

# Computer Aided Composition.

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## ABSTRACT

*This paper presents a scheme for the composition of the piece for percussion "Broken Cane". The process of the composition is derived basically from diatonic theory and mathematical operations exposed by John Clough. In addition, the work uses stochastic process and self-similarity ideas derived from new mathematical concepts. "Broken Cane" was composed with the idea of a live performance and a live signal processing of the basic material. This composition uses digital signal processing and effects with an overall plan to distribute the sound over a set of 8 or 4 loud speakers in the performance concert hall.*

**Keywords:** Computer Aided Composition, Diatonic Theory, Contour, Set Group Pitch. Live DSP.

Space

## 1. INTRODUCTION

Music and mathematics have always had a very close relationship. There are very specific examples in the history of music from early music to music of our time.

Several composers used some numerical relations to write music pieces, but methodology and algorithms have been formalized in the 20th century to help CAO/CAC composition, as in the examples of Hiller, Xenakis, Barbaud and others.

With the coming of the computers appeared mathematical theories derived from statistics, new mathematics and fractal linguistics, group theory, generative graphs, neural nets, Markov chains, genetic algorithms, machine learning.

Mathematics has made possible the generation of formal structures and the generation of constituent elements of macro and microstructure.

"Broken Cane" is composed with the help of theories derived from numeric relationships. These relations generate the generation of notes, rhythms, and elements of structure and formal development.

There are deterministic elements and random elements. Elements that came from statistical procedures, the introduction of 'top-down' recursive grammars, and the adaptation of problem-solving techniques from Artificial Intelligence.

## 2. SET THEORY. CONTOUR. GESTALT.

New concepts from AI include concepts derived from Set Theory and Contour Theory. Allen Forte write the "The Structure of Atonal Music" with notes derived from Milton Babbitt twelve tone theories.

The concept came from mathematical set theories with a numbers of operations.

Broken Cane is composed with techniques that came from set theory, contour theory and principles derived from Gestalt Psychology of Perception.

### 2.1 Set Theory.

Set Theory is the analytical technique we will use to analyze music from the XXth century and with special inters in atonal music.

A Set Theory study sets as a collection of objects. It was introduced by George Cantor in 1870.

Its basic fundament is binary relations but include operations as

Union

Intersection

Set difference

Symmetric difference

Multiplication

Power set

This theory was generalized and it was used in studies of Semantics, AI and Music Analysis. In music was introduced by Howard Hanson and later Allen Forte introduced set combinatory operations as Permutations, Transposition, inversion and complement. Musical set theory is more closely related to group theory and combinatorics than to mathematical set theory. Operations on ordered sequences of pitch classes also include transposition and inversion, as well as retrograde and rotation. Rotation of an ordered sequence is equivalent to cyclic permutation. Operations also include symmetry operations.

## **2.2 Contour.**

A musical pitch contour describes a series of relative pitch transitions, an abstraction of a sequence of notes.

The pitch contour of a sound is a function or curve that tracks the perceived pitch of the sound over time. In music, the pitch contour focuses on the relative change in pitch over time of a primary sequence of played notes. The same contour can be transposed.

## **2.2 Gestalt theory.**

Gestalt theories give us a methodology for identifying, classifying, and interpreting “musical gestures. The classification of musical gestures is based on theories of form perception taken from Gestalt psychology.

A gesture may be developed and transformed, and the profusion of related gestures imparts spatial coherence to a work of music as a unitary gesture.

Basic concept of gestalt derived from contour theories give us elements for analysis and composition:

SG spatial gesture  
CSEG contour segment  
PS point shift

A spatial gesture emerges from the consecutive activity of multiple performers within an ensemble.

Various gestures are differentiated by the specific orderings, in time, of sonic events occurring at separate points in ensemble space.

The idea gives us proximity and similarity based on Tenney and Polansky.

## **3. BROKEN CANE**

Broken Cane is a piece for marimba and vibraphone.

The basic methodology for the composition of the piece came from diatonic theory, group set and self-similarity procedures. The main idea came from numerical relations that establish a contour that is the basic for the entire composition.

The composition has three movements where the third is a reconstruction of the early movements.

The numerical relation in the work has different set pitches groups.

The paper is centered in the structure that controls the pitch contour, the rhythmic development and the formal structure.

### **3.1 Structure**

The development of music is always associated with the development of time. Different styles provoke different forms to understand the flow of music.

The idea of structure in recent music history, came from Henrich Schenker’s concepts as introduced by Allen Forte’s The theory of Atonal Music.

Western music and non-western music styles have devised different forms of structure over time

The general structure in Broken Cane derives from the same concept and set group that introduced in the melodic line and in the rhythmic development.

The Concept of the piece Broken Cane came from the idea of mosaic development derived from authors as Debussy, Reynolds and others. In order to adjust the different units of numbers and the entire piece is necessary to use the classical concept of minimum common multiple and greatest common divisor. The entire score is divided into section following the contour of the basic set group. The general structure in Broken Cane derives from the same concept and set group that introduced in the melodic line and in the rhythmic development. The entire score is divided into section following the contour of the basic set group. Each movement is divided into sections and it follows top down grammars theories.

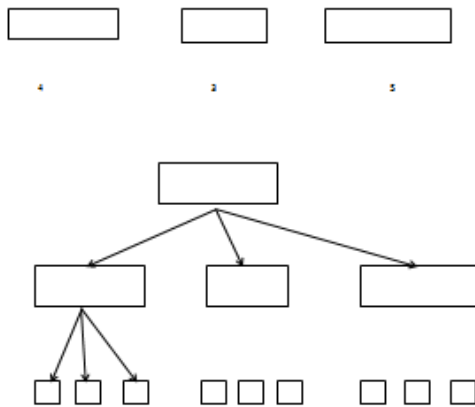


Fig 1. Top Down structure

### 3.2 Digital Signal Processing

The composition will have an electronic sonority realized with synthesis techniques and a DSP live process from software adequate as PD and / or MAX.

### 3.3 Space

The sound file can be processed with cutting and distribution of fragment over a set of speakers. The ideal will be 4 speaker/8 speakers around audience. The distribution can be realized with stochastic process and /or triggered from pedals for the performer. The electronic implementation is designed in Pure Data and can be controlled for the performer or a sound technician in the audio mixer with a single click in every section

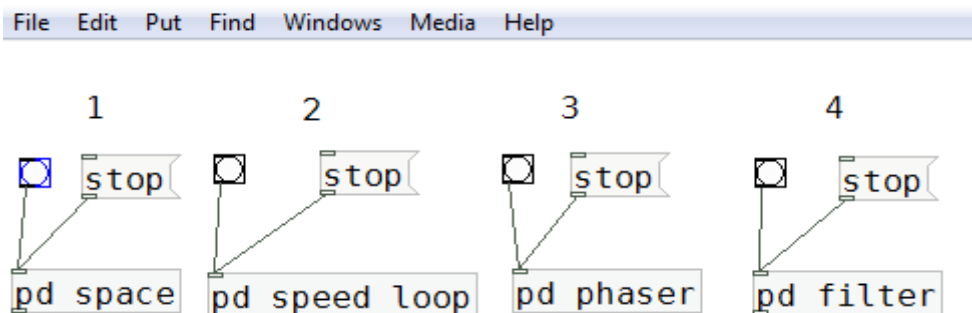


Fig 2. General Patch

The piece will have 3 movements with a mosaic structure using loops and repetitions.. Simultaneous loop can produce a delay and phasing of motives in different speed and tempos. This can give the possibility to change tempos and speed. There is an influence of Ligeti's micropolyphony and Nancarrow's irregular meter.. There are some characteristics of this composition:

Live percussion against pre-recorded sound and /or live recording sound  
Continuum and background over the performance space  
Continuum background notes and chords  
Modulation and timbre variations  
Electronic and DSP processing

#### 4. CONCLUSION

Broken Cane is a piece written with methodology derived from concepts of new mathematics but with musical principles in the process of the composition the mathematics, AI and software and algorithm must be always used with the idea of music and artistic identity.

Concepts derived from Diatonic Set Theory and Computer Assisted Composition are also used to compose the piece Broken Cane.

AI is a discipline that can use several process derived from several mathematical concepts.

AI, software programs and algorithm must be considered always as an aid for composition, (computer aided composition) .

It should be noted that without prejudice to software or theories, the final work must have a relevant artistic entity.

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