

Dancing Backwards in High Heels and Other Problems in Animation

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INTRODUCTION

A couple, usually a man and a woman, dance in Closed Position in Ballroom Dancing, and this places restrictions on the synchronism of the angular movement of the hips, knees, and ankles of the four legs of the two partners. Much of the time, one of the partners dances backwards. How to describe and prescribe such movement is unclear.

Previous work has described the production of such animation from descriptions in an animation language [6], and of the translation of Labanotation scores into movements of a single figure (LINTER).

The computer program described in this article (LINTEL) combines these to produce animation of two figures dancing together from the Labanotation files. The program LINTEL also allows zoom in and out, rotation about the 3 axes, and shifting in 3D, while the figures are dancing, as well as variable speed and single frame forward and back animation.

A major problem in writing such a program has been the generation and maintenance of the holds between the two partners, given the difference in height (and leg length) of the partners, and the high heels worn by the woman, which make for different step lengths of the two partners. In particular: how can natural movement be produced for the partner moving backwards? For brevity and in deference to Ginger Rogers, who it has been claimed was a better dancer than Fred Astaire because she had to do all the steps backwards and in high heels, in this paper I will refer to the partner moving backward as the 'woman', and the partner moving forward as the 'man'.



The Closed Ballroom Hold

BALLROOM DANCING

The five ballroom dances: Modern Waltz, Tango, Viennese Waltz, Slow Foxtrot, and Quickstep, are danced the world over both socially and in DanceSport competitions. These 'Standard Ballroom' dances have diverse origins, rhythms, tempos, and aesthetics, but have one thing in common: they are all danced by a couple (usually a man and a woman) in 'Closed Hold', maintaining five areas of contact between the partners while performing all the figures of the dances.

THE CLOSED BALLROOM HOLD

The closed ballroom hold requires the maintenance of five points of contact between the partners while they are dancing. These consist of three hand contacts:

1. the man's left hand holding the woman's right hand,
2. the woman's left hand resting on the top of the man's right upper arm (behind the arm in the Tango),
3. the man's right hand placed on the left shoulder blade on the back of the woman.

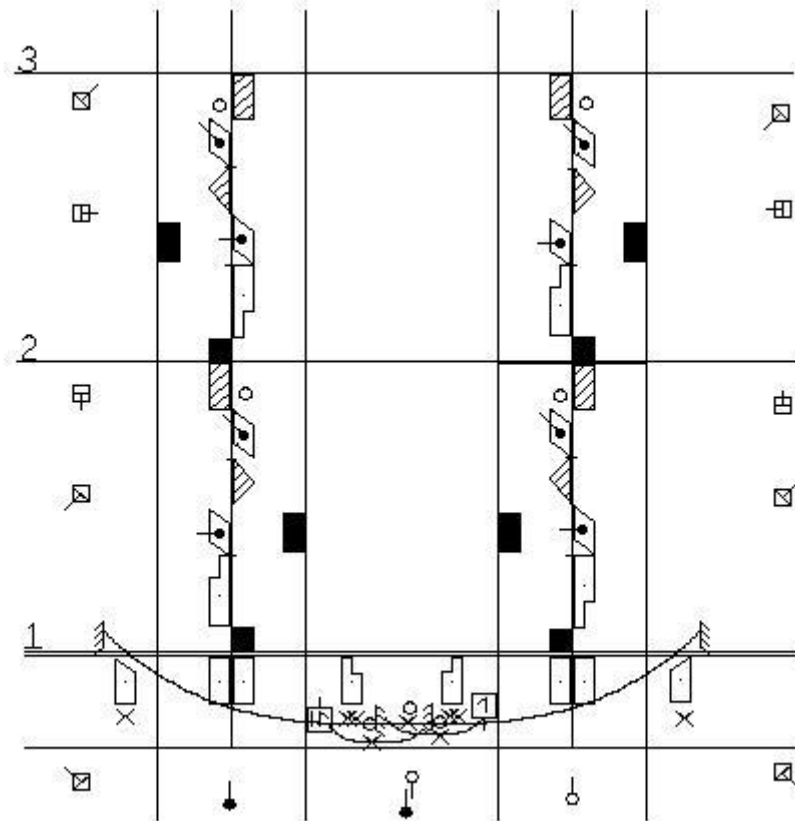
In addition to these 3 hand contacts, there are two more areas of contact:

4. the woman's left elbow rests on the man's right elbow,
5. the right area of the chest of each partner touches that of the other.

Ideally, in this hold, the woman's upper arms are both held horizontal by a suitable placement of the man's arms and hands. This not only makes it comfortable for the woman to follow the man's lead, but also gives the couple a deportment of regal appearance. This deportment is a characteristic of dances coming from Western Europe, and is a heritage of the origin of ballroom dancing in the royal courts of Europe. The erect and fixed torso is even more evident in Classical Ballet, which had the same origins [1].

The peculiar ballroom dancing "Closed Hold" possibly had its origins in the time when men wore swords while dancing. This can be seen in the sixteenth century illustrations by Sebald Beham [2] and Fabrito Caroso [3], although illustrations predating this time show men dancing without swords but with the ladies on their right nevertheless.

As most men are right handed, it was conventional to wear the sword and scabbard on the left-hand side of the belt, so as to facilitate the drawing of the sword with the right hand. Thus if a man was to put his arm around a woman's back, she would have to be on his right, or she would keep tripping over the sword. Thus he could only put his right arm around her; and if she was receptive to this advance, she would place her left arm over the man's right. From here it is a simple matter for the man to offer his left hand for the woman to hold for additional balance while dancing.



The Reverse Turn of the Modern Waltz in Labanotation
[\(click here to see animation\)](#)

LABANOTATION

Many methods have been proposed for prescribing dances on paper, but one attaining international usage amongst amateur and professional dancers is Labanotation, which was invented by Rudolf Laban in the 1920's [4]. In Ballroom Dancing: this is based two vertical staves, one for each dancer, each consisting of three vertical lines. Symbols alongside the central line represent ground support, which in Ballroom dancing indicate movements and positions of the feet and legs. Movements and positions of the arms and other parts of the body are represented by symbols on either side of the outer staff lines.

Basic symbols represent positions and movements in 8 horizontal directions. Three levels of height are indicated by the shading of the symbol. Other symbols are used as modifiers to show to what part of the body each basic symbol applies. Bow lines are used to indicate physical contact between parts of the body and between dancers. The notation can be used to describe any human movement to an arbitrary degree of precision. The lexicon of the full notation has over 1400 symbols.

LED

A simple editor, LED, has been written [5] to write scores involving a basic subset of just over 100 symbols of Labanotation. This has been used to notate the New Vogue dances commonly used Australian Dancesport competitions. The data files produced by this editor are simple: they are ASCII files with one line per Labanotation symbol. Each line records the

type of symbol, its direction, its x and y coordinates on the score, its height and width, and its shading.

LINTEL

This is a program that generates animation of one or two animated humanoid figures doing the movements prescribed in a Labanotation score generated using LED. The notation is first translated into a script file for the NUDES animation system [6], and this is then reread and animated using OpenGL. The program allows the user to zoom in or out, pan in three directions, rotate in three dimensions, freeze, advance single frames forward and back, and speed or slow up the movement. This latter is done by simply changing the number of polygonal facets used to approximate each body part.

LOCOMOTION

Simple Labanotation allows the specification of locomotion in each of eight directions: forward, backward, sideways left and right, and diagonally forward and back: left and right. In LINTEL this is accommodated by the translating each of the eight locomotion direction symbols into a call to one of eight corresponding NUDES subroutines. For the animation of a single dancing figure, the exact details of the movements of the hips, knees, and ankles of the two legs are not important to achieving a natural movement. Every person moves slightly differently in coordinating the angles at these six joints, and so the human eye is very forgiving of variations in this coordination.

However, in Closed Ballroom Hold in Ballroom dancing, forward and backward movement are achieved very differently. To move forward, the body is pushed forward from the standing foot without extending the knee of the moving leg. This accommodates the limited backward extension possible in the human hip of the woman. The didactic catchphrase for the man is "nose over toes". No foot must never be placed ahead of the torso. This movement pattern takes years to develop properly, as the man is totally unbalanced during the step, and only avoids falling forward by the strength of the back ankle.

Moving backward as described by many dance teachers is totally different. First the moving leg is extended backward while the body is maintained in a stationary position. Once the leg is extended, the body is pulled to be over the back foot, whilst leaving the front foot forward of the body.

Constraining the movements this way avoids the problem of treading on each other's feet. This avoidance is assisted by the partners standing slightly to the right of each other, so that the toe of the right foot of each partner is always placed between the feet of the other partner.

For a couple in closed ballroom position, the forward and backward movements described above must happen but cannot be synchronous. For the bodies to travel at the same time, the torsos of the two figures must be moving at the same time. In practice, in starting from rest, the man takes a grace step back or to the side, so releasing the moving leg from supporting the body. During this movement, the woman can extend the moving leg backward in preparation to move the body. Subsequently, the man leaves the standing leg behind his torso at the end of the step. This is matched by the woman leaving her standing leg ahead of her torso as she moves backward. Thus a 'step' in ballroom dancing starts and ends with feet

apart. This may be termed the 'Degas Principle', for Degas normally drew his dancers with feet apart[8,9]. This is aesthetically more attractive than having the feet together.

FOOT RELEASE

Taking a step back when the feet are already apart using the technique just described has a problem. Attempting to extend the thigh or knee of the front leg to move that foot back will lead to a rise in the body if the standing leg is extended to clear the moving foot from the floor. This problem can be avoided when stepping forward. When stepping forward, flexion of the thigh and knee of the moving foot lifts that foot off the ground so that the body need not change height. The unsynchronised rise and fall of one of the partners and not the other looks odd, and is often called 'rattling'. In order to release the moving foot when stepping backward, without body rise, the thigh of that leg must first be flexed, and then the knee flexed. Only when the foot is clear of the ground may the thigh of the moving leg be extended backward for the step to take place. The angles and timing involved in this brief flexion must be very carefully chosen for the movement to look smooth and natural.

HOLD MAINTENANCE

With the difference in leg length of the partners, the convention is that the woman has to accommodate the stride length of the man. She does this in reality by using articulation angles for her legs that are sympathetic to the man's movement.

In LINTEL, the spacing between partners is again maintained by modifying the woman's movement, but in a simpler but less physically possible way, by sliding her along the floor to maintain an inter-pelvis spacing preset for each of the holds. The arm and hand contact is maintained by raising or lowering the man's arms to create contact using for example Buckdale's algorithm [7]. This repositioning of the woman and the movement of the man's arms are done after performing all the other prescribed movements which occur between each frame of the animation.

APPLICATIONS

Each of the Ballroom dances has over a hundred figures which are commonly danced socially and in competition. These can each be described in Labanotation and displayed by LINTEL. This display can be used:

1. to demonstrate idealised animations of each of the figures, with interactive control of the speed and view, to make it easier for dance students to understand, learn, and perform them;
2. after putting figures together in enchainments, LINTEL can be used to ascertain the overall look of a the combination, to aid in the choreographic process.

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