Albert Mayr

CREATIVE TIME-ORGANIZATION VERSUS SUBSONIC NOISES

> Et Deus aeternus temporum dat tempora, ut alleviet homini fastidium et alleviet labores homini, quasi quibusdam congruentissimis melodiis.
>
> Joannes Aegidius Zamorensis
> *Ars Musica*

I. Hark, the Clock!

Much has been written and said about music's time, much less—at least in recent epochs—about time's music. Today this most subtle, yet most powerful form of music finds fewer and fewer listeners. It has become, in fact, harder and harder to listen to. The "congruent melodies," i.e. "the rhythms of times which were given to us to alleviate our labors" (as the 13th-century music theorist had put it) have long since been silenced and drowned by subsonic noises.* In its organization of time, Western civilization has, to an appallingly large extent, replaced rhythmic aliveness with abstract measures, reducing it to a "functional mechanism" (Baudrillard 1974). The main tools by which these

* see section IV.

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measures are set, the clock as we know it and the modern calendar, are obviously, taken as such, remarkable achievements, but in their impact on our lives they are not so much companions enabling us to be "in harmony with things at the right moment" (see the Chinese *shih*, Larre 1976) as they are hostile guardians "watching our steps."

In common day language we speak of time as of a currency: we may have enough of it, try to save it, spend it, waste it, run out of it. This mainly quantitative vision of time, until recently, pervaded not only our practical scheduling tasks but also much of the research devoted to social temporalities (the term "time-budget studies" leaves little doubt about it).

No effort was spared in the invention of time-saving devices and techniques. The reduction of the amount of time required for the production of consumer goods, for travel, commercial transactions, etc. would, so it was thought, automatically increase the degree of temporal autonomy, afford more leisure time to more people. But the slavery to the clock did not diminish. Trapped by his narrow approach to time-allocation, Western man could conceive of only one escape from his obsession with (and in some cases addiction to) the clock: speeding things up even more. In the meantime we have become aware of the fact that mere acceleration offers no viable solution. Yet, in order to "consider the qualitative aspect of the pattern of working hours" (Marić 1977) and of other social time-patterns, new criteria, different from the previous ones, are needed; at present they do not seem to be available. A broader perspective is necessary.

II. Audible and Inaudible Music

Social cycles[1] are low frequency[2] phenomena. In this frequency region we find astronomical, geophysical, biological rhythms. It

[1] The term here is meant to denote only time-patterns of an easily identifiable cyclical nature, e.g. rhythms in work, education, transportation, election of political representatives, etc. Aspects of less verifiable cycles (cf. the culture-cycle theories proposed by Spengler, Toynbee, etc.) cannot be discussed here.

[2] The upper limit of the low frequency region is often set at different values. Here we adopt the practice which sets it at the upper limit of audible sound, i.e. ca. 15 kHz.

is also the frequency region of music with its components of audible sound and rhythmic-formal configurations (cf. Bielawski 1981). Man's brainwaves, e.g., are located in the zone which corresponds to the "crossover" between audio and subaudio signals, i.e. to the range where the perception of audible pitches changes into that of pulsations.

Our knowledge about the low frequency cycles in man and nature is increasing continuously, yet we seem unable to put this knowledge to use effectively; our time-tables are still quite old-fashioned.

Today music appears to be the only example of an organic, yet systematic, organization of low frequency cycles; in its valid manifestations, it succeeds in coordinating physical, psycho-physiological, and social time-factors.

It may seem at least unorthodox to link music—which we have come to regard as something exclusively acoustic—to obviously inaudible phenomena such as natural and social rhythms, to present an aesthetically oriented discipline as model for everyday time-organization which is mainly geared toward efficiency.

But in the theoretical writings of past epochs, the organization of sound and musical rhythm are put—with striking insistence—in relation to other, inaudible periodicities. Music is seen as the epitome of the concert of periodicities in and around us (see the Chinese *shi lü*, Larre 1976; Daniélou 1959) or even as a weak imitation of this concert. "The highest form of music has no sound," said Confucius. Boetius (ca. 520) states that there are three genera of music: *musica mundana*, which consists of the motions of the heavenly bodies, the alternation of the seasons and the other environmental cycles; *musica humana*, resulting from

It may be useful to list the parameters which will be used most frequently in this paper: *frequency* = the number of cycles per time-unit, expressed in cycles per second (cps) = Hertz (Hz); *period* = the time for one cycle; *amplitude* = the extent of an oscillation, here also applied to the size of a population-segment entrained by an oscillation; *phase* = different meanings, here used to indicate the distance in time between identical points of different cycles; *wave-form* = the shape of a cycle; *duty cycle* = in the square wave the ratio between the upper (positive) segment of the cycle and the whole cycle; *modulation* = variation in one or more parameters of an oscillation resulting from the "control" by another oscillation, e.g. frequency modulation = variation in the frequency of one oscillation according to the wave-form and amplitude of the control-oscillation.

the harmonious interaction between the physiological, intellectual and emotional forces in man; and finally, as the least noble one, *musica instrumentalis*, which corresponds to our notion of music.

Boetius' tripartition of music was carried on and elaborated by later authors for eight centuries. (It is hard to believe that this was due only to Medieval *Autoritätsgläubigkeit*). Joannes Aegidius Zamorensis, who was already quoted above, wrote: *Ligantur enim qualitates elementorum et consonant sibi ad invicem quasi per quasdam congruentes chordarum consonantias et rationabiles harmonias.* In the 16th century Kepler wrote about the *Harmonice mundi* with explicit reference to musical proportions. Reinecke (1970) comments: "The specific nature of music seems to suggest metaphors including the function of isomorphy of musical theories with general theoretical structures of cognition." And adds: "... this [metaphoric character] still feeds, with its magical undertones, some sectarian undertakings." Today, in fact, the polysensorial concept of music embedded in a panmusical vision of the world tends to conjure up, both to musicians and non-musicians, images of esoteric and intrinsically unscientific practices, comparable to those of the alchemists, without any real value as a working hypothesis. Perhaps it is not to be left at that.

III. Toward a Musical Analysis of Subsonic Oscillations

We can approach the subject from another angle, i.e. perform some simple calculations. Contrary to what is thought in elementary theory—where pitch systems and durational values are two distinct categories—audible frequencies and rhythms are just two aspects of the same physical phenomenon: periodic oscillations. The fusion threshold at ca. 15-25 Hz (above which the sensation of pulses becomes one of continuous pitch) is characteristic for the perceptual mechanism of our species. The basic unity of rhythm and pitch has been acknowledged for some time by contemporary compositional theory; thus the lower limit for musical frequencies, which acoustics textbooks still report at ca. 20 Hz, would actually have to be set at ca. 0.15 Hz, corresponding to a period of 6.6 seconds. Above and around this value—which coincides with the average capacity of our short-term memory—

we find the rhythmic-formal configurations which can be directly perceived as periodic (longer periods usually require mental reconstruction of some sort).

Below the fusion threshold sensations can be polyvalent: subsonic cycles may be heard (when the respective oscillations contain audio partials), or seen, felt or sensed; they may involve partly one and partly another sensorial channel, or remain sensorially ambiguous.

If we choose as a reference point either man's average respiratory frequency, ca. 0.2 Hz, or the average heart rate, ca. 1.3 Hz, we find, in a specular distribution, the musical frequencies around and above these values and the biological periodicities down to the circadian cycle around and below them. Both extensions, upward and downward, cover 4-5 powers of ten.

This proximity and partial overlapping of musical and biological frequencies sheds new light on the hypotheses of an inaudible music.

Other elements point in the same direction. Along the gamut of musical frequencies we perceive a strong affinity, a high degree of fusion, between oscillations with a frequency ratio of 1:2 (the octave in Western musical terms). Mosetti (1956) has shown, quoting Vercelli, Zeuner, Polli and various other authors, that this ratio, together with its geometrical mean, V2, recurs in a wide variety of other low frequency phenomena, such as barometric fluctuations, variations in rainfall, growth rate of trees, lung diseases, typhus mortality, variations in the number of railway passengers and many others. The privileged role of the octave in music—both for pitches and rhythms—thus appears to have its counterpart in inframusical periodicities.

Frequency relations, in general, play a commanding role in music; they are an essential part of its basic vocabulary. The different cultures have elaborated a variety of scales and modes according to which frequency relations (intervals, in musical terms) may be ordered. Both audio and rhythmic intervals retain their perceptual qualities almost throughout their frequential zones; their degree of fusion is—if we accept some simplification—inversely proportional to the complexity of the terms of their frequency ratio. In music, absolute frequency accounts only for rather gross categories, whereas the chromatic vocabulary of visual

arts is based mainly on absolute frequency since this parameter determines the sensation of a specific color within the spectrum of visible light. (The transposition of musical intervals into chromatic frequency relations does not yield comparable perceptual results, cf. the works of Veronesi).

Much contemporary music has abandoned exactly defined and clearly perceivable intervals in favor of more randomized or extremely complex (and, thus, also perceptually ambiguous) frequency relations; high-number rhythmic ratios have replaced the small-number ratios of traditional music. However, the hierarchy of easily identifiable intervals seems to die hard.

Time-tabling, as it is practiced today, shows little concern for cycles and their frequency relations: time-units are added, subtracted, multiplied and divided as if they were apples or liters of gasoline. Also, more generally speaking, in the explorations of the environment we are usually so busy counting (i.e. numbering items which we consider constant in time and space) that we find it difficult to focus on the ever changing but recurrent *Gestalten* which are formed by the various cycles of becoming and passing away (cf. Lorenz 1963).

This is certainly related to the subordinate role the acoustic-rhythmic sphere plays in our vision of the world. "The mathematization of our image of the world is based on a one-sided preference for the optic-haptic sphere of our sensory experience. It is in that sphere that we measure, determine direction and form number" (Schaltenbrand 1975). The hour has come to give the other sensorial channels a larger share in the formation of cognitive processes and in the priorities for the shaping of the environment. (For a pioneering investigation of man's relation to his acoustic environment see Schafer 1973, 1975, 1976).

IV. Consonance, Dissonance and Noise in the Organization of Time

The enlarged concept of music applied to the explorations of low frequency oscillations offers a new angle[3] from which time-units and synchronizers (*Zeitgebers*) may be discussed.

[3] This implies that interdisciplinary research dealing with music—which so

Time-units

In order to find practical applications, any time-tabling policy must make reference to a framework of periodic time-units. If we examine our most widely used units (year, month, week, day, hour, minute and second) we find that only two of them, the year and the day, correspond fairly accurately to natural cycles. The average month (ca. 30.4 days) is one day longer than the lunar cycle (29,53 days). The confusing variety of month lengths resulted partly from stretching, i.e. augmenting the number of their days to make their total match the number of days in the solar year, and partly to arbitrary variations, e.g. to comply with the vanity of an illustrious personage after whom a certain month had been named.

The problem of the discrepancy between the lunar and the solar year (10.87 days) has been dealt with differently in various cultures: either by letting the (lunar) calendar year and the solar year drift more and more out of phase and, perhaps, taking drastic measures to re-synchronize them once in a while or by some form of intercalation (some extra days every year, an extra month every three years, or other intercalations). Now one does not readily see why any of these intercalations should be a greater evil than the confusion of our present system. For my part I consider it much more musical to rely, e.g., on the periodic appearance of the palolo worm for the re-adjustment of lunar and solar year—as the Trobrianders do (see Leach 1950)—than to still pay tribute to the glory of some Roman emperor by leaving the length of "his" month untouched. In spite of the overwhelming evidence for the chronobiological importance of the lunar cycle, we are stuck with a hybrid calendar which neither fits in with the natural cycles nor is easy to handle in calculations. This desynchronization between a natural and a man-made cycle is an example of what I call subsonic dissonance.[4] The other units, the

far has been mainly uni-directional—has become more bidirectional; we have the physics of music, the psychology, the sociology of music, etc. What about the music of physics, psychology, sociology? *...sine Musica nulla disciplina potest esse perfecta; nihil enim est sine illa* (Isidorus Hispalensis 7th cent.). See Mayr 1981a.

[4] It should be remembered that in contemporary musical thought consonance and dissonance are not opposites (nor do the terms imply any value judgment

week and the subdivisions of the day, did not originate from natural cycles but reflect the number systems of certain cultures (e.g. the Babylonian system with base 69) or their numerological preferences (e.g. 7 or 12 in the Judaic tradition). The same is true for the multiples of the year in modern civilization. We have established arbitrary cycles by simply bundling the years by the round numbers of our decimal system. Why not use the 11-year cycle in solar activity, the *saros* (18 years and 11 days), the 45-year cycle in the variation of the magnetic field of the earth, etc., for this purpose?

To return to the week, what was it but cultural imperialism that made the peoples of the world adopt the 7-day week based on the biblical account of the Creation rather than the 6-day week of the Abouré based on the legend of the six interviews the Spider—acting as an intermediary between Heaven and Earth—had with God (see Niangoran-Bouah 1964)?

Since we have months of different lengths we may as well have variable weeks. This would allow us to form, in alternation, months of 29 and 30 days (cf. the Hebrew and the Moslem calendar) with a close approximation to the synodic lunar month, and to keep the week cycles in phase with the month. The 29-day month could consist, e.g., of three 7-day weeks plus one 8-day week; the 30-day month of two 7-day and two 8-day weeks. (See also the reforms proposed by the World Calendar Association, e.g. Joyce 1954). The division of the day into 24 hours of equal length resulted from the standardization of the previously variable hours grouped in two sets: 12 for the day from sunrise to sunset, 12 for the night. The re-adoption of a clock with variable hours would automatically bring back activity-rest patterns more in tune with the seasonal characteristics. We might try using such a clock at least during our vacations.

Minutes and seconds do not appear to be in consonance with man's cycles in this frequency region (see, e.g. Fraisse 1956,

as in traditional music theory) but merely different regions on the same quality-scale. The boundary between these regions varies depending on the context and other factors. Leaving these aside for the moment, one can say that pairs or groups of frequencies for which the lowest common multiple is low are more consonant than others for which the l.c.m. is high (as for our month and the actual lunar cycle).

Iacono, n.d. Pöppel 1972). Although we are forced to use these measurement units continuously we cannot help feeling that they are basically exterior, alien to ourselves.

Zeitgebers

The predominance of abstract time-units has its counterpart in (and forms a feedback loop with) today's multitude of *Zeitgebers* which also have become increasingly abstract, i.e. removed from the individual's direct sphere of experience (see Jeannière 1977). Formerly the number of *Zeitgebers* was limited, particularly in rural areas: nature, the Church (which often acted in concordance with or as an extension of the political rulers) and—as a result of the strategies developed in adapting to the aforementioned synchronizers—the various traditional time-marks, the customs regarding the rhythms of communication, social interaction, etc. They were easily recognizable, the legitimacy of their role was never questioned, the amplitude of their control affected almost the total population (i.e. it coincided with their areas of diffusion), it extended into all moments of a person's life and it remained fairly constant over long periods of time.

The modulation patterns resulting from the action of these synchronizers and their interaction in different environments were an essential part of cultural identity. They deserve the same attention as the other factors by which cultural heritage is usually defined: language, spatial arrangment of settlements, folklore, etc. (Cf. also Lynch 1972).

With the division of labor, the interlinkage of economies, the overall diversification of human activities and the stratification of political decision-making, we have come to be controlled by a great number of synchronizers. It would be a burdensome task for anybody living in an industrialized country to single out all the *Zeitgebers* and *Zeitgebers* of *Zeitgebers* which, in one way or another, determine the shape of his or her day. Many of us act as synchronizers to persons with whom we have no personal relation whatsoever. The sheer number of the *Zeitgebers* makes them necessarily antagonistic, the patterns of their amplitudes and diffusions have become increasingly intricate and undergo frequent, and sometimes sudden, changes. "In contemplating

how people live their lives in time and space and how large numbers of people synchronize their activities in space in the pursuit of a satisfying life, one cannot but marvel that there is not more chaos in human affairs than is actually experienced from day to day" (Chapin 1978).

Areas which until some decades ago had relatively closed geographic, economic and cultural systems, e.g. mountain valleys, and had developed a rhythmic identity based on the local *Zeitgebers*, may now have a high percentage of inhabitants whose life-rhythms are controlled by external, sometimes quite distant synchronizers: the commuters who go to work in the next town, the persons employed in the tourist industry, etc.

One particular rhythm may become the apple of discord for quite dissimilar synchronizers (e.g. the school year in Italy, which the owners of summer resorts would like to see more and more compressed while didactic priorities would call for a more stretched-out year, not to mention the all too frequent elections which cut it short by one month).

This, by now inextricable, maze of synchronizing agents cannot but generate subsonic noises, i.e. a random assortment of consonance and dissonance between the cycles of the *Zeitgebers* and the natural cycles as well as between the cycles of the *Zeitgebers* themselves. Like audio noise, also subsonic noise remains such after amplitude—or frequency—modulation; but unlike audio noise, from which escape is still possible, subsonic noise has now invaded Walden Pond.*

The non-conformity of the waveforms of natural and man-made cycles adds to the noise. Time-tabling is still conceived mostly in terms of square waves (of the on-off type) while this waveform is rarely to be found in natural oscillations. The average distribution of work during a life-time could be described as being controlled by several square-wave-gatings in series:

1. Period: 24 hours; duty cycle: 1/3 (gating the distribution of work during the day). Gated by
2. Period: 7 days; duty cycle: 5/7 (work distribution in the week). Gated by

* The sanctuary where Henry David Thoreau sought refuge (Editor's Note).

3. Period: 12 months; duty cycle: 11/12 (work distribution in the year). Gated by
4. Average period: 75 years; average duty cycle: 3/5 (work distribution in a life-span).

Individual and group behaviour and performance exhibit, of course, a variety of other waveforms within these rigid gatings (see, e.g. Colquhoun 1971).

Due to the all-pervading presence of subsonic noise, isolated measures aiming at the improvement of the rhythms in circumscribed activities of minorities are of little use. As much as the innovations, e.g. in working rhythms, are to be welcomed (compressed work week, staggered and flexible working hours, part-time work, flexible retirement age) they risk merely to replace one form of noise by another as long as the framework of time-units and the interaction with other *Zeitgebers* is not thoroughly re-examined. (The shuffling of dissonant intervals in a noisy cluster may produce the odd consonant interval but does not remove the overall noisiness of the cluster).

It would not only be impossible but also undesirable to strive exclusively for a high degree of consonance in the organization of time. (Also the attempts to compose music only by highly consonant intervals, e.g. La Monte Young's *Dreamhouse*, are, though sometimes fascinating, rather limited. The intervals between the natural rhythms themselves occupy various positions on the consonance-dissonance scale.

What is called for is a compositional approach toward the organization of time. This implies that long-term interdisciplinary projects be carried out to investigate the different consonance-dissonance distributions between natural oscillations on one side and artificial time-units and *Zeitgeber*-entrained cycles on the other (see also Carlstein & Thrift 1978).

V. Time-Tabling as a Creative Discipline

The compositional approach implies also that we (re)-develop—apart from specific research—a greater awareness of the manifold cycles around us in everyday life; that we emphasize more the

(polysensorial) perceptual ability to seize situations, places, persons or groups by their particular interplay of rhythms and by the consonance-dissonance relation of their rhythms to our own rhythms. (Cf. Mayr 1979). This ability is not highly valued today.

For transmitting information, for conveying what we consider to be the main features of situations, places... we have come to rely more and more on media and techniques in which the temporal components are either absent (photography) or, more or less willfully, distorted (the other visual media).[5]

In past epochs, when access to low-cost yet accurate image-producing equipment was not so readily available and radio still unheard-of, information was passed on verbally, either through the direct, unamplified spoken word or through the written page. In the symbolic system of verbal language the real-time rendering of temporal magnitudes and relations is, but for exceptional cases, out of the question; however this apparent lack (if compared with the visual media which offer unreal-time montages of real-time chunks) makes language, ultimately, a more diversified and subtle carrier for temporal structures (except, of course, in detailed investigations into the time-structure of very circumscribed events).

A consequence of the onslaught of visual information is that we have come to perceive our environment much more in photographic, or filmic, terms than in musical ones. While the disciplines concerned with the attractiveness of our visual-spatial environment (architecture, interior and industrial design) are booming, we show little curiosity for its temporal aspects. We tend to be interested only in one short time-span in the life-cycles of other organisms, to wit, the one during which they are of some immediate practical use to us or fulfill some rather narrow concept of beauty. In cities particularly we find (and thus get to see,

[5] Except for real-time, live broadcasting, temporal distortion of some sort is unavoidable. (Though also live broadcasting presents some theoretical problems regarding its "real-timeness" when it covers more than one time-zone). Sequences, layerings and durations of events in time and, thus, their analog representation through images cannot be condensed without distortion, since time—which for all practical purposes, has only one dimension—does not allow for scaling as is possible for spatial configurations where two or three dimensions are available.

Non-commercial filmmakers have been concerned with the problem of real-time in their medium (see, e.g., Warhol's *Sleep*).

For real-time in radio see Schafer 1982.

touch, smell and taste) only ripe fruits (naturally or artificially ripened as it may be); we buy flowers in their bloom and dispose of them as soon as they don't appeal to us any longer. We seem horrified at the prospect of having to witness a full cycle of becoming and passing away.

This attitude extends to our fellow men. Schaeffer & Sclar (1980) report extreme cases of age segregation in U.S. cities: "According to the 1970 U.S. census, the median age in the Los Angeles area was 28 years, but within the area wide variations existed. There were youthful towns, towns for the more mature, and towns devoted to the aged. There were the towns... where half the population was below 21... There were also mature towns as... where the median age ranged between 35 and 40... In... one belonged still to the younger half at 68."

The authors also pinpoint the negative consequences of similar population patterns: "The age-segregated neighbourhood—which became a feasible urban form only when the automobile became commonplace—is a natural breeding ground for insecurity and alienation."

Now it won't do simply to say that we don't like to be reminded of the passing of time, that we are afraid of death and thus keep everything out of sight that might trigger associations in these directions. I hold that we are all too (falsely) comfortable with our deafness to the subsonic noises to be willing to "listen" for some time. (There is a certain irony in the fact that very often we use—or rather misuse—canned conventional music to prevent us from paying attention to the subsonic noise. As we know this applies to audio noises as well).

To date any reference to this set of problems is absent from the curricula of our schools. On the primary level pedagogical concern with time is, more often than not, limited to inculcating an abstract concept of punctuality. On the higher levels we have worshiped ever greater precision in the measurement of time at the expense of the ability to discover the richness and variety of clocks in and around us. "We should examine, I believe, increasingly more complex clocks instead of increasingly more ideal ones. Instead of oscillating atoms we should consider evolving genes, feeding fruit flies and migrating elephants." (Fraser 1978). Children may show a surprising awareness of periodic phenomena.

They need little encouragement to heed their own body rhythms and to compare them with the rhythms of others, to observe or intuit rhythmic features in the speech, movements, activities of relatives and friends, to follow the cycles in animal and plant life. Their vocabulary and their standards of measurement may be quite different from ours, but since they are less conditioned by the spatialization of time prevailing in our civilization,[6] they can provide us with interesting insights in the ways temporal relations are experienced.

Music education on all levels—specially when it includes notions and practices derived from experimental music and from electroacoustics—can offer many valuable opportunities in this field: individual rhythmic personalities may be discovered and asserted; preferences for certain rhythmic configurations may be explored and discussed (including inframusical periodicities, cf. Mayr 1981b); problems of synchronization, rhythmic hierarchies, matching of subsonic waveforms, etc., may be dealt with not only in view of the successful performance of musical scores but from a broader perspective which takes into account the form of these problems in everyday life. Contemporary music has developed a wealth of notational systems from which one may derive suggestions for the complex problem of representing events in time graphically. The awareness of one's time-horizon (cf., Le Shan 1952, Nowotny 1975) may be sharpened even through a minimal involvement in composition. (Perhaps some training in composition should be made mandatory for all persons whose positions imply time-tabling for others).

Once we have laid sufficient foundation we will have created a discipline in which "phantasy may contribute to the shaping of group-relations" (Mitscherlich 1965).

Albert Mayr
(*Academy of Music, Florence*)

[6] Also Piaget's work (1927) appears to be heavily influenced by it.

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* *S.T.* = J.T. Fraser *et al.* eds. *The Study of Time I-IV*, Berlin-Heidelberg-New York, Springer.

APPENDIX

The following examples may illustrate how some of the preceding considerations are reflected in my activity as a composer. *Namplay* (1971) was still conceived for a concert situation; *Rhythms* (1977) is an open-air sound-installation; *Calendario armonico* (1981), a graphic work, is an example of speculative time-table design.

NAMPLAY

1. Instructions

Each group of players writes its own score, using the elements given, i.e. the bitstrings resulting from the conversion of letters to binary numbers.

The bitstrings are arranged in an array (see example: there the bitstrings corresponding to the first 3 letters of each name were used). The resulting score is read as follows: each performer plays the bitstring corresponding to his name, one bit at a time; a 1 indicates an event (acoustical, visual or other) to be performed or triggered by the player, a 0 indicates "tacet."

Each (vertical) column of bits represents a group-situation within a time-unit the length of which is not specified. The time-unit begins when one or more active players in a situation start(s) his (their) event(s). The other active players must begin their events before the end of the first event in the time-unit, but the events need not be simultaneous or have the same length. Once all active players in a situation have brought their events to an end the respective time-unit is considered finished.

Rests between time-units are *ad libitum*.

During performance the score should be projected on a screen.

2. A possible score of the piece

Pietro	0	1	0	1	1	1	0	0	1	0	0	1	0	0	0	1	0	1
Giancarlo	0	0	0	1	1	1	0	0	1	0	0	1	0	0	0	0	0	1
Frederic	0	0	0	1	1	0	0	1	1	0	0	1	0	0	0	1	0	1
Christian	0	0	0	0	1	1	0	0	1	0	0	0	0	1	1	0	0	1
Paul	0	1	0	1	1	1	0	0	0	0	0	1	1	0	0	1	0	0
Don	0	0	0	1	0	0	0	1	0	1	1	0	0	1	0	1	0	1
Birgid	0	0	0	0	1	0	0	0	1	0	0	1	0	1	1	0	0	1
Yves	1	0	1	0	0	0	1	0	0	1	0	1	0	0	0	1	0	1

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RHYTHMS

Sea ——→ Harbour
Projectversion for Splitsko Ljeto 1980 / Sound installation

A rhythm of the sea, that of the tides, is emphasized acoustically in the harbour: a chord of three notes makes an extremely slow glissando, starting in Synchronism with the beginning of the rising tide and covers—during the approximately six hours—the range of audible frequencies from the lower limit to the upper limit.

Then, during the next six hours, the chord returns to the lower limit, and so forth.

This chord, produced with voltage-controlled oscillators, is broadcast via loudspeakers in a possibly large area of the harbour, intertwining itself with the daily rhythms of the site.

CALENDARIO ARMONICO
(Edizioni Supergruppo / Multipli, Ravenna)

For some years now my work has centered around the question to what extent aesthetic criteria may be applied to the organization of time.

Calendario Armonico is an example of one possible approach: the extension of the model "sound" to sub-audio periodicities.

Two samples are reproduced below.

This calendar, in fact, is shaped according to a harmonic audio spectrum (where the most relevant partials usually are to be found between the fundamental and the ± 12th overtone) and visualizes the subdivision of the 365 days period up to the 12th partial, with the positive semi-cycles in colour and the negative semi-cycles left white.

For the phase 0 point I chose, for a variety of reasons, the 21st of March.