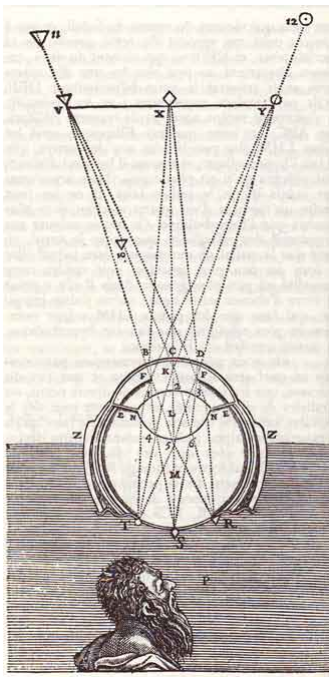


Time, music and mathematics

Wilfrid Hodges

Dartmoor, November 2009

<http://wilfridhodes.co.uk/greenwichtime.pdf>

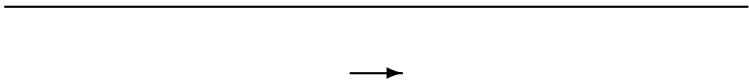


'Time'

'Ear' (!)

Mathematician

Time looks like this:



Grasshopper warbler



- (1) Events in time
- (2) Rhythms and repeated events
- (3) Hierarchies of rhythms
- (4) Clash of rhythms
- (5) Mixing time and space (pitch)

1. Events in time

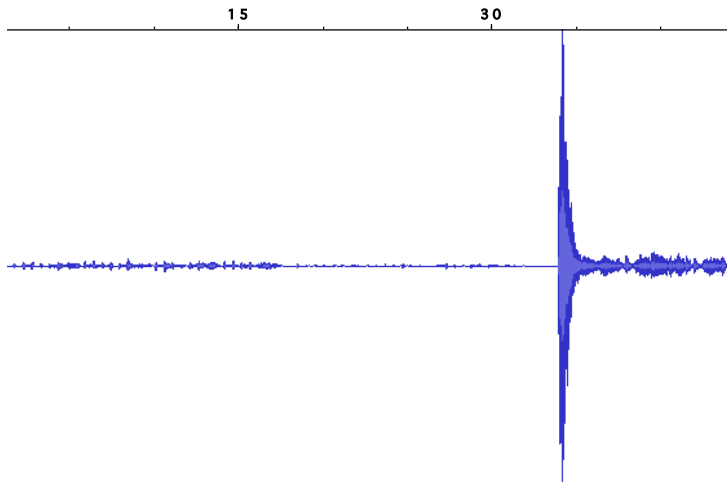
Time only becomes interesting when an event occurs in it.

Three kinds of event:

- (a) At a point.
- (b) Over an interval, i.e. between two points.
- (c) With a clear start (the 'attack') but no clear end.



(a) A point event (Haydn, 'Surprise Symphony')



(b) An interval event (Haydn, 'The Creation')

Choir

Allegro *a tempo*

ev - er, ev - er, ev - er, ev - er un - der - stood

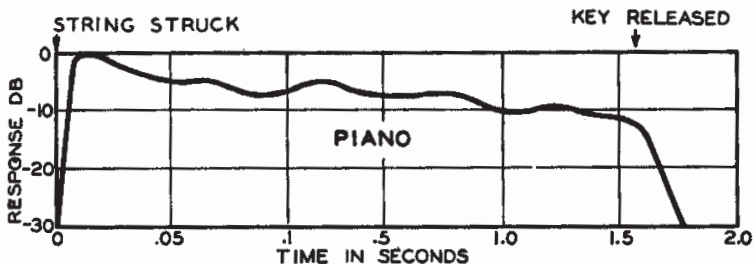
Orchestra

Allegro *a tempo*

The image displays a musical score for the interval event 'ev - er, ev - er, ev - er, ev - er un - der - stood' from Haydn's 'The Creation'. The score is written for a Choir and an Orchestra. The Choir part is in treble clef, and the Orchestra part is in bass clef. The tempo is marked 'Allegro' and 'a tempo'. The lyrics are 'ev - er, ev - er, ev - er, ev - er un - der - stood'. The score shows the interval event being analyzed, with the lyrics 'ev - er, ev - er, ev - er, ev - er un - der - stood' written below the notes. The tempo markings 'Allegro' and 'a tempo' are placed above and below the staffs respectively.

(c) An event with clear start but no clear end

A piano note



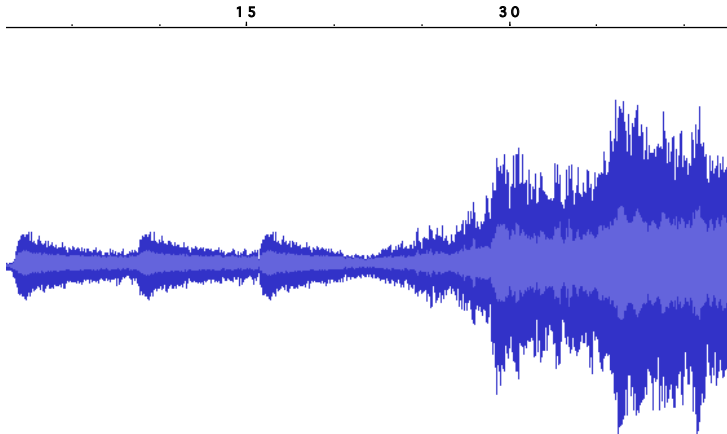
Haydn, 'Minuet al Rovescio'

MENUET AL ROVESCIO



2. Rhythms and repeated events

Pärt, 'Cantus in Memoriam Benjamin Britten'



Dot-dot-dot in Britten 'Peter Grimes'

A musical score for three staves, likely representing a string trio. The notation features a 'Dot-dot-dot' pattern, which is a series of three dotted notes. The first staff has a 'pizz' (pizzicato) marking above the first note. The second staff has a 'pp pizz' (pianissimo pizzicato) marking above the first note. The third staff has a 'pp' (pianissimo) marking below the first note. The score is divided into three measures by vertical bar lines. The first measure shows the initial notes, the second measure shows the continuation of the pattern, and the third measure shows the final notes. The text 'End of Opera' is written at the bottom right of the score.

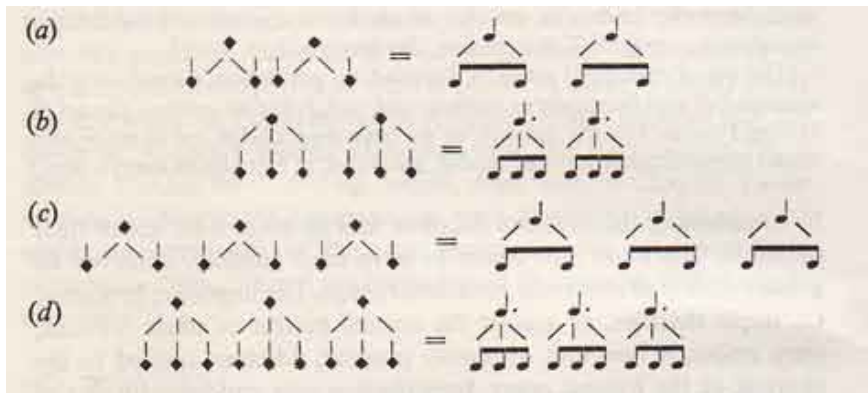
pp

End of Opera

Glinka, Finn's song in 'Ruslan and Lyudmila'



3. Hierarchies of rhythms



“Whichever art makes the greater use of perfection [i.e. dividing time into 3s] appears to be the more perfect.

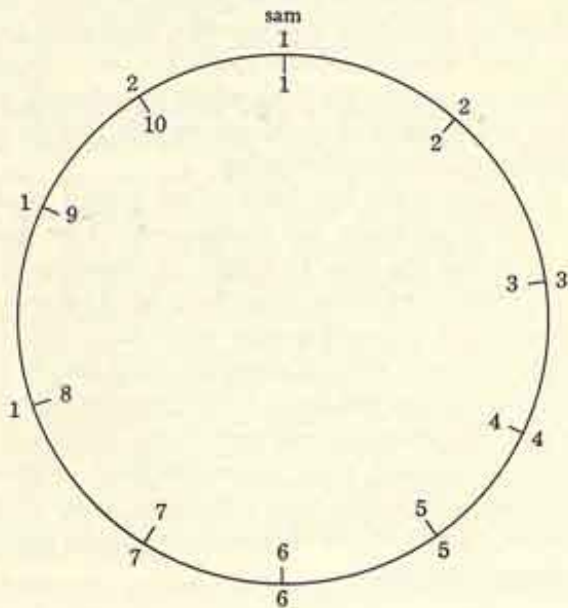
But this is true of the ancient art. . . .

The new art has what it calls imperfect time [which divides time into 2s or 4s].”

Jacob of Liège, c. 1330.

Ravel, ‘String quartet’

(Cf. Genesis, ‘Apocalypse in 9/8’.)



b. The Karnatak *jhampa tala*.

4. Clash of rhythms

Time ratio 1:2 (Brahms, 'Ein Deutsches Requiem')

Soprano solo

Tenors

Strings

A - ber ich will euch wie - der se - hen und eu - er Herz soll sich freu - en, und

Ich will — euch — trô - sten, ich

The image displays a musical score for a section of Brahms' 'Ein Deutsches Requiem'. It features three staves: Soprano solo, Tenors, and Strings. The Soprano and Tenor parts are in treble clef with a common time signature (C). The String part is in grand staff (treble and bass clefs) with a common time signature (C). The lyrics are written below the vocal staves. The Soprano part has a melodic line with eighth and sixteenth notes. The Tenor part has a more rhythmic line with quarter and eighth notes. The String part features a complex rhythmic pattern with sixteenth and thirty-second notes, creating a 'clash of rhythms' with the vocal parts. The lyrics are: 'A - ber ich will euch wie - der se - hen und eu - er Herz soll sich freu - en, und' for the vocalists, and 'Ich will — euch — trô - sten, ich' for the strings.

Time ratios 20:19:18:17:

Nancarrow, 'Study 36 for player piano'



5. Mixing time and space (pitch)

Josquin Desprez (c. 1500), 'Huc me sydereo',
represents a meteor shower



To read

J. Fauvel, R. Flood and R. Wilson (eds.),
*Music and Mathematics: From Pythagoras to
Fractals*, Oxford University Press 2003.

L. Harkleroad, *The Math behind the Music*,
Cambridge University Press 2006.

Diagrams from G. Reaney in *The New Oxford History of Music*
vol. III 1960;

W. Malm, *Music Cultures of the Pacific, The Near East, and Asia*,
Prentice-Hall 1977;

and H. Olson, *Music, Physics and Engineering*, Dover 1977.

Music cited

- ▶ Johannes Brahms, Ein Deutsches Requiem, EMI Classics 1993.
- ▶ Josquin Desprez, Huc me sydereo, Archiv 2000.
- ▶ Mikhail Glinka, Ruslan and Lyudmila, Bolshoi 1978-9.
- ▶ Joseph Haydn, The Creation, Oiseau-Lyre 1990.
- ▶ Joseph Haydn, Piano sonata Hob.xvi.26, Auvidis Valois 1993.
- ▶ Joseph Haydn, Surprise Symphony, Brilliant Classics 2001.
- ▶ Inde du Nord, Girija Devi en concert, Harmonia Mundi 1995.
- ▶ Conlon Nancarrow, Studies for Player Piano 36, Wergo 1990.
- ▶ Arvo Pärt, Cantus in Memoriam Benjamin Britten, EMI Classics for Pleasure 2002.
- ▶ Maurice Ravel, String Quartet, Lindsay String Quartet, ASV 1995.