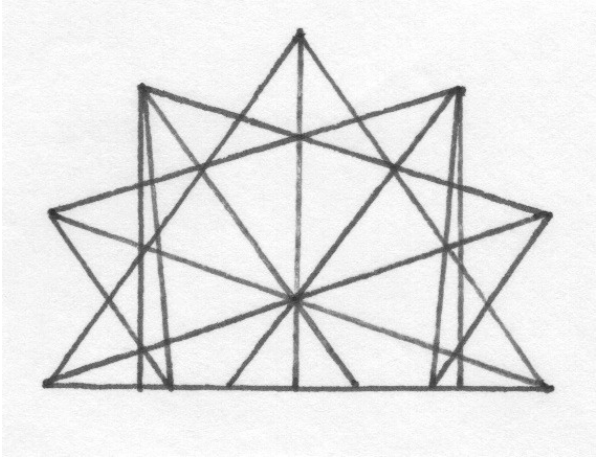
The Spectrum Keyboard



Siemen Terpstra

www.siementerpstra.com

THE SPECTRUM KEYBOARD

The Spectrum Keyboard is a redesigned music keyboard intended for digital synthesizers, samplers, and other electronic media applications. It is planned as a 'musical typewriter,' making the playing of chords and scales much easier than the old black-and-white keyboard. The old keyboard is a medieval design whose layout was influenced more by historical factors than by design efficiency.

The main advantage to the new design is the ease and speed in playing musical patterns. It does not require a large hand like the old keyboard; hence it is ideally suited for the teaching of harmony to children. The hexagonal grid allows maximum information within a minimum of space. Even though there are more digitals to the octave than the old keyboard, the arrangement is more compact, so that the player has a greater 'stretch' in making voicings.

The design is 'planimetric,' so that the 'shape' of a given chord or scale type is the same in any key. There is a one-to-one correspondance between interval size and digital pattern. This factor alone gives it tremendous advantages over the old design.

The integration of more digitals per octave allows the keyboard to be inter-system with regard to tuning. As a result, besides playing in the usual 12-E.T., one can play in other interesting harmonic systems like 19-E.T., 31-E.T., and 43-E.T., without the need to relearn chord 'shapes.' Hence it liberates the ability of the computer to explore alternative harmonies. It allows increased access to information, releasing the computer's ability to handle large amounts of data relating to tuning and timbre.

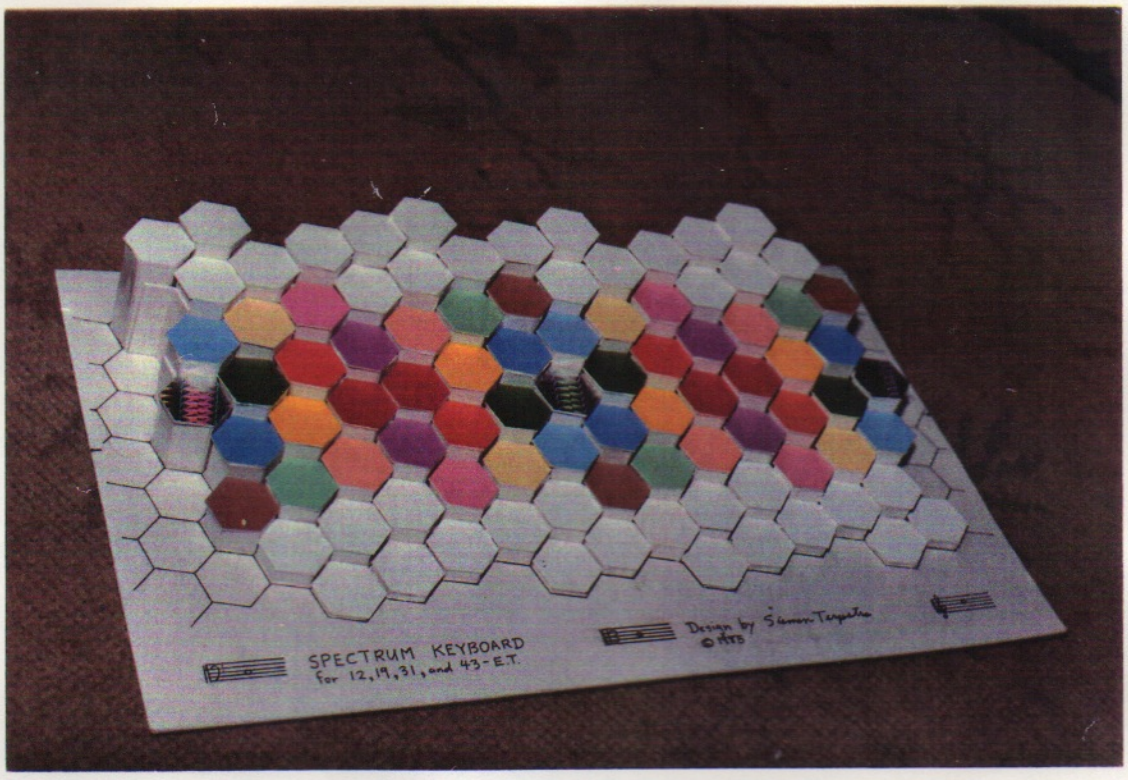
The black-and-white colour code of the old keyboard is scrapped in favour of a 'rainbow spectrum' based on an analogue between the harmonic series spectrum and the colour spectrum. It is entirely rational and consistent, and it further eases playing ability by aiding in pattern recognition.

The colour code and the general layout result in a keyboard which would be very attractive on stage. The design has a 'space age' quality in its appearance.

Finally, the system of digital elevations further assists in 'feeling' out the patterns. The keyboard would have a light 'action,' somewhat like a computer keyboard. As a result it would be a joy to play.

In summary, the new design would liberate the potential of computer-based electronic media to handle large amounts of information. Unlike the old keyboard, which takes years to learn to play, this keyboard would access the information with a minimum of effort.

Below is a photograph of a two-octave patch of the design. The working model would employ 5 to 7 octaves, as is usual with synthesizers and samplers. The digital for 'C' is shown in mylar, but would be illuminated in the working model, as a further position check.



Minimum budget required to get the project started:

$4300 - prototype ($2300 for parts, etc, $2000 for engineering)
$2000 - legals (incorporation, etc.)
$1000 - accounting
$4000 - promotional package for financial presentation to get production money.

$11,300

SPECTRUM KEYBOARD

SPECIFICATIONS

designer: SIEMEN TERPSTRA

The Spectrum Keyboard is an innovative music keyboard for electronic music systems (ie. synthesizers, samplers, etc.). The design objective is to produce a keyboard which is maximally efficient and hence easy to play. At the same time, the design objective calls for maximal information access for computer controlled systems.

The primary inspiration for the design comes from the harmonium keyboard pattern given by Mr. R. H. M. Bosanquet in his theoretical treatise: ELEMENTARY TREATISE ON MUSICAL INTERVALS AND TEMPERAMENT, 1876. Although this design was quite valuable in introducing planimetric symmetry into the music keyboard, it was nevertheless seriously flawed, difficult to play, and never gained wide acceptance by musicians. The present design represents a radical alteration of the original pattern, resulting in a keyboard which is musically practical and at the same time preserving the positive attributes of the Bosanquet keyboard. I will clarify the design specifications making reference to the Bosanquet to show the reasons for the drastic changes.

First of all, the Bosanquet keyboard used a total of 84 digitals to the octave. (As in all keyboard designs, the pattern repeats at each octave). These digitals were 'finger-like' in shape, like piano keys, and arranged in tiers. Some of the digitals were coloured black, the others were white. In contrast, the Spectrum Keyboard radically reduces the number of digitals to 45 per octave, for reasons to be explained latter. The piano-like digital shape is scrapped in favour of a hexagonal grid, so that the keyboard is shaped very much like a typewriter keyboard. In fact, the basic design approach is that of a MUSICAL TYPEWRITER. The hexagonal grid allows maximum information within a minimum spacial format, so that the keyboard is wonderfully compact in spite of the large number of digitals per octave.

The Bosanquet keyboard was haunted by the medieval 'black-and-white' piano design, not only in the shape of the digitals, but also in the colour layout. The new design replaces the black-and-white approach with a multi-coloured pattern which is beautiful in appearance and practical in its function as an aid to performance efficiency. The colour code is entirely rational, and based on a symmetrical analogue between the Harmonic Series of sound and the rainbow spectrum of colour. In addition, the key which we call "C" in musical parliance is illuminated in each octave, so that position is further clarified. The colour code overcomes the problem with the Bosanquet design which was criticized for being excessively symmetrical. This excessive symmetry led to confusion of position so that the player would become lost among a jungle of black and white keys. The colour

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code and the smaller number of digitals per octave eliminates this problem.

The Bosanquet keyboard had 84 digitals per octave, because it was intended for the 53-Equal-Temperament tuning system. Some of the notes on the upper end of the manual were made identical to some on the lower end in order to avoid having to jump frequently from the lower to the upper digitals when playing in certain keys. Hence the added number of digitals. The Spectrum Keyboard, on the other hand, reduces the number of digitals to 45 for a number of reasons. First of all, it is not intended for 53-E.T. Rather, it is intended for 12-E.T. and the Meantone Series of Cyclical Temperaments (notably 19-E.T., 31-E.T., and 43-E.T.) and other cyclical temperaments which can be expressed as a closed cycle of musical Fifths. In fact, the Bosanquet design does not work well for 53-E.T. since it overemphasizes the Pythagorean intervals and makes the Just intervals (which are more desireable) more difficult to finger. It is ironic that Bosanquet intended his design to overcome the limitations of 12-E.T. and access the subtleties of quasi-just intonation; yet his design is more suited to the former rather than the latter. In all fairness, however, we must admit that he was aware of the inter-system potential of his 'generalized keyboard,' and used it for implimenting the pure Quarter-Comma-Meantone intonation extended to 36 notes per octave. The new design recognizes the cultural bias toward 12-E.T. but allows a wide range of systems to be available without the need to change fingerings or chord shapes. The old standard medieval design is limited to tunings which have only 12 notes per octave, whereas this design sets the limit at 45. Hence much more pitch information is available under the fingers at any time. This situation liberates the innate potential of electronic keyboards to be easily reprogrammed into many various intonation systems.

The new design preserves the system of elevations present in the Bosanquet design, but radically alters the scale. The old design was extremely vertical, but the new design is far less so. It is more comparable to a typewriter or computer keyboard slope. The elevations are indicated by the numbers on the given pattern diagram. Here the digitals are numbered from 1 to 45. The numbers refer to the elevation of the digital in millimeters, so that digital 17 has 17 millimeters elevation. Thus the rise varies from 1 to 45 millimeters. It is potentially desireable to reduce the slope even more by using a smaller increment, say 0.75 millimeters as the base rate. The slope of the design can be readily altered in this manner. It is extremely important to have some slope, since a flat hexagonal grid is much more prone to errors in fingering. The planimetric slope is important in establishing the 'feel' of the keyboard.

The amount of 'action' on the digitals is also open to some debate. On the one extreme, the keyboard could have no action at all, so that it is touch sensitive without the need to press down the digital at all. On the other extreme, the action could be quite deep and weighted like on a piano. Obviously both of these extremes are not desireable. Rather, the action should be very

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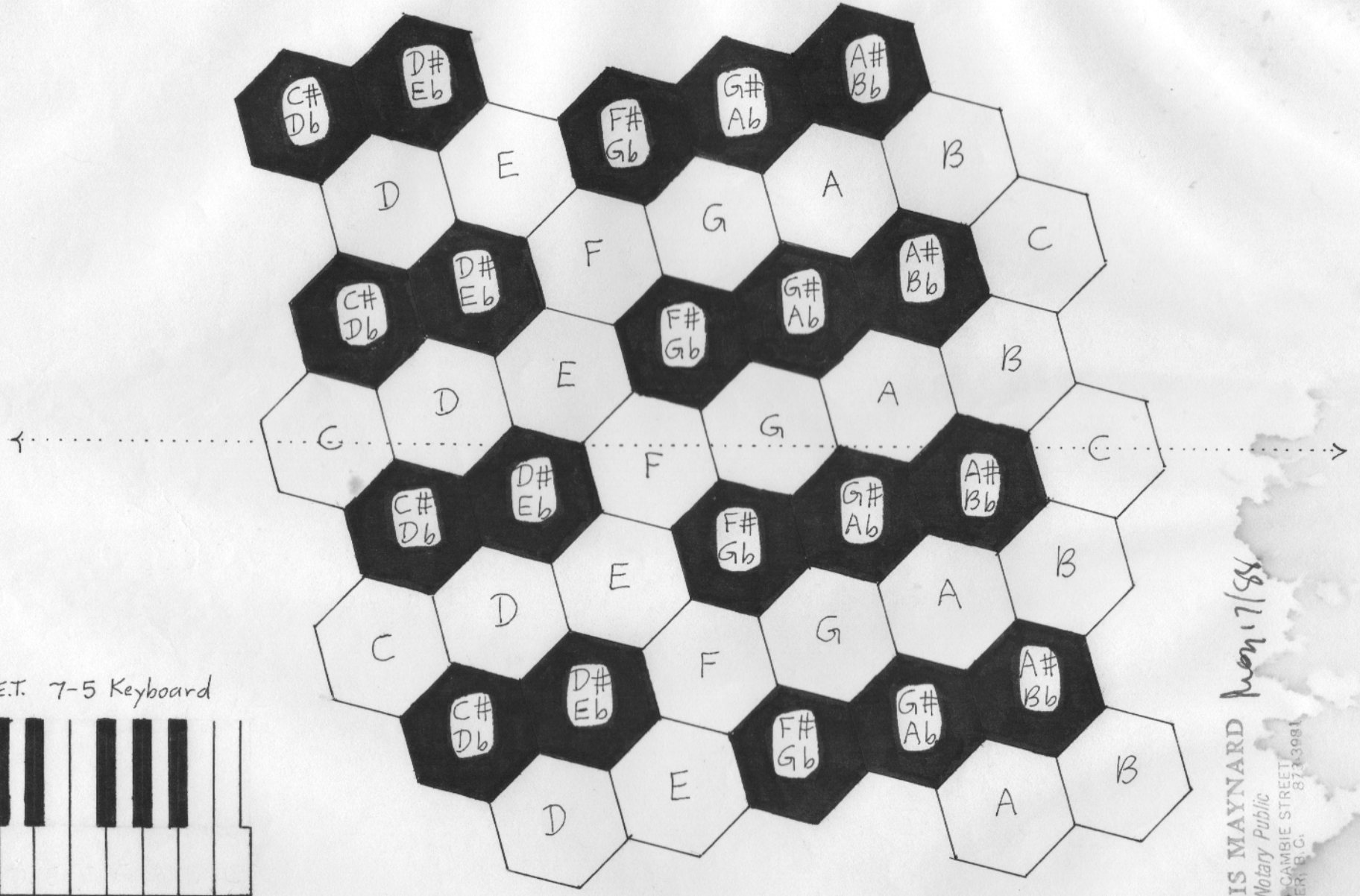
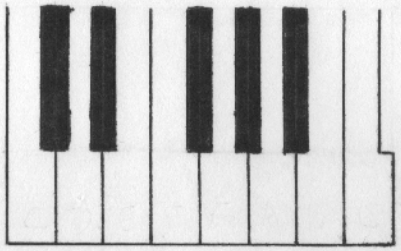
12-E.T. showing Black-White Colour Code
Spectrum Keyboard:



12-E.T. 7-5 Keyboard



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19-E.T.

Mon. 7/84

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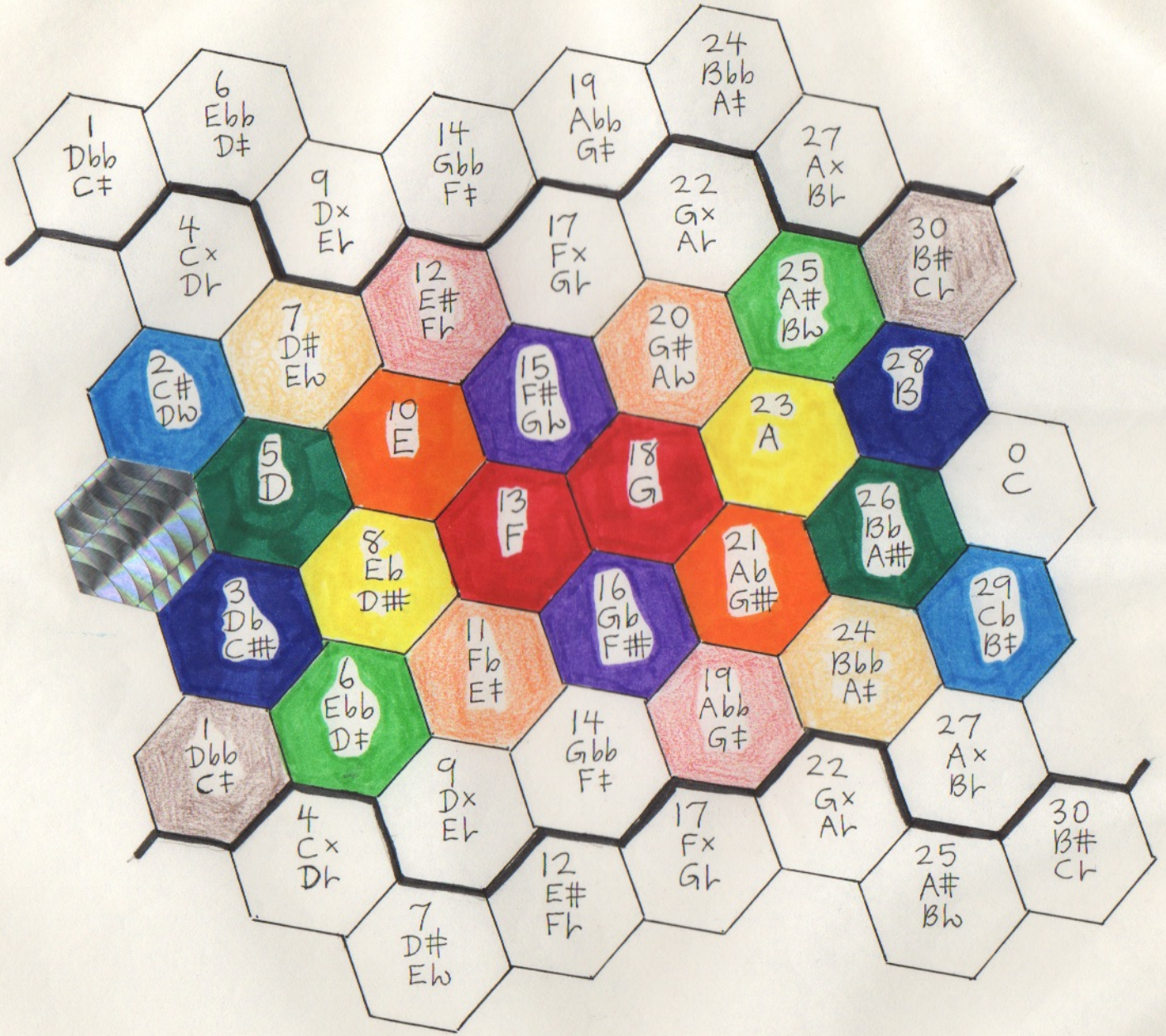
31-E.T.



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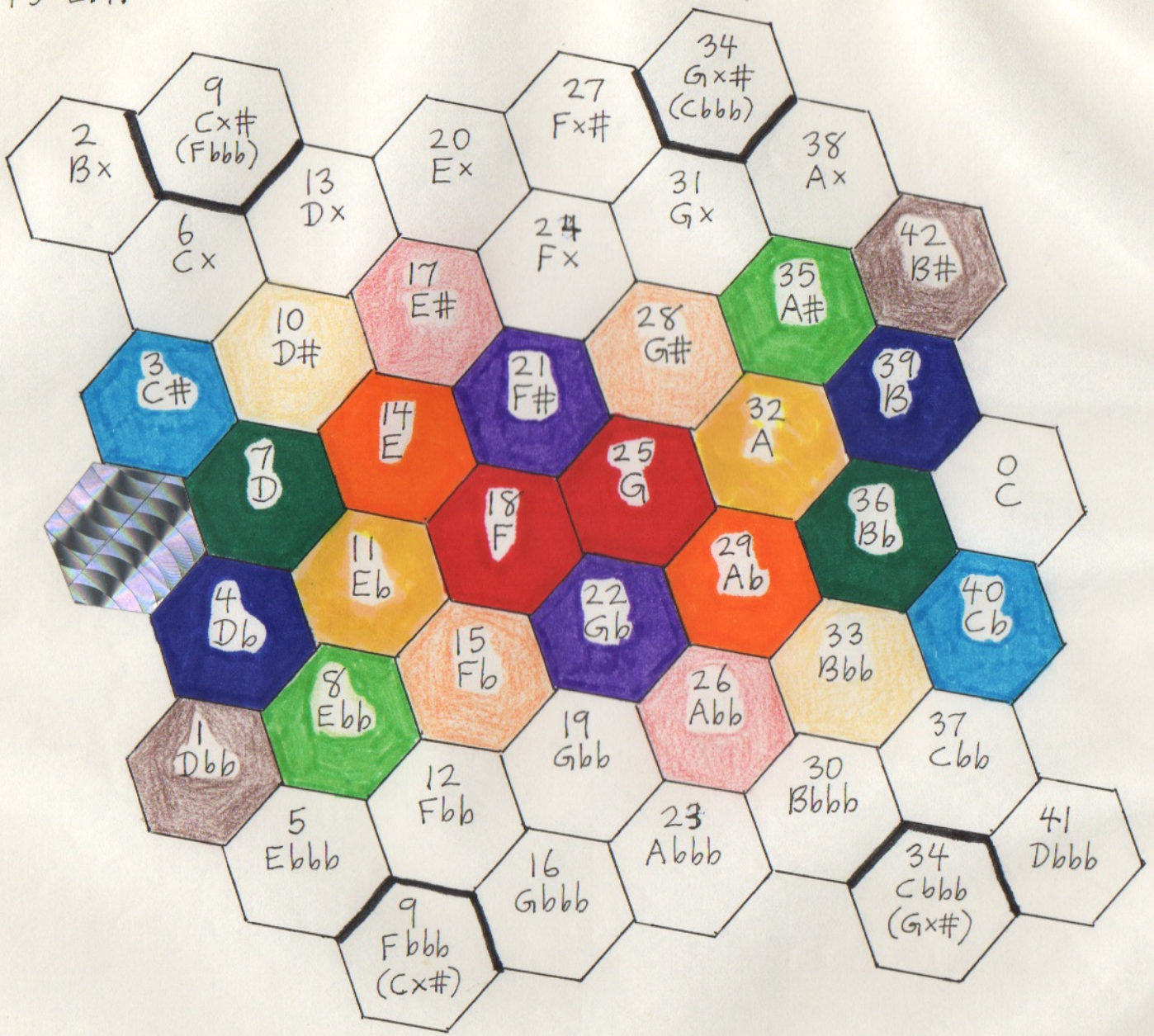
43-E.T.



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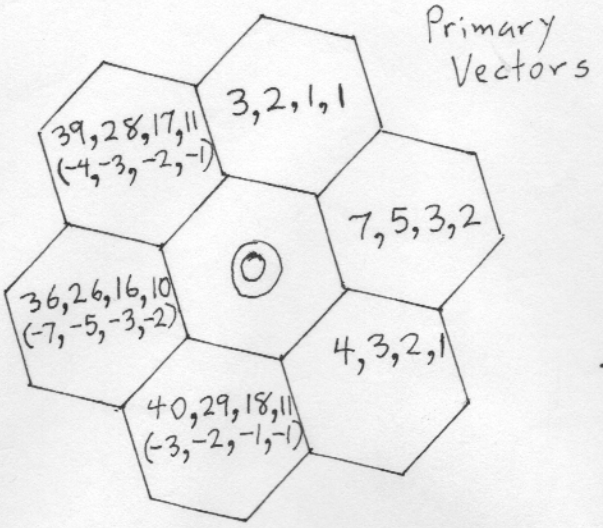
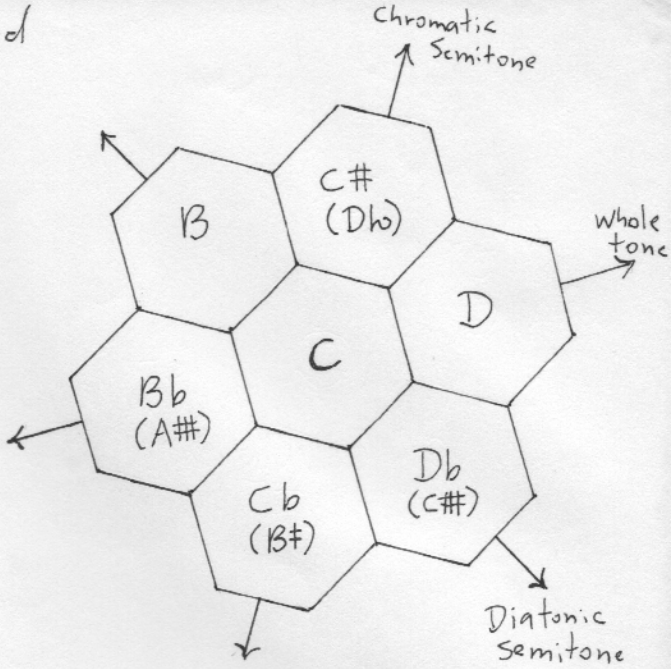
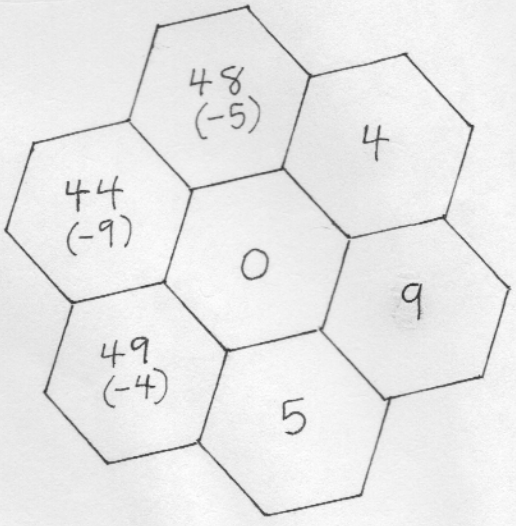
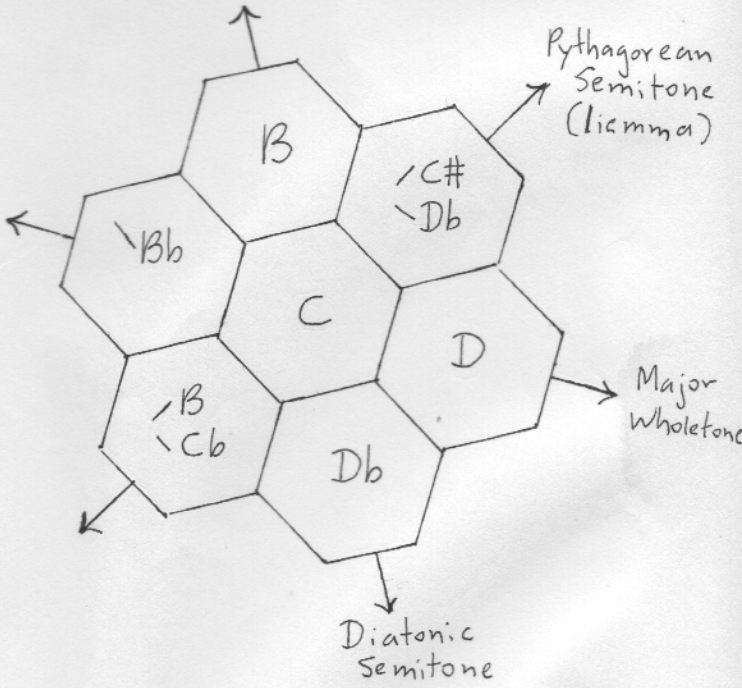
Pattern for 12,19,31,43-E.T. Keyboard





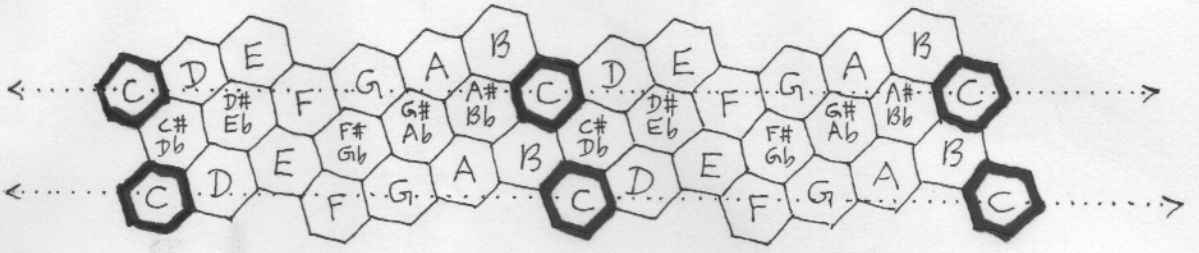
53-E.T. Keyboard: Primary Vectors:





Generalized Keyboard Pattern for 12-E.T.:

"6-6" Pattern – 19 Digitals per Octave – allowing unlimited modulation within a practical, planimetric pattern – allowing alternative fingering patterns (the result of the use of 19 digitals) so that "positions" are much easier than the Medieval (7-5) Keyboard

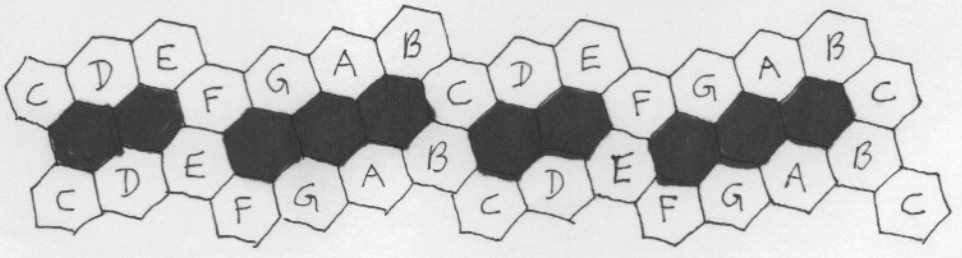


Dotted lines show the horizontal axis of expansion of the pattern. Only two octaves are shown, but the pattern may be extended to the desired number of octaves (usually 5).

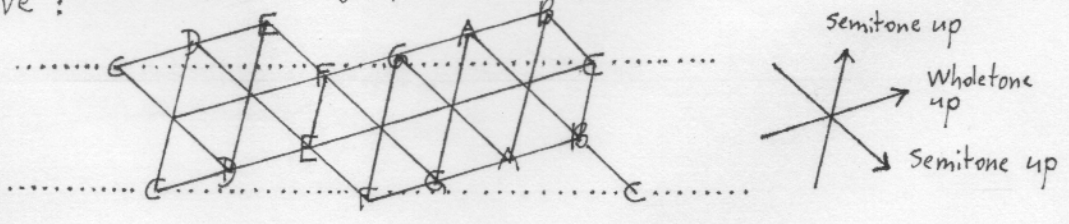
Vertical elevations are not shown on these diagrams.

The hexagonal digitals (for closest packing) may be replaced by circular digitals, as long as the underlying triangular grid is preserved.

Pattern with "black + white" colour code:



Below is the underlying equilateral triangle grid for one octave:



Primary interval vectors shown above

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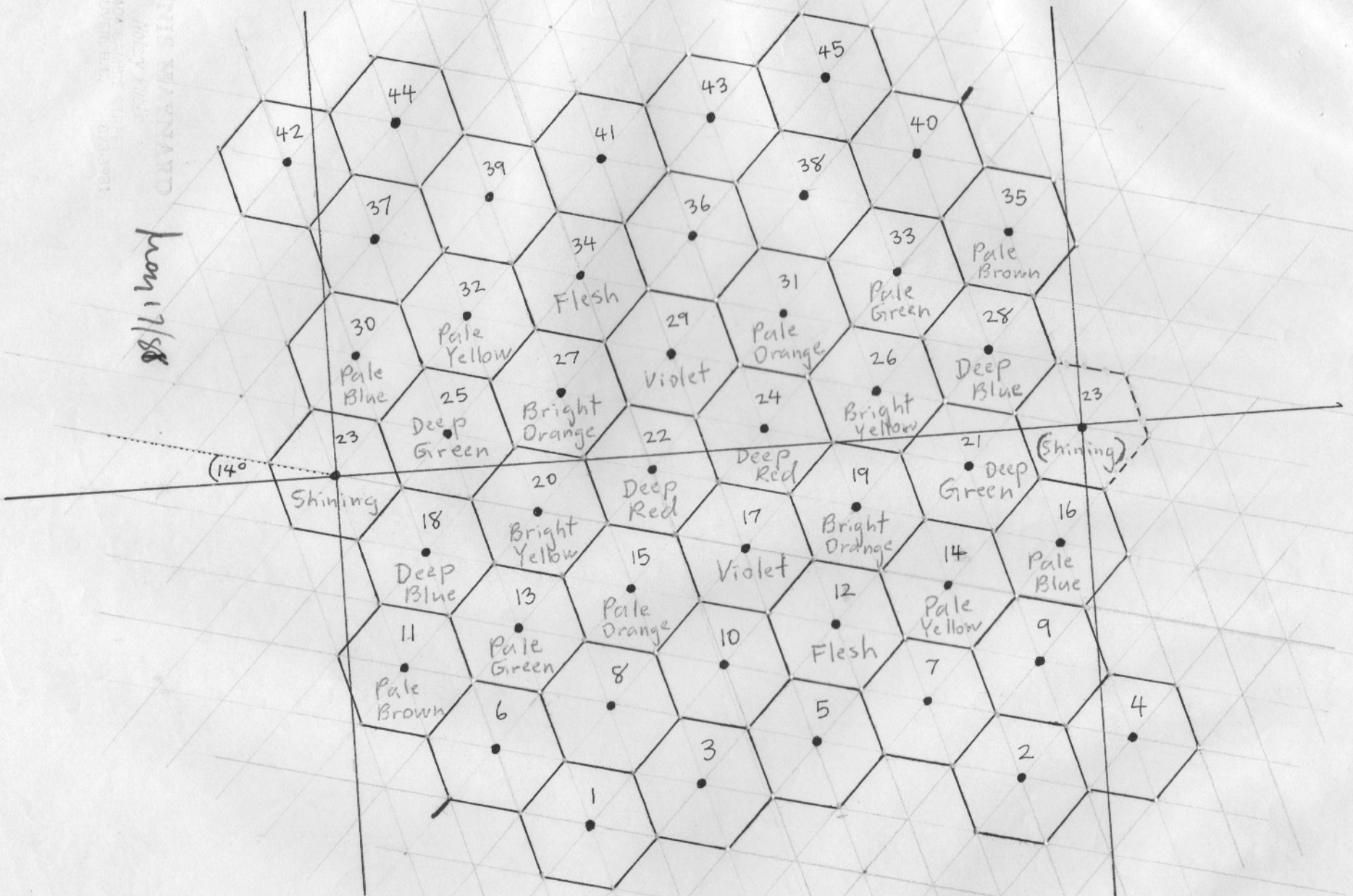
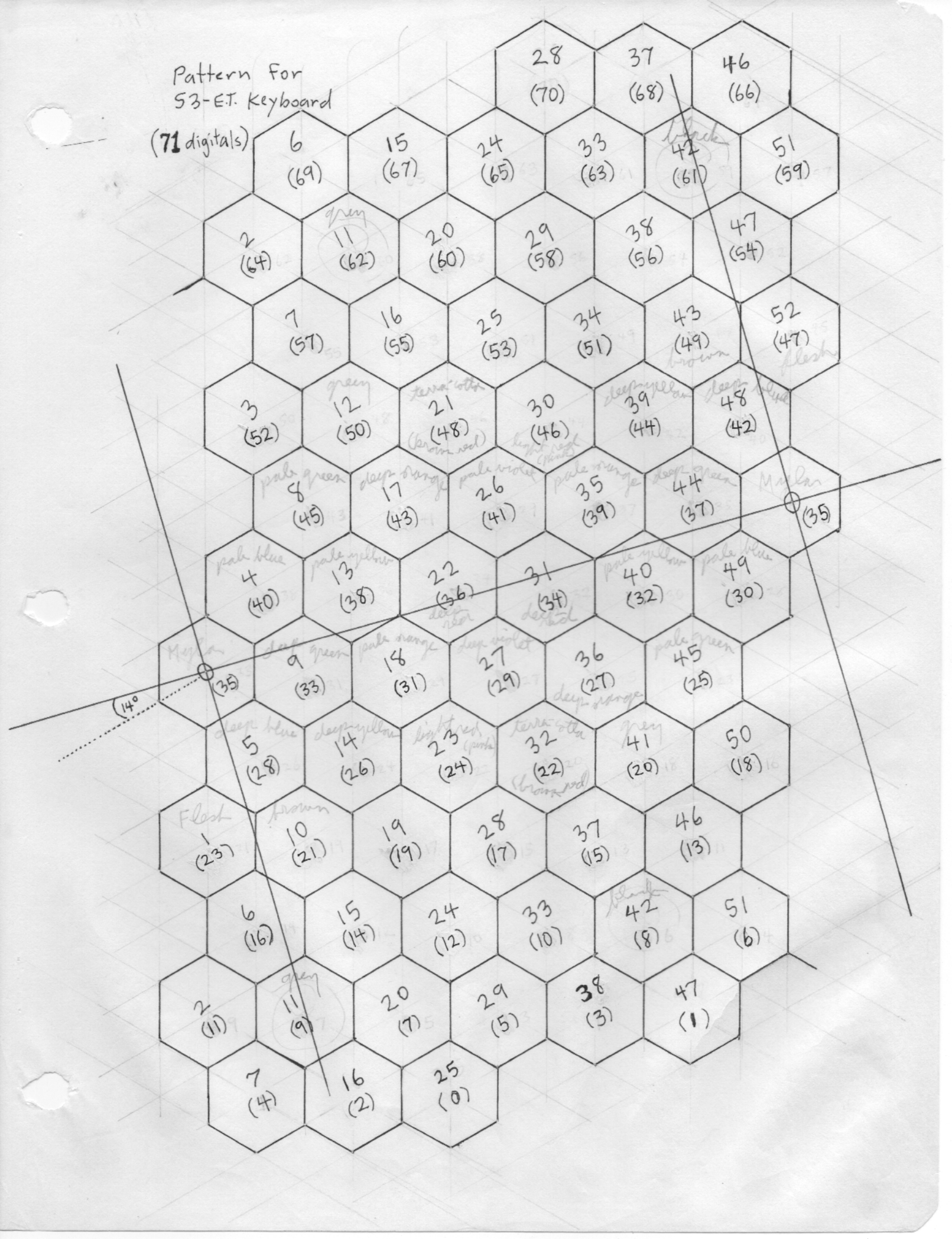
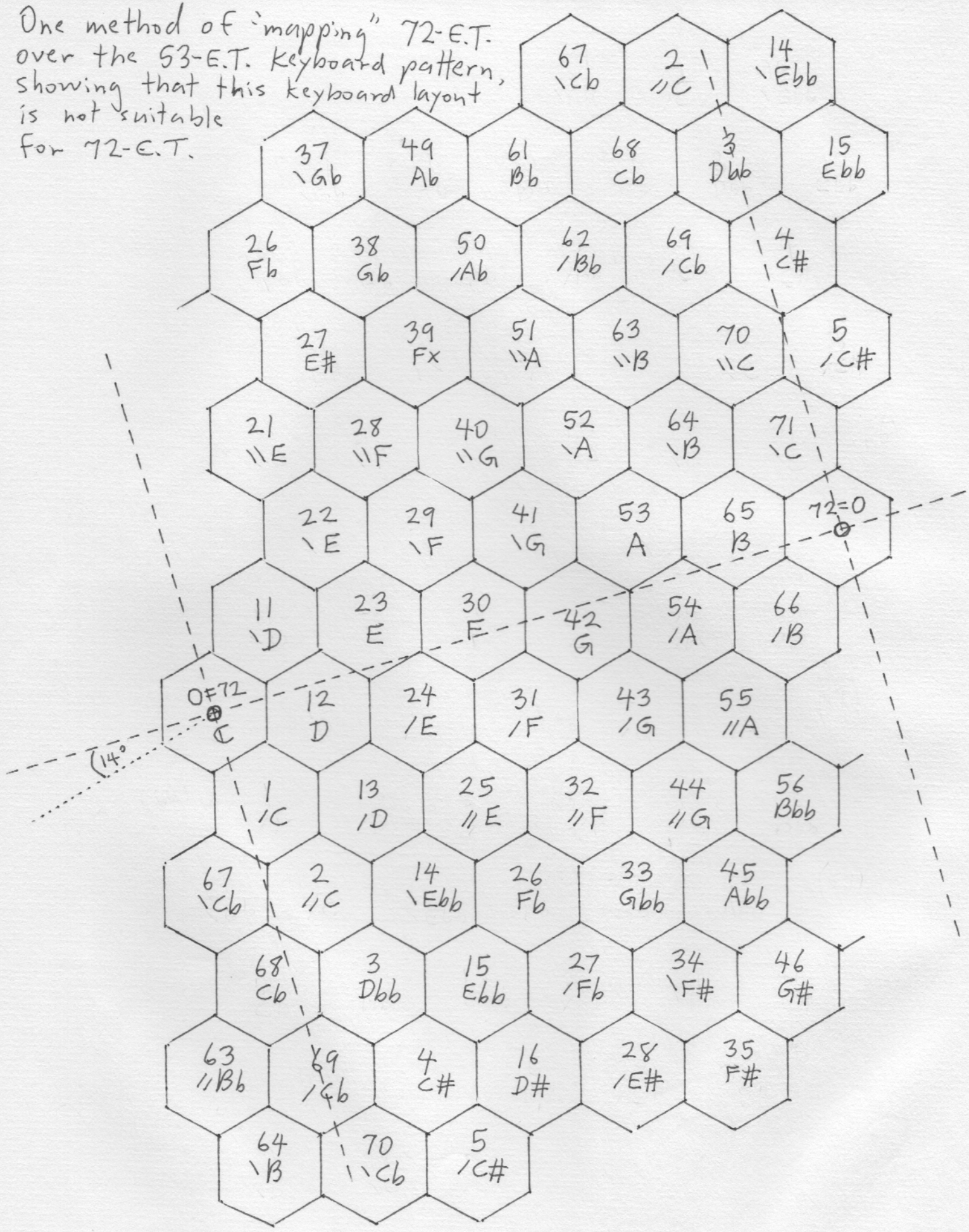
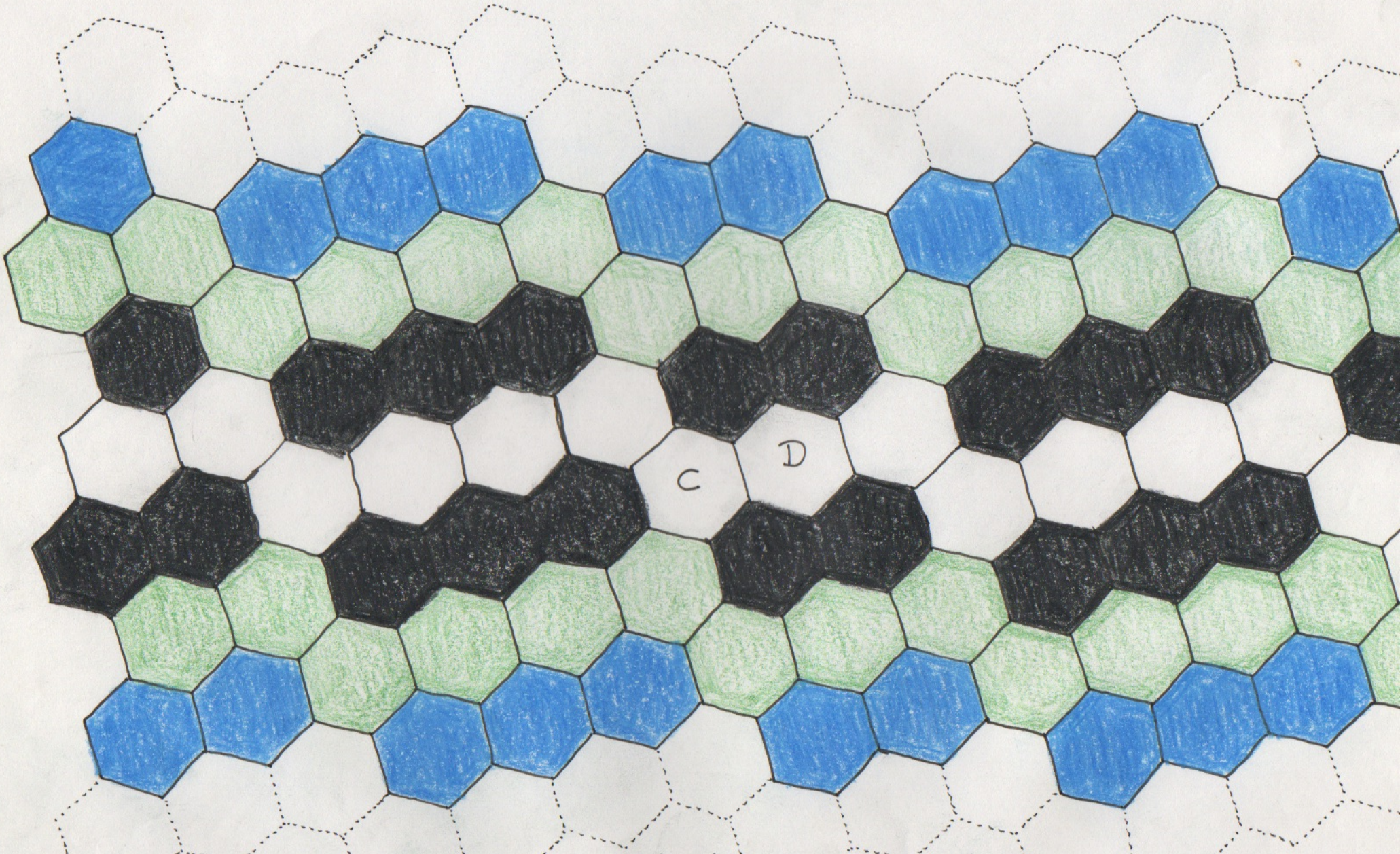
Pattern For 12-19-31-43 Keyboard




Pattern for
53-E.T. keyboard
(71 digitals)
28 (70)
37 (68)
46 (66)
6 (69)
15 (67)
24 (65)
33 (63)
42 (61)
51 (59)
2 (64)
11 (62)
20 (60)
29 (58)
38 (56)
47 (54)
7 (57)
16 (55)
25 (53)
34 (51)
43 (49)
52 (47)
3 (52)
12 (50)
21 (48)
30 (46)
39 (44)
48 (42)
8 (45)
17 (43)
26 (41)
35 (39)
44 (37)
(35)
4 (40)
13 (38)
22 (36)
31 (34)
40 (32)
49 (30)
(35)
9 (33)
18 (31)
27 (29)
36 (27)
45 (25)
14°
5 (28)
14 (26)
23 (24)
32 (22)
41 (20)
50 (18)
1 (23)
10 (21)
19 (19)
28 (17)
37 (15)
46 (13)
6 (16)
15 (14)
24 (12)
33 (10)
42 (8)
51 (6)
2 (11)
11 (9)
20 (7)
29 (5)
38 (3)
47 (1)
7 (4)
16 (2)
25 (0)

One method of "mapping" 72-E.T. over the 53-E.T. keyboard pattern, showing that this keyboard layout is not suitable for 72-E.T.





Generalized keyboard for (12), (19), (31), (43), (55) (50)

- meantone sequence with best major thirds on the dominant side,
* one O of Fifths

- 55 digitals per octave, options 17, 31, 41, 55 digitals
white black Green Blue white

best for e.t. 12 19 31 43, 50, 55