Dance notation systems, like music notes, enable documentation of symbolic representations of movement as signs on paper for individual analysis and interpretation. Today, dance notation systems operate within a digital environment in dance notation applications that facilitate the process of recording movement. I argue that a key objective in the development of these applications should be to provide the user with an unambiguous method to record and represent movement. Existing dance notation applications have employed various tools with distinct techniques and technologies to support the discipline's communication. This communication is among choreologists, dancers, and choreographers during the creation, rehearsal, and reconstruction of dance works. Labanotation, motion capture, and 3D animation help these participants describe and record movement. Figure 1 presents the current use of these technologies in various applications.

These applications offer varying functionality in their use of technology for the representation of movement and can be broadly defined in three different categories. Dance notation applications make up the first category—they help notate or record specific forms of movement using dance notation (see Figure 1a). Dance notation systems such as Labanotation provide a precise system of recording a comprehensive range of human movement, analogous to the techniques musicians employ to notate music. (An overview of Labanotation is available at http://www.dancenotation.org/inbasics/frame0.html.)

Notation-based applications, the second category, include applications that use dance notation as a basis for their development (see Figure 1b). The last category, dance technology, consists of applications that use emerging technologies to record and visualize movement (see Figure 1c). While each application has a defined use, it’s important to consider how effective the technologies they employ are in successfully achieving their objectives. Here, I focus on dance applications in these three categories. I consider the limitations of existing technologies in their ability to effectively describe and record movement within a specific context.

**Evaluation criteria**

To evaluate existing technologies from an end-user perspective, we need to study the function they provide in offering a suitable level of accuracy in the description of movement and their accessibility to the dance community. Key aspects concerning the functionality, usability, and expediency of dance notation applications have to be identified and tailored to allow each criterion to specify a distinct condition. These criteria include:

- the ability to record a reasonably accurate range of human movement,
- providing flexibility and control during the editing process,
- enabling nonexperts to operate the technology,
- providing immediacy for recording and editing movement,
- demonstrating ease of use in its intended environment,
- requiring minimal storage space with immediate removal capabilities, and
- remaining cost-effective to the dance community.

I’ve applied these criteria to the examination of the following currently used technologies for describing and recording movement:

- Labanotation as it finds use in existing notation editors such as LabanWriter (http://www.dance.ohio-state.edu/3_research_gallery/laban_writer.html),
- 3D animation as it currently exists within the DanceForms application (http://www.danceforms.com/), and
- motion capture with an emphasis on data capture.

By mapping the technologies found in existing dance notation applications against the previous criteria, I’ve established a method of analysis. I take a use of functionality that alleviates complex processes to facilitate the user’s needs as the measure of appropriateness for evaluation.

**Labanotation**

Before the advent of computer technology, dance notation systems were used to represent movement as signs on paper. Here, I evaluate Labanotation within the context of a digital environment that is used within the LabanWriter dance notation application (see Figure 2). To use a dance notation system with an expressive facility—capable of describing a comprehensive range of human movement—requires a thorough understanding in movement analysis and an expert knowledge of its symbolic vocabulary. Traditionally, a choreologist trained in the use of dance notation systems (such as Labanotation) trans-
lates symbolic representations of movement for dancers to interpret and perform. The nature of composing a score in Labanotation is a timely process that is relative to the complexity of the range of movement described. This is a fundamental concern regarding the accessibility and current practice of Labanotation.

The function of Labanotation, as found in existing dance notation applications, allows for an efficient means to record and edit notation. This results in the production of relatively small data files that users can easily access and digitally transfer to an Internet location. Archiving files in a digital format ensures the preservation of data that users can print and produce in a physical form. Currently the Labanotation editor, LabanWriter, is available to the public as a free application.

Motion capture

With an emphasis on capturing data, motion-capture systems provide a method of documenting movement that involves the recording of a sensor or marker’s point of reference during a sequence of movement. These sensors are usually attached to the human body where the recorded information is translated to a computer usable form. Three methods exist in the motion-data-capturing process: mechanical, electromagnetic, and optical. Each of these processes provides varying degrees and amounts of accuracy in their ability to capture motion efficiently.

Mechanical motion capture uses an exoskeleton suit made up of metallic pieces to track and measure information from joint angles and locate limb positions as a performer moves. A disadvantage of this technique is its inability to supply ground plane calculations or calculate movements that disconnect from it should a performer become airborne through a sequence of jumps. Electromagnetic techniques offer the absolute positioning of motion data in a near real-time environment. This is the preferred technique for performance animation; however, it requires a space free from metallic objects, as it's
highly susceptible to interference from surrounding magnetic fields and might require the use of a purpose-built stage. Optical motion capture uses multiple cameras to record points and varying perspectives of motion garnered from reflective markers worn by a performer. Captured information from each camera undergoes a cleaning process to render the files usable for motion capture applications and requires further processing time to provide the resulting data in a 3D format, making this a lengthy process. A consequence of this technique might produce an inaccurate account of motion data from occlusion during the capturing process.

Apart from the processes involved in capturing motion data, Hachimura et al. suggest that motion capture systems provide a means to record human movement that is more precise in comparison to Labanotation. Having acknowledged the concerns regarding the accessibility and complexities Labanotation presents as a technology to record movement, it’s important to note that the process of capturing movement using motion capture systems is lengthy, voluminous, and costly. Concerns of accessibility, usability, cost, and expediency of motion capture as a technique to record movement, at present, outweigh the significant benefits it holds in capturing detailed human movement.

**3D animation**

The DanceForms 3D animation package for dancers enables choreographers and dance educators to notate movement sequences in a 3D environment. (Screen shots of the DanceForms interface are available at http://www.credo-interactive.com/danceforms/.) As a tool to notate movement, DanceForms presents the dance community with an application more familiar to professional animators working with character animation development for film or computer game industries.

This application is customized specifically for use by dancers who know little of animation techniques yet rely on a process of keyframe animation to record dance sequences.

The function and technology of dance notation applications is significant to the success in which complex processes might be facilitated to allow for the accurate documentation of movement. Achieving this using DanceForms is tied to a user’s ability to set keyframes of dance poses to effectively document a precise record of movement. Keyframe animation is a time-consuming process. The time required to learn the skills necessary to use DanceForms as an application and generate keyframe animation is considerable. The provision of built-in library models and animation tools within DanceForms would accommodate novice users in their experience of recording movement. Even so, this form of movement generation is limited in scope compared to the options available in providing a comprehensive range of movement.

Currently, DanceForms is an accessible tool to the dance community, evident by their current user database (http://www.charactermotion.com/danceforms/inst.html). DanceForms also presents a relatively expedient method to edit and record movement (see Figure 3). The application itself produces moderately small data files that remain accessible by digital transfer and are easily archived.

**Reduce findings**

After mapping Labanotation, motion capture and 3D animation (see Table 1), each technology proved highly successful in its ability to meet at least one of the parameters defined by the criteria. It then became necessary to further evaluate these technologies by nominating a key criterion. Technologies that provide a higher degree of accuracy in their description of movement were favored in circumstances that found two technologies to be of equal value with the initial criteria. Therefore, this criterion (range of movement) became essential to the comparative analysis of each technology within the set framework. This method of evaluation distinguished the initial criterion as a basis upon which I considered the following criteria. Research by Wang, which illustrates and evaluates the strengths and weaknesses of notation-based, audiovisual, and motion capture technology, found that Labanotation provides the most rigorous and accurate description of movement.

Following this method of comparative analysis, Labanotation sticks out in providing a technology that remains readily accessible to the dance community and encompasses the ability to successfully preserve, transfer, and document a wide range of human movement.

**Developing Labanotation**

Labanotation is a complex language. As a result, using Labanotation requires a thorough understanding of its symbolic language to take advantage of its expressive capacity. A key aim in facilitating the understanding of Labanotation is to create an awareness of its ability to document movement and allow greater accessibility of its use to the dance community.
A significant development to emerge from collaborative research and discussion among Lars Wilke, Tom Calvert, Ilene Fox, and Rhonda Ryman is the creation of LabanDancer. (A screen shot of the LabanDancer interface is available at http://www.ickl.org/conf05_london/sessions/sessions42.html.) This application acts as a translator between Labanotation and human figure animation. It translates the description of movement from Labanotation to a 3D animated form to assist the dance community in using existing Labanotation scores. The benefits associated with LabanDancer highlight the potential for increased accessibility to the information of Labanotation scores. A concise description of LabanDancer is available elsewhere.4

Similar to this, LabanEditor presents an application that uses Labanotation to let users input, edit, and display movement in an animated form. A user interface employs a method of composing Labanotation that employs the use of symbol selection buttons.3 These buttons facilitate the interactivity required by users to specify the type, length, and correct positioning of a notation symbol on the staff. A preview window displays this information in a stick figure animation while a motion viewer provides a 3D human figure animation.3

Developments surrounding this application offer the potential to automatically translate motion capture data to Labanotation data and produce Labanotation scores in LabanEditor. A detailed description of LabanEditor is available elsewhere.3

These developments contribute considerably to the technology and functionality of notation applications that allow greater access to the information of Labanotation scores. However, these applications are ill-equipped to detect or prevent errors made during the composition of Labanotation scores. They would otherwise require an expert knowledge of Labanotation to operate effectively.3 This highlights a need to facilitate the correct composition of Labanotation.

Through the development of sophisticated interface design and the implementation of emerging technologies for visualization and computer graphics, new interactive environments can be developed to allow for greater human–computer interaction. A systematic approach to the composition of Labanotation scores could enable the correct syntax and formatting of notation symbols and provide a precise method to record movement. This would simplify the process of composition to assist those with little knowledge of the intricacies of Labanotation and potentially enhance dance literacy.

Table 1. Evaluation of technologies that record and edit movement.

<table>
<thead>
<tr>
<th>Technology</th>
<th>Movement Range</th>
<th>Editing Capabilities</th>
<th>Ease of Use</th>
<th>Immediacy of Task</th>
<th>Physical Attributes</th>
<th>Storage and Transfer</th>
<th>Cost Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motion capture</td>
<td>Highly successful</td>
<td>Average</td>
<td>Average</td>
<td>Highly successful</td>
<td>Average</td>
<td>Average</td>
<td>Average</td>
</tr>
<tr>
<td>Labanotation</td>
<td>Successful</td>
<td>Highly successful</td>
<td>Successful</td>
<td>Average</td>
<td>Highly successful</td>
<td>Highly successful</td>
<td>Highly successful</td>
</tr>
<tr>
<td>3D animation</td>
<td>Average</td>
<td>Successful</td>
<td>Highly successful</td>
<td>Successful</td>
<td>Successful</td>
<td>Successful</td>
<td>Successful</td>
</tr>
</tbody>
</table>

Conclusion
The evaluation of technologies that record and edit movement is limited by its specific focus. Labanotation is a proficient means of recording and editing a wide range of human movement. Fundamental issues concerning the accessibility and practice of Labanotation helped identify problematic areas between the development of an ideal and an appropriate use of technology. As a result, it’s reasonable to suggest that no single technology provides an exact representation of movement. A combination of technologies will be vital to the development of sophisticated dance notation applications that provide an unambiguous representation of movement for individual analysis and interpretation.

Underlying concerns surrounding the practice of Labanotation highlight a potential to develop applications that facilitate the composition of Labanotation. Integrating a structured process to the composition of Labanotation that provides user feedback and preventative measures within notation applications would ensure the correct syntax of score creation and offers the possibility to facilitate the complex process of notating movement in the future.

References

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