Computers helping dance notation help the dance: a vision

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1. DANCE NOTATION: WHAT AND WHY?

The production of a ballet is one of the most frustrating endeavors in the performing arts today. The frustration stems from the fact that a substantial amount of information must be shared among a large number of individuals, and the only manifestation of this information is in a few human memories. Often the information is evolving: a choreographer will work from day to day with a company of dancers, saving only a fraction of material from one day to the next, until, eventually, the 'vision' of a complete piece of choreography has been formed. Alternatively, in the case of reconstructing a piece of choreography, disagreements inevitably arise as to whose memory of the original is most accurate. In the absence of any 'hard' information, such disagreements can only be resolved by the strength of authority.

These problems do not arise when a symphony orchestra prepares a concert. In fact, such problems are quite unthinkable in the world of music. This is because the 'vision' of the composer has been set down in a notation which has been second nature to the vast majority of performing musicians for well over a thousand years. However many years he may have been lying in his grave, the composer has managed to communicate his authority to the performers of today through the score and part books of his music.

The predominance of music notation has led many 'fans' to assume that notation plays a similar role in the dance. Unfortunately, this is only a half-truth. In fact, the origins of dance notation go back practically to the origins of classical ballet ([Hutchinson]); but, as we shall see, notation has never 'caught on' among dancers as it did among musicians. In the following section we shall attempt to analyze why this is the case, after which we shall consider how the computer might be able to remedy this situation.

2. CURRENT PROBLEMS IN DANCE NOTATION

Any idea which is unpopular always has a bastion of myths to support its unpopularity. The primary myth about dance notation is that it can't possibly work (not that it doesn't work, mind you—one may simply deny the possibility of contradicting evidence). The reason behind this myth inevitably stems from an argument to the effect that the human body has so much more subtlety and so many more degrees of freedom than any musical instrument that no notation could ever come close to capturing such an overwhelming amount of information. Leaving the dance community aside for a moment, such an argument would be regarded as patent nonsense by any performing musician. He knows that his notation does not embody the full range of subtlety of expression on an instrument; indeed, that is what makes performing so interesting. He understands that the score is but an abstraction of a musical performance and that performance is unthinkable unless he first contributes a substantial amount of his own information to that score. Are we to assume, then, that no such level of abstraction exists for choreography? *Au contraire!* History has provided us with an abundance of abstractions, and *this* turns out to be one of the more substantive problems surrounding dance notation.

2.1 Lack of universality

In the early years of ballet, dance notation was not a particularly burning issue because it was a rather simple matter. All dances were made out of a relatively small number of archetypal patterns, and "recording" a dance was simply a matter of indicating which patterns were selected, in what order they were executed, and what path the dancer followed while executing these patterns. (An analogy with the neumatic notation of chant may be appropriate.)

As the vocabulary of ballet became freer, such "neumatic" notations became less useful. The issue of "commonly accepted patterns" also dissolved as dance styles began to cross international boundaries. There followed a wide variety of attempts to record movement iconographically. (The number of variations on the stick figure in the name of dance notation is almost mind-boggling.) Unfortunately, such "icons" could never represent *movement*; they could only represent selected positions assumed in the course of movement. *How* one progressed from position to position tended to be described in an *ad hoc* manner, generally fully understood only by the inventor of the notation.

In spite of these many unsuccessful attempts, this century has seen two genuine abstractions of human movement incorporated into notations—one developed by Noa [Eshkol] and Abraham Wachmann, the other by Rudolph Laban ([Hutchinson]). Both of these abstractions are based on the skeletal system—a view of the body as a system of bones...
connected at joints. Both also incorporate systematic representation of the passage of time. Thus, one is presented with a continuous representation of positions assumed by the skeleton throughout the flow of time, as opposed to the "selected snapshots" of an iconographic notation. Unfortunately, while these two notations share a common abstraction, their syntaxes differ radically. Neither can be readily embraced by one who is familiar with the other. This, then, is the key "political" problem with dance notation.

Each notation has its own strongly devoted band of followers, organized as an international society and firmly convinced that theirs is "the true way." At a time when it is hard enough to get the majority of the dance community to accept notation of any sort, such factionalism is of little benefit. (Incidentally, several of the iconographic notations have also managed to gather their own factions. A dancer who is seriously interested in notation is bound to have about as much trouble as a Republican who is seriously interested in a presidential candidate.)

In a sense, one may say that the presence of two viable notations is worse than having none at all. Excessive quibbling over syntax tends to cause one to forget that at the foundation of both is an excellent semantic model for describing choreography. While it would not be particularly difficult to train a dancer to read both notations, there being no differences in the basic principles, the antagonism of factionalism will continue to discourage any dancer from learning either.

### 2.2 Difficulties in recording

Once a notation is selected, one must still face the fact that preparing a dance notation score is not an easy process. The main difficulty is that while a composer may be able to get all his ideas set down in score working strictly on his own, a choreographer tends to grow his ideas out of interactions with his dancers. Under such circumstances, a choreographer is not really in a position to spend his time writing scores; so this role is assumed by a third party, a "dance notator" who acts somewhat like a court stenographer while rehearsals are in progress.

A professional notator described the difficulties in preparing a dance notation score as follows (Brown):

"First of all, before the notator's preparation of the final pencil draft, there is the process of writing and rewriting rough drafts. As the dancers learn, the notator jots down symbols. If they are many dancers quickly learning difficult movements, it becomes impossible for the notator to write everything while the dancers are learning. The dancer learns a total movement with all parts of the body operating "in parallel," while the notator must record each change in a body part—being limited by the speed at which he can write. Because of this limitation, the notator learns to write essential key symbols which cue his memory. When viewing his notes after the rehearsal is over, the notator will fill in the details and check these at the next day's rehearsals.

A problem with this way of working arises when a notator works with a large ballet company staging a new work. Because of the company's organization, many hours a day must be devoted to teaching the work. In some situations, the choreographer may be working with different groups of dancers throughout the flow of time, as opposed to the "selected snapshots" of an iconographic notation. This makes the process of filling in details "after hours" difficult. As a rule, the filling-in process generally requires one to two hours for each hour spent in rehearsal. Even if we overlook the fatigue of a day which involves twelve hours of rehearsal time, simple arithmetic shows that there just aren't enough hours in the day to keep up with the work outside rehearsal. The notator must be tremendously organized and must have sufficient stamina to stay abreast of what every dancer in the company is learning—committing most of this information to memory. Frustration sets in when the choreographer decides to add and drop parts of the dance or to revise steps and sections. Battling constantly with the organization of notes, the notator tries to "get everything down," filling in missing spots during "clean-up" rehearsals, which are conducted after all the dancers have learned their parts. Finally, when the dance is ready for production, the notator collects all the information regarding props, scenery, lighting and costumes. These are included in the score, since the score serves as a historical document to be used for reconstruction purposes.

Under such working conditions the notator is in no position to work on the final pencil draft as the rough notes are accumulated. The notator will not have such time until after the dance is in performance. The job then becomes a matter of many hours of solitary work copying the rough notes, laying out pages of graph paper, and refining the actual notation used as a historical document.

Autography, in itself, is also a very time-consuming process. The autographer must know enough Labanotation to be familiar with the symbols to be copied and the basic rules of layout (in case the layout of the final pencil draft has to be modified). When the autography is done by hand, the autographer must also be skilled in working with special pens, indelible ink, templates, and reproducing paper. The symbols are arranged on the page as specified in the notator's pencil draft and layout booklet. Calculations for margins and aesthetic spacing are made before proceeding with the inking, where each line is separately drawn and connected."

It should be noted that the problems of autography are more serious for Labanotation than they are for the notation of Eshkol and Wachmann. However, the basic problem of collecting the actual data remains the same. Furthermore, the astute reader will have noted in the above scenario that one must still rely heavily on the powers of human memory. Once a score is prepared, it can be used as a historical document to be used for reconstruction purposes.

Unfortunately, the only individuals who are capable of reading dance notation scores are those same individuals who serve as dance notators. Neither choreographers nor dancers, in general, can, on their own, extract all the information which these scores contain. Not only does this mean that the choreographer is in no position to pass judgment on
the accuracy of the score, but also it implies that for purposes of reconstruction, a dance notator must again be brought to rehearsals. However, the role of this notator has now shifted from “court stenographer” to “ballet master.” Using the score, the notator can demonstrate all the movements as they have been recorded. Thus, the notator will work with the dancers the same way that the choreographer does. The difference is that all authority of information resides in the score; the notator is simply the medium by which the dancers may gain access to the score.

3. COMPUTER ASSISTANCE

3.1 Data entry

The above description of the plight of a dance notator in preparing a score might, in another context, be construed as an advertisement for a word processing system. In fact, the technology of word processing is precisely the sort of remedy which will alleviate all the time-consuming frustrations of score preparation. The only potential obstacle arises from the fact that the basic data structure for word processing is one-dimensional, the character string, while dance notation scores are inherently two-dimensional.

Fortunately, the technology of computer graphics allows us to manipulate two-dimensional structures as easily as one-dimensional ones. The real issue is whether or not the notation is well enough structured that it can be conveniently manipulated in a syntax-directed fashion. The notation of Eshkol and Wachmann poses no problem in this respect, since it consists of elementary configurations of numbers placed within the boxes of standard graph paper. Labanotation, on the other hand, has a much broader vocabulary of graphic symbols; but it has been demonstrated that these symbols are highly organized according to a structure which may be reflected in the internal structures of a text processing system ([Smoliar]).

Given such a “notation processing system,” one may envisage the notator of the future working with a portable graphics terminal which may be easily installed in a ballet studio. All initial notes may be entered during rehearsal into some common file structure which will become the data repository for the particular ballet. As the steps are taught in greater detail, the notator will be capable of using the time to update the score as it has been recorded thus far. Then, as rehearsal enters the final stages, the notator will be able to follow along in the score, confirming the accuracy of the recorded material. Much of the routine efforts of “filling in” and “cleaning up” may be relegated to system functions performed by the notation processor, leaving the notator free to worry primarily about the semantic content of the notation. Finally, given a suitable device for hard-copy output, the need for a separate autography stage will be eliminated. All information necessary for graphic formatting will already be present in the file structure of the score, so that the preparation of a “final” draft will simply be a system output function.

How realistic is this vision? For Labanotation the basic theoretical problems have been solved, and a prototype system has been implemented ([Smoliar]). However, the technology of the implementation is not at all appropriate to the ballet studio, utilizing large and expensive processing and graphics equipment. The major problem is to take the results of research conducted to date and pass them through a development phase which would result in a usable product. Unfortunately, such a development project would entail a substantial expense for a product which would never be particularly widely used. (Even assuming an overwhelming interest in dance notation, the number of notators will never approach the number of secretaries.) Thus, the development of the product itself could never be cost-effective; and, as a result, for sheerly economic reasons, the feasibility of this vision is pathetically low.

3.2 Notation interpretation

From a point of view of data processing, the problem of “notation illiteracy” is far more substantial than the data entry problem. The latter is only concerned with formatting a well-defined system of symbols; the former must address the semantics behind these symbols. Of course, the real issue behind these semantics is the issue of human movement itself. What is required, at the data processing level, is the ability to construct a simulator of human movement. Given the existence of such a simulator, one may then regard a notation score as a set of commands to that simulator.

How might such a simulator be structured? Clearly, the basic underlying model of the human skeleton must be present, since this model is incorporated in the abstractions of the systems of both Laban and Eshkol and Wachmann. When one addresses more detailed specifics, however, one discovers that much of the basic structure of Labanotation may be interpreted as a rather powerful plan for a highly general simulator ([Weber]). Under this model every joint of the skeleton may be regarded as being endowed with the “processing power” to orient itself with respect to some well-defined system of reference. Furthermore, both the origin and the axis-orientation of this system of reference may vary during the course of the simulation, according to specific commands incorporated into the notation. Furthermore, every moment is classified as either a gesture, which simply changes the orientation of the skeleton, or a support, which entails a major movement of the center of gravity. (Gestures will, necessarily, entail minor movements of the center of gravity.) A simulator based upon these principles has, in fact, been designed ([Badler]).

Clearly, no dancer or choreographer will be interested in the specific mechanisms of a computer simulation of human movement. However, given an implementation of such a simulator, one could monitor its behavior through a graphic display of human figures. These figures need not necessarily resemble “ideal” dancers. (Remember, the notation itself is still only an abstraction of the movement it represents.) However, the display should be capable of capturing all information which the notation has recorded. Furthermore,
given the essentially invariant behavior of the simulator, the display may be highly flexible. One may "observe" the simulator from alternative points of view, perhaps changing the point of view while the display is in progress. Given many figures, one may wish to ignore displays of all but one or two. These are facilities by which a dancer would be able to observe the steps and learn a part in a manner similar to the protocols of the rehearsal studio. (These facilities are also far beyond the capabilities of any conventional video recording techniques.) Finally, the output as prepared by such a simulation system would be a playback of the score which the choreographer could observe as a means of approving the accuracy of the contents of that score. Working in conjunction with the notator, the choreographer could have a direct hand in establishing the score's validity.

Once again, there is the question of feasibility of such a vision. If the prospects of a notation processing system are slim, there seems to be little hope for the development which would be necessary to produce such a display system which could become a convenient installation in a ballet studio. One can only hope that the need for the simulator itself may attract the interests of better-endowed institutions. It would not be the first time the arts would benefit from a "spin-off" of a product of high technology.

4. OTHER VISIONS

4.1 An information management system for recorded dance

4.1.1 A network of data bases

Given that the two visions proposed in the preceding section appear to be rather remote, it may be somewhat unwise to fantasize further. Nevertheless, these visions have some implications which are worth dwelling upon in their capacity to foster further visions. The mere fact that we have proposed a variety of digital representations of human movement, for example, leads us to consider possible applications involving data bases.

One of the greatest problems facing the dance world, as we have seen, is the reliable dissemination of information. In general, a company learns its choreography from a choreographer who "resides" there. If another company wishes to perform the same ballet, they must make arrangements for the choreographer, or some other reliable authority, to "visit" for the purpose of teaching the choreography. While the choreographer may be the only reliable authority in the matter of teaching all the subtleties of performance, teaching the basic steps to a new company is generally a rather tedious and tiresome undertaking. The problem, once again, is one of the information imprisoned in an individual's memory.

A network of data bases of dance notation scores would go a long way toward alleviating this difficulty. The result would be one of a nationwide (if not worldwide) library of the ballet repertoire. Local sites would be responsible for recording and maintaining their share of this repertoire.

Given the ability for computer interpretation of dance notation, this library would be accessible even to those "illiterate" in the notation. One could draw upon the computer not only to provide the score but also to provide the sort of performance of the score described in the previous section. Under these circumstances, a choreographer could rely upon the services of the computer to handle teaching the basic steps, leaving him free to concentrate upon the final details of performance. (A similar situation, without the use of a computer but with dancers "literate" in Labanotation, currently exists in the Syracuse Ballet [Ubell].)

4.1.2 Copyright issues

A critical component of any information management system is a mechanism which protects the information managed by the system. Such a mechanism should secure responsibility for the creation of a score, as well as protecting the choreographer's rights to determine who may read that score. These ideas deserve a bit of further elaboration.

First of all, what is the nature of the information to be subject to protection? In the system proposed in the preceding section, this information is divided into two categories: (1) notation scores, and (2) animated interpretations of notation scores. Four levels of protection may be applied to both of these categories:

1. No access—a user is denied any access to a particular score or animation.
2. Read only—the user may use the system to view a particular score or animation, but access is limited to what may be observed while seated at a display terminal.
3. Copy—the user may request a physical copy of a score or a film or videotape of an animation.
4. Update—the user is allowed to modify the information in a notation score or animation or access the program which translates notation into animation.

The information management system may then maintain records regarding which levels of protection apply for which notation scores and animations to which users of the system. Authority to update will incorporate authority to change a particular protection level. Thus, initially, the notator will maintain a protection level of 4 and use it to limit access to preliminary versions of the score. (The choreographer and dancers, for example, may be allowed read only access, while the rest of the users are forbidden all access.) Ultimately, by assigning a protection level of 4 to a choreographer for a completed score and animation, the system automatically allows that choreographer to be the ultimate arbiter of protection status for his "personal" information or to delegate this authority to any user of his choice. Requests from users for permission to see protected information may also be handled by the system through a "mailbox" facility.

Under such a system it is likely that information will be better protected from copyright abuse than printed scores or films. A page of dance notation displayed at a terminal...
cannot be taken over to a Xerox machine to be copied without authorization. Also, it should not be difficult to guard against users photographing or filming images displayed at a terminal. There remains the problem of a user copying out a notation score by hand, but this problem is comparable to that of an individual preparing a notation score strictly from attending performances of a ballet. While this system would not prevent all forms of copyright abuse, it would only allow those which are extremely difficult or inconvenient to implement.

4.2 Choreography

While many choreographers derive their inspirations from spontaneous interactions with their dancers, not all choreographers enjoy the luxury of a company of dancers existing purely to satisfy their creative urges. Even in the best of companies, rehearsal time is limited; and a choreographer cannot always explore his creative urges at his personal convenience. Here, again, the composer is at an advantage. In the absence of an instrumental ensemble, he may still turn to a keyboard to experiment with his ideas.

The sort of facility we have been discussing could ultimately serve as an analog to the keyboard for a choreographer. Of course, it would require the choreographer to learn the notation; but is that asking more than requiring that a composer possess certain keyboard skills? The intent is not to use the computer to produce an artistic object, but rather to assist in those mental processes which are invoked during the act of creation. It will be little more than a device with which the choreographer may better plan his rehearsal time.

Considering what has happened in music, one must envisage the possibility of attempts to automate choreography itself. The results in music, to date, have been rather unimpressive. There have already been some analogous attempts in choreography. Unfortunately, in both cases these tend to be diversions of individuals who are rather casual practitioners of the art. Lacking the patience to negotiate the excruciating details of creation, they turn to technology for a crutch. Unfortunately, human audiences tend to respond to acts of human creation; and unless the performers manage to contribute some element which transcends the meagre bookkeeping of the alleged choreographer, the resulting product tends to have little to offer even the most dedicated audience of human beings.

4.3 Scholarship

If the production of dance appears to be in the Dark Ages when compared with the world of music, the issue of dance scholarship is practically pre-historic. Once again, the problem is one of recording information. It is very difficult to analyze a ballet when all one has are verbal accounts of that ballet. (One might just as well pass legal judgment strictly on the basis of hearsay evidence.) The accumulation of a repertoire in scores would open the doors to possibilities for comparative analysis. Even in music, the theory of composition, as we know it, did not come into its own until notation was a common practice. The study of dance history can, eventually, become more than an accumulation of indirect accounts, but only if we see to it that the dancers themselves are allowed the benefit of objective recording.

REFERENCES


From the collection of the Computer History Museum (www.computerhistory.org)