The First Wave: The Origins of Wavefront Software

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In the fledgling years of America's computer graphics industry-from thelate 1970s through 1980s-a handful of great groups invented the tools ofthis promising new medium. These groups were scattered across thecountry-in New York, California, Utah, and Ohio. Some flourished withsupport from universities and wealthy benefactors; others developedsoftware in the trenches of commercial production. Among the latter was oneHollywood group that blended skills in filmmaking, engineering,architecture, animation, and computer science. With TV networks, filmstudios, ad agencies, and corporate clients expecting each project to bemore dazzling than the last, this group developed innovative ways ofcreating computer graphics-and they did it on deadline. The studio wherethis group first came together was the award-winning Robert Abel &Associates, and the software ideas that took root there would eventuallygrow into one of the production world's most successful tools: Wavefront.

Say the word "Wavefront" to filmmakers today, and they will know you aretalking about software. In 1994, Silicon Graphics bought Wavefront andmerged its code with

the former competitor's software to create the popularCGI product Alias|Wavefront.

During the decade before that, however, Wavefront co-founders Bill Kovacs,Larry Barels, and Mark Sylvester had steadily built Wavefront Technologiesfrom a small group of Santa Barbara-based computer hackers into a WallStreet success story. With users as diverse as Disney, McDonnell-Douglas,Boss Film, and Ford Motors, Wavefront became a brand name software packagein the emerging medium of 3-D CGI. As one the earliest companies to provideoff-the-shelf software to the production community, Wavefront Technologiesnot only built their brand, they helped spur the growth of the digitalproduction business itself. This year, in recognition of that impact, theAcademy of Motion Picture Arts and Sciences bestowed technical achievementhonors on the designers who pioneered the Wavefront code.

A little over a decade ago, if you wanted to use computers for filmmaking,you had to write the software yourself. So back in 1978, when architectBill Kovacs joined Robert Abel & Associates, he set about programming amachine that the military had previously used as a flight simulator. TheEvans & Sutherland Picture System II had a joystick that movedblack-and-white, wire-frame graphics around in a virtual 3-D space. Backthen, RAA was not producing pictures with the E&S machine; their businesswas creating commercials that optically combined photographed elements. TheE&S was a simply a previewing tool that allowed artists to manipulatewire-frame "animatics" like moving blueprints until they achieved thedesired choreography of elements. That choreography data, when fed intoRAA's motion-control camera system, enabled the camera to replicate therehearsed moves during filming of actual elements. "We saw that usingcomputers for previsualization was the future," remarks Abel.

The E&S' FORTRAN code, recalls Kovacs, "was primitive, but it had a goodstructure and was bug-free." Originally written by Tom Barron (of CameraG), the software had been "souped up by an ex-Abel guy named BarrySchindler," says Kovacs, "so I had a great foundation on which to jam."Despite the limited power of the DEC computer that drove the E&S system,Kovacs tripled the software's functionality. "No other

studio could do thismotion previewing. It gave us a unique advantage."

Then Kovacs contributed an unexpected insight that changed everything. Onenight, sitting at the E&S in RAA's rabbit warren of offices, he recallslooking at the screen and marveling at how sharp the images were. "SuddenlyI saw it as a piece of high-contrast artwork. We had a camera set up infront of the screen to shoot our motion tests, so all we'd need to createcolored graphics was a computer-controlled color filter wheel in front ofthe camera. I then developed a little script that would allow us to dohundreds of passes." Taking the E&S beyond previsualization to createvector graphics signaled a new phase. CGI was no longer just a means to anend; it was a medium itself.

RAA first harnessed the E&S to animate grids for Disney's film The BlackHole, but what really advanced vector graphics was a technique called"vector-fill." The program used millions of lines to make computer-drawnobjects look solid. Kovacs perfected it in collaboration with Con Pederson,who had co-founded RAA after supervising effects for 2001. Kovacs says thatit was Pederson who taught him a filmmaker's mentality. "He would invent atool in his mind, and I would code it-and try to make sure it was done inthree hours," remembers Kovacs. "I couldn't say 'no' to a production personwho was using the code. Con would often want some very specific tool, butI'd try to generalize it so that others could use it. It was fun to writetools on-the-fly to meet actual design needs and then try to implement themas part of a generalized tool set." John Hughes, an early RAA staffer whonow heads Rhythm & Hues, states: "Con and Bill did almost everything tosimulate solids on those vector machines. It was pretty amazing." Theadvertising community agreed. The commercials RAA created for AT&T andCanon both earned Clios.

While the graphics looked elegant, the process of creating them was not.RAA

Technical Director Jim Keating, who worked on several projects, groanswhen he remembers those multiple-pass filming sessions. “Those were killerjobs-you’d sit in front of a terminal for 36 hours and just shoot.”

Abel notes that the results became better looking as the range of colorsRAA could create increased. “But we didn’t say we were doing computergraphics because that scared some people,” he recalls. “They thought thatmeant CAD/CAM, which looked cold and phony. We’d just say we could make anidea come alive through an ‘animation technique.’” One corporate client whodid embrace RAA’s vector-fill approach was TRW. The Escher-esque spots thatKenny Mirman and Frank Vitz animated for TRW won scores of honors.

One of the biggest challenges during this period came from Panasonic, whichsaw CGI as a medium that could demonstrate its 3-D television system. ForPanasonic’s “Glider,” RAA’s Randy Roberts envisioned a CG paper airplanefloating through a 3-D environment. To help him realize that concept,Kovacs hired Richard Hollander as the project’s technical director. “I hadno idea what it meant to be a TD at that time,” admits Hollander, who nowheads Blue Sky|VIFX. “Bill just handed it to me and said, ‘Don’t worry;just do it.’” Animated completely on the E&S, “Glider” won RAA yet anotherClio.

Vector-fill graphics had clearly come of age, but the company was pushingthe limits of what vectors could depict. Their contribution to Disney’sTron in 1981-a sequence called “Flynn’s Ride”-was beautiful but daunting tocreate. “We said, ‘never again,’” recalls Abel. “It was time to write newcode.”

The emerging trend at the time was raster graphics, which displayed solid,shaded objects composed of thousands of pixels. “We knew that vector-fillwas just a transitional phase and that raster graphics was where we wereheaded,” says Hughes. “As soon as we could afford to build a rastergraphics system we did.” A key part of that investment was hiringprogrammers. Keating remembers that raster graphics called for moresoftware skills than the average technical director had, so the team

had tobring in more software people. “Bill Kovacs and I looked at the system andrealized we had all the components,” recalls Hollander, who had agreed tohelp write the raster code. “We could use the E&S to preview what we weregoing to animate, and we could to do 3-D animation. All we needed was arenderer, so I introduced Bill to Michael Wahrman, and he was hired towrite that,” he notes. “Everybody had ideas for that-Michael, Bill, Con,and myself. What was exciting was that we were adding a component that wasquite realizable into an animation infrastructure that was very mature forthe industry at that time. The process of tying it all together was veryrewarding. It laid the basis for many of the concepts that Wavefront wouldlater develop.”

In 1981, when Wahrman arrived at RAA, the UNIX/C programming language wasreplacing FORTRAN. “Wahrman was our UNIX guru,” says Kovacs. “He wrote thecore renderer, and Hollander wrote the light models.” The tools they had towork with then seem laughable today, observes Wahrman. “You couldn’t buy aUNIX workstation or a paint system, and our film recorder was Tom Barronshooting off the screen! But even with limited computing resources, wedeliberately integrated our work into Abel’s visual effects productionmethodology. We had a great group of filmmakers as mentors, and we’d listento them and put their ideas into code. Unlike other software at the time,this code came out of a grass-roots production facility. Everything camefrom trying to solve problems for people like Tim McGovern, Frank Vitz, andJohn Hughes.”

McGovern, who arrived in 1981 like Wahrman, recalls that the productionprocess was pretty arduous. “We had no scanners, and to even record asingle frame to video required expensive gear and tricky programming.” Notonly was the software in a constant state of evolution, it also had no userinterface. RAA could not squander software development time on making thetools artist-friendly, so TDs like McGovern sat with art directors in frontof computer screens and became virtually joined at the hip. Kovacs says theTDs’ intelligence made the software work on deadline. “Our system was likea piano,” he laughs. “A piano’s 88 keys are also a pretty user-un-friendlyinterface, but you can play Mozart if you practice.”Their raster capabilities

increased when Abel purchased the first SiliconGraphics IRIS workstation in 1982. McGovern explains, “Now we could drawfully rendered images on the screen.” Of course, RAA needed newprogrammers, and Kovacs hired Roy Hall and Kim Shelley to write thenecessary code. Shelley wrote choreography software that would allow themanipulation of multiple objects. “The early SGI hardware was effective butslower than hell,” notes Kovacs. “It was difficult to get TDs to work withit, yet Kim needed observational information on how they’d use it. It’s notcode until it produces images that TDs want. Without their input, aprogrammer can easily stop short.”

Hall’s task was to write rendering and compositing software for the SGI.The Cornell scientist soon learned what it meant to program for filmmakers.”I’d write software, and they’d say ‘We really need to do this,’ so I’dadjust it. Then I’d come in after they’d been up all night and see stuff onscreen and go: ‘Wow-who did that? Where’d that software come from?’ They’dsay, ‘We found out that if you make the intensity of the lights negative,it sucks out the light and makes shadows.’ I’d think, ‘Oh, that’s a bug inthe software-you’re not supposed to be able to do that.’ But they’d say:’Don’t change it! Give us more of those bugs!’ We had this incrediblesituation where people were doing marvelously bizarre things. I was tryingto do science, but they had pictures to make and not a lot of time to doit.”

Pederson recalls: “Bob would pitch a job and get it, and then we’d try toback him up. Our software people were always responding to a job-not justthe one at hand, but also the next job we were pitching.” Despite thisworkload, Abel took the unprecedented step of devoting resources to anexperimental raster film, the Randy Roberts-designed short, “HighFidelity,” in 1983.

“We wanted to prove that we had raster code,” says Abel. The film, whichdepicted geometric characters emblazoned with colorful patterns, became amilestone. It

initiated strategies for animated texture mapping andreflections and also confirmed for Abel that the company's evolvingsoftware was essential to success. "Having great rendering code helpeddistinguish us," he says. "We had such good artists, and our code couldrender up to the level where our eyes said 'That's great looking.' Ourstuff took on certain sensory qualities instead of seeming plastic, whichis how so much CG stuff looked."

During the production of "High Fidelity," Kovacs became convinced thatRAA's code was marketable and proposed an expansion into the commercialsoftware business. While Abel saw the potential (and would later sellsoftware under the name Abel Image Research), Kovacs felt that productionwould always be Abel's overriding interest. After meeting Santa Barbarabusinessman Larry Barels, Kovacs recalls thinking that "nothing couldhappen without the focus of a dedicated company." Yet he was reluctant toresign and partner with Barels. "'How can I leave?,'" he thought. "I'd haveto rewrite all this code!' But I realized that even if Bob said 'Take thecode,' I'd have to rewrite it to really make it salable. I also realized itwas in my brain. Software is nothing more than a condensation of ideas-ifthe ideas are firm in your mind, the software is literally trivial towrite. Most of the time people spend programming involves screwing aroundwith prototypes. You write something, use it to find out how functional itis, and then rewrite it. I'd gone through so many revisions before, Ididn't have to guess."

So in 1984, Kovacs began writing his new code, trading computer time onJohn Hughes' personal IRIS machine for stock in a new software companycalled Wavefront Technologies. "I knew we'd ultimately need a completesystem-one that would let you model, animate, and render. I started withanimation because that was the new thing to really be solved. There wasnothing out there that could preview animation." Kovacs' productionexperience had taught him to think like a cameraman, not a computerscientist, and he expanded the camera-oriented paradigm of the RAAsoftware. "The first thing I did-because Abel's system only allowed forthree independent objects-was to switch to an infinite number of objects,lights, and cameras in a flexible hierarchy."

Wavefront also got new modeling code from Keating and a new renderer fromHall. “My job was to find some way to easily produce 3-D data,” Keatingnotes. “We had the habit at Abel’s of combining material from many places,and that guided our philosophy. We wanted to be able to incorporate datafrom a keyboard, a tablet, or other kinds of input.” Flexibility was also avirtue of Hall’s renderer, notes Kovacs. “It had complete resolution andformat independence. It was also the first object-oriented piece of code inthe animation industry, and that benefited us immensely. Roy built in allthe coolest principles.” Says Hall: “The big thing was that we integratedstuff really well. We paid meticulous attention to detail. Wavefront’simages had edges that were really good. We’d learned at Abel’s that if youdon’t get that part right, things fall apart.”

Abel himself continued to produce award-winning animation with RAA’s code.RAA created the famed “Sexy Robot” and innovative spots for Benson & Hedgesand Hawaiian Punch with the software that Abel eventually sold to Kovacs.Wavefront itself pursued some production work under the direction of JohnGrower, (now of Santa Barbara Studios), which Kovacs says “let us test ourtools.” Hall notes: “John never let us forget the name of the game wastelling stories, and our tools should serve that end. The greatest thingthat Bill and I and Jim Keating had going was that we’d been in production.Many people were writing software to solve problems they didn’t understand.We knew what the questions were.”

They also knew that customers would keep demanding new capabilities, justas Abel’s people had. To keep pace, Kovacs’ team structured Wavefront in away that invited custom code-users could write their own plug-ins asneeded. “Rhythm & Hues started with Wavefront and kept customizing it untilthey eventually replaced it,” notes Kovacs. Con Pederson, who still usesWavefront at MetroLight Studios, sees all this history as

a naturalevolution. “It’s technological Darwinism,” he states.

Wavefront’s influence was underscored earlier this year as Kovacs, Hall,Hollander, Keating, and Wahrman accepted their honors from the MotionPicture Academy. Hall views the honor as “an acknowledgment that atechnology that was so inadequate for so long actually has matured.” Kovacshappily agrees. “It was one of the few times in my life that I accuratelypredicted where things would go!”

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