

# LABANOTATION AND LIFE FORMS®: COMPUTER ANIMATION AS A COMPLEMENT TO DANCE NOTATION

by

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## **ABSTRACT**

This presentation suggests ways in which notators can use the Life Forms® animation program to complement the teaching, learning, and use of Labanotation. It begins by presenting examples of dance animations, addresses questions of notation versus animation assumptions and conventions, and concludes with a hands-on workshop introducing basic animation techniques.

### **1.1 Introduction**

This presentation suggests ways in which notators can use the Life Forms® animation program to complement the teaching, learning, and use of Labanotation. It begins by introducing the Life Forms® application for animating human movement and addresses the relationship between notation and animation. It presents examples of dance animations to illustrate how animation provides a visual complement to notation and goes on to suggest the strengths and limitations of each medium. It addresses the issue of notation assumptions and conventions, issues that can be clarified through the process of key frame animation. The presentation concludes with a hands-on workshop introducing basic animation techniques.

### **2.1 Life Forms®**

Life Forms® is the animation program used in the Dance Notation Bureau's Interface Project (Fox et al., 2001). It was developed by Tom Calvert of Simon Fraser University stemming from work he did with Labanotator Zella Wolofsky in the early 1970s (Barenholtz et al., 1977). The program began as a tool for visualizing dance – for generating choreographic ideas – and was for a time known as COMPOSE (Calvert et al., 1993).

Today the application is being developed and marketed by a Vancouver-based company called Credo Interactive (<http://www.charactermotion.com>). Commercial animators in the advertising and entertainment industries are its strongest market. But Dr. Calvert is still committed to promoting its use in the Dance world. Merce Cunningham has used LF as a stimulus for devising new movements, and to interact with his dancers through onstage projections (e.g., *Trackers*, *Biped*, *CRDSPACR*, *Beach Birds for Camera*).

Life Forms Dance Studio is a special version of the program that comes with libraries geared to Dance teachers and choreographers. Version 3.9 is bundled with the Ballet Moves CD (Ryman, 2000). Future releases will include a Modern Dance Moves library (Ryman, in progress) based on Daniel Lewis's book, *The Illustrated Dance Technique of José Limón* (1984), with Labanotation by Mary Corey.

### **2.2 Animation and Notation**

Calvert (1982) describes how animation systems must deal with three elements: how to input movement; how to model movement; and how to output movement. First is the input: how do you describe movement to a computer? Some researchers have tried to use language, either natural languages like English, or computer languages called macros. Some have tried notation input, like Benesh (Herbison-Evans, 77; Politis, 1987) or Laban

(Barenholtz et al., 1977; Savage and Officer, 1984), the goal of the Interface Project, which was described in an earlier session. Some have used biomechanical input based on kinematic description, using instruments like electrogoniometers that feed measurements directly from the moving person into the computer. Today wireless techniques are used to detect body joint displacements in a process called motion capture (MoCap) (Maiocchi, 1996). Life Forms<sup>®</sup> gives the users several ways to manipulate the figure through a process known as key framing. Each key frame stores information such as body shape, orientation, location, and altitude, and a string of key frames defines the timing of a movement sequence (as explored in the hands-on session). Life Forms<sup>®</sup> also accommodates MoCap input. Key framing can be thought of as analogous to notation in that the user can specify the ideal movement, what the choreographer sets versus what the dancer actually does. MoCap, on the other hand, is similar to film or video in that it records the unfiltered raw data – one dancer’s performance complete with personal idiosyncrasies and human error, subject to equipment limitations and malfunctions. Whereas MoCap and video represent “the dancer,” key framing and notation represent “the dance.”

Next is the system model: how do you convert or translate the input to the output. For this, researchers tried various types of mathematical equations. Life Forms<sup>®</sup> uses Euler angles and quaternions<sup>1</sup> to orient each body segment in space, and provides different options for calculating transitions between positions (e.g., spline versus linear interpolations). To represent transitions as in Labanotation, a new interpolation option is being developed for the Interface Project.

Third is the output or representation of movement. For dance people who tend to be visually oriented, representation is a crucial element: it has to be immediate, that is in “Real Time,” and it has to be clear. Life Forms<sup>®</sup> provides several different display choices and several different human figures, as described shortly.

In theory, it is possible for dance notation input to generate animation output and vice versa, if a translation program can be written (the long-term goal of the Interface Project).

### **2.3 Animation versus Notation**

It seems clear that dance notation and computer animation can be used to enhance and complement one another, along with photographs, film, video, DVD, and of course the written and spoken word. Each medium, however, provides unique information and has inherent strengths and limitations. Each represents dance and human movement in unique ways that direct the viewer’s eye, ear, and mind, and affect how we perceive and analyze. In effect, each system controls how we look at movement.

Consider “1st arabesque” for example (see Figure 1a). Benesh notation focuses our attention on the positions of the extremities. It uses four signs to plot the location of hands and feet, the minimum amount of information needed to convey “arabesque.” Labanotation shows the direction in space taken by the arms and legs, and also the palm facings, using about nine signs and symbols to record a basic arabesque. Line drawings taken from the Life Forms<sup>®</sup> Figure Editor and shaded figures from the Rendered Window (see Figure 1b) give a literal key framing of the symbols in the notation (top and side view). Compare these to the refined key framing in Figure 1c. To produce these, the user must specify much more information, including adjustments in the pelvis and spine, the turnout of the legs, the stretching of the raised foot, and the position of hands and fingers. Some of this “extra” information is understood from human anatomy (e.g., it is impossible for the thigh to hyperextend 90 degrees; the pelvis must move too). Some is understood according to ballet conventions (e.g., the pelvis tilts as little as possible and the

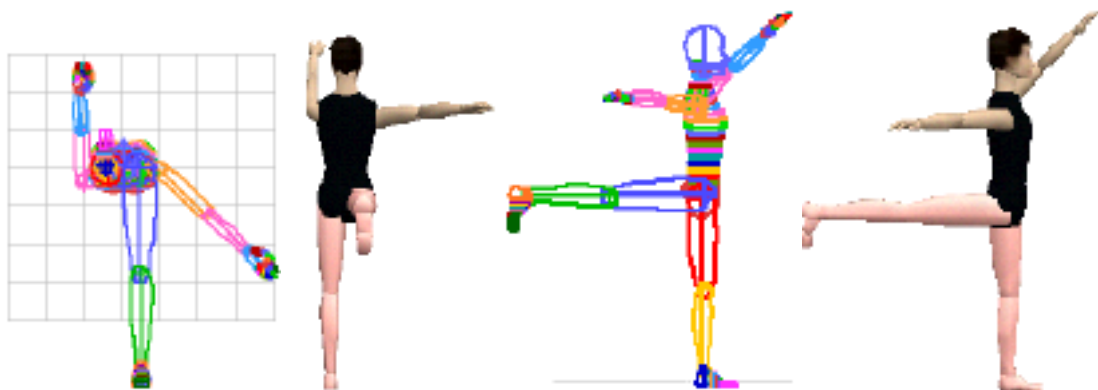
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<sup>1</sup> Euler angles and quaternions are explained in relation to the Interface Project (Fox et al., 2001).

spine adjusts to keep the shoulders square). Some is assumed according to notation conventions (e.g., Benesh notation specifies only the position of the hands in arabesque, since context clarifies the rotation and extension of the arm and fingertips; Labanotation generally shows palm facings in arabesque, and an intermediate position for the back arm).



**Figure 1a.** 1st arabesque in Benesh Notation and Labanotation



**Figure 1b.** Literal key framing of 1st arabesque in Life Forms® Figure Editor and Rendered Window



**Figure 1c.** Refined key framing of 1st arabesque in Life Forms® Figure Editor and Rendered Window

In notation systems, “extra” information can be glossarized or assumed according to context, and omitted to streamline the score. In animation every detail must be explicitly input into every relevant joint in every key frame. In theory, once all the “rules” have been

identified and defined, an expert system can be written to refine the rough animation (cf. the Interface Project). Most importantly the animation drawings *represent* the body, whereas the notation *abstracts* it. Notation exists apart from any physical depiction of the body whereas animation cannot. To create a realistic animation, every detail must be explicitly input into the computer. The more realistic we want the animation to be, the more detailed the input we must provide in order to produce good output on the screen.

### 3.1 Representing the Body

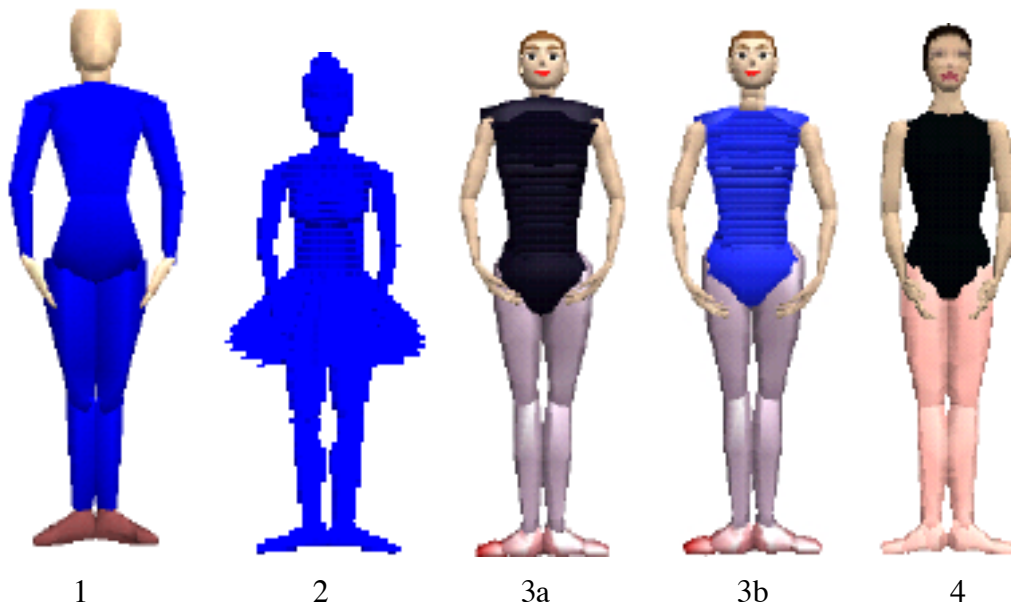
Life Forms allows you to choose from six types of on-screen representation. These vary in their levels of abstraction from the most abstract to the most concrete or realistic (see Figure 2). The stick figure is the simplest representation and perhaps the most like notation. It requires the viewer to imagine and fill in details relating to the 3rd dimension: that is, depth and contours. The rendered image is fleshed out and realistically colored. This type of representation is most like an animated cartoon. Because it is most “life-like,” observers tend to have higher expectations that it look “real” rather than realistic. As you can imagine, it is easiest to see details in the rendered figure, but detail is often not necessary when, for example, we need to see only the basic structure of a movement. Viewing an animation in different styles makes us aware that the type of representation we chose affects *what* and *how* we perceive human movement, and how we perceive and conceive the *dancer* and the *dance*.



**Figure 2.** Levels of abstraction in representing the body:  
stick, bounding box, outline, contour, surface, rendered

### 3.2 Developing Dancer Body Models

Life Forms® provides default male and female figures which are based on standard human proportions refined by a graphic artist. In addition to looking un-dancer-like, these models have only two upper torso segments, not enough to represent the kinds of movements that characterize western theatre dance forms like Ballet and Modern, and certainly not enough for Jazz. To meet the needs of the dance community, a number of figures have been tested (see Figure 3a): a young dancer available on the Life Forms® Power Moves CD, a figure called Natasha which was used for the Ballet Moves CD, a modified Natasha available on Credo’s website, and the new female ballet dancer developed for the Interface Project. In addition to looking dancer-like, it has enough segments to represent a wide range of ballet vocabulary (e.g., three torso segments and a curvable arch segment in the feet).



**Figure 3a.** Developing the ballet body model:  
 1. Life Forms® default female, 2. Power Moves dancer figure, 3. Ballet Moves dancer figures (original and modified “Natasha”), and 4. Interface Project female ballet dancer



**Figure 3b.** Developing dancer body models:  
 Interface Project male modern, male ballet, female modern, female ballet

Figure 3b illustrates the four dancer models developed for the Interface Project: the male and female modern and ballet dancers. Their contours, hair, clothing, etc. are specific to their gender and style. However, all have the same basic architecture and contain the same number of segments and limb lengths so that positions and movements can be copied between models with minimal distortion. Each model has 58 movable linked segments: Pelvis; three torso segments: Upper Chest (upper thoracic spine: T1-6), Chest (lower thoracic spine: T7-12), Chest and Waist (lumbar spine: L1-5); Neck and Head (cervical spine: C1-5 only); Head; Arms (two limbs with three segments each: Shoulder, Upper Arm, Lower Arm); Hands (two with sixteen segments each: palm plus three segments for each of five fingers); Legs (two with two segments each: Upper Leg, Lower Leg); and Foot (two with three segments each: Foot, Arch, Toes).

#### 4.1 Aid to Notation Teaching, Learning, and Use

There are several ways we might use this technology to enhance the teaching, learning, and use of dance notation. For example, we can use animation to illustrate theory by modeling notation concepts, from simple directions to complex paths. This exercise may help us examine its validity and usage.

#### 4.2 Modeling Notation Theory

Life Forms® may be used to illustrate Labanotation frames of reference, e.g., the body key versus the space key. Consider the phrase shown in Figures 4a and 4b.

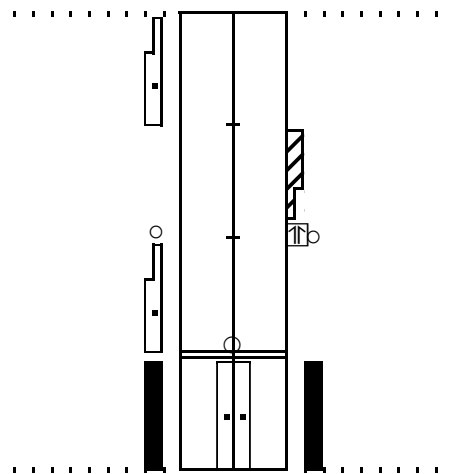


Figure 4a. Labanotated phrase

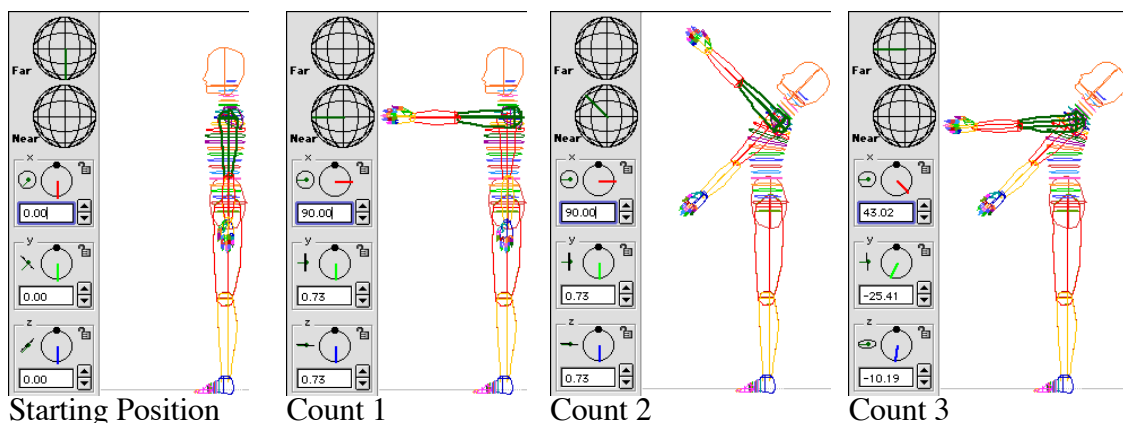
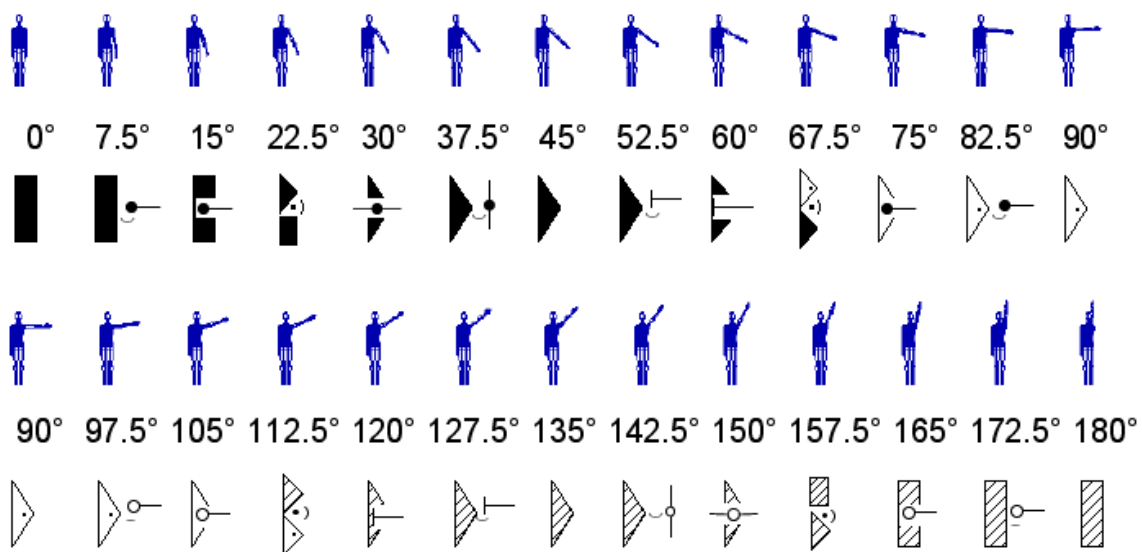


Figure 4b. Figure Editor: Positioning the arm in relation to the body versus space

Life Forms® presents various methods for specifying the position of body parts through the Figure Editor. The globe interface (upper left of the window) allows direct manipulation of the body part in space (absolute, up and down in relation to gravity), whereas the x-, y-, and z- fields in the lower left allow the user to input joint angles which position the body part relative to its “parent” segment (or proximal end, in relation to the body).

The arm starts place low, neutral position or  $x = 0$  degrees. On count 1, the arm is 90 degrees forward in relation to the body. On count 2, the upper chest tilts back high, but the arm is still 90 degrees in relation to the body (by default in Life Forms®, all “descendant” or distal body parts are carried along). Count 3 shows the arm 90 degrees in relation to space (a horizontal line in the top globe), but oblique in relation to the body ( $x = 45$  degrees).

Figure 4c summarizes the range of basic and intermediate directions from place low through side right middle to place high (Hutchinson, 1977, p. 439).



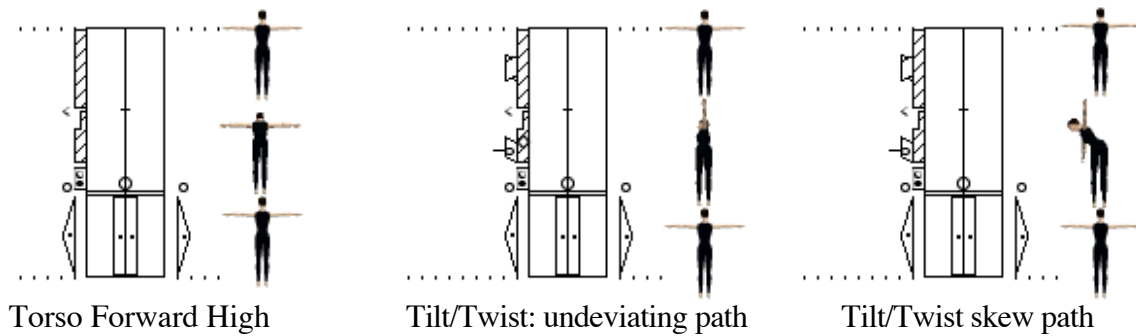
**Figure 4c.** Modeling theoretical concepts: basic and intermediate directions

The basic directions are in line with theories of human spatial perception (Howard and Templeton, 1966) which state that humans can most clearly perceive the horizontal, as, for example, a side middle gesture. We can also clearly perceive the vertical, as place low and place high gestures. Next, we discriminate halfway between the horizontal and the vertical, as oblique gestures (side low, side high). We are less able to perceive orientations between horizontal and oblique or between vertical and oblique (as the halfway positions). Labanotation shows intermediate directions, that is, directions between the horizontal, vertical, and oblique, by using a system of pins and bows. The basic direction symbols are modified to show directions at 7.5-degree increments.

While these symbols are clear in theory, it is less clear whether we can discriminate a 7.5-degree difference in real life situations, unless we have clear reference points in sequence or in context. For example, which of these arm positions would be closest to a ballet demi-seconde? Would we need to specify 30° versus 37.5° versus 45°? Or would any of these be read in context, and altered to suit the body proportions of the dancer, and the style of the work, regardless of what the symbol said? This has been an important question in the Interpreter Project: Can symbols be interpreted literally or do that take their meaning in context. We are seeing that there is actually a “tolerance” or range of acceptable

interpretations for a basic direction symbol, as addressed in the ICKL paper “Movement Signs Across Contexts” (Marion, 2001).

Animation can also be used to illustrate complex concepts, as in Figure 4d. Playing the animation from various views clearly illustrates the difference between undeviating (planar) and skew (three-dimensional) paths. (For an interesting representation, in Stage View, select View > Top, then Control > Smear before playing the animation.)

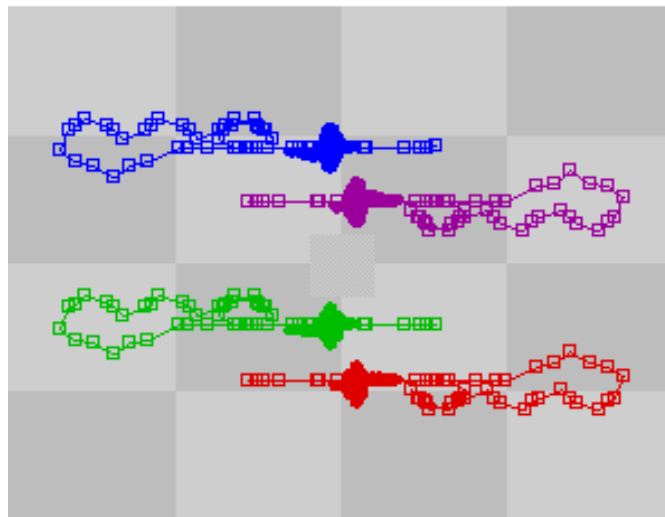


**Figure 4d.** Modeling theoretical concepts: undeviating versus skew paths

### 4.3 Multimedia Resources

Numerous multimedia resources are emerging for dance educators and researchers (Maletic and Sutherland, 1995; Ryman et al., 1995). In addition to helping us teach notation, animations may help students learn notation by illustrating their interpretation of notation symbols and scores. On-line courses are being developed using interactive multimedia. These could integrate animation, notation, video, and words to produce effective web resources for notation.

Finally, computer animation may enhance the way we use notation. By illustrating scores (see Figure 4c), animation can make them more useful to those with limited skills.



**Figure 4c.** Floor plan of four dancers seen in Stage Window, Top View

Animation may also enhance the production of notation scores by notation professionals. Two-way translation from Labanotation to animation and the reverse is a long-term goal of the Interface Project. In theory, it is possible to use motion capture input to generate a

rough score that could then be refined by the notator. Eventually, this process could be used to verify a score by comparing notation input and animation.

### 5.1 Building Dance Animation Libraries

The questions raised in this article have informed the creation of animated Ballet and Modern Dance libraries. The first of these, Ballet Moves, was developed using the “Natasha” body model and bundled with Life Forms Dance Studio 3.9. It is being revised using the new female dancer.

The Modern Dance library is being developed based on *The Illustrated Dance Technique of José Limón* (Lewis, 1984), with notation by Mary Corey. I decided against translating from Labanotation to animation at this point, since many of the questions raised are still unresolved. Instead I developed each basic position and movement element from a physical interpretation of Lewis’s word description, then compared the result to the notation and refined it where my interpretation was inconsistent. The notation, however, provided important landmarks that enhanced the precision of each animation.

### 5.2 Notation as an Aid to Animation

To illustrate the process involved in translating from notation to animation, consider Limón’s Successional Arms (Lewis, 1984, p. 40, 186). Figure 5a shows the direct translation from a simplified score, using the level of detail the Interface Project Plug-in can now accommodate (i.e., basic directions for arm gestures).



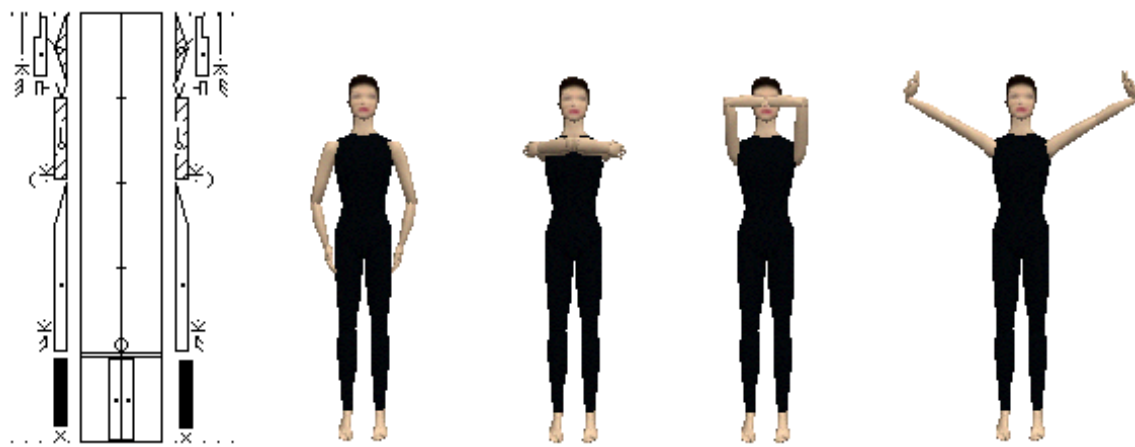
**Figure 5a.** LabanWriter file translated to Life Forms® animation

While the destination positions look correct, the transitions do not. When the animation is played with the default Shape Interpolation (Linear), there is an unwanted scoop between place high and side high. This is a result of the mathematical equations used by Life Forms® to generate transitions between key framed positions, i.e., the system model. The Life Forms® default and the basic Labanotation assumption are in conflict.

To produce transitions in line with Labanotation theory, a new Laban Linear Shape Interpolation was developed for the Interface Project. To see this in Laban terms, think of the default path undeviating (versus skew) we assume for arm gestures, where front is determined from the shoulder line (we can also think of this as the base of the arm or the untwisted facing of the free end). We understand how a tilt and rotation can produce a skew versus a deviating path for torso tilts. Thinking of the arm in the same way, you will see that the Life Forms® linear interpolation generates a skew curve when an arm tilts (i.e.

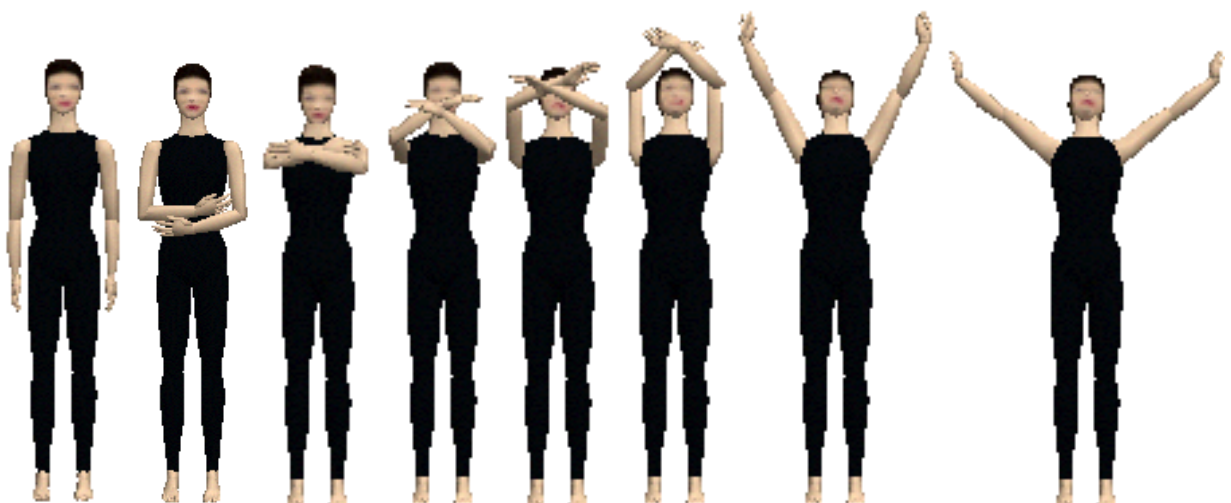
takes a new direction) and rotates (around its long axis) at the same time. The Life Forms® default is a skew (front is determined from the free end; up/down are determined in relation to the build of the body, cf. the body untwisted part key).

Figure 5b shows my literal key framed translation from Corey's abbreviated Labanotation (Lewis, 1984, p. 186). The arms begin place low, 1 degree contracted, i.e., a 30-degree angle at the elbow, with counter-adjustment at the shoulder to maintain the hand below the shoulder joint. This literal translation suggests that a 1-degree contraction may be too great to show a relaxed or rounded look (versus the 8-degree scale with 20-degree increments). On counts 1-2, the arms take forward diagonal middle (crossed) with a 3-degree folding (90 degrees) at the elbows. Here the arms collide, but the notation may be intentionally vague to allow either arm to pass in front of or above the other. On count 3, the arms take place high (white pins show the intermediate position one-third toward forward high). Again, the arms collide with elbow folding retained. On count 4, they take side high with the thumb side of the hand facing forward and 3 degrees of wrist flexion over its back surface (i.e., 90 degrees of wrist hyperextension).



**Figure 5b.** Key frames literally translated from Labanotation

Figure 5c shows eight key frames based on a physical interpretation of the word descriptions, refined with the help of the Labanotation.



**Figure 5c.** Key frames based on words and notation

## 6.1 Life Forms® for Notators

To conclude the presentation, participants were invited to explore basic animation techniques through a series of tutorials. Although based on ballet movements, they introduce principles that apply to human movement animation in general. The tutorials are available online from Credo's web site (<http://www.charactermotion.com>), and on the Ballet Moves CD-ROM bundled with Life Forms® 3.9 Dance Studio.

- Tutorial 1 Introducing Life Forms: Exploring Windows and Menus
- Tutorial 2 Creating a Port de Bras: Exploring Sequence and Timing
- Tutorial 3 Creating an Allegro Enchaînement: Exploring Altitude
- Tutorial 4 Creating a Pirouette: Exploring Facing
- Tutorial 5 Creating a Ballet Walk: Exploring Location and Paths
- Tutorial 6 Creating a Battement: Exploring "Tweening" and Refining Body Positions

## 7.1 Summary and Conclusions

This paper has suggested ways in which computer animation may complement the teaching, learning, and use of dance notation. It has also proposed the reverse, that an understanding of human movement gained through notation may enhance the animator's skills. The DNB Interface project is exploring complementary uses of Life Forms® and LabanWriter. In the meantime, notators may benefit by exploring this relationship to their own advantage.

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