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Microtone. Any musical interval or difference of pitch distinctly smaller than a semitone. Some writers restrict the term to quantities of less than half a semitone; others extend it to refer to all music with intervals markedly different from the (logarithmic) 12th part of the octave and its multiples, including such scales with fewer than 12 pitches as are used, for example, in south-east Asia.

Microtones encountered in music theory include the tiny enharmonic melodic intervals of ancient Greece, the several divisions of the octave into more than 12 parts, and various discrepancies among the intervals of just intonation or between a sharp and its enharmonically paired flat in various forms of mean-tone temperament. The Indian concept of a *śruti* might also belong in this list (*see* INDIA, SUBCONTINENT OF, §III, 1(ii)(a)). Intervals incompatible both to the just and to the Pythagorean diatonic scale appear in Arab music theory in the 10th century, in al-Fārābī's definition of the *ṭunbūr chorasanī* tuning, and proliferate subsequently (*see* ARAB MUSIC, §I, 3(ii)). The theory of Byzantine chant also mentions microtonal intervals, although indirectly at first, associating them with the *phthora*, which may denote alteration, modulation or microtonal inflection depending on the context. Manuscripts of the 15th and 16th centuries explicitly describe microtonal intervals as 'minute parts of the tone' or 'thirds or quarters of the tone'. Near Eastern musical traditions of the present (Turkish, Greek, Arab, Persian) show great abundance in microtonal inflections and scale intervals. Theoretical systems such as those by Kyrillos Marmarinos (1749), Chrysanthos of Madytos (1832), Suphi Ezgi (1933), Ekrem Karadeniz (1981) and Simon Karas (1989) specify 17, 24 or 41 individually named degrees within the octave and employ divisions of the octave into 36, 53, 68 or 72 equal intervals. The potential of these traditions as living repositories of microtonal music has not yet been sufficiently explored.

Theoretical divisions of the octave into equal microtones have included the 19 division employed by late Renaissance and early Baroque musicians including Costeley and Titelouze; the 31 division calculated by Christiaan Huygens in the 1660s (often dubiously attributed to Nicola Vicentino); the 55 division discussed by Joseph Sauveur in 1701 and attributed by G.A. Sorge in 1748 to Telemann; and the 53 division implicit in the Renaissance concept that the Pythagorean whole tone

(Microtone cont.)

(monochord ratio 9:8) could be divided into nine equal parts, four of which would comprise a Pythagorean diatonic semitone (ratio 256:243): thus the octave, consisting of five whole tones and two semitones, would implicitly contain 5 x 9 + 2 x 4 equal microtones. Theorists of the 17th century showed that the 53 division contains virtually pure 3rds as well as 5ths (*see* INTERVAL, Table 1), and later R.H.M. Bosanquet (1875) built a harmonium tuned to this scale.

The use of microtones in Western art music is essentially a 20th-century phenomenon, though Julián Carrillo had experimented with his 'sonido 13' system of equal-tempered quarter-tones in the 1890s. Two basic approaches may be distinguished. Either microtonal intervals are introduced as finer divisions within regular 12-note equal temperament, or they arise as a necessary condition of different tunings. The former sort of microtonal composition was practised by Carrillo, by Charles Ives early in the 20th century and by Alois Hába and Ivan Vishnegradsky from the 1920s onwards. Hába also used smaller intervals, particularly the sixth-tone, and wrote a great many microtonal works, from piano pieces and string quartets to a full-scale opera. The capacity of string instruments to play microtones is limited only by the player's ear, but Hába's music required the construction of special instruments, including quarter-tone pianos, harmonium, clarinet and trumpet, all made in the 1920s and 30s. In the 1950s Carrillo had pianos built to play in every integral division of the whole tone down to the sixteenth-tone. Ives and Vishnegradsky wrote instead for multiple pianos differently tuned.

The foremost problem in microtonal music – beyond the making and tuning of instruments – is perhaps that of harmony; this may have encouraged composers to look in other directions from the 1970s onwards. Another prompt would have come from the new availability of quarter-tones on woodwind instruments, facilitated by unusual fingerings. On the one hand, quarter-tones became normal in music where high virtuosity and speed are in the foreground and natural consonance is not an issue, such as that of Brian Ferneyhough and Chris Dench. On the other, they found a cogent place in the upper treble for composers who based chords on harmonic spectra, for example Tristan Murail, Gérard Grisey and Claude Vivier.

The harmonic question is differently settled, of course, when microtones are conceived not as additions to the equal-tempered chromatic system but as basic intervals in other tunings – tunings which have customarily been developed not in order to make available intervals smaller than a semitone but to find better approximations to just intonation than 12-note equal temperament can deliver. Harry Partch pioneered this approach, employing a 43-interval octave which made available frequency ratios involving the primes up to 11 and their multiples (his ascending scale begins 1:1, 81:80, 33:32, 21:20, 16:15, 12:11), and building his own instruments. Just intervals have also been achieved with a range of instrumental and vocal resources, notably by Eivind Groven, Lou Harrison, Ben Johnston, La Monte Young and James Wood.

Other composers have developed alternative equal temperaments, especially those which offer good simulacra of just intervals, as do the temperaments with 19, 31, 41, 53 and 72 intervals to the octave. Joseph Yasser argued for a 19-interval octave as a logical evolution from the 12-interval one of convention, just as the latter evolved from the 7-interval diatonic scale. Adriaan Fokker commissioned a pipe organ in 31-interval equal temperament, allowing accurate renderings of the just major 3rd and natural 7th. This organ has been used by other Dutch musicians such as Henk Badings and Hans Kox, and its tuning system has been applied by composers in the USA. Groven and Johnston have used 53-interval equal temperament, the 'Mercator system' favoured by earlier theorists. Easley Blackwood has composed with alternative equal temperaments on the piano, ranging from 13 to 24 intervals per octave.

Electronic music allows any kind of tuning without the need for virtuoso technique, retuning or the physical construction of new instruments, and without the complications of new notational systems, of which several kinds exist for equal-tempered quarter-tones, the most commonly used microtonal intervals. However, only in a few cases have composers set out to explore a defined microtonal system with electronic means. Examples include Stockhausen's *Studie I* (1953), in which there are 25 equal-tempered intervals within each stretch of two and a half octaves, and Krenek's *Spiritus intelligentiae, sanctus* (1955), with 13 equal-tempered intervals per octave.

See also INTERVAL; QUARTER-TONE; SEPTIMAL SYSTEM; TEMPERAMENTS; THEORY, THEORISTS; MICROTONAL INSTRUMENTS.

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