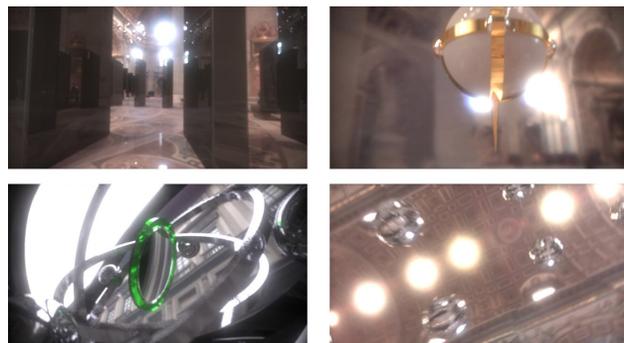


# Image-Based Modeling, Rendering, and Lighting in *Fiat Lux*

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## Introduction

This animation sketch presents how image-based modeling, rendering, and lighting were used to create the animation *Fiat Lux* from the SIGGRAPH 99 Electronic Theater. The film features a variety of dynamic objects realistically rendered into real environments, including St. Peter's Basilica in Rome. The geometry, appearance, and illumination of the environments were acquired through digital photography and augmented with the synthetic objects to create the animation. The film builds on the techniques of *The Campanile Movie* and *Rendering with Natural Light* from SIGGRAPH 97 and 98.



## The Imagery and Story

*Fiat Lux* draws its imagery from the life of Galileo Galilei (1564-1642) and his conflict with the church. When he was twenty, Galileo discovered the principle of the pendulum by observing a swinging chandelier while attending mass. This useful timing device quickly set into motion a series of other important scientific discoveries. As the first to observe the sky with a telescope, Galileo made a number of discoveries supporting the Copernican theory of the solar system. As this conflicted with church doctrine, an elderly Galileo was summoned to Rome where he was tried, convicted, forced to recant, and sentenced to house arrest for life. Though honorably buried in Florence, Galileo was not formally exonerated by the church until 1992. *Fiat Lux* presents an abstract interpretation of this story using artifacts and environments from science and religion.

## The Technology

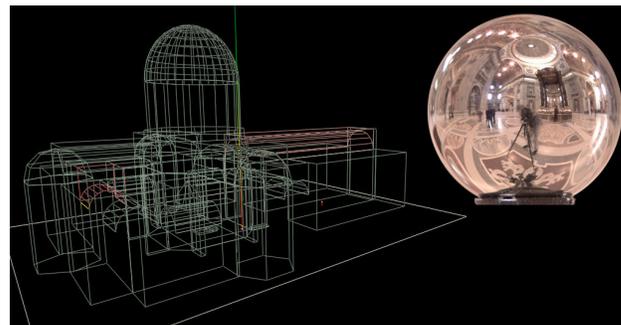
The objects in *Fiat Lux* are synthetic, but the environments and the lighting are real. The renderings are a computed simulation of what the scenes would actually look like with the synthetic objects added to the real environments. The techniques we used represent an alternative to traditional compositing methods, in which the lighting on the objects is specified manually.

The environments were acquired in Florence and Rome; the images in St. Peter's were taken within the span of an hour in accordance with our permissions. To record the full range of illumination, we used high dynamic range photography<sup>2</sup>, in which a series of exposures with varying shutter speeds is combined into a single linear-response

radiance image. Several scenes exhibited a dynamic range of over 100,000:1.

The appearance and illumination of each environment was recorded with a set of panoramic images and light probe measurements<sup>3</sup>. Each light probe measurement was made by taking one or two telephoto radiance images of a 2-inch mirrored ball placed on a tripod; each provided an omnidirectional illumination measurement at a particular point in space. Several radiance images were retouched using a special high dynamic range editing procedure and specially processed to diminish glare.

We constructed a basic 3D model of each environment using the Façade photogrammetric modeling system<sup>1</sup>. The models allowed us to create virtual 3D camera moves using projective texture-mapping, as well as to fix the origin of the captured illumination. The light probe images were used to create light sources of the correct intensity and location, thus replicating the illumination for each environment. The illumination was used to "un-light" the ground in each scene, allowing the synthetic objects to cast shadows and appear in reflections<sup>3</sup>. The dynamic objects were animated either procedurally or by using the dynamic simulator in Maya 1.0. Renderings were created on a cluster of workstations using Greg Larson's RADIANCE global illumination system to simulate the photometric interaction of the objects and the environments. The final look of the film was achieved using a combination of blur, flare, and vignetting filters applied to the high dynamic range renderings.



Contributors: Christine Cheng, H.P. Duiker, Tal Garfinkel, Tim Hawkins, Jenny Huang, and Westley Sarokin. Supported by Interval Research Corporation, the Digital Media Innovation program, and the Berkeley Millennium project.

See also: <http://www.cs.berkeley.edu/~debevec/FiatLux>

## References

- 1 Paul E. Debevec, Camillo J. Taylor, and Jitendra Malik. *Modeling and Rendering Architecture from Photographs*. In SIGGRAPH 96, August 1996.
- 2 Paul Debevec and Jitendra Malik. *Recovering High Dynamic Range Radiance Maps from Photographs*. In SIGGRAPH 97, August 1997.
- 3 Paul Debevec. *Rendering Synthetic Objects into Real Scenes: Bridging Traditional and Image-Based Graphics with Global Illumination and Dynamic Range Photography*. In SIGGRAPH 98, July 1998.