing such subjects is always based on a compromise – an exposure on the lights leads to an overall underexposed picture, while an exposure on the darks results in blown-out highlights.

Our eye can also only perceive a small percentage of the tonal range at once and is limited in a similar way to the image converter of a camera – but there is one element where our eyes function differently, namely that they only focus on a small angle, scanning the environment to register the overall scenery. While our eyes leap from detail to detail, they adapt to the varying light; from the individual impressions registered

This Lexus was never at the beach of St. Peter Ording, nor was it ever in photographer Claus-Peter Dudek's studio. HDRI panorama photography and 3D modeling merge virtuality with reality

this way, our brain assembles a complete picture and reproduces an exceptionally high contrast range. The human eye thus knows neither over- nor underexposure, nor limits to the differentiable tonal spectrum.

CREATING HDR EXPOSURES

In order to reproduce a similarly high dynamic range with photographic means, you would have to expose the same subject with differing exposure settings, thus simulating the dynamic adaptation of the eye. Every exposure registers a different part of the tonal spectrum – in a fast one, the detail in the lights is maintained, while in a longer one the shadow will be well differentiated. The tonal values of the individual frames in the exposure series overlap, and when you merge them into an HDR picture in an imaging program they can cover any given tonal range – the more varied the exposures, the larger the desired contrast.

Regardless of how high the dynamic range can get, printing procedures cover only five aperture stops and even the presentation on the computer screen cannot measure up to the contrast range of the actual data. In order to reproduce an HDR image truthfully, its tonal value has to be compressed to the respective few f/stops that can be differentiated in print or on the computer monitor. A mere compression of the contrasts would result in flat images – if the brightest lights and the darkest blacks were separated by only a few f/stops, the reproduction of tonal values would be limited to minimal brightness differences across most of the image.

For this reason you would emphasize the most important part of the tonal spectrum at the cost of the remaining tonal values, whereby you can compress individual elements of the picture separately from one another in an attempt to reproduce, to some extent, the real contrast range in spite of the limitations of print mediums. The quality of an HDR image largely depends upon this last step. Frequently, a photographer goes for a spectacular effect but misses the actual point of HDRI technology, which is to up the photographic tonal reproduction to the level of the ability of the human eye.

HDR EXPOSURES IN THE PHOTOGRAPHY OF AUTOMOBILES

The new photographic potential that arises with HDRI becomes clear when we look at the work of Claus-Peter Dudek, photographer in Hamburg , as he is hired by car companies to fuse HDRI, panorama photography and 3D modeling into a flexible technique for product visualization. One of Dudek's specialties is in photographing new cars in attractive

The shiny paintjob of the virtual Lexus in the foreground reflects the scenery behind the viewer. Even under strong magnification you would not be able to tell the 3D model apart from the real cars parked in the back right

settings – commissions that can only be realized by surmounting a number of challenges. Transporting prototypes to a photo shoot on location is difficult, often impossible. The only alternative that generally remains is to photograph the vehicle in the studio and later superimpose it onto an outdoor image. The lighting in the studio thus has to be adapted to the light conditions of the location, and, in order to accentuate critical details effectively, several differently illuminated exposures must be merged before the result can be mounted into the scenic shot.

After that, convincing shadows and reflections have to be retouched into the picture – a particularly sophisticated task, because the effect of the paint finish relies heavily upon this. If the client desires last minute changes – be it a different configuration, an alternate paint finish or a final change to design details – then the work has to start all over again. This is how Dudek used to work. Today, a 3D model of the car frequently replaces the elaborate studio shoot. These high-detail 3D models are available as a byproduct of industrial production and, if need be, only have to be rendered into a photo-realistic format. In the ideal scenario the model can be used for the exterior and interior views, as well as for other details in between – allowing you, for instance, to present the car with an open door, complete with lock, handle and window button.

THE PHOTOGRAPHIC TECHNIQUE

Embedding a 3D render in a photographed environment obviously requires more than conventional photographic means – at least if you want credibility. The outdoor shot relied upon a specialized camera, a SpheroCam HDR by Spheron VR AG in Waldfischbach-Burgalben, Germany. By rotating its CCD scanline the SpheroCam HDR exposes a 360-degree panorama, taking only a few minutes even at the highest quality setting. With a fisheye lens mounted vertically, the camera registers an angle of 180 degrees vertical and can thereby create a complete spherical panorama. Thanks to automatic exposure sequences, the HDR version of the SpheroCam can extend the dynamic range to 26 f/stops, making it a precise measuring tool for all light conditions, from direct sunlight to abysmal blackness. Using a second panorama taken from a slightly altered angle, you can, per triangulation, calculate the distance between any given picture detail and the camera by marking the respective positions in both panoramas. In spite of the panorama camera being quite fast, the lighting may change during the exposure; clouds might move before the sun. In such cases the brightness differences are either corrected in postproduction or the exposure sequence is simply repeated. After exposure, the control software of the SpheroCam removes the reproduction errors caused by the fisheye lens from the picture; then it is retouched manually, whereby the camera tripod and its shadow are eliminated.

The photographer chooses the composition in which the car is to be embedded from the HDR panorama taken on the beach in St. Peter Ording

Adapting the image to the 3D model requires a fair amount of retouching; the existing tire marks have to be adapted to the wheelbase of the Lexus

The 3D software can calculate from the brightness levels captured in the HDR panorama how the shadow is cast by the car

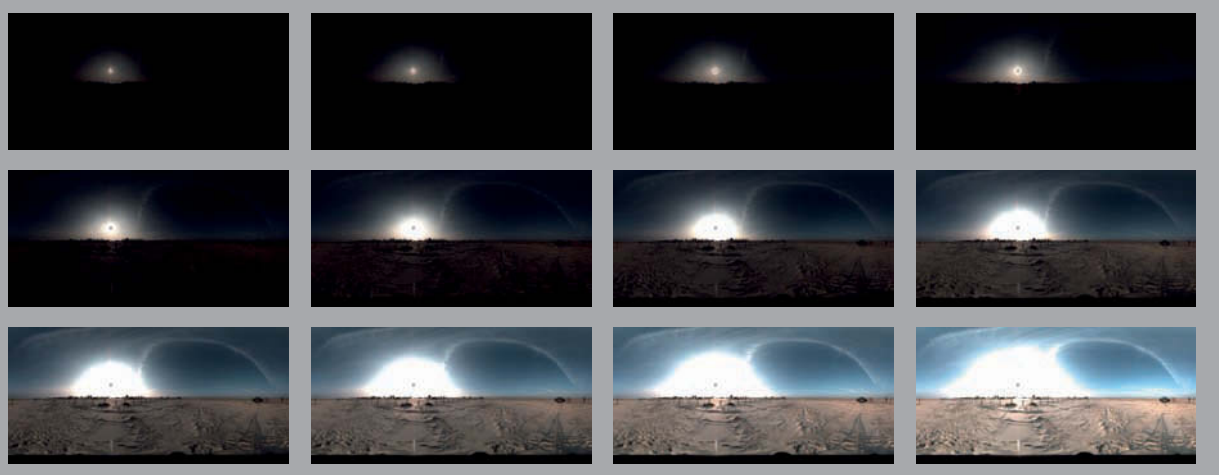
From the known material characteristics of the car body the 3D software can compute a realistic view of the model car; the reflections show the real scenery including elements that are not shown in the composition but which were captured in the spherical panorama

REALITY MEETS VIRTUALITY

The SpheroCam HDR provides the conditions for the photo-realistic rendering of the car, which is placed virtually in the center of the panorama – in other words, precisely where the camera had been standing, so that you don't have to retouch that area; but smaller deviations from this position are also possible. The panorama not only fully reproduces the environment, allowing you to design realistic reflections and the like, it also registers the intensity of the light that falls onto the car from every angle. Unlike conventional cameras, which merely approach an authentic reproduction of tonal values, the SpheroCam HDR can measure all light values from the deepest shadow up to a 67.108.864-times brighter source. From this data, the Spheron software can calculate a light field to help Maya, a 3D modeling software, reproduce natural-looking light and shadow effects. And not only do the reflections look natural, they are natural – they are reflections that were actually there, behind the viewer, as the spherical panorama captured these, as well. The 3D application can now generate any given view, showing the virtual car parked in

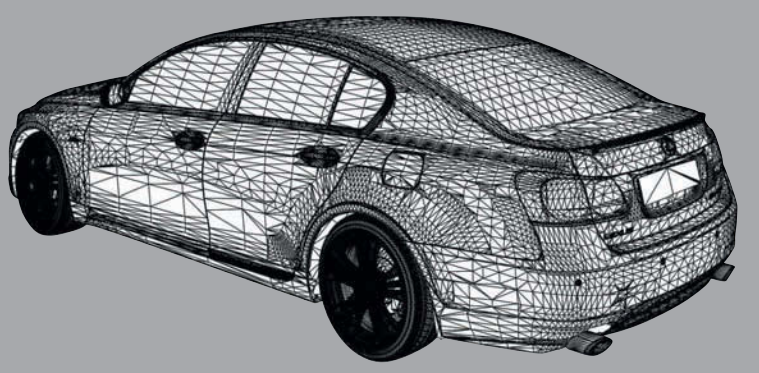
HDRI – AT A GLANCE

1 HOW AN HDR IMAGE IS MADE



A digital camera reproduces a limited dynamic range; but when a series is produced with varied exposure settings, every exposure captures a different part of the overall tonal spectrum. Combining them into a sandwich, the dynamic range of the resultant picture can be as big as you want it

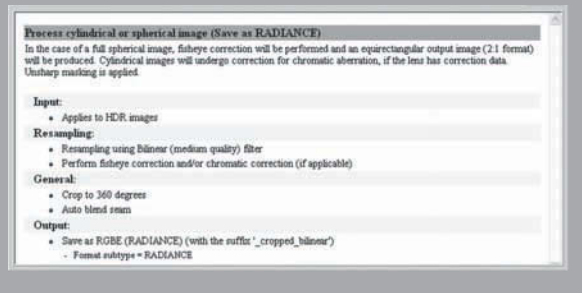
2 THE CAR MODEL



Industrial production often uses highly detailed three-dimensional models containing components that are not even visible to the viewer, such as the window button and the door lock

3 THE SPHEROCAM HDR

The motor-controlled panorama camera rotates around its own axis while registering 180 degrees vertical with a vertically mounted fisheye lens. By means of automatic exposure sequences the camera can differentiate a contrast range of up to 26 aperture stops



Post-manipulating the panorama image: once the exposure has been controlled in this histogram (right) the panorama picture has to be equalized (above)

authentic scenery – you can view it from all angles, including the bird's eye view, the interior view and the view out of the car. An HDR panorama and a 3D model enable you to generate multifold perspectives, and you can easily present an alternatively configured or painted model in different environments. Last minute changes, as ordered by the client, thus represent no major challenges.

Claus-Peter Dudek not only uses this technology to produce individual shots – posters and the like – for print campaigns, but also for movies and interactive online presentations: virtual camera rides around the car, navigable panoramas, and "configurators" for the prospective car purchaser, allowing him, with the click of the mouse, to switch between the countless car interior and exterior configurations, shown perfectly rendered in a genuine backdrop.

THE IMAGINATIVE EYE

This kind of photography has little in common with classic photography. Today even photographs taken the conventional way are often composed of several, differently exposed partial views. This blurs the borders between traditional technology and a hybrid version of photography and other procedures. Yet, the specific photographic character of this modus operandi is maintained, because the photographer still has many of the same tasks. The ostensible photo is indeed a computer- generated view of a chiefly virtual reality, but the photographer can and must access his studio knowledge. This enables the photographer to consciously add light sources with predefined characteristics to the virtual scene. He can place brighteners that virtually reflect the light that was present during the shoot; and the panorama exposure already challenges his imaginative eye. As the photographer exposes the background of a subject that, when starting out, only exists in his head, he has to anticipate potential problems and conflicts that may arise during the montage.

3D modeling is not a universal solution to all photographic problems. Rather, it is limited to subjects from industrial production, which are fairly easy to model and already exist as reference for the real-life product. What's more, as realistic as the generated images then may be, when it comes to precisely reproducing the tiniest details of form and fabric, virtual technology still has its limits, at which point Claus-Peter Dudek simply grabs his Hasselblad H2D-39.