

The Rise of a New Art Form-The Birth of MoCap

by Nancy Anisfield

As motion capture approaches its fifteenth birthday, third generation magnetic tracking technology is taking the “sensory experience” of mocap to a new level. The stats are impressive:

- A character in a 20-minute cartoon can be animated in one-tenth the time it takes to produce the same result with traditional tools.
- The full-body motions of up to five performers can now be simultaneously captured in real-time--without occlusion-- for close interaction of multiple characters.
- Wired and wireless motion-capture suits now realistically capture even the most subtle natural motions.
- New tools overcome metal and noise issues that once plagued the effectiveness of magnetic tracking systems.

Call it “body snatching.” Call it “sensorship” at its best. While much of mocap’s creative potential still lies untapped, it is clear that magnetic motion capture has come of age. Mocap has advanced to center stage

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Working in marketing at Polhemus Navigation Services back in the early 1980s, Jack Scully knew motion tracking had a commercial future beyond military applications. He also saw that computer graphics markets were poised to discover motion tracking. What he did not know when Polhemus gave him and engineer Ernie Blood their walking papers in 1986, was that their start-up motion tracking company, Ascension Technology, would start a revolution in the way computer generated characters are animated.

Enter Chris Walker: producer, director, entrepreneur. Trained as a classical animator in the Disney style, Walker was also an innovator and inventor from the beginning of his career. He once designed a six-plate multiplane animation stand for shooting traditional cells. He also developed stereo techniques for motion control and backlit animation. And he believed real-time sensor feed-back technology would one day overcome the tedious process of animating characters.



Ascension's Jack Scully (left), and Modern Cartoons Chris Walker (right) reminisced at Siggraph 2004 about their early collaborations that led to the development of motion-capture technology for animating computer characters.

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Although estimates varied, the average cost traditional television animation back then was \$10,000 a minute. A 30-second commercial could take eight weeks or more to produce. (Today, 3D animated theatrical movies such as *Toy Story* and *Shrek* can cost up to a million dollars a minute.) Pursuing an antidote, Walker founded Mr. Film Studios in 1987. The new production company was dedicated to the creation of high-quality computer-generated character animation along with the development of tools to assist in real-time animation and motion capture. In the beginning, Mr. Film animated characters using keyframe techniques on a PC, a somewhat more automated process although rendering typically took 45 minutes per frame. Still impatient, Walker pressed on, examining every technological option that might suit his mission.

“The first sensor technology I looked into was audio-based, using sparkers to triangulate between sound frequencies,” says Walker. “Optical motion tracking wasn’t an option back then. It wasn’t real time. I wanted to speed up the process. Optical motion capture not only required lots of post-processing, it was not as sophisticated as magnetic tracking. I spent a lot of time at the Sensors Expos in the early 90’s, looking at every type of technology possible. It was there, or perhaps through *Sensors Magazine*, that I first encountered Ascension.”

Scully and Blood had founded Ascension Technology in 1986. They had both been at Polhemus when the original patents for AC magnetic tracking technology were issued a decade or so earlier. The AC magnetic trackers were, at that point, primarily used to track the movement of a military pilot's helmet for automating target acquisition.

The drawback to AC magnetic tracking technology has always been the data distortion caused by interference from nearby metals. During Ascension's first year, Blood developed DC magnetic field tracking technology to reduce metal interference problems. DC technology proved to be far more resistant to interference from metals in the environment, including those in aircraft cockpits.

"We had no thoughts of using trackers for animation in those early days," says Scully. "It was all simulation and early VR. Chris conceptualized the mocap process for animation."



Real-time motion capture was born at Siggraph 1991 when Chris Walker and Steve Tice introduced Silver Suzy as a new way of automating the animation process.

In 1991, Walker, in collaboration with Steve Tice of SimGraphics, presented his vision of the future in the "Tomorrow Realities" Forum at SIGGRAPH. It was there that "Silver Suzy" – and motion capture itself – made their debut. Listed as "Project Number 18, Performance Cartoon," the program description read, "This prototype attempts to address two major computer character animation issues—quality of performance to achieve screen personality and automation of production techniques."

Silver Suzy was the first application of sensors and real-time sensor feedback to character animation. One magnetic sensor was used to either measure the position and orientation of a surfboard or alternatively act as a controller for a virtual camera. Along with a SimGraphics Flying Mouse and Virtual Technologies CyberGlove, the system set Suzy in motion as she surfed through a star field. An on-loan SGI Skywriter computer, SimGraphics software and a laser projector produced the display.

Walker describes that first mocap animation as "just a way of tilting Silver Suzy's surfboard or changing the camera position. Additional software animated Suzy, so it appeared that she was keeping her balance, leaning into the turns while surfing the galaxy." Silver Suzy was *the* buzz at SIGGRAPH '91 and later at the IDEAS '91 conference in Singapore. But more sensors and a more robust system were needed for tracking the character itself, so Walker contacted Ascension.

"I remember Chris as a low-key yet strong advocate of computer-assisted animation," says Scully. "He was bored to tears by keyframing and was actively looking for a better solution. At first, we regarded his work as neat, but limited in sales potential. Still, we decided to support him to see if something good might happen. Within two years, it happened. A new market was born. We knew we were ready for primetime when prestigious special-effects houses, including Pacific Data Images and Industrial Light and Magic, started calling us."

At that time, Ascension was working with NASA Ames to develop a long range, four-sensor tracking system for virtual reality applications. They had built a few extra prototypes and lent one to Walker. One memo, dated January 2, 1992, serves as a formal introduction to the versatile tracking system now used worldwide in industries as diverse as oil exploration, flight simulators and biomechanic feedback.

"Dear Chris: Enclosed please find an information packet describing The Bird – our six degrees-of-freedom input device. The advance copy of our new Flock of Birds press release describes how the technology can be employed to track multiple sensors."

Using Flock of Birds serial number 001, Mr. Film then created "Dr. Scratch," a hip-hop skeleton who debuted at SIGGRAPH '92, dancing to an ecology-themed song by rapper Ice-T. A short Dr. Scratch videotape soon traveled around the world, heralding a new era in computer animation. It demonstrated that the motions of a human being could be used to animate a computer-generated character in real time.



Dr. Scratch, the world's first mocap character for feature film

Within a few years, Walker had developed a full magnetic body suit and lobbied hard for more sensors per performer. Early suits were soon equipped with data gloves, a facial expression tracker and nine body sensors. Mr. Film's in-house production studio, The Blue Room, was equipped with a blue screen and stage supporting a full range of real-time character applications.

At the same time, Ascension's magnetic tracking technology was also moving forward. Dr. Scratch's moves had made him an instant star, but Scully remembers that early Flock systems really were not designed for character animation. "The Flock was essentially a stack of up to 12 plastic boxes, one box per sensor, each with power supply cables. Each box also had its own RS232 cable hooked to a terminal server, which provided Ethernet interface to a host computer. Not exactly compact," Scully recalls.

"It could be a mess," Walker says. "But we solved the problem fairly quickly. We stacked the boxes above the performance space, then wrapped the cables in bundles with a bungee cord hanging down. That way, the cables would stay retracted up and out of the way as much as possible. The cables were only eight feet long, so they weren't so long and did not get tangled."

Although Walker says the wrapping system worked extremely well, he soon approached Ascension with the idea of a more compact system, then a wireless system.

To remedy the multi-box problem, Ascension first developed MotionStar, officially releasing it at SIGGRAPH 1995. "It contained a rack-mounted chassis for all sensor electronics and a fast Ethernet interface," says Scully. The following year, Ascension solved the rest of the problem: the 20-sensor MotionStar Wireless set performers free—no tethers, no cables.



Hilbur, star of Mr. Film's first mocap tv series.

As magnetic motion tracking advanced, responding not only to animation's needs but to commercial markets elsewhere, motion capture started moving forward in leaps and bounds. In October 1994, Walker's *Hilbur & Company* debuted on Scandinavian television. Working with TRASH Television, a Swedish production company, Walker created the first mocap children's show, starring a rascally little cyber-monkey. Hilbur was animated with MotionStar sensors and rendered in real time using an SGI "Reality Engine" computer. Over 800 episodes were broadcast over three years.

Top Cat appeared the next year, transforming the original 1960s feline into a talk show host interviewing celebrities such as *Baywatch*'s David Hasselhoff and *Guns & Roses* guitarist Slash. This interaction between an animated character and human guests introduced TV audiences to real-time performance animation. Soon after, Mr. Film morphed into today's Modern Cartoons Ltd. with arguably the mocap industry's most extensive list of credits.

Walker remembers an early epiphany. In 1995, he created Carmen, a blond bombshell who became a star on Portuguese television. "The revelation came working on Carmen, when we put all the pieces together," Walker explains. "When we combined face and gloves and suit, we saw something entirely new. For the first time we were not treating facial capture or the gloves as something on the side. At that moment, I realized the potential of motion capture. Mocap should be an actor and a director merged together within the paradigm of performance. The director no longer tells the actor what to do; at times he is the actor."

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As the popularity of magnetic mocap grew in the late 1990s, many new competitors entered the animation marketplace. These included mechanical (Anogalus) and optical (Motion Analysis and Vicon) technologies. The optical systems had previously been developed for biomechanical research and analysis at the university level. During this time, most animators chose DC magnetic tracking for motion capture because of its real-time capability, affordability, portability and ease of use. Optical systems using banks of passive cameras found a niche market for those interested in capturing extremely accurate measurements over long ranges. When first introduced, these systems still did not provide real time tracking and still relied on extensive post processing to achieve their results.

According to Scully, DC magnetic and high-end camera systems are the chief technologies used today by most animators. “While the price of passive optical systems now approaches wireless magnetic systems, they still must overcome occlusion problems and typically cannot track more than two performers at once. DC magnetic systems, such as MotionStar Wireless, now track up to five performers simultaneously as we did for Sony Entertainment Europe’s *The Getaway*. Recent enhancements now provide data that is nearly as clean and jitter-free as top of the line optical systems,” Scully says. He adds, “We also now offer an active-optical system, ReActor 2, that provides great accuracy and overcomes data dropouts caused by optical marker occlusions.”



Sony Entertainment Europe's *The Getaway*, for Playstation 2.



Radio Shack's Battery Man

Since their introduction, Ascension’s MotionStar products have been used to capture human movements for hundreds of characters in motion pictures, television shows, computer games and ads. MotionStar’s cast of characters includes, among many more, the Pillsbury Dough Boy, Donkey Kong, Roughnecks Starship Troopers, Larry King at the Super Bowl, Jay Jay the Jet Plane, lottery game host Basil Basset, Doonesbury’s Duke, the New York Knicks’ TecKnick, and Radio Shack’s Battery Man and Charge Boy.

MotionStar Wireless 2 now has new backpack electronics and improved algorithms, delivering the most data per sensor of all motion-capture trackers. Modern Cartoons, now based in Berkley, California, continues to expand its horizons. They recently set up a studio at the Fiji Institute of Technology and are working on a full-length film, *The Great North Pole Elf Strike*, to be released at Christmas 2005.

Motion capture continues to offer significant time and cost savings. In Walker’s view, “Motion capture replaces the step of acting out a scene on video tape which the animator then uses for reference. This is an incredibly fast way of getting human motion into a computer representation of the acting. My guess is that animating characters in a film with motion capture techniques can probably save 70 percent of labor costs. That represents a bundle of money on a major film production.”

“Motion-capture technology started at the very high end of the market,” says Scully. “Now it’s becoming available to animators and even educators at entry levels.”

According to Scully, what cost \$250,000 just ten years ago is now available with better performance at less than \$25,000.

At Siggraph 2004, Ascension launched this next wave in mocap technology with the release of AnimationStar. It is a turn-key, truly affordable workstation for capturing human motions and animating 3D characters. Based on PC computing, it contains all hardware and software (Alias-Kaydara MOCAP 5.5) necessary to bring the great benefits of Chris Walker’s mocap vision to animators in all walks of life.

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