Paris and Musique Concrète

The revival of the arts after the Second World War took place in an environment altogether more favorable for the development of electronic music. The rapid advances in technology as a result of the war, an upsurge of interest from many quarters in new sound techniques, and a generally expansionist economic climate provided sufficient incentives for institutions to provide support.

In Europe two broadcasting networks, Radiodiffusion Télévision Française (RTF) in Paris, and Norwestdeutscher Rundfunk (NWDR) in Cologne, took up the initiative. Both of these established studios of considerable importance, in the first instance pursuing radically different objectives. Movements toward new paths in musical composition during the second half of the century tended, at least initially, to polarize around select groups of activists with a strongly defended identity, and these studios were no exception. The Paris group, which will be considered first, became dedicated to the advancement of musique concrète, while the Cologne group championed the cause of elektronische Musik.

Intense disagreements developed between the studios and these were aired in public on a number of occasions, notably at the summer European festivals of contemporary music that were then approaching their zenith in terms of their international significance. The reasons for this overt hostility were not merely a matter of patriotism, although understandably this factor played a part. They lay more
fundamentally in marked differences of outlook as regards acceptable practices of electronic composition.

To talk of a group when considering the early years of the Paris studio is a little misleading, for the initiative and leadership for the project came from a single pioneer, Pierre Schaeffer. Schaeffer, an electronic engineer, served his apprenticeship with the RTF during the 1930s after initial training at the Paris Polytechnic. His technical skills led to rapid promotion, and by 1942, at the age of only thirty-two, he was able to persuade the corporation, then under the control of the German occupying forces, to initiate research into the science of musical acoustics with himself as director. From very modest beginnings as a Studio d’Essai this venture gradually gathered momentum, the more familiar name Club d’Essai being substituted in 1946. In the course of his research Schaeffer’s attention was drawn toward the use of recording techniques as a means of isolating naturally produced sound events, and in 1948 he started to consider how such material might be used as a basis for composing.

Schaeffer’s preliminary investigations, inspired to some degree by an interest in the Futurists, were concerned with an exploration of the properties of percussion sounds. His recording equipment was very basic, consisting of a simple direct disc-cutting lathe, with all its attendant limitations. Taping facilities were introduced in due course, but not before a considerable quantity of work had been carried out using the former facility. During the first four months of 1948, he studied the effect of striking a number of percussion instruments in different ways. This led him to observe that any single musical event is characterized not only by the timbre of the main body of the sound, but also by the nature of its attack and decay. On 21 April he carried out experiments recording bell tones on to disc, where by operating a volume control inserted between the microphone and the cutter he was able to eliminate the natural attack of each note. Two days later he speculated whether an instrument might be constructed to produce the sounds of an orchestral instrument by means of a bank of previously recorded events. This idea anticipated the Mellotron, an early precursor of the digital sampler introduced in 1963. This device plays prerecorded loops of tape, triggered individually via a conventional music keyboard.

Having made a superficial study of the attack, body, and decay of isolated sound events, and also the effects of playing recordings backward, Schaeffer turned his attention toward the task of resynthesis. His first work, Etude aux chemins de fer, was constructed from recordings made at the depot for the Gare des Batignolles, Paris. These included the sounds of six steam locomotives whistling, trains accelerating, and wagons passing over joints in the rails. The piece was constructed for the most part from successive rather than overlaid extracts of material, and this drew particular attention to the repetitive characteristics of the sounds. Schaeffer quickly realized that sources retaining a significant proportion of their identifying characteristics after processing created major problems of association. As a result, the piece was more an essay on the activities of a seemingly schizophrenic goods yard than the intended creative study in sound.

In an attempt to overcome this difficulty he reverted to more conventional sources of musical sounds, investigating the effects of playing recordings at different speeds. This led to the discovery that such alterations affected not only the pitch and overall duration of individual events, but also their amplitude envelope (attack-body-decay). Such interdependence made it impossible to vary one of these characteristics without affecting the others. A further study of the relationships between these intrinsic features led to a series of short Études, realized during the early summer of 1948.

The Étude pour piano et orchestre endeavoured to combine the sounds of an amateur orchestra tuning up with a spontaneous piano improvisation played by Jean-Jacques Grunenwald. The result was largely unsatisfactory in musical terms, for there was no coherent dialogue between the areas of sound material, creating the impression that two apparently unconnected pieces had been crudely mixed together. This early discovery of the problems of integrating dissimilar sources was an important one, for it identified a major stumbling block for composers of electronic music. Two of the studies, Étude au piano I and Étude au piano II, were based on sounds derived from the piano alone. Schaeffer had considered the possibility of a piano à bruits from a very early stage in his investigations, unaware at the time of similar experiments by John Cage in America. His provisional conclusions, however, led him to reject live performance on a modified piano as little more than a simple extension of the normal characteristics of the instrument, and these studies were created instead by manipulating recordings of traditionally produced sonorities. Pierre Boulez created the source textures, the intention being to reflect different musical styles, for example, classical, romantic, impressionistic, or atonal. Schaeffer then endeavored to achieve a degree of continuity by careful juxtaposition of the selected material, but once again the fragmentary nature of the latter proved problematical.

The first public presentation of these pieces took the form of a broadcast entitled Concert à bruits, transmitted by the RTF on 5 October 1948. The reactions of the unsuspecting listeners were fiercely divided, developing into a spirited controversy both in musical circles and the general press. Further developments, however, had to wait for several months, for Schaeffer was posted abroad until the spring of 1949 as an official representative at a number of symposia on recording and broadcasting. On his return, he approached the RTF with a view to gaining the funds necessary for supporting a team of assistants. In response, they appointed the composer Pierre Henry as co-researcher, and as studio technician seconded the sound engineer Jacques Poullin, who had already expressed an interest in Schaeffer’s work. During the summer of 1949, Schaeffer began to reappraise the role of natural instruments as sound sources, carrying out experiments that retraced much of the ground covered by Varèse some twenty years previously. His next
piece, *Suite pour quatorze instruments*, is of particular significance, for it provided the starting point for his work on a syntax for *musique concrète*.

His main preoccupation at this time was the possible parallels that might be drawn between the processes of conventional and *concret* composition. This led to the identification of two distinct methods of approach. On the one hand, composers may choose to start the creative process by developing a clear concept of the sound structures they wish to achieve. Such a picture then requires rationalization and modification in terms of the available practical facilities, leading in the case of *concret* to a precise set of studio routines, which may then be executed. On the other hand, composers may wish to start with a selection of potential sound sources, offering a range of characteristics with which they may experiment, building up from the results of such investigations the elements for a complete composition.

These distinctions were to prove important not only for Schaeffer, but for the development of electronic music in general, for they highlight important procedural difficulties encountered in relating the subjective world of musical creativity to the objective, scientific world of the sound studio. It will be seen in due course how the former approach requires provision of a versatile specification language, capable of translating a variety of musical ideas into equivalent studio procedures. The latter approach, by contrast, involves a less complex dialogue between the composer and the system, built around the functional characteristics offered by the devices themselves, or in the case of *concret* the intrinsic characteristics of the chosen sources. Classical ideas of an "orchestra" and a "score" may thus be pursued, electronic devices, where appropriate, taking the place of traditional instruments.

In practice most composers have drawn upon aspects of both approaches and Schaeffer was quick to recognize the existence of a dichotomy. His earlier pieces had for the most part proceeded from a general idea of the desired result to an attempt at its realization by the selection of suitable material and processes. In the *Suite* he experimented with almost the reverse approach, studying the intrinsic characteristics of instrumental music and then applying suitable *concret* procedures to produce a new musical work. Each of the five movements highlighted one particular aspect of this compositional method. The Courante, for example, was a monody assembled from the juxtaposition of short extracts drawn from the entire library of source material. The Gavotte, in contrast, used interpretations of one short musical phrase on different instruments, juxtaposed to create a set of variations. Extensive use was made of pitch transposition, effected by playing the source recordings at different speeds.

Schaeffer was not happy with the musicality of the results, and not without cause. The latter movement suffered particularly badly from its reliance on a single phrase, which despite many interpretations and transpositions retained many of its original characteristics. As a result the primary impression gained was one of monotonous repetition with little sense of shape or direction. These difficulties provoked him to carry out closer analyses of the nature of sounds, leading to a preliminary definition of an *objet sonore*, a basic sound event, which is isolated from its original context and examined in terms of its innate characteristics outside its normal time continuum. He asserted that the abstraction of such events from natural sound sources to provide components for the regeneration of musical material required processes compatible with the principles of post-Webern serialism (this was later to be challenged fiercely by the German school of *elektronische Musik*).

Schaeffer tried to establish why his transformation procedures failed to remove or materially alter many of the distinctive characteristics of his sound sources. He concluded that techniques such as playing recordings at different speeds or in reverse, and the use of elementary montage, did not produce anything essentially new. The use of musical instruments, musical habits, and musical structures had conditioned the way in which he had carried out his processes of analysis and resynthesis, and it thus seemed appropriate to return to his original starting point, the world of noises, as a more basic source of sound information. Such a move, however, did not remove the problems of association, as he had already discovered in preparing *Etude aux chemins de fer*, and it proved necessary not only to examine the nature of sounds in more detail but also to perfect an expanded range of transformation techniques.

Taking sound events of varying lengths and degrees of complexity as sources, Schaeffer began to study them not only on a "macro" level as before, identifying the primary characteristics of the structures as a whole, but also on a "micro" level. The latter approach involved examining the inner detail of the characteristics themselves, for example the way in which an attack developed, or the changes in timbre occurring during the body of a note. Such exercises, however, did not offer any major solutions to the problems already posed. At one extreme, the "micro" elements were still of sufficient duration for the retention of distinctive characteristics that would survive processes of juxtaposition and transposition. At the other extreme, the division of sound events into too short a series of extracts led all too quickly to the isolation of meaningless "blips."

Despite these setbacks, Schaeffer decided that his investigations had reached a stage where he was ready to embark on a major piece of *musique concrète*, and in collaboration with Henry commenced work on *Symphonie pour un homme seul*. During the early stages of formulating his ideas, Schaeffer encountered considerable difficulty in selecting suitable sources of material. Two lines of development were uppermost in his mind at this time: (1) the extension of the possibilities of instrumental sources by means of new technical aids, and (2) the development of his principles of *objets sonores*, and their rules of composition.

His quest for an area of sound material that would prove sufficiently rich to sustain a major composition led him to select a source which in many respects offered connections with instrumental material and noises; the sounds of a man. His ini-
tial idea was to select sound material solely from noises that could be produced naturally by the man, for example breathing, walking, and whistling. These sources, however, proved too limiting and this selection was soon extended to include sounds drawn from the man’s communication with the world via his actions, for example, the production of percussive sounds, or the playing of orchestral instruments. The inclusion of a prepared piano in the latter category was inconsistent with his earlier views on such devices, and this element of ambivalence suggests that Schaeffer had still some way to go before achieving a thorough consolidation of his ideas. In this instance, the influence of Henry clearly served to widen his artistic outlook, resulting in a less dogmatic approach to the use of technology as a compositional tool. The final catalogue of sounds selected as sources was as follows:

**Human sounds**
- Various aspects of breathing
- Vocal fragments
- Shouting
- Humming
- Whistled tunes

**Nonhuman sounds**
- Footsteps, etc.
- Knocking on doors
- Percussion
- Prepared piano
- Orchestral instruments

The work is divided into eleven movements, some of which are modeled loosely on classical structures, for example, Partita, Valse, and Scherzo. The rhythmic pattern of the spoken word or phrase acts as the central theme, highlighted by the use of repeated loops and the juxtaposition of extracts with complementary fragments of instrumental and percussive patterns. The mood is light and humorous, contrasting sharply with the rigid structures of the early pieces of *electronische Musik*.

During the winter of 1949–50, Schaeffer and Henry turned their attention towards staging the first public concert of *Musique concrète*, finally presented in the hall of the École Normale de Musique, Paris, on 18 March, the *Sympathie* providing the central feature. Schaeffer was at last able to investigate how the characteristics of a concert auditorium might best be exploited, and accordingly designed and built a complete live performance system incorporating several sets of turntables, loudspeakers, and mixing units. The performance did not go as smoothly as expected, for the routines involved in mixing and projecting the sounds around the hall were under-rehearsed, and the complexities of creating live montages from unwieldy turntables proved at times overwhelming.

The concert, nevertheless, was well received by many of those who attended, and was followed by further public recitals on a more modest scale in the Club d’Essai, where the equipment of Schaeffer’s studio could be utilized more conveniently. The critic Roger Richard, writing in the magazine *Combat*, 19 July 1950, noted that:

>A public not especially prepared or warned to be on their guard readily accepts the impact of this extraordinary music... *Musique concrète* is ready to

leave the laboratory. It is time musicians exploited it. When musicians and musicologists such as Roland Manuel, Olivier Messiaen and Serge Moreaux express interest in it we can trust in this departure.

After a short period of absence, Schaeffer returned to his studio in the autumn of 1950 to find Henry working on two of his own compositions, *Concerto des ambiguïtés* and a *Suite*. Henry had encountered considerable difficulty in devising an acceptable method of notation for his construction score. Accordingly, Schaeffer became preoccupied with the task of creating a practical syntax for *musique concrète*, using these two works as experimental models. The characteristic source phrases in the *Concerto* had been notated traditionally whilst the material for the *Suite* consisted of a series of graphic drawings. The structure of the *Concerto*, however, rapidly rendered the use of conventional scoring unsatisfactory, for the principal sound source was a prepared piano, producing acoustic results that differed significantly from the note/events suggested by the original score.

After much thought he concluded that it was necessary to assemble a *soffège* for the *objets sonores* that would classify sounds in terms of hierarchies of tessitura, timbre, rhythm, and density. A provisional system of scoring was adopted, closely modeled on the classical Western music system. Using conventional five-line staves for each sound element, a page of the score was divided into four areas: (1) living elements such as voices, (2) noises, (3) prepared instruments, and (4) conventional instruments. The time scale was linear, drawn along the bottom of the score in seconds, with a vertical dashed line every five seconds. For natural instruments and vocal sources normal clef and notational symbols were employed, excepting that the duration values of the individual pitches had to be modified to conform to the time axis. For concrete sounds, elements of standard notation were combined with extra graphical symbols to give an approximate indication of the events’ pitch characteristics with respect to time. Schaeffer appreciated that the method suffered from several disadvantages, for example, the use of the vertical axis to represent pitch precluded any clear indication of timbre. This method of representation was nevertheless a distinct improvement.

The year 1951 was to prove extremely important from a technical point of view, for the RTF agreed to provide Schaeffer with a new studio. This development led to the introduction of the tape recorder as the principal recording medium in place of the ageing disc cutters. The effect was considerable, for the whole philosophy of *Musique concrète* was based on the simple manipulation of microphone recordings, the use of electronic sound sources and electronic processing devices being expressly forbidden. The initial reaction was singularly unenthusiastic, for the long and close association with the old equipment had fostered a methodology such that its limited facilities had become a major part of the musical process. Familiarization with the enhanced capabilities of tape, however, gradually dispelled such prejudices, although it was some time before the disc cutters were totally abandoned.
In addition to a set of conventional tape recorders, including, however, one capable of registering five independent tracks of sound, three special versions were also installed. One of these, known as a Morphophone, was fitted with a row of twelve playback heads instead of the usual one. Each head in turn thus reproduced the sounds captured via the recording head, producing delayed echoes that could be mixed to create a pulsed type of reverberation. The two other machines, known as Phonogènes, were designed to play prerecorded tape loops via a single replay head at different speeds. One provided a continuously variable range of tape speeds while the other, controlled by a twelve-note keyboard with a two-position octave switch, provided twenty-four tempered pitch transpositions.

Pouillon had been particularly concerned with the problems of sound distribution in an auditorium ever since the experience of the first public concert of musique concrète. The ability to record five sound channels on a single reel of tape provided the basis for a well-organized system of multichannel distribution, and this inspired him to develop a sound projection aid known as a potentiomètre d’espace. It is important to appreciate that very little was known about the practical applications of multichannel recording in the early 1950s. The monophonic long-playing record, with its extended fidelity, was only just beginning to pose a serious challenge to the old 78s, and the stereophonic groove had yet to leave the research laboratory. Pouillon’s enhancement of a multichannel playback system was thus quite remarkable for its time, offering composers the opportunity to explore spatial projection as an added dimension for musique concrète. Four loudspeakers were employed to reproduce discretely encoded sound information, recorded on four of the five available tracks. Two loudspeakers were positioned at the front of the auditorium on either side of the stage, a third in the center of the ceiling, and the fourth halfway along the back wall.

The effects of off-axis listening, arising from the impossibility of seating an entire audience at a point equidistant from all the loudspeakers, were minimized by employing specially designed units that concentrated their energy in a 60° cone, thus increasing their power of direct sound projection. This arrangement had one major advantage over the more usual four-channel convention of a loudspeaker in each corner, for the use of a ceiling loudspeaker made it possible to create illusions of vertical as well as horizontal movements, adding an extra spatial dimension to the diffusion of sound. The fifth tape track supplied an additional channel of information, to be distributed between the four loudspeakers by a concert performer operating the potentiomètre d’espace itself. The latter consisted of a small hand-held transmitting coil, and four wire receiving loops arranged around the performer in a tetrahedron, representing in miniature the location of the loudspeakers in the auditorium. Moving the coil about within this receiving area induced signals of varying strengths in the loops, this information being applied to electronic amplitude controls, regulating the distribution of the fifth track between the four channels.

The new studio led to a considerable expansion of activities. Schaeffer and a growing number of associates adopted the title “Groupe de Musique Concrète, Club d’Essai.” This organization was subsequently renamed “Groupe de Recherches Musicales” (GRM) in 1958, and formally adopted by the RTF as part of “Service de la Recherche de l’ORTF” in 1960. During 1951 Schaeffer and Henry worked intensively on the first opéra concrète, Orphée 51. Many practical problems arose in the construction of a score, and Schaeffer found his visions of a grand opera greatly tempered. After a less than satisfactory premiere in Paris the work was revised and considerably expanded as Orphée 53 for a performance at Donaueschingen in October 1953.

The difficulties encountered in sketching Orphée forced Schaeffer to develop still further his ideas regarding a solfège for musique concrète. This led him to formulate the idea of an orchestre concret, based on the observation that certain sounds would continue to display specific characteristics whatever the degree of transformation effected, within the perceptual limitations of the human ear. The persistence of these characteristics resulted in these elements being treated as “pseudo” instruments, notated in the realization score in a manner similar to that accorded to conventional instruments.

Schaeffer also felt it necessary to prepare two entirely different types of score. These were: (1) la partition opératoire, concerned with registering the technical procedures invoked within the studio, and (2) la partition d’effet, concerned with indicating the development of musical ideas in terms of parallel staves, each associated with an element of the orchestre concret. To an outside observer an idea of the structure of the work could only be given by the second representation, this taking the form of the provisional score discussed earlier. The notational system, however, was still far from adequate, and the problems of sound classification greatly retarded his progress throughout 1951. These frustrations precipitated a deep personal crisis, exacerbated by the discovery that his colleagues were more interested in developing musical ideas within the constraints of the existing studio than with the task of pioneering new techniques and developing an associated morphology. This conservatism disturbed him greatly, for he could foresee not merely disagreements but more serious conflicts arising between musicians and scientists over the future of the medium.

His morale was boosted considerably by the appointment of the scientist André Moles as a research member of the team during the summer. Moles had become interested in the study of perception and had written a thesis on the physical structure of recorded sounds. His results closely concurred with the observations of Schaeffer, and a further study of the relationships between composers and their sound worlds led to analyses of psychoacoustic phenomena that were to prove invaluable in the quest for a solfège. He was also acutely aware of the problems of communication encountered in using an electronic medium for composing. Accordingly he also advocated the design and development of machines that could record and display acoustical features in a graphic form.
It was during 1951 that the previously mentioned disagreements between the proponents of musique concrète and elektronische Musik began to erupt. Schaeffer and Henry's Symphonie pour un homme seul, broadcast on radios Cologne (NWDR), Hamburg, Baden-Baden, and Munich, was received with considerable hostility by those who preferred the German approach. The Summer School at Darmstadt, the Internationale Ferienkurse für neue Musik, took up the controversy by organizing a symposium on the subject of sound technology and music. The French and the Germans disagreed violently and the Swiss criticized both for describing their work as "music."

Schaeffer returned to his studio to spend several months in a further period of consolidation, determined to defend and expand the aesthetic principles in which he believed. His diary at this time reflects the conflicts that arose at Darmstadt. In particular, he criticized the concepts of elektronische Musik for providing no obvious key to these problems of communication associated with contemporary music. He also denied the suggestion that musique concrète had no connection with the musical languages of Schoenberg and Stravinsky, saying that it had a middle role to play, between the polarities represented by the two composers. In support of this view Schaeffer equated techniques of montage and tape looping with the polytonal and polyrhythmic structures of Stravinsky. He also suggested that the objet sonore provided a basis for an extension of Schoenberg's Klangfarbenmelodie, reaching beyond the concept of a melody of timbres derived from a series of pitches to include more comprehensive structures derived from other acoustical features.

In 1952, Schaeffer finally published a definitive syntax for musique concrète in the form of a treatise entitled "Esquisse d'un solfège concret." This appeared as the last section of a book, A La recherche d'une musique concrète, which outlined the events of the previous four years. The treatise is divided into two main sections. The first consists of a set of twenty-five provisional definitions for use in the description of objets sonores, and the basic processes that might be applied to them, while the second is concerned with the application of these definitions to create an operational language for the synthesis of musique concrète.

The twenty-five provisional definitions may be summarized as follows:

1. Prélèvement, concerned with the initial action of creating a sound and then recording it on disc or tape.

Any such sound event (objet sonore) is then classified in two ways, each associated with its own set of definitions:

A. 2. Classification matérielle des objets sonores, the material classification of sounds prior to any aesthetic or technical analysis. This classification is based on the temporal length of each sound and its center of interest. Three classes are identified:

3. Échantillon, a sound lasting several seconds or more with no clearly defined center of interest.
4. Fragment, a sound lasting one or perhaps a few seconds with a clearly defined center of interest.
5. Éléments, short extracts isolated from a sound, for example the attack, decay, or part of the main body of the event.

B. 6. Classification musicale des objets sonores, value judgments on the nature of sounds, in particular their degree of complexity. Four classes are identified:
7. Monophonie, concomitant elements isolated by the ear from an accompanying texture. Schaeffer draws a parallel with the subjective ability to identify a melody within a polyphonic texture.
8. Groupe, a monophonie of some significance lasting many seconds, which may be studied for its internal development or repetitions. A groupe, by definition, is constructed from cellules or notes complexes:
9. Cellule, thick sound complexes with no overall shape, involving rapid changes of rhythm, timbre, or pitch, or complex combinations of notes that cannot easily be discerned.
10. Note complexe, any element of a monophonie that displays a sufficiently clear envelope (attack, body, and decay) to be equated to a musical note. Schaeffer adds a rider to the effect that the element also must be of a simple nature.
11. Grosse note, a note complexe in which the attack, the body, or the decay is of a significant duration. Beyond certain limits, a grosse note must be treated as a groupe.
12. Structures, the ensemble of material with which the composer starts his examination. This may consist not only of cellules or notes complexes but also of ordinary notes, prepared or not, obtained from classical, exotic, or experimental instruments.

The next group of definitions identifies the operations involved in processing sound prior to the main task of composition:

Manipulations. Three types are identified:
Transmutation, any manipulation of the material that leaves the form essentially unaltered.
Transformation, any manipulation that alters the form of the material, rather than its content.
Modulation, any manipulation that is not clearly a transmutation or a transformation, but a variation selectively applied to one of the three attributes of pitch, intensity, or timbre.
Paramètres caractérisant un son leads on from definition (16) to propose
parameters for the analysis of concret sounds. In place of the classical notions of pitch, intensity, and duration, Schaeffer substitutes the idea of:

18. Three plans de référence, which describe the evolution of each of these quantities as a function of one of the others: pitch/intensity, pitch/duration, and intensity/duration.

The importance of these plans merits a close examination of their characteristics, and these will be returned to in due course.

The next group of definitions describes the primary processes involved in realizing a piece of musique concrète:

19. Procédés d’exécution. Six operations are identified, the last three being concerned with the spatial organization of the material in its final realization:

20. Préparations, the use of classical, exotic, or modern musical instruments as sound sources, without any restriction as to the mode of their performance.

21. Montage, the construction of objets sonores by simple juxtaposition of prerecorded fragments.

22. Mixage, in contrast to montage, involves the superimposition of monophonies, to create polyphonic textures.

23. Musique spatiale, all music that is concerned with the projection of objets sonores in space during a public performance.

24. Spatialisation statique, the projection of clearly identifiable monophonies from specific locations. This feature arises from the use of different channels on the multitrack tape recorder for the distribution of information at the time of mixage.

25. Spatialisation cinématique, the dynamic projection of objets sonores during performance using the potentimètre d’espace.

These definitions by their very nature could only serve as generalizations of the various processes involved in the earlier stages of musique concrète. The whole soffège was subjected to significant change as Schaeffer’s work continued, and ultimately consolidated in a formidable work, Traité des objets musicaux, which appeared in 1966.10 This synopsis nevertheless gives a useful insight into the philosophical principles applied during the period of its gestation. Indeed, the three plans de référence have a more lasting significance that extends well beyond the limited sphere of concret composition, for they are germane to any psychoacoustic study or synthesis of sound material.

Schaeffer defined his plans as follows:

1. Plan mélodique ou des tessitures, the evolution of pitch parameters with respect to time.

2. Plan dynamique ou des formes, evolution of intensity parameters with respect to time.

3. Plan harmonique ou des timbres, the reciprocal relationship between the parameters of pitch and intensity represented as a spectrum analysis.

These three plans may be combined as follows:

The result highlights the problems encountered in creating a visual representation of sonic events. Although several attempts have been made to improve on this model over the years, the impossibility of reducing such detail to a single two-dimensional graph has proved a major stumbling block. The model cannot be expanded to embrace multiple objets sonores, and is in itself only capable of limited accuracy. The plan harmonique, for example, only provides an accurate indication of timbre at one selected instant during the course of the event. If this spectrum changes significantly several extra plans harmoniques might be required to represent the timbre at different stages in the evolution of the objet sonore.

Schaeffer was only too well aware of these difficulties. His solution was to construct a syntax that was based on a limited number of descriptive criteria for each plan. This involved a rationalization of the seemingly infinite range of sonic possibilities into categories that were neither too specific nor too vague. His approach was based on the following line of reasoning: In the strictest sense, it is impossible to give a simple description of the evolution of pitch with respect to time unless the sound under examination is exceptionally pure. As noted earlier, a thorough description would demand the superimposition of the plan harmonique both on the plan mélodique, to obtain a frequency/time graph of partials, and also on the plan dynamique, to obtain an amplitude/time graph of partials. Such an outcome destroys the whole purpose of the simplified analytical model.

Fortunately, the psychology of perception offers a viable compromise, for the brain, when evaluating the quality of a sound at a selected instant, takes into account the acoustic phenomena that immediately precede it. Indeed, there is a minimum sampling time necessary for the comprehension of any sonic event. Experiments have shown that sufficient information is contained in extracts of the order
of about one twentieth of a second for the brain to identify any center or centers of pitch interest with some degree of certainty. Lengthening the analysis interval permits the ear to study the changes in these centers with respect to time.

Schaeffer's approach is of considerable significance, for it focuses attention on aspects of psychoacoustics that are an essential part of any study or manipulation of sound material, whether natural or electronic in origin. He made an important distinction between two very different elements regularly encountered in objets sonores: (1) the complex spectrum associated with a sharp attack or an abrupt change in content, and (2) the more ordered, slowly changing spectrum usually associated with the body and the decay. The latter characteristic is particularly clear if the objet is a note with a definite pitch center. The former characteristic is often described as a transient response, an important feature in many natural musical sounds. One of the major problems of all-electronic synthesis even today is the difficulty encountered in creating satisfactory transients, and this key aspect will be returned to in due course.

During attack transients the spectrum table is extremely complex, so much so that a plan harmonique drawn during this particular stage of a sound would be most misleading, for its content will be undergoing rapid changes only partially comprehended by the ear. The spectral elements are in many instances so disordered that the result is a semicontinuous spectrum of noise, indicated on the plan mélo Dialogue by a wide shaded band or bands of frequencies. The body and the decay, by contrast, are often sufficiently stable for a much narrower band or bands to be drawn, in particularly clear cases reducing to a line. Schaeffer thus proposed that a single plan harmonique for an objet sonore should be drawn during the body of a note, at the point where the spectrum reaches its greatest state of development. The preceding diagram illustrates the use of the three plans to identify the salient features of a sound of moderate density, displaying three predominant areas of partials after an initial transient. It also reveals that the decay is characterized by a more rapid attenuation of higher partials relative to their lower counterparts.

Five principal criteria were proposed for evaluating the plan mélo Dialogue, to be associated specifically with the pitch characteristics displayed during the body of the objet sonore. These were: (1) stable, displaying a fixed pitch characteristic; (2) cyclic, displaying a pitch vibrato of about 5 to 6 Hertz (Hz); (3) continuous ascent; (4) continuous descent; and (5) discontinuous, where the pitch flickers in a complex fashion.

Suggestions for subsidiary criteria included a variation on (2), spinning, to describe sounds that fluctuate more rapidly about a central pitch, and a variation on (5), indistinct, to describe the pitchless quality of uniform noise.

The principal criteria for the plan dynamique were divided into four groups, one for the attack, two for the body, and one for the decay. Three principal criteria are specified for the attack: (1) plucked, (2) percussive, and (3) aeolian.

Two subsidiary criteria were suggested for use in describing the artificial types of attack encountered in the use of concret techniques: (1) stepped, to describe an attack that develops as a succession of terraced levels, and (2) pulsed, to describe an attack that develops in successive waves.

The decision to provide two complementary sets of principal criteria for the body of the sound requires some explanation. Schaeffer clearly felt it desirable to classify not only the nature of the body itself but also the way in which it develops out of the attack. Six principal criteria were proposed under the latter heading. These were: (1) shock, no sustaining into a body at all; (2) natural resonance, the sound sustained by a smooth natural reverberation; (3) artificial resonance, the same effect created by artificial overlaying; (4) drubbing, a beating continuation of the attack impetus; (5) pulsation, sustaining by repetition of the attack either sequentially or by partial overlaying; and (6) artificial, a synthetic sustaining characteristic produced by a montage of various elements.

Five principal criteria were proposed for the body itself, with the intention that these should be treated as complementary to the criteria for the plan mélo Dialogue,
ruptions to the natural decay characteristic; and (5) artificially cyclic reverberation, superimposition of an amplitude vibrato onto the decay.

The plan harmonique, as already observed, provided an analysis of the timbre spectrum of an objet sonore, most suitably at the peak of its development. Schaeffer’s approach was slightly different for this plan, for he divided his principal criteria into three complementary groups, concerned respectively with density, richness, and coloration. Four principal criteria of density were proposed: (1) pure, a single fundamental tone; (2) blurred, a less distinct fundamental; (3) thick, an identifiable primary area of frequency, but with no clear fundamental; and (4) white, no distinct frequency area.

The decay of a sound, concerned with the gradual dissipation of the accumulated energy, was accorded five principal criteria. These were: (1) cut dead, rapid decay with almost no reverberation; (2) normal reverberation, a natural exponential decay; (3) artificially extended reverberation, generally involving a subsidiary peak of reverberant energy; (4) artificially discontinuous reverberation, sharp inter-
in intensity up the spectrum; (2) clear, few partials, but with a more evenly distributed energy spectrum; and (3) brilliant, a similar energy distribution to that shown in a clear sound, but with a greater number of upper partials forming more concentrated groups.

These thirty-three criteria, for all their generalities, provide for some 54,000 different combinations of sonic characteristics, a daunting indication of the scale of the task facing any prospective morphologist. The “Esquisse d’un solfège concret” was only intended as a preliminary treatise, designed to serve the needs of a particular school evolving around the philosophy of musique concrète. It is pertinent, nevertheless, to note that this pioneering attempt to study the nature of sound in relation to the electronic studio provided a major point of reference for those who have subsequently sought to pursue this important area of psychoacoustic research.

The year of publication could not have been more auspicious. During the rebirth of the arts after the Second World War, Paris had become increasingly important as a focal point for developments in new music. Composers who worked in the studio at this time included Jean Barraqué, Pierre Boulez, Michel Philippot, and Hermann Scherchen. Others to visit the facilities included Yves Baudrier, Marcel Delannoy, Henri Dutilleux, Karel Goeyvaerts, Jean-Jacques Grunenwald, André Jolivet, Olivier Messiaen, Darius Milhaud, and Karlheinz Stockhausen. The compositional ideas of the period influenced the way in which concret techniques were developed, particular interest being paid to the application of serial or similar determinate procedures for the specification of duration, pitch, dynamics, and timbre. Messiaen, for example, produced a short study, Timbres-durées, and Boulez employed a precise plan for both duration and pitch in his Étude I sur un son, using the Phonogenes to give chromatic intervals and octave transpositions of a single sound source. Neither of these composers, however, sustained more than a passing connection with Schaeffer’s studio, discouraged perhaps by the inevitable lack of refinement at this time.

Stockhausen’s brief association with the studio arose during his year’s study with Messiaen at the Paris Conservatoire. Goeyvaerts had drawn his attention to the synthesis possibilities of the sine wave generator, and the recording facilities at the Club d’Essai attracted him for reasons that were distinctly counter to Schaeffer’s ideas. Stockhausen nevertheless completed a short piece of musique concrète, a short rhythmic study entitled Étude (Electronic Composition 1953 no. 1) before returning to Germany in early 1953 to start his long association with developments at Cologne. In 1954, Milhaud produced a work entitled La Rivière endormie for mezzo soprano, two actors, orchestra, and tape, and Varèse visited the studio to produce the first version of the tape part for his piece Déserts, an important event that will be returned to in a later chapter.

Toward the end of the decade the principles of musique concrète became far less prescriptive, more elaborate electronic processing techniques gaining gradual acceptance. Natural rather than electronic sound sources, however, were to remain the primary interest for many composers. During 1957–8, the Greek-born composer Iannis Xenakis produced his first major studio work, Diamorphoses (revised 1968), in which he applied principles of mathematical organization to the processes of composition with concret sounds. The mechanistic influence on the modern world is reflected in the choice of sonic material, for example jets, bells, and the sounds of physical destruction.

Over the same period, Schaeffer began a major reorganization of both his methods of composition and also the studio itself, and the term musique concrète was replaced by the far more universal description experiences musicales. Schaeffer’s two major compositions of 1958, Étude aux allures and Étude aux sons animés, also demonstrated a significant change in his creative outlook. Instead of concentrating on the manipulation of material extracted from naturally generated sound sources, he placed considerable emphasis on the reverse technique of additive synthesis, building up rich timbres from simple electronic components. This approach reflected the philosophies of the Cologne and Milan studios, both to be discussed
shortly. Henry departed to found his own studio Apsome elsewhere in Paris, and Luc Ferrari and Francois-Bernard Mâche joined Schaeffer's team, the group renaming themselves "Groupe de Recherches Musicales" (GRM), as noted earlier.

Diversification of ideas and techniques was by then leading to very new pastures for some. Xenakis, for example, having worked with sounds of both natural and electronic origin, began to experiment with computers, first as normal data-processing machines and then as sources of synthetic sounds themselves. By the early 1960s, work inspired by Schaeffer's studio was merging with other lines of development to create a rapidly expanding medium of electronic music; the age of isolated pioneering was coming to an end.

Cologne and *Elektronische Musik*

*Elektronische Musik*, unlike *musique concrète*, was pioneered not as the result of the efforts of a single individual, but as the result of a collaborative venture between several interested parties, drawn from both musical and technical backgrounds.

During 1948, Dr. Werner Meyer-Eppler, at that time director of the Department of Phonetics at Bonn University, was visited by Homer Dudley, a research physicist at Bell Telephone Laboratories in New Jersey. Dudley brought with him a newly developed machine called a Vocoder (Voice Operated reCOrDER), which could operate both as a speech analyzer and also as an artificial talker. In the former capacity, the instrument operated by detecting the energy levels of successive sound samples measured over the entire audio frequency spectrum via a series of narrow band filters, the results being displayed graphically as functions of frequency energy against time. The relative levels detected by these filters thus produced a dynamic analysis of the changing timbres. Synthesis, the reverse process, was achieved by scanning graphs displaying shaded representations of selected timbres and supplying the characteristics to the feedback networks of the analytical filters, suitably energized from a noise generator to produce audible spectra.

Although the fidelity of the machine was limited, its purpose being primarily to process speech rather than music, Meyer-Eppler was considerably impressed by its functional characteristics. During 1949, he published an account of the history