The Art and Science of Imaging Worlds

Griffith Observatory's planetarium show *Signs of Life*

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ABSTRACT

Signs of Life is Griffith Observatory's new 35-minute, 8K, 60fps planetarium show in which we discover what it took to put life in the universe in the one place where we know it exists. In this program we'll discuss how the team was guided by Griffith Observatory's legacy in science-based storytelling. The team will describe the artistic process of merging cinematic sensibilities with scientific accuracy to create worlds in the universe. We'll also explore the importance and effectiveness of presenting science information artistically.

ACM Reference Format:
Dawn Fidrick, Gee Yeung, Bob Niemack, and Don Dixon. 2020. The Art and Science of Imaging Worlds: Griffith Observatory's planetarium show *Signs of Life*. In *Special Interest Group on Computer Graphics and Interactive Techniques Conference Talks (SIGGRAPH '20 Talks), August 17, 2020, Virtual Event, USA*. ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3388767.3411060

1 EARTH

The story calls for a flight over Earth to illustrate the ways it is a perfect place for life. To show the science in an artistic way, we emphasized the Earth's distance from the Sun, its atmosphere, Moon, sunset, sunrise, and the aurora borealis, all in one shot! CG Generalist Jared Broddle recalls, "We needed extremely high-resolution textures. NASA's "Blue Marble" images are 24,000 pixels square, but this was a one third the required resolution. I learned of *Sentinel 2*, which is an ongoing mission to photograph the globe in extreme detail, its global image is more than one million pixels wide. "Landsat Weld" dataset provided color patches. The "Tandem-X" global elevation dataset, "MODIS Land/Water Mask", and "Global Human Settlement Layer" all worked for matching elevation, water mask and night imagery. After stitching and processing, the Earth asset was ready for 8K renders."

SIGGRAPH '20 Talks, August 17, 2020, Virtual Event, USA

ACM ISBN 978-1-4503-7971-7/20/08.
https://doi.org/10.1145/3388767.3411060

2 MARS

Mars is a dry planet, but three billion years ago it had great oceans filled with water. We wanted to show there are geologic formations formed by the flow of water. We focused on the outflow channel from an impact crater, Aram Chaos. CG Generalist Tom Bradley began with data from the *Mars Global Surveyor* spacecraft and used the Mars Orbiter Laser Altimeter (MOLA), which measures surface terrain. These data sets were processed in Geographic Information System software called QGIS. Autodesk Maya turned the files into a realistic and accurate 3D surface. Since low-resolution Context Cameras (CTX) gathered the original information in strips, each strip had to be blended to its adjacent strip to create a seamless surface. We introduced clouds to give a sensation of depth and scale.

3 PROTO-PLANETARY DISK

This scene illustrates how most planets, including Earth, form. The process begins with the explosion of a red supergiant star, Antares. This shot is one of the most complex in the show. We had many conversations that straddled the balance of art and science. It evolved continuously as we integrated its story, effects, and the desire to create something believable that, in fact, has never been seen. Broddle recalls, "The proto-disk you see in the background was a significant challenge. It is a swirling disk of gas, dust, and debris that is a newly forming solar system. It was created using Houdini as a volumetric effect. Initially, I was attempting to scatter and advect many particles, but the memory usage was too much, and the appearance was too noisy. I tried to simulate swirling smoke, but it just didn't want to behave in a zero-g or Newtonian way. The final version started with a 3D model of the shapes, converted to volumes, and then advected and displaced into its final form."

4 TRAPPIST-1E

In the past 25 years, NASA has been looking for planets outside of our solar system. These planets are known as extra-solar, or "exo," planets. In this shot we highlighted the planets orbiting a star called Trappist-1. Astronomers have found seven Earth-sized rocky planets orbiting it. Three of these planets are in Trappist-1's "Goldilocks zone," which makes them good candidates to have the right conditions for life. Trappist-1e is tidally locked and therefore we showed snow on the shadow side of the rocks and none on

the other. Getting the right proportion of snow to look accurate was tricky. We also speculated about precipitation levels and wind velocity to create a scientifically plausible planet.

5 EUROPA

Jupiter's moon, Europa, is riddled with icy fault lines, and deep beneath the frozen surface is a liquid ocean larger than all of Earth's oceans. Europa is the hero of the shot. The camera starts very wide and far from the moon before we travel and eventually crash dive onto the detailed rocky trench. Far-to-near shots without any cuts are very difficult because the artists have to work in seamless level-of-detail progressions that occur front and center on camera. It was a technical and rendering behemoth. The team developed wide, medium, and close-up assets that blended perfectly into one another. The moon sphere had a high density patch that was ZBrush sculpted to match the flow of intricate lines and grooves that make up the moon's surface. Finally, large quantities of rocks were scattered across the landscape to provide realism and scale to the world.

6 ENCELADUS

In 2005, NASA's *Cassini* spacecraft discovered jets blasting water ice, organic molecules and other material into space from the south polar region of Saturn's moon Enceladus. They maneuvered the spacecraft to fly through the plumes to collect samples of the erupting vapors and found water vapor, carbon dioxide, methane, molecular nitrogen, propane, acetylene, formaldehyde, and traces of ammonia - all chemicals related to life. The emitting plumes were recreated with scientifically accurate venting locations. CG Generalist, Estevan Guzman used scientific data and imagery captured by *Cassini* to map the "tiger stripe" locations and vents. We took artistic liberties with the spray distance from the vent source to create a more viscerally dramatic camera flyby. We also supplemented the feel of the spray as we pass through the jets by adding layers of shimmering particle FX elements and a sun dog.

7 TITAN

Saturn's largest moon, Titan, is the only moon in the solar system with a thick nitrogen-rich atmosphere similar to Earth's. To construct a plausible terrain for it we studied earthly analogs, specifically karst topography in which limestone and other soluble rocks have been eroded by flowing water. At Titan's surface temperature, -180 degrees Celsius, however, water is as solid as rock. Titan's surface is primarily water ice eroded by liquid methane and ethane, which are gases at temperatures on earth. Our shot required us to fly a camera through the orange haze that envelops Titan, through cumulus clouds, and through a rugged river valley that opens into a lake. We did have to sculpt the river valley in Zbrush meticulously and develop textures to simulate the tar-like tholin deposits that coat the ice.

8 MICROBES

To visualize the biology inside a water drop on Earth, the team visited Lisa Gonzalez from the BioSCAN Project, Entomology Department at the Natural History Museum of Los Angeles County to look at microbe ecosystems from samples we gathered in our backyards. We used the Keyence digital microscope to record video of aquatic microorganisms. On that day, we discovered that water is not as populated as we imagined and that clusters of microbes are relatively sparse. We took some artistic license by increasing the density of creatures in the shot to illustrate the visual dance of bacteria, rotifers, paramecia, and water bears. We kept the footage to use as reference for the shot which was developed with guidance from advisor Gael McGill, Director of Molecular Visualization at Harvard Medical School. We also used the mMaya double stranded DNA kit made by Clarafi, a project created by Digizyme.

ACKNOWLEDGMENTS

Signs of Life was made possible through the public-private partnership between the Los Angeles Department of Recreation and Parks, Griffith Observatory, and Friends Of The Observatory. The project was also supported by of The Vanguard Society, The Ahmanson Foundation, Goldhirsh Foundation, The Ralph M Parsons Foundation, Rose Hills Foundation, Union Bank Foundation, and L.K. Whittier Foundation.

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