

# A REVISED GRAMMAR FOR THE FOXTROT

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## ABSTRACT

The application of formal grammars to multidimensional structures is described. A previous article by Myers attempting to formalise the grammar of the Foxtrot is considered. A brief history and description of the Foxtrot (Blues, Rhythm) is given. A subset of the dance is described in terms of six constraints on the movements. A context free grammar for this basic Foxtrot is proposed which accommodates the constraints. It consists of 66 productions including 16 terminal symbols. The formation of this grammar suggests that we may have constructed the grammar for verbal languages as images of the grammar representing the constraints on three dimensional polyarticular movement.



## INTRODUCTION

Formal grammars were invented as a method of describing allowable one dimensional sequences of symbols (Hofstadter, 1979:130). Ballroom dancing may be viewed in this way (Herbison-Evans, 1989:3). Due to the geometrical constraints of space and gravity, and the desire to maintain aesthetic connection to the musical rhythm in time, there are limitations on which steps can follow each other. These constraints can be described by a grammar.

Grammars were originally devised to describe the complex rules applying to the formation of acceptable sentences in natural verbal languages. Grammars were later found to be of great value in describing formal computer languages, and especially useful in the construction of translators between computer languages (Pohl, 1981:227). Subsequently, a grammar was discovered which described a two dimensional situation, namely the disposition of lines and their junctions which were valid projections of three dimensional assemblages of polyhedral blocks (Waltz, 1972).

The description of a four dimensional dance (three dimensions of space plus one of time) by a grammar was first suggested by Williams (Williams, 1976), although the inadequacies of her examples were criticised (Gell, 1979). Myers subsequently provided a much more complex example describing the Foxtrot (Myers, 1981), but failed to account in a formal fashion for the connection between the musical phrase and the individual steps. His proposed

relationship of the various properties of the steps to the rest of the grammar is rather obscure, as he does not define many of the abbreviations which he uses.

## THE FOXTROT

This a dance performed by couples in ballroom hold to music with a 4/4 rhythm and a 30-40 bars/minute tempo. A dance of this nature was variously called the One Step or Two Step in the Victorian era in Western Society (Coll, 1919:73). This had one step per beat or two steps per bar; hence the dual nomenclature. It was embellished into a nightclub performance dance by Vernon and Irene Castle, and popularised by Harry Fox in the stage show "Ziegfeld Follies" in New York in 1913 (Gwinn, 1985:913). Fox's involvement has been taken as the origin of the name 'Foxtrot', although the term had been used previously by the military for an equestrian gait (Simpson, 1989:134). This name is still used in dance studios of the schools of Arthur Murray and Fred Astaire. The dance is called ``Rhythm Dancing" or ``The Blues" elsewhere (Moore, 1951:154).

The dance has been developed into two derived forms internationally: the Quickstep and the Slow Foxtrot. The Quickstep retains the walks, runs, chasses and pivots of the original Foxtrot, but also includes hops, skips and locks, and is done to a faster tempo music at 46-48 bars/minute (Moore, 1951:41). The Slow Foxtrot is performed to slower music (30 bars/minute), but only retains the walks and pivots. The chasse (step, close, step) is often considered antithetical to the flowing aesthetic of the Slow Foxtrot (Moore, 1951:154).

The Foxtrot, as performed and taught by such studios as those founded by Fred Astaire and Arthur Murray, has a very regular structure. The music is partitioned into phrases of 8 bars of the 4/4 rhythm, and the dance follows this phrasing meticulously. At the start of each 8 bar phrase, the man steps with his left foot (only the man's steps are described; the lady's are the inverse). Steps are either Slows or Quicks: a Slow occupies 2 beats of the music; a Quick occupies 1 beat. Steps are taken with the left and right feet alternately, and may be taken forward, backward or to the side. Stepping to the side may only be done to the side of that foot, i.e., the feet do not cross: the left foot may step only to the left side, and the right foot to the right side. Every bar must begin with a step. Another allowable step is to close the feet, but only if they are apart.

This complex web of rules can be expressed in a number of ways. One goal of such an expression is their implementation as a computer program. The computer implementation has two important results.

One is that the computer program can be used in a system to translate or interpret the Foxtrot into, for example, a notated script or computer generated animated figure dancing. This has potential applications in teaching, both of the dance and of notation.

A more subtle result of attempts to computerise such rules is the insight they give into the movements they describe. Computers need to be told everything. Omissions or ambiguities may slip past the human examination of such rules, but computer programs are inclined to highlight such problems. Attempting to solve these problems then gives an insight that is difficult to obtain any other way.

One way of implementing a set of rules in a computer program is to formulate them as a formal grammar. Such a grammar has a series of productions, each describing a way of

replacing one set of symbols by another set. The intermediate symbols stand for the abstract conceptual components of the language. The terminal symbols represent the actual visible entities: words for a verbal language, movements for the Foxtrot.

## PREVIOUS WORK

The paper by Myers gives an excellent introduction to the nature of a transformation grammar. He then devised a partial grammar for the Foxtrot, based on the two major didactic steps of the Foxtrot as taught at the Arthur Murray studios: the Magic and the Box steps. Myers pointed out that only the steps of one of the partners need be considered, as the steps of the other partner may be derived from these by simple inversion of left/right and forward/back. This is true only for a subset of the dance; steps in promenade position and steps outside partner cannot be so derived. Myers also suggested that the equivalent of the sentence in the Foxtrot is the eight bar musical phrase, however he failed to find a formal expression of this suggestion. These concepts are developed further here, and the abstract levels of the musical phrase (sentence) linked to the steps by a series of intermediate abstract levels (non-terminal symbols).

This extension is contrary to Myers' and Williams' warnings concerning the different conceptual worlds of speech and movement. They suggest that these worlds are different in semantic and logical complexity. However, the grammar developed here suggests that at an abstract level, the structures of these worlds are similar. This similarity could be a coincidence, or it could be an artifact of the author's mode of thought, or it could be a reflection of a deeper relationship between speech and movement.

Myers quotes the Murray studio dictum: that there are six ways to move : forward, backward, left, right, turning left, and turning right. This is extended here to ten: forward, backward, left, right and closing, each of which may be performed with no turn, or with some amount of turn (here: with direction and degree unspecified). Myers' description of the relationship between the turns and the steps, and their other properties is rather obscure, as he used a number of undefined abbreviations.

## PROPOSED GRAMMAR

Inspection of the six examples given in Labanotation by Myers suggests that the grammar has to accommodate the following constraints:

- (1) the dance is performed in 8 bar phrases;
- (2) the man starts each phrase with a step on the left foot;
- (3) the left and right feet step alternately;
- (4) a foot may step either forward, backward, to its own side or it may close in place;
- (5) a closing step may not occur immediately following another closing step;
- (6) a bar must contain an even number of quick steps.

These are achieved in the grammar by binary subdivision of the 8 bar phrase, and is formalised by using non-terminal symbols to break the phrase down into halves of 4 bars, the halves into quarters of 2 bars, these into single bars, and the bars into several single steps. Most components can be started and finished with either foot, thus requiring up to 4 versions.

In the proposed grammar, the symbols are abbreviated descriptions of the movements, e.g., LQT= Left Quick Turning.

The letters L and R prefix movements commencing with the Left and Right foot respectively.

Symbols containing digits refer to multiple movements extending over one or more bars, with the final letter indicating the foot that the next movement must start with. The digit indicates the number of bars involved.

The symbols for single steps have S or Q as the second letter, indicating whether they are slow or quick respectively. Steps taking 2 beats are called 'Slow' and steps requiring one beat are called 'Quick'.

The letters N and T in the third position indicate steps that are either 'Non-turning' or 'Turning'.

The final letter (F,S,B, or C) indicates a step that is respectively forward, sideways, backwards or closing. The symbols used for 'closing steps' ( which end with the feet together rather than apart) end in the letter 'C'. By combining these closing steps only with a preceding non-closing step, to form the non-terminal abstract concept of a 'chasse', consecutive closing steps can be disallowed.

Single steps need no additional final letter indicating which foot is used next.

The grammar is listed in Appendix A. The metasymbols used in the grammar are:

| or

+ followed by

::= is composed of

The proposed grammar appears to reproduce successfully the six listed constraints of the Foxtrot. It does so with a simple context free form.

## CONTEXT FREE GRAMMARS

Context Free Grammars are a particularly simple form of the more general recursively enumerable grammars needed to describe the natural languages (Cohen, 1986:739). They can be implemented by particularly simple computer program structures involving a pushdown stack, and do not need the full power of a Turing Machine. The simplicity of the grammar is a reflection of the high degree of abstraction and stylization in the subset of dancing that it describes. If we were to introduce more practical constraints, for example, involving the length of the steps and the size of the dance floor, the grammar would become much more complex. Alternatively, if we consider a more abstract level, the grammar becomes simpler,

just as utterances in natural languages at a more abstract level consist simply of an unrestricted sequence of sentences following each other.

The magic and box rhythms referred to in the previous article (Myer, 1981) appear in the current grammar as particular combinations of slows and quicks, viz. (for the man):

M ::= LS + RS + LQS + RQC

B ::= LS + RQS + LQC + RS + LQS + RQC

As Arthur Murray discovered, these combinations are useful didactic structures. Students often learn best by progressing from the particular to the general, and the initial teaching of the magic and box rhythms forms a sound foundation for students to gain an understanding of the complete Foxtrot structure. The proposed grammar successfully avoids allowing stepping in place (although this is allowable in other dances such as the Paso Doble). Modifications would be needed to accommodate the brush steps of the Slow Foxtrot and Quickstep, in which successive steps occur with the same foot. Extensions to the grammar would also have to be made to describe the direction and amount of turn in turning steps, and also to describe contrary body movement, sway, rise and fall, and steps in promenade position and outside partner.

## DISCUSSION

The formulation of a grammar to describe the movements in a dance raises an interesting possibility as the solution of a question posed by Chomsky (Chomsky, 1968:68): how could innate structures have developed in the brain of a newborn child capable of recognising phrase structure grammars (Buxbaum, 2005)? The work on the Foxtrot suggests that the logical constraints on movements in time and three dimensional space of a polyarticulated body, such as humans have, naturally constitute such a grammar. If this is so, in the process of evolution, animals will have developed mental structures to recognise and use such grammars. Having such structures in the brain would then make it natural to create similar structures for other activities. Thus we may have created the structure of our verbal languages to match the structure of the constraints on the way we move. It is tempting to suggest that we have chosen to speak to match the way that we dance.

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The 'Magic Rhythm' is copyright of the Arthur Murray Dance Studios.

## APPENDIX A

L8L ::= L4L + L4L | L4R + R4L

L4L ::= L2L + L2L | L2R + R2L  
L4R ::= L2L + L2R | L2R + R2R  
R4L ::= R2R + R2L | R2L + L2L

L2L ::= L1L + L1L | L1R + R1L  
R2R ::= R1L + L1R | R1R + R1R  
L2R ::= L1L + L1R | L1R + R1R  
R2L ::= R1L + L1L | R1R + R1L

L1L ::= LS + RS | LQR + LQR | LS + RSC  
R1R ::= RS + LS | RQL + RQL | RS + LSC  
L1R ::= LS + RQL | LQR + LS | LQ + RQSC | LS + RQQC  
R1L ::= RS + LQR | RQL + RS | RQ + LQSC | RS + LQQC

LQR ::= LQ + RQ | LQ + RQC  
RQL ::= RQ + LQ | RQ + LQC

LQSC ::= LQ + RSC  
RQSC ::= RQ + LSC  
LQQC ::= LQ + RQC  
RQQC ::= RQ + LQC

LS ::= LSN | LST  
RS ::= RSN | RST  
LQ ::= LQN | LQT  
RQ ::= RQN | RQT

LSN ::= LSNF | LSNS | LSNB  
RSN ::= RSNF | RSNS | RSNB  
LST ::= LSTF | LSTS | LSTB  
RST ::= RSTF | RSTS | RSTB  
LQN ::= LQNF | LQNS | LQNB  
RQN ::= RQNF | RQNS | RQNB  
LQT ::= LQTF | LQTS | LQTB  
RQT ::= RQTF | RQTS | RQTB

LSC ::= LSNC | LSTC  
RSC ::= RSNC | RSTC  
LQC ::= LQNC | LQTC  
RQC ::= RQNC | RQTC

LQS ::= LQNS | LQTS  
RQS ::= RQNS | RQTS

LSNF ::= "left foot slow straight forward"  
LSNS ::= "left foot slow straight sideways (stepping left)"  
LSNB ::= "left foot slow straight backward"  
LSNC ::= "left foot slow straight closing"

LSTF ::= "left foot slow turning forward"  
LSTS ::= "left foot slow turning sideways (stepping left)"  
LSTB ::= "left foot slow turning backward"  
LSTC ::= "left foot slow turning closing"

RSNF ::= "right foot slow straight forward"  
RSNS ::= "right foot slow straight sideways (stepping right)"  
RSNB ::= "right foot slow straight backward"  
RSNC ::= "right foot slow straight closing"

RSTF ::= "right foot slow turning forward"  
RSTS ::= "right foot slow turning sideways (stepping right)"  
RSTB ::= "right foot slow turning backward"  
RSTC ::= "right foot slow turning closing"

LQNF ::= "left foot quick straight forward"  
LQNS ::= "left foot quick straight sideways (stepping left)"  
LQNB ::= "left foot quick straight backward"  
LQNC ::= "left foot quick straight closing"

LQTF ::= "left foot quick turning forward"  
LQTS ::= "left foot quick turning sideways (stepping left)"  
LQTB ::= "left foot quick turning backward"  
LQTC ::= "left foot quick turning closing"

RQNF ::= "right foot quick straight forward"  
RQNS ::= "right foot quick straight sideways (stepping right)"  
RQNB ::= "right foot quick straight backward"  
RQNC ::= "right foot quick straight closing"

RQTF ::= "right foot quick turning forward"  
RQTS ::= "right foot quick turning sideways (stepping right)"  
RQTB ::= "right foot quick turning backward"  
RQTC ::= "right foot quick turning closing"

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