

# C O S M I C V O Y A G E

## PRODUCTION FIRSTS AND FACTS

*Cosmic Voyage* -- an IMAX® film produced by the Smithsonian Institution's National Air and Space Museum and the Motorola Foundation -- blends cutting-edge technology and state-of-the-art computer-generated images to create a visually stunning journey through the known dimensions of the universe. To make this ground-breaking film, the producers assembled a "renaissance team" comprising some of the world's leading astronomers, physicists and biologists in addition to entertainment industry experts in computer animation, software and virtual reality. The following "firsts" and "facts" are some of the innovative technologies and techniques used to create this pioneering film:

### FIRSTS ...

- *Cosmic Voyage* marries the most recent technological advances of computer animation with the latest scientific information and the world's largest film format, IMAX (70mm/15perf).
- More than 15 minutes -- 21,000 frames (at 50 megabytes of data each) -- of this production are original IMAX computer animation ... the most found in any IMAX film.
- At the center of the film is the "cosmic zoom" technique which is used to travel out to the outer reaches of space and then into the smallest particles. These are the two longest continuous computer-generated zooms ever created in the history of filmmaking and a first for IMAX.
- To properly depict the colliding and condensing of galaxies, the National Center for Supercomputing Applications developed a new virtual reality technique called the CAVE™ "Virtual Director" that allowed them to choreograph the movement of the camera through the 3D stereo space to visualize the motion. *This ingenious technology has many applications for commercial filmmaking and Hollywood has already taken notice.*
- Many of the images in *Cosmic Voyage* -- including the subjective rendering of quarks, the smallest known building blocks of matter -- have never been viewed before by any

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audiences, even scientists. In addition, audiences will "witness" the first computer simulation time in IMAX of the recreation of the birth of the cosmos, or "Big Bang" and travel through an accurate rendering of a DNA strand. All of these computer-generated visual simulations are based on the most up-to-date observational and data-based scientific theory.

- In IMAX, the complex computer-generated images occupy at least 10 times the film area of standard screen productions. The drawing sharpness with which the images in *Cosmic Voyage* were created is over twice that of the popular film *Toy Story*, which was created by one of the partners in this film, Pixar Animation Studios.
- In addition to the space and land-based observational data used, more than 950 hours of time on a Cray C-90 supercomputer were needed to calculate the precise positions of stars and gases and simulate the colliding galaxies portion of *Cosmic Voyage*.
- The starfields viewed in the film are derived from the Smithsonian Astrophysical Observatory's detailed star maps and helped the producers accurately show the correct position, apparent brightness and even color temperature of tens of thousands of stars.
- It took six weeks of time on a Silicon Graphics Power Challenge Array multiprocessor supercomputer to compute the scene of galaxies condensing after the Big Bang.

# C O S M I C V O Y A G E

## FILM FEATURE

### FROM OUTER SPACE TO INNER SPACE: *COSMIC VOYAGE* ZOOMS TO THE FRONTIERS OF CREATION

Staring wide-eyed at the distant points of light dotting the night-time sky, we spot a shooting star, but fail to witness the last breaths of a supernova. Squinting at an up-close inspection of our hands, we may notice a fleck of dirt, but certainly miss our skin's minute molecular make-up. The naked eye can see only a very limited slice of the universe. Thus, our imaginations struggle to fathom the incredibly vast dimensions of the world in which we live.

Audiences will come face-to-face with the mysteries of the universe in the spectacular IMAX® giant-screen film *Cosmic Voyage*. The production takes viewers on a journey of discovery that brings into focus the worlds beyond our sight. Never before has a large-format film used such astounding amounts of data-based computer animation to visualize and demonstrate some of the greatest scientific theories, including the birth of the cosmos and the nature of black holes.

Sponsored by the National Air and Space Museum and the Motorola Foundation with support from the National Science Foundation, this larger-than-life production breaks the boundaries of standard theater screens and envelops viewers with a picture ten times the size of conventional film.

At the heart of the *Cosmic Voyage* experience is the clear understanding that humans stands near the middle of infinitesimal atoms and an ever-expanding universe. To illustrate this fact, the film embarks on a guided tour across some 42 degrees of magnitude -- from quarks (the smallest known particles of matter) to superclusters of galaxies -- ultimately enhancing viewers' sense of scale. Combining state-of-the-art computer-generated images with a concept called the "cosmic zoom," viewers are hurled into the extreme limits of the known universe before plunging downwards to scrutinize the subatomic domain.

While viewers spend much of the film's 35 minutes tumbling through the billions of years it took to create the surrounding universe, they come to Earth from time to time with breath-taking on-location footage taken in Greece, Italy, Holland and America. This magnificent adventure through time and space pulls audiences from their seats and launches them into a spectacular world of extreme dimensions encompassing inner and outer space.

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To realize the creative concept of *Cosmic Voyage*, the filmmakers assembled a "renaissance team" of top-rated scientists, astronomers, physicists, biologists and computer animation experts. This diverse team was led by IMAX filmmaking veterans and the film's producers Jeffrey Marvin and Bayley Silleck through their New York-based production company, Cosmic Voyage, Inc. They were brought together to complete a very daunting task: develop a complex and creative storyboard about the voyage through vast dimensions in what Silleck calls "a very challenging medium, IMAX". Because of the large format, many of the computer animation sequences needed to depict the universe had never been attempted before. To simulate and render these scientific visualizations, Silleck and Marvin called upon the unique talents of John Grower, president of Santa Barbara Studios (SBS); Donna Cox, president of Creative Visualizations Unlimited and director of the Renaissance Experimental Laboratory and Loren Carpenter, senior research scientist at Pixar Animation Studios, the company that recently produced the popular commercial film *Toy Story*. The producers also enlisted the assistance of Peter Parks, founder of Image Quest Ltd., to shoot the live action macrophotography of microscopic organisms.

### *A Cosmic Rollercoaster Ride*

The "cosmic zoom" portion of the journey begins appropriately in Venice, Italy, where Galileo Galilei developed the telescope more than 400 years ago. As a progressive thinker of his time, Galileo would most certainly be proud to know that technology has made it possible to send his creation into orbit, where the Hubble Space Telescope is found today.

The audience begins by taking one step out into space to examine the scene from ten meters away. Each successive leap outwards increases the field of vision tenfold. Within seconds, our own solar system shrinks from sight. After 26 steps, they have reached the outer edge of space and are 15 billion light years from Earth!

Continuing the tour, viewers retrace their footsteps and touch down in the Dutch town of Delft -- home of Antoni Van Leeuwenhoek, who developed the microscope. Traveling inward by powers of ten, audiences are guided into the living kingdom of a drop of water and further into its minuscule world of electrons, protons and neutrons -- the building blocks of all matter. Before long, they are introduced to the smallest particle known to humans -- the quark.

*Cosmic Voyage* also looks back 15 billion years to a time when the entire observable universe was smaller than a marble. The universe, scientists theorize, was born exploding, and gave rise to the structure of galaxies in expanding space that we see today. This theory, known as the Big Bang, comes to vivid life on the screen.

After beholding this extraordinary burst of energy, the audience observes the development of the cosmos. Swirling gas clouds clustered together from the pull of gravitational forces become galaxies of mingling stars, gases and particles. As massive stars explode in violent death, they spread the elements of which we and our world are made. We are literally made from star dust. Finally, viewers witness the rise and diversification of life on Earth.

### Meeting of the Minds

The film's producers -- along with John Grower and Donna Cox -- began their collaborative efforts nearly three years ago by setting out to re-create events that span billions of years. Challenge number one: Creatively and colorfully depict the cosmic zooms into outer and inner space, the universe exploding, a comet hurtling towards Earth, galaxies colliding and a supernova violently erupting. Challenge number two: Gather and store the gigabytes of space and land-based observational and supercomputer data needed to accurately render and simulate 3D models of these scientific phenomena.

The answers came after years of planning, preparation and hard work -- and, in many cases, enabled the producers to break new ground in IMAX filmmaking. Silleck and Marvin enlisted some of the greatest scientific minds in the U.S. to gather the data for these images. They utilized the detailed star maps of the Smithsonian's Astrophysical Observatory for many scenes, and actual astrophysical data, run through supercomputers to simulate "actual" colliding galaxies.

In fact, most of the gigabytes of data they collected were transported from one production partner to another via the Internet. A total of 950 hours of Cray C-90 supercomputer time were necessary to run the model of the galaxies colliding. The condensing galaxy sequence alone required six weeks of round-the-clock calculation on a multi-processor supercomputer.

In the end, an unprecedented 15 minutes of film, or 21,000 frames of IMAX (70mm 15-perf) film at 50 megabytes of data each, were created. The amount of data was so immense that just to recreate the condensing and colliding galaxies required Cox to hand deliver it to Santa Barbara Studios so it could be filmed in IMAX. Had the data been sent back over the Internet, it would have flooded the system.

### Cave Dwellers

Another first for *Cosmic Voyage* was the use of innovative virtual reality techniques to analyze and choreograph the condensing and colliding galaxy sequences. After the scientists modeled these segments on supercomputers, the astrophysical data was then loaded into the "CAVE"<sup>TM</sup> (cave automated virtual environment). The CAVE is a high resolution, stereo 3D, video and audio environment where rear projection images of the galaxies seemed to hang suspended in space. Cox and her colleague Robert Patterson choreographed these sequences with the newly-developed "Virtual Director" CAVE software, allowing them to "become" the camera and move through the cosmic data with the use of voice commands.

They entered the CAVE wearing wireless microphones and stereo liquid crystal glasses and used a magnetically tracked hand-held wand for spatially controlling the camera. The wand also helped Cox and Patterson navigate around the data. The freedom of motion gained with the "Virtual Director" could often be dizzying, but it enabled them to easily fly and roll through the galaxies in 3D, searching for the most revealing and exciting angles. The camera paths created in the CAVE were then combined with Pixar Animation Studio's custom "Star Renderer" to produce the high resolution imagery.

Over 100 gigabytes of scientific data were actually turned into approximately 100 gigabytes of imagery. The result: a tour-de-force collision of galaxies never before seen in such sharp, giant-screen splendor.

### **The Truth is Still Out There**

While technology can help us visualize some of the wonders of the universe, there remain many mysteries awaiting human investigation. The gravitational whirlpool of a black hole, the horizon of the universe and the possibility of extraterrestrial civilizations are just a few of the many riddles that excite our curiosity.

But, as we enter a new age of discovery and continue our *Cosmic Voyage*, the rapid development of technology coupled with the young minds of aspiring scientists, may turn today's questions into tomorrow's revelations.

# C O S M I C V O Y A G E

## THE MAKING OF *COSMIC VOYAGE*

-- Roundtable Discussion with Creators Bayley Silleck, Jeffrey Marvin, John Grower, Eric DeJong and Donna Cox --

*Cosmic Voyage* promises to envelop audiences as it whisks them away on an awe-inspiring journey around the known dimensions of our cosmos. The film highlights the vast expanse of the universe from quarks to galaxy clusters through computer-generated imagery, 3D modeling techniques and other state-of-the-art production tools.

Spearheaded by Director Bayley Silleck and Producer Jeffrey Marvin, the computer animation sequences of the production -- which make up an unprecedented 15 minutes of the IMAX® film -- were created by a diverse team from across the country, including experts from Santa Barbara Studios, the National Center for Supercomputing Applications and Pixar Animation Studios. *Cosmic Voyage* is a prime example of how revolutionary advances in technology and computer animation software have begun to impact the entire film industry. In fact, Hollywood filmmakers have definitely taken notice of some of the advances used to make *Cosmic Voyage*, especially the "Virtual Director."

The following is a roundtable discussion with producers Bayley Silleck and Jeffrey Marvin; director of Santa Barbara Studios, John Grower; the film's associate producer for scientific visualization and director of the Renaissance Experimental Laboratory at the National Center for Supercomputing Applications (NCSA), Donna Cox and scientific advisor at Santa Barbara Studios Dr. Eric DeJong. It explores the high-end technology used to create *Cosmic Voyage*.

**INTERVIEWER:** *Please explain the concept behind *Cosmic Voyage* and how the creative idea for the film was born.*

**SILLECK:** **Cosmic Voyage* sets out to show human beings where we are in the context of the greater universe. We learn about molecules, we learn about galaxies, we learn about planets, but how do these things all fit together? How do they relate to us? After watching the film, we hope that audiences will take away a greater sense of the wider world.*

*As for the creative idea behind the project, Jeff Marvin and I were talking about potential IMAX subjects and he mentioned a book by a Dutch teacher called Cosmic View which shows how all such elements in the universe relate to each other. The book was a revelation for us in*

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that it provided an extraordinary view of how things around us are all related. With this conversation, our idea was born. The "cosmic zoom" technique which was used throughout the film to "fly" audiences to the outer reaches of space and then back into the smallest particles of matter.

**GROWER:** *Cosmic Voyage* brings to the IMAX screen imagery that has never been seen before. Scientifically based, the film incorporates over 15 minutes of revolutionary high-resolution computer imagery and on-location film footage. It is big, it's clear, it's beautiful and we hope the audience will come away inspired.

**INTERVIEWER:** *Could you talk a little bit about the technical team assembled to create such revolutionary imagery?*

**MARVIN:** To pull this all together, we assembled two distinct groups. One for animation and one for macrophotography. The animation group was comprised of three companies -- Santa Barbara Studios, Pixar Animation Studios and The National Center for Supercomputer Applications (NCSA). We then recruited a company called Image Quest 3D from England to produce the macrophotography. They all did a terrific job in delivering the incredible amount of images that we needed.

**INTERVIEWER:** *To help IMAX audiences visualize the vastness and turbulence of our universe and the tiny, mysterious world of atoms and quarks, what major challenges did the team face?*

**GROWER:** At Santa Barbara Studios, we faced quite a challenge as we were charged with creating a slew of scientifically accurate, yet entertaining shots that had never been seen before on film. We used computer animation to develop a majority of the images which ranged from black holes, the early evolution of the solar system and comets crashing into primordial Earth to strands of DNA, electrons swirling inside an atom and the smallest existing particles of matter, quarks. In accomplishing this, we developed a team comprised of our science advisor at Santa Barbara Studios, Dr. Eric DeJong and a diverse group of animators, filmmakers and artists. It was really our combined knowledge that made it all possible. In total, we, at Santa Barbara Studios, created 11 of the 15 total minutes of computer animated sequences seen in *Cosmic Voyage*.



- COX:** At NCSA, our first challenge was to orchestrate many researchers and artists from across the globe in producing fantastic visualizations of the early universe -- including colliding and condensing galaxies -- using the supercomputer. Our second primary challenge was to ensure that the audiences would be able to see and understand the images on the screen.
- INTERVIEWER:** *Could one of you please elaborate on the role of a science advisor in creating the film?*
- DeJONG:** My primary role was to come up with the technical design for *Cosmic Voyage* so we could actually visualize the entire structure of the cosmos on a variety of different scales. In order for this to happen, the team at Santa Barbara Studios had to design the trajectory from which we would view the universe and then create models of certain key elements like the solar system and the Milky Way Galaxy. I was intimately involved in the entire process, helping to ensure scientific accuracy.
- INTERVIEWER:** *What are some of the technological firsts associated with the film?*
- MARVIN:** *Cosmic Voyage* incorporates many technological firsts. For example, this is the first IMAX film to rely on the use of 3D computer graphics in combination with live-action images as an integral part of the content. The amount of rendering time needed to combine such digital images with live action animation represents quite an extraordinary technical challenge. The fact that the film incorporates 15 minutes of such high-resolution computer animation also qualifies as a first.
- COX:** There has never been an IMAX film in which so much data-driven visualization was used to tell the story. Some of the top scientists from across the country modeled their theories in three dimensions on the supercomputer; we then used the resulting data to turn out visualizations on the supercomputer that were absolutely dynamic and inspiring to people who see them. It is almost like taking an audience and dropping them billions of years in the past. This film is particularly unique in that we have gone beyond special effects and created whole new technologies with the help of some of the best science we have today.
- At NCSA we developed another first that we've called the "Virtual Director" which is a virtual reality choreographer. This was a tool that my colleague Bob Patterson and I used to control the computer graphics

camera when we were filming the colliding and condensing galaxy sequences.

**INTERVIEWER:** *What is the "Virtual Director" and how do you think it will impact the major motion picture industry?*

**COX:** The "Virtual Director" allowed Bob and me to stand in a totally immersed environment, otherwise known as the CAVE™, and literally choreograph the sequence. With other choreography tools you sit in front of the computer, look at an image and move a mouse. You are outside of the image as you try to control the camera that looks at the 3D computer graphics space. With the "Virtual Director," you are completely immersed. When you walk into the CAVE, you are actually inside of the data as you operate the camera through a 3D stereo space.

The "Virtual Director" will revolutionize Hollywood filmmaking by providing animators with far more creativity and control of their work. Instead of simply clicking a mouse they will be able to immerse themselves in the shot like never before. The tool will completely change the way special effects are created. Computer graphic, synthetic environments will take on an entirely new form as animators continue to gain new and greater perspectives in design.

**INTERVIEWER:** *How does it feel to work in a "virtual setting," specifically one like the CAVE?*

**COX:** You walk into a room and there are 3D images all over the floors and walls -- even hanging suspended in front of you. For example, when Bob and I were going to "perform" the motion of the colliding galaxies, we both put on the stereo goggles and he also held a wand. We could see the stars and galaxies all around us as if we were completely immersed in that environment. We felt as if we could reach out and touch the stars, just like in a 3D movie. The information simulated in the CAVE's 3D stereo environment was then virtually designed to give the audience a feeling of actually being inside the colliding or condensing galaxy sequences.

**INTERVIEWER:** *In terms of production value, how does the computer animation in a film like **Cosmic Voyage** differ from one like "Toy Story?"*

**COX:** The primary difference between the two films is that, for *Cosmic Voyage*, we incorporated such large amounts of scientific data and formatted it for the IMAX frame (70mm/15 perf). In this way, computer-generated images occupied at least 10 times the frame area of a conventional film such as *Toy Story*. In addition, *Cosmic Voyage* uses data-driven visualization, whereas *Toy Story* uses 3D computer graphics to achieve narrative character animation. Both *Toy Story* -- which was produced by Pixar Animation Studios -- and *Cosmic Voyage* illustrate the progress which has been made in terms of the scientific research as well as the hardware and software technology necessary to produce quality 3D computer animated movies.

**INTERVIEWER:** *Does anyone have any final thoughts about the production that they would like to add?*

**SILLECK:** I think it is important for people to realize that *Cosmic Voyage* is truly unique in that it brings the world of science and the world of art together in the highest quality film format today, which is IMAX. And I don't think that the universe has ever been seen in quite the way it is in *Cosmic Voyage*. I think the detail combined with the extraordinary power of the IMAX medium is going to create an experience unlike any other.



**FOR IMMEDIATE RELEASE**

**IMAX® AUDIENCES EMBARK ON A  
*COSMIC VOYAGE* THROUGH TIME AND SPACE**

Audiences around the world will have a unique opportunity to experience the wonders of the cosmos and explore humanity's true place in the vast continuum of nature -- from the tiniest building blocks of matter to superclusters of galaxies in outer space.

*Cosmic Voyage*, an IMAX® film presented by the Smithsonian Institution's National Air and Space Museum and the Motorola Foundation, is narrated by three-time Academy Award® nominee Morgan Freeman. *Cosmic Voyage* is produced by Jeffrey Marvin and Bayley Silleck and written and directed by Bayley Silleck. Additional support is provided by the National Science Foundation. The 35-minute film, which is distributed worldwide by Imax Corporation, takes viewers on a spectacular journey through the known dimensions of our universe.

Highlighting *Cosmic Voyage* is a "cosmic zoom" extending from the surface of the Earth to the largest observable structures of the universe, and then back down into the sub-nuclear realm -- *a guided tour across some 42 orders of magnitude!*

*Cosmic Voyage* breaks new ground in filmmaking both on and off the screen. The film presents the latest scientific information on the formation and structure of our universe in a breathtaking and ambitious blend of live action footage and cutting-edge computer animation, which accounts for an unprecedented 15 minutes of the film. In fact, key members of the

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production team developed a new software technology called the "Virtual Director" to help simulate the computer-generated images, a process which is enticing Hollywood filmmakers.

This larger-than-life film format allows viewers to observe stupendous events such as the explosion of the "Big Bang," the collision of galaxies and the development of our own solar system. Viewers will also experience the smaller universe that exists on the microscopic level, by flying through a carbon atom and viewing quarks ... the smallest known building blocks of matter.

"I don't think the universe has ever been seen before in quite the way it is seen in *Cosmic Voyage*, says director Bayley Silleck. "The detail and the extraordinary power of the IMAX frame, I think, are going to create an experience unlike any other that has been seen in the world of film".

Live action sequences for this production were filmed on location in Greece, Italy, Holland, Hawaii and Utah. Macrophotography was done at Image Quest in England, while computer animation sequences were created by Santa Barbara Studios, the University of Illinois's National Center for Supercomputing Applications and Pixar Studios in the U.S.

Acclaimed actor Morgan Freeman, narrator of *Cosmic Voyage*, is best known for his roles in such feature films as: *Moll Flanders*, *Robin Hood: The Prince of Thieves*, *The Shawshank Redemption*, *Driving Miss Daisy*, *Glory* and *Street Smart*. In addition to three Academy Award® nominations for best actor in *Street Smart*, *Driving Miss Daisy* and *The Shawshank Redemption*, Freeman received a Golden Globe Award for his performance in *Driving Miss Daisy*. Freeman has also earned wide-spread acclaim for his work both on and off Broadway including a Tony Award nomination for his role in *The Mighty Gents* and four Obie Awards.

IMAX technology, invented by Imax Corporation, uses the largest film frame in motion picture history (ten times the size of conventional 35mm and three times the size of standard 70mm), together with wrap-around digital sound systems and the most advanced projection system ever built, to support the network of more than 130 specially-designed theaters around the world. Since the IMAX medium premiered in 1970, more than 510 million people have enjoyed the IMAX experience.

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Contact: