

HCI and Music: Squaring the Circle

Invited talk by Prof Jim Alty and Dr Simon Holland
at INTERCHI on 24th April 1993 in Amsterdam (*Joint
meeting of US ACM SIGCHI and European INTERACT*)

These are the slides of the first half of the invited talk, written and presented by Simon Holland. Jim Alty wrote and presented the second half of the talk.

MMI The Musician Machine Interface

Human Computer Interaction in Music

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Open University, Great Britain

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INTERCHI'93 Amsterdam: HCI and Music

HCI in aid of Music

- **Perform / analyse / compose**
- **Standard / innovative applications**
- **Musical expert / musical beginner**

- **What's in it for HCI?**

Harmony Space

Music Composition

Beginners

Popular music, Jazz, Rock and Roll

Basic Tonal Harmony

Harmony in any kind of tonal music

(Can deal with some microtonal scales)

(Transfer test)

Balzano's Theory of Harmony (1980)

- **Independent of frequency ratios**
- **Objects with perceptible circular ordering**
- **Cyclic group of order 12**
- **Naive account - omit group theory**

Background Musical Facts

- Octave Equivalence
- 12-fold division of octave
(number notes from 0-11)

Some musical phenomena

Kinds of musical closeness /ordering

- Chromatic, circle of fifths, diatonic

Centres (stable points)

- Major, minor

Structures

- Diatonic scale
- Triads: number of notes
pattern of notes
primary vs secondary
- Relation of position in scale to quality
- Modulation: closeness

How to characterise phenomena?

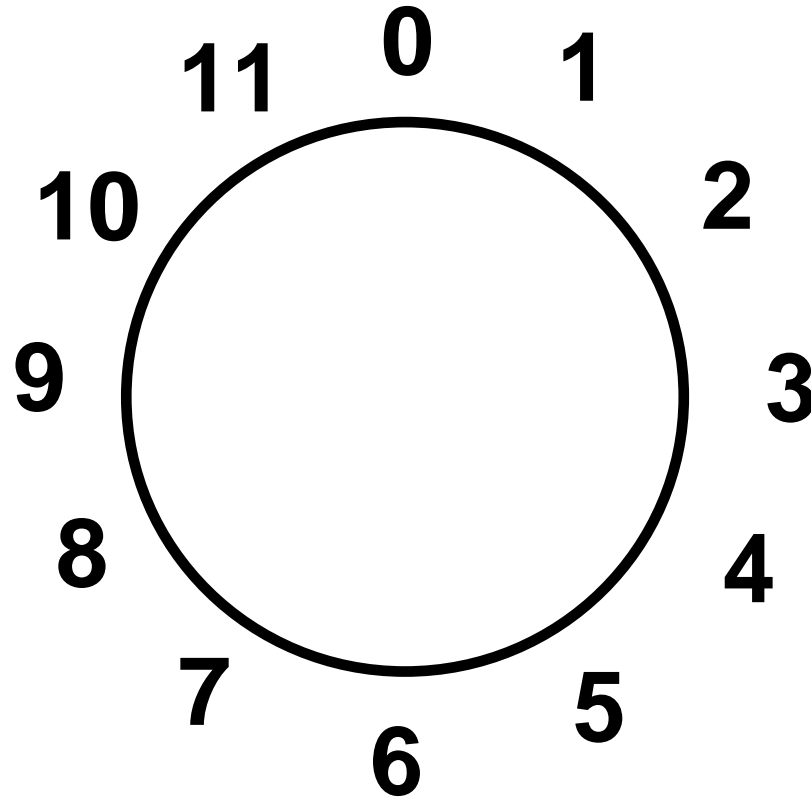
Find all possible co-ordinate systems

- Complete
- Give *unique* co-ords for each note

Unit distance

- Successive applications of some fixed-sized step

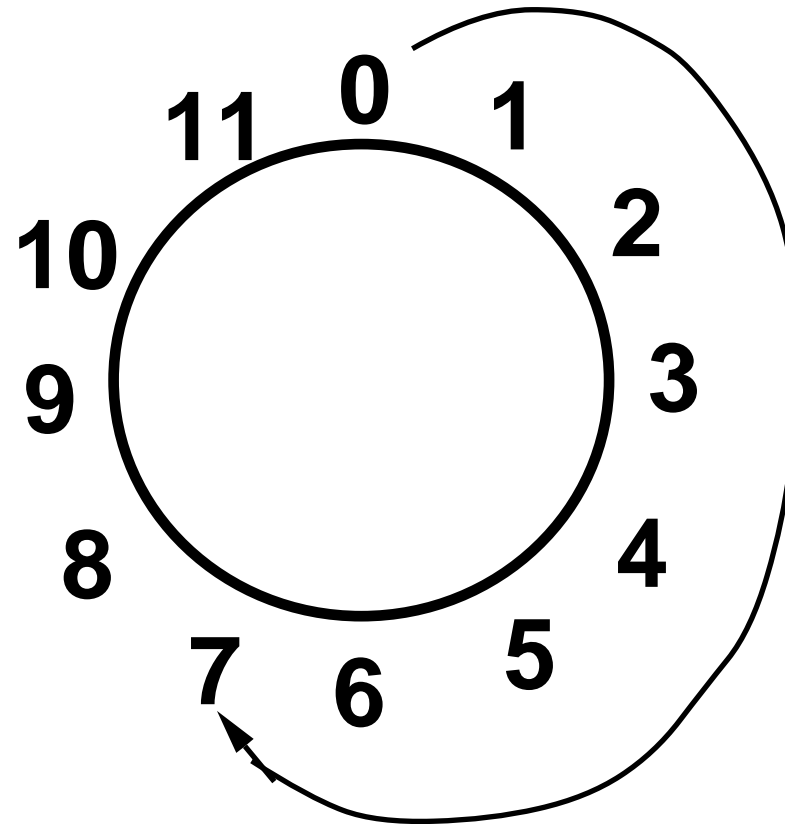
Chromatic closeness / ordering



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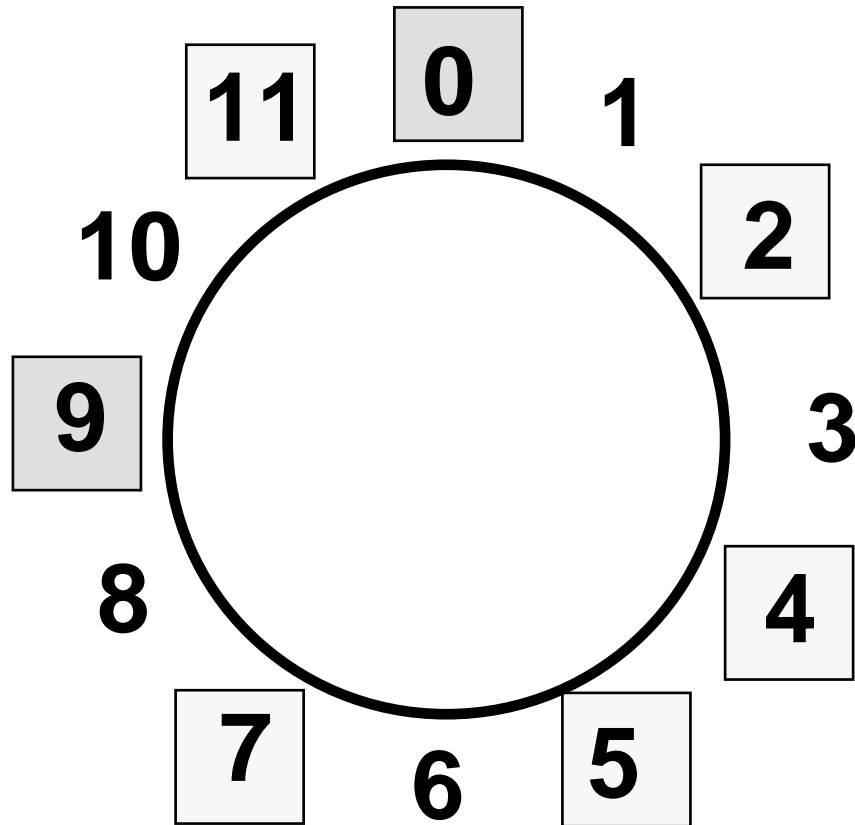
Fifths/ fourths closeness / ordering



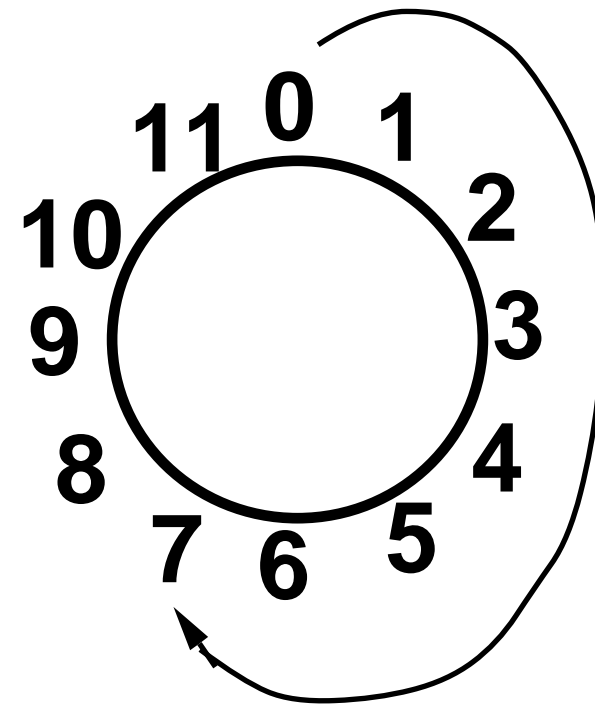
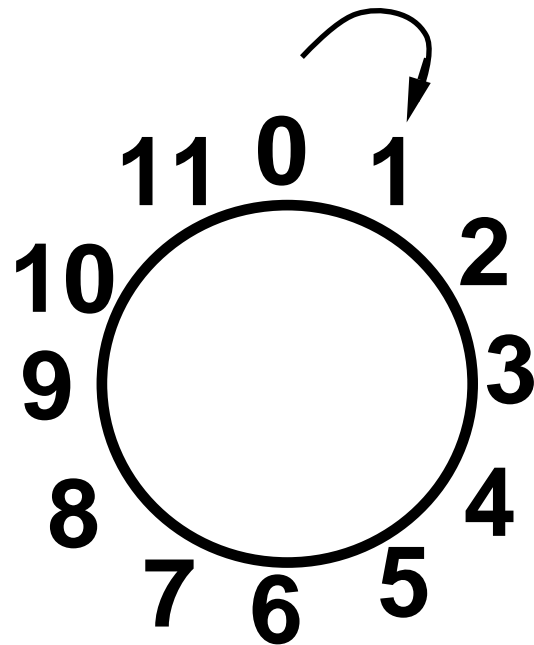
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Diatonic Scale



One - dimensional co-ordinate spaces



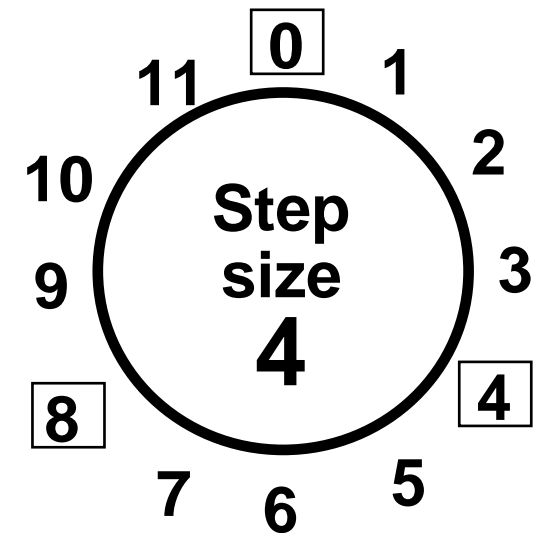
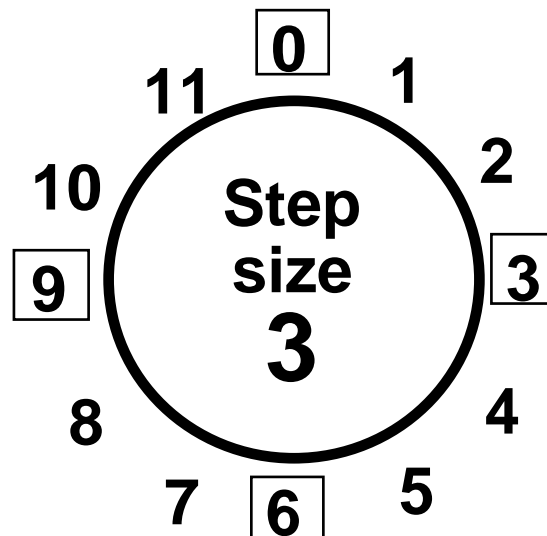
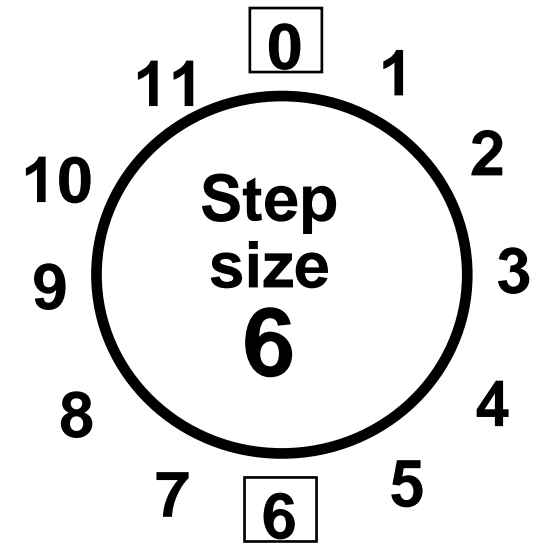
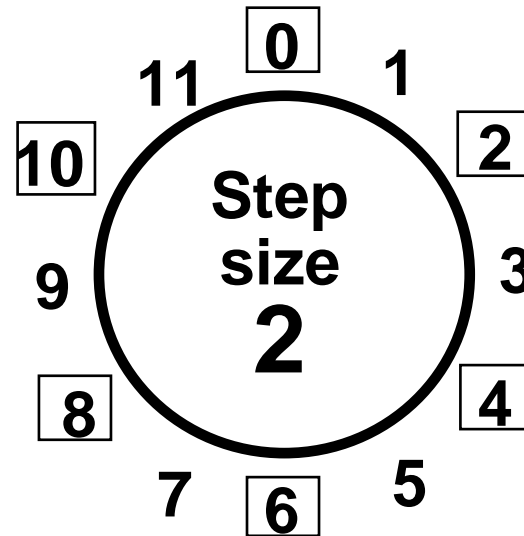
2D spaces?

- Complete
- Unique

- Not 1 or 7
- Not if both reach 6

- Step size 4 and 1 other
- Inc 3, or not reach odd

- 3 & 4 works!



Formal result

Given 12 objects with circular order

**Just 3 complete unique regular
co-ordinate systems**

Two 1-dimensional **steps size 1 (11)**
 steps size 7 (5)

One 2-dimensional **step size 3 x step size 4**

Exploitation of 'universal' skills in Harmony Space

Harmony Space exploits skills such as:

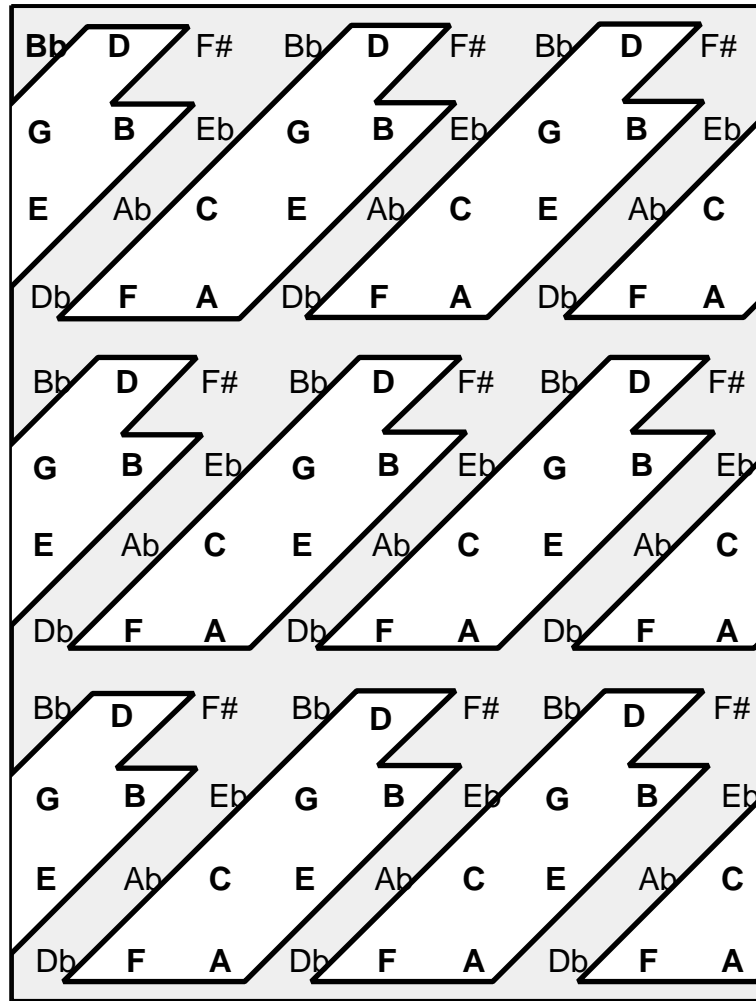
- recognise straight lines,**
- make straight line gestures,**
- keep within a marked territory,**
- distinguish points of the compass,**
- recognise and find objects that are close to each other.**

Design of the interface maps complex, unfamiliar skills into elementary motor/perceptual abilities.

Important musical concepts represented in grid

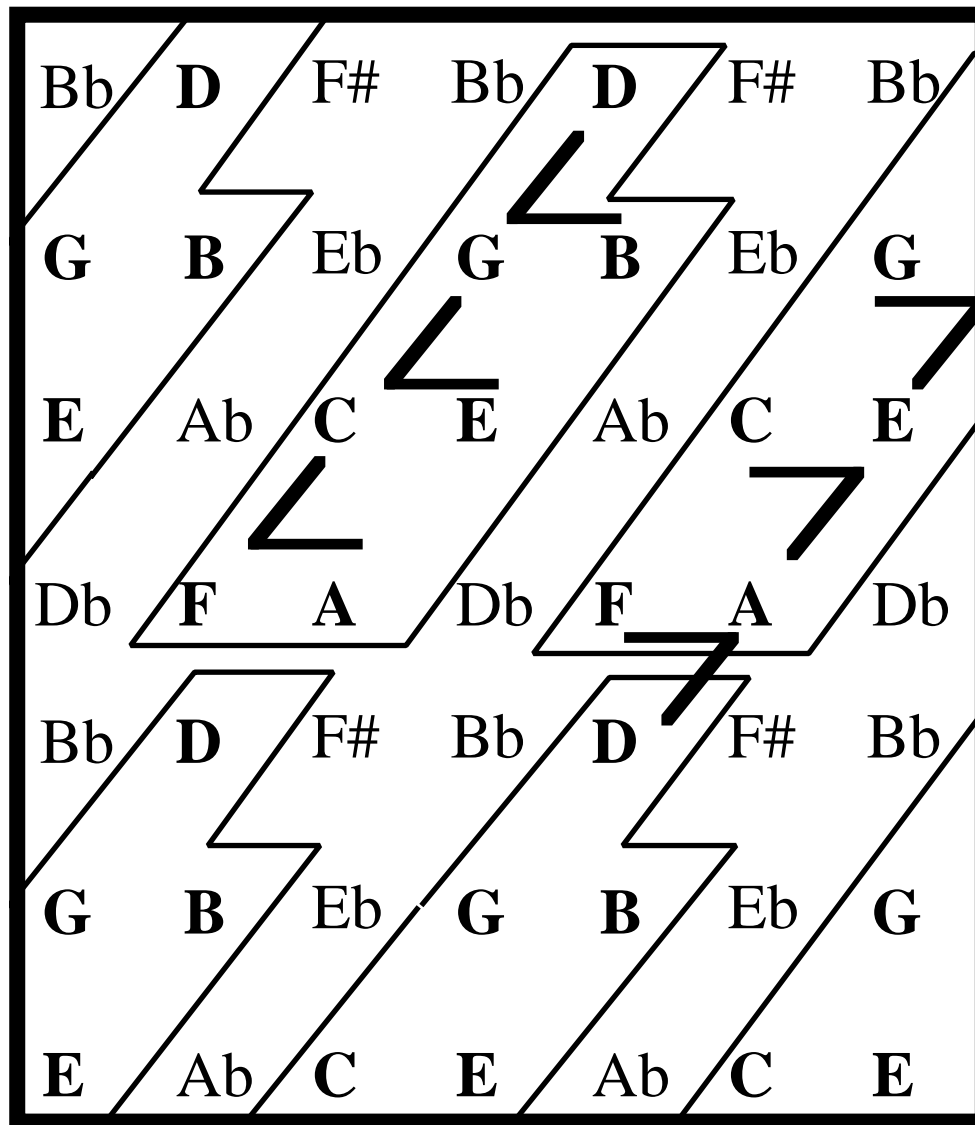
- Only 12 distinct notes
- Vert, horiz axes: steps size 3 & 4
- Emergent SE axis is step size 1
- Diag NE axis is step size 7
- Shaded area is diatonic scale
- Moving shaded area changes key
- Nearby modulation e.g. to dominant
- (Simplified note 'spelling')

**Step size 3
(Minor 3rds)**



Step size 4 (Major 3rds)

Triads



Uniformity and consistency

- **Spatial metaphor for pitch, interval, scale, chord, inversion, voicing, & key-relationships**
- **Motion metaphor for melody, chord progression & modulation**
- **Spatial containment metaphor for diatonic scale, chord qualities & diatonic chord progressions**
- **Centrality metaphor for major & minor centres**
- **Chord qualities - consistent shapes in any key**
- **Proximity metaphor - close intervals, chords & keys**

Some uses of Harmony Space

- Create vocab for novices to articulate, analyse & compose,
 - Musical instrument,
 - Compositional tool,
 - Harmonic analysis,
 - Modify music in 'intelligent' ways,
- Learn music theory,
- Notation: visualise relationships hard to see in trad notation.

Some conclusions for multi-modal interface design

Mapping concepts to motor / perceptual relationships can lessen cognitive load

Harmony can encode complex structured spatial information

Pitch is 3D - not a simple scalar - affects use in interfaces

Mapping from one sensory modality to another can illuminate domain (and both modalities)

Mapping from one sensory modality to another requires mappings that preserve/emphasise desired relationships

Some References

Holland, S. (1992) "Interface Design for Empowerment: A Case Study from Music" in Edwards, A. and Holland, S. (1992) (Eds) "Multimedia Interface Design in Education". Springer Verlag, New York.

Holland, S. and Elsom-Cook, M. (1990) "Architecture of a knowledge-based music tutor". In Guided Discovery Tutoring, Ed. Elsom-Cook, M. Paul Chapman Publishing Ltd, London.

Holland, S. (1987) "Direct Manipulation tools for novices based on new cognitive theories of harmony". pp 182-189 Proceedings of 1987 International Computer Music Conference.

***Preliminary* practical findings**

Small qualitative studies in preparation:

- **Pilot formative study in school**
- **Pilot formative work in teacher training**
- **OU tutoring in small groups**

Appears to make

- **Impracticable tasks possible**
- **Learning tasks/concepts faster**

Limitations

- **Specialised to Harmony**
- **Specialised to some aspects of Harmony**
- **Not good on melody, rhythm, voice leading, long term TR patterns, etc**
- **Western Tonal Music - centric?**
- **Music psychology is complex**
- **Music is very complex**

Further Work

- **Interfaces for other dims of music: rhythm, melody, long term temporal structures**
- **Analysing bodies of music**
- **'Translate' existing theoretical works**
- **Develop new teaching approaches**
- **Applying harmony to auditory interface design**
- **Applying mapping ideas elsewhere (outside music)**