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Making Sense of DMR

by Mark Bretherton

For some time it was my belief that running DMR titles in a single-screen IMAX theater would break the business model and simply wouldn't be a profitable exercise. I was sympathetic to the arguments of the producers of traditional product that DMR titles pushed their films off screen and could therefore limit the flow of new product. I wanted to run a profitable theater, highlighting unique giant-screen product, but I could see there was also an audience for DMR titles. Was it possible to do both successfully?

Since 2004 I have been running both DMR and traditional product at the Sydney IMAX Theater and I now believe it is possible to have a programming policy that works well for both types of film and to the benefit of the theater.

I've learnt some interesting things along the way. Perhaps most surprising is that, in most cases, I can expect traditional product to outperform DMR product. In

*(see **BRETHERTON** on page 10)*

Inside *LF Examiner*

Impact of Recession on Giant Screen Theaters

by Judith Rubin

Part II: International Theaters

In Part I, published last month, we examined effects of the economic downturn on giant screen theaters and the institutions that house them, looking at three venues in the US. This month we report on the experiences of theaters in Canada, Europe, Singapore, Thailand, India, and Australia.

Canada

This summer, unusually cool weather was more of a damper on visitor numbers at the Montreal Science Centre and its 380-seat **Telus IMAX Theater** than was the recession, according to **Julie LaRoche**, director of sales, business, and entertainment. Chilly, rainy conditions kept people away from the normally busy Old Port of Montreal during the evenings, and numbers at the theater were down from last year. "During the day my shows are sold out," said LaRoche in July, "and museum results have exceeded expectations, but after 7 p.m. it goes down."

You don't go to a rainy port for date night, and as a result, the schedule was curtailed: where last year they added an 11 p.m. screening on the busiest nights, this year the last show was at 9 p.m. Sundays through Wednesdays, and 10 p.m. Thursdays, Fridays, and Saturdays. The theater is showing *U2 3D* and *Under the Sea 3D*. "The 9 p.m. show of *Under the Sea* is not

*(see **RECESSION** on page 6)*

Premiering this month
Cloudy With A Chance of Meatballs
See page 18.

Making *Molecules*

by Kurt Przybilla

NanoSpace! A final frontier? The nanoscale world is so small that it lies hidden far below the wavelengths of visible light, beyond the realm of conventional cameras. This is a world of atoms and molecules, the basic building blocks of the universe from which all things are made. The discovery, isolation, and exploration of the different chemical elements that make up all matter is at the heart of our scientific understanding. Nanotechnolgy, which has become a hot topic in science and the media, is advancing rapidly and will change the world in which we live. But atoms and molecules remain beyond the experience and perception of most people.

"If only one idea could be passed on to the next generation, it is the concept of atoms and molecules, and that everything is made of them," wrote Nobel laureate Richard Feynman in his famous 1970 *Lectures on Physics*. Passing this powerful message on to the next generation is the mission and passion of the scientists turned producers behind the new animated giant-screen adventure, ***Molecules to the MAX!***

"The film transports audiences to places no one can ever go, to help them understand this profound idea through direct experience," says **Dr. Shekhar Garde**, executive producer and leader of the scientific team that created the film's molecular simulations. "By introducing audiences to atoms in this exciting new way, and immersing them in the molecular environments of a wide range of everyday materials, we hope that people will leave the theater looking at everything completely

*(see **MOLECULES** on page 13)*

Making Molecules to the MAX!

*(from **MOLECULES** on page 1)*

differently, realizing for the first time that every thing they see is actually made of atoms and molecules."

Supported by the **National Science Foundation**, *Molecules to the MAX!* follows the adventures of Oxy, a precocious oxygen atom and captain of the *Molecularium*, the most fantastic ship in the universe. Oxy is dispatched by the Unified Field of Atoms, along with two hydrogen atoms, on a mission to planet Earth to make contact with some atoms that have become involved with a mysterious force called "Life." Being sent to the "water planet" as an H_2O molecule enables them to mix right in, as all life depends on water. Once they have discovered the secret of life, they are to report back to Atom Base immediately. Thus ensue the hijinks and misadventures of this nanospace odyssey.

The film is the culmination of an unprecedented collaboration between a group of scientists at the NSF-funded Nanoscale Science and Engineering Center at **Rensselaer Polytechnic Institute** in Troy, NY, and the creative team at the production company, **Nanotoon Entertainment**. The film draws on the talents of professionals from a wide range of disciplines, teaming artists, writers, animators, musicians, and actors with chemical engineers and computer and materials scientists.

L to r: Co-writers Kurt Przybilla and V. Owen Bush.

Nanotoon Productions

The genesis of Molecularium

The Molecularium® Project at Rensselaer began in 2001 when **Dr. Linda S. Schadler**, head of educational outreach for the NSEC and a leading nanomaterials expert, was talking with the director of a local children's museum about creating an engaging, fun exhibit to teach kids about atoms and molecules. Understanding these basic building blocks of the universe, she said, is critical to understanding the environmental, energy, and health issues we face as a nation. Something clicked when the conversation took an astronomical turn, and the director showed her a model of the planetarium that was being built at the museum.

"The idea for using a planetarium as a venue to teach about atoms and molecules just popped into my head," Schadler said. "And once I had the vision, I couldn't let it go. If you can go to the stars, why can't you go down to the molecular level? When I saw the planetarium dome I knew we could immerse people in the material. That's how materials engineers think. They picture themselves inside the material."

Inspired by this vision, she set out to make it a reality. "If I want my kids to learn about the natural world of animals or astronomy, there are all kinds of shows out there, but when it comes to materials science, there really isn't anything," says Schadler.

Her colleague Garde, a professor of chemical and biological engineering, was inspired and immediately dedicated himself to the cause. "Galaxies, to me, are very far away and I don't think about them every day," says Garde. "I drink water every day, and thought, 'Wouldn't it be fun to jump into it at the molecular level and see what it looks like?'"

The result of their collaboration was a simple, seven-minute, monochrome vector-graphics show they called *Molecularium*, in which a simple water molecule serves as a guide to the world of atoms and molecules. Despite the simplicity of its animation, this initial effort was a great success and very popular at the museum. It proved that the topics of atoms and molecules could be captivating to kids, and assessment data showed that audiences were learning a lot.

"It was clear that it worked even in a very crude format," says **Dr. Richard W. Siegel**, director of RPI's Nanotechnology Center. The scientists knew they were on the right track, but the simple look of the show, which was limited by the projection technology, was not what Schadler had originally envisioned. "We wanted to have full color, Hollywood-style animation." Encouraged by the results, the team was determined to take their idea to the next level.

In early 2004, Schadler, Garde, and Siegel were awarded an NSF supplemental grant to make a new *Molecularium* show for digital domes, with the RPI team serving as executive producers. They brought on **V. Owen Bush**, who was working on *SonicVision*, a groundbreaking fulldome visual music show for the **American Museum of Natural History**'s Hayden Planetarium, to bring their idea to life.

Developing the story

Bush enlisted me to help develop the basic treatment and premise for the production. I'm a writer, educator, and inventor, and saw our challenge as writers was to make this invisible world of atoms and molecules interesting and believable to an average audience of kids, while at the same time teaching them something.

Once we hit upon the idea of using atoms as characters, we knew we could use audience's enthusiasm for stories to de-

*(see **MOLECULES** on page 14)*

The Molecularium team at Rensselaer Polytechnic Institute.

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velop an emotional connection to the characters. After all, if people can believe in talking mice and cars, why not talking atoms? What best captivates the attention and imagination of kids? The fantasy worlds of Pokemon, Harry Potter, and the Disney universe, are ironically more "real" to most children (and some adults) than the very real world of micro- and nano-scale science. We chose an approach normally reserved for fantasy-based entertainment to create a science-based educational experience, weaving the key concepts into the storyline. Instead of science fiction, we would use fiction to teach science.

We started by developing principles of the "cartooniverse," deciding it would be a fun world, filled with music and dancing, using catchy songs as mnemonic devices for learning. Atoms would get younger as you moved down the periodic table, so hydrogen atoms would be the same age as the youngest members of the audience. The dome would become the atoms' ship, the *Molecularium*, a magical vehicle capable of flying faster than the speed of light and shrinking to sub-atomic sizes, in which they explore the nano-scale worlds of everyday objects. Atoms that board the *Molecularium* would be freed from the constraints of scientific principles, able to bond and unbond at will, use their electrons as hands, and do things that are inconceivable outside of the ship, where everything would follow scientific principles, and the molecular environments would be scientifically accurate.

With Bush directing and me producing, we assembled a small team of talent to make the show. **Chris Harvey**, creative director of AMNH's *SonicVision*, signed on as art director. **Blake Holland** and **Joshua Minges**, formerly on **Douglas Trumbull**'s team at **IMAX Ridefilm**, signed on as technical directors, and **Steve Rein**, a professional computer animator for over twenty years, signed on as lead character animator.

Riding Snowflakes

In February 2005, the team debuted *Molecularium: Riding Snowflakes*, a 23-minute digital-dome experience. This show was the first glimpse into the Molecularium cartooniverse, which features a cast of atom characters, including Oxy and her sidekicks Hydro and Hydra. The show created a sensation in the digital-dome planetarium community for its entertaining story and characters, its technological innovations, and its unprecedented repurposing of the planetarium's dome space. It won awards and accolades around the globe and is being distributed worldwide in several languages.

Though there was some initial skepticism from gatekeepers at large planetariums because of its unusual subject matter and approach, independent assessment data consistently showed that audiences loved the show and that all ages were learning a lot. The **Chabot Space and Space Center** in Oakland, CA, conducted an extensive evaluation with over 1,200 people that clearly showed that viewers of all ages learned significant amounts from the show. **Alexandra Barnett**, executive director of Chabot at the time said, "*Molecularium* has gotten rave reviews from teachers and from the public. We were skeptical at first, as it seemed like a lot of content for the age range of the cartoon format, but everyone learns something new in this fast paced show with its memorable songs and characters."

Molecules to the MAX!

With the success of the show in the digital-dome world, the Molecularium Project gained momentum and the team quickly set its sights on creating a larger, more ambitious giant-screen sequel, *Molecules to the MAX!*

"If you are doing something that makes a positive impact, it drives you to keep pushing that idea further to reach broader audiences and pushing yourself to do better," says Siegel, a nanotechnology pioneer. He was amazed at the transformation that one screening of *Molecularium* had upon his young granddaughter. After viewing the film, she seemed to be looking for atoms and molecules everywhere, and seeing the world around her with new eyes. Siegel became the project's greatest advocate and set about assembling the resources to bring the Molecularium Project to a new level, the giant screen.

Curtis R. Priem, designer of the first graphic processor for the PC, co-founder of Nvidia Corporation and an RPI alumnus, saw the show in September 2005 and was inspired. "The Molecularium Project is a perfect example of how highly techni-

cal information can be communicated in a simple, accessible form that even children can understand." He threw his support behind the project with a generous gift to RPI to make a giant-screen film. This gift was supplemented by funding from the NSF and the State of New York.

The opportunity to make a 70mm film was an exciting, but daunting, challenge. Everything, from the scientific simulations to the story and character animation, had to be bigger, better, and much more complex for the largest film format in the world. We had learned many lessons during the production of the dome show and knew from the outset that it was a massive undertaking. Fortunately, the entire team was up for the challenge and work began in early 2006.

The writing process began with more audience testing of *Riding Snowflakes* to find out which elements were resonant and memorable, and which ideas were lost on the audience. Since most things were working well, the new screenplay focused on developing the characters, expanding the audience and the story, and giving the atoms a new mission to seek out the secret of life, since everyone wanted to explore more of the bio-world.

Owen and I revisited classic cartoon influences: Disney's *Silly Symphonies*, Warner Bros.' *Merry Melodies*, adventure films like *Fantastic Voyage* and *10,000 Leagues Under the Sea*, forgotten educational films like Capra's *Hemo the Magnificent*, and Disney's *Donald in Mathemagical Land*. "In some ways, *Molecules* is a throwback to the early musical cartoons," says Bush.

We felt that since the subject matter was so innovative and fresh, the idiom of the film should be classic and traditional, like a lost classic of animation. "This strategy has a lot to do with the visual and musical choices. The songs in the film are rooted in American popular standards and the arrangements are tied to swing and Big Band, a timeless sound that resonates with children of all ages," Bush says.

Building the team

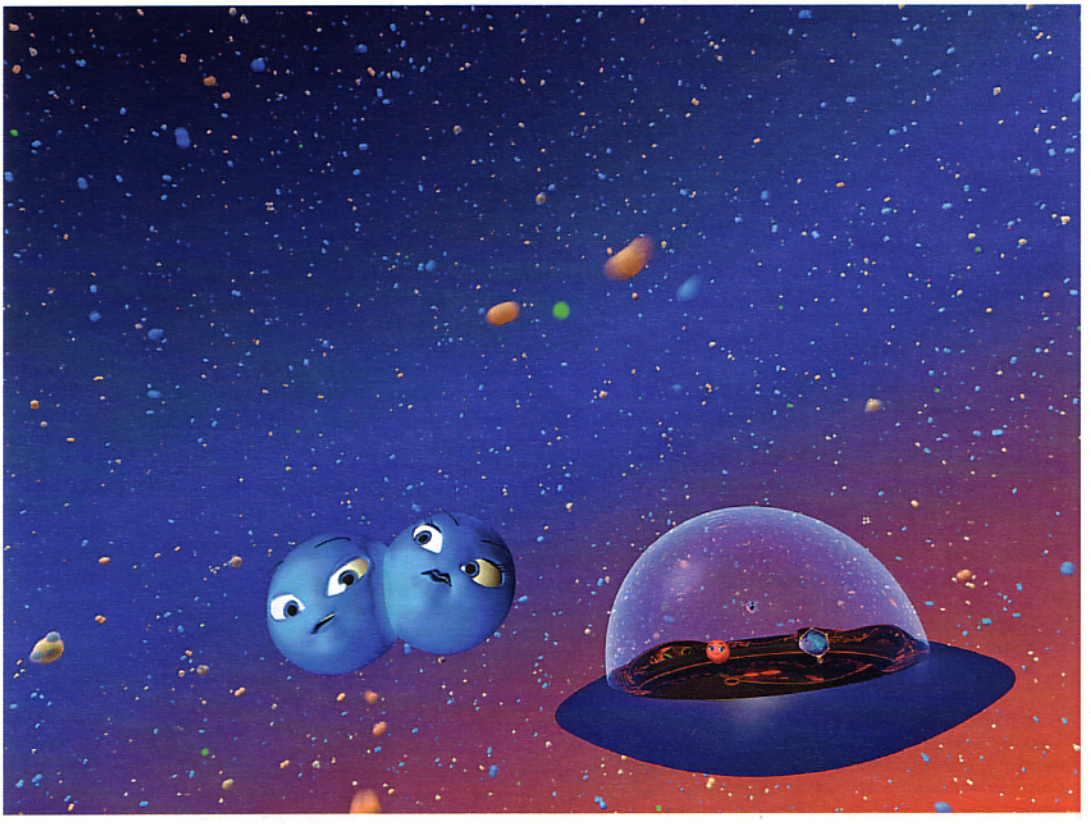
For a project of this scale, Nanotoon needed to expand its production team. While RPI provided a unique set of computational and intellectual resources, we were faced with the dilemma of being in production in a town with no animation, filmmaking, or creative industries. RPI offered a rich pool of intern talent with great aptitude but little experience. In recruiting, Owen and I searched for multi-talented professionals who would be willing to relocate to Troy and work in a supervisory relationship, mentoring a small team of highly motivated novices.

Nanotoon rented a small set of rooms in an extended-stay hotel directly across from our downtown offices, persuading its owner to give us a deep discount throughout the production phase. The hotel became an after-hours HQ for the visiting artists on the team, and helped them develop a strong camaraderie. When we couldn't recruit artists with the specialized skill-sets we needed, we worked remotely with the best in the business, using video-conferencing and other networked collaboration tools.

"My experience at Nanotoon, and working on the *Molecularium* movie, was really unique," says **Adam Gaige**, who started on the project as an intern and landed a job as a technical director at **Dreamworks** after graduating from RPI, "especially when compared to the environment I'm in now. At Nanotoon, everyone wore a lot of hats and took part in a lot of different aspects of the movie, from coding scripts to modeling and simulations."

Pushing science

The molecular environments in *Molecules to the MAX!* are driven by cutting-edge scientific simulation data. This was made possible by MolecuMan, a proprietary molecular conversion program that Nanotoon developed for this production. "In *Riding Snowflakes*, the major technical accomplishment was that we could slowly load thousands of atoms onto the screen. With MolecuMan, we were able to load millions of atoms instantly," says **Justin Rosen**, lead technical director. This greatly



A scene from Molecules to the MAX!

Nanotoon Productions

Premiering This Month

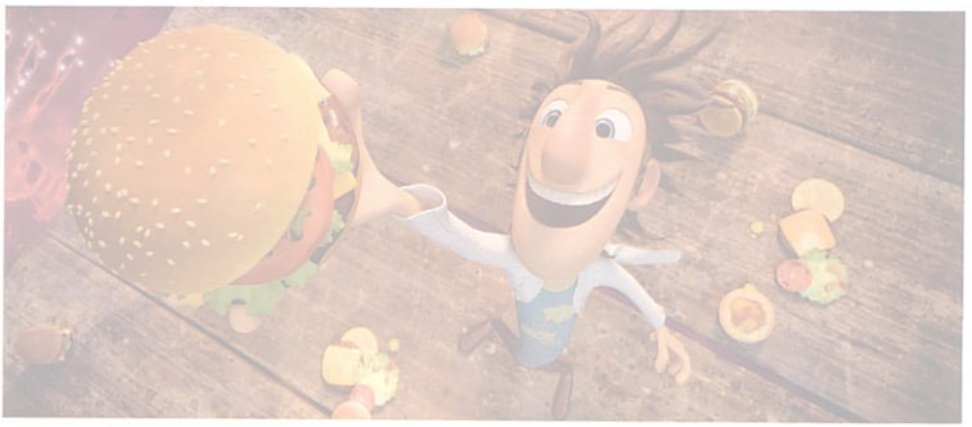
Cloudy With a Chance of Meatballs

"Aspiring inventor Flint Lockwood is the socially awkward genius behind some of the most bizarre contraptions ever conceived. But even though all of his inventions, from spray-on shoes to a monkey-thought translator, have been spectacular failures that caused trouble in his small town, Flint is determined to create something that will make people happy.

"When Flint's latest machine, designed to turn water into food, accidentally destroys the town square and rockets up into the clouds, he thinks his inventing career is over. Until something amazing happens – cheeseburgers start raining from the sky. His machine actually works!

"The food weather is an instant success, and Flint forges a fast friendship with Sam Sparks, the weathergirl who comes to town to cover what she calls 'the greatest weather phenomenon in history.' But when people greedily ask for more and more food, the machine starts behaving erratically, unleashing spaghetti tornadoes and giant meatballs. With the town about to be buried beneath mountains of marshmallows and waves of watermelons, it's up to Flint and Sam to use their combined expertise to shut down the machine and put everything right."

Directed by Phil Lord and Chris Miller, produced by Pam Marsden, written by Phil Lord and Chris Miller, based on the book by Judi and Ron Barrett. Starring the voice talents of Bill Hader, Anna Farris, James Caan, Neil Patrick Harris, and Mr. T. The film was produced by Sony Pictures Animation and distributed by Columbia Pictures.



Columbia Pictures

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enhanced the team's ability to produce more accurate and immersive molecular environments.

The giant screen required simulations that were massive in both scale and complexity. "The artists at Nanotoon were emboldened by the first film's success and more ambitious with the large-format film," says Garde. "They didn't want to fake anything and really pushed the scientists, requesting larger, more involved simulations to flesh out the molecular environments of the film."

Building a simulation is nothing like animation; one uses equations of physics and chemistry to predict the outcome beforehand and then spends thousands of machine hours before getting a result. Luckily, Garde's team of scientists had already spent a lot of time in that exact process. But the massive simulations needed were challenging and constantly crashing the computers. Two of the water simulations at the heart of the movie were the "freeze" and the "melt." Bush wanted a very dramatic effect for the "melt," like a tidal wave of liquid coming at the viewer through the ice lattice. He says, "We asked for something very unusual of the simulation team, which was to create scientifically accurate simulations that also carried the narrative and had emotional resonance within the world of the story."

The parameters of the simulation software were crude compared to nature. The water molecules would instantly switch from one state to another within a frame or two. They would be solid, liquid, or gas, with no in-between state. The simulation team needed to invent new ways to create simulations to satisfy the needs of the story. For the scientists, these challenges and their solutions were some of the most difficult challenges they had ever faced.

Nanotoon's new MolecuMan plug-in amazed the scientists and animators on the project. For the first time, they were able to watch fully rendered movies of their experiments. No simulation was too big or too long for it to handle. The "simdailies" process was like panning for gold, watching hundreds of iterations of atoms flying around on the screen, looking for the one that met the narrative, scientific, and aesthetic criteria.

Creative challenges

Making a film about a world that is unobservable by visible light presents many challenges. "One of the most interesting challenges for the art department was figuring out how to picture these unseen worlds," says art director Harvey. "How do you design surfaces that you can't actually see? We combined familiarity with novelty to inform the audience. So, for example, the surface of frozen water molecules reminds us of ice while still appearing surprising and magical."

"When you're doing the sound design for the interior of a helium balloon as experienced on the molecular level, there aren't a lot of references," says sound designer Jesse Stiles. "So we had to do a lot of creative thinking and develop some novel approaches. The director was really interested in the golden age of animation, so a lot of the sound effects that recur throughout the film – atoms bonding and unbonding, transformations of molecular scale – were all made with musical instruments." Because the soundtrack was very musical, he worked closely with David Last, the composer of the score, to keep

things in tune and on tempo.

The characters presented their own challenges to the animators. "They have no hands to gesture with, no posture to communicate subtle emotions, no limbs to establish rhythm," says lead animator Rein. "Adding to that difficulty, the giant-screen format resulted in lots of widely framed shots, and characters could easily get lost. We spent a lot of time developing a vocabulary of individual motion signatures to differentiate the characters, and focused on fine-tuning the choreography, so that if a character was about to deliver an important line, its movement would anticipate that and draw attention."

"Most important to me is that the world we create is believable," says Bush "While we are portraying a world which is entirely alien in every way to most audiences, it should also feel instantly familiar, as if it is a world that they've been to before and want to return to again and again."

Computational demands

Animation and scientific simulation are always computationally intensive, but the demands of the giant screen are extreme. The technical team had to develop an entirely new render farm, render pipeline, network, and storage system, optimized for the ultra-high resolution, fully immersive molecular environments that the large-format medium demanded.

Initially, it was extremely difficult to estimate exactly how much computational power would be needed or how long anything would take to render, but the one thing we knew from experience was we would use every processor that we could get. By the end of the production, we had assembled a render farm at RPI with over 400 processors and over 60 TB of storage. But even this was not enough to complete the job in time. Fortunately, RPI is also home to the Computational Center for Nanotechnology Innovations, one of the largest supercomputers in the world and the *Molecularium* team was given access to even more processors to get the job done.

New dimensions

Since *Molecules to the MAX!* grew out of a dome show, special attention was paid to how the film will look projected in a dome. The visual imagery lends itself naturally to the shape and the team's extensive experience working with this immersive format resulted in a movie that plays exceptionally well in dome theaters.

A whole new dimension was added to the show when additional funds were raised to take the show to 3D, a long-sought goal of the team. We were very excited to have **Sean Phillips** as stereoscopy consultant to create a truly immersive 3D experience that makes the simulations even more visible and comprehensible.

"This show is original and really different from what is out there, pushing the format in new directions, which is exactly what this industry needs to grow," says **Jonathan Barker** of **SK Films**, the distributor of the show. The 2D and 3D giant-screen versions also benefited tremendously by being recorded to film by **David Keighley** at **DKP/70MM Inc.**, with a final sound mix by **Cory Mandel** at the studios of **Technicolor Creative Services** in Toronto.

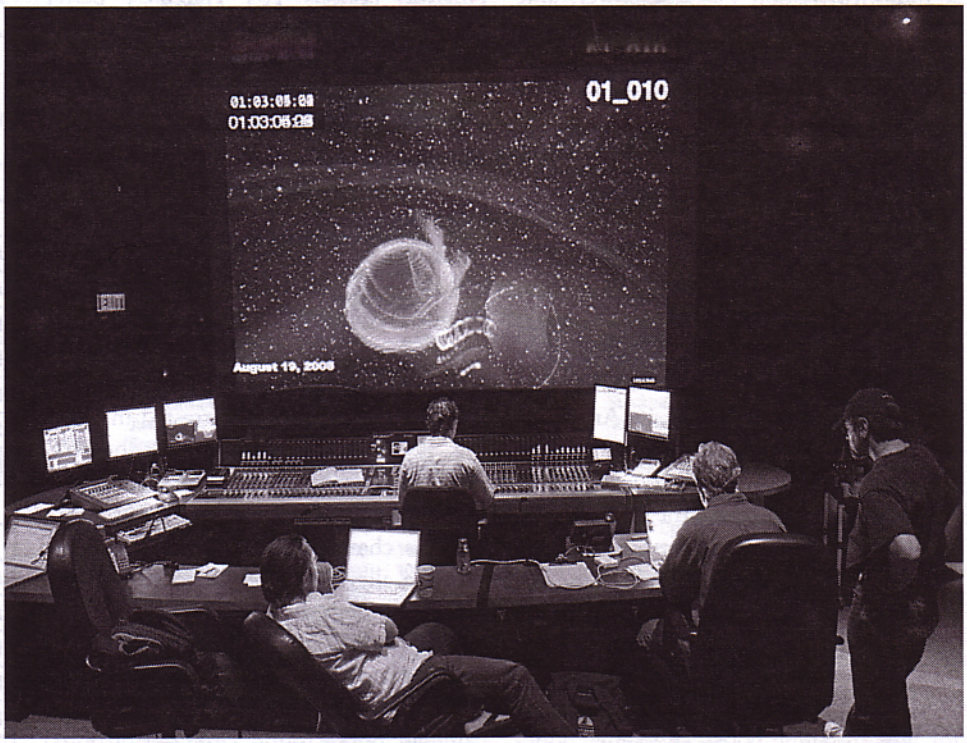
Stealth education

"At the end of the day, *Molecules to the MAX!* is about educating viewers and raising public science literacy," Siegel says. "But to make the movie an effective vehicle to propagate important scientific and educational messages, it was imperative that the team not allow the core properties of the medium – immersive, engaging entertainment – to take a back seat." By carefully engineering the characters, plot, look, and feel of the film, the Molecularium team created a movie where viewers are swept up in the storyline and learn, or re-learn, a ton of important science – without even trying.

"I think adults will learn just as much as children will from *Molecules to the Max!*" Schadler says. "Just being able to picture the world of atoms and molecules accurately will prompt people young and old to ask new questions about the world around them."

The 3D version of *Molecules to the MAX!* premieres at the **Giant Screen Cinema Association** conference in Indianapolis on Sept. 22.

Kurt Przybilla is an educator, inventor of TetraTops, the world's first spinning top with more than one axis of spin, and writer and producer of Molecules to the MAX! *He can be reached at kurt@nanotoon.com.*



Mixing the sound track at Technicolor's studios in Toronto.

Nanotoon Productions