

Genealogical Reflections

The expression "Computer Music" comprises a dense complex of different processes the unique functions of which, brought into synthesizing interplay, furnish the acoustic raw material for the composer's work.

"Computer Music" is a compound term, a typical heirloom of the ideology of the 19th century, inasmuch as it implies an antithetical division: Science - Art, as is to this day common practice in certain academic circles. Accordingly, the computer is seen to represent Objective Technology, music the Subjective, Emotive Composite of Body and Soul. The external differences are obvious and were deemed sufficient to postulate a strict academic separation which, however, cuts the vital nerve, since it is precisely the polarity of these two domains that produces the fructifying interaction. For us, therefore, the word "Computer Music" constitutes an integral whole, within which the polar opposites keep the inner dynamics of events flowing.

The superficial approach perceives the computer merely as a tool, as a technically extraordinarily highly developed instrument, which is also implied in the modern expression "High Tech". This instrument, however, in collaboration with man, produces, apart from a quantitative enhancement, first of all novel concepts of a qualitative nature.

Every new insight proceeds in two stages. First it unfolds the contents of what has been perceived and then it effects the perception of its beauty. *feeling?*
This is precisely the point at which science and art fuse. This is the point which accorded Bach's Enigma Canon, inscribed on his portrait, the Place of Honor in the Leipziger Sozietät der Musikalischen Wissenschaften.

In his search for new fields and larger scopes, man has created the adequate computer as a new, equivalent tool. As with every tool, here, too, one observes the tendency of the tool to liberate itself from its creator. The musical instrument is a mechanistic extension of the human body and its functions. The emancipation from the vocal instrument eventually led to the polarity of vocal and instrumental music. Although in musical compositions over the centuries both are seen to interact, the mechanical instrument increasingly strives to break free of the limits of human capacity. Thus the third pedal of the Steinway Grand relieves the pianist's hands of having to sustain a bass note. Computer - controlled organ registers provide the composer with a possibility for a significantly faster change of registration. The last link of this chain is at the same time also the first link of a new chain, namely the computer as sound producer and thus the emancipation from the playing instruments in human hands. Although the associated loss of the interpreter has today still a shock effect, we shall see further below that the composer together with the audience are able to compensate for this loss.

Far more problematic is the degree of identification of the composer with the computer as tool for his composition. The computer is an extra-human instrument and, although designed and built by man, is capable of carrying out extra-human operations involving large quantities and high quality. Although lacking a soul, it is linked to man by its programmer's mind. To fully utilize its potential in the service of man, its neural plexus with man must be found. In an essay "Form und Technik" (in "Kunst und Technik", Berlin 1930) Ernst Cassirer cites the following highly relevant phrases from Friedrich Dessauer's "Philosophie der Technik": "The meeting of an inventor with the 'object' created by him and, for the first time,

having taken on shape, is an encounter of unusual intensity, a revelation of great power. The inventor looks at what was achieved by his effort, although not only by that effort, not with the feeling: I have made you, but: I have found you. You were already there, somewhere, and my search for you took me long...That it is only now that you are here is because I found out only now that you are as you are. You could not possibly appear, fulfilling your purpose, before you were in my vision as you as such were, because you could be only thus. Now, it is true, you are in the visible world. But I found you in another world and you refused to step into the visible realm until I had perceived your true shape as it really was."

The process of search is thus a *conditio sine qua non*, yet stems from a need the reasons for which must be perceived to avoid a search *in vacua*. This need, in its turn, has antecedents which we must clarify, at least for that part that led to the computer's task in music. These antecedents we find in the history of music, but by no means in the conception of a so-called "progressive" development throughout the centuries. New cross-roads are found only through the search of an eminent individual, and the decision as to which one of the different paths to follow was and will always be an individual one, uniquely determining the consequent effects. For the antecedents and the need for searching in the field of computer music I am going to select three individuals whose decisions have altogether set the milestones along the road into the 21st century: Guido d'Arezzo, Jean Philippe Rameau, Ludwig van Beethoven. There are here several factors, based on experience, that, like broad rivers coming from different directions, fall into a great, common sea.

The relationship between spoken language and music comprises elementary conceptions, perceivable already in the Greek tragedy, which later on led

to the emancipation of music from the spoken word. At first, the spoken sentence, too, is an integral part of a musical expression, dramatized by three accentuation possibilities: the acute, pointed accent (which could raise the pitch by up to a fifth), the Gravis, which marks a drop in pitch, and the Circumflex, a combination of both. The poetry, thus recited as mixed with pure speech, was inseparable from the body language of the soloist and the rhythm of the dancer. All together created the Muse. A precondition for the later and specific concept "Music" was the theoretical perception of the tone as sound experience, the realization of the vibration and thus the concretization of the invisible sound wave. This turned the single tone into a raw material, with the world of sound being organized with the aid of systems. Greek antiquity had a carefully worked-out system of scales, constituting as it does the basis of the music of Western civilization. In this context, Curt Sachs (in "The Rise of Music in the Ancient World", Dent & Sons, 1943) says the following: "Modern musicians take the scale for granted. They have gone through the analytical process of mincing live melodies into dead notes, out of which any desired number of new melodies can be put together. And they accept as self-evident that these notes are held ready to be seen and used in a graduated arrangement from low to high. They do not realize how abstract and sophisticated such arrangement is unless, doing research work in exotic or folk music, they try to make the person they are testing sing or play the scale on which, according to Occidental inference, his melodies are based. A man ^uuntouched by Western civilization will take a good time to understand what he is asked for, and even so he will be at a loss to construct a scale....To the ^{naïve}~~native~~ player, a note cut from its melodic context has no more reality than a hair pulled out of an animal's pelt."

And yet, even the single tone conveys, apart from its exactly definable

pitch, a sound experience, evoked in a thousand ways by every human voice and every type of extra-human tone generator. The relation of such a sound to man is anything but a pragmatic function. Taking, for instance, from colloquial language the expression "Ring of Bells", I have in my mind the general conception of a bell in shape and material, as well as its architecturally determined position high up in the church steeple for physical-acoustical reasons. All this relates more or less clearly to the "bell" part of the expression. The "ring" (as associated with "bell") evokes in the reader or listener an abundance of emotive associations: mourning bells, wedding bells, fire alarms, war alarms, peace bells – all this proclaimed by the selfsame bells, without additional words. And if Mephisto says in Goethe's *Faust*, Part 1: "Man usually believes, if only words he hears, that also with them goes material for thinking", one may also assume, upon hearing a sound, that something also must be there to think about. This is indeed the case, only the musical reasoning process fundamentally differs from the linguistical one. The spoken word is the carrier of a defined conceptual content. Sound as a raw material as against this defies any contents of general validity. The meaning of a single sound can be explained only descriptively, using words, and even so, comprehension is dependent on the individual receptivity of the listener.

When now sounds are organized into a system, certain relationships are created between them which, in the course of the development of the system may, by dint of grammatical and syntactical arrangements, attain a pragmatic meaning also in music. At that point there emerges a musical culture, common to all those that grew up using such a system.

The abstraction of a tone scale from a raw material of an infinite number of frequency nuances, translated into a set of predetermined intervals,

opened up a new world of constructive possibilities which gradually led to the emancipation of music from the text and its literal or literary meaning. Even at the stage when music was most strictly tied to the text, the absolute pitch of tones played an independent role in the service of Melos. Measurability of the single tone and the knowledge of the proportional relationships within the system of intervals combined with the psychological effects of a scale made up of intervals charged with, or relieved of, tension, created the precondition for the later aesthetics of dissonance - consonance. Precise intonation became of equal importance in singing and in instrumental playing.

At this point, already in classical antiquity, a new need was felt, a need recognized long ago in language and met by fixation of the spoken word with the aid of graphic symbols, that is, by writing. The common engagement of reading and hearing (since the inner ear "hears" also the symbol read as letter, or word or sentence) brings about an extraordinary heightening of the sensory perception. As the written word is now recorded on material, it becomes independent of time, can always be re-called, and is thus a reliable extension of human memory. The word as written down also enhances the persuasive power of its contents which in any case is interpreted by the reader. The graphical code for the thought as written down and formulated as a chain of words, trains the memory and enhances not only thinking, but also reflection. Doblhofer, the historian of Writing, has said: "Writing allows thinking man to contemplate his self". (Ernst Doblhofer, *Zeichen und Wunder*, DTV 1964). Over millenia, writing and printing have become a means for heightening the perception of individual thought.

To record, likewise, fleeting sound, using graphic symbols, was a need of

both East and West. A growing understanding of the physiology and psychology of Sound increasingly demanded its application to higher forms of communication. For the Ancient Greeks, sound notation consisted of modified letter shapes of the alphabet (see New Oxford History of Music I, p.358). It was an adequate prodder of memory for the tones attached to the word-syllables and as such fulfilled its function. With increasing mastery of the sound material also grew the independence of the latter from the sound and rhythm of language, and developed its own type of communication, differing from the conceptual contents of the word. Since then, we unfortunately use the same term "language" for both the language of daily intercourse and the language of music, although the latter is of an entirely different nature. In order to make practical use of the language of music, a special theory of language had to be developed for it, already the earliest formulations of which reflected an inherent dichotomy: On the one hand, the digital measurability of the physical properties of sound, on the other, the sum total of all properties as musical acoustics, which appeals X to the sensory reflexes of the listener. This dichotomy is, however, applicable only for analytical purposes. In musical reality, physis and psyche of sound are interwoven so intimately, that one quality evokes the other.

X So far, we have in fact discussed only the events related to the individual tone, which were sufficient to necessitate a systematic order already in classical antiquity. ^There was created the elaborate Greek system of scales, which not only assigns to the individual tone its fixed place but, beyond that, also relates it to its neighboring tone. The interval relation is contingent on a recapitulating memory which, upon registering the second tone, refers back also to the first tone. Here are the roots of polyphony and of the later harmonic systems: Due to our memory capacity we are able to follow the acoustic flow both linearly and vertically.

Slowly, there comes into being a musical syntax which, beyond the aesthetic impression, confers on the musical composition as a whole musical meaning and message. Yet meaning and message are verbal concepts the contents of which cannot be translated into the musical, even when, using descriptive elucidations, an approximation of the sound meaning is attempted. This precisely characterizes the point of contact as well as of separation between the language of intercourse and the language of music. The critical position of the point of contact and of separation is found at the spot where even the language of intercourse can no longer be explained. Referring to this, the philosopher Moritz Schlick remarks: "That the work of the philosopher does not consist in the laying down of propositions, i.e., that the imparting of meaning to these propositions cannot be effected by further propositions, is easily realized. Because if I were to try to state the meaning of my words by explanations and definitions, that is, with the aid of new words, one would have to go on asking for the meaning of these other words, and so forth. This process cannot continue ad infinitum, it always finds its end in actual presentations, in a demonstration of what was meant, i.e., in arbitrary acts. Only these are not capable of, and do not need, further explanations. The ultimate conferrence of meaning is thus always effected by acts. It is these that constitute the philosophical activity". (Quoted in W.R. Fuchs, *Knaurs Buch der Denkmaschinen*, Droemer Knaur, Zürich 1968, p. 30).

A musical composition is thus a structured act, presented by the composer with the aid of structured sounds. Whether of the smallest or of the largest extent, such a work constitutes a "philosophical activity". Philosophizing in terms of sound instead of in terms of words entails many thought processes that have their analogue in language. In the same way in

which each language has melodic turns that are characteristic only of itself, so different musical cultures have developed their typical melos. Here, the point of contact of language and music is evident. The total duration of a language phrase as well as of a musical phrase is compounded of microdurations, each with its specific statement. A well-functioning memory is therefore able to draw, from past and present, probability conclusions concerning what is to come, as soon as certain formulation habits have been acquired which facilitate superficial recognition. (A fact known to every good prima-vista player when, in spite of a belated turning of the music sheet, he has managed to continue to play more or less correctly.)

The essence of all that has been pointed out so far constitutes the precondition for the quest of Guido d'Arezzo. As part of the process of music's becoming independent, the graphic aspect of musical notation, too, had to be able to meet the higher requirements. While the Neumes were able to indicate a melodic wave motion, they could not precisely define intervals. They were no more than good mnemonic aids for an already known course of a melody. Now more demanding musical structures began to develop. I mention only the structure of the Gregorian chant: Initium - Mediante - Finalis, in the course of which some phrases were still tightly bound to the text, while some syllables of the text were already treated freely and ~~floridly~~. At that stage of the already very demanding musical intellect of music, the Schola Cantorum, too, needed pedagogical aids to make sure of the textual faithfulness of church chant in all communities. The system of notation of Guido d'Arezzo with all its graphical implications became the point of departure of a musical development within which it became possible to note down polyphony, harmony, metric groupings and, finally, pure instrumental music up to, and including, large scores such as, e.g.,

Mahler symphonies.

Committing sound to writing, creating and re-creating man trained his musical memory. Prepared by this training, he succeeded in steering his musical thoughts into the adventurous world of sound complexes which propagated linearly, vertically and in the time continuum, structured as rhythm, in spherical space. This is an immense achievement which would have been impossible without Guido d'Arezzo's notation. The fixing in writing created the preconditions for three-dimensional hearing.

Strengthening memory for carrying on linearly was the most obvious condition. This was followed by the perception of chordal constellations in the polyphonal fabric. Third to become represented in the notation was measured time. In the later aesthetics of music of the 19. century, these three emanations in the form of melody, harmony and rhythm were to become the primary elements of musical syntax. This great arc stretches from the High Renaissance to the beginning of computer music. Greek antiquity created the preconditions for the Renaissance by studying the physical nature of sound by scientific observation and measurement. In parallel, the irrational effect of sound on the emotions of man was ordered by rules and norms, producing statements that would invest the world of sound with language-like effects of communication.

All this happened in the antechamber of the Renaissance, so that, at the time of the High Renaissance, Gioseffo Zarlino in his *Institutioni Harmoniche* was able to produce a system of chordal, i.e., compound sounds. From these roots would grow the tonal thinking within which J.S. Bach developed a harmonic wealth that, up to and including Wagner, yielded the ~~the~~ entire chordal building material. In his *Traité de l'Harmonie*, Jean Philippe Rameau has formed this world of sound into a new system of musical

communication.

This work of music theory constitutes the beginning of modern musical thinking in Western civilisation, a further step in the arc leading to computer music. With the newly-posed tasks, the musical-professional intellect of the composer grew, the gifted individual advanced by leaps and bounds and the phenomenon was seen to develop of the critical gap between the discoverer and his disciples. With Beethoven, this crisis is topical even today. It is quite possible that several issues touched upon by Rameau will have their renaissance in computer music, if in a different context. Rameau has established aesthetic norms by empirically transferring the consonance-dissonance relationship from contrapuntal *cantus firmus* usage to the modern major-minor tonality and adapting it to the harmonic root principle. Basing himself on Zarlino and Sauveur, he has, using the triad and its inversion possibilities, led to a recognition of the varying bass functions in the chordal structure, thereby establishing the functional aspect in the harmonic tonality system. Each degree of the diatonic scale, seen vertically, is now given its harmonic function. The scale will now yield only such melodies as will conform to the theory of harmonic functions.

Composers and listeners thus learned to think in series of harmonically related ~~/p~~ scale degrees, common to all of which is their striving, differing in intensity, to attain the root of the scale. Thoroughly compatible with this are first attempts at serial thinking, found already with the classics, which would like to restore to the melodic series a measure of independence from harmonic functions. I quote from a lecture by Hans Keller on Wagner (from "Richard Wagner: Mittler zwischen Zeiten", Ursula Mueller-Speiser Verlag, Salzburg 1990, S.187).

"What I have discovered is this: Schönberg's kind (...) of serial thinking was not an invention of his, but a natural component of the process of composition which - as I have shown- has occasionally come to the foreground with Bach, Haydn, Mozart and Beethoven. [Keller refers to Mozart, G minor Symphony, Finale, beginning of the development:

Ex. 1

and Beethoven, Finale of the Ninth Symphony:

Ex. 2

The Beethoven example is also mentioned by Hermann Scherchen in his "Vom Wesen der Musik", Mondial Verlag, Winterthur 1950]

It is obviously true that these composers, operating as they did within tonality, did not work with tone series, but, unconsciously, with series of degrees, that is, with successions of scale degrees, independent of their rhythmic articulation. With the 15-years old Mozart I have indicated this in an early quartet and have thus shown that what one has here is a very natural component of the process of composition, which has nothing at all to do with constructivism". To this last point in Keller's statements I shall return further below, with reference to computer music.

Still missing for the establishing of musical communication with the computer was an important pre-requisite for which, too, Rameau had readied the musical world of thought. The major-minor tonality and their built-in harmonic functions demanded the "well-tempered" scale. The "well" of that term is in fact a compromise entailing the sacrifice of pure intonation. One learned to lose, in order to win something new and important. It is not a quantitative more that we gain, but a different quality of the sound experience. We had hardly managed to consolidate the root of the triad as the unshakable basis of the chordal edifice, when, in the

X inversions, we present the same root as an unstable phenomenon, ready to let itself ^{be} exchanged against other intervals of the chord. As much as Bach's sequences are the hallmark of his music (compare Bach's with Vivaldi's sequences), so is the use of the first inversion of the triad characteristic of Mozart's music. The triad thus appears in stable as well as in unstable constellations, a phenomenon which is a basic rule of dramatization and thus plays its role also in computer music.

Of far greater consequence is it then that even the tonic, the basic tone, or root, of the key - and not merely of a chord - develops an urge for change into adjacent and, later, also remote keys. This process is known as modulating. It is the "well-tempered" tuning, also known as temperament, that enables the transposing of one key into another, while, at the same time, maintaining the interval relationships constant. The theoretical manipulation of modulating can of course be learned and its techniques are described in every textbook. It goes without saying that modulating has brought an immense "more" into sound relationships. Referring to technical tools, Ernst Cassirer has formulated a proposition which is fully valid also for modulating: "The real, the deeper profit lies also here in the gain of "form"; in the fact that the extension of the action modifies at the same time its qualitative meaning and thus creates the possibility of a new world aspect." (Ernst Cassirer, Form und Technik, in "Kunst und Technik", *ibid.*).

Temperament

X Figuratively speaking, the fundamental tone, the root, does no longer stand on its basis, but floats in the center of the space of its circle of fifths. It can reach every point of this wide harmonic space either step by step or by leaps. Its view of the world has completely changed. The target of a nearby or remote key is no longer attained according to Euclid's theorem whereby

the straight line is the shortest distance between two points. Rather it is the adventurous way through space that begets the target as its fruit.

Beethoven's works are full of such transitions from one key to another which, however, are in reality but an "auskomponieren", a composer's *elaboration*, ~~finding~~, of the harmonic space. In the so far unpublished manuscripts of my teacher Heinz Tiessen (in the archive of the Akademie der Künste, Berlin) I found the following note referring to the subject of modulating:

"Modulating is also a character test. As he modulates, so is the man. He better refrain from modulating, if he does not want to be found out. The possibilities of successfully dissembling are more limited than one hopes. As one must not write poems, paint, sculpt, build, write letters in long-hand, if one does not want to be exposed, so one should certainly not compose, even if one is not the confessing type and tries to present oneself as matter-of-factly detached and aloof."

At this point of the consolidated theory of harmonic functions, the predominance of spiritual qualities becomes apparent, in spite, or because of, the recognition of the immensely expanded developments in the musical ~~space~~ ^{space}. Nothing essentially new was added to these theoretical constellations for 150 years. Their soil was rich enough to sustain a climactic flowering of musical masterpieces.

Yet a conflict-producing substance was injected into that soil at the very beginning, a substance that was bound one day to lead to changes. The conflict resided in the rift between Nature and Art. On the one hand, the nature of the overtone series yielded the limiting quality of the octave, with the added fifth and sixth complementing the fundamental harmonic structure in the vertical as triad. Everything beyond that were derivations,

facilitating a deeper aural perception of the overtone series. Against nature, however, agitated the "well-tempered" tuning which permitted the division of the octave into 12 chromatic half-tone steps, thus leading to a weakening of the root morale.

Hermann Pfrogner concluded his book "Die Zwölfordnung der Töne" (Amalthea-Verlag, Zürich 1953) with the following final cadence: "Doesn't one say that an approaching "unknown" ^{casts} ~~throws~~ its shadow ahead?" As the light source of this long shadow one could consider Rameau and much of the "unknown" was driven to the surface in the scattering zone of its intensity. At the same time, there begins the crisis of notation, although at the beginning it was able to elastically ^{accommodate} ~~satisfy~~ the raised demands. For in the large expanses of Pfrogner's shadow there were germinating, since the classical period, profound changes in the musical syntax. I shall restrict myself only to such examples as will later be seen to be of relevance to our main subject.

In his book "Vom Wesen der Musik" (Mondial Verlag, Winterthur, 1946), Hermann Scherchen mentions bars 137 and 138 from the 1st movement of Beethoven's Eroica symphony, in the texture of which are combined no less than six different meters. Thus Scherchen: "The polyrhythm of the example shown appears in the "Eroica". While no ear can aurally analyse this wealth of contrasts, everybody is able to aurally experience it! When enjoying music, we thus employ "degrees of capabilities" far in advance of the development of our organs. The musical work of art enables us (since Beethoven) to practice capabilities that anticipate later man and his realities."

Experiencing the enjoyment of art, analysis and synthesis are inseparable. The more primitive the analytical faculty, the poorer the capacity for synthesis. Here, Scherchen prophetically alludes to "later man", whom the computer will educate to higher analytical capabilities. Enhancing the capabilities of analyzing listening enhances, to an analog extent, also the spiritual quality of synthesizing listening. The most important aid in the attaining of this stage is notation. From the writing of the above Eroica quotation to, say, a Ligeti score, one can draw a line, towards the end of which the weaknesses of traditional notation become more and more obvious.

As a consequence of gaps in the notation, Beethoven increasingly resorted to verbal instructions, e.g., for not exactly measurable tempi, and although Mälzel's metronome brought some relief, its indications were mere average values, the rigidity of which lost their validity in case of non-rational deviations. No wonder that in the 'twenties of the 20th century we find examples in which the composer continuously changes metronome indications.

A qualitative approachment of secondary and primary elements begins already with Beethoven. While melody, harmony and rhythm could still be somehow measurably ~~be~~ represented by the notation, dynamics, agogics and color were left to word or graphic symbols of totally insufficient measurability. Five ppppp with Tchaikovsky or "Barely audible" with Webern, "Slowly and with much expression" or "Allegro furioso" became crutches across immeasurability.

Beethoven's questing mind, due to his higher capability, is seen to be

active also within the given possibilities of the notation. In the last bar of the slow introduction of his last piano sonata, it is precisely the notation that compels us to direct our attention to a sustained sound, from which then emerges the sharply articulated theme of the first movement. The rapid alternation between the low G and A flat in the left hand along an entire bar is usually denoted by the composer as a trill.

Ex. 4

In his commemorative edition of Beethoven's piano sonatas, Arthur Schnabel expressly warns against playing this bar as a trill. What induced Beethoven to precisely calculate movement in time and to compel the reading eye of the interpreter to accurately analyze the duration of the microparts? Beethoven expands this conclusion of the slow ^{part} ~~movement~~ over three bars and turns its sound contents from the end of the slow ^{part} ~~movement~~ into a newly beginning arsis for the tonic of the theme. The novelty in this compositional process is the ^{exhaustive} listening to a single sound and the discovering of the substantive morphosis of its functional energy, the fusing of conclusion and beginning. The interference in the rapid alternation of the half-tone step avoids a static state and inspires quest and discovery. As against this, the virtuoso trill, especially with use of the pedal, would produce an amorphous acoustic mass. Here, Beethoven was still able to use the notation to establish his will.

The beginning of the "Hammerklavier" sonata, too, demonstrates the nascence of the idea from a single deep bass tone which chordally concentrates, in space, its first overtones over four octaves - a breakthrough of music into spherical space.

Ex. 5

For Beethoven, sound per se became more and more a field of discovery. To this day, the Recitativo in the 1st movement of the D minor piano sonata

op. 31 causes pianists a great headache. Beethoven notes down the word "Pedal" for the duration of the one-part line of the right hand. This is commented upon by Francis Tovey (in the Edition of the Royal School of Music, London 1931) as follows: "On Beethoven's Pianoforte the pedal could be sustained, as he indicated it, through whole phrases of recitative with excellent effect, in Beethoven's own words, "like a voice from a "tomb-vault". The voice "from a tomb-vault" which Beethoven had had in mind, is but the reverberation effect on a bass complex through interaction with the vibrations of the strings of the piano, kept open by use of the pedal. Today such a vibrational phenomenon can be produced on every synthesizer of electronic music. The recitative must therefore be played with an imaginative use of the pedal, in order to realize Beethoven's perception of the sound mixture. Pianists only rarely find the courage required to do so and risk criticism referring to a "mushy pedal".

Ex. 6

A sound is therefore not of a predominantly ~~sensory~~ or sensual nature, but also embodies the quality of a mental process. Beethoven's orchestral language is full of such inventions which, on their part, have kept appearing in orchestral works right into the 20th century. Already Nietzsche perceived Beethoven's music in a much broader context by representing Beethoven as one of the "more profound and perspicacious" men of this century who, experimentally, have anticipated the European of the future".

Against these stirring new territories, musical notation has been increasingly lagging behind. The light source of the "shadow ^{cast} ~~thrown~~ ahead" becomes now almost painfully visible. Painfully, because in the state of decay of the system, aesthetic standards lose their normative authority. The dethroning of the tonic made possible chordal combinations for which

neither Zarlino's nomenclature nor, later, Rameau could provide the technical terms. With all our systematization and theoretical labor, we have again become illiterates, as we cannot even give names to our sounds. A term like "cluster" is a romantic illustration of quantity and is bare of any detailed obligation. As an escape hatch, not least also because of a moral predicament, we took from the environment of technological progress the absolute numerical value and idolized it for the strict serial technique. The precision of the number seduced the insecure composer, giving him a false sense of security. All parameters followed the dictate of the number. Soon enough this boiling cauldron produced an extreme reaction. The music of strict seriality collided head-on with the totally undetermined music, the aleatorical or chance music. The "12" were superseded by a nebulous, but beautifully sounding slogan: "Total Freedom".

Where does notation stand in relation to aleatorics? For whom and indeed why, note down Chance, the *raison d'être* of which is extinguished at the moment of putting it down. Now notation is turned into so-called musical graphic art. The composer draws lines, circles, dots, bold and thin figures which, when seen, may induce dramatical or lyrical emotions. It is left to the interpreter to translate the optics into acoustics. Such a musical graphic art can at the same time serve as an exhibit in a picture gallery. In addition, there creeps into musical conversations the term: "Open Form".

Without a scale or a series or a trope there is no longer a defined beginning or end. The closed circle opens and can no longer retain any contents. Form ^{is} produced in open, unlimited ^{formal} processes, ~~as Gestalt~~. Art is invaded by that military term "Avant-garde". Here as there, the danger of being cut off is the same.

In this state of unconscious creative giddiness, the computer extends to

John Cage declared: "Art, instead of being an object made by one person, is a process".

the composer a little finger. Should the composer accept it, he will soon receive the entire hand. The first lights are spreading over Pfrogner's shadow. Soon they will light it up fully and a new shadow is possibly already being created, since the computer arouses dormant "degrees of capability" in both the composer and the listener. To use Nitzsche's language, the computer brings into being the "more perspicacious man" of our day. The mind of the programmer turns the computer into a link in the chain of human cerebration. Its incorruptibility compels us to sharply distinguish between tradition and convention, to preserve the core and to control the lure of novelty by overcoming it. For the offer of as yet immeasurable possibilities is so vast that the seduction of using the computer aleatorically can be resisted only by a conscious decision. Similarly deliberate economies must be applied to the use, for musical compositions, of algorithms. *X comprehensive*

How then should we relate to composition with computer-controlled sounds? The material realities of this new world of sound again compels us to have recourse to a notation that will assist us to control this immense space and not to get lost in it. This understanding became for me as composer the point of departure for all subsequent creative action. I have attempted here to outline the development that has brought me to these crossroads.

As now composition commences with the invention of the first sound, a sound that embodies a whole world, the starting point for a notation must necessarily differ from that of Guido d'Arezzo's system. The composer now demands of the computer expert to design a notation in which all parameters of the sound are graphically and visually expressed, and at the same time to program the computer in such a way that it will be able to

read these graphics and to feed it to the synthesizer for putting together the sound. The solution of this problem resulted in an iconographic notation, a semiotic expression of a musical concept. The graphic signs are the intermediaries in the pragmatic relationship between composer and computer. In the dialogue between the two they are inspired by the different modes of behavior of man and machine.

X With this point, the composer, in noting down his work, plays the role of the interpreter. The process of composition is in any case accompanied by a continuous interpretation of the notation image as passed through the filters of his mind, or as spontaneously dashed off. Nottebohm's edition of Beethoven's sketches most penetratingly illustrate the interpretative ~~reflections~~ ^{considerations} of the composer. This process takes place not only in the mind, it is also discernible outwardly, as the so-called "gestus", as a bodily expression that has become visible, as body language. The most extreme example of this is the conductor who does not produce a single tone, but interprets the musical work by no more than making use of facial and body gestus as expression of his mentality.

The machine, too, has its gestus which, however, is no more than the unequivocal expression of its momentary function, without reference to past events or anticipation of future ones. In the programming of the computer, the gestus of the programmer may be woven in, having its effect on the machine's intelligence.

In the written-down symbols of the notation, however, the gestus finds a much stronger outward expression. Without drawing conclusions as to character, this gestus can be seen as an integral part of the interpretative thinking during the act of composing. I shall only mention

Bach's manuscripts of the violin-solo sonatas, in which the - then - arched bow is discernibly reflected in the arched note bars of the eighth or sixteenth notes, thus being also an essential part of phrasing.

This gestus now leads to a very sensitive interpretation in the course of preparing the iconographic drawings for the computer. One could have thought of using computer graphics for the iconographic notation. However, here the gestus of the writing composer would have encountered the strange gestus of the machine, which, whether he liked it or not, would have interrupted the body rhythm of the writer. I recall the first multi-track recording machine, developed by the Canadian Hugh Le Caine at the National Research Council, Ottawa, immediately after the Second World War. The plurality of channels was connected to a sensitive - touch keyboard which, through transferring, by means of a finger, of the individual hand-pressure ^{gestures,} ~~gestus~~, controlled the sound volume. The desire to incorporate a gestus in the technological process is thus not new as such. New is now the fact that this gestus appears in the iconographic image and is directly fed to the computer. Consequently, the extended chain of the "sensitive touch" in the iconographic notation must modify the musical sound function and thus, in the sequence of sounds, give expression to the personal gestus, that is, the personal interpretation, of the writing composer. This merely excludes an outside interpreter. The omitting of the usual mediating interpreter is naturally a radical break with the conventions of the concert routine. While the combination of instrumental and computer music remains definitely legitimate, it is foreseen that in the course of time computer music will become an independent aural experience, in the same way in which, in earlier history, instrumental music separated from vocal music. Then a concert public will assemble in a concert hall, not to primarily listen to an interpreter, but to

X experience the message or the "philosophical activity" of a composer who has created his work with ~~B~~Body and Soul".

Of primary importance is now the development of our "degrees of capability", in order to make both the compositional and the absorbing, listening process, in Nietzsche's words, "more perspicacious". *2 comprehensive*

1. Discussion of the process of composing.

X The sound ~~as~~^I the substance of composing is liable to make the composer rapidly dependent on it. Then begins the gold rush in search for novel sound ~~experiences~~^{sensations} which veer into the associatively illusionary. These are the sound equivalents of wishful thinking which do not bind anyone to assume a spiritual commitment. They are in the category of drugs.

X Sound as such is, however, a noble material, existing in an equilibrium between freedom and discipline. The valuing of, and the respect for, the single sound are a precondition for a carefully weighed economy in the utilization of the material. The sound, although measurable in all its parameters, must not be confused with a number. The number is a symbol of an unequivocal measurement of quantity. The sound, as against this, is a symbol of a spiritual quality ~~which~~^I finds expression in the ambiguous relationships between parts.

X The computer demands of us to enter the microcosmos of the sound, to deliberately determine its inner relationships and, thus, to implant the single sound into the composition as a vital and ~~vital~~^{vigorous} seed.