Building a Gamelan from Bricks

Tzu-En NGIAO
New Zealand School of Music
tengiao@gmail.com

ABSTRACT

The composition process of the acousmatic piece *Gazelle Rain Petals* began with the construction of the elemental pitch and rhythmic modules – the organo-geometric brick modules, as a musical metaphor to Dubuffet's lithographic series *Les Murs*. These brick modules are 4-pitch series (tetrachords) that cover all possible pitch permutations to represent 4-sided geometric as well as organo-geometric structures. For the harmonic conception based on the monochromatic hue of the brick wall, 12-tone rows were constructed out of those brick modules (tetrachords). The 12-tone rows were selected based on the characteristic profiles of their constituent modules and were subsequently deployed in an intricate rhythmic/contrapuntal structure of the musical "wall" scored for pitched instruments, resulting in a gamelan sounding musical passage. The brick analogy provided an intermodal (graphical and musical) link between graphical abstraction and musical abstraction, and also a method of configuring the 12-tone pitch-space. The profiles of tetrachords and their relationships with each other in a tone row governed how the 12-tone pitch-space could be traversed. Further development of techniques investigated here could be realised in a computational system that allows for the creative control of a visual pitch-space beyond geometric or organo-geometric abstractions for the purpose of creative composition.

1. INTRODUCTION

The most striking graphical features of Jean Dubuffet's lithographic series *Les Murs* [1] in Figure 1 are:

(i) The recurring motif of the brick wall and its multifarious appearances – significantly different from the others – across the series.
(ii) The juxtaposition and integration of external figures, to various degrees, against the brick walls.
(iii) The monochromatic hue of black and white.

These features came to bear a huge influence on the conception of the art work's musical reflection. The dividing line between the figurative and textural entities in the art work are at times bold and clear while at other times, appears to be vague and ambiguous. A very elemental motif could be easily discerned here i.e. the brick

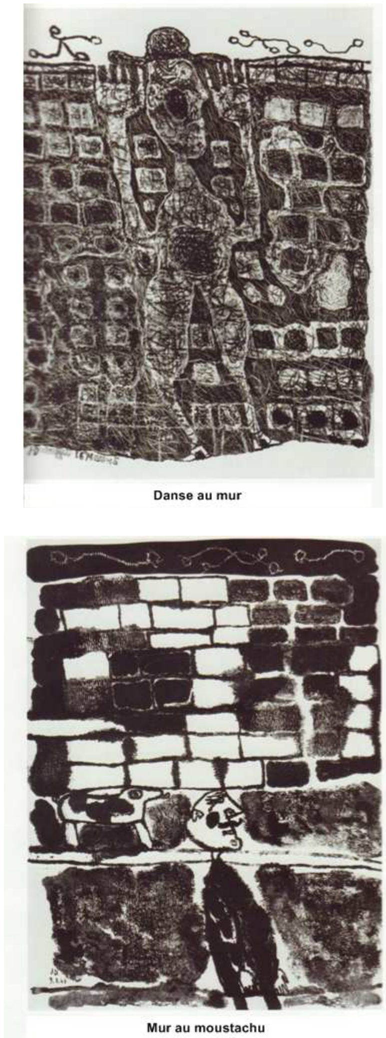

Figure 1. Two plates from Dubuffet's *Les Murs.*

as the most basic figurative building block. This basic figure of the brick is then treated as individual modules that can be willfully stacked up and aligned to compose a larger figure i.e. the wall. Using ingenious techniques of distortion, exaggeration and abstraction, Dubuffet had also successfully turned some of these figurative brick walls into dramatic textural planes. By placing naïve-looking, unrealistic portrayals of human and animal figures as well as manic graffiti-like inscriptions on and against the walls, the artist constantly teases our visual perception of graphical subjects in and out of plain figuration and abstract texturality. We are also faced with the challenge of figuring out whether the external figures exist as an integral part of or as separate entities in relation to the brick walls. The use of only black and white hue, coupled with the graphical modularity of brick figures would come to inform the kind of structural harmonic (colouristic) construct of the "musical" wall.

2. THE ORGANO-GEOMETRIC CONSTRUCT OF BRICKS

2.1 Geometric Abstraction and Musical Representation of Bricks

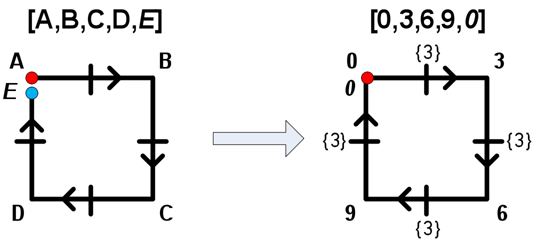

Figure 2. Graphical geometric abstraction translated to the musical pitch and rhythmic realization of a "square".

We could look at the graphical motif of the "brick" used in the art work from a simple geometric perspective. The three common graphical figurations of the brick motif extracted from the art work are shown at the top of Table 1. One can then categorise these figurations according to their geometric abstraction. While most graphical bricks look like conventional squares or rectangles, other brick-like figurations are enclosed entities which assume quadrangular silhouettes.

Having obtained the three basic geometric abstractions for the brick motifs in the lithographs, their musical equivalents were conceived. There is, though, a limitation on the possible musical analogies for geometric abstraction. This shall be explained with the aid of the basic shape of a square in Figure 2. Each point or vertex (e.g. point A) of a physical (visual) geometric shape can be represented by a definite musical pitch (e.g. 0 belonging to one of the 12 available musical pitches).

The distance between two vertices (e.g. A-B) became the unit duration of one pitch before the next pitch is to be sounded. According to the particular square in Figure 2, the distance A-B has been translated into a duration of 3 unit duration for pitch 0 before the next pitch, 3, is sounded. One may start to wonder how a point, B, that existed on a graphical plane can be translated into the particular pitch, 3, in the musical domain. This brings us to one of the characteristics of a square – the equidistance between any one vertex to another. Since all sides of a square need to be of equal length, so shall all durations between one musical pitch to another. The number 3, for instance would represent 3 unit duration. The number 3 may be arbitrarily chosen but true to the geometrical "essence" of the square, all the pitch duration between pitches of this particular musical square are required to be consistent i.e. 3 unit duration. This arbitrary number can also be extended to determine the pitches that form the musical square. Hence in Figure 2, the musical square is made up of a 5-pitch row of [0 3 6 9 0], where the next pitch is always obtained via the addition of the number 3 to the previous pitch (using the modulo-12 numeric series). The pitch row [0 3 6 9 0] does not only denote the pitch information of a musical motif but also carry with it the durational information to each corresponding pitch. Each individual pitch row, with its particular pitch and rhythmic construct, would be used as elemental musical modules to construct the analogous musical "wall". These pitch rows as brick modules, bear with them the unique pitch and rhythmic constructs that were conceived out of the equally unique graphical properties of the lithographic subjects.

Perfect geometric shapes such as a square, rectangle, and triangle are all regarded as enclosed shapes because a two-dimensional space is completely bounded by their sides. We could imagine drawing a square by starting on an initial point A, and complete the shape by returning to the exact position of A. Thus, the square in Figure 2 can only be an enclosed shape if the start point A (red) coincides with the end point E (blue). And it follows that when translated into musical pitches, a musical square can only be deemed an "enclosed" shape if the end pitch coincides with the starting pitch. The pitch row [0 3 6 9 0] is a perfect square due to the coincidence of the starting pitch and the ending pitch – for they are essentially the same pitch. And if we regard pitch rows that start and end in the same pitch as "real" geometric shapes, we may then proceed to label those that start and end in different pitches as "virtual" shapes.

Let us take a look at these seemingly sparse concepts of geometric abstraction that has been tailored to the needs of musical realisation had offered us the series of pitch rows (doubling as durational rows) as shown in Table 2. It shows the two main types of pitch rows that could be constructed according to the geometric abstraction concepts of equidistance, start points and end points. These two types of musical geometry are the "square" and the "rectangle". The rectangles can be further divided into two types - the ones with short and long sides, and ones with long and short sides. In order to understand how these pitch rows came about and how they were classified, it is important to also refer to the illustrations in Table 1. Table 1 helps us in visualising these concepts of geometric abstraction as well as illustrating each geometric configuration with a corresponding example for the musical realisation of a pitch row. The squares are built out of a series of the same interval while the rectangles are constructed on alternating pairs of "long" and "short" intervals. Because the order of "long" and "short" can be reversed to produce two orientation of the rectangle, pitch rows based on this order were also being collected. Since all possible intervals i.e. 1 to 11 of a 12-tone musical pitch system are utilised, one will notice the omission of intervals 7 to 11 in the construction of "square" pitch rows. This is due to the desire to reduce the number of "square" pitch rows in reflection of the comparatively smaller proportion of "square" bricks that appear in the lithographs in relation to "rectangle" bricks. And because intervals 7 to 11 have been regarded as the inversion of intervals 1 to 6, it was thought that a convenient place to have enough "square" pitch rows would be up till interval 6.

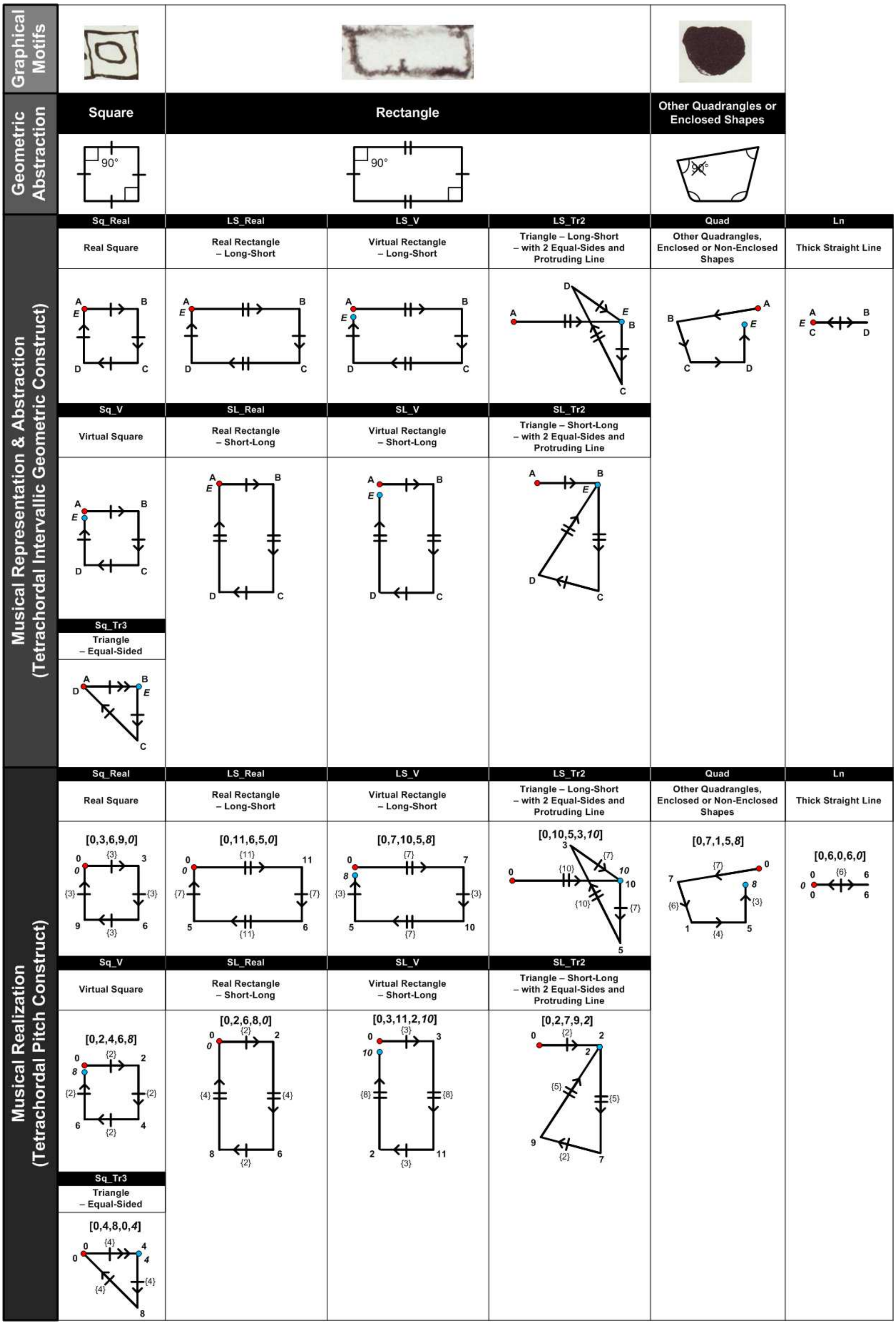

Table 1. Graphical motifs of bricks, their geometric abstraction and musical realisation.

Due to the limitation of the 12-tone pitch system, pitches do repeat themselves within the compass of the 5-tone pitch rows. Such convergences or coincidences of pitches when coupled with the concept of start and end

SQUARE (Equal-Sides)							
Constituent Intervals	Pitch Row					Geometric Abstraction	
AB=BC =CD=DE	A	B	C	D	*E*		
1	0	1	2	3	*4*	Sq_V	Virtual Square
2	0	2	4	6	*8*	Sq_V	Virtual Square
3	0	3	6	9	*0*	Sq_Real	Real Square
4	0	4	8	0	*4*	Sq_Tr3	Triangle - Equal-Sided
5	0	5	10	3	*8*	Sq_V	Virtual Square
6	0	6	0	6	*0*	Ln	Thick Straight Line

RECTANGLE (Short-Long Sides)							
Constituent Intervals		Pitch Row					Geometric Abstraction
Short AB=CD	Long BC=DE	A	B	C	D	*E*	
1	2	0	1	3	4	*6*	SL_V
1	3	0	1	4	5	*8*	SL_V
1	4	0	1	5	6	*10*	SL_V
1	5	0	1	6	7	*0*	SL_Real
1	6	0	1	7	8	*2*	SL_V
1	7	0	1	8	9	*4*	SL_V
1	8	0	1	9	10	*6*	SL_V
1	9	0	1	10	11	*8*	SL_V
1	10	0	1	11	0	*10*	SL_Tr2
1	11	0	1	0	1	*0*	Ln
2	3	0	2	5	7	*10*	SL_V
2	4	0	2	6	8	*0*	SL_Real
2	5	0	2	7	9	*2*	SL_Tr2
2	6	0	2	8	10	*4*	SL_V
2	7	0	2	9	11	*6*	SL_V
2	8	0	2	10	0	*8*	SL_Tr2
2	9	0	2	11	1	*10*	SL_V
2	10	0	2	0	2	*0*	Ln
2	11	0	2	1	3	*2*	SL_Tr2
3	4	0	3	7	10	*2*	SL_V
3	5	0	3	8	11	*4*	SL_V
3	6	0	3	9	0	*6*	SL_Tr2
3	7	0	3	10	1	*8*	SL_V
3	8	0	3	11	2	*10*	SL_V
3	9	0	3	0	3	*0*	Ln
3	10	0	3	1	4	*2*	SL_V
3	11	0	3	2	5	*4*	SL_V
4	5	0	4	9	1	*6*	SL_V
4	6	0	4	10	2	*8*	SL_V
4	7	0	4	11	3	*10*	SL_V
4	8	0	4	0	4	*0*	Ln
4	9	0	4	1	5	*2*	SL_V
4	10	0	4	2	6	*4*	SL_Tr2
4	11	0	4	3	7	*6*	SL_V
5	6	0	5	11	4	*10*	SL_V
5	7	0	5	0	5	*0*	Ln
5	8	0	5	1	6	*2*	SL_V
5	9	0	5	2	7	*4*	SL_V
5	10	0	5	3	8	*6*	SL_V
5	11	0	5	4	9	*8*	SL_V
6	7	0	6	1	7	*2*	SL_V
6	8	0	6	2	8	*4*	SL_V
6	9	0	6	3	9	*6*	SL_Tr2
6	10	0	6	4	10	*8*	SL_V
6	11	0	6	5	11	*10*	SL_V
7	8	0	7	3	10	*6*	SL_V
7	9	0	7	4	11	*8*	SL_V
7	10	0	7	5	0	*10*	SL_Tr2
7	11	0	7	6	1	*0*	SL_Real
8	9	0	8	5	1	*10*	SL_V
8	10	0	8	6	2	*0*	SL_Real
8	11	0	8	7	3	*2*	SL_V
9	10	0	9	7	4	*2*	SL_V
9	11	0	9	8	5	*4*	SL_V
10	11	0	10	9	7	*6*	SL_V

RECTANGLE (Long-Short Sides)							
Constituent Intervals		Pitch Row					Geometric Abstraction
Long AB=CD	Short BC=DE	A	B	C	D	*E*	
11	10	0	11	9	8	*6*	LS_V
11	9	0	11	8	7	*4*	LS_V
11	8	0	11	7	6	*2*	LS_V
11	7	0	11	6	5	*0*	LS_Real
11	6	0	11	5	4	*10*	LS_V
11	5	0	11	4	3	*8*	LS_V
11	4	0	11	3	2	*6*	LS_V
11	3	0	11	2	1	*4*	LS_V
11	2	0	11	1	0	*2*	LS_Tr2
11	1	0	11	0	11	*0*	Ln
10	9	0	10	7	5	*2*	LS_V
10	8	0	10	6	4	*0*	LS_Real
10	7	0	10	5	3	*10*	LS_Tr2
10	6	0	10	4	2	*8*	LS_V
10	5	0	10	3	1	*6*	LS_V
10	4	0	10	2	0	*4*	LS_Tr2
10	3	0	10	1	11	*2*	LS_V
10	2	0	10	0	10	*0*	Ln
10	1	0	10	11	9	*10*	LS_Tr2
9	8	0	9	5	2	*10*	LS_V
9	7	0	9	4	1	*8*	LS_V
9	6	0	9	3	0	*6*	LS_Tr2
9	5	0	9	2	11	*4*	LS_V
9	4	0	9	1	10	*2*	LS_V
9	3	0	9	0	9	*0*	Ln
9	2	0	9	11	8	*10*	LS_V
9	1	0	9	10	7	*8*	LS_V
8	7	0	8	3	11	*6*	LS_V
8	6	0	8	2	10	*4*	LS_V
8	5	0	8	1	9	*2*	LS_V
8	4	0	8	0	8	*0*	Ln
8	3	0	8	11	7	*10*	LS_V
8	2	0	8	10	6	*8*	LS_Tr2
8	1	0	8	9	5	*6*	LS_V
7	6	0	7	1	8	*2*	LS_V
7	5	0	7	0	7	*0*	Ln
7	4	0	7	11	6	*10*	LS_V
7	3	0	7	10	5	*8*	LS_V
7	2	0	7	9	4	*6*	LS_V
7	1	0	7	8	3	*4*	LS_V
6	5	0	6	11	5	*10*	LS_V
6	4	0	6	10	4	*8*	LS_V
6	3	0	6	9	3	*6*	LS_Tr2
6	2	0	6	8	2	*4*	LS_V
6	1	0	6	7	1	*2*	LS_V
5	4	0	5	9	2	*6*	LS_V
5	3	0	5	8	1	*4*	LS_V
5	2	0	5	7	0	*2*	LS_Tr2
5	1	0	5	6	11	*0*	LS_Real
4	3	0	4	7	11	*2*	LS_V
4	2	0	4	6	10	*0*	LS_Real
4	1	0	4	5	9	*10*	LS_V
3	2	0	3	5	8	*10*	LS_V
3	1	0	3	4	7	*8*	LS_V
2	1	0	2	3	5	*6*	LS_V

Geometric Abstraction - Description for Rectangles	
SL_Real	Real Rectangle - Short-Long
SL_V	Virtual Rectangle - Short-Long
SL_Tr2	Triangle - Short Long - with 2 Equal Sides and Protruding Line
LS_Real	Real Rectangle - Long-Short
LS_V	Virtual Rectangle - Long-Short
LS_Tr2	Triangle - Long Short - with 2 Equal Sides and Protruding Line
Ln	Thick Straight Line

Table 2. Musical organo-geometric motifs (brick modules) – pitch and rhythmic rows constructed based on the concepts of geometric abstraction.

points yield additional geometric configurations such as the equal-sided triangle and the thick straight line as illustrated in Table 1. We can say that these geometric configurations were essentially borne out of the "idiosyncrasies" of the set of pitch rows which are built on the two initial concepts of equidistance and start and end points. Once these ideas of geometric configurations became clear to us, they are consolidated back into Table 2 by labelling each pitch row with the geometric abstraction it represents.

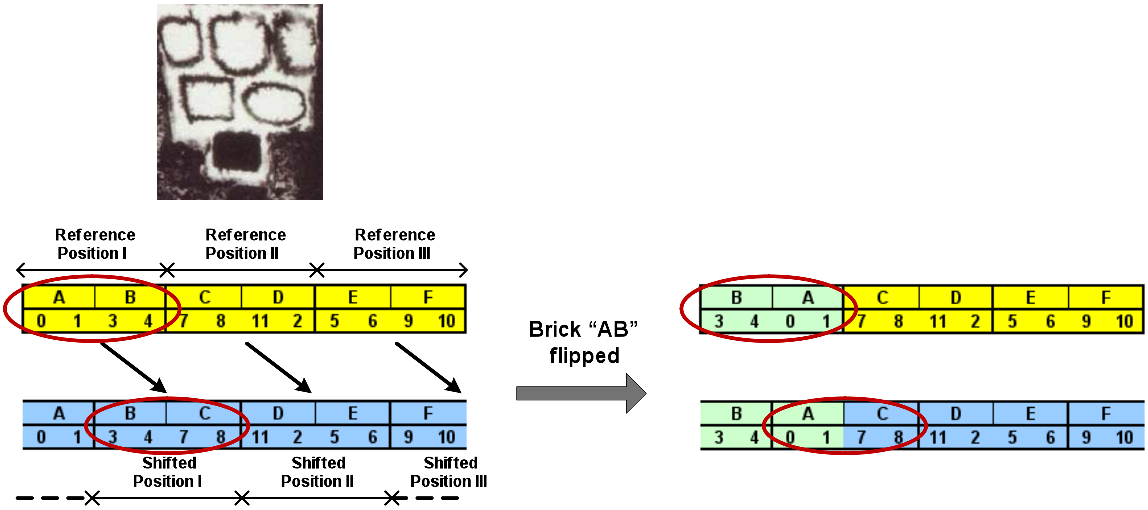

Figure 3. The concept of shifting positions, repetition and the flipping of brick motifs (tetrachords) in 12-tone rows.

2.2 Organo-Geometric Motifs and other Motifs

In addition to squares and rectangles, properties of the 12-tone system also produced some geometric shapes which do not exist in the lithographs such as the triangle with two equal sides and a protruding line. Another category of geometric shapes is the quadrangles as seen in Table 1. Quadrangles are four-sided shapes without the tangential angles between the sides which characterise squares and rectangles. The 12-tone system also yielded quadrangles both as enclosed or unenclosed space entities depending on whether the start and end points coincided with each other. These kinds of shapes that do no strictly conform to the properties that define rigid geometric shapes look more like naturally occurring shapes such as stones, hence we could regard them as more "organic" than “geometric”. A more convenient way is to refer to them as "organo-geometric" shapes or motifs.

Another geometric abstraction that only arises from the idiosyncrasies of the musical system is the "thick straight line". Along with other shapes that do not originate from the lithographs such as the various triangular entities, these unique conceptual motifs demand to be treated differently from the predominant squares and rectangles and would consequently determine some musical aspects of the final composition.

3. COLOURING THE WALL “BLACK”

3.1 The Concept of the Colour “Black” and 12-tone Harmony

The Hungarian composer György Ligeti used to liken the homogeneity of the 12-tone (dodecaphonic) harmonic sound world to an almost monochromatic haze of greyness, especially within a piece of music of sufficient textural density when the perceptual distance between the listener and the microscopic intervallic profile of pitch relationships became so wide that it suffers a total lack of tonal or colour distinction and heterogeneity [2]. It is this intriguing analogy that has inspired the possible use of 12-tone harmony to represent the bleak, monochromatic tones of Dubuffet's lithographic walls. It is from here that the concept of reconstructing our musical wall in 12-tone harmony eventually came into light. As a tribute to the father of 12-tone and serial music, Arnold Schoenberg [3, 4], the use of 12-tone pitch rows were to be employed here. However, this is to be combined with the concept of the organo-geometric pitch construct of brick modules conceived in the previous section. Since it is the bricks that have given form to the graphical wall, a fitting musical metaphor would be to build all our 12-tone pitch rows on the basis of the musical organo-geometric pitch rows (brick modules).

3.2 Organo-Geometric Brick Modules as Tetrachordal (4-pitch) Harmonic Construct

While as a larger-scale harmonic construct, the musical wall is imagined to be monochromatic, ranging from hues of the lightest shade of grey to the consummately black, on a smaller scale within this harmonic structure, the use of constituent musical brick modules would break this down into smaller, more distinct entities of colours. A 12-tone pitch row (representing monochromaticism) could be comprised of a subset of pitch rows (representing colour-centricity). The obvious advantage of the brick modules' 4-pitch anatomy is such that placing three of them end-on-end would give us one complete 12-tone row! One way of managing the overwhelming task of constructing 12-tone rows out of the innumerous possible combinations of 4-pitch modules would be to enlist the pitch-class set theory developed by Allen Forte [5]. According to Forte, all tetrachords or 4-pitch collectives can be reduced to twenty-nine best orders of pitches, or what is called pitch-class sets (PCS 4-1 to PCS 4-29).

3.3 Constructing 12-tone Rows with Tetrachords

To construct a 12-tone pitch row, three tetrachords (brick modules of 4 pitches each) are required. Because the best

	12-tone Row												Tetrachords						Comparison between Tetrachords on Reference and Shifted Positions	
													Reference Position I	Reference Position II	Reference Position III	Shifted Position I	Shifted Position II	Shifted Position III	Similar?	Mirror?
A	2	7	0	1	4	6	8	10	3	5	9	11	6	21	25	15	23	22	No	No
B	0	1	2	5	6	7	10	11	3	4	8	9	4	7	8	4	8	7	Yes	No
C	0	1	3	4	7	8	11	2	5	6	9	10	3	18	7	7	18	3	Yes	Yes

Table 3. Tetrachords of the same and different pitch-class sets in reference and shifted positions in 12-tone rows.

order of tetrachords begins with the initial pitch normalised to pitch 0, we need to transpose each tetrachord to begin on another 11 pitches to cover all 12 pitches to be represented in a 12-tone row. To construct 12-tone rows based on all possible combinations of three end-on-end tetrachords, we start on one transposition of the first tetrachord. This is then put against twelve transpositions of a second tetrachord. This is in turn compounded against a further twelve transpositions of the third tetrachord. The resulting list of tone rows created this way were screened through to pick out pure 12-tone rows i.e. rows without repetition of any single pitch.

3.4 Reconfiguring and Refining 12-tone Rows in a Metaphor of Layered Brick Walls

As shown in the little clip of the lithographic brick wall in Figure 3, the vertical boundaries of bricks in one layer are almost always aligned approximately at the middle section of bricks on an adjacent layer. Mathematically speaking, one layer of bricks is 180° out-of-phase with another. This graphical characteristic may be realised as a musical metaphor. Because each musical brick motif (tetrachord) can be conveniently and equally divided into two groups of two pitches, we may view this division as a reflection of the vertical alignments of the graphical bricks. In Figure 3, each half-division of tetrachords within a 12-tone row is labelled A to F. A tetrachord can occupy one of three reference positions or one of three shifted positions. In the event that the pairs of pitches of AB divisions were reversed or "flipped", the pitch content of the tetrachord under reference position I remains unchanged. On the other hand, a similar reversal of AB divisions would render the tetrachord that exists under shifted position I (now AC divisions) different in contrast to that before the flip.

If we look intently at the clip of brick wall in Figure 3, our vision may be drawn diagonally from left to right across the visual design due to the perceived shifting positions of the bricks from the top to the bottom layer. This visual perception of the "movement" of bricks from one discreet position to another could be translated into a musical analogy of "shifting" tetrachords. The "movement" of tetrachords could be achieved metaphorically by choosing 12-tone rows which have the same tetrachords occupying reference position I and its subsequent position i.e. shifted position I. This concept is illustrated in Figure 3 by following the direction of arrows and also by examples of 12-tone rows listed in Table 3. The numerals in Table 3 indicate specific tetrachordal pitch-class sets. The number 6, for example, is the short for PCS 4-6. For 12-tone Row "C", tetrachord of PCS 4-18 in reference position II can be said to have "moved" to shifted position II. However, this is not the case for PCS 4-3 and PCS 4-7 in the other positions. Nevertheless, row "C" is regarded as containing similar tetrachords in all three of its reference positions as in the shifted positions. On top of that, another intriguing aspect of this tone row is that the order of tetrachords in its reference positions is “mirrored” in its shifted positions. For reference, we may compare these two unique characteristics found in tone row "C" with those in tone rows "A" and "B".

P1	A	B	C	D	E	F
P2	B	A	C	D	E	F
P3	A	B	D	C	E	F
P4	A	B	C	D	F	E
P5	B	A	D	C	E	F
P6	B	A	C	D	F	E
P7	B	A	D	C	F	E
P8	A	B	D	C	F	E

P1	0	1	3	4	7	8	11	2	5	6	9	10
P2	3	4	0	1	7	8	11	2	5	6	9	10
P3	0	1	3	4	11	2	7	8	5	6	9	10
P4	0	1	3	4	7	8	11	2	9	10	5	6
P5	3	4	0	1	11	2	7	8	5	6	9	10
P6	3	4	0	1	7	8	11	2	9	10	5	6
P7	3	4	0	1	11	2	7	8	9	10	5	6
P8	0	1	3	4	11	2	7	8	9	10	5	6

Figure 4. Eight permutations of 12-tone row “C” by combinations of flipped half-divisions along tetrachordal positions.

In Figure 4, tone row "C" is subjected to eight permutations by flipping the paired divisions of pitches along tetrachordal positions in different possible combinations. Figure 4 also shows pitch-rows obtained with this manner of permutation.

3.5 Assigning 12-tone Rows in Analogy to Brick Wall

Table 4 is sample list of 12-tone rows that have been assembled based on the permutational notion of “mirrored” pitch contents. Each tetrachordal collective at six different reference and shifted positions have also been classified according to their organo-geometric profile types (SL_V, SL_Real etc.). As the rows are built on elemental blocks of tetrachords, musical geometric abstractions such as the "thick straight line" (Ln) or the "equal-sided triangle (Sq_Tr3) will not surface in these tone rows.

In Table 4, a special column is dedicated to indicating the type of organo-geometric types combination that characterises each tone row. Tone row RQ1, for example, consists of a combination of “rectangular” and “quadrangular” brick modules; hence it is labelled as "Rec_Quad". The penultimate column provides an indication of whether more than 50 percent of the brick modules be-

Tone Row Name	12-Tone Row												Tetrachords						Organo-Geometric Type						More than Half are Quadrangles?	Organo-Geometric Types Combination
													Ref Pos I	Ref Pos II	Ref Pos III	Shf Pos I	Shf Pos II	Shf Pos III	Ref Pos I	Ref Pos II	Ref Pos III	Shf Pos I	Shf Pos II	Shf Pos III		
RQ1	0	1	3	4	7	8	11	2	5	6	9	10	3	18	7	7	18	3	SL_V	SL_V	Quad	Quad	SL_V	SL_V	No	Rec_Quad
RQ2	0	1	5	6	9	10	11	2	3	4	7	8	8	4	7	7	4	8	SL_V	SL_V	Quad	Quad	SL_V	SL_V	No	Rec_Quad
RQ3	0	3	4	7	9	10	1	2	5	6	8	11	17	7	13	13	7	17	LS_V	Quad	SL_V	SL_V	Quad	LS_V	No	Rec_Quad
RQ4	2	7	0	1	5	6	10	11	3	4	8	9	6	8	8	8	8	6	Quad	SL_V	SL_V	SL_V	SL_V	Quad	No	Rec_Quad
RQ5	4	7	0	3	9	10	1	2	5	6	8	11	17	7	13	13	7	17	SL_V	Quad	SL_V	SL_V	Quad	SL_V	No	Rec_Quad
RQ6	0	3	4	7	1	2	9	10	5	6	8	11	17	7	13	13	7	17	LS_V	Quad	SL_V	SL_V	Quad	LS_V	No	Rec_Quad
RQ7	0	1	5	6	2	3	4	9	10	11	7	8	8	6	3	3	6	8	SL_V	SL_V	Quad	Quad	SL_V	SL_V	No	Rec_Quad
RQ8	2	7	0	1	3	4	10	11	5	6	8	9	6	8	3	3	8	6	Quad	SL_V	SL_V	SL_V	SL_V	Quad	No	Rec_Quad
RQ9	3	4	0	1	10	11	2	5	8	9	6	7	3	18	1	1	18	3	SL_V	SL_V	Quad	Quad	SL_V	SL_V	No	Rec_Quad
RQ10	2	5	0	1	10	11	3	4	8	9	6	7	4	8	1	1	8	4	Quad	SL_V	SL_V	SL_V	SL_V	Quad	No	Rec_Quad
RQ11	4	5	0	1	3	6	7	10	11	2	8	9	7	17	13	13	17	7	SL_V	Quad	LS_V	LS_V	Quad	SL_V	No	Rec_Quad
RQ12	5	6	0	1	7	8	9	2	3	4	10	11	8	6	8	8	6	8	SL_V	SL_V	Quad	Quad	SL_V	SL_V	No	Rec_Quad
RQ13	2	5	0	1	8	9	3	4	10	11	6	7	4	8	7	7	8	4	Quad	SL_V	SL_V	SL_V	SL_V	Quad	No	Rec_Quad
RQ14	4	5	0	1	7	10	3	6	11	2	8	9	7	17	13	13	17	7	SL_V	Quad	SL_V	SL_V	Quad	SL_V	No	Rec_Quad
RQ15	4	7	0	1	8	9	5	6	2	3	10	11	18	3	7	7	3	18	Quad	SL_V	SL_V	SL_V	SL_V	Quad	No	Rec_Quad
RQ16	0	1	4	5	7	10	3	6	11	2	8	9	7	17	13	13	17	7	SL_V	Quad	SL_V	SL_V	Quad	SL_V	No	Rec_Quad
RQ17	2	6	0	1	9	10	11	3	4	5	7	8	5	5	3	3	5	5	Quad	SL_V	Quad	Quad	SL_V	Quad	Yes	Rec_Quad
RQ18	4	7	0	2	6	8	10	1	3	5	9	11	22	22	25	25	22	22	Quad	SL_Real	Quad	Quad	SL_Real	Quad	Yes	Rec_Quad
RQ19	5	8	0	2	3	4	6	7	9	10	11	1	27	3	2	2	3	27	Quad	Quad	SL_V	SL_V	Quad	Quad	Yes	Rec_Quad
RQ20	0	1	2	4	8	10	6	7	3	5	9	11	2	2	25	25	2	2	Quad	SL_Real	Quad	Quad	SL_Real	Quad	Yes	Rec_Quad
RQ21	0	1	2	5	9	10	6	7	3	4	8	11	4	3	20	20	3	4	Quad	Quad	SL_V	SL_V	Quad	Quad	Yes	Rec_Quad
RQ22	0	1	3	5	9	11	6	7	2	4	8	10	11	11	25	25	11	11	Quad	SL_Real	Quad	Quad	SL_Real	Quad	Yes	Rec_Quad
RQ23	0	1	4	8	10	11	6	7	2	3	5	9	19	7	29	29	7	19	Quad	Quad	SL_V	SL_V	Quad	Quad	Yes	Rec_Quad
RQ24	3	4	0	1	9	11	2	5	8	10	6	7	3	27	2	2	27	3	SL_V	Quad	Quad	Quad	Quad	SL_V	Yes	Rec_Quad
RQ25	2	6	0	1	3	4	5	9	10	11	7	8	5	5	3	3	5	5	Quad	SL_V	Quad	Quad	SL_V	Quad	Yes	Rec_Quad
RQ26	4	7	0	2	6	8	10	1	3	5	9	11	22	22	25	25	22	22	Quad	SL_Real	Quad	Quad	SL_Real	Quad	Yes	Rec_Quad
RQ27	3	6	0	2	8	10	4	5	11	1	7	9	12	15	21	21	15	12	Quad	SL_V	Quad	Quad	SL_V	Quad	Yes	Rec_Quad
RQ28	4	7	0	2	8	10	5	6	1	3	9	11	22	11	21	21	11	22	Quad	SL_V	Quad	Quad	SL_V	Quad	Yes	Rec_Quad
RQ29	0	1	2	4	8	10	6	7	3	5	9	11	2	2	25	25	2	2	Quad	SL_Real	Quad	Quad	SL_Real	Quad	Yes	Rec_Quad
RQ30	0	1	3	4	8	11	6	7	2	5	9	10	3	4	20	20	4	3	SL_V	Quad	Quad	Quad	Quad	SL_V	Yes	Rec_Quad
RQ31	0	1	4	5	10	2	6	7	11	3	8	9	7	19	29	29	19	7	SL_V	Quad	Quad	Quad	Quad	SL_V	Yes	Rec_Quad
RQ32	0	1	3	5	9	11	6	7	2	4	8	10	11	11	25	25	11	11	Quad	SL_Real	Quad	Quad	SL_Real	Quad	Yes	Rec_Quad
S1	0	1	2	3	4	5	6	7	8	9	10	11	1	1	1	1	1	1	Sq_V	Sq_V	Sq_V	Sq_V	Sq_V	Sq_V	No	Sq
SRT1	0	2	4	6	9	11	5	7	1	3	8	10	21	21	23	23	21	21	Sq_V	SL_V	SL_V	SL_V	SL_Tr2_	Sq_V	No	Sq_Rec_Tr
SRT2	4	6	0	2	7	9	11	1	3	5	8	10	21	21	23	23	21	21	SL_V	SL_Tr2_	Sq_V	Sq_V	SL_V	SL_V	No	Sq_Rec_Tr
SRT3	0	2	4	6	11	1	7	9	3	5	8	10	21	21	23	23	21	21	Sq_V	SL_Tr2_	SL_V	SL_V	SL_V	Sq_V	No	Sq_Rec_Tr
SRT4	4	6	0	2	5	7	9	11	1	3	8	10	21	21	23	23	21	21	SL_V	SL_V	Sq_V	Sq_V	SL_Tr2_	SL_V	No	Sq_Rec_Tr
SQ1	0	1	3	5	7	9	11	2	4	6	8	10	11	22	21	21	22	11	Quad	Sq_V	Quad	Quad	Sq_V	Quad	Yes	Sq_Quad
SQ2	0	1	4	6	8	10	11	2	3	5	7	9	15	12	21	21	12	15	Quad	Sq_V	Quad	Quad	Sq_V	Quad	Yes	Sq_Quad
Q1	0	1	2	6	8	9	10	3	4	5	7	11	5	6	29	29	6	5	Quad	Quad	Quad	Quad	Quad	Quad	Yes	Quad
Q2	0	1	2	7	8	9	10	3	4	5	6	11	6	6	6	6	6	6	Quad	Quad	Quad	Quad	Quad	Quad	Yes	Quad
Q3	0	1	3	6	8	9	11	2	4	5	7	10	13	13	13	13	13	13	Quad	Quad	Quad	Quad	Quad	Quad	Yes	Quad
Q4	0	1	5	7	9	10	11	2	3	4	6	8	16	4	11	11	4	16	Quad	Quad	Quad	Quad	Quad	Quad	Yes	Quad
Q5	0	1	4	7	8	10	11	2	3	5	6	9	18	12	12	12	12	18	Quad	Quad	Quad	Quad	Quad	Quad	Yes	Quad
Q6	0	1	3	7	8	9	11	2	4	5	6	10	29	13	5	5	13	29	Quad	Quad	Quad	Quad	Quad	Quad	Yes	Quad
Q7	2	5	0	1	8	10	3	4	9	11	6	7	4	16	11	11	16	4	Quad	Quad	Quad	Quad	Quad	Quad	Yes	Quad
Q8	2	7	0	1	6	10	4	5	11	3	8	9	6	5	29	29	5	6	Quad	Quad	Quad	Quad	Quad	Quad	Yes	Quad
Q9	2	7	0	1	6	11	4	5	10	3	8	9	6	6	6	6	6	6	Quad	Quad	Quad	Quad	Quad	Quad	Yes	Quad
Q10	3	6	0	2	8	11	4	5	10	1	7	9	12	18	12	12	18	12	Quad	Quad	Quad	Quad	Quad	Quad	Yes	Quad
Q11	3	6	0	1	7	10	4	5	11	2	8	9	13	13	13	13	13	13	Quad	Quad	Quad	Quad	Quad	Quad	Yes	Quad
Q12	3	6	0	1	7	11	4	5	10	2	8	9	13	29	5	5	29	13	Quad	Quad	Quad	Quad	Quad	Quad	Yes	Quad

Table 4. Sample of 12-tone rows with organo-geometric tetrachordal profiles.

long to the quadrangle type or not. We chose only 12-tone rows with quadrangles owning less than half the share of the total number of brick modules. Some tone rows such as SRT1, have triangles in their mix of brick modules. Such rows shall also be disqualified (shaded grey in Table 4. Other reasons for omitting certain tone rows from the mapping pool are due to their undesireable harmonic colours or for belonging to harmonic profiles that have been sufficiently represented by previous tone rows.

After heavy harmonic and organo-geometric conceptual profiling, selected 12-tone rows (shaded black in Table 4) were then deployed in an intricate rhythmic/contrapuntal structure of the "wall" scored for pitched instruments, resulting in a gamelan sounding musical passage. Eventually, this musical wall was broken up into bookend halves and juxtaposed against independent and unique[1] musical figurative materials in the final musical composition, *Gazelle Rain Petals*.

4. CONCLUSIONS

A huge part of the methodological focus has been lavished on the conception of the brick wall even though the lithographic series is based on a dynamic dialogue between geometric figures of bricks and anthropomorphic or physical object figurations juxtaposed against the walls. After laying down the groundwork for geometric abstraction based on graphical properties, the proliferation of musical materials took on an elaborate life of its own. Additional analogic concepts (e.g. 12-tone harmony for the colour black and shifting tetrachordal components for brick modules) were layered upon the ongoing conception process for the musical materials.

By heavily deriving and manipulating both pitch and rhythmic constructs from the abundant source of 12-tone rows, the amount of musical materials to be dealt with could be overwhelming without computational assistance. Though no computational system has been specifically developed for the creation of this work, the intensive mathematical permutations required could do with future computational algorithmic implementation. The brick analogy provided an intermodal (graphical and musical) link between graphical abstraction and musical abstraction. In this case, the visual art work has inspired an inventive method of configuring the 12-tone pitch space. The profiles of tetrachords and their relationships with each other in a tone row governed how the 12-tone pitch-space could be traversed. A further development of the set of techniques investigated here could be realised in a computational system that allows for the creative control of a visual pitch-space for the purpose of creative composition. This could include more complex graphical abstractions for configuring pitch-space and harmonic colours by building on the geometric and organo-geometric pitch-spaces explored here.

The juxtaposition of clear gamelan sounding passages against musical passages of a contrasting character may be attributed to the separate treatment and development of figurative materials (i.e. depictions of figures against

[1] The word "unique" here means "solitary in type or characteristics". Hence, "unique melodic motifs" is used to differentiate between specific motifs which are conceived separately from the majority of generic motifs produced through the methodical construction of intervallic series.

the wall) and the figurative-textural material (i.e. the brick wall). The freedom and almost improvisational nature bestowed upon electronic sound manipulation of unique musical figures had provided a fine balance of melodic, rhythmic as well as harmonic variety with the homogeneity of the musical wall. Yet hanging on a fine analogical thread to the graphical source, the more carefree electronic sound gestures acted upon the musical figures is merely a metaphor for the seemingly extemporaneously drawn figures on Dubuffet's lithographic plates.

5. REFERENCES

[1] A. Husslein-Arco (ed.), *Jean Dubuffet: Trace of an Adventure.* Munich: Prestel, 2003.

[2] R. Steinitz, *György Ligeti: Music of the Imagination*. Boston, Massachusetts: Northeastern University Press, 2003.

[3] M. J. Grant, *Serial Music, Serial Aesthetics: Compositional Theory in Post-War Europe (Music in the Twentieth Century)*. Cambridge University Press, 2005.

[4] G. Perle, *Twelve-tone Tonality*. University of California Press, 1978.

[5] A. Forte, *The Structure of Atonal Music*. New Haven and London: Yale University Press, 1973.