New Clapping Music: An Analysis

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This piece is an experimental composition that shows how hypereuclidean sets can be used dynamically to vary rhythms, textures, and create structures in a short composition. I used tools I wrote in C++ and in Max/MSP to derive the rhythmic sets used in each measure. The software tools can be found (and freely downloaded) from Github at https://github.com/lauprellim/euclid. I used the subtract-first method of generating hypereuclidean sets as I believe it yields more interesting musical results; however, the rotate-first method yields three derivations of the Clapping Music ostinato, whereas subtract-first only produces two. Below is a bar-by-bar analysis of the composition.

1. The first bar is the Steve Reich's classic "Clapping Music" ostinato, given in "box notation" as [`x x x . x x . x . x x .`], or as a set of onsets as [0 1 2 4 5 7 9 10], or as an IOI (inter-onset interval) as < 1 1 2 1 2 2 1 2 >. It is a second-order hypereuclidean set, derived through the subtract-first method of generating hypereuclidean sets either as $12(11^2, 8^7)$ or as $12(11^7, 8^0)$. As mentioned above, the rotate-first method derives the same set in three ways, as $12(11^7,8^0)$,$12(11^7,8^{11})$,or $12(11^9,8^7)$. For the purposes of this composition, the choice of first-order set is of no consequence, but the choice of the subtract-first method *is* important.

2. In bar 2 a third-order hypereuclidean set enters. It is somewhat trivially derived from the Clapping Music ostinato, and can be given as $12(11^2, 8^7, 7^0)$. It simply "omits" the last element of the classic Clapping Music ostinato.

3. As in the previous measure, bar 3 introduces a fourth-order hypereuclidean set that is derived in an analogously banal manner from the new set that entered in bar 2. This is $12(11^2,8^7,7^0,6^0)$,and as in bar 2 it simply omits the last element from the next-highest hypereuclidean set. Up to now, the composition seems somewhat formulaic and can hardly be said to be interesting. Perhaps the composer's anxiety about calling a piece "New Clapping Music" is reflected by setting such low expectations at the beginning?

4. The fourth and last voice enters. This is a fifth-order hypereuclidean set $12(11^2,8^7,7^0,6^0, 3^0)$. Like the previous entrances, the last element of the last voice is omitted. But because this is a set of cardinality 3, another note gets dropped as well. Up to now, the rotations of Parts 1, 2 and 3 are all 0, whereas (by necessity) the rotation of Part 4 (the "bass" ostinato) is rotated 7 elements.

5. Now a new process begins that will govern the structure until bar 18. Part 3 is rotated 1 (rotation is always clockwise, modulo 12). This results in the Parts 1 and 2 also seeming to rotate clockwise by 1, even though they are not rotated themselves (yet).

6. Part 3 is now rotated by 2, and Part 2 is rotated by 1. Part 1 is still rotated by 0. We can begin to see the upper three parts start to drift away from each other.

7. Part 3 is rotated by 3, Part 2 by 2. Part 1 is now rotated by 1. It is as if there is a "rotation canon" happening here: Part 1 has finally "caught up" and is beginning to rotate along with the middle two parts. The result in this measure is a series of staggered entries among the top three parts, making an interesting retrograde relationship with the staggered *ends* of the top three parts in measures 4, 5 and 6. In the composer's view, the first potentially subtle musical relationship has finally emerged...

8. The rotation indices of the top three parts increment by 1: Part 3 is now rotated by 4, Part 2 by 3, and Part 1 by 2. A certain amount of unpredictability has begun to enter the system as the staggered entries or ends disappear.

9. The rotations continue to increment by 1. In bar 9, Part 3 is rotated by 5, Part 2 by 4, and Part 1 by 3.

10. Again, rotations increment by 1. Part 3 is rotated by 6, Part 2 by 5 and Part 1 by 4.

11. Once again, rotations increment by 1. Part 3 is rotated by 7, Part 2 by 6 and Part 1 by 5.

12. Here we have the crux of the composition, and one might even say its *raison d'être*... When Part 3 is rotated by 8, Part 2 by 7 and Part 1 by 6, something very interesting happens. Up until now, the structure of Part 1 has always been asymmetrical. For example, in bar 4 – where the rotation indices of all three upper parts were 0 – Part 1 had the onsets [0 2 5] with IOI $<$ 2 3 7 $>$. In the immediately previous measure 11, Part 1's onsets were [1 6 8] with an IOI of $<$ 5 2 5 $>$ – a form which has one axis of symmetry because it is geometrically an isosceles triangle. In the process that has been going on until now, this is the first (and only) time that Part 1's structure is symmetrical in 3 axes – in other words, it is geometrically an equilateral triangle. Hence, its onsets are [2 6 10] and its IOI is $<$ 4 4 4 $>$. This seems to be a potentially very interesting musical relationship, especially when the repeat signs are followed in the score.

13. As the process continues, Part 1's symmetry dissolves. Part 3's rotation is 9, Part 2 is 8, and Part 3 is 7.

14. Part 3's rotation increments again to 10, while Part 2 lags behind at 9, and Part 1 moves to 8.

15. Predictably, Part 3's rotation increases to 11, Part 2 to 8, and Part 1 to 9.

16. At this point, Part 3 rotates to 12 – which is equivalent to 0 (mod 12). It has rotated around the entire circle once, and it now "freezes" at 12 (or 0). Part 2 rotates to 11, and Part 1 rotates to 10.

17. Part 3 has "frozen" in place at rotation 12 (or 0), but now Part 2 has also cycled around the circle once, and similarly halts at rotation 12. Part 1 rotates to 11.

18. Now all three upper parts have each cycled around the circle once, and remain frozen at rotation 12.

19. With nothing more to do, Part 1 drops out...

20. Followed by Part 2...

21. And finally Part 3, leaving only the Clapping Music ostinato alone. As it began the composition, it also closes it out.

In some small way, I hope this simple piece pays homage to the immensely moving and profound work of Steve Reich – a composer I have admired since I first heard him as an undergraduate student at Vassar College.