MUSICA NOVA
IN THE THIRD MILLENNIUM

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Josef Tal

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in the Third Millennium

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P. S.

Much to our regret, due to an unfortunate oversight the name of the translator Mr. Haim Schneider has been omitted.

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Behind the Scenes of Music Theory

I

The count of years, whilst I was putting down these lines, stood at 2002. Of the twentieth century I have lived 90 years and may now set out on my way into the third millennium. The great contemporary topic is the globalization of the ways and doings of man. At the same time, ethnology explores the characteristics of the many societal groups.

Opposing forces clash vehemently and produce a continuous interplay of tensions and resolutions involving all degrees. In this turbulence, the creative individual is required to make decisions which, possibly conditioned by the empiricism of a systematic study technique and being able, in glaring contrast thereto, to point out new aims through the independence of autodidactic thinking.

Such reflections arise when, due to music-theoretical occurrences throughout the entire 20th century, all music-theoretical systematic is reduced to a state of total exhaustion. Thus the question is asked loudly: "What now"?

Deep below the surface germinate new seeds which, in patient incubation, reach out with their tendrils in many directions. In the meantime, the surface of the musical presence is void of a theory. Below, however, a crucible simmers with new acoustic forces from which will spring the building blocks of future structures.

It is now the task of exploration to track down these developments. Composing and exploring are then a simultaneous activity like proceeding on two legs: while one leg strives towards the terra nova, the other provides stability, making use of the
experience from the past. Future music education will turn this intimate duality into the point of departure for the cultivation of creative autodidactics.

As the question concerning musical connections is often multidimensional, the conceptual term, too, may assist the composer to arrive at an answer. Consequently, musicians like Schenker, Schönberg and Hindemith felt compelled to rethink traditional theorizing, embedded as it was in the dross of time, before they would formulate their own perception. Thus Bach and Buxtehude might well have talked and discussed many an undecided question before, in practice, they became law. Actually, verbalization of musical problems constitutes an eminent pedagogical tool. I shall come back to that further below.

Self-criticism now compels me to look into my own decisions and thus justify this modest booklet. It is often difficult to distinguish between autobiography and autodidactics. Repetitions are thus liable to appear which, however, are the result of different contexts. A report concerning a decision is by no means to be understood as a self-recommending model, but as an anonymous object battling with the matièrè.

A seemingly minor occurrence took place right at the beginning of my music studies. I was prepared for the entrance examination for the Staatliche Hochschule für Music Berlin by the Deputy Conductor of the Deutsche Oper Berlin. The theoretical subjects also included full-score playing and orchestration. I had to arrange a Minuet written by Mozart for piano in three different versions: for a string orchestra, a woodwind orchestra and a brass orchestra. The textbook to be used by me for this purpose was the extensive work on orchestration by Richard Strauss. While still doing these exercises and working on the sound perceptions, I had doubts that irritated me: I wondered whether Mozart would have used the identical Minuet melody for all three instrumental groups? Or is there a mysterious connection between sound color and the musical utterance, so that a change of color might also change the message? My teacher ignored this question. Only as a student at the Hochschule
did I have the opportunity to bring up the subject in a conversation with the Deputy Director of the Institute, Georg Schünemann, who strongly advised me to visit the new Studio for Electronic Music. Schünemann who was both an excellent flautist and an eminent scientist in the wide field of the History of Music and Music Pedagogy, gave me this advice when, in our conversation, I told him about the doubts awoken in me by my work on the orchestration of the Mozart minuet. His advice brought me closer to the sought-for answer to the question of the cooperation between physics and the psychology of music. As far as I was concerned, my joining the Studio for Electronic Music constituted the beginning of exploration in a new aesthetic of music.

Of the extent of the meaning of such an exploration for musical composition I was at that time not yet conscious. As a result of the political events in Hitler’s Germany I was however soon to realize it. Emigration to Israel (then, Palestine) and the Second World War totally interrupted the contact with electronic music. Only after more than twenty years was I to be able to renew the connection. In this intermediate period I had to rely on myself to find answers to many open questions. It was possibly precisely in the past that one could find a parallel to the conflict situation in the music theory of our own days. Bach did not have to face the question: tonal or atonal? - with all the consequences flowing from such a decision. However, the great New Territory at that time was the world of collision between counterpoint and harmony. Bach related to the culmination of that conflict in the two volumes of the "Well-Tempered Clavier".

J. S. Bach: Fugue in C minor, Well-Tempered Clavier, Vol. 1
The subject of the second Fugue in C minor, 1st Volume, is disposed in two voices in the melody, as is found in many such formulations in the violin and cello solo compositions. By shifting the stresses, repetitions of the 16ths figures are brought into symmetrical and asymmetrical relationships. For imitation of the subject of the fugue in the second voice, a counterpoint is provided in the figured-bass style.

This beginning of a fugue, radically modern in Bach’s time, I should like to contrast with the beginning of the Fugue in B-flat minor, 1st Volume. The emotional, highly charged fugue subject whose musical utterance should strictly speaking have had its origin on an operatic stage, should indeed be surprised that it was now expected to satisfy also harmonic demands by way of compromise with ‘well-tempered’ intervals, because harmonic modulation processes enhance at the same time also melodic expressiveness. Thus, the subject of the fugue must actually satisfy two antithetical elements, i.e., be a servant of two masters. In this fugue, the counterpoint to the subject is created out of the subject itself and is therefore not an extraneous second subject that engages in a contrapuntal discussion with the first subject. In its melodic and harmonic development, such a bold idea produces unusual dramatic effects.

J. S. Bach: Fugue in B-flat minor, Well-Tempered Clavier, Vol. 1
Thus, in each of the fugues of these two volumes one cold discern a new musical constellation. These fugues are not the outcome of new rules and laws or of a new system, but are the result of an individual exploration of the new sound material. Bach explored not only the confluence of harmonic functions and contrapuntal requirements, but also touched upon the open question of sound color. Thus, the Brandenburg Concertos are precursors of Béla Bartók’s *Concerto for Orchestra*. What is more, the subdivision of the octave into twelve equal semitones is not only a precondition for the “*Chromatic Fantasy and Fugue*”, but also an ancestor of the dodecaphony of the 20th century. Bach’s music-theoretical expositions did not take place on the writing desk of rules, but served the exploration of the existential aim of creative ideas. Emanation of these forces had its direct effect. Beethoven’s “*Diabelli-Variations*” do not signify a figurative change of costumes around a subject, but an exploration into the profound potential of small organisms. Under the name of Variation, each of these particles was able to father a new work.

The exploratory component in the real compositional process is largely dependent on the power of the professional intellect and attains a primary function in a musical epoch that lacks a musical theory, such as characterizes the beginning of the third millennium. Given the reality of such a weakened basis of the musical existence, the urge to anticipate or predict increasingly becomes an anchor for far-reaching insights. Each predictive step is the result of retrospection which reveals the reasons underlying the above weakening. Thus prediction and retrospection are merely parts of the same path, the beginning and the end of which are only way stations of infinity.

We are used to divide our life from birth to death into three periods of experience: past, present and future. These periods of life appear to correspond to a linear sequence of yesterday via today to tomorrow. Reality, however, is infinitely richer than that. Our memory facilities possess a mechanism for the storing of recollections of physical and mental experiences. These recollections are capable
of being evoked at any time and can be confronted with the present instant, whether we like it or not. This creates a dialogue by means of transference and comparison, which enhances the potency of the imago. A recall down to the last detail is only possible in cases of absolute and unbiased explicitness. This mixture of the recalled matter with the relevant instant of the present results in the decision on further action, an action that leads into the immediately adjacent future. According to the inherent potential of the combinatory process in the present, it is possible to predict a contiguous, or even a distant, phase in the future. There is thus no recall without prediction, both of which are individually received in the center of the present, and are individually translated into action. Characteristic temperament quotas of the individual determine whether formation of this phase will be symmetrical, asymmetrical, or even by leaps and bounds. As with the circulation of blood, these phases, too, circle throughout the entire life of the individual and permeate his thinking while awake and while dreaming.

The degree of insight into the future depends on capacity and intensity of the perception of the experiences gone through.

Prediction is therefore no mystification of prophecy.
In the first decade of our twentieth century, two music-theoretical works of far-reaching importance were published in Vienna: "Neue Musikalische Theorien und Phantasien" (1906) ("New Musical Theories and Fantasies") by Heinrich Schenker, and "Harmonielehre" ("Theory of Harmony"; 1910) by Arnold Schönberg. At this moment of the onset of atonality and the rocking of all music-aesthetical conceptions one could have expected two such eminent musical thinkers as Schenker and Schönberg to offer a first theoretical foundation precisely of this novel musical development. Instead, both of them stopped at the threshold to the new territory of the so-called 'Modern Music'. However, this apparent full stop was in reality a mere upbeat, a provocation resulting in the subsequent accent. Both composers felt the need for a critical revision of the theoretical tradition, in order to enter the new territory with enhanced confidence.

Such inquiring spirits are possessed by a zeal for understanding. What was it that urged these two researchers at the same time and at the same place to burrow for other sources? Where and how did each of them decide to make a beginning? Each of them was fully conscious of the deadly effect of freedom from all rules. Behind the expression 'atonal' lurked the total loss of all disciplined thinking.

Discipline in music means being bound to a network of relationships between tones. Such a network is the arbitrary product of the professional intellect. Seen this way, it becomes clear what urged Schenker and Schönberg, each in his own way, to search for a regeneration of musical rules, as in the meantime much had become mechanized and robbed of its vitality.

For Schenker the composer, tonality, inclusive of its chromatic outgrows, was still a rich field of relationships, so that for him there
was no immediate urgency to embark on a journey into the theory of atonality. It is precisely this restraint that linked him to a later, still remote future. Before this, for him imaginary jump, he still searched for new insights into tonal relationships.

We have now arrived at a point of a development that, looking back into the past, still discovers vital saps in apparently dead branches, enabling the eye, seeing far into the future, to find new ways.

At the same time, Guido’s notation finds itself at a point of saturation where it was unable to absorb the new information quantities and qualities. I shall now briefly deal with this double emanation of tradition, which links a yesterday and a tomorrow to simultaneity in the present.

Technological development in the twentieth century – especially in the field of electronics – during the second world war and since, has dragged the so far undefined influence of sound on the human nervous system ever deeper into mystification, but, at the same time, has also opened a new world of sound process ability. We call this world ‘Electronic Music’, or ‘Electro-Acoustic Music’, and now also ‘Computer-Music’, since the computer is so far the most perfect instrument for the realization of this music. For this task, the computer must be especially programmed.

For the information fed to the computer by the composer, the graphics of the traditional notation is no longer an adequate intermediary, as all parameters of the musical language must be unequivocally understood by the computer. The latter is thus not a musical instrument to be played on, but a producer whose production is made audible via the appropriate technology. This does away with differing renderings by different interpreters, as it is the composer himself who feeds the computer his own interpretation. Later, this will greatly influence the art of listening. Upon repeated listening to the same work, and according to his perceptive ability, the consciously listening individual will discover new correspondences. With understanding comes enjoyment.

Before continuing along this line, I shall try to follow the tracks of its origin in the past.
In the early Middle Ages already, long before the expiry of tonality, there arose in the musician, the thinker in intangible tones, a new consciousness of simultaneousness. The polyphony of the Occident postulated a simultaneous plurality of melodic lines with independent melodic contents. Attentive listening to a melodic line infers from the memory of past portions the total contents of the movement and follows the course with expectations and surprises. Thus the same ahead-and-back motion as in speech communication.

With the arrival of the independence of contents in polyphony, the demands on perception multiply. From now on, composers and listeners live in a musical - architectural blueprint in which past, present and future continuously intersect and are stressed to different degrees with the aid of the musical- acoustic voice registers, e.g. when two phrases meet, one in the middle and low alto register, the other in the high tenor register. Here is the preparatory stage for far greater perceptivity in the future.

Because the multiplicity within the simultaneousness discovers—at first as by-product— the harmonic combination of tones in the present, the combination of tones, known from instrumental practice as 'chord', possesses a different musical will than the single tone of a melic line. The combined effect of the tones of a chord generates an energy that, so far, is not measurable, technically. The subjective perception of harmonic energies is therefore expressed in terms of aesthetizising substitute designations such as consonance and dissonance.

Ever since, in the Occident, polyphony and harmony have become the keystones of the composer's trade, a culture battle is fought between the two for primacy in terms of musical significance. No ideology is at stake, the contestants being sensuous reaction versus analytical ratiocination. At this point, I again refer to Schenker. What fascinated him was the tug-of-war between these forces. In them, he searched for still undiscovered factors, which indeed, about a hundred years later, were to play a decisive role. Already in Schenker's recent past so much matter for conflict had agglomerated that music theory, too, had to take a position. Thus, in 1725, there
was published the paradigm of all later textbooks of counterpoint, the “Gradus ad Parnassum” by Fux. At the same time, and emerging from the same cultural soil, there appeared Johann Sebastian Bach’s “Chromatic Fantasy and Fugue”, a virtuoso masterpiece in which an invisible spirit has subdued the opposing wills, forging them into a oneness. Polyphony existed on the strength of centuries of hereditary rights of melic construction. As against this, tonal harmony and its already fully developed chromatics constituted a dangerous trespassing on the rights of autonomous melos to whom the functional chromaticism prior to the establishment of harmony was foreign. In the realm of music, polyphony and harmony aim at opposite directions. It took the uniqueness of a Bach to join the one to the other.

The rescue in this emergency was attempted by Fux. The scaffold of the “Gradus ad Parnassum” hinted at a polyphonal architecture. Point of departure is the cantus firmus, the melic rights of which are preserved, though concentrated to a minimum. Already the first species: note against note, grants the countervoice the same melic rights, but at the same time controls the intervals formed in the light of the already accepted harmonic aesthetic. With this, polyphony and modern harmony were directly interlinked. Together with the systematic development of these species, there begins also in the field of theory the cultural battle between the opposing sound contents in the horizontal and the vertical progress. By clever formulation of laws, the “Gradus” tried to do justice to the will of both ideals. It was Schenker’s flair and historical knowledge that prompted him to rewrite Fux’s “Gradus”, at the same time scrutinizing it closely. Schenker was certainly familiar with the tasks set to Beethoven by his teacher Albrechtsberger. Evidently, Fux’s “Gradus” was the model followed by his teaching method. Beethoven’s creative curiosity urged him on to write several questioning remarks on the margin, but for a satisfying answer the time was not yet ripe. Therefore Schenker had to re-think Fux’s problem, which included also the replacing of the overbearing title of Fux’s book by a sober, workmanship-like Der strenge Satz (The
Strict [rules of] Composition), which was followed by Der freie Satz (The Free Composition). The cultural background of Schenker’s The Strict Composition is the music theory of the nineteenth century, while that of Fux’s “Gradus” is the conflict between polyphony and harmony. This conflict is again the point where past and present overlap in various stages of development and the intersections produce emanations that reach into the more remote future, to then unfold their full effect.

This relates in particular to the role of harmony in the domain of musical sound. Already in the 14th century, Zarlino had laid the theoretical foundation for dealing with the sound phenomenon of the triad. Already with Josquin de Prés, we find in the motets four-part choir movements of pure chordal sequences under a melodic top voice, in extreme contrast to the polyphonic mode.

After that, the Flemish School developed a good coordination of harmonic concord with the course of polyphony, which eventually led to the zenith of the Palestrina style.

However, in the background of this broad historic representation, there germinated another growth which to this very day produces conflict-generating material, and which in the near future will lead to radical changes in the concept of musical composition. As early as the time of the Flemish School this backstage growth moved closer and closer towards the footlights. ‘Modern’ music in those days was characterized by the fascinating sound effect of the harmonic chords. However, they also caused confusion and diverted attention from the musical and textual contents of the melic progress. This spiritual cause of conflict acted as a trigger of a kind of cultural-political court action in the framework of the Council of Trent (1562), in which music was shown its proper place. As their main argument, the church fathers claimed that music had developed into such a dense polyphonic sound pattern that the sacred words of the text were no longer comprehensible, for which reason music did no longer function as servant of the rite. The already famous Palestrina was summoned as musical expert by the authorities of the Council and ordered to restore the proper relationship, in composition, between
music and the sacred text. If one looks at the scores of Palestrina’s last masses, he emerges as a deeply grateful master – student of his teacher Arcadelt, a prominent member of that assailed School.

From the historic point of view, the Council of Trent was an event of the remote past, but the real villain in the piece was not recognized as such. As with the help of our ability to remember, we have slowly learned to perceive the connection between the single voices in the polyphonic texture, the present task was to recognize the elementary force of harmony, since it was harmony that monopolized the attention of the listener, thereby diverting it from grasping the meaning of the text. The single tone as such, without relationship to a melodic phrase, or also as part of a chordal combination, remained for quite some time an elementary natural event. Borrowing from optical experience, it was invested with the quality of a Klangfarbe [tone colour] – timbre. All human voices, all musical instruments are carriers of specific timbres. Thus, if a harmonic entity is sounded by a choir or an orchestra, the nervous system of the listener is immediately affected. While the effect is obviously subjective, what is common to all listeners is the minimal intellectual effort required in order to become affected. The giving up of the pleasure of mentally following the polyphonic relationships in favour of the immediate sensuous gratification by harmony and the thus threatened lowering of the intellectual level were more or less the instinctively perceived motives of the Council of Trent. For all that, the musically highly educated church fathers didn’t see the dire consequences even in their dreams.

Very quickly, melodic thinking became dependent on the triad, with the melic gesture being maintained by diatonic connecting tones between the broken triad intervals. The highly developed scale theory of antiquity and the Middle Ages was simplified to only two scale types: major and minor – positive and negative. The time was ripe for a harmony textbook in keeping with this development. This was the “Traité de l’harmonie” of the composer Jean Philip Rameau. The book was published in 1722, curiously enough almost in parallel with Johann Josef Fux’s “Gradus ad Parnassum”. The strong influence
of harmony can be said to have had benevolent and malevolent effects. Simplification of the musical context on the one hand, and the sensuous pleasure rapidly reacting to the sounds on the other, was very much favoured by the new social order. Liberalization of the masses created the people’s song. Not refined melodies of Troubadours or Minnesingers, but folk songs distilled from the soul of the masses. This engendered originality and authenticity, but also cliché, shallowness and superficial typification. This situation produced, e.g., such a musical concept as ‘Song with Accompaniment’. The accompaniment in itself has no musical meaning, being merely a harmonic embellishment using the harmonic substance of the melody. (In the Art Song, the connection and relationship to the melody takes a different form.) In the music departments of the mass media radio and television, programs are classified as ‘serious’ or ‘entertaining’, that is, music with profound contents, or music for superficial chatting. With this division, the past of the Council of Trent touches our present, except that today far wider circles are brought up this way and, as culture symbol, are more rapidly enthused. ‘Serious’ music makes up for the loss of genuine counterpoint by the increasingly equivalent role of all musical parameters in the composition. From this exceedingly rich tone material there emerged the Golden Age of Western music. The great mass of the concert-going public was confronted by a creation of great profoundness and, at the same time, by a decadently falling level of everything spiritual. These were the precursors of World Wars I and II.

For Schenker, tonality was not yet exhausted. It is true that, altogether, one should have dealt more intelligently with music theory, because as early as the end of the nineteenth century there appeared the curious phenomenon of the teacher of music theory who had never done any composing, nor had he felt any need to do so. He represented theory as a science, which had no need to be connected to practice. However, as music theory is the knowledge and exploration of compositorial relationships, theory and practice in music are inseparable. Riemann’s Theory of Functions has found
an ideal corrective in Schenker’s *Urlinie* (primordial line). It is true that, in Schenker’s graphic analysis of a composition, the harmonic keystones of the total architecture are already perceived in the *Urlinie*. His analysis is, however, not content with the numbering of the scale steps, as between these steps a musical event takes place which comprises more than melody and harmony, etc. The relation between the *Urlinie* and the events in between is not that between the main and the secondary voice. The graphic demonstration therefore demands its variants. What is analysed is not the multi-voice treatment, but the multi-layer treatment (using Schenker’s own term). Every detail serves the *Urlinie*. Even the tonic is not only the keynote, because in modulation it must be ready to assume also other functions. The complete *Urlinien-analysis* represents music in space, to which end Schenker has prospectively divided the different layers into back-, middle- and foreground. A tonic chord sounding in that or the other space has thus not only its predetermined function as tonic, but also its unique function in that composition.

It is the idea of space that, in acoustics, realizes radiation in prismatic refraction. This had already been experimented with by Giovanni Gabrieli in his multi-choir, multi-orchestra compositions by utilising the spaces of the large St. Marcus church in Venice, in order to produce timbres and acoustic iteration for enrichment of the contents of his composition. With Schenker, space is not to be understood as structural space, but grows organically with the performance of the work. Towards the end of our century, space will again play a role which Schenker, of course, could not foresee. It is the preparation for the jump into electronic music. Schenker perceived space theoretically for the multidimensional activation of the sound contents, similar to the way in which Piscator, the director, used height and depth of the stage for the dramaturgical interaction. The springboard for electronic music was the misnamed “Bruitism”. But simultaneously with the attention-demanding ‘noise’, Arnold Schönberg chose another path.

It was the path that, pioneeringly, led the entire twentieth century towards the next century. As with Schenker, Schönberg’s “Theory of
Harmony", too, is a retrospective re-formulation of the traditional function-harmony. It shows the clear development of the Neudeutsche Schule, much discussed at the turn of the century and personified in Wagner - Liszt contra the neo-classicism of Brahms. Seen in the historic perspective, this polemic, too, is a claim without proof, as already in the premises, the one is seen to profit from the other one. However, it demonstrates again the persistence of nature in creating controversy. This gene is the source of all aesthetics, which, in the twentieth century, enters the stage of eruptive mutations. A highly sensitive person as was Schönberg felt such upheavals in advance. Although the harmonic material of his theory of harmony did as yet not lead to definite atonal reflections, frequent interior rumblings should be paid attention to. A single example should suffice: Schönberg turns to the minor triad of the third degree. In theory and practice, this chord plays a subordinate role. It is largely avoided, because its fifth is at the same time the leading note of the tonic of the scale. Besides, it has two tones in common with the first and also the fifth degree. It thus lacks the power for renewal on the one hand, and, on the other, drags the fifth as leading tone towards resolution, which, however, does not correspond to the bass progression of a fifth required for this purpose. However, the fifth of the third degree must not be listened to as a leading tone; in the harmonic context it may have an independent function. In the second inversion of the third degree, it may even be the root of the six-four chord. If then there appear above this root the third and fifth of the seventh degree as transitional tones, the selfsame fifth of the third degree will become the root of the seventh, and as such is at once ready to adapt to the transition behavior of the other intervals and to assume the function of the note leading to the root of the first degree. If such a behavior takes place in daily social life, we call it 'lack of character'. Detached from moral points of view, it is seen as mutation. No wonder that this specific tonal domain awoke Schönberg’s special interest. In this domain, the seventh degree constitutes an organic part. To hear it merely as a dominant without root would be no more than a makeshift solution to the moral conflict. The healthy component of
the seventh degree demands that it carry out the fifth - dominant jump into its own first degree, which, in the scale, is the third degree. Schönberg devotes a long chapter to the seventh degree. The ambivalent situation in the domain of the third and seventh degree compels him to engage in excessive extra musical polemics. Music theory has long reacted to the ailing moral in the tonal system by attaching to the augmented fourth (in the seventh degree in its inversion as diminished fifth) the label diabolus in musica. An interval which enforces a downwards-leading and an upwards-leading semitone is a diabolical miscreation. Yet it was this very semitone step that, from the earliest beginning of the tonal system, implanted a problem which was at the same time welcome as well as unsolvable. In the same way as the harmonic chord vis-à-vis the single melody tone postulated a sensuous factor, the two semitone steps in the scale were accepted as 'natural' steps, while all other semitones were regarded as 'chromatic' alterations of their neighbouring tones. With the term 'Chromos', the concept of color was introduced into acoustics as sensuous stimulant, a consistent enhancing of which can be observed from Gesualdo da Venosa's motets up to Wagner's Tristan Prelude. Within the life span of several generations, chromaticism has in the past gone through several stages, up to the point where a specific present is going to do away with it. At this point I shall arrive further below. In the meantime, chromaticism will have a steadily increasing effect on the decadence of the tonal system.

This development phase, too, is critically discussed in Schönberg's "Theory of Harmony". It is modulation that, in various ways, makes use of chromaticism: for weakening an old tonality or key and strengthening a new one. A music student in about the first third of this century was still taught that, for modulation into a key remote on the circle of fifths, to shorten the way he should use chromaticism sparingly and with great circumspection. The aim was to present modulation as a dramatic pathway and to vary the technique of transition to a new tonic domain. However, this period was already the heyday of chromaticism. Thus, the just mentioned ideal of
modulation was confronted by the opposite ideal, that is, to arrive at however remote a tonic via the shortest way with the least number of chords and the most drastic chromaticism. This is a virtuoso game employing the technique of the tonal language of these days. The technical term ‘chromaticism’ for the semitonal timbre changes was much loaded with sensuous stimulation; one began to talk of ‘alteration’ in the sense of a disintegrating inner change in the original tone. This produced also a weakening of the leading-tone dependence and an exacerbation, towards dissonance, of the sound relations between the tones of the chords. The result was an unstable and unreliable tonality, a clear and barefaced demoralization of the tonal system. Luxurious alteration as a means for modulating into remote tonalities along the sensational shortest path became a musical-theoretical sport in the teaching of the theory of music. Still worse than alteration was in this respect the ‘enharmonic modulation’. The chord of the diminished seventh, anyhow a weakling consisting only of minor thirds and always ready to indulge in the delight of an enharmonic modulation, provided the deceptive impression of the object having been attained in one or two steps. My teacher of composition, Heinz Tiessen, said in a lesson on the subject of modulation: “Show me how you modulate and I tell you who you are.”

The role of morality in the musical craft cannot be defined by rules. Schönberg did not fail to deal with the subject in his “Theory of Harmony”. In fact, it was on his mind from the first page of his book. It compelled him to both, bear down on the meaning of the word, and, via a moralising admonition, turn it into a discipline proper. In order to attain this goal, he had to critically repeat the traditional theory of harmony, to transpose the past into the living present and, in the last chapter, to enter the future.

In this chapter begins the first activity in the process of the fusion of tonality at its apex and its decline at the fin de siècle, with the furiously developing natural sciences and the industrialisation of their technologies prior to the first World War. At this point in the cultural history of Western civilization, the time was clearly ripe to
launch the chapter ‘Modern Art’ which was to overthrow all conventional aesthetics. Rapidly a plethora of subjects for conflict piled up, not only between consumer and producer, but also in pseudo-philosophical theories, ideological rifts - intellectual conflicts that, throughout the entire twentieth century, will harass the creative forces in their spiritual struggle with matter, until finally, in the future, the phoenix will be able to rise from the ashes. But what indeed constitutes the spiritual struggle with matter?

While for a long time musicians have been empirically aware of the existence of overtones, it is only since Helmholtz and Fourier that we are able to precisely calculate this natural phenomenon in all its details. Nevertheless it was, and still is, difficult to define the emotional significance of the overtones of a fundamental note. Taking a cue from the color spectrum of light, the interaction of the overtones was invested with a color quality, giving rise to the term ‘sound color’ (timbre) as already mentioned. Only by association is it possible to assign a color to a tone, and even so this will always be subject to an individual decision. Wrong or right - timbre has become a significant initiator in the thinking of the composer. Thus new theories and fantasies pile up, all in order to make an abstruse sound world more accessible. It is in this way that the last chapter of Schönberg’s “Theory of Harmony” must be understood. It is in fact a discussion of the author with himself, to think his way towards the already visible shore. The very first example in this final chapter is an eleven-note chord from his monodrama “Erwartung” (Expectation). The technical aspects of the presentation of such a multi-tone chord are explained; but help must also be extended to aesthetics, which by now is already in serious trouble. For the basis of such sonorities unscrupulously undermines the inner consonance-dissonance relationships between the intervals. The closer the position, the sharper the dissonant collision. Schönberg shows himself very considerate with respect to his listener. He shows how the potential for dissonance can be rendered bearable for the listener by a combination of presenting the chord in the open position, in a delicate instrumentation and in low dynamics. This point of view clearly demonstrates the attitude
of the composer towards his public. The eleven-tone chord, noted down with so much consideration, is nevertheless no longer at home in the tonal system.

This eleven-note chord symbolizes the point of interpenetration of tonality and atonality. Through centuries of linguistic use, the word 'tonal' was mechanized and the feeling for the profound significance of this term was lost. It comprises a variant with an additional reference, namely 'fundamental tone' (also known as 'tonic key note'). The component 'fundamental' is taken from nature over an extended acoustical experience related to the existence of the overtones. As already indicated, this physical phenomenon is today within the range of technological control. Only a sinus tone, i.e., a tone without overtones can be regarded as a solitary tone. In musical practice, every tone possesses an infinite row of overtones, rigidly organized by nature in their interval sequence, and in their selection and volume dependent on the vibrating matter of the sound producer. The musical tone is thus the sum of its unique overtone characteristics. Nature also determines the neighborhood
of the overtones, so that those in closest proximity to the fundamental tone – octave, fifth, third – are the easiest to perceive and, in the musical context, have the strongest aesthetizing influence. With higher perceptive aptitudes of people, consciousness will be affected also by more remote overtones. The fundamental tone is thus primus inter pares between its overtones, the inner relationships of which result in its individual character. The function of the fundamental tone thereby constitutes a natural model for the creation of relationships on a higher plane of the art of composing. The fundamental tone may also act as a representative of other functions. It may be the fundamental note of a scale which serves a melic organization, it may be the base of a chord organized harmonically. As music floats in space, the local concept 'fundament' stands in all cases for the function 'point of departure'.

Verbalization of the tone relationships becomes more precise with the introduction of the term 'Cadence' (cadere – to fall). This is preceded by the observation of another natural phenomenon, namely the cadences in human speech communication – an exceedingly differentiated subject which I shall mention here only in relevant main points. Inhaling and exhaling constitute the technical execution of the raise and fall of the human voice. In orthography, these cadences are symbolized by the punctuation marks comma and period.

It appears reasonable that this natural phenomenon was to find its accommodation in the systematics of the theory of music as cadence formula.

Now, in the 18th century, would two men formulate this natural subject of nature from two points of view. They were Isaac Newton the physicist who formulated the Law of Gravity, and Jean Philipp Rameau the composer who, in his “Traité de l'harmonie”, realized the Law of Gravity in the drop of the chord of the fifth degree into the first degree. Since due to gravitation everything related to the first degree, this chord was called the Tonic Triad. The music that sprang from these gravitational relationships became the ‘tonal’ music.
The emergence of tonality reflects the openness of its contemporaries for the findings of science and the achievements of art, the high intellectual level of their spiritual leaders who took pains to prepare convincing theoretical foundations. There is thus some logic in the fact that, with the inroad of atonality, men like Schenker and Schönberg fell back to the traditional textbooks of Counterpoint and Harmony, not only to review the subject critically, but also to learn from the unsolved problems and fallacious solutions. It was in the air that the first violent attack of atonality on the fundamental-tone mentality and the negation of the Tonic sequences would soon lead to a state of vacuum as far as theory was concerned.

In this situation the disproportion between freedom and discipline becomes overwhelming. Schönberg's compositorial biography passes through tonality and atonality, yet he could not be satisfied with the prefix a only. His ethics compelled him to oppose a moral jungle of unbridled freedom with a new discipline. I presuppose the knowledge of the twelve-tone technique and will therefore mention main points. The decisive step in the new orientation was the following formulation of Schönberg: "Composition with twelve tones related only to one another".

Thereby Schönberg achieved the obliteration of the all-domineering tonic -plus fundamental note gravity and replaced it with the twelve-tone row of arbitrarily selected intervals, within which no tone may be repeated to avoid any dominating function. Immediately and vehemently a loud opposition raised its voice against the counternature of such a construction, as no cadence could now strive to a conclusion. An easily found example of the 'Degenerate Art' of the 'twenties'.

What, however, happened in reality?

Again, it was two men: the physicist Albert Einstein and the composer Arnold Schönberg. The consequence of Einstein's Theory of Relativity led to the breaking through the stratosphere and the opening up of outer space. Schönberg's equivalent is the abstracted force countering the gravitation of planet earth and the new organization of the expanded living space. Schenker, too, was
conscious of these changes in space and adopted different conclusions.

The initial development of the twelve-tone language - so far only hinted at - was immediately affected by the chemistry of the changes in aesthetics. It speaks for the high artistic intelligence of Schönberg that he explored also these changes and was always ready to translate new understandings into new predicates. This fact is decisive for today's generation because soon we shall find ourselves facing a problem quite similar to that which prompted Schönberg to formulate his twelve-tone music. What is more: with the end of tonality, the prefix a has led us into a music world full of negations which, with the beginning of the third millennium, will become even more pronounced. In this respect we live today in the prenatal stage of a novel musical future. As the first composer, Schönberg has tilled the new field with the seed of the twelve-tone music. Against the prefix a he has sown the seed of the 'row' and its lawful order, thereby again fulfilling the demands of a mental discipline. Never claiming absolute validity, the seeds of this discipline were largely dependent on the soil on which they fell. Two points of this aspect I should like to elucidate.

Schönberg's above-mentioned definition of the 'set', i.e., "tones that relate only to one another", does leave open also other relations, the strictness of the rule notwithstanding. More active than the tones relating to one another by dint of the numerical order, memory involuntarily relates to the entire set. Simultaneously with storing of the facts, memory also individually selects certain intervals or even groups of intervals, that is, is weaves threads back and forth, which will have a decisive influence on the texture of the composition being created. This specific process is therefore cognizable neither methodologically nor from the side of discipline. The prefix a thus re-enters via another door, that is, a numerical process and an a-numerical process take place at the same time. The singular discipline is always that of the singular composer and is an integral component of the creative process. As autodidactive education, it will in the future have a decisive effect on the formation of his professional
personality. We therefore must strictly distinguish between the discipline imposed by an external authority and a subjective discipline of the professional intellect. This I shall presently demonstrate with the aid of a second example.

The authority, in this case Schönberg, has prohibited the repetition of single tones, not to speak of groups of tones. All that is still reaction to the tonal heritage. Let us listen to the beginning of the first movement of Schönberg's Fourth String Quartet.

A group of four eighth notes (under a common bar) is thrice repeated as a whole, as is a single note of the group. The external authority must give way to the subjective dictate. Repetition is reinforcement - intensification as well as dilution - automatisation. Repetitions with variations present a commentary on this or that detail. Therefore, repetition cannot follow a prescribed rule, which, at the same time, however, facilitates misuse. Let us observe the intentionally produced repetition of the four-note group in the Schönberg example. Each fourth eighth note of the first two groups abandons the repetition and restores the connection between the mutually related tones of the set. The third group is varied with a syncopated rhythm, which demands a cadence-like conclusion. This subtle and ingenious piece of craftsmanship is also clearly based on a very clever decision concerning the application of the twelve-tone technique. Whatever strictly follows the rules relates only to chord formation along the vertical and the course of the voice along the horizontal, both of which follow the numerical progress of the set.
At times one is tempted to draw parallels between this deep-seated mental compulsiveness and certain political phenomena of this period. In the model-concentration camp Sachsenhausen, the Nazis had perfected the system of de-individualization of the inmates. This was seen as one of the sources of power for the mental domination of large population masses. While the aims of different 'totality' seekers may differ, what they have in common is the process of stunting of the individual potential.

All relationships in the texture of the musical text were bound to become caricatures of a principle that, like a parasite, lives on the negation of its basis.

Dis-individualization requires totalization as a tool. Schönberg felt it lying dormant under the cover of the row liberated from gravitation. He thus preserved the individuality of all but two of the parameters. In the example of the fourth string quartet we can see his preventive measures against totalization. Yet still during his lifetime and immediately after his death, the totalizing composers - and somewhat later the minimalists reared their heads, both in the service of dis-individualization.

It made a certain logical sense when, almost simultaneously with the 'totally serial' music, there was formed the phalanx of the 'totally free' music. There had opened up a latitude of limitless width in which every "New Theory and Fantasy" - to use Schenker's term - was welcome. As neither observation of rules nor relationships were desired, the intellectual result grew wildly and uncontrolledly, and became rapidly a playground for esoteric mystics. Instead of providing a historical overview, we shall concentrate on a musical event that, later on in the next millennium, will demand all available forces: mutation of the tone. Up to now, regardless of the scale system to which it belonged, a tone was unequivocally defined by its pitch. From the outset, however, it was associated with the ambiguous criterion of the so-called timbre, which always had a significant function in music. As far as the communicative colloquial language was concerned, the oscillatory characteristics of pitch could be defined numerically, while explanatory words referring to timbre
relied on mysticism or on adopted habits. As already mentioned, scientific progress has rendered the overtone spectrum analyzable, thus facilitating the precise definition of the timbre of a tone. While during the earlier years there was a wide gap between theory and practice, electronics, due to technological development especially during the 'thirties and 'forties, began to build an appropriate instrumentarium for timbre-based music. Since then, we speak of 'electronic music'. Today, technical control of the overtone spectrum is taken for granted. From now on, the overtone spectrum of a tone is not only dependent on the design and material of a musical instrument, but can be arbitrarily assembled with the aid of the electronic equipment. This means, that the solitary tone is already composed, that the tone is given structure and shape and, therefore, that the concept 'timbre' is no longer sufficient for characterizing it's content or message. Due to the technical control of the overtones, one is also made conscious of their spectral collaboration, so that one perceives not a singularity, but a plurality; not a tone, but a sound, a sonority. If we also affect the three temporal properties of a tone spectrum, namely attack – sustain – decay, we have presented a sound personality of a rich and intensely individual information content. It is the computer that facilitates the technical control of immeasurable information quantities, therefore we now speak of 'computer music'. This, by way of example only, is a creative detail of the music of our days, which, together with a certain amount of experience, we carry along into the next millennium.

At this point, I should like to return to the beginning of our millennium, because the just mentioned experience of quantities of musical information was even then the decisive factor as to the direction Western music would take. It was the beginning of polyphony. One had to learn to simultaneously perceive melic lines of differing contents. One had to become aware of relations of differing shades, which the composer had established between these lines, and was confronted by a complex entity of musical information. Even before these intensive structures made their appearance, the individual lines were already fully developed in their own structural
make-up, so that the musical memory had to cope with a heavy burden constituted by this specific abundance.

The need of the day was therefore for a notation that allowed this information to be recorded and to be exactly repeatable. Thus originated Guido d’Arezzo’s notation, which was modified only after about a thousand years, at the end of the twentieth century (by music graphics). It is almost unthinkable that a Mahler or Stravinsky score could have been conceived and realized without Guido’s notation system. We may rightly state that music as an independent art genre was made possible only thanks to the notation of Guido d’Arezzo.

Returning to computer music and taking into account the huge quantity of information at our disposal, it appears to me that a notation for computer music is a prerequisite for the composer’s craft. As already stated, the computer is not a musical instrument on which the composer’s work is reproduced. Computer music is rendered audible only via loudspeakers. The listener must acquire this music with the aid of an intelligent sound consciousness. To this end, acknowledge of the notation of computer music will be as helpful as is the skill of reading for the enjoyment of a book. My own experience in this field induced me to follow Guido d’Arezzo’s footsteps and, in co-operation with electronic engineers, to develop a notation for computer music, on which I shall report in the second part of this paper.

In the meantime some more remarks concerning ‘totally free’ music. Not only is this music a radical reaction to the ‘totally serial’ music, it contains also its own symptomatology, which will dominate future music at the onset of the next millennium. To begin with, it is again ‘totality’ that carries the seed of suffocation. Any attempt to counter this tendency would be a noble undertaking. Thus let us dare to take the first step and ask a question, which is by no means naive: How can one define the process ‘composing’? Observation, over a longer period of time, of children in a Montessori-type kindergarten will provide a precise answer to our question. At first, the child will continue piling building blocks one upon the other until the tower topples over. The first stage is the slow, almost
methodical erection, during which the tension already anticipating
the collapse rises. Then the second stage: the spectacular crash,
followed by the dramatic sight of the building blocks colourfully
strewn about the floor. Through frequent repetition, understanding
of this process has been attained, to be followed by the next learning
phase, which takes place on a higher level of co-operation between
intellect and feeling. Finally, a mature work of art emerges, in which
the dramatic tensions are integrated into the planned design and,
while nothing collapses, in each of even the smallest parts of the
whole, there are acting opposing forces. By then, the child has long
outgrown the kindergarten, but its roots will remain fresh and
creative for life. This extended answer can be defined in only one
precise word: exploration.

Composing is the exploration into means and ways for attaining
a pre-set aim. All theories of music arise from exploration-based
reflections during the act of composing. Today, at the beginning of
the new millennium, we cannot say to have freed ourselves from
every theory and discipline, but rather to have lost these research
means, in order to breathe a spiritual void instead. It will take the
future a considerable time to overcome this loss. But not only loss is
at stake, also is discovery, without which the spiritual risk capital
will not turn into new fertileness. The young generation of composers
who are today in the first decades of their life, must go through all
these mutations in order to acquire as soon as possible the capability
of independent exploration.

I assume the present day to already represent the near future
and suggest several thoughts for exploration. This should by no
means be regarded as part of a course of instruction, but rather as an
example for further reflection, taken from my own experience.
Building a relatively rich and carefully scrutinized spectrum of a
continuous tone, we have composed a sound, the effect of which
can be intentional in many respects. The simplest effect is an
associative one, reminding the listener of past episodes of his life
and linking this with dreams and fancy ideas. This type of sounds,
known today as ‘sonorities’, are very popular for use in summer
nights in nature, since they embody the conventional concept of romantic idylls. To suffuse such sonorities with carefully selected natural sounds is mere child’s play for the computer but, in a more subtle execution, can be scored for an orchestral performance. Here, the traditional links up with today’s technology, and both are given to mutual influence. I am mentioning this example as a first one, although it is not my musical concern. But - symptomatic for an appraisal of the level of the listener mass – it obviously is the product of decades of poor spiritual nourishment. Strictly speaking, this example can be traced back to Mattheson’s Affektenlehre at the time of Bach, who has cited many examples from these hypotheses concerning the effects of music. But Bach immediately proceeded to search for the forces that are effective in such motifs, in order to extract from them new material for the composer’s work.

Could one not analyze also the sonorities, the exceedingly rich, compound sound spectrum of which is chiefly used only for illusorily associative stimulation? One encounters at once a so far unknown aesthetic relation. According to the style of the sonorities there are no melic passes of precisely defined pitches, the intervals of which could be aesthetically evaluated using the traditional yardstick of consonance or dissonance. The sonorities fuse into one another in many modes. Dominant pitches are isolated, yet not melically related, occurrences. In this totally free sound world, the terms consonance and dissonance have no validity any longer. The computer cannot be programmed for consonance or dissonance, unless the programmer takes over the composer’s craft. Long before the computer’s invention, it was again Bach who intensively inquired into the concept of sonorities. His collaboration with Silbermann on the hammer mechanism of the piano resulted in the characteristic piano tone with its overtone-rich attack and the prolonged decay when the vibrating string is undampened. Harmony, already fully developed in Bach’s time, required an instrument that would do justice to the sound quality of that harmony. Bach’s commuting the technical innovations into the message of the composition became the basis of Beethoven’s significant exploration in the musical sphere.
Today, the sonorities have established themselves with incomparably more pretentious means and, at the same time, without any obligation whatsoever to a musical dictum of any sort. Still far away from knowledge and capability to control sonorities as an independent artistic device, we are at the stage of the toddler in the Montessori-type kindergarten. While the material in its multi-layered structure is analyzable all right, it is not measurable in its effect.

We feel the tension caused by an intangible energy. It is this energy that, in the future, will be heir to consonance and dissonance. I firmly believe that, at some future point, the energies of certain spiritual creations will be measurable. The process of dramatizations comprises so many energy stages that, in common parlance, the concept ‘dramatize’ will not mean more than a spontaneous stimulus for thinking. And yet, there are an infinite number of specific energy steps active. As long as technical measurability is not yet at hand, both the author of a creation and his consumer must nurse and develop their capability to measure.

In conjunction with the energy concept, I should like to discuss a dominant detail in the totally free music of our day, namely the use of repetition. I have touched upon this subject already in connection with the twelve-tone music and Schönberg’s fourth string quartet. Repetition, as well as the avoidance of repetition, are parts of the structural planning of the composition, of its analyzable external form. This form, however, is not a mold into which a content is poured, but the opposite: it is the outer face of the contents searching for form and carries the contents’ unique energy features. The power or weakness of the repetition is thus the result of the exploration of the content prior to, or during, the act of composing. As already mentioned, repetition of a musical idea may be very helpful in strengthening memory and, in case of a varied repetition, may also bring forth new developments.

Yet it must never be superfluous. In the ‘totally free’ music a wide field was also allowed to ‘chance music’. The etiology of a chance is inexplicable, as is the occurrence of a chance. With the term ‘chance’ we seek a way out into mysticism; or else we admit our ignorance,
given our limited understanding. In any case, 'chance' is not supported by acquired knowledge and, thus, has no theoretical underpinning. With the existence of chance music, we have reached the maximum of a theory-less situation in music. Accordingly, one could say that the twelve-tone idea of Schönberg was perhaps a necessary, but insufficient experiment of the past, which could explain its short-lived existence. Yet the opposite is the case. The twelve-tone row has introduced the first positive aspect into atonality, thereby setting the stone rolling. That it would encounter obstacles is in the nature of its dynamicism which would overrun everything. This dynamicism is based on the idea of the twelve-tone row. In order to master the twelve tones of the row, they were numerically disciplined, so that none could escape the row. With this numeric relationship between the separate intervals, Schönberg achieved apart of the surmounting of gravitation, also the surmounting of the traditional emotional interpretation of sequences of intervals. Together with the numerical dictate of harmony, this training of perception took a long time to master. Therefore, Schönberg applied the numerical discipline only with regard to melody and harmony.

Soon, however, a new phase began in the twelve-tone row: The overcoming of the numerical discipline. Memory, its enormous capacity to store, its virtuoso delight in drawing threads of references - all this is again empowered, but now as a secondary discipline. It is the surmounting of the twelve-tone row as an instrument for the overcoming of everything that stands in the way of an unobstructed view into the third millennium. This is the dynamicism of the stone that Schönberg (and also Schenker) set rolling, a process still fully under way. It is still the aesthetic consideration that distinguishes between primary and secondary elements. As yet, notation has precise graphics only for the traditional primary elements: melody, harmony, rhythm, while all secondary elements are expressed verbally only - all this in a period of a fundamental reorientation of aesthetics.

In the twelve-tone practice, Schönberg turned again repetition. Yet not in principle, but out of a conscious reflection, as the beginning
of his fourth string quartet has shown. Total negation means total lack of references, total non-recognition to what has been said. After total serial music, the problem of repetition in totally free music thus becomes more acute. Won is a total liberation from tradition, lost is individuality.

In the Western world, starting from the end of WW II, there are acting side by side advanced tonal music, atonality, twelve-tone music, total serial music, chance music, and now also computer music.

The implications of the twelve-tone music will be felt only when the modifications of the early stages of the original are forgotten, because Schenker’s space concept will be added to initiatives coming also from other sides. Still, whatever may happen - in principle it is the discipline of freedom that is demanded. This discipline cannot be nailed down with laws and rules, but must be achieved in each new work by connection, relationship and context, meaning that the macro- and micro portions of the total body of a composition should reflect the mental unfolding of a composer’s creation, while preserving his individuality. This produces an increased professional-intellectual exploratory activity, boosted by an intensively emotional high-tension. The circle of this highly complex process is organically joined by the computer. It possesses the instrumental means to realize the composer’s hot imagination, which it contains in written documentation.

The composer, however, is capable of preparing for it a programme of a musical constellation such as would not be performable, but could still be comprehended, still remembered, thus opening a new world for musical language. As soon as computer music will possess a graphic notation that will provide the acoustic memory with a reliable support, the composer in this new world will be able to combine exploration and imagination.

Then the computer will be not only an additional model for experimentation in electronic sound combinations, but also the translator of a new program in the language of music, which will commence the history of music of the third millennium. This does
not imply any wiping out of the past, because relationship and commitment are the personal discipline of everyone. Relationship is woven, and commitment is the preservation of the fabric. It is the fabric of every base. No rule or law can encompass this fabric. Later, when a convention will have been worked out in the new language discoveries, it will again be possible to formulate a new theory from the sum of these experiences. Until then, every composer is the theoretician of his individual discipline.

We dare to take the first steps into the third millennium with great expectations and anticipations. I should like to remind the reader of Schenker's "New Fantasies", which led him to the concept of 'multi-layeredness'. On the way from horizontal monophony to polyphony, there was awakened the consciousness to vertical harmony. The dense relationship between vertical and horizontal opened up the three-dimensional sound space and made possible the formation of complex layers compounded of all parameters.

Between the two World Wars, the plastic arts, too, had worked out the pre-stages for the soon-to-follow multi-media technique which, from the purely external aspect, is a phenomenon parallel to the musical multi-layeredness, but in its consequence, fundamentally different. Except for music, the means of the multi-media technique consist of tangibly concrete matter. These two developments of the arts most strongly engage the five senses of human beings and train them towards the higher demands of perception. It is foreseeable that, in the early stages of the third millennium, Schenker's multi-layeredness will make a breakthrough towards multi-dimensionality, because only the latter is capable of being distinguished from the tangible matter of the multi-media in every constellation. At this point the computer will have attained its definition as a music instrument. On its way into the third millennium we shall bestow upon it some further characteristic features.
III

We swept across a period of a thousand years and its essential main features. As children of the twentieth century, we are the rich heirs of a musical high culture of the West that, after the Second World War, began to conquer also the East. Today, as a matter of course, we listen to the interpretation of Central European classics or romantics by conductors and instrumentalists from the Far East. On the other hand, Spengler's "Decline of the West" represented already after the First World War the unavoidable showdown with new constellations. Masterpieces found themselves next door to experiments groping in the dark. New, exact systematics in conjunction with probability calculations - all these attempted to stave off the cataclysm, a severe earthquake shaking traditional music culture brought about by atonality, dodecaphony and electronic music. This mutation did have good reasons, which we intend to ferret out in order to be able, in the third millennium, to again fruitfully cultivate the land. This, as opposed to Spengler, represents a different linking of present and future, because Spengler is both a historian and a prophet whose prophetic vista understandably stresses decline. Here, I restrict myself to musical culture only. Its rise in the Occident took place uninterruptedly over a thousand years, while its decline in the twentieth century was an abrupt plunge. The rational swing of a pendulum thus does not apply. Underlying the process is rather a disruptive factor to which one by one all conventional sensuous evaluations fall victim, while newly acquired understandings cannot yet be sufficiently established and qualified. It is the discrepancy between the mastery over technical progress on the one hand, and its translation into ideal abstractions, on the other. In this respect, concretization of the invisible and intangible world of sound was the most difficult task.
Let me move back to the beginning of understanding of the nature of the fascinating sounds in the universe. At about the turn into the first millennium it was the work of two men who carried out that concretization. These were the Greek Pythagoras and the Egyptian Ptolemy. I shall obviously not deal with the description of Pythagorean monochord experiments and the vibrations of the proportionally divided strings. What is relevant for our purpose is the introduction of numbers as indicator of the distance between two adjacent tones (interval), which may sound sequentially or simultaneously. Let us take as an example the interval of the second: whether major or minor, the second, in the diatonically horizontal passage, is an ideal representative of the ratio. However, in simultaneousness, the irrational second causes spontaneous confusion. The measurability of these physical phenomena is the point of departure for the intellectual grasp of the world of sound. Inseparable from the objective measurability is the direct effect on the nervous system of the subjectively listening recipient. This other side of the exactly measurable we are used to call feeling or sensation which, to this day, are non-measurable phenomena. They produce in the listener enhanced or weakened energy reactions. Towards an understanding of human reaction to single tones and to intervals strove that other great mathematician of the ancient world, the Egyptian Ptolemy. As measurement in numbers is impossible, a circumscription in words must represent the emotional content instead. Thus, Ptolemy invests the interval of the fourth with the qualifier ‘beautiful’. This of course is connected with the Pythagorean measurements and the resulting even and odd numbers, which enables intellectual listening to distinguish between simple and complex ratios.

But then, the definition of the word ‘beautiful’ cannot be discussed in the present framework. Ptolemy touched on yet another point of great consequences, the dispute centering on the Pythagorean Comma. Exact measurements led into the region of micro-intervals and thus to the resolution limit of human hearing. But at a much earlier stage already, there were difficulties with the intonation of
stringed instruments, because due to the comma, the increased irrational did not permit response to even numbers. Ptolemy therefore talked of the 'good sense of the ear' by which he referred to decisions involving compromise which, very much later, led to equal temperament. By his talk about the 'beauty' of the sound and his demand of 'good sense' from the ear, Ptolemy provided the roots of the soon developing Aesthetics of Music and Psychology of Sound of the Occident, both of which grew in modern times into independent branches of musicology.

What, however, was it that brought Ptolemy from exact mathematics to the aestheticizing description of music? This point signifies the parting of ways of East and West. It was precisely the well-grounded natural scientist that strove for new insights into the world of sound. For the sake of the subject, I should like to talk here about the genetics of the musical intellect. Its gene contains the object of knowledge, acquired empirically or methodically, and its immediate consequences with respect to subjective feeling. It is dependent on the degree of intensity of the sensation. Intellect and feeling have each it's own potentiality, with the creative quality being determined by the manner of their co-operation. Thus feeling, too, has to be nurtured: the infinite variability of feeling was translated into language and reduced to word concepts, which can be used as tools for a linguistic communication that is nearly an equivalent of measurable properties of sound. Such words concepts, some of which became exact terminologies, joined not much later, by virtue of mere habit, the ranks of aesthetizising technical terms. In the course of time, all these conceptually graspable words added up to vocabulary with which it was possible to discuss music, with intellect and feeling as an inseparable unit. At the same time, feeling was always at a disadvantage in spite off all aestheticizing effort of intellect, because each word concept restricts feeling.

Over the centuries, this produced a great music-theoretical literature, the basis of the craft of composition in the Occident. Rules and laws were set up to systematize the calculatable and the intuitive, with everything accepted being morally and aesthetically well based.
To differentiate between consonance and dissonance is the analogue of the difference between beauty and ugliness. Thus oriented, the musical feelings of the Occidental society were over the centuries brought to a common understanding with the tangible elements of the tones. This development extended over all spheres of music. To bring feeling and mind to a common denominator, so to speak, was a continuous effort of the professional intellect in music throughout all developments. The day was bound to come on which the indefatigable search produced new insights which then, charged with high tension, broke out of the limits of the conventional system.

Of these transformations taking place during the twentieth century I mention now only the three terms: atonality, twelve-tone music and computer music. With these innovations, forcing their way in rapidly and without preparation, a tradition-bound mass of listeners could not abide. The music aesthetics originated by Ptolemy was accepted as nature-given, so that today the 'unnaturalness' of the atonal music, is preferably given proof of by citing the overtone series of Helmholtz. The average music lover derives very little profit from the professional intellect: the solidly established aesthetics, as against this, reinforces feeling and enjoyment from his thus conditioned perception of music. This brought also music education into conflict situations.

Now the tide has turned. There has to appear a Ptolemy who does not appeal to the 'good sense of the ear', but to the good sense of the intellect, because aesthetics, having in the meantime standardized everything, has also paralyzed the professional intellect. If, in the past, it was possible, using measurable intervals, to determine the aesthetic differences between consonance and dissonance, today aesthetics is helpless when a distinction is to be made between sound and noise. Neither can aesthetics determine that order and chaos are opposites, as it has no point of departure for chaotic events.

Re-visiting Schönberg's twelve-tone order reminds us of the strict rules of the set as regards the melodic and harmonic course, while all other musical elements enjoy unlimited freedom. The fear from
unbridled freedom; the fear from chaotic freedom was an additional reason for the totalness of the twelve-tone order. For Schönberg himself, however, self-discipline in unhampered freedom was the balance-providing counterweight to strict order. Freedom was thus not chaotic, but served the interaction of feeling and intellect. This aspect points to a decisive direction on the way into the third millennium.

Before I continue my way in this direction, a surprisingly new phenomenon joins me as companion. It is the incursion of electricity into the composer's craft. It is not the electric current for our daily needs, but electricity for enhancing human energy sources for creative activity. It is the already mentioned electronic or computer music with which the technology of the twentieth century has triggered a giant step onto fallow ground.

Traditionally, it was the continuous development of musical composition that initiated the building of musical instruments, which had to meet the demands of partly mechanical, partly aesthetically newly opened-up fields of expression. At first sight, with the computer it would appear to be the opposite process: it is the composer that must meet the technical demands of the computer. Or may be there is a mutual influence at work? But then, is the computer at all a musical instrument? I believe that, on the horizon, we can already discern the central, musical event of the twenty-first century. The disciplined freethinker and his companion, the computer at his early stage, walk briskly on the way thereto.

This way towards the future will be strewn with many guesses and many questions with and without answers, with life in the third millennium already moving along it. The relation of intellect and feeling must become a cardinal factor in the musical sphere. The loss of validity of the traditional music aesthetics has already produced a gaping hole between calculation and effect.

Heavily loaded with a surfeit of experiences from the beginning to the end of the twentieth century, we walk towards a highly promising goal, fully conscious of the approaching difficulties. We
must first act on the basis of a decision to preserve and, equally uncompromising, on grounds of a necessary tearing down.

In the spiritual realm, too, there arises with time a cumulative chemical disintegration of mental substance, especially in periods of vehement mutational processes. Then there are seen to appear downright pathological manifestations on all stages of music pedagogy. Referring to this subject, of vital importance in the near future, I should like to touch upon a symptomatic detail, namely the explanatory analysis of a musical composition.

The conventional technique of analysis splits off in three directions. The first is still strongly rooted in the nineteenth century. As a prototype I might mention Paul Bekker’s biography of Beethoven, widely read even today, the larger part of which consists of analyses, or rather descriptions, of Beethoven’s compositions. May I quote from Bekker’s preface to his book: “...that the fruitful contemplation of a phenomenon like Beethoven can reside only in the translation of the material yielded into an artistically graphic visualization. Be it that, as a product of a subjective view, this visualization cannot lay claim to a general validity, be it that it carries the mark of transitoriness, yet it does possess a power that compels attention and a taking of positions, thus giving proof of its right to exist at the present time, having thereby fulfilled its noblest purpose.” The “artistically graphic visualization” extends, beyond the biographical material, first off all to the description of the compositions. This dangerous legacy has its roots in the mentality of program music. Graphic visualization facilitates immediate consumption by the listener. The abstract nature is transformed into a concrete graphic description. The tendency towards this kind of viewing music may in the future appear time and again, whenever musical intellect makes the rapid understanding of new constellations too difficult. But then, it depreciates its object.

The second of the three directions absolutely resists the blandishments of graphic hermeneutics. Here it is mathematics, as the science of number and figure that serves as the strictly abstract tool of musical analysis. The intimate relationship of mathematics
to music is given by the material affinity of tone and number. It could be logically expected that the system of the twelve semitones of the equal temperament used by dodecaphony would hold a treasure of mathematical combinations. Nature only waited for the birth of a mathematical-musical mental capacity, to have this treasure raised soon after the First World War by an American by the name of Milton Babbitt. Of necessity, his mathematical virtuosity led to the totalization of the twelve-tone series, while this technique, consistently applied, led also to the creation of structures based on the inherent serial link. The danger of totalness was already touched upon in the first chapter.

Still in the Babbitt’s generation, the sober mathematical calculation turned into the search for transcendental fields. Hoping by wiping out consciousness to reach a source of inspiration, the inclination towards transcendence became the antipode of the mathematical direction.

From these three directions there developed many ramifications, all of which act in parallel in the presence of the twentieth century and, as a heritage, will have a persistent influence on the twenty-first century. The wayfarer into the future will have to use this inherited baggage with great respect, because even where he would feel inclined to rid himself mentally of some of the ballast, a struggle is still taking place with forces that are by no means fully overcome.

This example, too, makes it clear that the entire twentieth century was a praeparandum, a preparative for the coming century. The profound transformations in all areas, which were both the result and the cause of the two World Wars that followed one another at a short interval, left their marks also on the arts in their struggle for survival. The very coining of the words 'World War — for the first time in the history of mankind — points to a change of scales. Occident and Orient are no longer terms for opposite major cultures. In their material existence, they are dependent on each other, because at their respective stock exchanges they trade according to common rules.

It is thus not amazing when a young Korean pianist, playing in the Carnegie Hall in New York, interprets a Mozart concerto, with
the Far East, Central Europe and the New World overlapping and acting according to common cultural ideals. This background of the most recent past, too, we lug along with our inherited baggage. The manifoldness, giddy-pacedness and ephemeralness of changing phenomena form the environment of this preparative of ours. Its future, long-term goal is unattainable by linear development. Temporal courses must be compressed by leaps, which causes a great many revered cultural values to fall victims to the acute lack of patience, having to clear the way. Tradition-bound contemporaries are greatly irritated by such processes and seek philosophical support by applying analytical means. Logic, however, resists misuse. It is thus the task of the preparative to keep open receptiveness for the unexpected, without losing the genuine and timeless in tradition. Seen like this, the entire twentieth century is an intensive co-operation of eruptive matter and creative outlines.

Now back again to the computer, but in different contexts.

The building of this piece of equipment and its animation by the composer goes hand in hand, as was the case with the mechanics of the piano, though on a very different level, technologically. Here, it should be understood that technology as well as composition must be imbued with a creative force, so that the two can meet at certain points, to realize new ideas. I thus refer again to the knowledge of the overtones in the physics of the tone, however with the intention of pointing out their function in computer music. Nature, as has long been known, has made each tone the dominating fundamental tone of its own series of overtones, thereby imparting to every tone a sensuous expression much like the function of the facial expression of a human being. The co-vibrating material of the generator of the tone affects the volume of the individual overtones in different ways, thereby altering the expression of the tone, called timbre. The timbre of a certain instrument would so-to-speak then be an analogue of Titian-red. Nature has also determined a fundamental arrangement of the intervals in the overtone series, namely from larger to successively smaller intervals. This musical-aesthetical decision of
nature is mirrored in the traditional theory of harmony as open and close positions in the representation of a chord.

In addition, the double repetition of the fundamental tone at the distance of two octaves is an early indication of the meaning and the use of repetition, while the subdivision of the octave into fifths and fourths postulates points of harmonic departure. Taking into account that every overtone has also his own series of overtones following the same arrangement, but that these series are of a progressively reduced volume, so that our aural capacity is aware of them only in exceptional cases, the weakness of our ears possibly appears to be an attenuation of our aural capacity devised by nature for reasons of wise economy. We therefore see that already the overtone series poses a strong challenge to our sensory faculties. With the computer, we are now in a position to accept that challenge.

From the multiplicity of impulses at the beginning of a new composition, I select that of curiosity relating to a future that demands much and promises much. I already live in that future and will readily respond to it. My first effort is not to formulate a compact or broad musical theme, but at first to compose a sound material the energy potential of which will provide me with suggestions for further utterances. I thus decide to write a composition for three tones of different characters. The programmed computer provides me with a long overtone series, which correspond to the normal aural capacity. Instead of using imitated instrument characters produced by a synthesizer, I use my experience to compose each tone while applying subjective criteria. I aim at an overtone volume that radiates an energy which, although technically not yet measurable, is nevertheless receivable sensually and transmits a content representative of the total composition. Such a tone wants therefore to be composed with great care, so that later, during the elaborative treatment, its character will not be distorted or even destroyed. A sensitive listening to this musical living being is a precondition for a congenial co-operation with the computer. The overtone series alone, however, is not enough to characterize this living being. Although it is a prominent part of its acoustic existence, the tone is not yet born.
In its birth there are present all the basic materials that will later cause this organism to mature and will put an individual end to its individual life. These three life periods are known as attack - sustain - decay. The duration of each of these parts constitutes the characteristics of each tone in its totality. Having composed the three tones, the composer can now use them to fashion his composition. The three tones are stored in the computer, every change, be it in pitch, duration, volume, overtone proportion – attack and decay – all exactly settable, are precisely realized and stored by the computer. Now follows the execution of the composition, using this very flexible raw material.

These three tones may be likened to representatives of instruments. They are not built of concrete material - they are composed. The relationship between the overtones and their fundamental tone are modifiable to form countless variants. Each of these variants has its acoustic and also its visual tectonics, which show up on the display screen of the computer. Eye and ear assist each other to perceive the internal tension of a tone – an important moment for the subsequent working out of the composition. Naturally, the formation of the three tones is preceded by the will to the message for which the three tone characters were created.

Here is a scenario for the forming of a composition. For lack of technical means, I shall provide only a verbal description of its beginning: a tone seeks traces of a neighbor. Having found him, they slowly start conversing. A third tone joins them. They form kaleidoscopically changing pictures and exhibit emotional excitement which leads them to a dramatic climax. They now collide with a strikingly contrasting transmutation of themselves by other parameters. At the point of collision, the theme is concluded. It is not a theme in the conventional melodic representation, but lives as a larva prior to turning into a caterpillar. By no means do I intend to verbally describe a composition of this kind. The above is merely meant to be an intimation of the change of form. However, it clearly shows the effect of Schönberg’s idea by revealing its core after the withered shell has fallen off. No more of system and method, but an
intensive nexus of relationship and coherence. As yet it is possible to note down the above-mentioned composition using the conventional notation, a composition also conceived in the framework of what is humanly interpretable. The imaginative activity of the human brain does not, however, rest, and soon the limbs of the human body will have reached the limits of the performable. At this point, the function of the computer will move to the fore. It is easy to foresee the jump-like proliferation of the musical information. Is the capability of our memory still sufficient to cope with the demands of this development?

The professional intellect of music was able to pull itself up on the interaction of sight and sound and could thus open up a new, wide field of corresponding feelings also to Ptolemaic aesthetics. As we concluded already earlier, composing is a process of inquiry.

At this point, something else must be added. To this day, the making of music is divided into two activities: the creative work and the interpretative work. The listener enjoys both modes, with mind and feeling enhancing one another. As music notation is full of lacunae, a rich opportunity is given to the interpreter to offer his own contribution as a commentary. This has its appeal, but also its danger. In a similar manner, the actor interprets the drama on the stage.

Now, however, the computer enters. The work of the creator is no longer documentable in music notation, since the computer is not a musical instrument on which the interpreter turns the written notes into acoustic life. Computer music of the third millennium has thus no use for the inherited notation.

I must now interrupt my excursion into the future, to report an episode from my life. Since the end of the ‘twenties I have participated in the exciting goings-on in the technology, theory and practice of electronic music. At first, electronic music strongly modelled itself on the instrumental music of the ‘moderne’. After the Second World War, it was given an explosive impetus by the galloping development of electronics, in particular, of the tape recorder. Electronic music belonged organically to experimental
music. Music notation had no function anymore, as neither tones nor their rhythm could be noted down, using the traditional notation. Everything invented in the musical context was the inspiration of the moment, together with the surprise of the electronically produced sound. The musical intellect roamed in a spiritually lawless domain: no obligation, no order, no aesthetics, no ethics. And this is essentially the situation to this very day, a situation that, in its own way, the computer has greatly underlined. The computer is a partner with strict demands: it demands from the composer a disciplined thinking in order to keep a tight rein on emotions. As a reward, the computer stores faithfully and conscientiously all information fed. If, however it is exploited as a spiritual no-man’s-land, this is also exactly stored, mercilessly exposing the foolishness of its informant who was unable to unite the world of the computer and the world of music. All this convinced me that the music of the future, which will be given its main impulse by electronic music, will be decisively affected by a notation corresponding to the sound.

This notation will not serve the performing instrumentalist as a copy, but rather, by its graphics, inform the programmed computer on every detail of the composer’s creation. Every graphic symbol is immediately stored and translated into sound, using a module developed for this purpose. The graphics printout can be used by the composer for correction, study and exploration. With this, the ideal partnership: eye and ear would in principle have re-established, and the musical intellect would again have a secure basis for its development. Such a process is clearly associated also with sacrifices. The most obvious sacrifice is the performing instrumentalist. Not only is it interesting to watch him performing. His body language, especially with conductors, provides often a graphic illustration of his music making. Still, in the meantime, the private ownership of a CD-library has educated the listener to concentrate on the music and he has learned to largely forego the graphic distractions. More serious, however, is the loss of differing interpretations. A mature composition embodies such an amount of musical spiritual goods that an ambiguity merely mirrors its richness. With the future
computer music, the composer, due to his graphic sound information, is at the same time, also his own interpreter. While this interpretation is obviously authentic, by being unique, it misses some other characteristic nuances. It is however easily assumable that, based on further technical developments, a good musician, using the composer’s originally stored information, will produce a second edition in which this or that detail is emphasized, as was in the past also the case with later Bach-Editions. The so-called ‘authentic’ interpretation, which today likes to strike a pseudoscientific pose, is basically also an interpretation, unless the interpretation adulterates the original by foisting on it foreign matter. The ‘New World’ of music of the twentieth century thus continues to press on, except that the technology of the computer is now directly linked to the human mental technology of the musician. We have already earlier touched upon the mutual influence of composer and instrument builder. Now the intensity of their relationship will lead to underrate-of results.

Before considering some other prospects, I should like to report in brief how the notation for computer music came about. In many discussions concerning partial or marginal domains of this subject it became clear to me that, to realize this project, it was necessary to secure both technical manpower and technical facilities, and their financing. I succeeded in interesting the Volkswagen-Foundation, which granted the Technical University in Haifa the required financial means. The person in charge of the laboratory for electronic music at this university is Prof. Uri Shimoni. When some years ago I joined this laboratory in the capacity of a musical consultant, I met there an electronics engineer, Mr. Shlomo Markel who was interested in my project to such a degree that he later did his PhD-thesis on this subject. We also had a close adviser in Prof. Dr. Eckhard Maronn, sound engineer and acoustics expert at the Academy of Music in Hamburg. It was largely Dr. Markel who brought the Notation for Computer Music to a technically operative stage, for which reason we decided to call this notation “Talmark Notation”. To all above mentioned persons and institutions that have so far participated in this work, I should like to express my profound gratitude. As could
not be expected otherwise, this was a co-operative enterprise, which demanded an infinite amount of patience as well as an unshakeable belief in the eventual accomplishment of the task at hand. It is in the nature of this subject that as a conclusion of our efforts we reached what is merely a viable starting point which, however, possesses all the means to attain full maturity at the end of a long way. For this reason, Dr. Markel agreed to have the essence of his doctoral thesis published in these pages. We hope that amongst the readers of both parts of the present pages there will be technicians as well as composers who will be encouraged to continue to make increasing demands on programming and development of sound.

Returning from this episode of my life, I am back again on the path leading to tomorrow and the day after tomorrow. As were the last decades of the twentieth century, so will the first epoch of the third millennium be characterized by the metabolism of the piled-up compositional material. While this was true also for the past, it is a very burdensome process for the present, because of the global production quantity. In a situation different from that in the sciences, the young composer at the beginning of the third millennium faces a theory-less music language. As a compensation for a no longer existing secure point of departure, he is confronted by roving ideologies which present themselves as music styles. When such comets have cooled down without causing much damage, they are rapidly forgotten.

Over half a century has by now passed and the next generations carry this musical domain of ideas into the third millennium. It is true, though, that recording technologies have vastly improved and the perception of what was heard has become far more acute, so that soon enough the concept ‘noise’ was experimented with also in instrumental music. The extreme registers of wind instruments, high as well as low, both wood and brass, offered a rich field of novel sound experiences. Even a string tremolo with double stops sul ponticello could evoke the soundscape of the roar of the see. It was in particular the original jazz that educated the auditory sense of the masses to accept instrumental sounds which in the past were
classified as noise. These examples demonstrate the nervous effects of sounds, whether produced conventionally or electronically. They could well serve as a basis for a contemporary Theory of Affects à la Mattheson.

With this we have reached the problem of defining the intuitive for the third millennium. Indeed a problem, because with the waning of tonality, the professional intellect of music has sunk into a big hole. It is now the task of this intellect to educate itself anew towards a healthy craftsmanship. The stage of the traditional music theory is totally empty. No more scenery behind which the intentions of the politics of art could hide. Precisely because of this, reconstruction is bound to begin with teething troubles.

Now, however, from the big hole there emerges again the spectre of dis-individualization. Given the totalizing attitude afflicting the post-serial music, its life span was only short. Yet now, the totalizing of the principle of anarchy offered an auspicious opportunity to reduce intellectual consciousness to the level of the masses. Standardization of musical slang, imitation of extra-musical environmental acoustics, constant repetition up to the total dilution of the spiritual substance, the use of musical elements such as rhythm and dynamics as narcotics for a merely sensuous nutriment, but also the cosmetic masking of cheap intellectual goods, plus variants of such methods - all this caused a rapid lowering of the level which was clearly discernible already in the first third of the twentieth century and, as a confusing means of distinguishing for purpose of the policy of dis-individualization, was defined as 'Entartete Kunst' (Degenerate Art). With this slogan, creative freedom was branded by lackeys of the total dictate.

Spengler’s utterance of the "Decline of the West" appears to have its inner logic. What is in question is the absoluteness of this decline. Botanists know that many a forest fire is caused by nature itself, to pave the way for a metamorphosis of the degenerate flora. The decline of different cultures may still have left them with sufficient energy which, after some time, presses for new manifestations. The thrust towards the sun may take a short or a very long period of
time. No doubt, the music of the nineteenth century constituted the high point of Western music creation in the tonal language. All generations that witnessed the conflagration caused by atonality as well as its aftermath and may even be still around to witness also its effect in the third millennium, know how much untapped energy is still dormant in the past and strives to be woken up, to lead music to a new zenith. This is the era’s demand from the first generation of composers of the twenty-first century.

I thus conclude my reflections with a theoretical explanation, the practical applicability of which will be decided by the future.

My theory sets out from the assumption that, in the not too far future, our view of the world will be conceivable as multi-dimensional. No existing tonal system will meet the demands of a multi-dimensional tone world. True enough, we find in the classical scale system anticipatory pointers to these demands, such as e.g., the intercalation of the semitone into the whole-tone row. The outcome of this ambiguous phenomenon is then decided by the composer, who gives the semitone either the function of a leading tone, or lets it act as a chromatic alteration of its base.

In the classical style, even the second possibility is still strictly circumscribed in its use, but as in the “Tristan” Prelude, tends towards a more remote and more ambiguous future. To prepare now new systematics for this glimpse into the expanses of the future world of tones is quite useless. We are still ignorant of the nature of the information quanta that have multiplied many times over. But to get to know it, we must set out on a planned inquiry. This is to be the beginning of my theory.

As was the case with the theoreticians of the Greek antiquity, my interest, too, is focused on the physics of the single tone. We have, however, learned much from the past and start at a relatively advanced stage of understanding. The knowledge of the physics of the tone has been joined by a specifically musical reaction.

The agogics of the fusing of all overtones into one tone can be perceived only in the end result of the complex. Here there exists a connection with the role of virtuosity in music. Not only the virtuoso
control of playing an instrument, but also the virtuoso control of the combining intellect of the composer and the virtuosity of the listener in comprehending the relationships. If we now add this particular point to all that was said earlier about the function of the overtones, a theoretical statement for the music of the future multidimension-ality constitutes already today a creative preparatory undertaking. Therefore, all of us – composers, listeners and interpreters - find ourselves invited to an enviably productive labor. The theoretical opening up of such fertile a field for the invention of tone mixtures is at the same time also a point of departure in the struggle for regenerating the individualization of musical thinking.

This, in turn, brings back the problem of temperament, but this time in a different context. The ‘well-tempered’ or equal temperament was regardful of the ‘clean’ intonation of the complex harmony. As opposed to this regardfulness, the computer not only sees no need to eliminate the Pythagorean Comma, but such an elimination is indeed entirely against its nature. Because it is in fact this Comma that opens up the micro-world for us. As it is, we are not satisfied with the splitting of the semitone into two quarter tones, we want the entire terrain between a tone and its neighbour in its finest still distinguishable subdivisions. This is no figment of the imagination, but will become a reality because, in the course of many generations, the computer will teach us the auditory perception of the micro-intervals. The fine subdivision of the interval terrain contrasts with the skipping over large areas and expresses the relationship between micro and macro structures at small and large scales.

With the introduction of the micro-world into Western music, the historic division into ‘Occident’ and ‘Orient’ is invalidated at least in this area. Spengler’s “Decline of the West” will be transformed into a rise of the global music of Planet Earth. Ethnological differentiations will be determined by the respective environment of the composers. To stabilize the colossal transformation process, which will set in at some point in the third millennium, the active co-operation of every professional musician is required.
The theoretical reflections of mine, set down in these pages, are intended as mere points of departure, possibly of use for later practical application. Of importance is to be conscious of the fact that from now on all musicians are master-builders of a tower in the world of tones, which instead of confusion, harbours understanding, and the abstract architecture of which symbolizes cultivated thinking.
Dr. Shlomo Markel

The Fusing of Art and Science in the New Notation for Future Computer Music

Musical composition as based on electro-acoustic sound generation is unique, inasmuch as a single basic sound element can be made to evolve into a complete and complex score.

The need for a practical notation for electro-acoustic music stems from the necessity to control the complex process of composition, as well as to provide access to the new computer media.

The main problem encountered in the search for a new notation for electro-acoustic composition resides in the large amount of information already contained in a single sound. Notation must therefore provide a sort of shorthand, using graphic symbols to represent the physical characteristics of the sound and the musically informative contents as they change with time.

In the electro-acoustic media, the step preceding the actual compositional work is the preparation of the basic sound element that is to serve as building block for the entire composition. These early stages deal with the infrastructure and foundations of the basic musical ideas, sorting them into two basic groups, to be known as envelope group and waveform group.

The preparatory work starts with the definition of the relative time proportions to be taken up by the three major segments of the sound, which in fact determine part of its characteristics: the attack time, the sustain time, and the decay time. By way of example, Fig. 1 illustrates this division, as represented in a conventional Cartesian
coordinate system, with the x-axis standing for time t, and the y-axis denoting the amplitude A.

![Graph of Amplitude vs. Time in Cartesian Presentation](image1)

Fig. 1 – Amplitude vs. time in Cartesian presentation, including the division into attack, sustain and decay regions

In the proposed notation, however, these domains are represented in polar coordinates. This is realized by providing an 'icon' in the shape of a closed curve, i.e. a curve extending over 360°, with the radius vector representing the amplitude, and the polar angle denoting time. As can be seen, these 360° have been divided into three segments, the attack, sustain and decay regions. In this particular example, the attack region is allocated 180°, as the attack time is of great significance with respect to the character of the sound. The rest of the 360° are split between the sustain time and the decay time.

![Graph of Amplitude vs. Time in Polar Presentation](image2)

Fig. 2 – Amplitude vs. time in polar presentation including the division into attack, sustain and decay regions.
While the previous step, represented in Fig. 2, defined the characteristics of the amplitude variation of the sound with time, the next step, illustrated in Fig. 3, deals with the definition of the pitch modulation element, which defines the 'pitch depth', that is, the frequency range (in Hz) within which the frequency of a specific sound may change, and 'pitch modulation', that is, the actual course of a sound's frequency with time.

Fig. 3 - Pitch modulation

Fig. 3 is a Cartesian presentation, in which the time domain is represented by the linear x-axis, while frequency (the pitch element) is represented by a logarithmic y-axis. The logarithmic scale in fact matches the natural sensitivity of the human ear.

Once these three elements: time, amplitude and pitch are defined, the complex within which they are correlated to one common unit, is referred to as the envelope icon (Fig. 4), of which the composer may prepare as many as he wishes, to be used (and manipulated) at later stages.

Fig. 4 - Envelope icon comprising polar amplitude presentation and Cartesian pitch presentation, including origins $F_0$ and $T_0$. 
The second basic group, as already mentioned, is the waveform group. Here, the composer defines the timbre characteristics of the sound in two possible ways: by defining the structure of the overtones of the basic pitch (the frequency element at the origin of the sound) as indicated in Fig. 5, or by arbitrarily drawing a waveform as shown in Fig. 6. In either of these ways a waveform can be defined to be replicated at the actual frequency in a complex structure score.

![Fig. 5 – Overtone structure](image)

![Fig. 6 – Arbitrarily drawn waveform](image)

The next step is to define a structure comprising as many basic waveforms as the composer desires. However, a recommended solution, tried out in practice, consists in mixing four different waveforms, while selecting the ratios between each two of the four waveforms available at the instant the waveforms are mixed (Fig. 7).
Fig. 7 – Mixture structure involving four different waveforms, in which two of the four are mixed at the instant the sound is produced.

Once the composer has assembled all the basic elements he has predefined as his musical materials, he may proceed with the actual utilization of these materials. He may thus produce superpositions of chords based on the same time and frequency values, but with different amplitudes associated with different waveform structures (Fig. 8), or with different amplitude and frequency envelopes, but within the same time region and with the same waveform structure (Fig. 9), or with the same envelopes as well as the same waveform structure, but in different frequency and time regions (melody, Fig. 10), or superposition of chords based on the same waveform structure, but with different amplitude envelopes and within different time and frequency regions (Fig. 11).

Fig. 8 – Superposition of chords of different waveform structure
In an even more complex structure, the composer can also invent a variety of sounds in parallel, combined with parallel permutations, with all these evolving from the basic sound.
Fig. 12 – Superposition of different envelopes, frequencies and time regions
1 – Chord complex consisting of two sound mixtures, each comprising two units, partly in $T_0$, partly in PM.
2 – Like 1, but with different frequencies.
3 – Like 1, with two new sound wave structures and different frequencies.
4 – Like 1, with different frequency, duration and PM.
5 – Like 3, but with changing PM.
6 – Different mixtures of 2 plus frequency, duration and PM.
7 – Like 6, with different frequency and duration in $T_{10}$ ('Melody').
8 – Like 5, but with changes in frequency and duration ('Harmony').
9 – Mixture like 1, new wave structure with shifts in frequency.
10 – Single sound, mixture like 2, new wave structure.
How these data are entered into the computer

The graphic notation can be generated in the computer on-line by the composer, or can be prepared by the composer off-line, and then entered into the computer.

The on-line approach is facilitated by providing the composer with an Advanced Graphic User Interface, which enables the composer to select the different components of the score, the envelopes, the chords and the rest of the sound elements, while providing the option of hearing the sounds ‘on the fly’. The composer may intuitively move from one layer to the other, dig down to the details, save, retrieve and superpose the variety of sound elements.

In parallel, the possibility is provided of drawing all the symbols on paper, to be subsequently entered into the computer for continuation with the Advanced User Interface. In this case, a scanner is used with additional software that reads and ‘understands’ the various symbols and signs. It also comprises packages to slim, skeleton and smooth the manually prepared drawings, identify the origin, extract the envelopes (polar amplitude presentation, pitch modulation presentation, waveform structure, chords and score), while building files in a manner enabling the computer to continue with the generation of sounds.

The above should be regarded as a very brief and condensed introduction into the basic principles of a notation for computer-based composition. It constitutes the beginning of a long-term development depending on the intimate collaboration of artistic and technical initiatives.
Josef Tal

Josef Tal (Grünthal) was born in 1910 in Pinne (now Poland). Tal's teachers at the Hochschule für Musik in Berlin included Tiessen, Trapp, Hindemith, Sachs, Kreutzer and Saal. He immigrated to Palestine (Eretz Israel) in 1934 and taught composition and piano at the Jerusalem Academy of Music, and was Director of the Academy from 1948 until 1952. In 1965 he joined the faculty of Hebrew University and eventually became head of the musicology department. In 1971 he became member of the Berlin Academy of Arts.

Numerous Tal works were written on biblical subjects, influenced by the Bible or were based on epic events in Jewish history. However, in style, Tal remained faithful to his European background and was not affected by the trends which dominated most Israeli compositions in the 1940s and 50s which, in the main, were based either on the folklore of the various Jewish communities in Israel or on the eastern musical traditions of the region. By that time, Tal was already deep into writing 12-tone music and with the passing years, his use of the dodecaphonic elements became less and less constrained.

The many honors bestowed upon him include a UNESCO grant for the study of electronic music; the State of Israel Prize (1971); Art Prize of the City of Berlin (1975); the Wolff Prize, Israel (1983); Verdienstkreuz 1 Klasse, Germany (1984); Commandeur de l’Ordre des Arts et des Letters, France (1985) and Johann Wenzel Stamitz Prize, Germany (1995).