When we speak of the role of computers in art, we could be referring to quite different things: art that is concerned with computers, or art that is merely created using computers. In the first case, a computer might be part of the presentation of the piece. Many such works combine visual and sound elements and result in works that are dynamic in nature. They may include projections, video walls (banks of TV screens), or other technologies and involve the public in new and unusual ways. Pieces that additionally somehow react to or change because of the viewer’s presence, “interactive installations,” represent in their scope and sophistication a burgeoning new area of art.

The second case, the use of computers as tools in artistic creation, is by now ubiquitous. Graphic art and design, video, photography, television, film, and music production all use computers today as a matter of course. But note: they are used in explicitly benign ways. The audience of the final product is specifically not supposed to be aware that a computer was involved in its creation. The synthesized piano heard in the pop song should not allow a moment’s doubt that it is anything other than a real piano. The digitally retouched photograph should convince you at a glance that the scene it depicts really did exist. The level of sophistication and prevalence of such techniques in all communicative media represent a profound change in the nature — or what Marshall McLuhan called the “subtext” — of the information reaching the public, and in this sense represents a force of change in our society. So McLuhan,
“The new media and technologies by which we amplify and extend ourselves constitute huge collective surgery carried out on the social body.... It is the entire system that is changed. The effect of radio is visual, the effect of the photo auditory. Each new impact shifts the ratios among all the senses.... No society has ever known enough about its actions to have developed immunity to its new extensions or technologies. Today we have begun to sense that art may be able to provide such immunity” [1].

In contrast to computer use in the more commercial arts, artists in the fine arts often reverse the situation. Instead of hiding it from us, they may deliberately seek to confront us with those qualities unique to computers, making pieces that are clearly beyond the capability of non-computerized methods. Computers are “turned on themselves” so that the final creation comments on the computer’s present or future role in society. Some of these artists are concerned with how we feel when we use computers, others focus on the onslaught of information that computers and electronic media are inciting. Still others work with Internet systems to create “web-based” art, a new concept of art in its own right. It was not long ago that these “thinking machines” were impressive in and of themselves. Computers fascinated us aside from anything they could actually do. I think it is fair to say that much of the success of early computer art capitalized on this fact. Those times have been compared to the early days of electricity, when new products were deemed exciting (and successfully marketed) simply for being “electric.” One could, for example, buy an electric bow tie. Though this earliest phase of the computer age may be waning, neither is the computer age mature. Though their physical presence — the ubiquitous ivory white box, trapezoidal monitor, and keyboard — is no longer of any particular interest, to a great many there remains a special kick involved with their use.

Many feel that our use of computers is, in many cases, entirely out of proportion to their usefulness. When you figure in the time it takes to learn them, many users may actually suffer a net loss in time economy because of the conversion to computers. Clearly there is something about computers and computer software which leads us to feel that they are more useful than they in fact are. Are they only very cleverly marketed, or are there other subterfuge factors drawing us to use them — factors that have nothing to do with their usefulness or time-saving properties for which they are touted? For example:

1) The attraction of the screen with its radiant and moving images. (Anytime there is one in the room, our eyes tend to go to it.)

2) The tactile feeling of the keyboard to our fingers.

3) The feeling of power we get to control large and complex systems with minute, trained movements.

4) The feeling of being on the “cutting edge” of an important fast-moving trend.

5) The general love of clever gadgets performing tricks for us? An attraction to futurism, science fiction, etc.?

6) The neatening and homogenizing effect computers have on how we express ourselves through text, graphics, etc.

7) The pleasures of a new “level” of existence, i.e., cyberspace. We can more easily collaborate and converse in new ways — on the “level of ideas” — without having to physically encounter those with whom we deal.

8) A largely false sense of security we get that our work is safely stored away (for posterity?).

9) A way, for many, to find companionship or sexual simulation.

10) Computer use is fashionable.

Together these factors may comprise the lion’s share of our collective rush to computerize (particularly in the consumer world). A large part of our interest in computers may thus be misunderstood or is going unnoticed. Such issues as the subconscious underpinnings to personal and collective behavior and the larger conundrum of where this technology is leading us, are, if nothing else, the dominion of the arts and artists.

Dance and the Computer

Dancing boasts an ageless tradition of undermining the intellect. Therein, it has been said, lies its power. From this perspective, the computer, as the ultimate tool of the intellect stands diametrically opposed to the art of dance. Dancers are, if nothing else, a group united by their faith in the inherent wisdom of the body. I wouldn’t say we look askance at the intellect exactly — it is enjoyed, but it is mistrusted. Look at
few inroads into dance, either in its design process, its recording, or as a medium through which it is presented.

In my work as director of the Palindrome Dance Company (now based in Nuremberg, Germany) bringing together the apparently contradictory worlds of dance and science has long been my focus.

A few years ago, I was working on a piece in which five dancers systematically weave in and among themselves in a complicated pattern. In order to sort it out — which dancers go where — I needed an overview. I began working with a software called “Life Forms.” With it, one can prescribe movements according to three parameters: shape, time, and travel around the stage. The beauty of the system is that these parameters can be approached independently, in separate windows. Using a mouse-controlled system, one begins by designing a series of shapes onto a figure on the screen. Each joint of the body is controlled separately. These shapes become the “key-frames” and the program calculates the “tween-frames” necessary to bring the on-screen dancer into motion. Her limbs, torso, etc., all smoothly move from one shape to the next. The graphics are three-dimensional and allow the user to view the dance from any perspective. In my case the overhead view was useful.

Though Life Forms is occasionally used in the dance world (most notably by the choreographer Merce Cunningham), it turns out not to be a terribly useful tool. Most who take the time to learn it do not go on to make very many dance phrases in this way. With a few special exceptions, it is generally faster and easier to solve choreographic problems in the studio directly with your own or other’s bodies. Whether future generations of such software prove more useful is anyone’s guess.

There are other scattered uses of computers as tools in choreography. Bill Young is a New York-based choreographer who uses a self-written program to randomly determine combinations of dance partners, body parts which must come in contact, and the direction of weight and energy to be transferred between the two. Printouts are distributed to the dancers who then have the task of working through the sometimes bizarre requirements to arrive at last at a remarkably smooth and harmonious result.

In general, however, viewing computers as tools, we could say that they have proven themselves to be pretty ineffectual in the art of dance.

The best known of these is “Labanotation,” which was developed by the German dancer and “Tanztheoretiker” Rudolf Laban in the early part of this century. It allows a remarkably complete record of human movement in all its detail and even includes notation for the qualities with which a movement is made. It is not uncommon to find it taught in university dance programs in the United States though few dancers become fluent in its use. For simply recording choreography the video camera is certainly the method of choice.

Founded in New York City in 1982, the Palindrome Dance Company has been based in Nuremberg, Germany, since 1987. Palindrome has an unusual focus: to make dance works, interactive performance pieces, installations, and workshops that correlate concepts and phenomena from science and technology with art. Sometimes, as in the case of the dance “DNA...” (1981), the connection is literal. The dance is a scale model of the DNA molecule — the blueprint for all life on earth. Other pieces, such as “Mobius Band” (1995) and “TRIO A” (1989) combine symmetries in time and space and function like puzzles that the audience solves as they watch. It is their artistic concept to bring science and technology into the sphere of art.

The rapidly-changing manifestations of science and technology are ubiquitous and touch us in personal ways. This happens not only as we use new tools, such as computers, but also through the emotions that accompany new understandings of the world around us. Palindrome brings together these seemingly disparate fields — the intuitive/feeling world of the artist and the analytical/thinking world of the scientist that each may be illuminated in the context of the other. Since 1994, they have focused on the use of computers and other technologies to generate new kinds of interaction between performing media, as well as new ways of involving the public.

The current Palindrome Troupe consists of four German, Swiss, and American artists and scientists, although for given performances the size may swell to 13 or more to include additional dancers, athletes, musicians, visual artists, computer engineers, and so on. The style of presentation is not theatrical. Roles are not played, stories are not told. Rather, performances are based on well-formed ideas articulated through projections, explanations, dance, and music. Palindrome performs with live music.

More information can be found on our web site: http://our-world.composeserve.com/homepages/palindrome

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But this misses the computer’s real significance in art. According to Timothy Binkley, a leading proponent of computer art, the computer is not really a tool at all. It can simulate many tools, including those that are useful in completely unreal worlds — beyond the point of physical possibilities. Binkley writes, “Rather than a physical tool, computers are a conceptual procedure.... The computer’s prowess portends abundant assets of an entirely different order. It supplies not supple substance, but agile agency. An unprecedented partnership between artist and machine transforms the art-making process and does not simply add another medium to its stable” [2].

Recent advances in software for music composition, sound generation, theater lighting, and the visual arts are bringing these formerly independent fields into ever-greater compatibility. Viewing the computer as a kind of collaborator, a new world of possibilities arises. Together with Frieder Weiss, a computer engineer, I have been focusing on the use of computers in performances since 1994. The results, which might be described as interactive multi-media dance works, have been encouraging. Computers in dance performances can:

- Allow direct interaction between media (for example, movement, lighting changes, music, sounds, projections). Dancers can perform in a stage environment that responds to their movements.
- Allow the audience to play an active role in performances.
- Give a dance a particularly spontaneous quality.
- Aid the public to understand complex movement patterns and other aspects of the dance as it is being performed.

We began by reviewing a variety of possible performer and audience “input” parameters — actions that can be measured by sensors and converted to digital input for the computer. Once “in” the computer, the choreographer, composer, and programmer worked to develop ways to combine and process the information for an evocative result. But to create a piece that is truly interactive — one in which a performer working in one medium affects changes in another which in turn affect the next action of the performer — new collaborative structures were needed which allow information to flow in new ways.

In a sense, interactivity is nothing new to dance. To a great many ethnic dance and music traditions, interactivity is crucial to their life and liveliness. There are, for example, African dance and drumming traditions in which these two activities are so closely intermingled that even their language reflects this: there is only one word for both activities. In classical ballet, no one would deny that the music can affect the way the ballerina dances, and perhaps the action of the dancers on the stage can also affect the way the musicians in the orchestra play. Nevertheless, it is clear that the role of interaction is diminished. Indeed, by far most ballets and modern dance pieces today are performed to recorded music. To me this trend underscores the importance of finding new ways to invigorate a performance with the liveliness that interactivity brings with it.

Interactive Performance

To allow new kinds of interaction between performance media, as well as between public and performer, Palindrome has developed a number of interactive systems. They are based on two kinds of technology.

The first type of technology involves systems based on “frame-grabbing,” the capturing of video images in the computer. Changes in those images are then used to induce changes in other media.

“TouchLines” is the name we gave to one of our computer programs. With it, one can draw lines on a video picture that are sensitive to minute changes. That is, if one of these on...

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4 The Awa of the Dogon tribes (Guinea Coast) offers one example of many. See [3].

Connecting the apparently contradictory worlds of dance and science.

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screen lines is touched by any part of a dancer's body, changes in sound, music, lighting, or projections can be triggered. A single TouchLine can be programmed to initiate entire spectra of sound, like a keyboard. These can be scaled according to need: one line may be controlled with the tiniest of finger movements, while another may require the dancer to run the entire length of the stage to play all of its notes. Additionally, some Touchlines can be used to control others, adding new lines and deleting old ones as they are called for in the course of the dance.

When two or more cameras are used, three-dimensional touch-sensitive "objects" can be defined. In our current program, "Press Escape," one camera is positioned high above the stage, two face the stage from the front corners, and one faces the public, allowing them input into some parts of the performance.

Press Escape is divided into separately titled sections. "Abstände" and "Game" employ a more sophisticated variation of TouchLines where the computer tracks each dancer separately by locking on to the color of their costume. We use this program to control projections, music, and sampled text according to two different parameters: 1) the absolute positions of the dancers on the stage, and 2) the positions of the dancers relative to one another. Each dancer can control a different musical instrument according to where they go on stage, or with the second variation, the distance between the dancers can be used, for example, to control the loudness of the music.

In "S.E.T.I.," a three-part chord is "bent," or pitch-shifted into different musical shapes according to where each of three dancers go on the stage. "Minotaur" is our most sophisticated use of this system. It involves four dancers playing a composed musical score entirely by their movements in 3-D space. In this case, the distinction between dancer and musician is rendered meaningless.

The second type of technology employs systems based on body-worn electrodes.

In "Heartbeat Duett," two dancers wear chest electrodes and transmitters while they dance. Each dancer's heartbeat is heard as a separate musical note. The resulting rhythm, a counter-point between the two heartbeats, becomes part of a composed musical score. As they dance their heart rates almost triple in speed, going from 60 to around 170 beats/min. The piece "Elektroden" allows the public to hear the electrical impulses generated by the muscle contractions of a dancer. As different muscles tense and relax a kind of body-symphony results. In this case, stage lights are also controlled by the dancer's muscle impulses.

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As two dancers wear chest electrodes and transmitters, the resulting rhythm, a counterpoint between their two heartbeats, becomes part of the composed music score.

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For dancers, the computer may indeed have a special significance. Through the rapid popularization of human movement as a performed art form, which in the West began only in the early 1900s, dance has remained, with a few important exceptions, a form viewed as largely subordinate to others. Make this test: the next time you have just seen a dance performance, ask your neighbor what they thought of it. In most cases, they will describe the music. Music tends to dominate our overall reaction. Dance is thus perceived to "follow" the music, or a story, or both. Interactive media, such as those I have described, provide an opportunity to make this relationship dynamic. Now the music or lights can, for example, also "follow" the dance.

Although this by itself may seem radical, since the early 1950s, the choreographer Merce Cunningham has led a revolution in the dance world which involves the separation of movement as an art form from its dependency on music and story. To me, and to all those who can accept this separation as self-evident, the real significance of the work we are doing lies a step further.

In interactive dances, the way in which the music, for example, "follows" the movement, is not really a reversal of the traditional situation. Rather, it introduces a new kind of relationship. In the traditional case, there are always fractions of seconds separating the dancer's movement from accents in the music. These are particularly pronounced at the start of a phrase, or in cases where the music is not particularly rhythmic, but whether obvious or not, this temporal separation is always there. In an interactive environment, the linkage between cause and effect — in this case, movement and sound — is automatic and,
moreover, instantaneous. This may seem like a small point, but in the way in which we respond to a performance, the effect can be profound.

Performances using interactive systems are still extremely rare, so I think it is too early to pass a final judgment, but I think it is possible that such work may bring to dance a renewed spontaneity and liveliness as well an expansion of the possibilities for expression in live performance.

Troika Ranch, a New York City dance company, has been experimenting with what co-director Mark Coniglio calls a “MIDI-suit.” The suit measures the degree of bending in various joints of the body and then transmits this information in the form of Musical Instrument Digital Interface (MIDI) signals to a computer where they are used to generate different sound or image changes. Co-director and dancer, Dawn Stoppello, described her experience performing with the suit, “To control the environment through the movements of my body is a special feeling and this affects my performance. I feel larger-than-life and I think this carries across to the audience. This has an impact that is independent of the understanding they may have of how the technology functions” [4].

Troika and Palindrome compared notes. The reticence to embrace these new forms is not limited to dancers. In the general public there is resistance as well. Most of the resistance seems to stem from misconceptions: that the dancers’ movements are “machine-like” or that the music sounds “synthy.” Neither is the case, but their hesitancy underscores the point that there is little inherently artistic about the machinery or its effects. Its interest arises entirely through the performer (or the audience’s) interaction with the computer system. Mr. Coniglio describes the use of technology with dance in terms of an amplifier of human expression. He uses the violin as a metaphor: “It makes a voice that is not human, and yet it can be maneuvered to extend and expand what is ultimately an entirely human expression” [3].

Musician as Dancer, Dancer as Musician

I don’t find recorded or broadcast music particularly entertaining (in fact, I avoid them when I can). When a musician performs before us, I believe only a part of our experience is the actual sound of the notes. To see a human being making a piece of music come to life, perhaps struggling with it, perhaps elated by it, but in any case working it out physically — through their body — comprises a key part of the music experience. Computers would seem to support this assertion: high-end synthesizers and sequencers can easily play even the most difficult scores at levels that can fool all but the most trained ears, yet few would be willing to pay for such a rendition.

In this light, our experiments pose an interesting question: if the movements of the musicians are indeed key to the audience’s experience, then could other sound-movement relationships engender a similarly strong response? From the perspective of a choreographer, what are the new possibilities for expression? While working on dances that create their own music, we face at every turn a myriad of interesting options whose effects we are only just beginning to understand.

Audience Interaction

An area of interest to both Troika and Palindrome is the challenge of making the viewer an active part of the performance. Note that the word “interactive” can have a variety of meanings. Interactions, or exchanges of artistic impulses and information, can occur between artists (for example, in the case of jazz musicians playing together), or between an artist and herself — as in the case of a system that extends her expression into other media, such as the computer-driven systems described above. But “interaction” can also refer to the audience: between artist and audience (during a live performance), or between the audience and the artwork itself (as in the case of an interactive installation).

In one section of a Palindrome performance, video cameras are aimed over the heads of the public, which allows them to contribute sounds (the accompaniment to the dance) by gesturing over their heads or standing up and making shapes with their bodies. It is not always the strongest piece artistically, but it is a popular piece! Once a few brave souls have tried it, virtually everyone wants to see what sounds are awaiting above their heads.
Of course when many people are jumping up and gesturing at the same time it becomes unclear who has created which sound and the feeling of control that Ms. Stoppillo mentioned is gone. This points out a danger for any piece using new technologies: it can very easily become unclear what the heck is going on.

That the audience is able to understand how an interactive system functions is of little or no importance to some computer artists. To Palindrome it is paramount. But now a tricky question arises. To simply explain the setup beforehand is risky. The danger is that the performance, what is ostensibly a piece of art, becomes a lecture with demonstration. One needs to find non-pedagogic ways to help the audience along. One solution is simply to have a piece build up slowly, step-by-step, starting with the simplest kinds of interactions first. In this way the piece can "explain itself" as it goes along. Another possibility is to affect explanations using other media — projections, sound tracks, program notes, audience involvement (for example, posing questions to the public). And, personally, I have no particular objection to an occasional verbal explanation, though this may come during or after a piece rather than before, giving the audience at least the chance to respond "innocently" to a work.

Mr. Coniglio and I are involved in organizations of similarly focused artists. Some of these organizations are Internet-based and through them we hope to promulgate our ideas and technologies to other dancers and choreographers. The development of colleagues around the world is crucial. The very few of us in the dance and art worlds with these interests need each other's feedback, ideas, and support. Mr. Weiss and I are happy to see our systems used by other performing artists. In this way, possible new applications of our work, as well as program bugs will come to light.

And bugs there are! This needs to be stressed: this is a very new area of work. There are numerous pitfalls that both Troika and Palindrome have been stumbling through. Virtually every piece in our current show has been completely overhauled. Some of the problems with which we are struggling are endemic to the area of interactive art as a whole.

The Guggenheim Museum Soho recently had an exhibition that examined some of the attempts to wed art and technology over the past decades [5]. It was a wide-ranging exhibition, and featured a number of computer-based works that allowed viewer interaction.

In "Passage Sets/One Pulls Pivots at the Tip of the Tongue," Bill Seaman allows the public to select words by scrolling through selections on a large screen. These words are then concatenated and recited back to form a kind of poetry. The viewer-controlled "poetry" accompanies projected images, film segments, and music, which are also selected from on-screen menus.

The piece was impressive on a number of levels. The speaking voice and the sound overall, were of excellent quality and beautiful to listen to. The film segments, which among other things, showed sensual images of a clothed couple touching were also quite beautiful. What was lacking was interactivity. My "poetry" seemed practically arbitrary, giving me little sense of "collaboration" on the piece.

Toshio Iwai's "Piano-As Image Media" is a surprisingly simple and elegant piece and seems to be enjoyed by children as well as adults (something I consider as a hallmark of good art). It consists of a horizontal translucent screen running from a control seat to the keyboard of a grand piano. The person at the seat controls a track-ball and switch. By clicking the switch, one can place notes on the screen, which together with the staves around them, scroll along until they reach the keyboard. At this point the written notes are indeed played by the piano. The written notes then continue their journey, now vertically, on a separate screen similar to the horizontal one. As they move upwards from the keyboard, the notes transform into geometric, multi-colored forms — a visual equivalent to the sounds still resonating from the piano.

As with "Passage...", the weakness with Iwai's piece that it was actually quite difficult to control the thing in any deliberate way (I did spend some time on it). The interactive input is reduced to little more than a role as initiator and pseudo-randomizer.

I brought my complaints on the Guggenheim show to Prof. Binkley. He pointed out my impetuousity. Remember this represents a revolutionary change in art. That artists are making works with interactivity at all is significant. The key impact of computers on the art world is, according to Prof. Binkley, that art is being redefined more in terms of a process, than a commodity. It is becoming a dynamic interplay of media, an exchange between art work and public. "If the computer brings about any dramatic cultural changes," he writes, "they will come from interactive systems, not possessionable products" [6].

The ideal that I seek, that of a creative venture, initiated and guided by an artist, but which

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5 The Dance & Technology Zone (D&TZ, at www.art.net/~dtz) is an excellent resource for artists and others who are particularly interested in using new media and information technologies in the creation and performance of dance, dance theater, and related live performance works. Their "upcoming events" section and "artist links" are particularly interesting. It is maintained by Mark Coniglio.
also receives real artistic input from the public, remains illusive. Prof. Binkley, framed my doubts as part of a larger enigma. Computer art, he explained, is “too easy.” Artists are often so overwhelmed by the possibilities that they lose themselves in the process of creation. At the end of their first computer art experience they step back and wonder, “Now what?” Computer art is both too easy and too difficult. This is the confusion that comes as we struggle to define the role of these new machines.

Prof. Binkley goes on to explain that the computer is neither a tool nor a medium. “The computer is not a medium because it is neither a submissive repository of imprinted information nor a communication conduit. It is rather more like the creatures who sit at the termini of media and cogitate between transmissions and receptions. Media embody culture, computers conceptualize it.” In the sense that a computer is able to take an artist’s idea or vision a step or two further, we can think of them as collaborators — a type of creative assistant, but one whose contribution is more conceptual than physical. Its ruminations are then interfaced to media to reveal what has occurred. “Interactivity is the lineament of computer art, a trait no medium exhibits. It can be realized in the gallery to encompass the audience and implement new genres where dialogue, and not speech, is the preferred mode of discourse” [2].

In my own work I try to show a reservation of final judgment. We point out some fascinating and attractive aspects of digitalization, but we also try to pose a question to our audience: “What are the social and, particularly, artistic risks of computerization?” It brings us more cyber-relationships, but does that mean fewer handshakes and heart-felt smiles? It may lead to more tricks with digital media, but does that also spell less creativity? It is naturally no longer a matter of discussion if computers should enter into so many disparate areas of our lives. The question has become: at what cost?

The computer’s application to dance may indeed be viable, but as the influence of computers continues to grow, changing the world in ways we can hardly imagine today, it becomes a task for all of us — though perhaps especially for artists — to look very carefully at these strange “tool-like” things, to turn them slowly in our hands, heads tilted.

References

Additional Reading