"Biped": A Dance with Virtual and Company Dancers, Part 2

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Part one of this article (see *IEEE MultiMedia*, Vol. 6, No. 3, July-September 1999, pp. 4-7) reported the premiere of Merce Cunningham's "Biped," critically acclaimed for its unique mix of physical and virtual choreography. "Biped" employs motion capture to record the physical dance moves of two company dancers and to transfer the movements to the virtual skeleton within the computer via the Character Studio plug-in. Riverbed artists Shelley Eshkar and Paul Kaiser created and texture-mapped fluid hand-drawings onto the skeleton. (The skeleton disappears and only the drawings are visible.) In live performance, these abstract apparitions are projected on a scrim (a transparent material separating the dancers from the audience).

In the intervening months, the talents that converged to spawn "Biped" have moved on from the collaboration to resume their original creative paths. The Merce Cunningham Dance Studio has been on European tour with "Biped," and Riverbed's Kaiser has debuted a solo work in the San Francisco Bay Area. Discreet and Unreal Pictures continue to refine and adapt the capabilities of the Character Studio software to the latest release of 3D Studio Max. So how did they come together in the first place, and how might they again?

Merce Cunningham

In her July, 1999 review of "Biped" for *The Village Voice*, Deborah Jowitt described the Cunnigham style as follows:

> His dancers—with legs attenuated, feet as busy, and spines often as lifted as any ballet artist's—give the illusion of making choices, even when complexities beset them. They can tilt their bodies, slash their arms, circle their heads, while tearing around a space rendered ominous by electronic storms of music and still look as if this is what they've decided to do. This is how they cope with whirlwinds.

But within Cunningham's style, "Biped" stakes out new ground. In performance, "Biped" is the third of three pieces, following "Summerspace" (1958) and "Sounddance" (1975). The first two works reflect the time of their creation and their place in contemporary art history. Given Cunningham's musical collaboration with John Cage and with his art directors during those times—Robert Rauchenberg and Jasper Johns—it's no surprise these earlier works reflect issues that dominated formalist painting and music when they premiered.

"Summerspace" reflected frenetic isolation, as dancers appear to scurry about self-absorbed, without regard for each other. It's raw and abrupt, even violent compared to the second piece: dancers in "Sounddance" appear more fluid. Not only did the dancers interact, but their speed, flexibility, and fluidity revealed more of their classical ballet training.

Described as a "visual artist's choreographer," Cunningham has a long record of embracing technologies for what they bring to dance, as well as using them as development and instructional tools. In the 60s and 70s he pioneered choreography for film and video, focusing on what the language of cinematography brings to the mix: how cameras move, cutting from one camera to another, and so on. However, his embracing computer technology in the early 90s derives as much from utility as from adventurousness—motion capture and 3D computer graphics presently offer the most accurate way to record dance.

Working with computers

Cunningham worked with computers in dance for the five years preceding his involvement with Kaiser and Eshkar of Riverbed, and Michael Girard and Susan Amkraut of Unreal Pictures. Life Forms was realized in a joint venture between the dance and science departments of Simon Fraser Universi-

Figure 1. Still image from "Ghostcatching." The virtual dancer maintains volume, yet the expressive lines accentuate the dynamics and grace of movement.

ty in British Columbia, with Cunnigham and Thomas Calvert of the university involved in the initial development. Subsequently, Life Forms has undergone further development and distribution by Credo Interactive. Priced under $500, the recently released Life Forms Pro version 3.5 is a character animation tool for choreography, previsualization, commercial and forensic animation, and movement planning for game developers. Unlike cinematic animation products such as Alias|Wavefront's Maya or Discreet's 3D Max, Life Forms is used primarily to develop motion sequences for export into other 3D modeling, animation, or production environments. In other words, it's a choreographer's notebook. As to his reasons for involving himself in tool development, Cunningham said,

> One of its uses is as a memory device. That is, a teacher could put into the memory of the computer exercises that are given in class, and these could be looked at by students for clarification. I have a small number of particular exercises we utilize in our class work already in the memory. But my main interest is, as always, in discovery.

The road from "Hand-Drawn Spaces" to "Biped"

"Hand-Drawn Spaces" was the first effort between Cunningham and Riverbed using the Character Studio software. Motion-captured dance was mapped onto the virtual skeleton, and from still frames of these movements, the artists modeled 3D figures, which they then animated with motion-capture data. The performance consisted

of the animated virtual choreography with the music track.

Thereafter, Kaiser and Eshkar worked with dancer Bill T. Jones to expand the idea of virtual performance at the Arthur A. Houghton Gallery of the Cooper Union School of Art. As skeptical as he initially was about archiving dance with motion capture, Jones became enthusiastic thanks to the accuracy of the captured results. The goal of their collaboration, "Ghostcatching," was to examine both the dance and space occupied by the virtual dancer.

Eshkar revised his drawing style to take advantage of the data's accuracy while maintaining figurative volume. He created line drawings to be texture maps placed on a virtual skeleton: no longer an animated sequence of 2D drawings, each character receives one simple drawing that remains expressive and maintains continuity throughout the sequence. The viewer sees a 3D gestural line drawing in motion that reveals the volume of the character and implies the environment it occupies (see Figure 1). With this bridge from 2D animation to a 3D volumetric motion-capture-driven dancer, the stage was set for the live and virtual dancers to perform together, in what became "Biped."

Working on the Biped

When Riverbed's Kaiser and Eshkar proposed using motion capture with Character Studio as a means of exploring the Cunningham dancers' motions, and 3D spaces as revealed through their motions, the software had not evolved suitably for the task. The Character Studio plug-in for Discreet's 3D Studio Max modeling and animation software (see Figure 2) consists of two modules: a virtual skeleton, or Biped, for which the piece is named, and Physique, used to skin the skeleton with a character mesh. While it already had the advantages of built-in inverse pendulum dynamics to show an accurate, gravity-driven walk cycle and proper anchoring, collision detection, and locomotion through footstep placement, Character Studio could not accommodate raw motion-capture data and afforded no way of joining and editing existing motion files. Unlike Life Forms, 3D Studio Max has a highly evolved tool set for building and texture-mapping characters, whether photorealistic or fantasy based, which made it preferable for generating the final ghost-like images used in the performance. Cunningham's involvement in developing Biped became much of the R&D and primary beta test of

what would become Character Studio 2.0.

Dancer Jeannie Steele took part in the motion-capture sessions used to create "Biped" and in all performances of "Biped." I interviewed her for this article just prior to the company's departure on tour with "Biped" in France, Germany, and Italy this fall. Asked what it was like to see her dance movements in virtual space, Steele answered that at first she was astounded to see the accuracy of the data from the unfiltered sensor patterns—not only could she recognize the distinctive dance movements, she could distinguish her pattern as unique from her fellow dancer. Then there was a secondary feeling of mild humiliation, much like hearing one's own voice on a tape recorder for the first time.

Asked if performing "Biped" differs from performing other Cunningham works, she noted that only rarely is she aware of how this piece is different. "Biped" begins with five solo dances before the first computer graphics character appears. Steele moves on stage as the first virtual dancer appears. She described her first performance with the character as bringing feelings of "being safe" or "having another person dance with me" and "dancing in an imaginary realm" because the dancers see what the audience sees. However, because the dance phrasing is so complex and requires complete concentration, she said these feelings were quickly replaced by her focus on executing her part of the performance.

The dance company's choreography and rehearsals follow the tried and true Cunnigham approach. Every step is choreographed and repeated in each performance. Likewise, the motion-capture data was cut up, recombined, reworked, and recombined again, until each virtual dancer's program was fixed prior to the premiere. Similarly, the set, costuming, and score do not change.

At the premiere performance in Berkeley, one audience member familiar with Cunningham's work by reputation only commented on "Biped's" raw quality and how scaling the virtual dancers at normal and larger-than-life size added heroism to their stature. She acknowledged her earlier skepticism about mixing a light show with dancers and had been prepared for disappointment. But afterward she found the dancers needed their virtual colleagues—they provided wings.

Where will they go from here?

The obvious question is "What's next?" "Biped" is touring Europe this fall and the Western United States in the spring. Steele said she's not planning
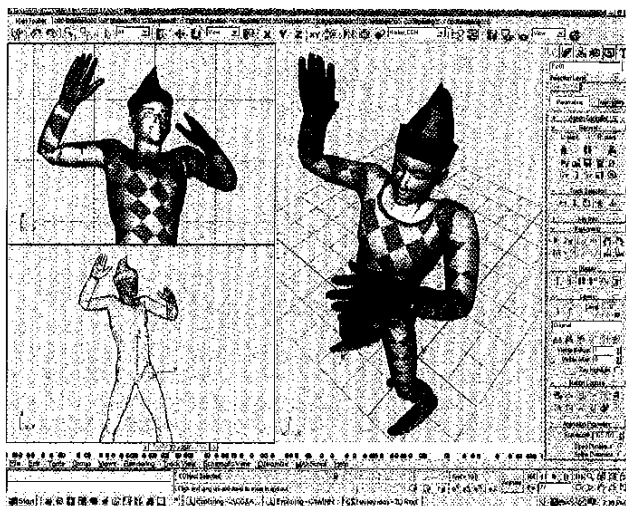

Figure 2. Screen shot of the Character Studio plug-in.

beyond that date, although she sees Cunningham using Life Forms almost daily on his Macintosh G4. There are no current plans to produce "Biped" on film or video. Kaiser and Eshkar will be working with Cunningham again on "Loops," one of Cunningham's earlier solos. This time they will motion capture only the maestro's hands.

Kaiser's solo piece at the California College of Arts and Crafts Gallery in San Francisco departs from the technologically based work done on "Biped." Named "If By Chance," the piece involves projecting a series of randomly distributed black and white cubes on screen while a soundtrack composed of dial tones, sine waves, and silence plays in the background.

I, for one, have two hopes for future directions. Modern Uprising is exploring the first—to develop motion capture into an inexpensive, flexible technique for archiving human movement.

The second is for these parties to build on what they've done and advance "Biped" the next step. With "Hand-Drawn Spaces" we saw motion capture applied to skeletons and hand-animated with gestural drawings to create the dance. With "Biped" the drawings were mapped onto the skeletons, and the resulting virtual dancers are projected onto the skrim and stage. I'd like to see real-time virtual reality applied to the mix. That is, by spanning the performance across two networked spaces—each with a separate dance group and audience—using real-time motion capture to generate the virtual dancers. The physical performance before one audience simultaneously generates virtual dancers for the other and vice versa. **MM**