

## MATRICES IN MOTION

An exploration of contra dance patterns interpreted  
through performance-oriented dance

This thesis studies the patterns found in contra dance, representable by manipulations of 2x2 matrices, and investigates their use onstage in performance dance idioms. On March 26 and 27, 2010, eight dancers explored these patterns in a twenty minute dance performance titled *Dance Hall: Tänze de nasha lingua*. It contained seven sections comprised of contra dance, ballet both on pointe and flat, tap dance, and body percussion, and included songs in six different languages. Each section examined a different question through the choreography. This paper is a reflection of the artistic process required to create *Dance Hall: Tänze de nasha lingua*, including research, casting, music selection, and the choreography.

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Crystal Menninga

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## MATRICES IN MOTION

### An Introduction

Contra dance, according to Merriam Webster, is “a folk dance in which couples face each other in two lines or a square” (Contra dance). Any contra dancer, however, will not hesitate to elaborate. Gary Shapiro maintains an entire website devoted to the question, *What Is Contra Dance?*, on which he offers six definitions, each one with a unique slant. The “earnest attempt” definition starts off:

A dancer and his or her partner dance a series of figures, or moves, with each other and with another couple for a short time. They then repeat the same figures with another couple, and so on. The figures are similar to those of old-time square dancing. The figures are combined in different ways for each different dance. (Shapiro)

The “analytical” definition explains the musicality:

The dances are done to live music, usually reels or jigs. The music consists of an A part and a B part, which are related much like a chorus and a verse. Each part consists of 16 beats, or steps, and is repeated twice. So a complete dance goes A, A, B, B, and consists of 64 beats total. The A and B parts are usually specified A1, A2, B1, B2. The music is phrased in 8-beat sections, and to a lesser extent, in 4-beat sections. A typical figure takes up 4, 8 or 16 beats of music. (Shapiro)

The other definitions range from serious to humorous, although each shares a different aspect of this unique social dance form.

My first exposure to contra dance was during the January Term of my sophomore year in college when I accompanied a friend to a contra dance in Maine. Nervously I went, learned a couple of steps before the dance started, and was suddenly being asked to dance and whirled around the dance hall. From that time on my interest was piqued. I was invited to the dances in Greenfield, Massachusetts, known locally as the best place for contra dancing, and my appreciation for contra grew. At first I did nothing to question my newfound interest, but eventually I began to wonder why contra dance pleased me so much. Yes the whirling was exhilarating, but I could accomplish that by spinning in place for an hour. There was something more than just the actual dance movements. After watching videos of contra dance online, I realized why I found it appealing. Contra dance is based on math. In fact, it *is* artistic math. Dancers are arranged in two rows with partners standing across from one another, typically with two sets of partners facing each other, dividing the two parallel lines into sub groups of perfectly aligned squares. The caller's job is to create an exciting dance, weaving the dancers in and out of formations, and by the end of 64 counts, to have had the couples progress one place forward. I researched the subject online and found several short essays written on the topic of matrix manipulation and contra dance. I have always loved studying math and finding mathematical patterns hidden in everyday life, so this discovery fascinated me. However, as I read these articles, I found that they were all written from a mathematical point of view, for a mathematical purpose. None of the dancers had approached the topic

from the other side—that is, using these mathematical patterns for further study in dance. The closest I found was an experiment by Larry Copes who sought to create a contra dance illustrating the eight symmetries of a square. Through slight modification (he replaced the identity element with an additional reflection) he was able to create such a dance through use of a computer program he designed, keeping in mind important dance elements such as which steps may only be done when the lady is to the right of the gent, etc (Copes). This was fascinating, but I was sure these complex, and yet stunningly regulated, patterns could also be approached from a performance dancer’s point of view. I knew that for my thesis I wanted to pursue an intersection of mathematics and dance, and this seemed to present the perfect opportunity.

Nearly all of the patterns in contra dance are based on squares of dancers and how the dancers can embody and manipulate those squares. There are 24 different ways to arrange four objects in a square. In a contra, each object translates to one of the dancers: Lady 1 ( $L_1$ ), Lady 2 ( $L_2$ ), Gent 1 ( $G_1$ ), and Gent 2 ( $G_2$ ). Thus, the possible arrangements for the dancers in a contra become:

L <sub>2</sub>	G <sub>2</sub>	G <sub>2</sub>	L <sub>2</sub>	G <sub>1</sub>	L <sub>2</sub>	L <sub>1</sub>	G <sub>2</sub>
G <sub>1</sub>	L <sub>1</sub>	L <sub>1</sub>	G <sub>1</sub>	L <sub>1</sub>	G <sub>2</sub>	G <sub>1</sub>	L <sub>2</sub>
L <sub>2</sub>	L <sub>1</sub>	G <sub>2</sub>	G <sub>1</sub>	G <sub>1</sub>	G <sub>2</sub>	L <sub>1</sub>	L <sub>2</sub>
G <sub>1</sub>	G <sub>2</sub>	L <sub>2</sub>	L <sub>1</sub>	L <sub>1</sub>	L <sub>2</sub>	G <sub>1</sub>	G <sub>2</sub>
L <sub>2</sub>	G <sub>2</sub>	G <sub>2</sub>	L <sub>2</sub>	G <sub>1</sub>	L <sub>2</sub>	L <sub>1</sub>	G <sub>2</sub>
L <sub>1</sub>	G <sub>1</sub>	G <sub>1</sub>	L <sub>1</sub>	G <sub>2</sub>	L <sub>1</sub>	L <sub>2</sub>	G <sub>1</sub>
L <sub>2</sub>	L <sub>1</sub>	G <sub>2</sub>	L <sub>1</sub>	G <sub>1</sub>	L <sub>1</sub>	L <sub>1</sub>	G <sub>1</sub>
G <sub>2</sub>	G <sub>1</sub>	L <sub>2</sub>	G <sub>1</sub>	G <sub>2</sub>	L <sub>2</sub>	L <sub>2</sub>	G <sub>2</sub>
L <sub>2</sub>	G <sub>1</sub>	G <sub>2</sub>	L <sub>1</sub>	G <sub>1</sub>	L <sub>1</sub>	L <sub>1</sub>	G <sub>1</sub>
L <sub>1</sub>	G <sub>2</sub>	G <sub>1</sub>	L <sub>2</sub>	L <sub>2</sub>	G <sub>2</sub>	G <sub>2</sub>	L <sub>2</sub>
L <sub>2</sub>	G <sub>1</sub>	G <sub>2</sub>	G <sub>1</sub>	G <sub>1</sub>	G <sub>2</sub>	L <sub>1</sub>	L <sub>2</sub>
G <sub>2</sub>	L <sub>1</sub>	L <sub>1</sub>	L <sub>2</sub>	L <sub>2</sub>	L <sub>1</sub>	G <sub>2</sub>	G <sub>1</sub>

All of these arrangements are used in contra dance, although it is up to the caller to decide which ones will be used in a specific dance. Many other dance forms also draw from these manipulations, such as Irish céilí dancing, Scottish cèilidh dancing, and English country dance; however, none of these are considered to be stage forms of dance. Instead, they are culturally based dances done at social gatherings and parties, classified in the category of social dance. They rarely cross paths with performance dance, which includes types such as ballet and tap.

Why is this? Audiences love geometry, as shown by the success of Busby Berkeley's kaleidoscopic patterns of girls moving around the stage, as documented by an online Dictionary of Dance:

For more than a decade his spectacular dance sequences—he loved to make complex geometrical shapes with a huge ensemble of dancers—graced many of cinema's most successful musicals. His precision choreography took place on ambitious sets in which hydraulic lifts and revolving platforms were featured, while his penchant for overhead camera angles allowed the full geometry of his kaleidoscope-like choreography to be appreciated.  
(Busby Berkeley)

Symmetry has always been an integral part of choreography. Therefore, I believed that these social dance patterns would in fact lend themselves to performance dance. Essentially, each square of dancers is a  $2 \times 2$  matrix, and the two rows of dancers are nothing more than several  $2 \times 2$  matrices. Thus, my purpose was to study the manipulation of  $2 \times 2$  matrices as the foundation for patterns in performance dance. Based on my personal experience, I chose to experiment with ballet, tap, and body percussion. Ordinarily these three dance forms would not be presented onstage together or even on the same program. However, I knew that each would present unique challenges that I accepted as secondary goals, which I termed “sub-goals.” I also developed sub-goals based on artistic freedom juxtaposed with the rigidity of the aligned matrices. Among these challenges were:

- How would I choose music that would lend itself to all forms?
- Would a social form be appreciated onstage in its original form?
- How well could I create a dance in which the dancers stayed in strict form, complying with the 2x2 matrix?
- If, in my 2x2 matrix I chose zeros for one or more of the entries, how would that affect the choreography in terms of patterns and artistry?
- Would the geometric patterns become mundane and thus require more variation?
- How would I find commonalities in rhythm, movement, and line?

I decided to address each of these in my work and, aside from the first sub-goal, specifically concentrated on one per dance. The following sections detail the creative process from music and casting selections to artistic insight for the matrix-influenced choreography.

## MUSIC AND CASTING

An integral part of any choreographic process is the music selection, which sets the tone and the pace, and influences the choreography. The audience expects the music and dance to complement each other unless the choreographer is making a distinct statement; although, a choreographer will be criticized for being a slave to the music, a complaint meaning the choreographer too literally followed the music when choreographing.

Mark Morris is perhaps the best known choreographer who choreographs to the music as a means of interpretation. From choreographer Hannah Kahn he learned “how to craft a dance—in keeping with the music” (Acocella 45). However, that has never stopped reviewers from claiming that “his choreography was too simple, above all, too simple musically—that it just copied the music step-for-note” (Acocella 65). Naturally, this extreme devotion to the music has also earned him considerable praise. Gérard Mortier, director of the Théâtre de la Monnaie in Belgium, once stated that he knew “that this man is special. It’s his attitude toward the music. I would say Béjart uses music for his spectacle. Mark Morris serves the music” (Acocella 73).

Musical training was imperative to my artistic investigation. By learning to play the piano and viola at a young age, I have been greatly influenced by

music and the study of music, from practicing daily to studying the nuances of more advanced principles. This developed into a love of rhythm, which manifests itself in my natural tendency toward tap and rhythm-based dance forms. When choosing music for my piece I wanted songs that I could play with and that would push me artistically. For instance, I sought out songs with unusual phrasing that did not follow the standard 8 beat phrase that is so common in current popular music. I was open to seemingly extra measures tagged on at the end of a phrase, or working in time signatures other than 4/4. In addition, I wanted to work with songs that were upbeat and similar in energy, with at least one slower song that would provide a rest for the audience and serve as a reawakening moment. Yet, I still had not succeeded in finding a musical theme. I wanted six songs that would unite in one overall dance piece, not six individual dances that were unrelated.

I found that before choosing any of my music I needed to find a common thread. Stepping back and looking at the purpose of my thesis, I reminded myself that it was essentially based on contra dancing, a form of folk dance. Folk dance is representative of culture, something I had explored during my year abroad in Montpellier, France. While there I realized how important learning about different cultures is to me, especially in their own language. Thus, although a French major, during my junior and senior years I took beginning classes in German, Occitan, Polish, and Russian. Five languages and five distinct cultures, each one of which I had come to appreciate through my studies. One song per language would serve to represent the personal influence each culture has had on

my artistic vision. However, there were only five languages; I was still searching for a sixth song. While in France I pursued Irish dance and spent a significant amount of time listening to various reels and jigs, constantly reflecting on how much they sounded like traditional contra music. Finally I decided that I would choose an Irish song for my sixth song, although I wanted it to be purely instrumental. In my vision the choreography was American, but I wanted the songs to be distinctly international.

At last I had found my thread; I would use a song from each culture I had studied while in college, just as I would use the various dance forms I had studied at the same time. Being a French major and having spent time in France, I had amassed a rather large collection of French songs. I knew that I did not want to choreograph each dance based on the lyrics of the song, so I selected “On n’est pas là pour se faire engueuler” based on the tempo, the rhythm, and its overall musicality. If the dance had been choreographed to the lyrics, the non-French speaking portion of the audience would have been missing a vital part of the overall work. By choosing the song based off of the music itself I avoided alienating anyone and was not influenced by the lyrics in my choreography. If an audience member understood the lyrics it would not pose any problems, but I wanted the dance to communicate the message, not the lyrics. Mark Morris shared a similar goal in his musical selection for *Beautiful Day*:

In the case of some of Morris’s religious dances, many spectators probably don’t know that the subject is religion. This fact is hard to ignore in *Gloria* and *Stabat Mater*, but you could miss it in *Beautiful Day*, where there are no crosses and the text is German. Indeed, “miss” is the wrong word. The

text, with its prayer for death and salvation, was part of Morris's inspiration in making the piece, but what is important to the dance is, again, what the body tells us—here, that something is happening that is both very grave and very intimate. In a sense, one no more needs the text to understand *Beautiful Day* than one needs to know humoral psychology in order to understand Balanchine's *Four Temperaments*. (Acocella 135)

In a similar way I wanted to base the audience's experience off of the interaction between the dancers and the music, not on whether or not they had studied various foreign languages.

From here I commenced my search for songs in the other languages that shared the same drive and energy as the French song. Two of my friends in France presented me with CDs of their work; one of them was of an Irish band called the Foggy Bartas, and the other was of an Occitan group headed by Philippe Vialard. I chose to use a song from each album as a way to pay tribute to my time in France and the memories I had of hearing their music live for the first time. From *Four Coffees Please* I chose "Scatter the Mud," and from *Coma la nèu de mai* I chose "I a pas de messatge," which was my favorite song from the concert I attended. At this point I ran into a bit of trouble with the music selection process. The entirety of my German collection consisted of Christmas music, and I had neither Polish nor Russian music. Around the same time I was referred to a German song titled "Das Gefühl", and immediately I knew that it would be perfect as the slower, relaxing song in the mix. I then spent several hours playing clips of Polish and Russian songs on the internet, trying to find ones that were suited for my dance. After about a week of seemingly random searching I found a recording of "Katiusha" ("Катюша") that I liked and added it to my collection. I

emailed my friend from Poland pleading for help in finding my last song; she responded two days later with two suggestions, and the first one, “Ballado, hej!” happened to be exactly what I was searching for. The tempo, style, and energy level all matched with my other selections, and the structure mirrored that of a contra tune.

I had all six songs but had not yet decided which dance, or even which types of dance, would go with each one. After much reflection, I decided to have “I a pas de messatge” as the introduction because it already seemed to be divided into different sections, supported tap with a strong beat, and had the correct phrasing for a contra dance. “On n’est pas là pour se faire engueuler” became a tap dance for four people, and as its opposite I had “Scatter the Mud,” a ballet quartet. “Ballado, hej!” made me think of contra dance every time I heard it, and it repeated its chorus several times; thus, it automatically was destined as the finale. This left me with “Das Gefühl” and “Katiusha” as the extra dances that were not yet assigned. I knew I wanted to include Irish dance, but rather than setting it to the Irish music, I entertained the idea of combining hardshoe and softshoe in a dance challenge to “Katiusha.” To research for the Irish choreography I watched videos of Irish *feiseanna*, dance competitions, including clips from the National and World Oireachtas. I also attended *Lord of the Dance* while in France, watched the movie *Riverdance-The Best of Riverdance*, and took private lessons. However, within a few weeks I had to abandon the choreographic idea as I realized I did not feel I had enough experience in the genre to create a

quality dance with Irish vocabulary. After seeing my tap students perform in the end of semester showings in the fall of 2009, Peter Jones made a comment to me about how I should pursue the collaboration of tap and body percussion. While debating about the direction I would go with “Katiusha,” I remembered this and decided to embrace his challenge. Now, the only song left was “Das Gefühl.” I knew it needed to be lyrical, but I already had an only ballet piece and an only tap piece. Thus, it needed to be a collaboration, but I was unclear about how and decided to take a step back and wait for inspiration. I was reading *Tap Dancing America* by Constance Valis Hill and came across the name Paul Draper. The previous summer at a master class someone had told me I reminded him of Draper, and eager to learn more, I watched several video clips available online and read about his inspiration in online articles and *Tap! The Greatest Tap Dance Stars and their Stories 1900~1955*. Essentially, he focused on bringing the beauty of ballet into the art of tap. As he states in *Tap!*, “I began to do the same steps that I always had done...The arms didn’t look right...I said, ‘ Maybe I ought to go learn how to dance!’ ” (Frank 236). These two disciplines are my favorites: tap and ballet. The day after reading his name in *Tap Dancing America* it came to me that I should use his work as my inspiration and create a duet for tap and ballet. Only, since my thesis was based on 2x2 matrices, I had two couples dancing the duet with an occasional blend into a quartet. To add to the lyrical quality I decided that I wanted the ballet dancers on pointe, as opposed to “Scatter the

Mud" in which I needed them in canvas shoes in order to incorporate Irish softshoe movement that would ordinarily be done in ghillies.

Finally I had each song picked out, the types of dance chosen, and knew which combinations would go with which song. Only, everything else was missing; I did not yet have dancers, an order, or even set choreography. I decided to choose my dancers first, knowing that they would inspire the choreography. Desiring to stay with the theme of four and wanting to cast myself as a tap dancer, I originally set out looking for three tap dancers and four ballet dancers, two of whom would dance on pointe. I asked Karen Labrie, Lauren Becker, and Lauren Wolter to be my tap dancers. They all said yes, but Lauren Becker also let me know that she was recovering from an injury and could not do excessive jumping in a high energy piece, which is how I had envisioned the tap quartet. Luckily Amanda Mehlman agreed to also join my cast. I had five tappers, including myself, and now needed to find the four ballet dancers. Previously I had worked with Hannah Zukswert and knew she would be a great dancer to have; happily she said yes. I was previously in dances with Sophia Weeks and Danielle Pite and loved their energy and style. They both also agreed to be in my piece. Now I was only missing one ballet dancer. I had not yet chosen the fourth ballet person and decided, rather than rushing into a decision, I would wait and ask later.

Choosing who would perform which dance was a game unto itself. Some of the choices were easy, such as who would do the up tempo tap piece (the four non injured tappers) and who would do the Irish ballet (the three dancers I had

already chosen and the to-be-determined fourth dancer). However, the collaborations were more challenging. With Lauren Becker's injury in mind I knew that I could create a softshoe style tap part in "Das Gefühl" that would match the lyrical quality of the pointe dancers. This way she would not have to jump or risk further injury, and the styles would correspond nicely. To accompany her I chose Karen since they had tapped together for four years at Mount Holyoke and could easily match their styles. Danielle and Sophia had both greatly impressed me with their facility on pointe and seemed like natural partners for this lyrical ballet. For "Katiusha" I wanted the focus to be on two energetic tappers and a chorus of body percussionists that would imitate and reciprocate the rhythms of the tap dancers. Amanda and Lauren Wolter both had the energy and personalities I desired, so I paired them as the tap dancing duet. For the body rhythm chorus I kept in mind shoe changes and back-to-back dances while assessing the dancers' ability for body percussion. Finally I decided on Lauren Becker, Sophia, Hannah, and either myself or the fourth ballet dancer. I felt ready to start the bulk of my choreography; I had most of my dancers, I had music, and I had inspiration.

After a few weeks of intensive rehearsals I decided that the time had come to find my fourth ballet dancer. I asked faculty for advice, sent out various emails, and was turned down by all whom I asked. Some candidates considered themselves too busy, some were already involved in the maximum number of dances permitted by the department, and some just never responded. One dancer

agreed to do it but withdrew after the first rehearsal because of time concerns.

After about three weeks I began to panic and eventually came to the inevitable conclusion that I would need to use one of the tap dancers, or else forgo my ballet quartet and 2x2 matrix. I asked the tapper who was also an advanced ballet dancer, and she politely declined. Thus, I had to use myself, which I had been hoping to avoid, since the other tappers were not comfortable performing ballet. This altered my point of view while choreographing because I had to rely on videos of rehearsal to watch the entire cast, but it did not alter my artistic vision.

Although later than I would have liked, I finally had each dance cast and was working on developing and setting the choreography. We rehearsed some during the fall semester, intensively during January, and very often during the spring semester leading up to the show. I would bring in ideas for movement, give them to the dancers, and adapt them to where they fit the individual dancers. All of the pieces were created this way, with my artistic vision and the dancers' collaboration.

## BRINGING IT TOGETHER

### “I a pas de messatge” and Artistic Decisions

Everything was going smoothly. I had done research on matrices and contra dance, I had dancers, and I had choreography for most of the songs. The songs related, but the dancers did not have a storyline to follow. They came onstage, they danced, they waited while others danced, and they ended. I wanted to hold true to the contra dance theme, and so I tried to emphasize that influence. I chose for my piece to take place in a dance hall, complete with wooden benches and appropriate lighting. To unite the dancers I choreographed the introduction such that the tap dancers would start on a platform out by the audience, and the ballet dancers were still behind the curtain. As the music started two of the tap dancers entered and started a friendly time-step tap jam. While they were dancing the other two tappers entered and picked up the time-step trade, sharing their steps and greeting their friends. They continued the improvisational appearance with one dancer starting a step and the others slowly joining in until eventually all transitioned into a dance in unison. For one chorus they stopped tapping, huddled up, and just chatted. While unusual for a performance-based tap dance, talking and greeting each other would be completely normal at the start of a contra dance, especially before the dancers had entered the building. After they had finished

their discussion they tapped again, in unison, and at the end of the chorus, collected their belongings and descended from the platform to go enter the dance hall.

At this point the curtain opened, revealing one dancer asleep on a bench and two others trying to wake her up, to prepare for the evening's events. When she finally awoke the tap dancers arrived onstage and the dancers all greeted each other. They slung down their bags and joined together in a contra, the same one that would be again presented in the finale, and introduced the notion of contra dance onstage as a basis for the choreography about to come. It was a means of indirectly instilling the idea of matrices and contra in the audience's mind, appropriately to the music "I a pas de messatge," of which the main lyrics translate to "There is no message in this song." At the end of the song the dancers laugh and run off to arrange their affairs in a more orderly fashion while chatting with fellow dancers.

The dancers were now united in a storyline and a set, yet I also wanted to choose costumes that would unite them but at the same time distinguish between the tap dancers and ballet dancers. I chose to have them all in dresses that had body when spun, with the tap dancers in shades of blues, greens, and purples, and the ballet dancers in brighter colors including yellow, red, and light blue. Since I danced in both groups I had to find a dress that would blend with both. I decided on a gray dress that matched the color palette of the tappers' dresses but was light enough to mix with the ballet dancers' dresses. All of the costumes blended

together, but when divided into the two groups the difference was noticeable and supported the individual groups. The stage layout and costumes were as in this picture:



I needed a title for my piece. The working title was *Matrices in Motion*, which I decided was appropriate for the written work. Yet, I did not want to inform the audience that all of the choreography was based on matrices and mathematics. Similarly to how I did not want the lyrics to influence their viewing of the dance, I did not want any preconceived notions to alter their reactions. I did think the audience might need an idea as to the setting of the dance and decided to simply title it *Dance Hall*. However, the multicultural aspect played a large part in the piece, something I wanted to reflect in the title. By choosing a

subtitle in which each word was in a different language, I was able to accurately incorporate the cultural influences. *Tänze* is German for “dances,” *de* is French for “of” or “for,” *nasha* (наша) is Russian for “our,” and *lingua* is Occitan for “language” or “life.” Therefore, the full title of the dance became *Dance Hall: Tänze de nasha lingua*.

## HOW WELL COULD I CREATE A DANCE IN WHICH THE DANCERS STAYED IN STRICT FORM, COMPLYING WITH THE 2X2 MATRIX?

“On n'est pas là pour se faire engueuler” and the power of the matrix

While working on this tap piece, I deviated as little as possible from my basic intent: to explore the use of matrix-oriented social dance patterns in a performance setting. In a 2x2 matrix there are 4 entries, which in contra dance patterns may also be represented as the four corners of a square. Among other properties of a square, it holds for all squares that these four corners must be equidistant from the center, with a  $90^\circ$  angle in each corner. This in turn leads to the dihedral group of symmetries of a square, which I chose to explore in this dance. I based the movement patterns on the symmetries of a square, all of which are found in contra dance:

- Reflections across the x-axis: partners switching places
- Reflections across the y-axis: neighbors switching places
- Rotations clockwise and counterclockwise
- Reflections across  $y = x$ : “gents” switching places
- Reflections across  $y = -x$ : “ladies” switching places

The identity property (or a rotation of  $360^\circ$ ), which results in no change in the formation, occurred every time the dancers did not switch places while dancing; thus I chose to omit it from this study for sake of clarity and purpose.

Ordinarily in a contra dance, by the end of the sequence the caller must have arranged the dancers so that each couple has advanced forward one place. Because the purpose of my dance was not social, I decided to create a dance where the dancers ended in their original spots. To me it was analogous to the critique behind dance: the curtain opens, the dance happens, the curtain closes. How has the audience been affected? This dance was structured in a similar fashion: the dancers take their places, the dance happens, the dancers end in the same formation. What has the audience experienced? Even while keeping the dancers in strict formations I wanted to make sure that I was able to reach out to the audience and not leave them passively watching four people tap. Again, because I was not constrained by the rules and musical organization of a contra, I was able to keep each formation as long or as short as I wished. Thus, some positions would be held for up to 8 measures whereas others would only be held for 2 measures. In all I had 11 formation changes, resulting in 12 formations. I purposely set the final formation equal to the first as explained above, and several of the inner formations were also repeated from previous ones. By listing each formation in order, assigning a 1 to formation 1, a 2 to formation 2, etc, I made my list of formations

1-2-3-4-5-6-7-8-9-10-11-12.

Several of the formations were repeated, and I wanted to see if there were any obvious patterns. Replacing the number of the repeated patterns with the number of the first instance of each such formation, I found the string to read

1-2-3-2-5-6-2-3-2-10-11-1.

The sequence 2-3-2 was repeated, and as planned the dance started and ended with the first formation.

Listed below are the changes between each pattern.

1	start
1 : 2	x-axis reflection
2 : 3	y-axis reflection
3 : 4	y-axis reflection
4 : 5	$y = x$ and $y = -x$ reflection
5 : 6	$90^\circ$ counterclockwise rotation
6 : 7	$90^\circ$ counterclockwise rotation
7 : 8	y-axis reflection
8 : 9	y-axis reflection
9 : 10	$90^\circ$ counterclockwise rotation
10 : 11	y-axis reflection
11 : 12	$90^\circ$ clockwise rotation

Using the initials of the dancers (A : Amanda, C : Crystal, K : Karen, L : Lauren)

I wrote down the representation of each formation as seen from an aerial view.

	Upstage												
	1	2	3	4(2)	5	6	7(2)	8(3)	9(2)	10	11	12(1)	
Stage Right	K A L C	L C K A	C L A K	L C K A	A K C L	K L A C	L C K A	C L A K	L C K A	C A L K	A C K L	K A L C	Stage Left

Downstage

Using arrows, I tracked the changes of where each person was headed, shown in relation to the person with whom they were exchanging places if such an exchange did occur. This made it much clearer to see the overall patterns of movement.

	Upstage												
	1	2	3	4(2)	5	6	7(2)	8(3)	9(2)	10	11	12(1)	
Stage Right	↑ ↓	↔ ↔	↔ ↔	↔ ↔	↔ ↔	↓ ↑ ↔ ↑	↓ ↑ ↔ ↑	↔ ↔	↔ ↔	↔ ↔	↔ ↔	↑ ↓	Stage Left

Downstage

Sequences such as 2 : 3 and 7 : 8 took place during the chorus, which was repeated with the same patterns and steps as in a contra. For the final repeat I opted to have an alternate ending, varying the pattern and the steps. Therefore, the sequence 10 : 11 was a variation on the previous models of switching places and returning, since the dancers switched places and then proceeded to complete a 90° clockwise rotation to their positions from the beginning of the dance.

Often in tap a dancer will do the same steps three times in a row and then a break in place of the fourth time, giving rise to the traditional “3 and a break.” The chorus in the song only happened three times total, so I opted to use the third

time as my break, starting with the same choreography and then halfway through the final repeat breaking into a finale.

When choreographing the steps, I knew that I wanted to draw from contra dance, so I made up tap versions of various contra steps. To create a do-si-do I gave the dancers a tap sequence: step scuff hop toe heel toe heel step scuff cramp roll step, which they had to do turning right while circling around their partner. Thus, they were following the pathway of a turning do-si-do while doing tap footwork. Another example is the balance-the-ring that I altered for tap. Ordinarily it would be step (1) touch (2) step (3) touch (4) *chaîné* right (1 2) step (3) clap clap (&4). I had the tappers, in the same formation, do flap (a1) heel toe (a2) flap (a3) heel toe (a4) 2 turning flaps (a1 a2) flap (a3) heel click (4), then repeat it and end with 2 heel clicks (&4). Again, as with the do-si-do, the movement pattern was the same, but the footwork had been modified for tap. Other such instances included a ladies' and gents' chain across, circle right, circle left, and repeated balance-the-rings.

Here is an image of the dancers doing a contra step:



and here they are doing a contra step that has been altered for tap:



I found it difficult to choreograph with the dancers in such a strict formation, often facing the sides of the stage and each other instead of downstage. Because they did not look directly at the audience for the majority of the dance I had to rely on the shifting patterns to interest the audience. Had I based the steps off of the timing patterns in contra and not just the symmetries of a square, I would have been required to choreograph a 64 beat sequence that would then

have been repeated continuously until the end of the music. Not wanting to limit myself to 64 beats, I chose to follow the geometric patterns but not the musical limitations. This also helped to capture the audience's interest as there were repeated phrases, rendering the sections familiar to the audience, but they were also faced with new material to absorb. To allow the audience to concentrate more on the visual patterns than on individual dancers I purposely avoided having the dancers face the audience and make eye contact until more than halfway through the dance, and even then it only happened three times total—twice for brief periods of tricks, very close together, and once at the very end. However, as soon as the music ended, the dancers high-fived each other (the theatrical thanking of the partner instead of the traditional verbalized “thank you” at the end of a contra) and turned away from the audience, once again absorbed in their own world, leaving the audience to reflect upon the artistic expression of the dihedral group of symmetries of a square, represented by the geometric patterns and manipulations they just experienced.

IF, IN MY 2X2 MATRIX I CHOSE ZEROS FOR ONE OR MORE OF THE  
 ENTRIES, HOW WOULD THAT AFFECT THE CHOREOGRAPHY IN  
 TERMS OF PATTERNS AND ARTISTRY?

“Scatter the Mud,” Scatter the Zeros, Scatter the Dancers

In this ballet-based dance I wanted to vary the formations of the dancers since in the previous piece they were restricted to specific formations and patterns representative of the symmetries of a square. An audience can only focus on the same idea for a brief period of time, and two dances in a row with the same limitations as “On n’est pas là pour se faire engueuler” would have lost their interest. From a dancer’s point of view, I added to the choreography one dancer at a time. From a mathematical point of view, I entered zeros for all entries of the 2x2 matrix save one, and slowly replaced the zeros with ones, using the following notation:

- 0 There is no dancer present in the position, although the position is reserved
- 1 There is a dancer present in the position

The music started without any dancers; after sixteen counts Hannah began dancing by herself and was quickly joined by Sophia. In the first half of the dance I concentrated on expanding the size of the half empty matrix and included only a few placement patterns, representable by a reflection across the x-axis as

demonstrated in the discussion on “On n’est pas là pour se faire engueuler.”

Eventually the two dancers were joined by a third who proceeded to dance a short solo—the first time the audience had a break from simultaneous dancing. At the end of her solo all four dancers entered together, picking up where the duet had left off. The matrix was now complete; all zeros had been replaced; the originally empty set was now filled.

Choreographically, as in the other dances, I wanted to draw from outside sources. Since the song was an Irish medley and I am familiar with Irish step dance, I chose to use a mix of contra steps and Irish steps to create a unique Irish ballet. The duet was mainly inspired by traditional Irish softshoe with many cuts, tightly crossed legs, and limited arm movements. Keeping this influence I segued into an Irish contra upon the arrival of all four dancers. They started with a balletic grand right and left, weaving in and out by passing alternate shoulders and turning instead of taking hands.



After the grand right and left they transitioned into a balance-the-ring that they immediately repeated in order to rotate their formation 90° counterclockwise. As

I explained for “On n’est pas là pour se faire engueuler,” ordinarily it would be step (1) touch (2) step (3) touch (4) *chaîné* right (1 2) step (3) clap clap (&4). I had the ballet dancers, facing into the center, do *piqué* in first arabesque (1) *plié* (2) step back left for a *tour jeté* (3) land it (4) cross the left foot over in an overcrossed fourth (1) turn this into an altered *glissade en tournant* by bringing the right foot in to the left foot while turning (2) *plié* (3) *entrechat-quatre* (&4). Again, the accents were on the same beats and the movement pattern was the same as in contra dance; only the steps themselves were different. After the grand right and left and balance-the-ring the dancers continued interpreting contra movements by dancing a large circle right without holding hands. The actual steps were 2 Irish skips (a1 a2, a3 a4) step (1) *saut de basque* (2) step (3) *chassé en tournant* (4) to complete the first trajectory; the dancers repeated the same phrase on the next leg of the pattern. They then did a chain across without grabbing hands, ladies first, then gents, then again ladies, and then gents. In order to cover more space and to make the simple chain across step bigger I interpreted it as the dancers running across the diagonal in a straight trajectory while making eye contact, passing right shoulders. After each dancer had returned to her original spot they repeated the circle right pattern twice more and broke out into another adaptation of a swing. Instead of holding arms or hands they linked elbows while facing opposite directions and circled for two complete rotations, returning to their previous positions by the end of the phrase.

At this point the choreography returned to the vocabulary of the duet at the beginning. In a four count canon each dancer picked up the movement phrase that travelled her across the floor into a line where she started a repeating pattern that continued until all four dancers had arrived. This sequence revisited the idea of starting with an empty set and dancer by dancer replacing the zeros in the matrix with ones. Continuing with the duet's vocabulary, two simultaneous duets broke out, using the same steps but with different timing. Returning to the tap idea of three and a break, after repeating the same phrase three times, all four dancers united during the last eight counts to run upstage, push off of each other, and spin as the music faded out.

Through "Scatter the Mud" I investigated the effects of using zeros in a matrix of dancers. I staggered the dancers' entrances and timing in a canonic style, allowing the audience to view the same patterns as presented in the previous dance but with only part of the pattern physically realized. Since I was using the patterns, not in the communal setting of a contra dance, but in a performance setting, I had to pay attention to the relation between the dancers and the viewers. The dancers individually had to cover more space and do larger movements in order to communicate the patterns, which were not as obvious with fewer people. I also had to allow for this in my choreography and choose transitions that would resonate onstage. For instance, partners changing places upstage and downstage was relatively unnoticeable, but when they would switch places from stage left to stage right the audience's attention was captured. Therefore, when there were

only two dancers I used horizontal stage left/stage right changes most often, and when there were four dancers I was able to use both horizontal stage left/stage right and vertical upstage/downstage changes.

## COULD TAP AND BALLET HOLD THEIR OWN AGAINST EACH OTHER?

### The Challenge

After “*Scatter the Mud*,” I had four dancers in tap shoes and four dancers in ballet shoes. For the next dance I needed six dancers in tap shoes. Ordinarily in such a situation the choreographer would have the dancers exit the stage, change shoes, and return. I considered this option but felt it would be untrue to the piece and its setting. Dancers at a contra dance do not leave to change their shoes or take a break when not dancing. They sit on the sides of the room on benches and chairs and watch, encouraging the other dancers. Since I wanted to stay true to the contra dance feel, I incorporated the wooden benches into my set design, used window gobos in my lighting design, and most importantly, made the decision to keep the dancers onstage throughout the entire piece. This meant that at any given time there were dancers sitting on the benches, watching, and encouraging vocally and with choreographed, subtle movement. However, since the dancers would not be leaving the stage, I still had the issue of shoe changes. I solved it by choosing to have the dancers bring a bag, such as a contra dancer would, with their extra shoes, a water bottle, and whatever else they would need during a twenty minute dance. Then, when sitting on the benches, they were free to change their shoes onstage, drink water, talk with their neighbors, and call out

encouragement. This kept the energy fresh and sustained the environment I wanted to create, rather than having a stark stage, devoid of everything save dancers and their lighting.

When deciding the order of the dances I kept shoe changes in mind for timing, since several of the dancers had to switch from ballet shoes to tap shoes and pointe shoes. I also wanted to base the order more on the flow of the dances than on what was most convenient, and realized that inevitably I needed a transition between “Scatter the Mud” and “Katiusha” while the ballet dancers changed into tap shoes. I returned to the idea of the Irish softshoe and hardshoe challenge I had originally wanted to include but had cast away because of my lack of choreographic success with Irish dance. I set aside the Irish vocabulary and instead decided to set an *a cappella* challenge between tap and ballet after realizing that I had never seen them presented onstage simultaneously. In “Das Gefühl” they blended together into beautiful duets, but I also wanted to show that each could hold its ground when compared to the other. For the two “competitors” I used the two dancers not in “Katiusha,” Karen and Danielle, and had the dancers already in tap shoes serve as the “onlookers,” keeping a steady pulse. This way there was little focus on the dancers changing shoes, and it did not distract from the performance as seen in the following image:



The challenge was based off of a tap challenge, defined by Constance Valis Hill as “any competition, contest, breakdown, or showdown in which tap dancers compete against each other before an audience of spectators or judges” (Hill 3). A challenge is “motivated by a dare, focused by strict attention to one’s opponent, and developed through the stealing and trading of steps (Hill 2-3). The challenge in my piece was instigated by Danielle bumping into Karen at the end of “Scatter the Mud,” Karen taking offense, shoving Danielle off, and issuing her challenge. The ensuing dance-off was reminiscent of other, famous cross-idiom challenges, notably the friendly battle between the two tap dancers and three Irish dancers in “Trading Taps,” the thirteenth section of *Riverdance—The New Show* (Foley 40). They amicably show off their talent and unite in a finale, acknowledging the abilities of the other. I wanted to avoid the hostility of other famous challenges between tap and Irish, namely the 1997 battle at the Grammy Awards between Colin Dunn, representing Irish dance, and Savion Glover, representing jazz tap dance. “Not only were their own names and reputations at stake but also the percussive dance traditions—Irish step dancing and African

American rhythm tap” (Hill 291). In this battle each was determined to prove the other inadequate, there was little mutual respect, and each was determined to win. After both performed spectacularly, “the dancers just stood there, flat-footed, glaring at each other. Smiling through gritted teeth, they slapped hands, turned their backs on each other and walked off the stage, never looking back” (Hill 292). In my challenge I wanted to highlight the abilities of each and, in contrast to the above mentioned challenge, have them support one another. Karen and Danielle traded eights, and Karen started the smooth section with riffs and drawbacks. Danielle countered with a *developpé écarté derrière* nearly to her ear and a graceful *grand rond de jambe en l'air* to complete the adagio portion. In the next trade Karen switched to fancy jumps, finishing with a series of aerial pick up shuffles that would be daunting to many dancers. In return Danielle did a petite allegro combination showing off her *ballon* and *batterie*. The final round started with complicated maxi ford turns segueing into grab offs with toe stands. Danielle took the turning element and proceeded to do a *manège* around Karen, culminating in several *fouettés*. To bring the challenge to a finish Karen joined in with a closing “Shave and a haircut,” the traditional end a tap routine.

Originally the challenge was only included as an interlude while three of the dancers changed shoes, but it grew into a part as vital as the six dances with music. Although it did not relate to the matrix-theme, it tied together the various dance idioms and juxtaposed them in an artistic, collaborative fashion.

WOULD THE GEOMETRIC PATTERNS BECOME MUNDANE AND THUS  
REQUIRE MORE VARIATION?

“Katiusha” and “compressed” matrices

So far in my piece I had shown a contra dance, a tap dance in which the dancers stayed in a strict 2x2 matrix formation, and a ballet dance which played with the entries of the matrix. However, I had not yet used any other arrangements of four. The 2x2 matrix was my base because in contra dance the participants are arranged in aligned 2x2 matrices. The extent to which I restricted the choreography to this exact formation was up to my own interpretation. Approaching the matter from the viewpoint of the audience, I decided that it was time for a variant. Because of the extremely energetic nature of the song I chose to have a tap duet that would lead the dance, the drum majors in front of the band. To support their rhythms I included a four person chorus of dancers in tap shoes that complimented the tap duet as a body percussion orchestra.

Body rhythm is the art of making music and rhythm with the body, especially by stamping the feet and hitting the hands all over the body to create sounds of different tone and pitch. Over the past four years my personal style has been developed through various courses and master classes. My first introduction to the form was in Peter Jones’s Rhythmic Analysis course at Mount Holyoke

College, and I loved the ability to “tap with my body,” as I considered it. While in France I took two master classes by Nuria Lopez, a body percussion artist from Madrid, Spain, and upon my return to the United States took master classes with Tasha Lawson and the legend Keith Terry at the Dance Inn in Arlington, Massachusetts. By learning from each of these artists I have been able to develop my own style which is especially based on tap rhythms and use of the hands.

The body percussion quartet was treated as a chorus line and operated in a 1x4 matrix, which I referred to as a “compressed” version of the 2x2 matrix. There were still four entries, but they had been flattened into a single row. Throughout “Katiusha” the chorus line would stretch, condense, and travel, but the dancers remained in the same relation to each other for all but the last quarter of the dance. At the beginning they ran out in their line, horizontally across the stage, travelling in unison from stage left to stage right. Once there they started an eight count pattern, rotating in place an eighth of a turn every four counts for the first eight measures. For the next four measures they sped up the rotation and completed a quarter turn every two measures, giving the appearance of a body percussion machine. This “machine” then stopped rotating, and each part continued moving in perfect harmony. The rhythm was a direct variation of the rhythm of the tap duet and the angles of the “machine” aligned with those of the tappers. Following is an image of the rhythm “machine” upstage right in mid-rotation and the tap duet downstage:



Up to this point the trajectory of the two tappers was linear except for two phrases halfway through the rotation series mentioned above when they split into a figure eight pattern. I did not set out to choose such a pattern, but it seemed to make the most sense with the feel of the piece. I wanted to showcase their talents as tappers and include difficult tricks while keeping the audience's attention on both of them and not split their duet for the first half of the dance. However, halfway through I had the tappers and the body percussionists trade roles and the tappers became the backup and the chorus became the focal point. All six dancers united for two phrases while they physically switched places, the tappers continued with the same pattern, and the body percussionists broke into something new. After this brief interlude the dancers resumed their original roles for several more phrases. As the music introduced a new instrumental focus I had the dancers unite and support each other while they took turns with a sixteen count solo in the center of the circle. Once the solo series had ended five of them lined up to perform a complicated canonic body percussion phrase. They started in unison, overlapping arms and legs in perfectly timed sequence and then broke

into a one count canon creating a wave of sound and motion. In this image the dancers have just begun their canonic phrase.



The second half of the canon was based on a rhythmic pattern first introduced to me as a tap exercise by tap dancer Jay Fagan. Essentially, there is one beat per side, then two, then three, then four, then back to three, two, one. Because the four count pattern is only done once right and left (it is not repeated on the way “down”), each half of the pattern conveniently adds up to 16 beats, or one phrase.

The full tap pattern is listed below:

Beat 1-16	Left	Right	Feet
1		1	stamp
2	1		stamp
3-4		2	toe heel
5-6	2		toe heel
7-9		3	flap heel
10-12	3		flap heel
13-16		4	dig brush toe heel
1-4	4		dig brush toe heel
5-7		3	flap heel
8-10	3		flap heel
11-12		2	toe heel
13-14	2		toe heel
15		1	stamp
16	1		stamp

I then took this tap pattern and translated it into a body percussion phrase as follows:

Beat 1-16	Left	Right	Hands
1		1	thigh hit
2	1		thigh hit
3-4		2	thigh hit, clap
5-6	2		thigh hit, clap
7-9		3	brush away, brush back, clap
10-12	3		brush away, brush back, clap
13-16		4	chest hit, clap, brush away, brush back
1-4	4		chest hit, clap, brush away, brush back
5-7		3	brush away, brush back, clap
8-10	3		brush away, brush back, clap
11-12		2	thigh hit, clap
13-14	2		thigh hit, clap
15		1	thigh hit
16	1		thigh hit

Just as I had previously translated contra steps into ballet and tap sequences, I had converted a tap pattern into a body percussion phrase.

This dance originally “compressed” the 2x2 matrix into a 1x4 matrix with a supplemental 1x2 matrix, and finished in an even more “compressed” 1x5 matrix of coordination and rhythm. By expanding the range of patterns that satisfied my conditions I was able to incorporate new ideas and movement into “Katiusha,” thereby providing yet another take on the geometric patterns previously studied.

## HOW WOULD I FIND COMMONALITIES IN RHYTHM, MOVEMENT, AND LINE?

Paul Draper, Ballet-Tap, and Das Gefühl

For the lyrical duet I looked to Paul Draper for inspiration. His journey reflected my own quest. If a tap dancer were to decide that he wanted to try tapping to classical music instead of Gershwin, would he have to alter his style? Draper found himself in exactly this situation and decided that something would have to change. His feet had the required grace, but his upper body was left behind. He could tap classically, but he couldn't perform classically. In searching for the solution, he pioneered a new style of dance commonly referred to as "ballet-tap".

Looking to ballet for inspiration, he took up beginning ballet classes at the School of American Ballet. "I was never, ever going to become a ballet dancer, but I started to learn how to move around so that I was able to do the things I had wanted to do—make sounds which were rhythmically appropriate and sensible, and imaginative and inventive, and still look something like a dancer" (qtd. in Frank 236-237). Through his ballet training Draper was able to incorporate classical steps and port de bras into his tap routines. Whereas the other tappers focused on "laying down iron" and entertaining the audience through flashy

moves, Draper shunned the cheesy show business style and focused on bringing tap into a more sophisticated, elegant atmosphere. “I was anxious to *do* the dance, not to sell it. I wanted to be a part of the art” (qtd. in Frank 235). He performed in concerts instead of in jazzy night clubs and refused to worry about not conforming to what the audience was used to. “I didn’t lay down iron. I was trying to dance. I was a dancer trying to make a difference as an artist, trying to make something that hadn’t existed before, and trying to change the lives of whoever saw it” (qtd. in Frank 235).

Not only did Draper incorporate balletic *port de bras* into his dancing, but he also added balletic jumps and extensions. “Tap Dance Concerto” includes a tap-ified version of a chain of *coupés jetés en tournant*, several *jetés à la seconde*, and finishes with a *sissonne* into three stamps. Several other balletic movements are also present, but these three are the most obvious as being untraditional to tap dance. In “Somewhere Over the Rainbow,” choreographed by Draper and performed by Karen Prunzik at Carnegie Hall, there is an endless supply of *glissades*, *battements à la seconde*, and *arabesque relevés lents*. Many other dancers have also included ballet based *port de bras* while tapping, but very few have also included actual ballet steps. I believe that is where Draper’s innovation lies. It is interesting to note that he was originally a ballroom dancer, then a tap dancer, and not until much later did he take up ballet. Thus, his movements, although balletic, are definitely more tap based, and he does not hesitate to

sacrifice ballet lines for more interesting sounds. I feel that the ballet influence did not penetrate his natural coordination and it was a learned process.

I have trained much more in ballet than in tap and consider myself a ballet dancer who transitioned into a tap dancer as opposed to Draper who was originally (and remained primarily) a tap dancer. Thus, my style is extremely ballet influenced. Draper did “ballet-tap,” and in my thesis I wanted to try out combining “ballet-tap” and “tap-ballet” to the song “Das Gefühl” by Annett Louisan. While choreographing I had to decide if I wanted to focus on the look or on the accented rhythm for each step. I consider tap to be primarily an auditory dance and ballet to be a visual dance. If all sound were cut away the heart of tap would be lost, but ballet would still be beautiful. On the contrary, in complete darkness tap would continue to pique our interest and ballet would be practically useless. My challenge was to keep both interesting throughout the dance in both forms, simultaneously allowing them to relate and share the same emphasis. The end result was a lyrical dance that allowed the ballet dancers to share the rhythms of the tappers, and the tappers to share the elegance of ballet.

Interestingly, when I began to pay attention to the previous training of my dancers, I learned that of the five tappers, two were at an advanced level in ballet, two were at an intermediate level, and one had never taken a ballet class. Of the ballet dancers, one had been tapping for six months, another for a month, and the other never. Yet, here I had cast the two tappers with the least ballet training in a duet with the two ballet dancers who had the least experience with tap. The goal

of this particular dance was to show the commonalities between tap and ballet, and I set out to achieve it with dancers who were essentially untrained in the idiom of their partners. Paul Draper went to the School of American Ballet to help himself integrate the two styles; I had myself and my knowledge of both styles to help my dancers. It was an intense choreographic challenge and proved to be one of the most stimulating of my work. I do believe that I was able to blend the two idioms and highlight the beauty of each in collaboration.

For instance, at one point the tappers do the rhythm &1&2&3&1 **2 3** with a lyrical quality to the first four counts and toe accents on the last two counts. I wanted to reflect this with the pointe dancers, so they did a melodic *balance* (1 2 3) *piqué* (1) **coupé coupé (2 3)** with the sharp, accented coupés coinciding with the tappers' emphasis on beats 2 and 3. Therefore, although the pointe dancers were not making noise they were still participating in the exchange of rhythm. This particular instance is especially interesting since in a *coupé* the accent is produced by lifting the foot off the floor, which is exactly the opposite of how a tapper makes an accent—by making contact with the floor. The movements look similar but the accent is provided by opposite feet:



The *coupés* were an example of a common rhythm, but I also wanted to include specific areas where I focused on common lines and shapes. One way I accomplished this was having the ballet dancers, while travelling backwards, do step (1) ***rond de jambe*** (2 3) step step step (1 2 3) ***rond de jambe*** (1 2) step step step (3 1 2) ***rond de jambe*** (3). The tappers mirrored the line of the leg to the side by doing flap flap (&1&2) **shuffle** (&3) hop flap flap flap (&1&2&3&) **shuffle** (1&) hop flap flap flap (2&3&1&2) **shuffle** (&3). Thus, for 1 count per set the line of all of the dancers' legs matched as seen in the following image:



The transition into the next step again had similar movements that resulted in the same shape, with the pointe dancers going into a *relevé* and the tappers preparing for a hop third:



By now I had shown that the dancers could match lines and rhythm, but I had yet to show how their movement could relate. One prime example I chose to include was having each do a turn, first in place:



and then the ballet dancers turned while travelling and the tappers continued to turn in place:



Thus, the audience was able to relate to the movement and the flow of the turn, sensing that the dancers were working together with a common interest.

Although the steps were different, the feel of the movement was the same for both tap and ballet.

By continuing similar strategies I combined the vocabulary and values of ballet and tap, letting both be graceful artistic expressions of emotion, reminiscent of Paul Draper. I found commonalities in rhythm, movement, and line, which united both forms in one lyrical dance. Draper was considered to be the tapper who brought extreme class to his performance much in the same way that “Das Gefühl” brought class and balletic elegance to *Dance Hall: Tänze de nasha lingua*. As he stated, “It is all within one context, one flavor—trying to create, trying to make a difference, trying to be a piece of the art. A dancer shapes space. He envisages and dreams and conjures up the space he wants. The way the universe makes its shape, a dancer does exactly that same thing” (qtd. in Frank 240).

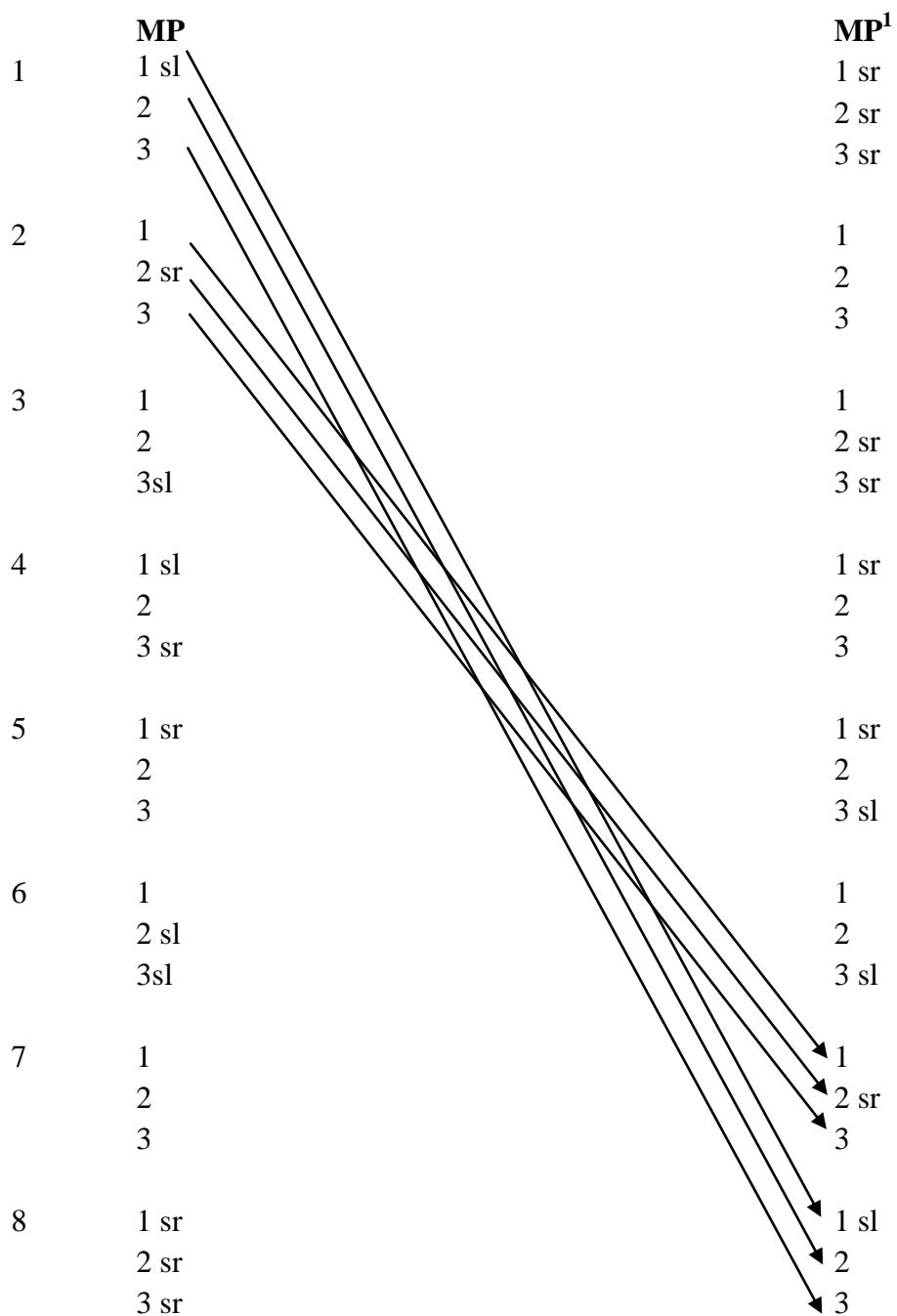
Aside from my goal of finding commonalities between ballet and tap, I also wanted to play with patterns of the steps. The most complicated instance of this was the shuffle series for the tappers. I took the basic steps of shuffle heel and drawbacks and created a visually and rhythmically interesting series. On the chart of quarter note beats I have marked ‘sl’ for shuffles with the left foot and ‘sr’ for shuffles with the right foot. Counts that have nothing written next to them

are drawbacks. There is always a heel on the **a** count (ex 1 & **a**). I called this My Pattern (MP):

(1)	(3)	(5)	(7)
1 sl	1	1 sr	1
2	2	2	2
3	3 sl	3	3
(2)	(4)	(6)	(8)
1	1 sl	1	1 sr
2 sr	2	2 sl	2 sr
3	3 sr	3 sl	3 sr

Once I had this pattern established I decided to invert it to create My Pattern<sup>1</sup> (MP<sup>1</sup>), a variation of the original sequence. It would have been easiest to do a direct reflection and have the first beat become the last, the second become the second to last, etc, but I wanted to try a more complicated pattern. Essentially, I exchanged the 3 beat measures in their entirety as opposed to each beat individually. Thus, the shuffles ended up on different feet for MP<sup>1</sup> in order to hold true to the sequence. Taking the 8<sup>th</sup> three counts of MP, I put them as the 1<sup>st</sup> three counts of MP<sup>1</sup>, took the 7<sup>th</sup> measure of MP and put it as the 2<sup>nd</sup> measure of MP<sup>1</sup>, etc. In the following diagram I show the mapping with arrows for the first and second measures. First I had the two tap dancers do the MP sequence

together and directly after, the MP<sup>1</sup> sequence. Once they had been established I split the dancers and had one do MP into MP<sup>1</sup> and the other do MP<sup>1</sup> into MP. This created a unique duet built on the same pattern but simultaneously showed the original and the inverted variation. Because both the shuffle heel and the drawbacks make sounds on the counts *downbeat & a*, MP and MP<sup>1</sup> rhythmically sounded the same. The contrast came in the physical look of each pattern and in the slight auditory nuance of the difference between a brush and a step.



Throughout this lyrical duet for four I found commonalities in rhythm, movement, and line between tap and ballet. They complimented each other and the dancers truly embraced the mélange. By looking to Paul Draper for inspiration, I was able to draw from his explorations into the world in which tap and ballet unite to create a beautiful classic idiom, pleasing to the eye and the ear.

## WOULD A SOCIAL DANCE BE APPRECIATED ONSTAGE IN ITS ORIGINAL FORM?

“Ballado, hej!”

Contra dance patterns were my inspiration for this study, thus I felt it only appropriate to include contra dance in my choreography. However, I was not sure how receptive the audience would be to a social form presented onstage. I did not want to alter the steps and make them performance based since I was interested in the way traditional dances are presented. Instead, I opted to use common contra steps to create a series that my dancers would perform in two squares. At the end of the sequence they would have advanced just as would be necessary in a real contra.

Traditionally a contra consists of phrases of eight counts each, but I chose to use the Polish song “Ballado, hej!” which has an extra two counts after the second and fourth phrases of the verses. Interestingly, these extra counts are not included in the chorus which uses the more traditional phrases of eight counts. Although the majority of the steps returned the dancers to their original place, during the execution of the steps the eight dancers were anything but stationary. I chose the following steps for my contra because of the way that they appear from

a bird's eye view and the interaction required between the dancers. The list of steps and the resulting changes is as follows, with the counts listed in parenthesis:

Position:	Name of Step:	Change:
1	Starting positions	
2 (8)	Balance the ring	90° counterclockwise rotation
3 (8)	Chain across, courtesy turn	90° clockwise rotation
3.5 (2)	Twirl your partner	no change
4 (8)	Right hand star	no change
5 (8)	Left hand star	no change
5.5 (2)	Step back	no change
6 (8)	Right and left grand	no change
7 (8)	Swing your partner	no change
8 (8)	Ladies gypsy around	no change
9 (8)	Head couples pass through	x-axis reflection

The representation is thus:

K: Karen, Hannah

L: Lauren Becker, Crystal

D: Danielle, Amanda

S: Sophia, Lauren Wolter

	Upstage											
	1	2	3	3.5	4	5	5.5	6	7	8	9	
Stage Right	K L	L S	K L	K L	K L	K L	K L	K L	K L	K L	D S	Stage Left
	D S	K D	D S	D S	D S	D S	D S	D S	D S	D S	K L	

Downstage

The diagram of manipulations would therefore be:

	Upstage											
	1	2	3	3.5	4	5	5.5	6	7	8	9	
Stage Right	↓ ← → ↑	→ ↓ ↑ ←	● ● ● ●	↑ ↑ ↓ ↓		Stage Left						

Downstage

While it can be fascinating to watch the same contra be performed multiple times in a row, it becomes monotonous after a certain point and no longer truly captivates an audience member's attention. I wanted to avoid this situation, so each time I repeated the contra I had the dancers change their orientation. The first time they were perpendicular to the front of the stage, in a perfect line from upstage to downstage. For the first repeat they shifted to a diagonal from downstage right reaching back to upstage left, and for the final two repeats they were horizontally spread out from stage left to stage right. This allowed the audience to view the contra from multiple angles and to notice new patterns each time the sequence was repeated. Below the three orientations are represented:



Since this was the finale I wanted to incorporate small sections from the other dances to remind the audience of how everything performed throughout the evening was related. Thus, after the first sequence of the contra, the four ballet dancers met in the middle and did their version of balance-the-ring with a tag at the end as seen in “Scatter the Mud.” The tappers kept the rhythm going with one

of the body percussion phrases from “Katiusha.” After the next sequence of contra the tap dancers arrived in the middle, and keeping the continuity flowing, also did their version of balance-the-ring with a tag from “On n’est pas là pour se faire engueuler” while the ballet dancers did a different “Katiusha” phrase.

“Ballado, hej!” established an affirmation to my theory that, when presented in a certain way, social dance would be accepted and appreciated onstage. Partly due to the energy and partly due to the intriguing patterns, the dancers connected with the audience and invited them to share the beauty of a social dance. Wearing tap shoes and pointe shoes, the dancers completed their two last repeats of the contra, bringing their evening of mathematically inspired dance to a close.

## INFLUENCE AND INTERSECTION

The main intent in this expansive exploration into an intersection of mathematics and dance was to study the manipulation of 2x2 matrices, drawn from contra dance, as the foundation for patterns in performance dance. While preparing for the process I researched what other academics and choreographers have found in their studies of the various relationships between math and dance. Most tend to focus on the geometry and physics of lines of the body and arrangement of the dancers. In many classical ballets the corps de ballet is artfully arranged in parallel lines, congruent circles, or neatly arranged figures. In a review of the Kirov, Hedy Weiss wrote, “As anyone at Wednesday's opening night performance of *Swan Lake* at the Auditorium Theatre can attest, the gorgeous geometry of this work's superbly synchronized female dancers easily commands your gaze” (Weiss). Not limited merely to basic geometry, the physics of dance has also been analyzed, notably in Kenneth Laws' and Arlene Sugano's *Physics and the Art of Dance*. Algebra popped up in Joan Acocella's book *Mark Morris*, notably in her comments on *Stabat Mater*:

[*Stabat Mater*] is put together like an algebra problem. There are twelve dancers, divided into three troops, and twelve dances, divided into three parts, with the three different drop curtains. In each part, only a prescribed number of dancers can be onstage—four in the first part, eight in the second, twelve in the third.” (Acocella 126)

While physics and elementary mathematical concepts do provide interesting areas for study, only a select few have explored more complex mathematical areas in choreography. In a review of Frederick Ashton's ballet *Scènes de ballet*, Rachel Thomas of "+ Plus Magazine" writes:

From the geometric patterns on the men's tunics and the perpendicular angle of the ballerina's tutu, to the movements and positioning of the dancers themselves, this ballet is a celebration of mathematics. Ashton was inspired by mathematics, and, according to the programme notes, used a system of Euclidean geometry to choreograph the piece. (Thomas)

Someone from the Royal Ballet adds that Ashton "arrived at rehearsals with a volume of advanced geometry under one arm and adapted theorems as floor patterns for the dancers" (qtd. in Thomas). Oskar Schlemmer was also interested in more advanced explorations into geometry and dance. In 1925 he wrote a letter to Otto Meyer that stated:

Je veux continuer avec la géométrie de la danse, employer des tapis à motifs géométriques variés (damier, etc.) sur lesquels danser. Chaque champ sera numéroté, et les numéros seront appelés durant la danse. (Boucher)

Translation :

I want to continue with the geometry of dance, using flooring with various geometric motifs (checkerboard, etc) on which to dance. Each field will be numbered, and the numbers will be called during the dance.

*Scènes de Ballet* and Schlemmer's interest inspired me in my quest to explore an intersection of the two disciplines.

When I researched mathematics and contra dance I found several websites devoted to explaining higher principles of math found in contra. Each one approached different topics, but they all related through their analysis of matrices and the consequent manipulations. Bernie Scanlon, Larry Copes, and David Schmitz presented especially interesting material, which helped guide my

explorations into the field. They are all mathematicians and contra dancers and kept their research strictly on the correlations between the two. I expanded upon their interests by incorporating other dance idioms in my examination of the patterns in contra dance and approaching the topic from the point of view of a performance dancer.

George Balanchine shared my interest. He created *Courtin' Time* in 1951 and six years later premiered *Square Dance* (George Balanchine). The former was a Broadway show “set in Maine and based on Down East folklore; [it] featured a square dance, a hoedown, a softshoe number, and a ballet” (Brief Notes). *Square Dance* is a ballet based on square dancing, originally complete with an onstage orchestra and a caller dictating the movements (Patricia Wilde). In this ballet Balanchine used the formations from square dancing as inspiration for his choreography, as well as square dance steps and calls. For instance, when Elisha Keeler called, "Now make your feet go wickety-whack! / Hurry up, girls, 'cause here comes Pat!" (Macdonald) Balanchine had his dancers do a *gargouillade* in time to “wickety-wack,” in an effort to satisfy the caller’s instructions (Patricia Wilde). I did not have a caller, but I did translate steps from contra dance to other dance forms, similarly to Balanchine.

I allowed all of these artists to influence my work, helping direct my choreographic quest. After watching the performances of *Dance Hall: Tänze de nasha lingua*, I feel that I did accomplish my purpose and sub-goals. In each of the sections I explored the interesting patterns developed from matrix

manipulation and successfully presented these findings in various dance idioms. Each dance went one step further and explored its sub-goal, from entering zeros in the matrix, to “compressing” it, to delving into the artistic intersections between different dance idioms.

**GLOSSARY**  
**OF TERMS REFERENCED**

**General:**

**Matrix**

a rectangular array of mathematical elements (as the coefficients of simultaneous linear equations) that can be combined to form sums and products with similar arrays having an appropriate number of rows and columns (Matrix)

**Sequence A : B**

the change from A to B

**Contra Dance:**

From the point of view of Person A:

D (lady) Neighbor      C (gent) Corner

A (gent)                  B (lady) Partner

Balance the ring

Take hands with the dancers on either side, step into the middle and back out, turn to the right and clap twice

**Caller**

The person who calls out the dances and communicates with the band

**Chain Across**

Two dancers on opposite sides take right hands and pass right shoulders,  
switching places

**Circle Left**

The four dancers in a group take hands and circle clockwise

**Courtesy Turn**

The gent takes the lady, who has just come from the center, and turns her  
around himself counterclockwise one time

**Do-si-do**

Walking around the dancer from the opposite side, the dancers pass left  
shoulders and return to their original places

**Grand right and left**

With every other person facing clockwise (thus the others facing  
counterclockwise) the dancers grab right hands with the person in front of  
them and pass right shoulders, then grab left hands with the new person in  
front of them and pass left shoulders, etc

**Gypsy**

The two dancers from opposite sides come into the middle, circle around  
each other once clockwise, and return to their original places

**Left hand star**

The dancers face counterclockwise and walk in this direction, using their own left hands to hold the left wrist of the person in front of them (thus forming the “star”)

**Neighbor**

The dancer of the opposite gender in the same group.

**Partner**

Contra dance is based on groups of partners, comprised of a gent and a lady, who travel together throughout the dance. Generally the gent starts on the left with the lady on his right, and the partners alternatingly face towards and away from the caller.

**Pass Through**

Generally done by the head couples; they take hands and pass between the other couple in their group

**Right Hand Star**

Same as a left hand star but using right hands and travelling clockwise

**Sequence**

The 64 beat dance that is repeated numerous times

**Swing**

Two dancers support each other and spin clockwise with a paddle step

**Irish:**

## Cut

The flicking of the leg into an overcrossed retiré position ideally with the knees in line and the foot of the working leg up by the hip

## Ghillies

The shoes worn for Irish softshoe dance; similar to ballet shoes

## Hardshoes

The shoes worn for Irish hardshoe dance; similar to tap shoes

**Tap:**

Shave and a haircut (Shave and a haircut, two bits)

The traditional end to a tap routine with the rhythm 1 & 2 & 3 & 4. One version is: touch, staggered pullback, step, hold, step, stamp

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