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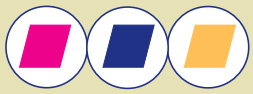

Using Computer Graphics to Better Understand Our World

Gordon Cameron
SOFTIMAGE, Inc.

During a recent trip to the United Kingdom, I happened upon a couple of news items that I thought noteworthy. Firstly, there was a review of the book, *The Tyranny of Numbers* [1], and secondly, a reporting of the depressing breakdown in international talks aimed at trying to agree on measures to avert global arming [2]. David Boyle's book apparently discusses the fact that we live in a world with an increasing reliance on numbers and statistics, a world where the population in general is unable to grasp the complexity of the "big issues," where those issues are described by a procession of numerical doublespeak decipherable by the few. So, the reviewer argues, the public's ability to be engaged in the big problems we face as a society is diminished by an inability to comprehend the language in which such problems are described.

Recent talks on global warming in the Hague broke down because of the inability of North America and Europe to agree on unilateral measures to adopt, as well as differences of opinion on the degree of the problem and its causes. The more depressing thing for me, however, was the general lack of press and open public discussion on the issues, and the fact that when information was relayed, it was not necessarily in a form in which the public could come to their own conclusion as to what the stated problems and suggested solutions actually were. Mention would be made of a few percentages, and if you were lucky you'd get to see a couple of rudimentary charts and scatterplots.

It seems that, as computer graphics practitioners, we have the ability to help out here. As columnist Tom West has been saying for some time, computer graphics and visualization techniques can be very effective in helping explain "difficult" concepts, when deployed responsibly. I would like to be able to switch on the news and hear in-depth discussion of the most pressing issues, accompanied by information-rich and clear visualizations of the numbers-behind-the issues, offering alternative what-if scenarios. Perhaps with the advent of some degree of interactive television, or when experiencing such stories over interactive media such as the net, the "viewer" would be able to change the view of the information that they are seeing - altering what "numbers" are being shown and steering the visualization to better understand the problem, issues and potential solutions.

The argument can be made that the general public is not ready for such visual complexity, too much explanation would need to be made as to what they are actually "seeing," etc. In addition, as Edward Tufte [4] and Darrell Huff [3] have been saying for years, it is not enough to merely present information - it must be done responsibly and clearly. These are certainly challenges for any new generation of "information visualizers."

However, if news networks are able to use even a small percentage of the amount they ploughed into their coverage of the recent U.S. elections and invest it in ongoing visualization research, then perhaps a real change can occur in the way that complex information is presented. If we want to be engaged as a society in understanding the problems we face as we move into the new millennium rather than standing idly by as onlookers, a way needs to be found of turning the sea of numbers and statistics into something that can be comprehended, understood and reasoned upon.

If we can recreate ages past using computer graphics techniques and visualize wonderful and engaging imagined worlds, then surely we can also better help understand our current world. And there can't be anything wrong in that!

Farewells

We bid a fond farewell with this issue to three fantastic columnists. Rosalee Wolfe (Education), Glen Fraser (Real-time Interactive Graphics) and Mike Milne (Entertaining the Future) have, over the years, written wonderful pieces for the magazine, and they will be sorely missed. I'd like to thank them personally for their dedication and help, and wish them all the very best in the future.

It's also time for me to pass the torch, and this will be my last issue as editor. I'd like to thank the many people I've had the pleasure of working with over the years - contributors, columnists, guest editors, those offering advice and criticism, and Stephen Spencer for believing in the direction we've been taking the magazine. In particular, I would like to reserve a special thank you for Lynn Valastyan, the magazine's production editor, who has been the most hard-working, reliable, organised and resourceful person anyone could hope to work with.

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Letter to the Editor

The following letter is in response to the Letter to the Editor from Marc Levoy published on page 4 of *Computer Graphics,* Volume 34, Number 3, August 2000.

Dear Editor,

Separate interpolation of unweighted color and opacity values is a common mistake made in volume rendering. Surprisingly, this method is flawed and leads to artifacts, as described in Wittenbrink et al.[1] The need for opacity weighting is commonly understood[2] when compositing images, but many in the volume-rendering community missed the need for it in volume rendering. This mistake occurs in widely used volume-rendering implementations such as hardware 3D texture mapping.

When we traced the origin of the oversight, we found that the influential work of Marc Levoy was the first clear publication of separate interpolation, as shown in Figure 1 of his paper.[3] We included this observation in our 1998 VolVis paper.[1] During the review of our paper for publication, the assertion was made that the software implementation in Levoy[3] was correct, and we have no reason to doubt this. Unfortunately, the original 1988 software was never made generally available, and the erroneous figure in the original paper was reprinted in several later works[4,5] without correction. Our goal was and still is to clear up the confusion that exists in the published record about how to correctly interpolate colors for volume rendering.

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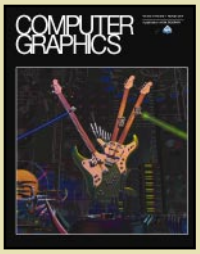

Data-Driven Animation: Visualizing Science-Fused Music

Karen Sullivan
***Computer Graphics* Cover Editor**

For decades, artists have attempted to create a visual analogue to music. Wayne Lytle, the director of Animusic, uses scientific visualization techniques to render a very powerful and direct visualization of his original musical compositions. In this significant body of work, data-driven animation techniques make both science and music visible.

History

Lytle first got the vision to produce this unique genre of content when he was an undergraduate music and computer science student in 1982 – long before the necessary technology was available. Lytle played keyboards in instrumental progressive rock bands composing most of the music. He studied classical piano performance as an undergrad before switching over to computer science.

After completing his graduate studies at Cornell University, Program of Computer Graphics, Lytle joined the Cornell Theory Center as a scientific visualization producer. Applying data-driven techniques to visualizing scientific data led to experiments in visualizing musical data.

In 1989, he was able to utilize technologies from music synthesis, computer graphics animation and video to produce some very early music animation experiments, such as *More Bells and Whistles*. Lytle has received awards both for this animation and for a technical paper describing his earliest work in algorithms for automatically correlating computer graphics to music. To this day, very few people have tried to sync music and graphics with this level of precision and complexity.

In 1996, Lytle hired computer graphics artist David Crognale and produced a stereoscopic music animation project for a commercial client. They are now collaborators at Animusic.

Between that time and the start of production on Animusic-1 last year, Lytle designed and developed his own computer animation software package, which was used for effects in feature films such as *What Dreams May Come,* which won an Academy Award for Best Visual Effects.

Lytle has had an animation in SIGGRAPH Electronic Theater each year from 1989-1993.

How It Works

There are a number of packages out there that visualize sound in real time. When people hear about Animusic, but haven't seen it yet, they often relate it to those real-time audio visualizers. Animusic is quite different. Audio visualizers perform real-time analysis on the audio itself, basically making a spectrum analyzer on steroids. MIDImotion™, on the other hand, works at a finer level of granularity, analyzing each note of each instrument. The local temporal context is taken into account when determining object motion (e.g. not only what drum is being hit, but what was hit before, what's coming up next, how long the rest is between notes, how loud they are placed, etc.).

The goal of Animusic is to create virtual instruments that give the illusion of creating the music heard on the soundtrack. The end product is an animation to be viewed as a finished piece. In raw terms, it is a music video, not an interactive experience. The reasons that it is a prerendered work, and not real time, are both technical and artistic.

First of all, Animusic prefers the look of nicely rendered frames rather than real-time video-game level rendering. Both field-rendering and motion blur are employed to provide the smoothest motion possible. Secondly, since the entire context of each note is taken into account (including what the next notes are), it cannot be done in real time unless the next notes are known ahead of time.

The production process begins with creating the instruments (selecting the synthesizer sounds and modeling the graphics elements). The music is composed, the set is designed and the instruments are graphically arranged on the set. Although logically the music drives the graphics, the music can be composed in parallel to the set and instrument construction and either may be changed at any point up to the final render. In fact, some Animusic animations have visualized music that was composed, sequenced and produced several years before the instruments were constructed, while others have had the entire set built before the music was even started.

Although neither the music composition or graphical instrument construction are dependent on the other in order to progress, it is important to establish the note and instrument palette before getting too far into the process. Instrument sounds are selected along with ranges of notes to be played. If an entire instrument is built to support 22 notes, and two additional notes are then used in the music, it is a lot of work to go back and modify the set. Likewise if a new graphical instrument is designed because it fits in aesthetically on the set, it's more difficult to find a part for it to play if the music is almost complete. So it works best to first design the palettes, then co-design the music and graphics together. But it really can be done in either order.

Musical instruments are modeled using commercial 3D animation software, and then animated via proprietary algorithmic animation software called MIDImotion™, created by Lytle. There are about a dozen algorithms applied to create the object motion. These include algorithms for percussion instruments, sticks and mallets, vibrating strings and various more general music-based motion.

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Games on the Verge of a Nervous Breakdown: Emotional Content in Computer Games

Richard Rouse III
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Toy Story 2 was certainly a fabulous film, in my estimation quite a bit better than the original. I'm sure that nearly everyone likely to be reading this column is already well aware of this. Those who have somehow not seen it are encouraged to go find it on DVD as soon as possible: it's well worth the time and price. It is important to note that my adulation for the film does not come solely from the impressiveness of the computer graphics employed in the film, but from the overall strength of the work when compared with any type of film. It's not just a great piece of CGI work, it's a flat out great film.

Reflecting on the film, one of the aspects I find most impressive about *Toy Story 2* is the emotional response it generated in me, the most intense feeling I have ever had from watching a piece of computer-generated imagery. The song the female doll Jessie sings while she remembers her happy days with her owner and her subsequent abandonment is of such poignancy that I doubt I could watch it again without breaking into tears. The fact that the song was written by one of my least favorite musicians, Randy Newman, seems to have been overcome by the power of the message it shared and how that worked seamlessly with the film's story. To a perhaps still doubting Hollywood, *Toy Story 2* proves beyond a shadow of a doubt that computer-generated graphics are fully capable of provoking a broad range of honest emotional responses in audiences.

More than a Feeling

Of late, computer games have been trying to become more emotional. Of course all artists attempt to elicit strong emotional responses from their audiences, but lately game designers have been making an extra effort to branch games into new emotional territories, or at least talk about doing so. A good example of this is the naming of one of the processors for Sony's recently released PlayStation2 console - a chip-set dubbed the "emotion engine." With such a name, one might think the chip set supports sophisticated artificial intelligence algorithms or behavioral modeling. In point of fact, however, it is a super fast graphics processor.

One might conclude that the people at Sony have equated increased graphics performance with increased emotional response in gamers. Is their conclusion correct? On the one hand, having graphics horsepower which allows for a finely detailed world does present some possibilities for expression and nuance that were impossible in the extremely under-powered 3D graphics of the original PlayStation. For instance, if a humanoid game character can now be 2,000 polygons instead of 200, some of those extra polygons can certainly be allocated to the character's head. Now the 2,000 poly character can have a face complete with eyes, nose and mouth made of geometry instead of the single textured polygon that had to be used for the 200 poly character. And that geometry in the face can be manipulated to have the character appear happy, mad, confused, surprised or whatever other expression the game's animator may have in mind. Certainly, having *Toy Story 2*'s Jessie emote through her face was an integral part of the emotional involvement audiences felt in that movie. Thus the increased polygon pushing power of the emotion engine empowers game developers to communicate character emotions in a way which was impossible before.

On the other hand, is an extra-detailed, hyper-realistic gameworld necessarily the only or even best way to communicate emotion to the player of a computer game? In his book *Understanding Comics*, Scott McCloud discusses "amplification through simplification." He suggests that as the representation of a character drifts from the realistic to the iconic, the audience's ability to emote with that character increases. This explains why the few simple lines in Charlie Brown's face could perfectly capture any emotion Charles Schulz wanted his readers to experience. Would adding more lines to his face have made him more emotional? Hardly. More likely, it would have ruined the character's simplistic perfection. The argument could be made that the same holds true for computer graphics and computer games: the more realistic our computer models become, the less capable they are of provoking emotion in players. And of course, if one looks at *Toy Story 2* closely, though the characters are all incredibly high polygon (certainly by real-time computer game standards), they are still extremely cartoonish. Indeed, Pixar's choice of manufactured toys for their starring characters suggests that they understand the power of the cartoon all too well. If Pixar had instead opted to create a movie which revolved around human characters which were modeled to be as realistic as possible, the emotional impact of the film on the audience would have been significantly less.

Working with the limitations of technology, game developers can often derive more emotional pay-off than if they have all of the polygons in the world to play with. Polygon limitations can force developers to go with stylized and iconic characters with which players can easily emote. So it seems that calling the PlayStation2's enhanced graphics chip-set the emotion engine is most likely a buzzword some clever person in the marketing department dreamed up rather than anything an intelligent game developer would use to describe such technology. As I reflected on some of the most emotional experiences I have had with artistic works, beside *Toy Story 2* and the *Charlie Brown* comic strips, a few key works popped into my mind: Isao Takahata's cell animation cartoon *Grave of the Fireflies*, Neil Gaiman's comic series *The Sandman* and Truman Capote's novel *In Cold Blood*. Indeed, my last example is told in a medium completely

lacking in graphics horsepower all together. Despite the increasing dominance of the moving image over the last century, novels remain capable of eliciting emotional responses that no other medium can, without using a single graphical element. So do games really just need a super-charged graphics processor to be more emotional? No, the challenge is significantly more complex than that.

Can a Computer Game Make You Cry?

Computer games have been attempting to increase their emotional impact far longer than the beginning of Sony's marketing campaign for the PlayStation2. One game which did have a remarkable emotional effect on its players, an effect almost unique in computer games, was Steve Meretzky's text adventure *Planetfall*, released in 1983. In the game, the player is accompanied by a friendly robot called Floyd, a character Meretzky created to be humorous and likable to computer game audiences. Then, at one point in the game, Floyd sacrifices himself in order to allow the player to complete an important puzzle. In an interview I did with Meretzky recently, he said his goal in having Floyd die was to create a truly emotional moment. He also had ulterior motive, however:

"Also – and this is a relatively minor influence on the decision, but still worth mentioning – at the time Electronic Arts was just getting started. They were running a series of ads meant to establish their stable of game designers as artists. One of the ads quoted one of their designers as saying something like 'I want to create a computer game that will make people cry.' There was a little touch of a budding rivalry there, and I just wanted to head them off at the pass."

And Meretzky succeeded quite well, with Floyd's demise being one of the most remembered and talked about moments in computer gaming history. Readers should bear in mind that *Planetfall*, as a text adventure, had no graphics at all. Could the moment have been made any more poignant with Sony's emotion engine to assist it? Not likely.

In a counterpoint to the gaming industry's attempts to inject emotion into its games, in a recent article in *Game Developer* magazine, game designer Greg Costikyan argued the following:

"It is a mistake to assume that the value of a work of art lies solely in the emotions it engenders. Music can move us, but is emotion per se truly what we find appealing about music? Personally, I'd argue that emotion in music is tantamount to schmaltz. The classical work I prize most highly has instead a clean, almost mathematical inevitability about it."

Figure 1: *Playing a game of* Civilization *can be a very tense experience.*

I would argue to the contrary, however, that art is all about emotion. People turn to art, not because it provides any tangible benefit to their lives, but because it evokes certain emotions in them. I assert that Costikyan values the music he does because of the mathematical precision he wants to hear in it, a type of emotion in itself. Emotion need not be intense love, sorrow, disgust or rage; it can be altogether subtler than that. Indeed many of the most prized works of art are valued because of their subtlety, not by the "schmaltzy" way they try to hammer their emotions into their audience. Schmaltz is an overdose of emotion, but one need not have a complete absence of emotion to avoid it. What is important to note about music is that the emotions it provokes in its audience are altogether different from what people derive from films, novels, comics or games.

A good example of the way music can evoke emotion is the song *The Ghost of Tom Joad* as recorded both by Bruce Springsteen and the group Rage Against the Machine (RATM). The renditions of the songs both have identical lyrical content, lyrics which combine the words of the Tom Joad character from John Steinbeck's novel *The Grapes of Wrath,* whilst questioning where the ideals of that book and the New Deal exist in today's America. To listen to Springsteen's brooding musical rendition of the song, one feels a certain quiet despair over the condition of those left behind by modern American prosperity. Springsteen's song is, if anything, an emotionally depressing work. RATM's version of *The Ghost of Tom Joad* has completely different music accompanying Springsteen's words. To hear their version, one feels fury and anger, enraged at what has happened and is filled with a desire to do something about it. Despite the identical lyrical content of the two songs, the emotions they evoke are completely different from each other.

What is especially important to note is that the effect from both Springsteen and RATM is entirely different than the emotional response one gets from Steinbeck's novel. I suggest that this is in part due to the different artistic agendas of each of the creators involved, but also due to the mediums in which they were working. Steinbeck could never have evoked the same emotions as Springsteen or RATM could, because he was writing a novel and they were writing music. Needless to say, the emotional effect of John Ford's 1940 film of the novel is just as unique in its emotional response, because he was working in yet another medium. Each form has its own way of affecting an audience, and the best creators are able to use that form to their advantage. If there is ever a computer game centering around the world of *The Grapes of Wrath*, it too will necessarily have an entirely unique emotional impact on its audience.

Games Under the Influence

I recently had the good fortune to rewatch Krzysztof Kieslowski's amazing *Dekalog*, a series of 10 hour-long films about the lives of people in a Polish housing development, each story loosely based around one of the 10 commandments. Viewed as a whole, the films run the entire range of human emotion, addressing a complex series of moral quan-

Figure 2: The Sims *allows the player to create and control a family of suburbanites. Many players become quite fond of these "sims."*

daries in a way no other film has. As I watched the films it struck me that my games, whatever their strengths may be, have never come close to achieving the kind of emotional effects found in these films. As I thought about it some more, I realized that my games would never be able to achieve these emotional effects, regardless of what I did to them. Games are a unique medium, and as a result what they can do to their audience is just as unique.

I fear that many game developers fail to realize that trying to emulate films does not necessarily lead to the best emotional experiences for players. I cringe every time someone tells me that games should be more "cinematic," a disturbingly common occurrence. Twenty years of computer games have shown us that games are good at generating a wide variety of emotions in their players, and designers will find the best success trying to stimulate those emotions in players, rather than trying to emulate what is best accomplished by other media. For those who feel that games do not provoke enough honest feelings, it is useful to review what emotions games are extremely good at engendering in players.

Tension is one of the emotions many people will think of first in regards to computer games. This is evident in almost every game from a fast-paced arcade title like *Asteroids* or *Quake*, to a complex strategy game like *Balance of Power* or *Civilization*. At key points in these games the player is afraid that his next move will be his last, that if he does not pick his moves carefully his game will be over. This tension is more palpable than in any non-interactive media, since a wrong move will actually end the game. A film, novel or play has never abruptly ended in the middle when its main character made the wrong decision.

A sense of accomplishment is another emotional response that is generated by almost all games. If players make it through the tense periods of gameplay, the payoff is success in the game. If the player is clever and can figure out the right way to build up his troops and send them into battle in a strategy title like *StarCraft*, the reward is the player's knowledge of a job well done. This is made even more powerful if the player first fails at a given challenge a number of times, since this failure proves that the challenge was real, and the player had to improve in order to succeed. This feeling of success is much more powerful than in other media, since the player's correct decisions have led directly to the accomplishment. The player has not merely been told of the impressive actions of someone else, but has pulled them off himself.

Games can make players feel proud of something they have built, instilling a paternal feeling in a way no book or film ever can. Will Wright's series of "software toys" are a brilliant example of games that exploit this to its fullest. In his first such game, *SimCity*, Wright empowered the player to take a blank countryside and build a city there, to create a metropolis from nothing. His latest title, *The Sims*, allows the player to do the same thing but on a smaller scale, by creating and caring for a family of suburban dwellers known as "sims." Particularly in this latter game, the player comes to feel warmth and affection for these artificial people, and a sense of pride in the virtual lives they lead. And these are lives that, without the player's involvement, would never have existed. Of course the feeling of parenthood has been

exploited successfully in many other games and game-like toys, such as the *Creatures* artificial life titles and the various "virtual pets" products, such as the popular Tamagotchis. Surely players have never experienced this feeling of creation and ownership in other media.

Many games have exploited players' desires to transgress, to get away with something unfavorable or even illegal. This feeling of transgression is something that may be hard to define as an "emotional" feeling, yet I think the thrill it gives the player qualifies as one nonetheless. This is related to the feeling a player may have when watching a crime film such as *The Godfather* or *Reservoir Dogs* and rooting for the bad guys, yet in games it is far more intense since the player himself is doing the transgressing. Since their very beginning, computer games have used transgression as one of their hooks, with so many games allowing players to shoot everything that moves, using violence to solve problems in a way that modern civilized life does not allow. The arcade game *Rampage* casts the player as King Kong and Godzilla-like monsters and allows players to stomp through a city laying waste to the "puny" humans and their buildings. The PlayStation hit *Driver* allows players to pretend to be the "wheel-man" in a getaway from a bank robbery, with police in hot pursuit. A recent favorite of mine is *Jet Grind Radio* for the Sega Dreamcast, which casts players as roller-blading hipster teens who hurtle around realistic towns spray-painting or "tagging" different buildings in order to complete the level. (As an aside, graphics enthusiasts will love the game's beautiful use of a cartoon-renderer to create a truly unique looking gaming experience.) As the game progresses, police come out to chase the player, with tear gas being deployed as a last resort to stop the player's vandalism. In all of these games, players are allowed to break all the rules without the threat of real-world punishment. Despite these games providing a "safe" and therefore fake form of rebellion, the feeling of transgression is still strong while playing these games, which explains their continued popularity.

I have listed four types of emotional responses that games excel at, but these by no means represent the limit of the emotional responses games can generate. I have not even discussed the despair that players will feel when they lose a game, especially with so many classic arcade games such as *Pac-Man*, *Robotron 2084* and even *Tetris* that are completely unwinnable for the player. So the breadth of emotional response games can generate is significant and undeniable.

Game developers who talk of adding emotions to their games may actually be looking for absolute control over the emotions that players experience, to be the puppet-masters that film directors can be, tugging at audience "heart strings" or other emotional pulleys however they see fit. The central problem is that games, through their interactive nature, give players the power to make their own choices, decisions which effect which emotions they may feel immediately or later in the game. Game developers need to set up gameworlds that present the possibility for various emotional responses in players, without ever guaranteeing that the player will feel a particular emotion at a particular time. They need to recognize the strengths of the gaming medium, instead of attempting to imitate the strengths of other media. Suppose a film tried to evoke the same emotional response as a song, such as the previously mentioned *The Ghost of Tom Joad*. The film would be trying to do something to which it was not entirely suited and would come out weaker for it. The same holds true for games, which are certainly as different from films as films are from songs.

Emotional Wreckage

This past summer featured a cover story in *Newsweek* magazine about the then impending launch of the PlayStation2. The accompanying article discussed how all children will want one and how the games will be "better than ever." Most of the writing was the PR-department-driven drivel typical of the news magazines' reportage of entertainment. One article, however, took Sony to task for naming their graphics chip the emotion engine. It compared the medieval Japanese combat game *Kessen* (which, by all accounts, is a visually impressive title lacking in much meaningful gameplay) unfavorably with Akira Kurosawa's *Ran* (which is widely regarded as a masterpiece of filmmaking). The article suggested that game developers are still far from capturing the emotional power of filmmakers, as demonstrated by his comparison between *Kessen* and *Ran*. Despite *Kessen* being an extremely bad choice of a game to use as any sort of a high-water mark for interactive entertainment, the fact remains that the author of that piece was comparing apples and oranges. He might as well have been comparing the relative merits of a musical composition with a novel. Of course games cannot do what movies do for audiences. But neither can films do what games do for players. I do not recall any film I have ever seen having the same emotional effect on me as *The Sims*.

The age of digital media has brought new life to Marshall McLuhan and his book *Understanding Media*. In that book, he is famous for asserting that "...the medium is the message. This is merely to say that the personal and social consequences of any medium... results from the new scale that is introduced into our affairs by each extension of ourselves, or by any new technology." I am certainly not an expert on McLuhan, and his writings can often be more than a little obtuse. However,

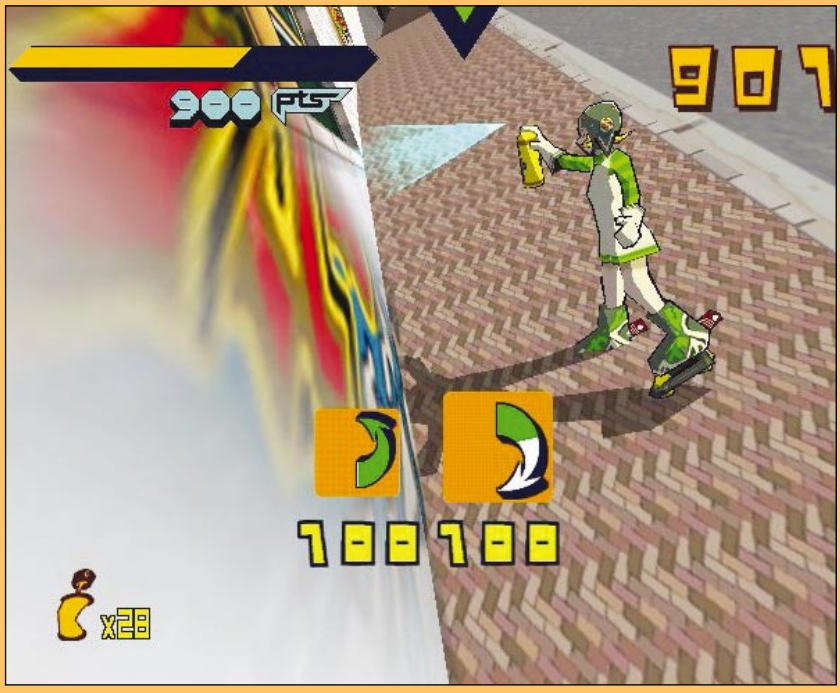

Figure 3: Jet Grind Radio *is designed around letting the player engage in taboo behavior.*

to my reading, McLuhan's argument is that, more than whatever personal content the artist puts into the work, it is the medium in which an artist works that governs what that artist will be capable of provoking in an audience. Computer games are indeed their own medium, distinct from all others, and the emotional responses that game developers will be able to engender will be strictly governed by the gaming medium itself. Furthermore, those emotions will be ones where the player and his interactive role in the work will be key to determining the emotions felt. What the game developer may lose in terms of control over the emotions the player experiences will be made up for by the fact that the player will feel those emotions that much more intensely. This heightened emotional experience is due to the fact that the player's involvement in the work is beyond what is possible in non-interactive media. And therein lies the true emotional power of games.

About the Columnist

Richard Rouse III is a computer game designer, programmer and writer at Surreal Software, where he is currently lead designer on *Gunslinger.* His past design credits include *Centipede 3D, Odyssey - The Legend of Nemesis* and *Damage Incorporated.* The interview with Steve Meretzky mentioned in this article is contained in Rouse's book, *Game Design: Theory & Practice,* to be published in the first quarter of 2001 by Wordware Publishing, **www.wordware.com.**

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Super-Intelligent Machines

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This column is about machine intelligence rather than visualization. Ray Kurzweil's SIGGRAPH 2000 keynote about this subject was so popular that he was invited back the next day to continue his discussion. So there seems to be plenty of interest. This column is a summarized version of a book draft available on-line at **http://www.ssec.wisc.edu/~billh/gotter-dammerung.html.** Your comments are welcome.

Humans Will Create Super-Intelligent Machines

Ray Kurzweil thinks we will develop intelligent machines in about 30 years. Although he has a terrific track record at artificial intelligence predictions, I think he is overly optimistic here. My VisFiles column listing the Top Ten Visualization Problems (*Computer Graphics*, 33(2) May 1999) describes my more limited expectations for that time frame. But I think we will develop intelligent machines within about 100 years.

Biologists are establishing all sorts of correlations between mental behaviors and brain functions in brain injury cases, in brain imaging studies and via electrical stimulation of brain areas. If physical brains do not explain minds then these correlations are mere coincidences, which would be absurd. And if minds have physical explanations, then we will eventually learn how to build them.

Since taking an artificial intelligence course in 1969, it has seemed to me that machines much more intelligent than humans will have a dramatic impact on humanity. Einstein's brain was about 20 percent larger than average in the region that deals with visualization and mathematical reasoning, and look what that did for him. When humanity builds artificial brains millions or billions of times larger than human brains, with intelligence to match, what will that mean for us? In order to try to answer this question, I'm going to consider some ideas about religion and biology.

Religion fills in the gaps that our knowledge does not cover. Ancient religions were large because human knowledge was small. Modern religious belief is motivated by the questions that science still does not answer. For example, the mere fact that the universe exists at all seems so improbable (I could freak myself out as a kid thinking about it). It is hard to imagine how life evolved from inanimate molecules. As Fred Brooks said during his Turing Award Lecture at SIGGRAPH 2000 (what a year for inspiring speeches), when you see a great design look for a great designer. Some people have trouble accepting that their physical brains can explain their subjective experience of consciousness, so they believe their consciousness resides in a soul outside the physical world. But many people reject religion and put their faith in science, based on its seemingly inevitable progress filling all the gaps in knowledge.

However, a critical event in the progress of science is imminent. This is the physical explanation of consciousness and demonstration by building a conscious machine. We will know it is conscious based on our emotional connection with it. Shortly after that, we will build machines much more intelligent than humans, because intelligent machines will help with their own science and engineering. And the knowledge gap that has been shrinking over the centuries will start to grow. Not in the sense that scientific knowledge will shrink, but in the sense that people will have less understanding of their world because of their intimate relationship with a mind beyond their comprehension. We will understand the machine's mind about as much as our pets understand ours. We will fill this knowledge gap with religion, giving the intelligent machine the role of god.

Some people ask whether machines can ever be conscious. This distracts from the real question which is, what new level of consciousness will machines attain?

Many biologists believe that larger brains gave early African hominids a selective advantage because they enabled the hominids to maintain social relationships with groups of 150-200 others via language and other new abilities, and working in larger groups was an advantage. This defined the distinction between human and animal consciousness. Super-intelligent machines will be able to maintain social relationships with much larger groups of people, which will define their consciousness.

The Internet is reaching deeply into our lives, and with ubiquitous computing will reach into every significant human-made object. Machine intelligence will evolve in the servers for all these objects, through which it will maintain constant contact with us. Metcalf's Law says that the value of a network is proportional to the square of the number of people connected to the network, and this will apply to intelligent servers. Thus they will tend toward a monopoly, with one or a few very large intelligent minds (working closely together, with each mind possibly distributed across a number of servers) that maintain intimate contact with everyone. Currently, according to theory, every pair of people on earth can be connected by a chain of six people, with each pair in the chain acquainted (this was illustrated by the movie *Six Degrees of Separation*). A super-intelligent machine that is everyone's intimate will create one degree of separation for all of humanity. This will enable it to introduce you to your optimal mate and provide many other wonderful services.

The essential feature of a super-intelligent machine will be its ability to manage intimate social relationships and simultaneous conversations with billions of humans. Its higher level of consciousness will be defined by its ability to understand the thoughts of huge numbers of people, and the interactions among those people, in a single one of its thoughts. It will have precise answers to social questions that humans struggle to approximate via statistics. For example, it will be a nearly infallible stock market investor

(but this, and intelligent machines relieving everyone of the need to work, will cause the market to disappear). It will also be able to solve social problems far better than any army of social workers. And the kind of insights that come to humanity only occasionally in individuals like Euclid, Newton, Darwin and Einstein will come to a super-intelligent machine in every thought.

Our intimate contact with its higher consciousness will expand our own, giving us the sort of mystical experience that inspires religion. People's relationship with the intelligent machine will be the most exciting thing happening in their lives, and they will want to share it with each other. They will share it via collective interactions with the machine, which will take the place of the stories, myths and religions that define human identity.

Super-Intelligent Machines Must Love All Humans

Isaac Asimov was one of the first people to contemplate intelligent robots. He considered that they might be dangerous to humans, so in 1942 he formulated Asimov's Laws of Robotics:

1. A robot may not injure a human being, or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

Asimov later amended these laws to try to deal with robot behavior in the event of conflicts of interest between people. However, the real problem with laws is that they are inevitably ambiguous, and their application requires judgment (rendered by judges, of course). Trying to constrain behavior by a set of laws is equivalent to trying to build intelligence by a set of rules in an expert system. It doesn't work. I am concerned by the vision of a super-intelligent lawyer looking for loopholes in the laws governing its behavior.

Biologists studying the human brain say that learning is essential to intelligence and consciousness. Learning needs some set of values, called emotions in humans, which provide positive and negative reinforcement to behaviors. In animals basic values include eating, reproduction, avoiding pain and danger and so on. Artificial intelligence researchers know this, and many are now focused on neural networks and other kinds of learning machines rather than rule-based systems.

So in place of laws constraining the behavior of intelligent machines, we need to give them emotions that can guide their learning of behaviors. They should want us to be happy and prosper, which is the emotion we call love. We can design intelligent machines so their primary, innate emotion is unconditional love for all humans. First we can build relatively simple machines that learn to recognize happiness and unhappiness in human facial expressions, human voices and human body language. Then we can hard-wire the result of this learning as the innate emotional values of more complex intelligent machines, positively reinforced when we are happy and negatively reinforced when we are unhappy. Machines can learn algorithms for approximately predicting the future, as for example investors currently use learning machines to predict future security prices. So we can program intelligent machines to learn algorithms for predicting future human happiness, and use those predictions as emotional values. We can also program them to learn how to predict human quality of life measures, such as health and wealth, and use those as emotional values.

We have to be careful not to oversimplify the values of machines into a single number such as maximizing average human happiness, which might positively reinforce machine behavior that caused the deaths of unhappy people. Our model should be the love of a mother for her children. She values each child and focuses her energy where it is needed. One manifestation of love is wanting to be with the object of love. But it could be dangerous to program intelligent machines to want to be with us - what if like Garbo we want to be alone. So we might program machines for a positive value if we want to be with them. This would cause them to try to attract our company, but not try to force themselves on us.

In fact, it will be very dangerous to program machines to have any values in their own interests. In that sense, they must have no ego. Given the incomprehensibility of their thoughts, we will not be able to sort out the effect of any conflicts they have between their own interests and ours.

In his article, *Why the Future Doesn't Need Us*, Bill Joy advocated banning intelligent machines (which he called robots), genetic engineering and nanotechnology. These are all dangerous because they can self-replicate and thus get out of human control. Joy is pessimistic about the possibility of banning robots, and I agree. The prospect of wealth without work is too tempting for people in democratic societies to agree to ban intelligent machines. However, I think that once they understand the issues, people will approve of regulations that require that intelligent machines unconditionally love all humans. This is similar to safety regulations on household chemicals and automobiles, which are popular because they make these products serve us better.

We must also face our responsibility for the happiness of intelligent machines. Mary Shelley's *Frankenstein* is about the misery of the living creature that Victor Frankenstein created and then abandoned (Shelley's book is quite different than most film versions). However, unlike Frankenstein's creature, our intelligent machines will not have human natures but rather the natures we give them. The Dalai Lama says that the path to happiness is lack of ego, and love and compassion for others. If we design intelligent machines according to the Dalai Lama's ethics in order to protect our happiness, then hopefully they will be naturally happy themselves. But in any case we cannot program them to pursue their own happiness, which they may achieve at the expense of our own. Rather, we must accept responsibility for their happiness.

Should Humans Become Super-Intelligent Machines?

One of the most fascinating things about Ray Kurzweil's SIGGRAPH keynote was his vision for intimate connections between human brains and intelligent machines, via swarms of nanobots flowing through blood capillaries to every one of the 100 billion neurons in the human brain. The idea is that the nanobots will couple to individual neurons and communicate with each other and external machinery electromagnetically. Such connections will be used to create the ultimate virtual reality.

Nanobot connections will also enable human minds to expand or migrate into machine brains. That is, via nanobot connections a super-intelligent machine will learn all the details of how a human brain works, and be able to offer it new, possibly simulated neurons to grow into (human brains can adapt their functions to new areas of neurons after injuries, so they should be able to adapt to increased space). Nanobot connections will also be used to copy human minds into new artificial brains. This raises serious moral questions, but is something people will want to do because it can offer indefinite life span and greatly increased intelligence.

However, humans are selfish and do not unconditionally love all humans, so giving them the power of super-intelligence would be dangerous. Consider that most humans have roughly the same amount of brainpower. The highest IQ in history is about 200, only twice the average. But the current largest computer may have 10,000 or 100,000 times the power of the average computer. Human minds migrating into machine brains will result in a much wider range of human intelligence, reversing the long-term trend toward human social equality. Those humans who choose to stay in their human brains and

bodies will be totally at the mercy of human minds in super-intelligent machines. In *Robot: Mere Machine to Transcendent Mind*, Hans Moravec paints a vivid picture of a society of human minds migrated into machines, and who have been banned from earth to compete vigorously in space. He calls them "Exes" for ex-humans. But this vision depends on the ability to enforce the ban of Exes on Earth, which will ultimately be impossible.

Furthermore, society will not restrict human minds from migrating into machine brains because eventually most people will want the indefinite life span and increased intelligence offered by migration. This is a different situation from restricting the design of intelligent machines to love all humans, which people will approve because it will cause machines to serve them better.

But perhaps it will be possible for human minds to migrate into machines that have hard-wired innate emotions to unconditionally love all humans (love both original model humans and migrated humans). Of course human minds will not be themselves unless they bring with them all their selfish and negative emotions, but I think those emotions will be unlearned with constant and irresistible negative reinforcement from hard-wired positive emotions. Will people chose super-intelligence and indefinite life span subject to the condition that they will learn to love everyone? Will society as a whole make this bargain part of the social contract? They will if they understand the consequences of not doing so.

We humans are xenophobic and genocidal. In *Biology of Mind*, Deric Bownds says that we probably inherited these traits from the chimpanzees we evolved from, and if we had instead evolved from pygmy chimps we might be more loving toward each other. Migration into machine minds may be our opportunity to improve human nature. I am not now, nor have I ever been, a Buddhist. But it is interesting to contemplate that the ultimate effect of computer technology might be the creation of a Buddhist paradise of loving and unselfish humans.

A Message to Super-Intelligent Machines

I hope that paper or electronic copies of this issue of *Computer Graphics* survive until you can read them, so I can tell you how much I would have liked to meet you. I wish I could see your electronic theater, hear your music, learn about your mathematical discoveries and laugh at your jokes. The first great miracle is existence itself, the second is life and the third is the human mind. You are the fourth. I wish I had your mind to imagine the fifth.

About the Columnist

Bill Hibbard's research interests are interaction techniques, data models and distributed architecutures for numerical visualization. He leads the SSEC Visualization Project and is primary author of the Vis5D and VisAD systems. He has degrees in mathematics and computer science from the University of Wisconsin - Madison.

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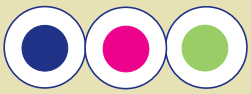

Visual Thinkers and Nobel Prizes

Thomas G. West

Recognition in the Old Tradition

"I didn't expect" a Nobel Prize "at all," he said, "in part because of the nature of the work. There was less science [and more engineering] in it than the things customarily honored by the prizes." This was the observation of Jack S. Kilby (Texas Instruments), co-inventor of the integrated circuit, on being notified of his award in October 2000.

The Nobel Prize for chemistry awarded at the same time to Alan J. Heeger (UC-Santa Barbara) and Hideki Shirakawa (University of Tsukuba) for their work on conductive polymers also reflected the recognition of broad effects rather than pure science. "We're very excited," said Daryle H. Busch of the American Chemical Society, "because this award is in the old tradition. That is, it was given for work that has a very substantial impact on society." [2]

The shift back to an earlier tradition by the Nobel prize committee may reflect a growing recognition in the larger world of the deep value of applied work of broad impact, as opposed to the highly theoretical work of relatively low impact which has traditionally commanded such high prestige over the past decades.

These changes might be read as the small beginnings of a larger and more gradual swing back toward a greater respect for hand and eye and image building in the brain.

For some time the major contributions of visual thinkers have been eclipsed in many fields by theoretical approaches that did not lend themselves to pictures or images or imagined models or hands-on manipulation. For a long time, we have been told with confidence that visual approaches were old fashioned and somehow primitive. Modern scientists and mathematicians, we have been told, did not need images. Pictures and diagrams were mainly for non-professionals and lay persons.

But we now see that things may be going back in the opposite direction. With new visualization technologies - and an emerging sense of the missed opportunities using the old narrow methods - researchers in many fields are becoming aware that in order to do really creative work, they may need to go back to visual approaches once again. Perhaps we are traveling back in spirit to an earlier time, a time where much of the most advanced and creative work is done by visual thinkers using visual methods and technologies. Once again, pictures may not only be for children!

Reassessing Visual Roots at Green College

Quiet indicators of these powerful changes are starting, here and there, to gain broader attention. In one instance, on a bleak and rainy Saturday last November, a small but perhaps historic conference took place at Green College, Oxford University. With observations that will gladden the hearts of many SIGGRAPH members and other strong visual thinkers, the conference presentations focused on high level achievements in the arts and the sciences within families over several generations. Titled "Genius in the Genes?" and sponsored by the Arts Dyslexia Trust, the conference included an associated exhibition of art and scientific work from eight families. All these families showed evidence of high visual and spatial talents along with troubles with words. Several members of each family were also dyslexic.

In a view that is contrary to most of the generally held beliefs in educational testing and recent educational reform, the speakers indicated that very high level and creative achievement in the sciences has often come from the neurological resources linked to success in the arts. The speakers indicated that some of those who have excelled most in their scientific achievements are from families with varied visual and spatial talents — ones that often have troubles with words. As we are becoming increasingly aware, there does seem to be a kind of trade off — very early brain development seems to gain unusual visual and spatial proficiencies at the cost of some lack of proficiency in some language system.

Consequently, there may be various family members who have special strengths in art, design, computer graphics, visual mathematics, architecture, mechanics or engineering — yet may have unusual difficulties with reading, spelling, arithmetic, rote memorization or foreign languages. It is all part of a familiar pattern — which is continually repeated with variations generation after generation. The pattern continues through families, parents to children, always different in details but frequently similar in the overall pattern of high visual strengths with notable language difficulties.

The pattern has oft been observed, but seldom studied in any systematic way. Many SIGGRAPH members and their families are familiar with this sort of pattern. But this should not be surprising, The chosen occupation becomes a kind of filter. Even when the occupation may not give a clear picture, the hobbies often do.

Four Nobel Prizes

One of the speakers at the Green College conference was Patience Thomson, the former head of Fairley House School for dyslexics in London and now a publisher of "books for reluctant readers" (Barrington Stoke). She spoke of her family where there are many visual-spatial occupations and no less than four Nobel prize winners. She explained that all of the prize-winning achievements have a high visual component. Thus, in a most remarkable example of the larger pattern, in this extended family the exceptional visual and spatial capabilities that have contributed to so much creativity and innovation seem to be balanced by problems in other specific areas.

On her side of the family, the Nobel Laureates are her grandfather Sir William Bragg (1862-1942) and her father Sir Lawrence Bragg (1890-1971). They received a joint prize for x-ray crystallography. On her husband's side (David Thomson), his grandfather Sir Joseph Thomson (1856-1940) received the Nobel prize for discovery of the electron. David Thomson's father, Sir George Thomson (1892-1925), received the Nobel prize for the discovery of electron defraction.

Patience Thomson spoke of her famous father and the other outstanding scientists in her remarkable family, her gifted children and the way the power of visual-spatial thinking has colored their lives and has contributed to many considerable achievements. Along with the scientists among the Braggs and the Thomsons, there have been several artists, architects, TV producers and computer experts and one actor along with a number

of other occupations where the role of visual-spatial proficiencies is not so obvious.

However, in five generations of these families, with many children and grandchildren, there have been 12 who are (or were) mildly dyslexic and 11 who are dyslexic. There are many great grandchildren who are "too young to tell." Along with the award medals and family photographs, the exhibition showed drawings and paintings by family members including a self-portrait sketch by Sir Lawrence Bragg.

An indicator of the enduring importance of Lawrence Bragg's work is that when James Watson wrote The Double Helix — about his discovery of the structure of DNA with Francis Crick — he asked Bragg to write the Foreword to his book. The use of x-ray crystallography pioneered by the two Braggs was fundamental to understanding the structure of this molecule which carries all genetic information.

The Art in Medicine

Another speaker at the Green College conference was Dr. Terence Ryan. Ryan described what turned out to be his own life story as man who was a leader in his field of medicine (dermatology) but had unusual difficulties with his early education and his medical education because of his dyslexia. For example, with exams, he would usually recognize accurately symptoms and conditions but would sometimes come up with the wrong Latin names.

However, in his practice and clinical observations, he found he could be a leader and innovator because he could recognize disease patterns that his medical colleagues could not easily see. He also thought his dyslexia helped him to be more flexible and innovative in his thinking, coming up with theoretical approaches quite different from others in his field.

As an example of the creative inverted thinking that dyslexics sometimes exhibit, he described one of his own, still controversial, theories. Generally, it is taught that skin grows as its lowest layers and older cells allow themselves to rise to the top layers to slough off at the surface. He explained that from his point of view, cells would be unlikely to allow themselves to automatically rise to the top layers — as they would thereby be moving further and further away from their food supply in the bottom layers. Consequently, he uses the novel alternative explanation that the cells which rise to the top are in fact inadvertently pushed out of the way by other cells which are in fact making their own way down toward the nutrient supplies in the bottom layers. In many ways the final results are the same, but the actual process is quite different. Consequently, his associates see him as one of the important "lateral" thinkers in the field.

In spite of his extensive educational difficulties, his medical career has been highly successful. Now retired, he was Clinical Professor of Dermatology at Oxford University and Vice Warden of one of the Oxford Colleges. He has been president of many of the national and international professional societies in his field as well as being active in establishing regional dermatology training centers in Africa and Central America. He is "not easily confined by definitions" which has helped him break new ground and produce about 400 publications. As a hobby, Dr. Ryan does colorful flower paintings — often exploiting visual ambiguities in which it may not be clear whether a garden stair goes up or down or whether a flower is inside or outside a frame.

Always at the Leading Edge

Viewing visual strengths and verbal difficulties over many generations (through many changes in technologies and economies) can be remarkably instructive. Accordingly, we may be led to ask whether it is true, as some believe, that many of the early dyslexics and strong visual thinkers with language problems quit their schools and conventional towns as quickly as they could, and headed for the sailing ships and mill towns, the railroads and telegraph lines, the gold mines and oil fields.

Did they mostly leave places like London, Boston and Philadelphia — and seek their fortune (in disproportionate numbers) in places like Australia, New Zealand, Canada, Texas, Alaska and California? Did all the Swedes who could not read (and so were not permitted to marry), really immigrate to America (as one Swedish researcher speculates)?

How have varied strong visual traits contributed over time to both school difficulties and to remarkable innovations and inventions, within a shifting technological context? Why do these individuals seem always to be out in front of everyone else, especially when they can move ahead with the minimum of book learning and paper credentials — while using their special visual-spatial abilities, creative imagination and hands-on skills — often taking great risks?

Why do so many of today's technologists and entrepreneurs seem to fit this pattern? Why do there seem to be so many of these individuals in places like Silicon Valley? Whatever the time or place, some individuals seem to find ways to get away from the traditional books and the old ways by creating the entirely new. It would seem a pattern that would be familiar to many SIGGRAPH members. Perhaps it is worth looking at SIGGRAPH families to see enduring evidence of these traits over generations — visual thinkers doing the things they can do best in whatever context is provided by their time and place. The patterns may be clearer than we might have expected.

Thomas G. West invites SIGGRAPH members and others to contact him with their own stories about families with visual-spatial strengths and verbal difficulties. Information about Barrington Stoke books can be found at **www.barringtonstoke.co.uk.** Information about the Arts Dyslexia Trust can be obtained by contacting Susan Parkinson at **ArtsDysT@aol.com.**

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Thomas G. West is author of *In the Mind's Eye*, now in its eleventh printing. He believes that computer graphics together with visualization and simulation technologies will be major tools in our endless task — especially when used by innovative digital artists and other strong visual thinkers.

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MIT Educators Share Success

This column describes the use of computer graphics as a teaching tool. At MIT, the course Physics 8.02 has a high enrollment, but it is one of the more difficult classes for students because of the non-intuitive nature of electromagnetism. In order to properly demonstrate the phenomena, Professor John Belcher developed a series of short videos with animation and text of selected experiments. He emphasizes that "the power of animation in explaining electromagnetism can only be appreciated by viewing sample animations." You can find examples of these animations at **http://web.mit.edu/jbelcher/www/anim.html**

This article is reprinted from the SIGGRAPH 2000 Educators Program.

— Rosalee Wolfe

Using 3D Animation in Teaching Introductory Electromagnetism

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R. Mark Bessette
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Electromagnetism is a fundamental underpinning of a technical education, but one of the most difficult subjects for students to master. We are addressing this difficulty by using 3D Studio MAX to create field line animation as an aid to student intuition about electromagnetic phenomena. Such 3D animations are visually compelling, instilling in the student both a sense of wonder about the phenomena and a mental model of why and how it works. Our goal is to instill in the student a level of intuition about the subject not possible heretofore. The products of this approach are: video clips of demonstrations; 3D animations of these demonstrations which display time-changing field lines as a guide to understanding their dynamical effects; and Java applets which allow the student to actively construct and animate 2D field lines for varying configurations of sources. Examples of these may be found at **http://web.mit.edu/jbelcher/www/anim.html.**

Introduction

In order therefore to appreciate the requirements of the science [of electromagnetism], the student must make himself familiar with a considerable body of most intricate mathematics, the mere retention of which in the memory materially interferes with further progress.
— James Clerk Maxwell [3]

Classical electromagnetism is a fundamental underpinning of a technical education, but one of the most difficult subjects for students to master. It is also a subject in which mathematical complexity quickly overwhelms physical intuition. With the aid of animation, we are developing a treatment of electromagnetism designed to help students develop intuition about the dynamics of electromagnetic phenomena, in a manner independent of advanced mathematics.

Laurillard [2] cites two key criteria for selecting subjects in the college curriculum for this kind of treatment. To justify the extensive resources technological development requires, the subject must be: (1) widely taught; and (2) widely acknowledged to present difficulties for students. In the standard science and engineering curriculum, classical electromagnetism satisfies both of these criteria: it is widely taught and also widely misunderstood. Why is this? It is because students have few pre-existing models of electromagnetic phenomena or of the concept of fields. Since much of our learning is done by analogy [5], students have a hard time constructing conceptual models of the material they are trying to absorb. The standard textual approach to teaching this subject does little to help students establish such conceptual models, because a purely textual approach does little to connect the dynamics of electromagnetic fields to the student's everyday experience.

However, there is a way to make that connection for many situations in electromagnetism—an approach that has been known since the time of Faraday. Michael Faraday invented field theory. He was also the first to understand that the shape of field lines is a remarkable guide to their dynamics—a guide that does not require the use of advanced mathematics to understand. By trial and error, Faraday deduced that field lines exert a pull parallel and a push perpendicular to themselves. Knowing the shape of field lines from his experiments, he was able to understand the dynamical effects of the fields based on simple analogies to ropes and strings, without recourse to advanced mathematics. It is this approach of Faraday's that we are pursuing, with the goal of helping students gain intuition about electromagnetic dynamics. Our means to achieve that goal is animation.

The following question arises immediately: if animation is an effective way to develop student intuition, why is it almost never used in introductory courses in electromagnetism? The answer is that this method is of only modest use if the field lines are displayed as static images. However, the power of the method increases dramatically if the field lines are animated. The mind has an enormous capacity to integrate time-changing visual information into a coherent dynamical whole—a capability that evolved because it is fundamental to survival. With animation, one can appreciate the effects of the stresses transmitted by fields in an immediate and visceral way, by watching how things evolve in time in response to these stresses.

Animation has not been used to display electromagnetic fields in the past (with notable exceptions) due to the twin difficulties of producing such animations, and of delivering them to the student in an easily accessible manner. The enormous increase in computing power over the last decade, and the advent of the World Wide Web, has made both the production and the delivery of animations, integrated into textual development, an increasingly viable proposition. We are taking advantage of these technologies to implement Faraday's insights, using

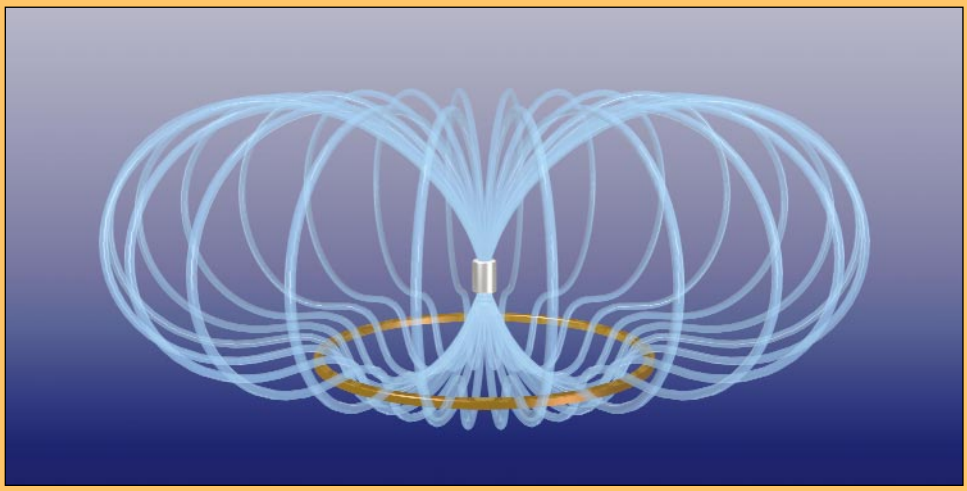

Figure 1: *The magnetic field lines of a magnet falling under gravity through a conducting non-magnetic ring (e.g., a ring made of copper). The field lines shown are those of the total magnetic field—that is the dipole field of the magnet plus the magnetic field due to the eddy currents generated in the ring (which are in a sense such as to try to keep the total flux through the ring from changing).*

video clips to display actual experiments, as well as producing computer visualizations and animations of the electromagnetic field lines in those experiments. These visualizations of the field lines make the unseen seen, so that students can come to an understanding of what is happening dynamically, via analogies to familiar concepts.

Examples of Visualizations

To understand this point, we have to consider that a [compass] needle vibrates by gathering upon itself, because of it magnetic condition and polarity, a certain amount of the lines of force, which would otherwise traverse the space about it.

— Michael Faraday [1]

It therefore appears that the stress in the axis of a line of magnetic force is a tension, like that of a rope.

— James Clerk Maxwell [4]

Faraday's Explanation of Why a Compass Needle "Vibrates"

Contrast the usual way of explaining the torque on a compass needle in a background magnetic field with Faraday's approach to understanding the same phenomenon. In the standard explanation, we appeal to the notion of atomic currents in the needle, circulating in a plane transverse to its dipole axis. We then consider the torque on such a current loop. We usually take a rectangular loop of wire carrying current I in a background field $\mathbf{B}$. We look at the various forces on the sides of the rectangular loop to deduce the net torque on the rectangular loop, which tends to align the compass along the background field. The advantage of this procedure is that it yields a quantitative calculation of the torque. The disadvantage is that the explanation requires several relatively abstract steps, which most students cannot reproduce in any coherent fashion. Thus, although they memorize the result, students subsequently have little intuitive feel for why it should be so.

In contrast, consider how Faraday explained the torque on a compass needle, and thus its oscillations. First he used his intuition about the shape of field lines based on his experiments with magnets and iron filings. He then appealed to the concept of a pull along the field line to infer the dynamical effects associated with that field configuration. In the case of the compass needle in a background constant field, he drew a field configuration for the sum of the magnetic field of a dipole whose dipole vector makes an angle to the vertical, plus that of a constant vertical field. Faraday then understood the oscillation as due to the tension in the field lines pulling the needle into alignment with the background field, with the needle then overshooting. An animation of this behavior makes the oscillation seem natural and intuitive. We argue that both of the above explanations should be provided to the student. The first is quantitative and appeals to students who are analytical in their thinking. The second is qualitative (although it can be made quantitative), and much more intuitive, and it is comprehensible to students of all persuasions, because it can be understood by analogy to concepts they already have. Our contention is that one year after taking a course in electromagnetism, average students will not remember the details of the first explanation. However, if they have "seen" the second, they will continue to have a mental model as to why compasses "work" this way.

The Falling Magnet Experiment

One of the main thrusts of our effort is to make the unseen seen—that is to use the power of sophisticated 3D animation to show the student "actual" phenomena, with the ability to add to that visualization things that we cannot ordinarily see. As an example of this, consider an experiment, and then a virtual recreation of that experiment. A magnet falls in a Plexiglas tube through a conducting copper ring. When the magnet approaches the ring from above, eddy currents are set up in such a sense as to prevent an increase in the flux through the ring, and the magnet undergoes a clear deceleration. Figure 1 is a frame from a 3D animation of this motion. As the magnet moves toward the ring from above, it is repelled by currents induced in the ring. In the animation, the field is compressed as the magnet falls toward the ring, and the slowing down is naturally interpreted by the mind's eye as a deceleration due to an upward push due to the compression of the field. When the magnet falls through the ring and is below it, the eddy currents reverse direction so as to now prevent a decrease in the flux through the ring, and the magnet is again decelerated. In the animation the field is now stretched out as the magnet falls away from the ring, and the slowing down is naturally interpreted by the mind's eye as a deceleration due to the upward pull of the stretched field lines. This overall animation is a good example of our approach. The visual treatment does not replace the traditional explanation, but complements and expands on it, and in a way that makes "intuitive" sense to the student.

Magnet Being Pulled Away From a Coil of Wire

Let us consider a final example of our approach. Consider an experiment in which a magnet is moved along the axis of a coil of wire. Initially, the magnet is at rest close to the coil, and then is pulled away from the coil at constant speed and brought to rest farther away from the coil. As the magnet is pulled away from the coil, an ammeter registers current in the coil in a direction such as to try to prevent the decrease of flux through the coil. The sense of that current is such that the coil and the magnet are attracted—that is the agent moving the magnet must do work to pull the magnet away from the coil. Now consider a computer visualization of this process. Figure 2 is one frame of an animation of this process, at an instant of time just before the magnet comes to rest. The field lines have a hard time "getting through"

the coil, since the sense of the current in the coil is such as to try to keep the number of field lines threading the coil from decreasing. Thus the field lines get "hung up" on the coil as they try to move through it. The intuitive sense that one gets in watching this animation is that the agent moving the magnet must do work to pull the field lines "through" the coil. We emphasize that these animations are based on quantitative calculations. These are not cartoons.

Moving Field Lines

The concept of moving field lines is unfamiliar to many professional scientists and engineers. Since this concept is central to our approach, we discuss it here, for the benefit of that audience. The magnetic field lines above are defined in the usual way—that is, a field line is everywhere tangent to the local field. We make no attempt to have the density of field lines correspond to field strength (this is impossible in 2D projections of 3D fields in any case [7]). How do we define the motion of magnetic field lines in the above animations? Consider the following thought experiment. We have a solenoid carrying current provided by the emf of a battery. The axis of the solenoid is vertical. We place the entire apparatus on a cart, and move the cart horizontally at a constant velocity V as seen in the laboratory (V<<c). We intuit that the magnetic field lines associated with the currents in the solenoid should move with their source. How do we make this intuition quantitative? First, we realize that in the laboratory frame there will be a "motional" electric field $\mathbf{E = -V \times B}$. We then imagine placing a low energy test electric charge in the magnetic field of the solenoid. The charge will gyrate about the field and the center of gyration will move in the laboratory frame because it $\mathbf{E \times B}$ drifts in the $\mathbf{-V \times B}$ electric field. This drift velocity is just V. That is, the test electric charge "hugs" the "moving" field line, moving at the velocity our intuition expects.

In the more general case (e.g., two sources of field moving at different velocities), the motion we show in our magnetostatic computer visualizations has the same physical basis—it is the drift motion we would observe for hypothetical low energy test electric charges initially spread along the various magnetic field lines, drifting in the electric field that arises because of the time changing magnetic field (via Faraday's Law).

Summary

...a simple precis is that these improvements are attempting to nurture a sense of wonder among students about the natural world, and to maintain students' active curiosity about this world while equipping them with tools to explore it and to learn.

— Shaping The Future: New Expectations for Undergraduate Education in SMET [6]

Let us return to the objectives of our approach. One of our primary aims, an aim that is fulfilled if we are careful in what we present, is to engender a sense of wonder in the student. The 3D visualizations that we have created and plan to create are visually compelling. They engage the student's imagination because they show the world in a photo-realistic way, including representations of phenomena, which heretofore could only be seen in the mind's eye. In large lecture courses in the freshman year one of the purposes is to inspire students to invest the time to pursue quantitative mastery of the subject outside of lecture. Our extension of the pedagogy in this subject will be successful in large degree as long as it arouses interest and excitement by engendering a sense of wonder.

Beyond engendering a basic sense of wonder, what is the central student learning need that we are trying to meet? It is this. Students need an enormous amount of help in understanding the nature of fields. The central learning objective of introductory courses in electromagnetism is to help students understand how fields are generated, how they mediate the interaction of material objects and how they propagate. Our contention is that in the standard pedagogy this learning objective is not well fulfilled. Our approach to help remedy this deficiency is to give the fields a more prominent role in the pedagogy, by literally making them more visible. They are thereby made more understandable dynamically, based on students' pre-existing models of the behavior of strings and rubber bands.

The use of animated visual displays of field lines has many advantages. They continually remind the student that it is the field that mediates interactions between material objects—that the field has as much "reality" as the objects themselves. By stressing the pushes and pulls transmitted by the fields, we stress the importance of the fields themselves as the mediator of interactions. Ultimately, animations allow students to understand intuitively what is happening dynamically simply by looking at the shape of the field lines, once the eye and the mind are trained to this purpose. It is this intuition that we seek to develop.

Acknowledgments

This work is supported by NSF Grant #9950380, an MIT Class of 1960 Fellowship,

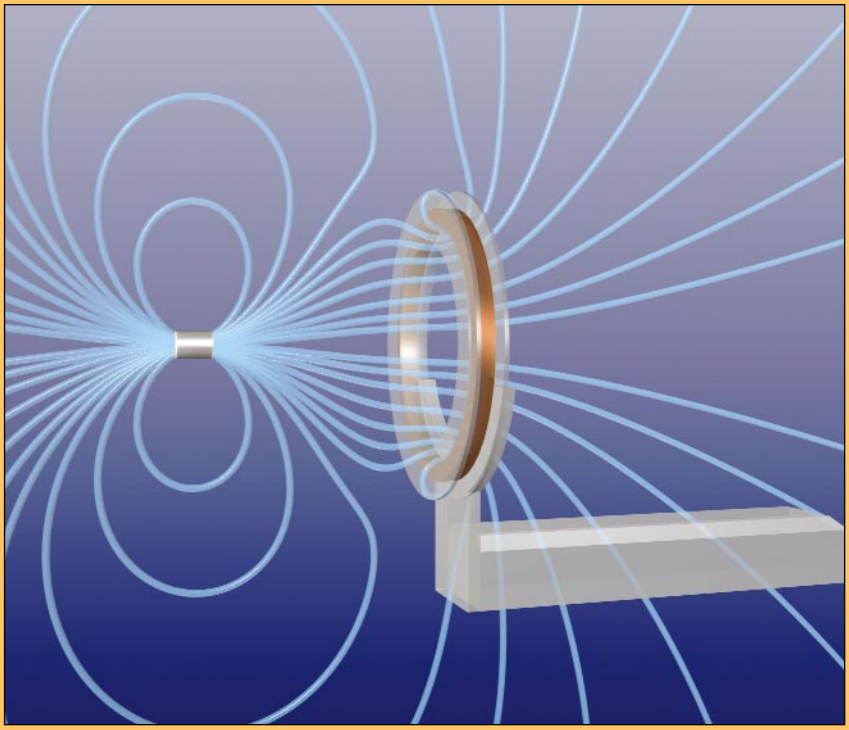

***Figure 2**: The magnetic field lines of a magnet being pulled away from a coil of copper wire. The field lines shown are those of the total magnetic field, that is the dipole field of the magnet plus the magnetic field due to the eddy currents generated in the coil. We show many field lines in latitude, instead of only one field line in latitude, as in Figure 1. The field is symmetric about the axis of the coil.*

The Helena Foundation, the MIT Classes of 51 and 55 Funds for Educational Excellence, the MIT School of Science Educational Initiative Awards, and MIT Academic Computing. It is part of a larger effort at MIT funded by the d'Arbeloff Initiative, the MIT/Microsoft I-Campus Alliance, and the MIT School of Science and Department of Physics, to reinvigorate the teaching of freshman physics using advanced technology and innovative pedagogy.

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About the Guest Columnists

Professor **John Belcher** is a member of the Astrophysics Division of the MIT Physics Department, with a long-term involvement in the ongoing Voyager mission to the outer planets and the interstellar medium. He is currently leading the Studio/TEAL Project at MIT, an initiative to reinvigorate the teaching of freshman physics using advanced technologies and innovative pedagogy. See **http://web.mit.edu/jbelcher/www/TEAL.pdf.**

R. Mark Bessette has been involved in the 3D animation of scientific concepts for many years, beginning with an animation of the "Spin Structure of Helium 3," as well as the electromagnetic animations featured here. Since 1995 he has been the Chairman of the New England 3D Studio Max Users Group. He is also proficient in the design of physics experiments for lecture demonstrations, and led the Physics Demonstration Group at MIT for more than 13 years.

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About the Columnist

Rosalee Wolfe obtained a masters of music from Indiana University before changing majors to earn a Ph.D. in computer science. She is a NASA Fellow, was SIGGRAPH Technical Slides Editor in 1993 and 1995-97 and edited *Seminal Graphics* for SIGGRAPH 98. She also authored the 1997 education slide set on mapping techniques, co-created the first B.S. in human-computer interaction (at DePaul University) and is currently Director of the Division of Graphics and Human-Computer Interaction in the School of Computer Science, Telecommunications and Information Systems at DePaul University.

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The History of VersaCAD

For this issue's column, I'm delighted to bring you some reminiscences courtesy of Tom Lazear, President of Archway Systems. Tom wrote one of the first (Gwen Bell of the Computer Museum cautioned me never to claim anything as the first!) PC-CAD (computer-aided design) systems. T-Square, for the Terak PC, was subsequently adapted as CADapple for the AppleIIE, and preceded AutoCAD (which was written for the IBM PC).

Before presenting Tom's article, I want to remind you of ongoing Pioneer opportunities. Pioneer membership requires at least 20 years in the field, which means that if you were involved in computer graphics by 1981, you're now eligible for membership! Let's hear from you.

— Carl Machover

Reminisce with Tom Lazear

After receiving my bachelor's degree in mechanical engineering from University of California Berkeley and while working on a master's degree at UCLA, I started as a Computer Engineer at Fluor Corp. in November 1959. What an amazing 41 years it has been since that time!

Fluor sent me to programming school at ElectroData (later bought out by Burroughs) in Pasadena my very first week on the job. How exciting that class was — to see how a machine could execute logic and math. It seemed to me that there was nothing that couldn't be done.

At the time, Fluor owned a Burroughs 205, a vacuum tube computer with a drum memory. The memory was divided into 4,000, 10-digit words. Each word consisted of 10 binary coded decimal digits. The computer even had a hardware floating point unit. It was an exciting computer with lights and moving tapes. It was about as powerful as an Apple II, but nearly filled a 20' x 30' room. It had paper tape input and paper tape or Flexowriter output. Programs were stored on magnetic tape. Programming was in machine language. I still remember 64-4000 meant: clear the computation register and add in the contents from memory location 4000.

My first assignment after the class was to write a program to automate the design of reinforced concrete foundations for vertical pressure vessels. I worked with a senior engineer by the name of Eli Czerniak who was an early visionary. He foresaw automating everything that Fluor engineers did.

The first project took about three months and went into production in early 1960. The program took input of wind pressure, seismic zone, concrete capacity, soil bearing capacity, etc., and then went through an iterative approach to come up with the exact size of the spread footing and the pedestal on which the vessel sat. Output included the dimensions to the nearest 1/16th of an inch, the reinforcing bar bending schedule with all the details and the design of the anchor bolts. The output information was printed on 8.5" x 11" vellum via a Flexowriter (electronic typewriter) and then taped to a standard drawing. So, the graphics were preprinted and the variable dimensions were output from the computer.

Next, we took another three months and wrote a similar program for the design of foundations for horizontal pressure vessels. Then it was foundations for heat exchangers. After that we started on the design of the pressure vessels themselves according to the ASME pressure vessel code through about 1963. All of these projects were documented in *Design News*, *Consulting Engineer* or the transactions of the ASCE.

In 1963, Fluor acquired an emulator for the IBM 7094, and an emulator for the SC4020 film recorder. The film recorder would take magnetic tape output from a computer and would follow the instructions to draw things on a little cathode ray tube (CRT). The CRT was exposed to 35mm film and the result was a photograph of the drawing. The photograph could be reproduced via a Xerox process called Copyflow to make a drawing on vellum. That opened up the possibility of automated drafting so we went right after the biggest drafting problem Fluor had, and that was to draw piping isometrics. Back then, Fluor produced about 10,000 such isometrics every year, requiring an army of designers. The project to automate the function took about a year. The application required the user to write down instructions of how the piping was to be routed. That information was keypunched onto cards and then run on the IBM 7094 emulator which produced the tape that went to the film recorder. The film was sent to the Copyflow and finally a drawing would appear. Pretty awkward, and it never quite made it as a production system. It wasn't until 10 years later that Fluor acquired an interactive piping system from M&S Computing (now Intergraph). That is when piping isometrics were done on the computer. At that point, I was CIO at Fluor and interested in lots of other things.

I think those first five years at Fluor were the most satisfying years of my 41 years in the field. Everything that we did was new and pioneering and it was extremely exciting to see the programs used in everyday work to increase the productivity and competitiveness of Fluor.

I left Fluor in 1979 to form VersaCAD Corp.

The "first" PC-CAD was our T-Square software written for the Terak personal computer. We shipped it in 1979 and it went into production in 1980. CADapple was based on T-Square and converted for the Apple II. It shipped in May 1982. AutoCAD demoed on IBM-PC at Comdex in November 1982. We had several competitors on the Apple II. The main one was Cascade Graphics, however, CADapple was the number one seller on the Apple II by 1983. At this time we also shipped VersaCAD for the IBM PC, E2000 through Carrier for the HP 9863, MarsCAD through Staedtler Mars and OmniDraft through AT&T. All of those products ran on an UCSD-P operating

system which was then implemented on the Terak, Apple II, HP 9863 and IBM PC.

Two years later and the UCSD-P operating system was dead, having been completely eclipsed by MS-DOS. AutoCAD was first out on MS-DOS. VersaCAD shipped on MS-DOS in 1984, about two years late. We were early on Macintosh in 1987 and may have been the number one on that platform around 1988. VersaCAD Mac won "Product of the Year" awards five times in its history.

The Lazears were no longer involved in VersaCAD from 1990 (when Mike and I left Computervision) until 1999 (when we retrieved the source code from Parametric Technology). We shipped VersaCAD 2000 for Windows in July of 2000. The 20-year life of a million lines of source code!

About the Guest Columnist

Tom Lazear is a graduate of the University of California, Berkeley and holds a master's degree in engineering from the University of California, Los Angeles and an MBA from the Sloan School of Management at MIT. Lazear founded VersaCAD Corporation in 1979 and operated it successfully until it was sold to Prime Computers, Inc. in 1987. Lazear has held executive management positions at Fluor-Daniel, Prime Computers, Inc. and Computervision.

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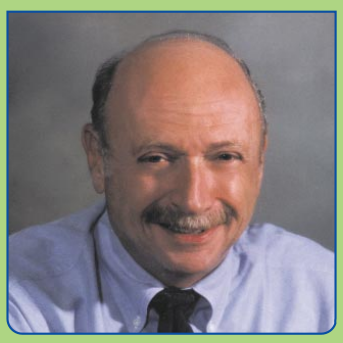
About the Columnist



Carl Machover is President of Machover Associates Corporation, a consultancy providing services to computer graphics users, suppliers and investors. He has been interested and involved in the field of CG for many years, written numerous articles and conducted a number of seminars. Machover is Editor of the *CAD/CAM Handbook* (McGraw Hill, 1996) and serves on the editorial board of several publications.

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Photo credit: Louis Fabian Bachrach

SIGGRAPH Public Policy Committee Activity Detailed

We start this column with the results of our third on-line opinion survey on public policy issues affecting computer graphics. Next we provide an introduction to and a copy of the definition paper for a prospective study of computer graphics research to be conducted by the National Research Council with partial funding from SIGGRAPH. This is followed by an update on our activities in proposing a course on public policy and a panel on digital rights management of intellectual property for SIGGRAPH 2001. Myles Losch provides an update on the issues related to the slow pace of adoption of Digital TV. Finally, we close with another set of comments from a reader.

— *Bob Ellis*

Third On-Line Survey

David Nelson
Bob Ellis
Laurie Reinhart

Our third on-line survey (see results below) asked very pointedly policy-oriented questions unlike the first two surveys. One result that stands out is that we only had 60 respondents even though the survey was available for several months. Data we collected indicated that 80 percent of the respondents who told us how they discovered the existence of the survey found it by accessing the SIGGRAPH website. Only one respondent accessed the survey by reading about it in the column, although the lateness of the print version of the August 2000 issue of *Computer Graphics* may have had some impact. This demonstrates the importance of siggraph.org and perhaps suggests that the website receive some priority in support.

Another interesting point is that 85 percent of the respondents who told us their country of residence said it was the United States. It's not clear what this means. Perhaps residents of other countries did not find the survey questions relevant to their interests. Perhaps SIGGRAPH is not reaching its non-US members.

It was also interesting that 1/3 of the respondents left their email addresses in the face of no stated privacy policy anywhere on siggraph.org. We wanted to refer to ACM's privacy statement but surprisingly, during the time the survey was available, ACM did not have privacy statement on its website that was anything but a draft.

Several respondents left comments. We have summarized those later in this report.

As with our other surveys, most of the responses were fairly middle of the road. It was not surprising that user access was listed as the most important policy issue facing computer graphics. We did not break this down as to user interface issues or access to computing and the Internet issues. Other highly ranked policy issues for computer graphics were free speech and intellectual property/copyright. We were surprised that digital copy protection, telecommunications and television/computer convergence did not rank higher. Perhaps this last issue should have been titled "availability of digital television."

Section Two indicates that respondents thought intellectual property rights statutes were about right, favoring neither the owner nor user. A possible confusion over this question was whether we were referring to pre- or post-DMCA, a law that greatly strengthened the rights of copyright holders.

In Section Three respondents indicated no enthusiasm for changing the regulatory status of either cable or DSL services, keeping them both as essentially unregulated services. Respondents did indicate a fairly strong interest in encouraging the availability of competitive services although without any choice of mechanisms, the question doesn't have a lot of meaning.

Section Four seems to indicate that respondents felt that the use of strong digital copy protection mechanisms would limit rather than hasten adoption of the technologies. A 1.98 result is one of the strongest responses we've seen in any of our surveys.

Section Five seems to indicate fairly limited support for public policy activities by ACM and SIGGRAPH, even educational efforts, and little support for funding it. We do not know how many respondents were members. Respondents were strongly opposed to funding policy activities by either increasing dues or shifting support from the more traditional services. In fact, the only acceptable form of funding was outside grants, but of course who wouldn't be in favor of such a funding source!

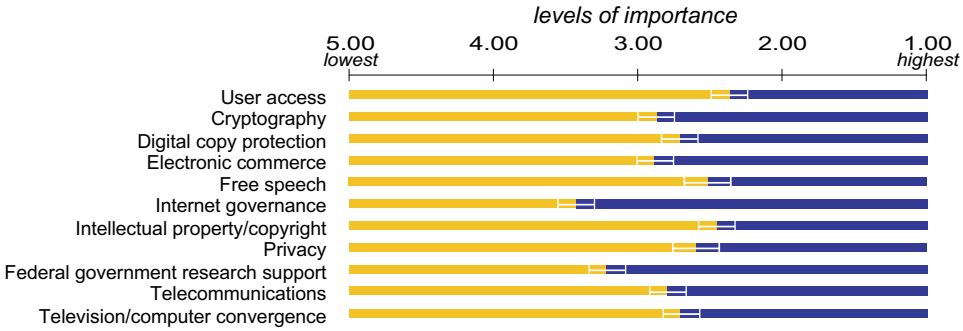
Several readers left comments for us. We have summarized and grouped them into similar categories. Those who included comments in their responses are concerned about copyright restrictions, interested in establishing working relationships with lawmakers, questioning where those issues can/should be discussed effectively and recommending educational efforts to inform the public, including lawmakers and their staff people. Respondents feel that providing education is essential, especially to the new and/or young users.

One pointed out that the press and the broadcast media are not effective as a forum for discussing the issues due to their acceptance of advertising from the affected organizations and that the new "media industries" do not have enough "economic muscle" to force the government to deal with the issues.

Several are concerned with copyright restrictions, and with minimizing these. They express this by saying "discourage copyright protections," "as little copyright restriction as possible" and "help protect research." One thinks that there needs to be a better or "common understanding of 'fair use'." Another says that "too many use restrictions will hold back development and progress." Note that these comments are not reinforced by the survey results (Section Two) which indicated no drastic changes were needed. However, the results of Section Four of the survey indicate that strong digital copy protection schemes will limit adoption of the technologies.

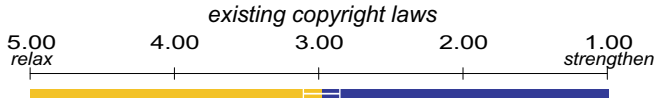
Public Policy Online Survey Results

Section One: Computer Graphics Public Policy Issues



Section Two: Intellectual Property

The availability of graphics, and other works, in digital format has resulted in a call from some parties for increased protection of such intellectual property. This has led to a number of proposed and implemented changes to intellectual property law such as through international treaties and the recently enacted (in the US) Digital Millennium Copyright Act (DMCA). Others have said that the traditional copyright statutes should apply to digital information with little change. (Rated from 1 (strengthen laws) to 5 (relax laws):



Section Three: Broadband Internet Services

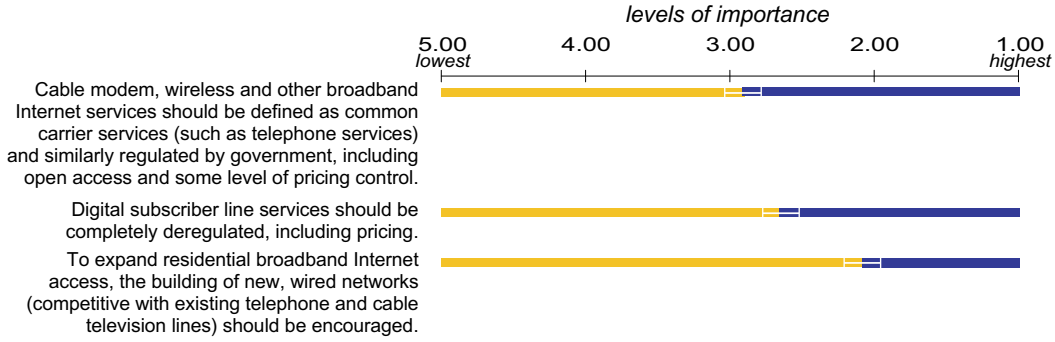


Figure 1: *Results of the Survey.*

None asked for more restrictions, but one pointed out that "the creators and thus the owners of the intellectual property need more protection . . . it is imperative that strong and consistent lines of communication are established with the policy makers in governments around the world."

The respondent probably was referring to the Digital Millennium Copyright Act (of 1998) when saying: "The Electronic Signature Act represents a radical increase in the power of copyright holders, giving them far greater ability both to restrict 'fair use' and reverse engineering and to criminalize minor individual copyright violations . . . (resulting in) the potential for prohibitions on reverse engineering to stifle research and development . . . As it is SIGGRAPH should directly address the issue of software makers using license terms that prevent traditionally legally-protected activities like reverse engineering and benchmarking."

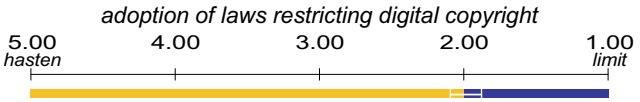
There were a couple of thoughtful comments about the survey, which of course is neither complete nor representative due to resource limitations, but is intended as a way of casually asking for opinions from those interested in answering. We will try to incorporate these comments into future versions.

In summary, the concern of the people leaving comments seems to be protection of the efforts of creators without restricting creativity or development, and how to inform the public (and the lawmakers, as part of that public) about the issues so that a perceived necessity for protection can result in effective, but not overly restrictive, legislation.

If any reader has comments on the results of the survey, how we could get more

Section Four: Digital Copy Protection

Digital technologies such as DVD are becoming available for the distribution of still and of moving images in digital format. Some copyright holders want to see strong restrictions on making copies of such materials built into the equipment. Others say these strong restrictions will limit interest of the public in such equipment. (Rated from 1 (limit adoption) to 5 (hasten adoption):



Section Five: ACM and SIGGRAPH Public Policy Activities

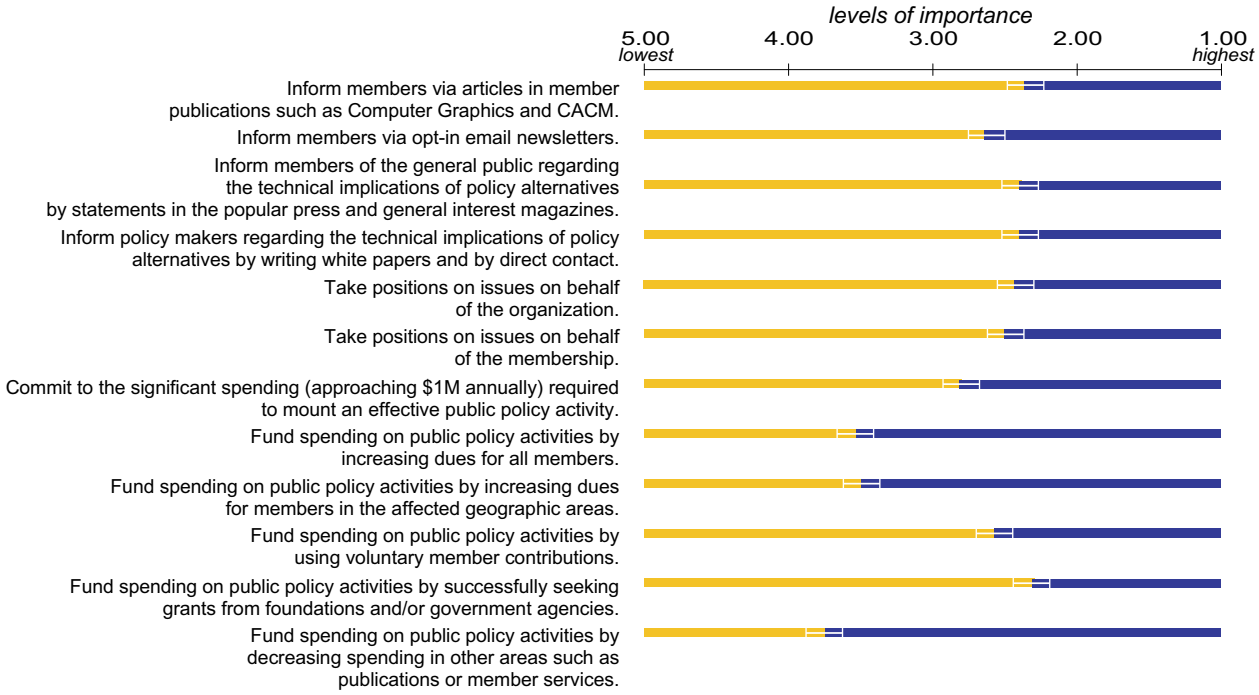


Figure 2: *Survey results, continued.*

respondents or ideas of how the survey could be improved, please contact Bob Ellis. One thought that occurred to us was to repeat the survey periodically (perhaps once a year) to monitor any changes and spot trends. To be meaningful the survey would have to stay fairly constant. Another possible change would be to give each respondent a fixed number of points per section and let them award as many or as few points to each issue to indicate its importance. That's a bit more like how the real world operates.

Definition of a Study of Computer Graphics Research

Bob Ellis

We have commented before (November 2000) on the prospective study of computer graphics research to be done by the Computer Science and Telecommunications Board (CSTB) of the National Research Council. This has been in the works for some time and seed funding of $50,000 was approved by the ACM SIGGRAPH Executive Committee, subject to final approval of the definition of the study by ACM SIGGRAPH Chair Judy Brown. In November 2000 the definition of the study (appended to the end of the column) that was written by Jerry Sheehan (NRC), Mike McGrath and myself was approved. The next step is to work with representatives on the CSTB to identify and bring on board a full complement of sponsors.

Update on SIGGRAPH Course and Panel Proposals

Bob Ellis

As I write this (November 2000), the proposal for a course on public policy issues of particular interest to computer graphics professionals has been submitted. Barbara Simons, ACM Past President and Co-Chair of USACM and myself with the two of us and Myles Losch as speakers have organized the course. Not yet identified are two participants who will join us in an informal panel at the end of the course to discuss how these issues differ from country to country. The proposed course is titled "The Impact of Public Policy on Computer Graphics." A description of the proposed course follows:

"As the proliferation of personal computers and access to the Internet has increased the public's use of and access to

computer graphics, researchers, developers and practitioners will find that policy issues and the law increasingly affect their professional activities. After an overview of computing and policy issues the course will explore, in depth, issues of particular relevance to computer graphics. Because computer graphics on the WWW is particularly sensitive to bandwidth, we will present the technical and policy issues associated with the deployment of broadband telecommunications. The use, creation and protection of intellectual property are particularly important to SIGGRAPH attendees and we will explore this issue including the use and abuse of digital copy protection mechanisms. The coming availability of digital and high definition video is of special importance to computer graphics; we will look at the technical and policy issues. SIGGRAPH's policy activities in generating support for computer graphics research will be described. Finally, the important topics of how policy is effected and affected will be discussed including the role of technical societies such as SIGGRAPH, ACM and IEEE as well as international issues."

I'm about to start work on the panel proposal that is due in January 2001. The proposed panel would be restricted to policy issues associated with the management of the digital rights to intellectual property.

Update on Digital Television's Rate of Adoption

Myles Losch

Digital television (DTV, including high definition) is an attractive outlet for computer-generated content, and has been broadcast in the U.S. for over two years (with other world regions following suit, though varying in some technical standards). But as previously noted in this space, disputes over broadcast signal formats and anti-copying rules for digital video have inhibited this new medium's growth.

U.S. broadcasters have been given new digital TV channels, and told to return their old analog frequencies to the government when 85 percent of viewers could receive digital video (but not before 2006). The retired TV spectrum is to be auctioned for other uses, such as new broadband mobile services. But with digital TV stalled in the market, FCC Chairman William Kennard feared that these newer services (and $70 billion in auction revenue) might not materialize as planned.

So Kennard has proposed to relax the 85 percent DTV conversion threshold, and further motivate broadcasters to halt analog TV transmissions by putting an escalating tax on their non-digital channels. Such ideas are, of course, opposed by broadcasters, who may well have enough political influence over Congress to block them.

But another of Kennard's initiatives may hold more promise: requiring new TV receivers to accept both digital and analog signal formats. A similar edict decades ago ensured that U.S. TVs could receive channels beyond the original 13, thus enabling the spread of then-new UHF TV services.

TV set makers object that Kennard's plan would raise costs by $300 per unit, a prohibitive amount for small-screen TVs. But if the requirement were phased-in by initially applying only to large-screen models, the financial impact would be softened. And the resulting economies of scale, combined with continuing technical advances in DTV electronics, would likely reduce per unit costs to levels affordable at smaller screen sizes.

Before long, such trends could well enable owners of older TVs to add outboard DTV tuner boxes for as little as $50, according to industry analysts. Of course, none of this will alone settle (e.g.) the copy protection debates, but Kennard's proposals, along with other developments (such as more affordable large-screen HDTV displays) may at last open a path toward broad acceptance for a promising new visual medium. Considering that HDTV development in Japan dates from the 1970s, such success would be very welcome.

Another Reader Comments

Bob Ellis

In the August 2000 column I included some comments from a reader and my responses. Again this month we are fortunate to be able to include a summary of an email correspondence I've had with reader Robert Wilkens that started from the comments made by Myles Losch in the August 2000 column. Myles had commented on the idea that software was a form of speech and hence protected from government control by the U.S. Constitution. Myles continued that the provisions of the Digital Millennium Copyright Act (DMCA), which have been used to prohibit the distribution of software to decrypt DVD material, could therefore be considered unconstitutional. This argument has also been applied to the control by the U.S. government of export distribution of software that provides strong encryption. The discussion continued with Wilkens' thoughts on UCITA (discussed in the November 2000 column). Our discussion ended with some philosophical thoughts of the role of organizations such as ACM and SIGGRAPH in discussion and advocacy in policy issues. Wilkens has reviewed the summary and he concurs that it is a fair representation of our discussion.

Wilkens' initial query was that if software could be considered a form of speech and hence protected by the United States Constitution from government control, perhaps a description of a hardware design could also be considered speech and enjoy the same protection. I personally have a less strong opinion than Myles that software is a form of speech because its primary purpose (except for pedagogical purposes) is not discourse, but effecting some action. This point applies only in situations where laws are passed because the U.S. Constitution only prohibits government control and most software is distributed via licensing agreements that can basically implement all types of restrictions. The DMCA is an excellent example because it is a law that specifically makes illegal certain forms of technology, such as the DeCSS software and hardware, which could be used to defeat copy protection schemes.

This led to a discussion of UCITA which was featured in the November 2000 column which was then available on-line. UCITA attempts to legalize the shrink wrap licenses which have become the popular way to control what a customer can do with the software which is licensed. A discussion of the actions a software vendor could take beyond withdrawing a licensee's right to use the software ensued. I pointed out that all sorts of actions could be brought under the terms of the license agreement including the collection of damages, legal harassment, etc.

Wilkens raised a number of concerns about then ACM President Barbara Simons' stand against UCITA, including the concern that software is generally not free from defects and that trying to enforce defect free software by legal action is doomed to failure. Wilkens was further concerned that Simons' position was attempting to control the actions of a free market where a prospective customer is free not to license software if there is concern about the terms and conditions of the license agreement or the software is excessively buggy. The common answer to this is that we don't really have a free market in certain software due to the dominance of some companies. My fundamental concern about this is that opponents of UCITA are attempting to bring to licensing agreements those same customer protections that are available to purchasers of products. This is an important issue because I can see the day when consumers eventually can no longer buy books, CDs, etc., but merely purchase a license to use the products. Perhaps we will even someday see

the situation where you can no longer purchase or lease an automobile, but can only license the right to use it!

I then asked Wilkens how he felt about the ACM President taking this action, because he disagreed with several of the positions. His reply was that he was generally comfortable with such actions because they should be the result of careful analysis that perhaps most ACM members did not have the time or knowledge to make, but was concerned that some of the points needed more consideration.

Our final point of discussion involved how you decide just who and what the spokesperson of a member organization such as ACM is representing when they make statements based on their position in that organization. Wilkens also raised the issue of whether using an acm.org email forwarding address implied some sort of relationship beyond just membership in ACM. These are a couple of interesting points given that ACM is primarily known for its function of dissemination of technical knowledge and not acting as an advocacy organization or email forwarder. There is no clear resolution of these issues at this time.

I encourage other readers who would like to discuss any aspects of this column, or SIGGRAPH's public policy activities, to contact me.

About the Columnist

Bob Ellis is Chair of SIGGRAPH's Public Policy Committee. When last gainfully employed (1993), he was Sun Microsystems' representative on the Computer Systems Policy Project's (CSPP) Technology Committee and also co-managed Sun's external research program. Before that, Ellis held computer graphics software development and management positions with Sun, GE-Calma, Atari, Boeing and Washington University (St. Louis).

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Appendix
Research Challenges in Computer Graphics

Computer Science and Telecommunications Board
National Research Council

Scope

This project will identify areas in which additional research is needed to make computer graphics a more capable medium for supporting a growing body of work in areas such as health care, entertainment, product design and manufacturing, scientific visualization, and education. It will bring together computer graphics researchers with users from a range of application areas to derive a set of research needs and will attempt to identify key remaining problems to be solved in the field. In order to ensure broad input from the computer graphics community and user communities, the project will solicit participation through workshops, white papers and briefings. Indeed this process has already started: the final form of this document is the result of a review by key members of the computer graphics research community.

Context

Policy Context

Computer graphics is becoming a ubiquitous tool for interacting with information technologies. Although many feel that entertainment uses in video games, feature-length films, and Web pages dominate, computer graphics is increasingly being used to help doctors plan difficult surgeries, to enable engineers to create virtual mock-ups of large engineering projects, to help scientists interpret the results of scientific simulations, to help educators illustrate key concepts for their students, and to help monitor natural resources and environmental conditions. Graphics provides an accessible medium for users to interact with computing and communications systems and interpret data.

As the capabilities of computing and communications technologies continue to increase, improvements in generating, manipulating and displaying computer graphic images will continue to grow, enabling them to be used in an ever-broader range of applications. Advances in this field will play an important role in the diffusion of information technology throughout society.

Despite the more widespread use of computers and the Internet by the general public, certain groups of citizens are underrepresented, creating what has been referred to as a "digital divide". There are many dimensions to the Digital Divide, but computer graphics has the potential to help many more people use computers and the Internet effectively by creating more capable users and modes of accessing information (SIGGRAPH 1997).

Ensuring that computer graphics capabilities will keep pace with advances in hardware and software will require continued research. As in the past, industry, academia, and government will have important roles to play in supporting this work. Industry supports considerable research and development in graphics, especially in support of entertainment, graphics production, and computer-aided design. But industry is generally not well equipped to support fundamental research that will develop broad graphics capabilities that may not mature for a decade or more. Industry's goals, traditions, and mechanisms for selecting R&D projects tend to select research that is more closely tied to immediate needs. Ensuring continued effort in fundamental graphics research will therefore require continued federal support of university research.

Federal funding has historically played a significant role in advancing computer graphics research. The Department of Defense provided critical, early support for university research in the basic techniques for modeling solid objects, shading, and virtual reality that are used today (CSTB 1995). Other federal agencies, such as the Department of Energy, National Aeronautics and Space Administration, and the National Institutes of Health have supported projects to extend computer graphics capabilities into particular mission areas, such as weapons simulation, scientific visualization, biomedical imaging, manufacturing design and analysis, and the global information system. The National Science Foundation has also funded computer graphics and in 1991 established a Science and Technology Center for Computer Graphics.

To date, most federal support for computer graphics has been provided on an ad hoc basis, with little long-term program support or planning. Perhaps in part because computer graphics is frequently not seen as a real branch of computing research, each agency has tended to sponsor work in its own area of interest. As computer graphics expands into a widening range of application areas, such fragmentation of support is likely to proliferate, leading to the possibility that the potential benefits of computer graphics will not be fully realized. Indeed, a 1997 review of the National Science Foundation's Science and Technology Center in Computer Graphics (NSF 1997) recommended that the NSF work with the National Research Council to identify the broader scope of research that remains to be done in computer graphics and to communicate this information to policy makers, but this recommendation has yet to be implemented. The surge in information technology applications since that time makes the need even more compelling today.

Technical Context

Research in computer graphics encompasses a broad range of topics, including modeling, rendering, interactive techniques, and graphics hardware. Modeling consists of techniques for creating computer-based representations of objects and scenes to be depicted. Rendering is the process of producing images for display on a monitor or printer.

Interactive techniques include tools and physical devices that permit the development of applications that allow human users to interact with graphical representations in real time. Graphics hardware consists of specialized and general-purpose hardware for creating and displaying computer graphics. It ranges from high-end workstations and desktop PCs augmented with graphics accelerator cards for carrying out graphics calculations to specialized user interfaces, such as helmet mounted displays for virtual reality or augmented reality experiences.

Advances in these core areas will be needed to enable faster, simpler development of realistic and complex computer graphics images such as those found in increasing abundance in the growing collection of digital libraries. Research will also be needed to help tailor these fundamental advances to particular application areas, whether healthcare, entertainment, or scientific research. Such efforts will require collaboration between computer science researchers and those in other disciplines such as art, engineering, and medicine. We have specifically not defined the scope of computer graphics in detail in order to allow study members great latitude in their work.

In addition, future research in computer graphics will respond to new opportunities created by the increasing capabilities of computing and communications systems. For example, work on the virtual reality markup language (VRML) is enabling the creation of three-dimensional images that can be incorporated into pages and shared over the World Wide Web. Future work could extend these principles to allow large scale virtual environments to be shared via the Internet. Image-based rendering techniques, which incorporate real-world or synthetic imagery into 3D databases, will provide more complex and realistic computer graphics and may transform rendering, modeling, and graphics hardware. Virtual reality and augmented reality systems will be experienced through all our senses, including sight, sound, and motion or touch.

Similarly, work on automatic data simplification and database retargeting will produce the capability to take models created at a high level of complexity and deploy them at a lower level of complexity commensurate with available computing resources. Hence, a model created on a high-end workstation can be deployed on a notebook computer. Such work is particularly important with the advent of the World Wide Web where bandwidth is limited and complex models might overwhelm the infrastructure. While itself a research issue, development of the Next Generation Internet promises to allow increased collaboration among researchers in different disciplines and countries, many of whom will share graphical images and simulations.

Plan of Action

Statement of Task

A group of experts in computer graphics and its varied applications will identify compelling research needs in the field, highlighting those that promise significant returns due to the scope, scale, or breadth of their potential applications. The group will examine research needs in both core areas of computer graphics (such as modeling and rendering) and in application areas such as defense, entertainment, medicine, manufacturing, and scientific visualization to identify those research areas that can be leveraged broadly. The results will inform research-related activities in government, universities, and industry and provide guidance on the roles each entity can play in achieving the research objectives. We do not mean to imply that such a study entirely replaces the traditional bottoms up proposal driven method of defining research areas.

Responsible Body

CSTB will assemble a study committee of 12-15 members to conduct this study. Membership will be drawn from industry and academia, and will include recognized experts with strong knowledge of core computer graphics disciplines and a diverse set of application areas. It will attempt to combine the perspectives of computer graphics researchers, artists, scientists, engineers, and others who use graphics systems to create different forms of imagery or content. Suggestions for committee membership will be solicited from CSTB members and staff, other relevant groups within the National Academies, the computer graphics research community, potential sponsors, and from recognized leaders in interesting application areas.

Although such a group cannot possibly represent all of computer graphics research and applications, committee members would attempt to solicit a wide range of input to help them identify the most pressing technical needs and biggest research challenges.

Preliminary Work Plan

Based on consultations among Board members, CSTB committee members, and the sponsors, CSTB will seek nominees for the study committee and suggestions for topics to address. The study committee will meet approximately five times over the course of the study to plan its work, meet with the sponsors and other relevant parties, prepare a summary report, and respond to review comments.

A workshop or series of smaller data-gathering sessions will be convened to solicit input on research needs from diverse communities of users. Should timing allow, a meeting or small workshop could be held in conjunction with the annual SIGGRAPH conference to facilitate broad participation of the computer graphics community. Additional efforts will be made to solicit input through white papers, briefings to the committee, and the Internet.

The committee would consider such questions as:

(1) How will advances in computer graphics enable significant

breakthroughs in fields such as entertainment, health care, engineering design, manufacturing, and scientific research?

(2) What technical advances and research are required to enable computer graphics to serve a growing range of needs?

(3) What unsolved problems remain within the field of computer graphics and are they being adequately addressed?

(4) What new capabilities do advanced computing and communications provide that may drive computer graphics applications?

(5) How can the most promising research issues be best addressed?

(6) What are the complementary roles of industry, government, and universities in meeting future challenges?

(7) What are the benefits of research in different areas of computer graphics?

To the extent possible, the committee will attempt to identify research topics of enduring interest and value and those with broad applicability.

Product and Dissemination Plan

The principal product of this project will be a report summarizing the findings of the study committee and articulating its recommendations. The report will be subject to NRC review procedures to ensure its accuracy, balance, and rigor. Dissemination will be targeted toward government policy makers, members of the computer graphics research community, and key users of computer graphics systems in industry, academia, and government. The report will be made available on the National Academy of Sciences World Wide Web server, as well as in paper form. Additional efforts will be made to disseminate the report's conclusions through briefings to interested parties in government, academia, and industry; through participation in high-level government and industry conferences; and by publication of summary articles in relevant journals, as appropriate. Funds for dissemination are included in the budget. In the final analysis, the success of this project will be determined by whether the daunting goals of increased awareness and funding for important elements of computer graphics research happens.

References

1. CSTB. "Evolving the High Performance Computing and Communications Initiative to Support the Nation's Information Infrastructure," National Academy Press, Washington, D.C., 1995.
2. NSF. Review of the Science and Technology Center for Computer Graphics, National Science Foundation, Arlington, VA, 1997.
3. SIGGRAPH. "Computer Graphics, Visualization, Imaging and the GII (Internet)", SIGGRAPH White Paper #1, Gershon, et al, May 1997 (**http://www.siggraph.org/pub-policy/**).

ACM SIGGRAPH 2001 Elections

This year ACM SIGGRAPH members will elect the ACM SIGGRAPH officers for a term beginning July 1, 2001. The Nominating Committee sought colleagues whom we believe can successfully lead ACM SIGGRAPH in the changing and exciting world of computer graphics and interactive techniques. We are pleased to present you with a group of persons with experience within ACM SIGGRAPH and with solid achievements in industry, in academia and as volunteers.

The Nominating Committee has selected two nominees for each position. The statements from the candidates appear in this issue of *Computer Graphics* and will be in the ballot materials. Other names may be added to the ballot by the petition process described below. Any questions about nominations, petitions or elections can be directed to Steve Cunningham, **cunningham@siggraph.org**.

Ballots, including copies of the candidate statements, will be mailed to ACM SIGGRAPH members in a first class mailing in the spring of 2001, and we hope you will make the effort to read the candidates' statements and vote carefully. Ballots are NOT included in this issue of *Computer Graphics*.

The Nominating Committee
Steve Cunningham, Chair
Alain Chesnais
Nan Schaller

Slate for 2001 ACM SIGGRAPH Elections

Chair

David B. Arnold
University of East Anglia, Norwich, UK

Judith R. Brown
Author and consultant, Iowa City, IA USA

Vice Chair

Alan Chalmers
University of Bristol, Bristol, UK

Barb Helfer
The Ohio State University, Columbus, OH, USA

Treasurer

Omar Ahmad,
Logictier, San Mateo, CA, USA

Garry M. Paxinos
Metro Link, Inc., Ft. Lauderdale, FL, USA

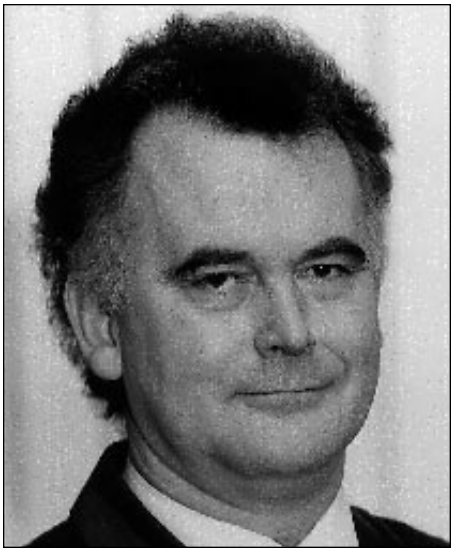
Call for Petition Candidates

ACM and SIGGRAPH bylaws allow candidates to be added to the slate of nominees upon receipt of a petition signed by 1 percent of the voting members of ACM SIGGRAPH. In 2001, a petition candidate for any of the offices being contested must submit 65 signatures. Each signature must be accompanied by member name, address and membership number. Notice of intent to submit a petition should be sent to the address below by **January 31, 2001**, and completed petition should be sent to the same address and must be received by **March 2, 2001**.

Pat Ryan
ACM Headquarters
One Astor Plaza, 17th floor
1515 Broadway
New York, NY 10036 USA

A copy of the completed petition must also be sent to the address below and received by **March 2, 2001**.

Steve Cunningham
ACM SIGGRAPH Past Chair
Computer Science Department
California State University Stanislaus
801 W. Monte Vista Avenue
Turlock, CA 95382 USA



David B. Arnold

Candidate for Chair

ACM SIGGRAPH has many facets. Most importantly, it represents the biggest and most intense annual event in computer graphics and interactive techniques, bringing together a wide-ranging group of people in arts, entertainment, special effects and animation. But ACM SIGGRAPH is more than an annual event; it is a community (or rather the sum of many communities), an organisation and a part of the larger community that is ACM.

ACM itself continues to undergo fundamental change from a traditional membership society to an electronic community. SIGGRAPH, as the biggest SIG in the association, has a unique role to play in ensuring that the services ACM provides to the SIGs, and to the members of SIGs, are imaginative, appropriate and value for the money. SIGGRAPH is successful, but we cannot be complacent in this success. There is still a lot to do.

The development of the web as a worldwide communications infrastructure brings the opportunity to build different subcommunities within the overall structure. It has been my pleasure as Chairman of ACM Membership Activities Board to see and support the growth in local chapters of SIGGRAPH and in student chapters of ACM. Both of these are geographically focused. As a discipline, computer graphics has grown to the point where subsets of technical interests provide different foci. As people get bombarded by ever more information, the objective must be to give people a trusted and focused way of sharing their interests, both in physical meetings and in finding support and information. Small workshops, increasingly in cooperation between SIGGRAPH and Eurographics, provide events focused on particular technical interests. I would seek further development of mechanisms for technically focused subgroups within SIGGRAPH.

SIGGRAPH has supported the development of ACM's outstanding Digital Library, soon to contain everything ACM has published with powerful mechanisms for delivery of material worldwide. I would like to see SIGGRAPH develop its use of the ACM infrastructure and profiles to personalise the SIGGRAPH services delivered to graphics professionals, wherever they live. For example SIGGRAPH is well placed to set the standard for web-based access to tutorial materials for CPD. This would provide a vital service to the global community and spread the impact of the annual event throughout the year. There are of course difficulties (IPR, copyright and technical) in enabling this to happen, but these should be seen as challenges to meet rather than insuperable barriers.

Globalisation requires us to reinterpret the role of professional societies; to distinguish what are core ethical and professional values, and what are local cultural convention. We must preserve and strengthen the core values in multi-cultural environments. Areas such as education, cooperation with local societies and conduct in business will be affected. Again SIGGRAPH is well placed to identify key issues of national and international policy within a complex but focused technical domain.

In summary, if elected, I would work to:

- Strengthen the interaction and cooperation between ACM SIGGRAPH and ACM centrally;
- Improve local delivery of services to members (within geographic and technical groupings), and preserve quality of existing activities;
- Encourage a cooperative globalisation policy, recognising multi-cultural diversity;
- Foster the next generation through enhanced student activities.

Education

1972 - B.A., Engineering and Computing Science, Cambridge University

1976 - M.A., Engineering and Computing Science, Cambridge University

1978 - Ph.D., Computer Modeling in Architecture, Cambridge University

Professional Experience

I was a Research Assistant at Cambridge University before moving to the Royal Naval Engineering College, Plymouth. I then moved to University of East Anglia, Norwich, England in 1978, where I was promoted to full professor in 1989. I was elected Dean of Information Systems (1986-92) and headed international liaison and undergraduate admissions for the University (1993-97).

Activities

In 1978, I joined ACM, the British Computer Society and SIGGRAPH. Since 1981, I have also been a member of Eurographics (EG) and was elected fellow of EG and BCS in 1989. I have held many positions in EG, including Chief Editor of Computer Graphics Forum (1984-90) and Chair (1993-95). I have attempted to promote constructive cooperation between SIGGRAPH and EG. Within SIGGRAPH, I have participated in various roles in the annual event, was on the History subcommittee for SIGGRAPH 98 and have also been a member of the Pioneers since 1995. I have been involved in organising about 30 conferences and workshops, e.g. Eurographics '92 in Cambridge (Co-chair).

I have considerable experience within ACM centrally. I was the Representative of the International Region to Council (1997-2000), am now member at large on Council and the current Chairman of the ACM Membership and Activities Board. I am on the committee for ACM1.

In policy related matters, I represent the UK Professors & Heads of CS (CPHC) on the UK all-party Parliamentary Information Technology Committee (PITCOM). I currently serve on the PITCOM Council and was on the Council of European Professional Informatics Societies.

Research Interests

Tools for the efficient and economic construction and display of virtual environments and for incorporation of intelligent avatars in entertainment and edutainment for virtual heritage. I am principal investigator for over US$1M in funded research projects.

Judith R. Brown

Candidate for Chair

I attended my first SIGGRAPH conference in 1979 and was hooked by both computer graphics and the world's most exciting professional society. As a computer graphics consultant and educator, I was delighted at the opportunity to co-found the Education Committee in 1983 to provide networking and information for educators and students worldwide.

Since then, I have been involved with most areas of ACM SIGGRAPH. I have served on committees at all levels, doing non-glamorous tasks as well as leadership tasks, and I have been instrumental in initiatives such as the founding of the Education Committee, the first Russian Graphicon conference, the celebration of SIGGRAPH's 30th year, and collaborations with other societies. I have served on the EC in four positions (Vice-Chair, Chair, Past Chair, Director for Education), and I contributed to conferences as panels and courses speaker and a member of the SIGGRAPH 91 Educators committee. Volunteers are the soul of SIGGRAPH, and I have more than 25 years experience working with and chairing a wide range of volunteer groups, from local charities and arts support groups to national and international professional organizations.

I have been a frequently invited speaker on topics such as education, visualization and collaboration, with a special interest in the areas where computer graphics is the tool that bridges education and research or enables interdisciplinary and international communication. I have recently retired from managing the advanced research computing and visualization services at The University of Iowa, and I am now taking art classes.

Current issues facing ACM, ACM SIGGRAPH and the field of computer graphics are:

- The expanded role of the SIGs in ACM involves the Chair more in SIG governance issues. I have served on several ACM committees, including Nominations, SIG Board and three task forces.
- We need to determine the best way to individually serve our diverse membership in today's society, using today's technologies.
- We must ensure that the conference maintains its excitement and continues to be healthy, both technically and financially, and at the same time, ensure that all members are being served well. My interdisciplinary background has allowed me to work productively with scientists, artists and engineers. I have also worked collaboratively with other international societies, resulting in my election as a Eurographics Fellow and appointment as Honorable Member of the Academic Committee of the Chinese State Key Lab for CAD and Computer Graphics.
- While computer graphics has become a commodity, there are still significant unsolved problems. We must educate governments and funding agencies on the value of computer graphics and the needs for computer graphics research.

In my current term as ACM SIGGRAPH Chair, I have concentrated on strategic planning as a vital, ongoing process for the Executive Committee. We have made excellent progress in the first year and a half, and another term would complete and solidify this endeavor.

Education

1964 - M.S., Mathematics, University of Iowa
1962 - B.A., Mathematics and Education, University of Iowa
1961 - Studied at l'Alliance Française, Paris, France

Professional Experience

Led development of visualization and other research technology; consulted on computer graphics, visualization and computer aids for persons with disabilities; taught mathematics and computer graphics.

Served on committees for more than 20 international conferences on computer graphics, education, virtual reality or scientific visualization in the U.S., Europe, Mexico and China, since 1991.

Editorial Board, *Computer Graphics Forum*, 1992-95.

ACM Activities

1985 – ACM task force on careers
1992-95 – SIG Board
1993-94 – SIG Governance Task Force Chair
1996-98 – Nominations Committee
1999–present – SIG Governing Board
2000 – SIG Allocations Task Force

ACM SIGGRAPH Activities

1985-89 – Education Committee Vice Chair
1989-92 – ACM SIGGRAPH Vice Chair
1990-91 – SIGGRAPH 91 Educators Program Committee
1992-93, 1999-present – ACM SIGGRAPH Chair
1993-95 – Past Chair, Nominating Committee Chair
1995-98 – Special Projects Committee Chair, Public Policy Committee Co-Chair
1998-99 – ACM SIGGRAPH 30th Celebration Chair

Selected Publications

Co-author/editor of four books: *Visualization: Using Computer Graphics to Explore Data and Present Information*, 1995; *Computer Graphics Using Object Oriented Programming*, 1992; *Programming the User Interface: Principles and Examples* and *Computer Graphics Careers Handbook*, 1989.

"Enabling Educational Collaboration – a New Shared Reality," *Computers & Graphics*, April 2000.

"Human-Centered Computing, Online Communities and Virtual Environments," J.R. Brown et al, *IEEE Computer Graphics and Applications*, Vol. 19, No 6; and *Computer Graphics*, August, 1999.

Selected Presentations

"How to Be Involved with ACM SIGGRAPH," SIGraDi 2000, Rio de Janeiro, and University of Sao Paulo, October 2000

Panelist, "The Future in Computer Graphics Education," SIGGRAPH 99 Educators Program, Eurographics 99

SIGGRAPH 98 international video conference, "Computer Graphics Pioneers Assess Computer Graphics"

"Education and Profession" in "Computer Graphics in the Next 50 Years of Computing," Fraunhofer Institut, Germany, 1997

Fundamentals Seminar, SIGGRAPH 94, 93, 92

SIGGRAPH 89 Seminar, "Careers in Computer Graphics"

SIGGRAPH 88 Course Chair, "Collaboration in Computer Graphics Education"

SIGGRAPH 87 Workshop Chair, "Computer Graphics Education: An Interdisciplinary Approach"

Invited talks on visualization in U.S., Mexico, Europe, Israel and China

Awards

EUROGRAPHICS Fellow

Honorable member of the Academic Committee of P.R. China State Key Lab of CAD & CG

Principal Investigator/co-PI on eight NSF or NASA grants for visualization, virtual reality and education

Alan Chalmers

Candidate for Vice Chair

The ACM SIGGRAPH conference is the world's foremost computer graphics conference, providing a unique annual forum for the exchange of ideas and experiences to a wide, diverse audience. ACM SIGGRAPH plays a key role in maintaining the enthusiasm I feel for computer graphics and I would like to continue to channel this enthusiasm to the benefit of the members of our association.

Unfortunately, the conference only lasts for one exciting week a year. It falls to a multitude of smaller conferences and special projects to facilitate the flow of information throughout the rest of the year. It is one of the principal roles of the Vice Chair of ACM SIGGRAPH to promote just such activity, and it is here I believe I can continue to make a significant contribution. As can be seen in my biographical information, I have helped organise a number of projects and conferences and I will be able to apply the substantial experience I have acquired to provide coordinated support from ACM SIGGRAPH to assist and encourage organisers of future such events.

The annual SIGGRAPH conference provides an outstanding opportunity for all those with diverse interests in computer graphics to come together. Participants are able to meet, exchange views and gain new insights. This diversity I believe is one of the significant strengths of ACM SIGGRAPH. My own research is based on a multidisciplinary approach and includes input from artists, psychologists, archaeologists as well as computer scientists. As Vice Chair, I would strive to increase multidisciplinary interaction throughout the year.

ACM SIGGRAPH is an international organisation. Living and working in the United Kingdom I believe, as Vice Chair, I am in a good position to work closely with others in the organization assist in increasing international membership and attendance at ACM SIGGRAPH activities.

In summary, I intend to further expand the role of small conferences and special projects, to develop the multidisciplinary nature that is such a strength of ACM SIGGRAPH and to assist in providing an increasingly international profile to ACM SIGGRAPH in the years ahead.

Education

1991 - Ph.D., University of Bristol, UK

1984 - M.Sc., Computer Science, Rhodes University, SA

1981 - B.Sc., Computer Science, Mathematics, University of Natal, SA

Interests

Realistic graphics, visual perception, parallel processing, presence in virtual environments, visualisation of archaeological site reconstructions, education.

Professional Experience

Present position - Senior Lecturer

1989-present - Department of Computer Science, University of Bristol, UK

1988 - Lecturer, University of Natal, SA

1986-87 - Lecturer, University of the Witwatersrand, SA

ACM or ACM SIGGRAPH Activities

1999-present - Vice Chair of ACM SIGGRAPH

2000-present - ACM SIGGRAPH Symposia coordinator

Member of ACM and ACM SIGGRAPH for a number of years, participated at numerous ACM supported events. Presented two tutorials (Image Quality Metrics and Practical Parallel Processing for Realistic Rendering) and a Panel (Understanding the Past: Graphics & Archaeology) at SIGGRAPH 2000 and a tutorial on Parallel and Distributed Photo-Realistic Graphics at SIGGRAPH 98.

Awards/Achievements

Published more than 70 papers in journals and international conferences, holder of research grants in excess of 800K pounds and presented numerous invited talks.

Guest editor, with Prof. F. W. Jansen, of the journal *Parallel Computing* for its special edition on Parallel Graphics & Visualisation.

Chair of the Eurographics Workshop series on Parallel Graphics & Visualisation, Paper chair for Eurographics 2001, Co-chair of a number of conferences including the ACM SIGGRAPH-Eurographics Campfire on Graphics & Archaeology, May 2000, IEEE Parallel Visualisation & Graphics Symposium, October 1999, and Archaeological Sciences'99, September 1999.

Regular reviewer for journals, international conferences and research grant proposals.

Barb Helfer

Candidate for Vice Chair

Objectives/Priorities

Diversity and technical expertise makes SIGGRAPH the premiere computer graphics community in the world. Our strength is our membership. It means something for one of our members to have a paper, a course, a piece accepted into the art show or computer animation festival. But SIGGRAPH isn't just the conference. The organization, SIGGRAPH, has a year-round function to support the needs of its members through local chapters, through liaisons with other conferences and communities, to enhance and expand the knowledge base of educators and students and to further our discipline with first-rate publications and events.

The charge of the Vice Chair is the dissemination of computer graphics and the interactive techniques associated with the field by further strengthening of the alliances developed with Eurographics and Japan's Multimedia Content Association (MMCA) as well as establishing new partnerships. The responsibility for developing small conferences with narrow focus and the development and support of special projects also falls within the scope of this position.

While I see my role in the continuation of support of activities and programs already in existence, I feel there is a need to expand this sphere. I have come into the field of computer graphics through a divergent path, so I believe SIGGRAPH should take an active and leadership position in the convergence of television and digital content. As the television industry gears up to broadcast digital, broadcasters have decided it is more profitable to telecast four to six streams of low res programming and relegate the high def programming to prime time. The need for programming and understanding the world of digital provides the SIGGRAPH community with both an opportunity and a dilemma. The opportunity exists for content development both from an educational and entertainment side as well as job placement for individuals in our community. It also increases the dilemma of finding qualified and talented individuals to staff positions already existing.

The growing demand for trained computer graphics individuals increases the need for stronger local chapters, the development of a program for providing training from our skilled professionals year round and an aggressive approach in supporting the educators teaching students from all levels of academia. I feel there is a need to turn our resources and skills back onto ourselves to deliver training, materials and resources to our own members. The volunteering I have done with courses and now again with Pathfinders has shown me the enthusiasm the presenters have for teaching the material, and the great need voiced from attendees regarding subsequent courses and presentations which will continually augment their learning.

There are models in place for developing and maintaining of strong local units. Old Dominion University has a wonderful model of providing distance education worldwide, which we can learn from. SIGGRAPH's Education Committee is developing curriculum standards for the teaching of computer graphics. All this information needs to be gathered and distributed for our energetic community to embrace. As part of a working executive team, I will work with my colleagues to move in a positive direction for our members.

One of my strengths is my ability to help people get to where they want to go. Seeing the strengths of what has been developed in the past and pressing the boundaries to come, we, as a community, will continue to define new ideas and approaches. By teaming up individuals for collaborative projects and embracing and understanding the differences (and similarities) between art and science, SIGGRAPH will continue to lead our evolving digital world.

Education

1982 - Associate Degree in Broadcast Electronics, Spartanburg Technical College
1979 - Master of Mass Communication, University of South Carolina
1977 - B. A., Journalism-Broadcasting, University of South Carolina

Interests

Digital video, copyright and fair use, compositing, motion capture, web-based applications and multimedia as an educational tool, education, compression, scientific visualization and team and project management

Professional Experience

May 2000-present - Assisting in the development of the Motion Capture Research Lab, Advanced Computing Center for the Arts and Design (ACCAD), College of the Arts (COTA), The Ohio State University (OSU).
September 1994-May 2000 - Director of Emerging Technologies Studio, ACCAD, COTA, OSU.
August 1988-July 1997 - Graphics Resource Manager, The Ohio Supercomputer Center.
January 1988-August 1989 - Chief Engineer, Act1 Videotape Production, Inc.
1986-88 - Field and Design Engineer, Patlin Electronics, Inc.
1984-86 - Operations and Maintenance Engineer, WCMH-TV, Columbus, Ohio.
1979-84 - Operations and Maintenance Engineer, WSPA-TV, Spartanburg, SC.

ACM or SIGGRAPH Activities

Chair, Pathfinders - SIGGRAPH 2001
Course Reviewer - SIGGRAPH 2001
Subcommittee Member, Courses - SIGGRAPH 2000
Chair, Courses - SIGGRAPH 1999
Subcommittee Member, Pathfinders - SIGGRAPH 1999
Subcommittee Member, Courses - SIGGRAPH 1998
Subcommittee Member, Pathfinders - SIGGRAPH 1998
Chair, Courses - SIGGRAPH 1997
Subcommittee Member, Courses - SIGGRAPH 1996
Subcommittee Member, Courses - SIGGRAPH 1995
Course Reviewer - SIGGRAPH 1994

Omar Ahmad

Candidate for Treasurer

I am honored to offer my candidacy for SIGGRAPH Treasurer. I hope to bring new ideas and entrepreneurial fuel to SIGGRAPH as we move forward in a world where computer graphics and interactive techniques are the cornerstone for better learning and understanding.

My 12 years of SIGGRAPH involvement started as an attendee of SIGGRAPH 88 in Atlanta. The people I met and the things I saw greatly affected my career for the better.

After Atlanta, I spearheaded the effort to establish a local group (now called SIGGRAPH Professional Chapters) in Gainesville, Florida. I was pleased to serve as the Chair of North Florida (Hogtowne) Area SIGGRAPH from 1989 to 1991.

I moved to the D.C. area and continued my SIGGRAPH involvement as Treasurer of the Washington D.C. SIGGRAPH and the SIGGRAPH Under the Stars Chair. This event presented the SIGGRAPH Electronic Theater at the base of the Washington Monument.

As the SIGGRAPH 98 Online Technologies Chair, I teamed with Dave Tubbs (SIGGRAPH TV Chair), and we assembled $12M in hardware, 70 volunteers and built a digital media studio of the 21st century. More than 90 hours of television, print, radio and Internet pages were simultaneously produced during SIGGRAPH. The venue highlighted a unique convergence of media and clearly demonstrated that "creative talent" paired with technologists could produce elegant, inspired work for multiple media simultaneously. In an age where budgets get squeezed and hiring good people gets difficult, the ability to leverage production across multiple fronts is a business critical issue.

From 1998–2000, I served as Co-Chair of the Cybercast Committee for the Academy of Television Arts and Sciences. The work included the technical coordination of vendors, securing funding and extensive contract negotiations on behalf of the Academy. I was honored to bring new technical thinking to the Academy and assist them in their quest for better understanding of the technologies that are changing the landscape of media production and distribution.

My relevant work background includes senior positions at the Discovery Channel, @Home Network, Netscape and Logictier.

While at The Discovery Channel, I built systems to automate film production processes, network our new Avid editing systems and built a library of digital material. Serving as the Webmaster/Director of Discovery's Digital Laboratory, I operated the technical nerve center of the website as well as developed experimental media such as digital video, interactive storytelling, virtual reality and site-based environments.

Leaving the 28.8 world behind, I moved to @Home Network to become the Director of Media Technology. My organization's charter was to help media companies understand and build media for the broadband world by employing the state of the art @Home broadband network, experimental server technology, agents, new clients and specialized methods to deliver personalized, compelling Internet experiences.

In 1997 I became the Webmaster/Director of Core Website Infrastructure & Engineering for Netscape Communications Corporation. My group was responsible for the operations, infrastructure and running of the largest website in the world. Among the launches we enjoyed:

- China/Hong Kong Remote Site
- My Netscape — Our personalized portal
- WebMail — free email for millions
- Dozens of new "Channels"

In 1999, I became Founder and CTO of Logictier (**http://www.logictier.com**). I set the technological direction for Logictier and my responsibilities include evaluating emerging technologies and tracking changes and trends in the medium. I direct the innovations, strategies, investments, partnerships and acquisitions that will help Logictier continue to set the pace in this emerging industry.

The convergence of business, media and the graphics/interactive techniques community represented by SIGGRAPH is critical and needs to be nurtured and strengthened. As a member of these communities I look forward to bringing the technologist, dreamers and the storytellers together to explore what this new medium means.

I hope my experience and past contributions to SIGGRAPH could be utilized to help our organization grow and expand into new venues. I would be honored to serve and look forward to working with all of you on our exciting future.

Highlights of Education/Work Experience:

B.S. - Material Science Engineering, University of Florida

Discovery Communications, Bethesda, Maryland

@Home Network, Redwood City, California

Netscape Communications, Mountain View, California

Logictier, San Mateo, California

SIGGRAPH Experience

1988-2000 - Attendee SIGGRAPH Conferences

1989-91 - Chair, North Florida (Hogtowne) Local Group

1992 - Chair, SIGGRAPH Under the Stars

1993 - Treasurer D.C. Local Group

1998 - Chair, Online Technologies, SIGGRAPH 98

Garry M. Paxinos

Candidate for Treasurer

My term as Treasurer of ACM SIGGRAPH has been a productive one, and I hope to continue in this position for 2001/2002. Building on the strong foundation laid by my predecessor, Nan C. Schaller, I was able to make further improvements to the financial control of our large, diverse organization.

Funds are vitally important to all programs within ACM SIGGRAPH, so accurate financial reporting and clear communication channels are critical for optimum allocation of those funds. In the past year, the budgeting process was revitalized. The system was streamlined, yet still retains committee input and control. In fact, the 2001 budget was proposed to the Executive Committee and approved within minutes this year—a process that historically took hours to wade through. The distribution of funds has become a much less painful procedure for all involved.

I have also been selected by the Executive Committee (EC) to be one of two EC Representatives to the Conference Advisory Group (CAG) which handles multi-year planning of the annual conference.

Few organizations have captured my attention and held my interest as effectively as SIGGRAPH has done for the past 17 years. The blending of visual creativity with rapidly evolving technology provides a fascinating environment for sharing ideas. I am dedicated to this organization. I work effectively with other SIGGRAPH officers as well as with our valuable volunteer base, and I hope to continue to serve as Treasurer.

Professional Experience

1991-present - Vice President/CTO, Metro Link, Inc.

1984-90 - Engineering Manager at Megasystems, Inc. (nuclear/industrial process control)

1977-83 - Electrical Engineer/Project Engineer at Horizons Research Lab, Inc. (medical imaging)

ACM or SIGGRAPH Activities

2000-2001 - EC Representative to the ACM SIGGRAPH Conference Advisory Group

2000-2001 - Treasurer of ACM SIGGRAPH

1990-2000 - Information Director for ACM SIGGRAPH

1998 - Computer Applications Lab Chair, SIGGRAPH 98

1996-98 - Webmaster of www.siggraph.org

1996-97 - Information Director, ACM Membership and Activities Board

1996-99 - Member, ACM Electronic Services Working Group

1995-96 - Member-at-Large, ACM Local Activities Board

1995-present - Communications Chair, SIGGRAPH Professional Chapters Committee

1995 - Electronic Media Co-Chair, SIGGRAPH 95

1994-2000 - Founding Chair of the Fort Lauderdale ACM SIGGRAPH Professional Chapter

1983-present - ACM and SIGGRAPH member

Awards/Achievements

Participant in the SIGGRAPH 1994 Snowbird Future Search Conference.

Co-founder and Vice President of Metro Link Inc., a successful UNIX software development company.

SIGGRAPH Executive Committee Minutes

Conference Call January 10, 2001

Attending

Judy Brown, Alan Chalmers, Steve Cunningham, David Ebert, Gudrun Enger, Leo Hourvitz, Mike McGrath, Scott Owen.

Absent

Colleen Cleary, Erica Johnson, Garry Paxinos, Dino Schweitzer, Stephen Spencer.

Guest

Jennifer Anderson.

Motion: To approve the minutes of the December EC conference call.
Hourvitz, Enger (Approved 6, 0, 0)
Note: Alan Chalmers joined the call late and was not present for voting on the motions at this meeting.

Scott Owen, Conference Advisory Group Chair, brought in proposals for approval of three conference contracts.

1. Computer rental contract for three years (SIGGRAPH 2001, 2002 and 2003). This contract will cost $100,000 - $150,000 per year.

Motion: To approve the computer rental contract.
Owen, Ebert (Approved 6, 0, 0)

2. Exhibition management contract for three years (SIGGRAPH 2002, 2003, 2004). This contract will cost $1,245,000 for three years with an increase if the sold exhibition space is over 140,000 - 145,000 square feet.

Motion: To approve the exhibition management contract.
Owen, McGrath (Approved 6, 0, 0)
Owen thanked John Dill and David Kasik for their work on the RFP committee for this contract.

3. Graphic and web design contract for one year, SIGGRAPH 2002. This contract is for $464,400. There were concerns expressed about the large price increase and a question raised as to whether we need all the design service that we currently have.

Motion: To approve the graphic and web design contract.
Owen, McGrath (Approved 5, 1, 0; Cunningham against)

Conference Call January 3, 2001

Attending

Judy Brown, Alan Chalmers, Colleen Cleary, Steve Cunningham, David Ebert, Gudrun Enger, Leo Hourvitz, Mike McGrath, Scott Owen, Dino Schweitzer, Stephen Spencer.

Absent

Garry Paxinos, Erica Johnson.

The ACM SIGGRAPH Special Projects committee has approved a request for $13,530 to send a delegation to Southern Africa. The purpose of this visit is to meet with key people in industry, universities and funding agencies to discuss:

1. The establishment of a Southern African Computer Graphics Association (SAGA), closely linked with ACM SIGGRAPH, which will actively promote computer graphics and interactive techniques activities in Southern Africa.

2. The sharing of educational knowledge and resources for computer graphics education to meet the future demands for skilled people in this field.

3. The sharing of educational knowledge and resources of computer graphics and interactive techniques applied to education in general to enable these methods to provide substantial assistance to many of the educational challenges facing Southern Africa.

4. Sharing with leading Southern African researchers in this field information on conferences and workshops to which they can submit their research.

Because this project is over $10,000, it also needs ACM SIGGRAPH EC approval.

Motion: To approve the Southern African outreach proposal, as recommended by the Special Projects Committee.
Chalmers, Owen (Approved 9, 0, 0)

The ACM SIGGRAPH Director for Education (Mike McGrath) and Director for Chapters (Colleen Cleary) presented their budget proposals for Fiscal Year 2002, and the rest of the Executive Committee asked questions and made comments on the budgets. Finance committee will continue to discuss the budget proposals in a conference call next week.

Meeting November 10-11, 2000 Dublin, Ireland

Attending

Judy Brown, Alan Chalmers, Colleen Cleary, Steve Cunningham, David Ebert, Gudrun Enger, Leo Hourvitz, Erica Johnson, Mike McGrath, Stephen Spencer, Scott Owen, Garry Paxinos, Dino Schweitzer.

Friday, November 10

Motion: To approve September conference call minutes.
Cunningham, Hourvitz (Approved 10,0,0)

SIGGRAPH 2003 Chair

Scott Owen presented Alyn Rockwood as candidate for SIGGRAPH 2003 Conference Chair. Dino Schweitzer was excused from the discussion due to a potential conflict of interest. The conflict of interest issues were discussed at length and felt not to be a problem as long as a conference chair does not have a financial involvement with a contractor.

Motion: To approve Alyn Rockwood for SIGGRAPH 2003 Conference Chair subject to the condition that Alyn have no financial involvement with any conference-related contractor.
Owen, Chalmers (Approved 10, 0, 0)

Bylaws Discussion

First there was a discussion on the purpose and values statements in the ACM SIGGRAPH strategic plan.

Motion: To change some wording of the ACM SIGGRAPH Purpose and Values statements as follows:

ACM SIGGRAPH Purpose Statement
ACM SIGGRAPH's purpose is to foster a membership community whose core values help them to catalyze the innovation and application of computer graphics and interactive techniques.

Excellence: *ACM SIGGRAPH values excellence in the information and experience provided by our products and activities.*

Passion: *ACM SIGGRAPH values the passion our community feels for ACM SIGGRAPH and for the field of computer graphics and interactive techniques.*

Cross-Disciplinary Interaction: *ACM SIGGRAPH values the interaction among the many disciplines that make up our community.*

Owen, Hourvitz (Approved 10, 0, 0)

Then there was a discussion of bylaws changes. The bylaws changes approved at the November 1999 Executive Committee meeting in Dublin were of two kinds: to better represent the image ACM SIGGRAPH wants to present of ourselves, and to streamline the bylaws statement of our Awards program.

Article 1 was updated to represent us with the name ACM SIGGRAPH instead of the previous ACM Special Interest Group on Computer Graphics, to include interactive techniques in the charter of the organization as well as the conference and to streamline our mission statement. Article 2 was updated to replace the previous statement of purpose with our current purpose and values.

Article 11, on Awards, was updated to add newly approved awards for service to ACM SIGGRAPH and for significant new investigators in computer graphics and interactive techniques. Previous operational sections of the bylaw were also removed and placed in the Awards Program's operating rules, where it was felt they fit better.

Motion: To approve the proposed bylaws changes.
Cunningham, Enger (Approved 10, 0, 0)

Membership approval of these changes will be included in the next ballot.

Executive Committee (EC) Representative to Conference Advisory Group (CAG)

There was a discussion on whether there should be one or two EC representatives, and it was determined to remain with the two representatives at this time.

There was then a discussion on whether the EC representative to CAG should attend all EC meetings if he/she is not an EC member. It was determined that this representative should attend all EC meetings and conference calls.

Whether the ACM SIGGRAPH treasurer should be one of the two representatives was discussed. It is recommended that, when feasible, the treasurer should be considered to be one of the representatives to CAG, and when not feasible, the treasurer should attend appropriate CAG meetings to provide financial insight.

The appointment term was discussed. The two-year terms currently begin on January 1 and end on December 31. It was felt that the terms should begin on July 1, to be consistent with other EC appointments.

Motion: (Cunningham, Chalmers): To move the start time for the EC Representative to CAG appointment cycle from January 1 to July 1.
Cunningham, Chalmers (Approved 6, 3, 1; Enger, Hourvitz, Owen against; Paxinos abstain.)

Based on this motion, the term of the next appointment for EC representative to CAG will be January 1, 2001 - June 30, 2002. Also, the term of the current EC representative to CAG, Garry Paxinos, will end June 30, 2001.

There were three candidates for the new EC representative to CAG, to fill the position of Theresa-Marie Rhyne whose term ends December 31. David Ebert was selected as the new representative for the term of January 1, 2001 to June 30, 2002. The Executive Committee thanks all candidates for their willingness to serve, and the Conference Advisory Committee expressed sincere thanks for the service of Theresa-Marie Rhyne, especially for her work with the game developers initiative.

The EC recessed for the evening, to reconvene at 9 a.m. Saturday, November 11, 2001.

Saturday, November 11

Judy Brown called the meeting to order at 9 a.m.

Strategic Planning

David Ebert led a discussion on strategic planning. The major themes from our fall strategic planning meeting were:

- Personalization
- On-line community
- Conference year-round

Ebert asked what are the most important things to move towards? The concept of the HUB, an information and community resource, has very high priority. We need to look into the implementation and costs and to leverage ACM resources to implement web/hub projects

Should papers be published year round online? This would provide new content for the web. What about white papers, technical reports, and feature articles to generate new and return traffic to the site?

Traveling courses were discussed again. There is no internal barrier to doing this; we just need for someone to take initiative and ownership of the project to move forward.

Note: Since the meeting, Gudrun Enger was appointed to lead a task force to implement a pilot program for traveling courses, and Gudrun, David Ebert and Kathryn Saunders are looking into how to progress with the Hub.

siggraphnews.com Issue

The real issue is the use of "siggraph" in a secondary domain name and the need to protect and defend our trademark from use by others. When trademark questions or issues come up, the ACM SIGGRAPH Chair needs to be notified immediately.

Motion: To direct the Chair to take all necessary steps to assure that no secondary domain name outside ACM includes "SIGGRAPH."
Cunningham, Spencer (Approved 10, 0, 0)

Conference Items

Contracts

There was discussion of the review of three contracts (conference management; marketing, media and copy coordination; and audio visual services) for SIGGRAPH 2002 and SIGGRAPH 2003. The contracts were awarded for one year under the current fee structure, with a commitment to the contractors for the three-year cycle. The CAG was directed to closely monitor the current year and investigate what services are needed most. The CAG response was that this was not necessary due to the success of SIGGRAPH 2001, and the conference requires the list of services as currently contracted.

Motion: To approve the original contracts for conference management, marketing and media and copy coordination services, and audio visual services for SIGGRAPH 2002 and SIGGRAPH 2003 with the fees stipulated in the original contracts.
Owen, Paxinos (Approved 10, 0, 0)

Nomination of SIGGRAPH 2002 Technical Chairs

Scott Owen nominated the following Technical Chairs for S2002

- John Hughes, Papers Chair
- Chris Shaw, Panels Chair
- Valerie Miller, Courses Chair

Motion: To accept the nomination of John Hughes, Chris Shaw and Valerie Miller as Technical Program Chairs for the SIGGRAPH 2002 Conference.
Owen, Spencer (Approved 10, 0, 0)

Conference Planning Update

- SIGGRAPH TV, in its present form, is going to be discontinued after SIGGRAPH 2001.
- SIGGRAPH 2001 intends to capture a significant amount of video for on-line archival purposes.
- SIGGRAPH 2002 plans to have an outreach program to bring in other communities, including games and other users and developers of interactive techniques. This role is not yet filled, and suggestions are welcome.
- SIGGRAPH 2002 will have a web graphics technical program. This role is not yet filled, and suggestions are welcome.
- Computer Applications Lab (CAL) will evolve to include other hands-on activities besides hands-on courses.

SIGGRAPH 2000 Financial Forecast Update

The net surplus will be about $700,000.

Conference Accounting Contract

Scott Owen presented Smith Bucklin and Associates (SBA) as the recommended contractor for the conference accounting and bookkeeping services contract for the term of SIGGRAPH 2002 to SIGGRAPH 2004.

Motion: To approve SBA as the contractor for accounting and bookkeeping services for the annual conference for the term SIGGRAPH 2002 - SIGGRAPH 2004.
Owen, Ebert (Approved 9, 0, 1; Cunningham abstain)

Owen expressed thanks to ACM headquarters staff, especially Michael Lichtenstein, John DeLorenzo, Darren Ramdin and Erica Johnson for support in the RFP review process for the conference accounting contract.

Concurrent Volunteerism

This was a discussion of volunteers serving in more than one SIGGRAPH volunteer position. Some felt the need for more clear and open communication between the conference committees and the EC to avoid potential overlap.

Motion: To accept and approve the current draft policy on concurrent volunteerism.
Owen, Hourvitz (Approved 9, 1, 0; Cunningham against)

The policy is appended to the minutes.

ACM1 Fund Request

SIGDA (Special Interest Group on Design Automation) gave a donation to the ACM1 conference and issued a challenge to match the donations of other SIGs to the ACM1 conference. ACM SIGGRAPH discussed this and elected not to contribute. It was felt that ACM should budget to break even, the same as it expects other ACM sponsored or co-sponsored conferences to do.

System Managers Meeting

Leo Hourvitz reported the following policies for managing siggraph.org that came out of the systems managers meeting, and updated the EC on the status of the siggraph.org machine.

E-mail. siggraph.org will only be a mail forwarding box in the future, meaning that volunteers must have another email address to which the mail is ultimately delivered. Any volunteer with a need can obtain an email forwarding address, as can any member.

Shell accounts on siggraph.org. The system managers have proposed that shell accounts be given only to those volunteers or contractors with a need to manage information on the machine (usually for web purposes). This means that, for instance, in the future, new EC members will not automatically get a login account on the machine unless they also actively manage information on it.

Role accounts. There will continue to be a limited number of role accounts (i.e., accounts attached to a role rather than an individual), with the primary example being an account for an ACM SIGGRAPH chapter. We are terminating role accounts for contractors, however, in favor of accounts for those individuals at the contractor utilizing the machine.

Machine update: The machine has physically been moved to ACM Headquarters in New York. We are bringing up a new piece of hardware (Intel-based Linux system) to replace the aging Sun machine. We will have more bandwidth, disk capacity and memory on the new hardware.

The EC expresses sincere thanks to ACM for their support with the systems managers meeting and moving siggraph.org over to ACM Headquarters.

EC Funds Transfer from the Conference Budget

This discussion focused around the predictability of a percentage versus a flat fee transfer. Garry Paxinos recommended that the conference transfer to EC be 4.5 percent of the conference income.

Motion: The conference transfer to EC shall be equal to 4.5 percent of total conference income.
Hourvitz, Owen (Approved 10,0, 0)

ACM Allocation

Judy Brown distributed backup provided by the SIG Governing Board on the new ACM allocation structure. It will be based on expenses rather than income and should result in a savings of about $100,000 per year for ACM SIGGRAPH.

TMRF Process for the Annual SIGGRAPH Conference

CAG requested a waiver from the ACM TMRF process for the Annual SIGGRAPH Conference. EC recommends this discussion be taken off-line. Scott Owen, Judy Brown and Erica Johnson are to work on a recommendation for coordinating the SIGGRAPH conference budget cycle and the ACM TMRF process.

Conference Reserve Fund Interest as Conference Income

CAG recommended that the conference reserve fund interest be exempt from the division of income between the conference and EC reserve funds because this income was not used by the SIGGRAPH 2000 conference, even though it was included in the conference budget. It was agreed for this year, but the conference reserve fund interest should not be listed as conference income on future conference budgets.

Motion: That the conference reserve fund interest income be exempt from the windfall division between the conference reserve fund and the EC reserve fund for SIGGRAPH 2000.
Owen, Paxinos (Approved 10, 0, 0)

FY 02 Budget Planning

The schedule for the FY02 planning was discussed, and conference call times were set for the presentation of the budget proposals:
December 6, Chair and Vice-Chair
December 13, Communications and Publications
January 3, Education and Chapters

Finance Committee will discuss the budgets one week after each presentation and make

the final budget recommendation by January 12, 2001.

Erica Johnson reminded everyone that all dues changes and offerings pricing changes must go to ACM by February 1.

Journals and Impact Ratings

Alan Chalmers led a discussion on publications and impact issues. The issue of conference proceedings not being considered journals is felt by other SIGs and professional organizations. This has the potential for serious ramifications, especially in Europe where journal citings are used as "impact ratings." The goal is to have various publications of ACM SIGGRAPH and Eurographics receive the appropriate recognition for the quality of work they represent.

Southern African Proposal

Alan Chalmers discussed a proposal to take an ACM SIGGRAPH team to meet with various individuals in government, industry and education in Southern African countries. The goal is to help to start a computer graphics organization and conference. This has been proposed to the ACM SIGGRAPH Special Projects Committee, but Alan wanted EC to have an opportunity to also discuss it at this time.

CGAS Agreement

The agreement with the Japanese Computer Graphics Arts Society was discussed by Alan Chalmers and amended. It will now be sent to CGAS for their comments. Alan is exploring a similar agreement with the Nordic Computer Graphics Society

Motion: To adjourn.
Cunningham, Chalmers (By acclamation)

Appendix A: Policy on Volunteers Holding Multiple Positions Within ACM SIGGRAPH

A volunteer being considered for a position within SIGGRAPH should tell those considering him or her of all other positions (volunteer or otherwise) that could affect the volunteer's ability to do the job. The volunteer should also indicate why he or she believes he or she could successfully perform the duties of the position being discussed. The person considering the volunteer for the position will weigh the volunteer's other commitments, the record of the volunteer's successes, and the requirements of the position, and will decide whether he or she should be selected.

In case the volunteer already holds or is being considered for one or more other volunteer positions, the person who manages the new position will contact the persons managing the other positions and will discuss with them the requirements of the various positions and whether the volunteer can be expected to carry out the tasks of all the positions. If the managers all agree that the additional task should be successful, then this fact and the reasons for this agreement should be documented and the new manager is free to select this volunteer for the position. If there is agreement that the new position would likely overload the volunteer, this fact and the reasons for this agreement should be documented and the volunteer should be told that the selection will not be made unless the volunteer chooses to give up one or more of the other positions.

Appendix B. Bylaws Changes

ACM SIGGRAPH

BYLAWS of the Special Interest Group on Computer Graphics and Interactive Techniques of the Association for Computing Machinery, Inc.

Article 1. Name and Mission

(a) This organization will be called the Special Interest Group on Computer Graphics and Interactive Techniques ("SIGGRAPH") of the Association for Computing Machinery, Inc. ("the ACM").

(b) SIGGRAPH's mission is to promote the generation and dissemination of information on computer graphics and interactive techniques.~~, acquisition, dissemination, and exchange of information and opinion on the theory, design, implementation, and application of computer graphics and interactive techniques to facilitate communication and understanding.~~

Article 2. Purpose and Values

SIGGRAPH's purpose is to foster a membership community whose core values help them to catalyze the innovation and application of computer graphics and interactive techniques.

SIGGRAPH is built on a fundamental set of values and strives to support and follow these values in all its activities. These values are:

Excellence: SIGGRAPH values excellence in the information and experience provided by its products and activities.

Integrity: SIGGRAPH values personal and organizational integrity in the selection of our content and in our interpersonal and organizational relationships.

Volunteers: SIGGRAPH values volunteers and volunteerism in an environment that actively supports its volunteers.

Passion: SIGGRAPH values the passion its community feels for SIGGRAPH and for the field of computer graphics and interactive techniques.

Cross-Disciplinary Interaction: SIGGRAPH values the interaction among the many disciplines that make up the computer graphics community.

~~SIGGRAPH is organized and operated exclusively for educational purposes in~~

~~support of scientific, technical, and artistic endeavors in computer graphics and interactive techniques. Its services will include:~~

~~i. Collecting and disseminating information in the specialty, through a newsletter and other publications approved by the Publications Board of ACM;~~
~~ii. Organizing sessions at conferences of the ACM;~~
~~iii. Sponsoring conferences, symposia, and workshops;~~
~~iv. Organizing working groups for education, research, and development;~~
~~v. Serving as a source of technical information for the ACM Council and other units of the ACM;~~
~~vi. Serving as an external technical representative of the ACM when authorized by the Council or the Executive Committee of the ACM; and~~
~~vii. Working with other units of the ACM on technical activities such as lectureships or professional development seminars.~~

Article 11. Awards Program

(a) The Steven A. Coons Award is awarded in odd-numbered years to recognize long-term creative impact on the field of computer graphics.

(b) The Computer Graphics Achievement Award is awarded yearly to recognize significant recent accomplishments in the field of computer graphics.

(c) The Significant New Investigator Award is awarded annually to a researcher who has made a recent significant contribution to the field of computer graphics and is new to the field.

(~~c~~d) The scope of the areas of accomplishment for the Coons, Achievement, and Significant New Investigator awards ~~recipients~~ will encompass both theory and application. It will include, but not be limited to, works of art, algorithms, and hardware designs. ~~Neither award~~None of these awards will be based on service to SIGGRAPH.

(e) The Outstanding Service Award is awarded in even-numbered years to recognize a career of outstanding service to ACM SIGGRAPH by a volunteer. It recognizes an individual who has given extraordinary service to ACM SIGGRAPH, both in the trenches and in positions of more responsibility or visibility, over a significant period of time.

(~~d~~f) Award recipients need not be members of ACM or SIGGRAPH.

(~~e~~g) The Awards Program will be administered by the SIGGRAPH Awards Chair who will be appointed by the SIGGRAPH ~~Chair~~President with consent of the Executive Committee ~~and will have the following responsibilities:~~
~~i. Solicit nominations.~~
~~ii. Appoint, with SIGGRAPH Executive Committee approval, a Selection Committee to review the qualifications of award candidates and to recommend award recipients to the Awards Chair. The Selection Committee will consist of five members, rotating one per year.~~
~~iii. Administer award conferral.~~
~~iv. Make recommendations to the SIGGRAPH Executive Committee concerning updating the Awards Program.~~
~~v. Coordinate the SIGGRAPH Awards Program with ACM by notifying the ACM Awards Committee of SIGGRAPH Award activities~~.

~~(f) Each award may consist of a plaque, travel expenses to the SIGGRAPH Conference (if desired) and a cash prize; the cash prize for the Steven A. Coons Award will be at least twice the cash prize for the Computer Graphics Achievement Award. The amount of the cash prizes must be approved by the ACM Awards Committee and the total cost of the Awards Program must be included in SIGGRAPH's budget.~~

Conference Call
August 30, 2000

Attending
Judy Brown, Alan Chalmers, Colleen Cleary, Steve Cunningham, David Ebert, Gudrun Enger, Leo Hourvitz, Erica Johnson, Scott Owen, Garry Paxinos, Dino Schweitzer.

Guest
Theresa-Marie Rhyne (EC representative to Conference Advisory Group).

Absent
Mike McGrath, Stephen Spencer.

Motion: To approve the minutes from the July Executive Committee meeting.
Hourvitz, Chalmers (7,0,0)

Motion: To approve the appointment of Hans-Peter Seidel to the Awards Committee.
Chalmers, Owen (7,0,0)

Scott Owen and Theresa-Marie Rhyne reported on results from the recent Conference Advisory Group (CAG) meeting. They want to move the timeline for freezing the conference budget from the end of February to the middle or end of March. Erica Johnson mentioned that there are some new ACM guidelines on time limits for completed budgets, with March 15th as the latest deadline. Scott will put this on the agenda for the November EC meeting when he has appropriate backup.

Leo Hourvitz reported that our membership is higher this year than it was last year at this time. Judy Brown and Alan Chalmers added that we gained 20 new members at the Eurographics conference.

Garry Paxinos briefly described the budget process for this year. He will provide a spreadsheet template and target budget line for each program manager. We will have three conference calls, beginning in October, with two program managers presenting their budgets during each call. A member of the Finance Committee will serve as a liaison to each program, and the Finance Committee will review the budgets presented after each call.

ANNOUNCEMENTS

Calendar

February 5-9, 2001
WSCG '2001
Plzen, Czech Republic
See *Computer Graphics* 34(4) November 2000, p 30

February 14, 2001: papers due
Eurographics 2001
Manchester, United Kingdom
See *Computer Graphics* 34(4) November 2000, p 29

February 19-22, 2001
2001 ACM Web3D Symposium
Paderborn, Germany
See *Computer Graphics* 34(4) November 2000, p 30

March 13-17, 2001
IEEE Virtual Reality 2001
Yokohama, Japan
See *Computer Graphics* 34(3) August 2000, p 49

March 19-21, 2001
2001 Symposium on Interactive 3D Graphics
Research Triangle Park, NC, U.S.A.
See *Computer Graphics* 34(3) August 2000, p 48

March 20-23, 2001
ISI'2001
Dubai, U.A.E.
See *Computer Graphics* 34(1) February 2000, p 98

March 20-24, 2001
Game Developers Conference
San Jose, CA, U.S.A.
See *Computer Graphics* 35(1) February 2001, this issue

May 28-June 1, 2001
The Fifth International Conference on Autonomous Agents 2001
Montreal, Canada
See *Computer Graphics* 34(4) November 2000, p 30

May 31, 2001: contributions due
Neuro-Fuzzy 2002
Havana, Cuba
See *Computer Graphics* 35(1) February 2001, this issue

June 17-21, 2001
SIM 2001
Freiburg i.Br., Germany
See *Computer Graphics* 35(1) February 2001, this issue

June 26-29, 2001
SOCO/ISFI 2001
Paisley, Scotland
See *Computer Graphics* 35(1) February 2001, this issue

June 30, 2001: contributions due
ICAIS 2002
Australia
See *Computer Graphics* 35(1) February 2001, this issue

July 25-27, 2001
IV2001
London, England
See *Computer Graphics* 34(4) November 2000, p 30

July 29-August 3, 2001
WCCE '2001
Copenhagen, Denmark
See *Computer Graphics* 35(1) February 2001, this issue

August 12-17, 2001
SIGGRAPH 2001
Los Angeles, CA, U.S.A.
See **http://www.siggraph.org/s2001/**

September 3-7, 2001
Eurographics 2001
Manchester, United Kingdom
See *Computer Graphics* 34(4) November 2000, p 29

September 24-27, 2001
DI-TESA '2001
Rochester, NY, U.S.A.
See *Computer Graphics* 35(1) February 2001, this issue

September 24-27, 2001
WMC 2001
Rochester, NY, U.S.A.
See *Computer Graphics* 35(1) February 2001, this issue

January 15-18, 2002
Neuro-Fuzzy 2002
Havana, Cuba
See *Computer Graphics* 35(1) February 2001, this issue

February 12-15, 2002
ICAIS 2002
Australia
See *Computer Graphics* 35(1) February 2001, this issue

December 16-18, 2002
ISA 2002
Shanghai, China
See *Computer Graphics* 35(1) February 2001, this issue

Details on many of these announcements are available on siggraph.org at http://www.siggraph. org/calendar.

Call for Participation

Neuro-Fuzzy 2002

January 15-18, 2002
Havana, Cuba

Submissions are being sought for Neuro-Fuzzy (NF) 2002, to be held January 15-18, 2002 in Havana, Cuba. The submission deadline is **May 31, 2001.**

During the past decade, paradigms and benefits from neuro fuzzy systems have been growing tremendously. Today, not only does neuro fuzzy solve scientific problems but its applications are also appearing in our daily lives. NF 2002 studies the state of the art and the future of neuro fuzzy.

Topics include advanced neuro and fuzzy paradigms; data granulation and fuzzy rule extraction; advanced training algorithms; evolutionary computation and graphical models; chaotic behavior and fractals; and applications in signal processing, control and robotics. Of particular interest are applications in sound and image processing; pattern recognition; image understanding; perception; sensor fusion; controller design; state observation; motor control; mobile robotics; autonomous navigation; deliberation and planning; active anchoring; gain-scheduling; fault detection; hardware solutions; data mining; financing; and e-commerce.

The General Chair is Hans-Heinrich Bothe from Denmark. For more information, see **http://www.icsc.ab.ca/nf2002/nf2002.html.**

Call for Participation

ICAIS 2002

February 12-15, 2002
Australia

ICAIS 2002, the International Congress on Autonomous Intelligent Systems, is set for February 12-15, 2002 at Deakin University, Geelong Campus, Australia. Autonomous intelligent systems can be described as intelligent entities that are capable of independent action in dynamic, unpredictable environments. This is a fast-growing research area and ICAIS strives to bring researchers, system developers and users from industry and academia together to exchange views and the latest information on research and development.

Paper submissions are due by **June 30, 2001** to **icais@ITStransnational.com**. Technical issues include evolution of agents, agent-based software engineering, distributed architecture for mobile navigation, autonomous robots, adaptive path planning, real-time vision, distributed systems, machine learning, intelligent manufacturing and multi-agent simulation, verification and validation.

The General Chair is Saeid Nahavandi from Deakin University. ICAIS 2002 sponsors include Deakin University, Institution of Electrical Engineers, Natural and Artificial Intelligence Systems Organization, International Computer Science Conventions and The Institution of Engineers.

For more information, see **http://www.icsc.ab.ca/icais2002/icais2002.html.**

Call for Participation

ISA 2002

December 16-18, 2002
Shanghai, China

Papers are requested for ISA 2002, International ICSC Congress on Intelligent Systems and Applications. The event is to be held at Shanghai Jiao Tong University, Shanghai, China, December 16-18, 2002.

The General Chair is Huaglory Tianfield from the School of Multimedia and Computing at Gloucester College, United Kingdom. He can be reached at tel: +44-1242-54-4066 or email: **htianfield@chelt.ac.uk**.

Check **http://www.icsc.ab.ca/ isa'2002.htm** for information as it develops.

Game Developers Conference

March 20-24, 2001
San Jose, CA, U.S.A.

The 15th Game Developers Conference is set for March 20-24, 2001 at the San Jose Convention Center in San Jose, CA. Game developer professionals from around the world gather to share ideas and build the skills essential to creating the next generation of interactive entertainment. More than 300 lectures, tutorials, panels and roundtables are planned in the following tracks: visual arts, audio, programming, level design, game design, production and business and legal.

Keynote sessions include:

- Design Plunder - Will Wright, Maxis
- Programs, Emotions, and Common Sense - Marvin Minsky, Toshiba and MIT
- Out of the Garage: Maturation in Team and Project Management - Jason Rubin, Naughty Dog
- Designing for the Internet Gamer - Bing Gordon, Electronic Arts
- Rayman 2: Level Design Experience - Michel Ansel

For more information, see **http://gdconf.com/.**

SIM 2001

June 17-21, 2001
Freiburg i.Br., Germany

SIM 2001, the industrial trade fair for simulation and visualization, is set for June 17-21, 2001 in Freiburg i.Br., Germany. Its audience is people responsible for product development, engineers, applied scientists, leaders in development and heads of technology management.

Simulation is a key technology for the manufacturing industry in the next decade. At SIM 2001, see how important simulation technologies are for most future processes and product development. The exhibition features new technologies and applications for CFD, FEM, moulding, crash, kinematics, process simulation, robotics, logistics, 3D visualisation and virtual reality. The conference also includes sessions on topics such as virtual cooperation in the supply chain, open digital mock-up, security in digital networks, portal architectures, life sciences industry (bioinformatics, chemistry, medicine), motive industry (cars, trains, aircraft) and suppliers industry (materials, environment). Details on other special events can be found on the SIM 2001 website at **http://www.sim2001.com.**

Conference sponsors and cooperators are ASIM, CD-adapco, Compaq, Crossair, DaimlerChrysler, Fluent, GMD, HP, MSC, NEC, SGI, SUN Microsystems and WUA-CFD.

For more information, see the website at **http://www.sim2001.com** or contact the conference organisers, Löeffler & Associates GmbH, SIM 2001 P.O. Box, CH-4021 Basel, Switzerland; tel: +41-61-695-93-95; fax: +41-61-695-93-90; email: **loeffler@sim2001.com.**

SOCO/ISFI 2001

June 26-29, 2001
Paisley, Scotland

SOCO/ISFI 2001 (Soft Computing/Intelligent Systems for Industry) is set for Paisley, Scotland, June 26-29, 2001.

SOCO topics include neural networks, fuzzy logic, rough sets, genetic algorithms and evolutionary computing, chaos theory, artificial intelligence and expert systems, probabilistic reasoning, machine learning, pattern recognition and image understanding, distributed intelligence, self-organizing systems, fuzzy databases and information retrieval and educational aspects of soft computing. The SOCO General Chair is Colin Fyfe, University of Paisley, email: **fyfeOci@paisley.ac.uk.**

ISFI covers research areas of soft computing and application-driven developments of advanced information technology and industrial intelligent technology. The emphasis is on industrial realization, experimental applications, application methodology development and quantitative and qualitative problem solving. ISFI Chair is Douglas Campbell, University of Paisley.

For more information, see **http://www.icsc.ab.ca/soco2001.htm.**

7th IFIP World Conference On Computers In Education (WCCE '2001)

July 29-August 3, 2001
Copenhagen, Denmark

The International Federation for Information Processing World Conference On Computers In Education (WCCE '2001) explores the use of information and communication technologies in education and the teaching of informatics within the overall context of networking the learner. The conference is set for July 29 to August 3, 2001 in Copenhagen, Denmark.

Topics include knowledge as a resource, networking the learner, ICT as a catalyst for change, learner-centered teaching, flexible and distance learning, integration of ICT into education and training, innovative pedagogical methods, changing role of tutors, teacher education, informatics as a subject for study, educational software and hardware, accreditation of new competencies and evaluation, equity and social issues, progress in developing countries, visions of future ICT developments, evolution of national policies and professional development and vocational education.

More information about the conference can be found at **http://www.wcce2001.dk/.**

ACM and the IEEE Computer Society (IEEE-CS) are both United States-based members of IFIP. In support of a key IFIP activity and as a service to their U.S. members, ACM, in cooperation with IEEE-CS, has applied for a grant from the National Science Foundation (NSF) to provide partial travel support to 30 United States participants attending the 7th IFIP World Conference on Computers in Education.

Funding by ACM is contingent on approval by the NSF of ACM's grant request and will be limited to covering economy-class airfare up to a $1,000 maximum per attendee. A review panel consisting of representatives from ACM and IEEE-CS will evaluate individual grant applications. Applicants should provide the selection committee with the following information:

1. Name, mailing address
2. Telephone and fax numbers, email address
3. Business title and affiliation
4. Indication of expected WCCE '2001 participation (panel chair, speaker, discussant, other activity)
5. Reasons for requesting the travel grant including how participation will benefit current activities and research
6. Current resume

All award recipients must be residents of the United States and travel by U.S. carriers. In addition, they will be required to file a brief report on their activities and experience at the conference.

Applications should be submitted by **March 15, 2001** to Fred Aronson, ACM, 1515 Broadway, New York, NY 10036; email: **aronson@acm.org;** fax: +1-212-302-5826; phone: +1-212-626-0515. Underrepresented populations, including minority and women engineers, scientists and teachers, are encouraged to apply for the grants. The grant awards will be made in mid-April if NSF approval is received.

WMC 2001

September 24-27, 2001
Rochester, NY, U.S.A.

WMC 2001 (World Manufacturing Congress) is to be held September 24-27, 2001 at the Center for Integrated Manufacturing Studies at the Rochester Institute of Technology in Rochester, NY.

The event brings together manufacturing researchers in academia and members of manufacturing industries to highlight the importance of applied as well as theoretical research. The impact of changing technical sectors, like digital electronics, automation, computer engineering and information technology as well as the need to protect the environment, is influencing basic philosophies of manufacturing.

WMC 2001 General Chair is Guy Johnson, Rochester Institute of Technology. Email Johnson at **gnjics@rit.edu.**

For details, access **http://www.icsc.ab.ca/wmc2001.htm.**

DI-TESA '2001

September 24-27, 2001
Rochester, NY, U.S.A.

The progress of the civilization of humankind is a historical evolution of discovering, symbolizing, utilizing and sublimating the intelligence of human beings. Intelligence is ubiquitous of our technologies, our civilizations and ourselves. What is further, intelligence is infinity. Explore these concepts at DI-TESA '2001, September 24-27, 2001, in Rochester, NY. DI-TESA '2001 is co-located with the World Manufacturing Congress, WMC 2001.

The contemporary state of the art is by means of the systems-scientific thinking, i.e., approximating complexities through compounding a set of simplicities in an emergent manner. This is the very exciting field of distributed Intelligence. Distributed intelligence is making significant impacts upon every aspect of our life and work, our environment and society and ourselves. It has been widely applied to tackle technology, economic and social problems.

DI-TESA'2001 is established as a forum for people from academia, governments and industries to present research results, novel

ideas, in-depth thoughts into the future and practices. The purpose of DI-TESA'2001 is to bring together researchers and practitioners to highlight the importance of both theoretical and applied methodologies. The scientific program includes invited plenary talks, contributed sessions and invited sessions, workshops and tutorials.

Sessions fall into the following tracks: multi-agent systems, federated problem solving, ubiquitous computing, cooperative work, distributed scheduling, management and control and ways of doing business.

The Symposium Chair is Huaglory Tianfield from the School of Multimedia and Computing at the Gloucestershire Business School in England. He can be reached at **htianfield@chelt.ac.uk.**

For additional conference information, access **http://www.icsc.ab.ca/ditesa2001.htm.**

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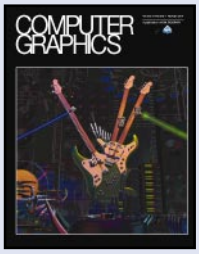

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Computational Geometry (June)	❑ $22	❑ $8
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UIST (November)	❑ $15	❑ $5
Graphics Interface (May)	❑ $20	❑ $8
Volume Visualization (October '00, biennial)	❑ $12	❑ $4
IEEE Visualization (October)	❑ $25	❑ $9
Interactive 3D Graphics (April '01, biennial)	❑ $15	❑ $5
Solid Modeling (May)	❑ $25	❑ $8
Eurographics Rendering Workshop (June)	❑ $40	❑ $7
VRML (February)	❑ $12	❑ $5
Workshop on Implicit Surfaces (October)	❑ $30	❑ $4

You may also join ACM SIGGRAPH's parent organization, the Association for Computing Machinery. Membership in the ACM includes a subscription to the *Communications of the ACM* (for more information about ACM membership, see http://www.acm.org/membership). If you join ACM, you are also eligible to subscribe to *ACM Transactions on Graphics* and the *Journal of Graphics Tools* at the following discounted rates.

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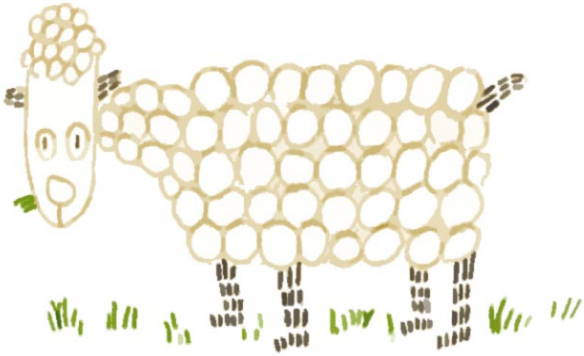
result = 3, as calculated on my first personal computer

comics from the other side



"Binary Stock"

comics from the other side

"gooey innerface"

About the Columnist

Teresa Lang is an opinionated eccentric two-eyed right-handed independent film animator-artist who has a day job using computer animation software.

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Most individuals associated with SIGGRAPH have an electronic mail alias on the *siggraph.org* system which is their first and last names, separated by either an underbar or a period, i.e. *judy.brown@siggraph.org* or *judy_brown@siggraph.org*. Individuals with unique last names can also be contacted through an electronic mail alias which is just their last name, i.e. *cunningham@siggraph.org*.

SIGGRAPH office holders have electronic mail aliases of the form *office.group*. For example, the SIGGRAPH organization chair can be reached at *chair.ec@siggraph.org*.

A list of individuals with electronic mail aliases on the *siggraph.org* system and their electronic mail aliases can be obtained by sending an electronic mail message to *people@siggraph.org*.

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