

Computer Graphics Advances the Art of Anime

Jan Krikke

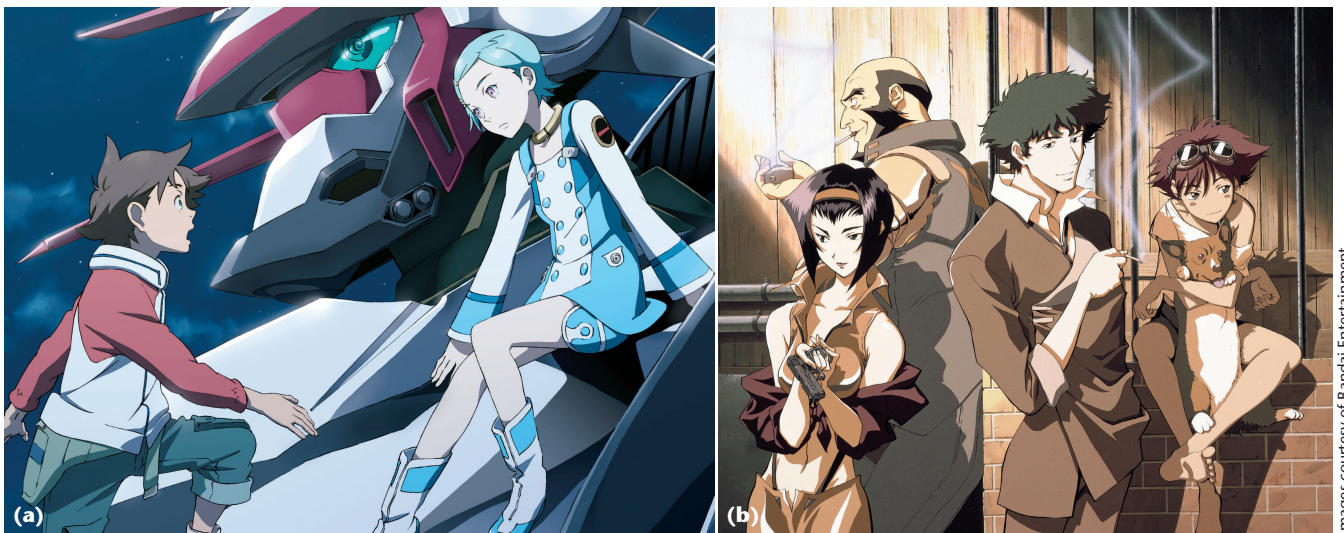
Three-dimensional computer animation movies like *Finding Nemo*, *Shrek*, and *The Incredibles* steal the global spotlight, but Japanese animators continue to produce thousands of hours of 2D cartoons every year. Most Japanese anime studios have computerized in recent years, not to create 3D animation and compete with the likes of Pixar, but to speed up 2D production. The continuing focus on 2D is partly economic (lower production cost) and partly aesthetic. Japan's traditional pictorial language, the antithesis of Western optical realism, is well suited to the visual immediacy of animation. Several Japanese studios are trying their hand at blending 2D and 3D, and some animation artists are developing a new visual style. But for now, 2D remains the core of Japan's animation industry.

Japanese animation, popularly referred to as anime (pronounced ah-nee-may), is notable for its dynamic, calligraphic style. The genre is directly related to manga, the graphic novels read by millions of Japanese, both children and adults (see Figure 1). Manga in turn is a distant cousin of Japan's classic scroll paintings, the kinetic pictorial format that combines a continuous visual image with a narrative text. (The scroll format is viewed in sequences, incorporating the element of time

in a still image.) The scroll painting, together with Japan's ancient calligraphic technique, led to the development of *ukiyo-e*, the colorful woodblock prints made famous by Hokusai and Utamaro, and admired by European modernist Manet as well as van Gogh. Like *ukiyo-e*, Japanese animation stands out for its visual immediacy and boldness of vision.

The production process of anime and *ukiyo-e* is also similar. Both are based on a division of labor. With *ukiyo-e*, the artist creates the original image, the wood carver engraves the image on several wood blocks (a different block for each color), and the printer inks the blocks and prints them on paper. With traditional animation production, the lead animator draws the main characters and keyframes on paper, artists or illustrators draw the images and the in-betweens (a sequence of drawings that suggest movement when shown in rapid succession), assistants transfer the drawings to celluloid, and colorists color the images. Camera operators mount the cels in front of background scenes and photograph them one at a time.

Rows of artists hunched over desks, drawing characters by hand, is still a familiar sight in Japan's anime studios. A made-for-TV animation typically requires 30



1 Two illustrations from the manga (graphic novels) (a) *Eureka* and (b) *Captain Bebob*. The manga style, characterized by sharp outlines and flat, unmodulated color, are rooted in *ukiyo-e*, and form the basis for the Japanese animation.

Anime Transcends Cultural Barriers

Japanese animation, or anime, transcends age and cultural barriers. The genre appeals to audiences around the world. Millions of children watch Japanese cartoons on TV, while sci-fi anime feature films like *Ghost in the Shell* appeal not only to general audiences, but also to the cyberpunk generation and art movie fans. When the New York Museum of Modern Art sneak-previewed the feature-length Japanese anime *Howl's Moving Castle* in 2005, fans lined up 10 hours before showtime to claim a seat. The Internet is a hotbed of anime devotees. A Google search for anime returns millions of hits.

Critics hail anime (and manga, the source of most anime cartoons) for its unrivalled storytelling, ingenious plots, and thought-provoking themes. The genre deals with romance, mystery, science fiction, and nonfiction. The stories are usually character-driven, making it easy to identify with the characters. Even titles targeting children do not shy away from death, spirituality, and existential issues. Anime has cuddly characters, but rarely talking animals common in Western cartoons.

Rather than stories that lead to happy endings, anime lets the audience ponder the distinction between good and evil, human and machine, and male and female (anime characters tend to have an androgynous quality). The stories are played out in fantastic settings and depicted in a visually compelling style, which explains why the genre also appeals to adults. The *Washington Post* called anime "haunting, high-tech, full of ideas that Occidentals can hardly express.... Such films as [anime director Katsuhiro Otomo's] *Akira*; *Ghost in the Shell* and its sequel; and the epic *Samurai X* have singularity and precision. To see them is to accept them into the cranial vault forever."¹

Anime and related merchandise constitutes a large part of Japan's cultural and entertainment product exports. According to the Japan External Trade Organization, the US market for made-in-Japan animation reached \$5 billion in 2003, more than three times the value of Japanese exports of steel products. Nintendo's hugely successful Pokemon franchise, first launched in the 1990s, has generated global sales in excess of \$4 billion. According to the Stanford Japan Center, the anime industry could ultimately grow into a global market worth more than 10 trillion yen, or approximately \$100 billion. The Japan Information Network supports the claim, saying Japan's domestic anime market is

worth \$27 billion and the export market is approaching \$60 billion.

American companies are cashing in on the anime boom. The Houston-based Anime Network is the first channel in North America solely dedicated to anime. Cartoon Network has been showing anime since the 1990s, and is producing Japanese-style animations in a specially constructed Burbank studio. Disney, DreamWorks, and Pixar have alliances with Japan's anime industry ranging from distribution to coproduction deals. On average, six anime conventions are held in North America every month, with the larger meetings attracting more than 20,000 people. According to Harvey Deneroff of Animation Consultants International, nearly every college in North America currently has an anime club.

Anime has become an international generic term for Japanese animation. The word is also used in Korea, Taiwan, and other countries producing animation in the Japanese style. Japan has become a global trendsetter for animation. Working in a Japanese anime studio is the dream of many Western animators. But the Japanese industry is not without its challengers. Korean players look set to catch up with their Japanese counterparts. Korean universities offer more than 30 animation courses, and the Korean government actively supports the animation industry with subsidies. China and India are emerging animation superpowers.

The region is also attracting US players. In 2005, Lucasfilm opened Lucasfilm Animation in Singapore. The studio covers 40,000 square feet and is packed with technological equipment from Hewlett-Packard, AMD, and Network Appliance. In announcing the project, Micheline Chau, the president and chief operating officer of Lucasfilm, said the company hopes to make games and movies that blend traditional Western animation with Japanese anime. Disney could be next to move into Asia. John Lasseter, the man behind the *Toy Story* films, *Finding Nemo*, and Pixar's other 3D blockbusters, is the new chief creative officer in the merged Disney/Pixar studios. Lasseter worked in Japan and admires Hayao Miyazaki, director of Academy Award winner *Spirited Away*.

Reference

1. S. Hunter, "'Steamboy': Anime Powered By Hot Air," *Washington Post*, 25 March 2005, p. C01.

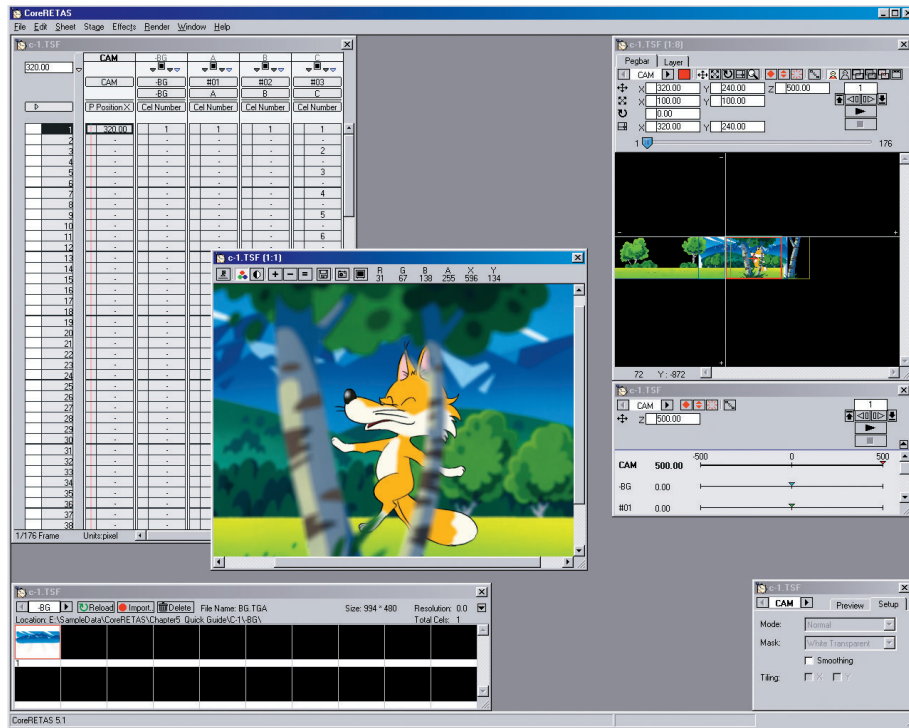
different cels for each second of animation. Most Western animation studios have replaced pencil and paper with computers and digital pen, but Japanese animators believe the handmade drawings convey emotional nuance difficult to duplicate with digital tools. Hardcore anime fans claim to recognize the specific signature of anime artists in the contours of their character drawings. Toei Studios, sometimes referred to as the Disney of Japan, is one of the few Japanese studios to have banned paper and pencils from their studios.

Computer-assisted 2D production

The continuing focus on 2D has not hurt the Japanese animation industry. According to the Japan External

Trade Organization, 60 percent of all cartoons shown on TV screens around the world are made in Japan. Feature-length animation movies like *Spirited Away* and *Ghost in the Shell* won major international prizes and earned more than \$200 million dollars each. The "Anime Transcends Cultural Barriers" sidebar discusses the economic growth of anime as well as its popularity worldwide.

Despite global success and rosy predictions, the Japanese animation industry has its problems. Foremost among them are cost pressures and a growing shortage of animators (the better-paying gaming industry competes for talent). Japanese studios are responding by computerizing all or part of the production. While most characters are still drawn by hand, studios now use com-



2 Screen shot from Celsys Retas animation production application Retas!Pro., the de facto standard animation tool in the Japanese animation industry.

puter graphics software to draw backgrounds and mechanical objects like robots, cars, and spaceships. Handmade character drawings are scanned into the computer and digitally colored. Artists use animation software to combine the hand-drawn characters with digitally drawn objects and backgrounds. Computers not only speed up production, they also offer greater control and versatility. Animators can rapidly adjust color schemes, change backgrounds, and add a greater variety of special effects like whirling dust, explosions, and vibrations.

Japan's leading animation production tool is the Revolutionary Engineering Total Animation System (Retas) from software developer Celsys (see <http://www.retas.com> and Figure 2). The company's Retas!Pro dominates the domestic 2D market with a share of more than 90 percent. All but one of the approximately 80 weekly TV animation programs currently shown in Japan are made with Retas!Pro. Celsys's near market monopoly is partly the result of foreign vendors failing to localize their products for the Japanese market. Equally important, Celsys analyzed the workflow of anime production, and tailored its software to the specific structure of the Japanese animation industry.

Japan's animation industry is highly fragmented. There are approximately 10 studios employing 100 people or more, 30 medium-sized studios, and as many as 2,000 small players with fewer than 10 people. (Large studios with 300 or more workers only employ about 20 percent of workers full time; the others are contracted on a project basis.) Few studios carry a project from conception to final product. They commonly subcontract various production stages to studios that specialize in one aspect of production. Celsys tapped into demand for specific appli-

cations by offering separate tools for drawing, pencil testing, tracing, painting, effects, and shooting (camera).

Retas!Pro was initially a bitmap system, but Celsys developed a technology to convert raster data to vector graphics, including Flash data. Moreover, the software can vectorize lines as outlines or as center points, and can modify both the curvature and the line width. The software handles not only 2D drawing but also live video and 3D computer graphics. Among the supported image formats are TGA, PICT, BMP, TIFF, RAW, YUV, MOV, AVI, and SGI.

Retas!Pro runs under Macintosh and Windows, and is available in Japanese, Chinese, and English. A growing number of animation courses in the US—at such schools as Pixar University, CalArts, Sheridan, and the University of California, Los Angeles—use the package. In February 2006, Celsys released an English version of its manga drawing tool, Comic Studio, through its subsidiary E-Frontier. The launch of the English version, renamed Manga Studio for the international market,

© Celsys. All rights reserved

coincides with the growing popularity of manga-style drawings outside of Japan (see the "Japanese Graphic Software Taps into Global Manga Market" sidebar.)

Celsys plays a key role in facilitating the internationalization of Japan's anime industry. Much of the grunt work of anime production (especially drawing the thousands of in-betweens) takes place in China, Korea, and the Philippines. Production outsourcing made computerization an imperative. Celsys helped Toei Studios to computerize the entire production process, from keyframing to tracing, coloring, and finishing. The two companies worked with Japan's telecom giant NTT East to build a LAN system that networks all of Toei's production facilities, including its overseas studios in the Philippines. This system links 23 affiliated studios by optical cable for transmission of large volumes of graphics data.

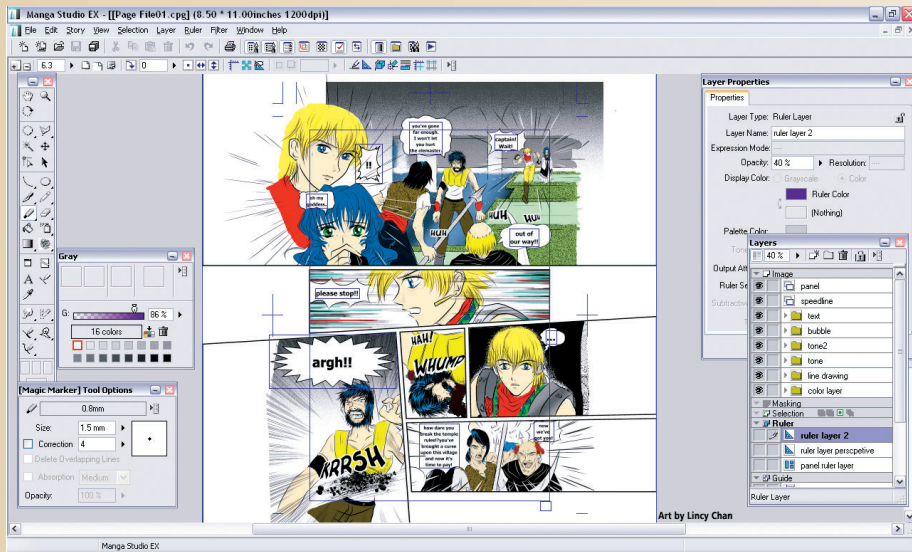
Merging 2D cel animation with 3D CG

Despite computerization of production, Japanese animation has retained its 2D feel. However, a growing number of studios are incorporating 3D CG in their anime productions. Among the pioneers is Tokyo-based Production I.G., maker of *Ghost in the Shell* and its sequel *Ghost in the Shell: Innocence*. The movies, based on a 1980s manga series from the influential manga author Masamune Shirow, have greatly increased the international profile of anime. Critics in the US and Europe used superlatives to praise the movie.

Shirow's *Ghost in the Shell*, not unlike William Gibson's *Cybermancer*, confronts the viewer with questions about what it means to be human in an increasingly technological world. *Ghost in the Shell*—GitS to its fans—takes place in 2029, when people have cybernetic implants

Japanese Graphic Software Taps into Global Manga Market

Manga, Japan's popular illustrated novel and the source of anime, is attracting a growing audience around the world. Major publishers in the West are selling translated versions of the illustrated novels, and thousands of professional illustrators and hobbyists—captivated by both the style and content of manga—are snapping up instruction books on how to draw manga. Japanese software developer E-Frontier (<http://www.e-frontier.com>) recently launched Manga Studio (see Figure A), a graphic software tool based on ComicStudio from Japan's leading anime software developer Celsys. E-Frontier is the first software company to offer a manga creation tool outside of Japan.



Courtesy E-Frontier

A Screen shot from E-Frontier's Manga Studio, the first drawing software specifically designed to produce manga comics.

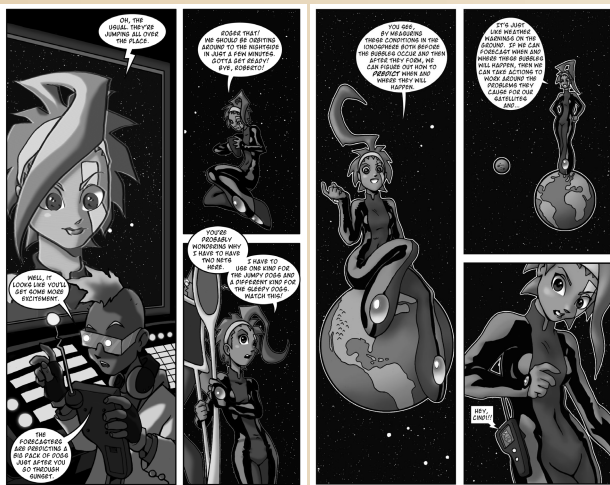
The launch of Manga Studio underscored the popularity of manga in the West. The Japanese-style cartoons have had a cult following since the 1980s, but the genre has now reached mainstream audiences. Penguin Group USA and Del Rey Books are both publishing more than 10 manga titles a year. The magazine *CosmoGIRL!* runs a monthly manga strip featuring a spunky college sophomore. In the past few years, girls have replaced boys as the main buyers of manga. According to *The New York Times*, girls aged 12 to 17 represent the largest audience for the genre. The Sunday comic sections of the *Los Angeles Times*, the *Detroit News*, and the *Vancouver Sun* carry manga cartoons, and a strip from manga artist Ron Kaulfersch appears in 30 North American newspapers.

E-Frontier offers two versions—Manga Studio Debut for the aspiring artist and hobbyist, and Manga Studio EX for professional illustrators. The professional version also targets illustrators who need high-end features like filters and tones. Users can select from 80 templates, a large selection of screen tones, single-click special effects, drag-and-drop tools, word balloons, and floating palettes. Users can print from any computer, format for the Web, or export for coloring the completed artwork.

Manga Studio EX stores drawings as resolution-independent vector images. Users can resize the drawings while retaining maximum image quality. The software's vector-based native format can be written to JPEG, BMP, PNG, TGA, and PSD files as well as output to a printer. Users can also import

3D figures, models, and backgrounds. The 3D line tone rendering feature lets users import 3D object data files (LWO, OBJ, DXF, and LWS) for 3D modeling. The software features automatic line smoothing to correct and adjust shaky, hand-drawn lines.

Manga has also attracted attention from academia. The University of Minnesota and the University of Massachusetts are among a growing number of universities with a manga society. Even NASA has embraced manga. The space agency commissioned the University of Texas at Dallas to create a manga to explain the coupled ion-neutral dynamics investigation (Cindi) research mission to students in grades six through nine. The manga, titled *Cindi in Space*, features an android (Cindi) who lives in a spaceship with her two robot dogs (see Figure B). Androids and robots are quintessential creatures in both manga and anime. Artists at the Minneapolis College of Art and Design created *Cindi in Space*, which can be downloaded at http://cindinspace.utdallas.edu/education/CINDI_IN_SPACE_cc4.pdf.



Created and written by Marc Hairston and Mary Urquhart, artwork by Erik Lervold

B Panels from *Cindi in Space*, a manga produced for NASA to teach school children about a research mission.



3 Still from *Ghost in the Shell*. The science fiction animation movie combines hand-drawn illustration with computer graphics.

and robots have near-human intelligence (see Figure 3). The *GitS* villain engages in ghost hacking, a cybernetic form of identity theft that involves altering the memories (that is, ghosts) of humans whose brains are linked to a global network.

Both *GitS* movies are acclaimed for their riveting stories, vivid imagery, and mesmerizing cinematography. While the original *GitS* is largely hand drawn and retains the traditional cel feeling of 2D animation, *GitS 2* is a hybrid of hand-drawn characters and CG. The robots, machines, and backgrounds in the sequel are mostly rendered in 3D. Cyborgs have a metallic shine, living dolls have a porcelain-like finish, and holographic projections have a soft 3D look. Purists who appreciate anime for its hand-drawn quality decried the intrusion of CG, but Production I.G. showed great skill in integrating CG seamlessly into what remains essentially 2D animation.

Saving time with 3D

Using 3D even while the aim is 2D animation has several benefits. 3D is a flexible data type. Models of robots, vehicles, and other objects can be created once, reused in a different scene, and shown from different vantage points. Three-dimensional CG also speeds keyframing, the task of creating movement in a scene. Instead of fixing an object's position, rotation, or scaling for each frame, 3D software interpolates the in-betweens from keyframes in a given scene.

Three-dimensional software tends to offer a greater variety of special effects and techniques. Particle systems—included in most high-end 3D software packages—let users simulate and animate rain, fire, wind, and other natural movements. These tools can define the states and behavior for individual particles—which can be anything from a single point to an object—or groups of particles. Particle movement can be calculated by different parameters. Users can make particles

repel or follow other particles, emit other particles, or react to gravity and wind. Particle systems enable digital artists to create movement that would be too time consuming to create in traditional animation.

Howl's Moving Castle, the highly acclaimed anime feature from Studio Ghibli, includes a scene with flags fluttering in the wind. Ghibli's CG department created the scene using Softimage XSI, Avid Technology's digital character software. Ghibli's CG designers created the flags by setting gravity according to three different wind types: a sideways force that determined the flag's waving direction, a vertical downward force expressing each flag's roundness, and a force animating the bottom of the flags and simulating their gentle waving. Each flag had its own unique movement, giving the otherwise realistic scene a surreal feeling.

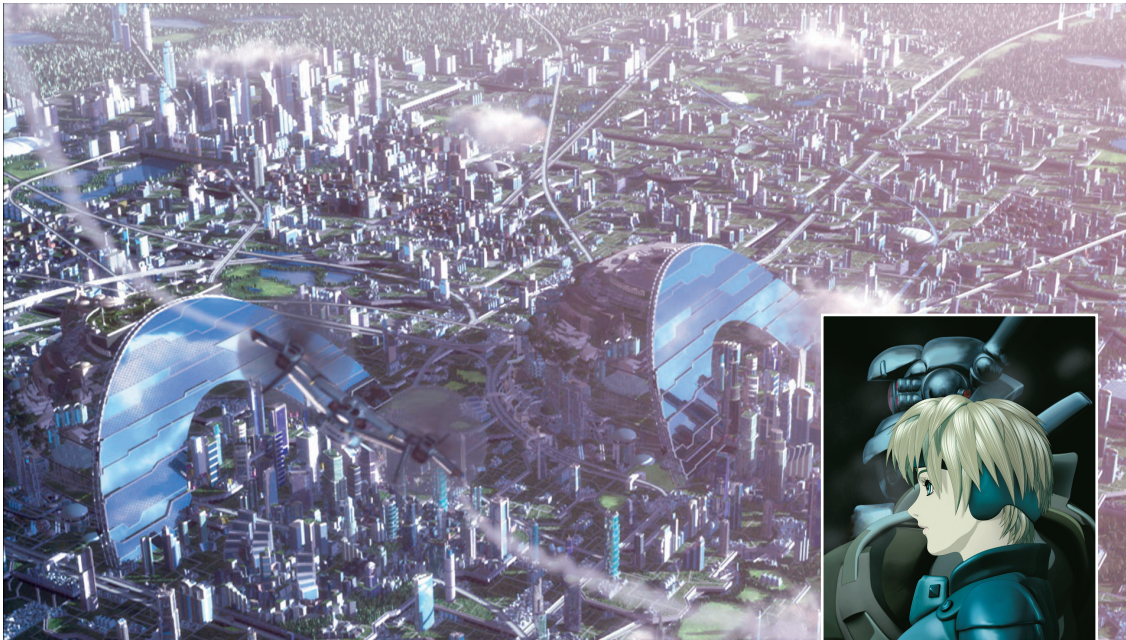
A new pictorial CG language

Combining 3D objects with 2D animation is a special challenge in digital animation, but toon shading (or cel shading) technology makes this easier. A tool for non-photorealistic rendering, toon shading gives 3D CG objects an artistic, hand-drawn feeling. Computer game developers widely use this technique. Toon shading is not applied to the actual object, but is part of the rendering phase. The rendering engine only selects a few shades of each color for the object. To enhance its cartoon look, toon shading can accentuate the object's outline. Most 3D software programs include toon shaders, but they are also available as plug-ins.

Toon shading helped *Ghost in the Shell* and *Howl's Moving Castle* to retain their 2D look despite inclusion of 3D components. The same cannot be said of *Appleseed*, a groundbreaking anime feature from Tokyo studio Digital Frontier. (see <http://df1.dfx.co.jp/en/index.html> and Figure 4). *Appleseed* features hyperrealistic imagery, and does not try to hide its CG pedigree (see <http://www.appleseedthemovie.com/>). Like *GitS*, *Appleseed* is a sci-fi adventure based on a Masamune Shirow manga. It explores another futurist theme: the world is devastated by war, human survivors and bioroids (morally perfect cybernetic pseudoclones) create a new utopian society, other humans attack, and the leading lady (a female mercenary) and her cyborg lover are forced to take sides. Should they trust the humans or the bioroids?

Appleseed's screen adaptation fragments the plot of the original manga, but the movie's visuals stunned the anime community. The movie, created with Softimage XSI, combines spectacular imagery with motion-capture technology and lip syncing. In a press release the studio described the movie as "3D live animation or cel-shaded motion-pictured animation where motion capture techniques enhance the reality of the movements and expressions of anime characters while these 3D characters are cel shaded by utilizing [a] toon shader."

Appleseed is an attempt to find a new pictorial language for CG imagery. A wide scene of the futurist city shows a highway meandering through an urban landscape of gleaming glass and chrome. Only the hyperrealistic quality of the imagery reveals that the scene was created with CG. The movie repeatedly treats the viewer to small details that show remarkable digital artistry:



© 2004 Masamune Shirow/Seishinsha/Applesseed Film Partners

4 Stills from *Applesseed*, a landmark Japanese animation featuring hyperrealistic imagery and a hybrid 2D and 3D style. In the inset, the character’s face is 2D, while the body armor suggests three dimensionality.

- specks of dust lit by a setting sun floating through the air,
- sheets on a bed forming wrinkles as the character moves, and
- waves that seem to follow Newton’s law of gravity as they gently break on a shore.

The hybrid 2D and 3D imagery at times produces a jarring note. The characters wear battle outfits that are meticulously rendered in 3D, yet the characters’ faces are drawn in the signature 2D anime style. “In the clash of 2D and 3D images,” wrote the *Chicago Tribune*, “*Applesseed* emerges as the cracked-voiced, pasty-faced example of computer animation’s clumsy adolescence.”¹ Others were kinder in their assessment, calling *Applesseed*’s visual imagery “eye candy,” “brilliant,” and a successful attempt to integrate the anime aesthetic into a 3D CG world. The *Japan Times* quoted Studio Ghibli President Toshio Suzuki as saying that *Applesseed* “is the future of animation.” In an email interview, Yasuhiro Ohtsuka, CG director of the movie, expressed his belief that Japanese studios will follow *Applesseed*’s example, but he adds, “Perhaps we should not call *Applesseed* ‘anime.’ I think the movie is a new genre.”

Some critics have made the same point, albeit in a disparaging way. But art history suggests Japan is likely to play a prominent role in the further development of a CG animation visual style. Classic Japanese art is nonphotorealistic. Ukiyo-e and other traditional images lack clair-obscure and other optical effects like linear perspective. The traditional Japanese image does not refer to an external, optical reality, it is an object in its own right. For example, this aspect of the ukiyo-e influenced van Gogh’s *Sunflowers* painting, which does not depict optical reality. The painting is a reality *an sich*—in and by itself. While CG is now able to simulate optical realism, Japanese ani-

matoms like Yoshinori Sugano believe photorealism is not necessarily the ideal starting point for a new visual style.

Sugano, the former CG director at Studio Ghibli who pioneered the integration of digital techniques and cel-animated movies like *The Princess Mononoke*, focused his efforts on what he calls “non-photorealistic computer graphics imagery.” In 1999, in an essay called “Manga and Non-Photorealistic Rendering,”² he explained his struggle to “create pictures that are, in a sense, more realistic than those rendered using so-called photorealistic techniques.” Sugano predicted CG artists might someday invent images that are not photorealistic but “CG-realistic.” Saguano summed up the possibilities of anime when he wrote, “Perhaps we will find methods of abstraction, representation and symbolization which are only possible using the computer. CG artists may influence the course of other media, as we are now influenced by the world of manga. The main reason I am so attracted to nonphotorealistic rendering is that it provides opportunities and possibilities to create new styles of visual image.” ■

References

1. R.K. Elder, “Movie Review: ‘Applesseed,’” *Chicago Tribune*, 12 January 2005; <http://metromix.chicagotribune.com/movies/mmx-050112-movies-review-rke-applesseed,0,218861.story>.
2. S. Yoshinori, “Manga and Non-Photorealistic Rendering,” *Proc. Siggraph*, ACM Press, 1999; <http://testwww.siggraph.org/publications/newsletter/v33n1/contributions/Yoshinori.html>.

Readers may contact Jan Krikke at jankrikke@gmail.com.

Readers may contact editor Mike Potel at potel@wildcrest.com.