

## Technology and the Instrument

This chapter appears in: in *musik netz werke - Konturen der neuen Musikkultur*, Bielefeld: transcript Verlag, 2002

In this chapter I shall discuss certain aspects of the theories of Pierre Schaeffer (1910-1995). Schaeffer was a French composer and music theorist. An extensive body of work including a reevaluation of the notions of the “instrument” and “instrumental thought” resulted from his interaction with technology. My interest in these theories stems from the researches I have undertaken as a musicologist. However, Schaeffer was concerned with what is called “interdisciplinarity” (his book the *Traité des Objets Musicaux* is subtitled “essais interdisciplines”) and he attempted to identify connections between distinct disciplines. Consequently, his works extend beyond musicological concerns and are a valuable resource for examining the influences of media technology (such as sound recording) on music. I am responsible for research on a degree programme called “Sonic Arts” which is based in London at Middlesex University. Our curriculum includes various art forms using sound as the principal means of articulating structure and creating meaning. Thus, students investigate not only electroacoustic music, digital audio and synthesis but also installation art, radiophonic art, interface design, interactive composition and sound design. Schaeffer’s theories are relevant to several of these areas and his researches provide a valuable framework for the understanding of many musical activities - both theoretical and practical. Indeed, it is precisely in the clarification of the term “instrument” where the application of Schaefferian theory has much to offer. With the proliferation of musical languages and the pervading use of technology in all areas of music, Schaeffer’s theories deserve greater recognition.<sup>i</sup>

The “instrument”, as traditionally defined, seems to be a redundant notion when applied to the medium of electroacoustic music, computer music or music created over the Internet. Composers frequently suggest that studio equipment now occupies an analogous position in the musical process<sup>ii</sup>. However, such claims can be simplistic. Is it helpful or accurate to describe computers and mixers as “instruments” other than as a convenient and fairly vague metaphor? By contrast, composers at the *Groupe de Recherches Musicales* in Paris have always asserted unambiguously that: “Le studio n’est pas un instrument” (Chion/Reibel, 1976: 240). Nevertheless, questions remain: is it possible or even necessary to think “instrumentally” when physical sound sources are absent and if many types of sounds defy inclusion in traditional instrumental categories? Paradoxically, we might claim that the physical presence of instruments (and pieces of equipment which might be regarded as instruments) disguises the true nature of instrumental thought. The full consequences of the instrument can perhaps only

be understood if the manner in which sound communicates is examined independently of any physical means of realisation.

The role of the instrument and instrumental thought was a major preoccupation for Pierre Schaeffer. Indeed, in the *Traité des Objets Musicaux* (1966) Schaeffer dedicated the first two chapters to “The Instrumental Prerequisite” (*Le Préalable Instrumental*) and “Playing an Instrument” (*Jouer d’un Instrument*). His use of the term in these first two chapters indicates his resolve in seeking a deeper understanding of this most fundamental musical phenomenon. If, by using studio technology, the instrument really has become superfluous then Schaeffer’s attitude might seem contradictory: it is, in my view perfectly consistent. He did not naively transfer the term “instrument” to equipment. Instead, he elaborated and generalised the concept by means of his studio experiences. Here sound was worked with directly using technology rather than mediated by the physical sound body of an instrument, often already codified with predetermined structures. Schaeffer needed to address the tasks of classification and description of sounds by perception alone. Due to the conditions of the recording studio, sources are invisible and as a result difficult, if not impossible, to identify with accuracy. This is known as the “acousmatic situation”. The resulting taxonomy - a system of classification with its underlying principles of organisation - was not linked via causality to a physical sound source and can, therefore, be applied to the composition and analysis of many different types of contemporary music. Schaeffer was also aware that in order to develop musical language it was necessary to research how individual sound objects can produce higher level structures. Consequently, he investigated how sounds might function within related families after their classification and description. Such operations were central to the five stages of Schaeffer’s “Programme of Musical Research” (*Programme de la Recherche Musicale* or PROGEMU). These stages are typology, morphology, characterology, analysis and synthesis. Typology deals with the identification and classification of sounds, morphology’s role is to provide a more precise description. The remaining three stages could only be hinted at as they are the stages at which composition, properly speaking, begins. The purpose of characterology is the study of how sounds might be placed in groups or *genres* on the basis of common perceived attributes. This is a subtle process and acknowledges that criteria interact in complex ways to produce unity within the *genre*. By collecting sounds together which appear to come from the same source an inherently instrumental notion begins to be reintroduced into electroacoustic work practices. Naturally, in the acousmatic situation there is no certainty that sound objects do actually originate from the same source - it is their *perceived* common origin that is important. Schaeffer called such a “virtual” instrument a *pseudo-instrument*. By means of analysis the composer will assess whether chosen criteria can communicate the kind of abstract structures that Schaeffer considered so important. Finally, by means of synthesis the

composer would create new sounds as required for the chosen musical context.

Schaeffer was pragmatic. Ideally, a body of compositions should exist before theories can be derived from them and he was suspicious of formulating prescriptive rules before empirical verification. However, the new medium of *musique concrète* meant that practice could not precede theory; both had to proceed simultaneously. It is, of course, impossible to do justice to the complex and subtle nature of Schaeffer's theories in such a short article. I shall, therefore, restrict my subject areas to those which are most relevant for the "instrument".

### 1 Technology and the genesis of Schaefferian theory

It is significant that Schaeffer worked at a radio station where his initial concerns were those of radio drama rather than music (see Chion/Reibel, 1976: 16). Nevertheless, after conducting several experiments Schaeffer soon realised that listening to recorded sounds in the new environment of the studio challenged many traditional musical concepts. These early experiences are chronicled in his book: *A la Recherche d'une Musique Concrète* (1952) (note the Proustian reference - Schaeffer's literary talents and inclinations are evident in his writings). This book was written in the form of a diary during the period from 1948 to 1952, thus we have access to his thoughts as the consequences of his first experiments gradually emerged. For example, on 19th April 1948 he wrote: "En faisant frapper sur une des cloches, j'ai pris le son *après* l'attaque. Privée de sa percussion, la cloche devient un son de hautbois. Je dresse l'oreille. Se produirait-il une fissure dans le dispositif ennemi? L'avantage changerait-il de camp?" (Schaeffer, 1952: 15). This single incident has, of course, since been repeated countless times by musicians working with technology. It indicated that recording and transforming a sound by nothing more than a basic intervention in its temporal progress can make the source unrecognisable when the result is played back in the studio. Recorded sounds become sound objects (*objets sonores*). By removing the visible source from the act of perception the listener is encouraged - we might even say compelled - to listen with intense scrutiny to the sound object. By repeated listening, many features of sound are revealed that usually pass unnoticed. Although these first experiments were conducted on technology that would be regarded as crude by today's standards (Schaeffer was still using discs rather than magnetic tape), they were fundamental to Schaeffer's subsequent development of *musique concrète*, he wrote "Où réside l'invention? Quand s'est-elle produite? Je réponds sans hésiter: quand j'ai *touché* au son des cloches. Séparer le son de l'attaque constituait l'acte générateur. Toute la musique concrète était contenue en germe dans cette action proprement créatrice sur la matière sonore." (Schaeffer, 1952: 16).

### 2 Concrete sounds

A common terminological misconception stems from Schaeffer's choice of sound materials. These were recordings of musical instruments, domestic implements, trains... in fact any source whatsoever. This vocabulary was described as "concrete" by Schaeffer and is a term with philosophical implications which are often lost in English (I am not qualified to comment on the term's use in German!). Schaeffer's intention was not to use such anecdotal material for their real-world associations - which has become an unfortunate (and persistent) misunderstanding. There is an undeniably poetic quality when sounds from the real-world are used both as "quotations" and for particular cultural associations. Many composers from Pierre Henry to present-day soundscape artists have exploited this vocabulary. But Schaeffer used concrete sounds because they often provided a rich variety of spectral and dynamic behaviours. Even though the early works by Schaeffer such as *Etude aux Chemins de Fer* scarcely concealed the actual sources, the intention was to manipulate sound objects so that identification of a source was disregarded in preference to perceiving the sound's intrinsic features, the "in-itself" (en-soi) of the sound objects. Schaeffer actually proposed abandoning the term *musique concrète* when he felt it had outlived its usefulness. The word "concrete", therefore, must not distract attention from Schaeffer's main task which was to establish how "abstract" relationships in music could be formed from such "concrete" material. He wanted: "(...) de poursuivre la recherche musicale à partir du concret, certes, mais tout entière vouée à la reconquête de l'indispensable abstrait musicale." (Schaeffer, 1966: 24). It is in the creation of such abstract relationships that the presence of instrumental thought can be clearly detected.

By means of typological classification (the first stage of PROGREMU) Schaeffer produced a "map" of the complete sound universe. This diagram is called the *Tableau récapitulatif de la typologie* or TARTYP (Schaeffer, 1966: 459). For the purposes of instrumental thought the sound types of the central box of nine "balanced" sounds (sons équilibrés) are the most important as they are of medium duration and have a "closed" dynamic shape. By contrast, those in the surrounding columns are either *sons homogènes* or *sons excentriques* and, due to their complex behaviour and extended durations, are not relevant for the present discussion. (I must stress that this does not imply these sounds are not suitable for music. Indeed, I would argue that it is precisely in the use of such sounds that the electroacoustic medium can realise its full potential.) Balanced sound objects resemble most closely traditional instrumental sounds in their durations and dynamic and spectral behaviour. Because they are discrete sound objects they encourage the comparison of their constituent features within sound families and the perception of abstract relationships between what Schaeffer called "morphological criteria" such as mass, harmonic timbre, dynamic behaviour, grain and allure. Schaeffer surmised that under certain circumstances these aspects could function as principal

articulators of structure.

### 3 Schaeffer's definition of the "instrument" and "instrumental analysis"

Schaeffer defined an instrument thus : "Un instrument ne répond à aucune définition théorique, sinon celle de permanence-variation (...) notion qui domine l'ensembles des phénomènes musicaux." (Schaeffer, 1966: 51). Several concepts arising from this definition must be discussed. The notion which he claimed "domine l'ensembles des phénomènes musicaux" can be expressed in a more extended form: permanence of characteristics/variation of values (permanence des caractères / variations des valeurs) or PCV2. This "model" of musical structure states that we hear relationships between certain criteria which vary in sound objects. However, such variations are only perceptible if other features remain stable. Those which vary are the principal means of articulating structure and are called values (valeurs); the stable features are characteristics (caractères). The most common manifestation of this model is expressed by traditional instrumental sounds and musics. For example, in a composition for piano the values are pitch, duration and, to a lesser extent, dynamic levels because these are the features which vary and which form the principal structural elements. The features which contribute to the stable "background" such as the general harmonic spectrum and the notes' dynamic form can be referred to as the piano's "timbre". Because the listener perceives the consistent similarity of the sounds - the piano "timbre" - the other features of pitch and duration are able to emerge as the main elements of the musical language. An inversion of this model of PCV2 is possible: if the composer ensures that pitches remain stable whilst the instrumentation changes, then pitch might become the permanent characteristic and correspondingly the varying instrumental colour will become the value. We have in effect Klangfarbenmelodie and the music's structure will result from the changes in this sound feature. Such modifications of the basic model are, of course, widespread in contemporary music. However, one aim of Schaeffer's programme was to investigate whether all perceptible aspects really could function as values and if so, how this might be achieved. Pitch, Schaeffer asserted, has the most potential for abstract relationships. For example, it has the unique capacity of being perceived independently if one has "absolute pitch". In addition, we recognise intervals and melodic contours even when they are altered by transposition and variation. Furthermore, due to the sophisticated framework of tonality, pitch participates in the creation of low and high structural levels. Similar claims can be made on behalf of duration. But, do successions or "melodies" of instrumental colour or dynamic levels function in the same manner? Can we perceive variations of a "motif" of dynamic levels as we do when we hear a motif of pitch and rhythm extended and elaborated or curtailed and reduced? Many contemporary composers have created "scales" of dynamics, durations, articulations, tempi... but these are usually organised and permuted according to serial schemes. This is, of

course, entirely legitimate but it is completely different from the Schaefferian perceptually-based aesthetic. Thus PCV2 is a general notion which, though it is most commonly manifested in instrumental music, can be subverted and applied to various musical situations.

Various attempts were made by Schaeffer deliberately to exploit a particular morphological criterion as a value. In his *Etude aux Allures* (1958) Schaeffer juxtaposed sound objects with various allures. Allure (one of the morphological criteria) can be defined as a “generalised vibrato”, hence an allure will be perceived as a undulation in pitch or amplitude (or possibly both). In addition, such variations will be heard as a function of duration. Thus, allures might be slow, fast, accelerating, decelerating, narrow, wide... Chion has emphasised the exploratory nature of the *Etude aux Allures* (Chion, 1976: 53). Schaeffer’s musical language is quite complex and occasionally allure does not always dominate clearly as the principal value. Nevertheless, it does achieves a greater prominence in the form-bearing hierarchy and thereby enriches the composition’s musical vocabulary.

#### 4 Timbre

The examination of the concept of “timbre” was an important part of PROGEMU. “Timbre” for Schaeffer was an “indication of origin” (marque d’origine) (Schaeffer, 1966: 55). This, naturally, included many aspects of the sound’s development in duration, not simply its harmonic spectrum (though this is an important factor). In the *Traité* he reminded readers of the etymology of the word “timbre” which originally referred to a specific source - the tambour or drum (Schaeffer, 1966: 55). Thus, in this case there was a real connection between the sound and its source. Several aspects must be considered when applying the term to instruments. Firstly, to be consistent each note would have its own “timbre” in the sense that it would reveal its causal origin. This is hardly helpful in considering a group of sound objects! (I should emphasise Schaeffer’s intention to go beyond individual sound objects to musical structures based on groups of sounds. Hence PROGEMU’s stages of characterology and analysis which went beyond the classification and description provided by typology and morphology.) The perception of an instrument’s “timbre”, the recognition that a group of sounds come from a single source is frequently an artificial construct. Homogeneity of “timbre” has always been a preoccupation of instrument makers who developed considerable empirical skills in manufacturing their instruments to achieve it. The physical mechanism of the piano illustrates this point. There are three strings in the middle and high registers but only two and then one in the bass registers. Furthermore, the highest notes need no dampening mechanism as their short lengths ensure relatively short resonances. These physical modifications are necessary for perceptual homogeneity and “educated” listeners will still recognise that all sounds come from the same source. Confusion might arise if notes were played in extreme registers or if

“extended” techniques were used. Secondly, “extended” techniques disrupt the unity of instrumental “timbre”. If, for example, the musician plucked a string from inside the piano rather than playing it in a conventional manner the instrument becomes a multi-instrument because the means of sound production is different. The conventional “timbre” of hammers striking strings is compromised. Each instrument thus includes different multi-instrumental timbres. It could be argued that we can only refer to the “timbre” of an instrument if every possible sound that instrument might produce is included. The “timbre” of a violin, for example, would therefore include arco, pizzicato, ponticello, harmonics, knocking the body, col legno... All come from the same source but because they originate in different ways this “timbre” clearly contains many clearly differentiated sound families. Moreover, several of these families, however interesting they might be as sound objects in themselves, have little potential for extensive structures. In the case of the piano, for example, banging the lid has a limited range of possibilities. In addition, unless there was visual verification (and in acousmatic music this is not the case) it is possible, perhaps even unlikely, that listeners would associate such a sound with the piano thereby breaching the sound-source connection of “timbre”.

Extended instrumental techniques are obvious examples of how a conventional “timbre” can be fractured. However, we should also consider how unity really is achieved within a sound family such as the conventional piano “timbre”. Due to the aforementioned physical construction of the piano we hear a single, unified collection of sounds regardless of their pitch register, dynamic level and articulation due to a number of complex interactions between all the aspects of the sounds. This is an acquired cultural practice. For example, if we were to record a single loud pitch and replay the recording at a low dynamic level it does not sound like a soft note - simply a loud one played back too softly! We hear and assimilate, often quite unconsciously, the harmonic content produced when a hammer strikes the string with force and are rarely confused by an inconsistent dynamic level when reproduced. Furthermore, if the same recorded note were transposed more than a few semitones up or down in pitch the sound is perceived as behaving unnaturally. This results from our knowledge of the way physical systems behave and our recognition of instrumental formants. These subjects are described in accounts of Schaeffer’s experiments which led to the formulation of notions such as the “piano law” (Schaeffer, 1966: 234-38). Thus, homogeneity of timbre is an empirically achieved construct. “Timbre”, if defined as our ability to recognise sound originating from the same source, is sensitive to any modification of the sound objects. This cannot be disregarded if virtual “timbres” or *genres* of the *pseudo-instrument* are created. Any alteration of specific aspects might result in new sound families with close or distant relationships. By creating sound families “artificially” the musician transcends any one source - indeed transcends real sources altogether - but the models of interaction in the real-world cannot be ignored.

At an early stage of his researches described in *A la Recherche d'une Musique Concrète* Schaeffer expressed the hope that machines might be enlisted in the creation of families of related sound objects. Schaeffer, with considerable humour imagined himself surrounded by turntables (an early example of turntablism perhaps?). He wrote: "Dans une anticipation cinématographique, à la manière de Hollywood, je me vois entouré de douze douzaines de tourne-disques, chacun à une note. Ce serait enfin, comme diraient les mathématiciens, l'instrument de musique *le plus général qui soit.*" (Schaeffer, 1952: 15) Two specially designed tape machines were eventually designed and built. These were the *phonogène à clavier* and the *phonogène à coulisse*. The former controlled the tape speed via a keyboard and produced twelve discrete pitch transpositions, the latter, by contrast, changed tape speed continuously by means of a handle (see: Chadabe, 1997: 33). Though these machines were used for sound transformations in early works composed in the studios of what was to become the GRM, their status as "instruments" is more questionable. Schaeffer realised that the simple action of acceleration would indeed produce a series of related sounds from the same "source" sound but the results were invariably unsatisfactory. As previously explained, the sounds that were produced tended to draw the listener's attention to the process of acceleration rather than a relationship caused by the interaction of common features. What was heard was the "timbre" (!) of acceleration and shifting an entire spectrum up or down in the pitch-field does not lead to instrumental unity. In other words, the origin of the sound families produced by these devices remained at the level of a recognition of the technical process rather than perceived inherent characteristics.

In addition to "timbre", Schaeffer's notion of "instrumental analysis" included "registers" (registres) and "play" (jeu). These two are the aspects of variation within the constant "timbre". Registers are the areas of perception in which pitch, dynamic level and duration can vary. Interaction between these perceptual fields is inevitable. Registers of pitch are evident in most traditional Western music. The purpose of analysis is to examine the potential other features might display for "scales". The morphological criterion of allure and Schaeffer's attempt to promote it to a value have already been referred to. Allure will participate in all three fields to a greater or lesser extent. In addition, while the creation of "scales" is important for abstract relationships between values, sound objects do not communicate solely by the variation of values. Excessive concentration on values could lead to a sterile and inherently uninteresting language. Composers are also concerned with how sounds are shaped within the perceptual fields both individually and as part of larger, global structures. Examples of "play" can be easily identified in traditional musical performance. For example, if we hear two versions of the same Beethoven piano sonata, the values will (or should) be the same within the normal constraints



of performance practices such as expressive timing. Individual performances will be differentiated by the way the pianist shapes and articulates each note at the lowest structural levels. Naturally, this will contribute to how phrases and sections are formed on higher structural levels. “Play” is how the sound objects’ concrete aspects are shaped so that the abstract relationships are clearly and satisfactorily perceived. Neither can be ignored. The electroacoustic composer, like the performer, must be equally concerned with “play” though in the former case matters relating to shape are transferred from real-time execution to the studio.

## 5 Sequencers and Samplers

Certain situations in modern technology seem to conform to and even appear to refine PCV2 and “instrumental analysis” - but we need to be cautious. For example, note-based compositions can be realised by digital sequencers and MIDI sound modules. While the values are conveyed accurately in terms of registers the careful shaping and articulation of “play” are usually absent. In addition, we might ask: if the mixer, for example, really is an “instrument”, what are its registers? There is no doubt that the faders can create a register of dynamic level but there are two important qualifications. Firstly, the result will still depend mainly on the sound which is input. Instruments, properly speaking, do not simply transform sounds: they are also sources (though occasionally some composers do use mixers for their crude noise producing potential). Secondly, if a fader is adjusted to produce a softer dynamic level the “laws of adjustment” as previously described will not occur. The likelihood, therefore, is a crude “scale” of dynamic level without any integrated sense of the sounds originating from the same source. A modification of the spectral content by scrupulously adjusting the equalisation might improve this to an extent (a process made easier today with automated mixers) but lower dynamic levels in real instruments also involve the sound object’s dynamic shape and its duration. It is, therefore, a complex process which is not simulated simply by adjusting a fader. The same criteria can be applied to the computer. Registers and potential for “play” are not inherent, they exist due to the software design which, naturally, depends on the skill of the programmer who is frequently influenced by the demands of market forces. I must emphasise that I am not criticising the roles of mixers, computers or indeed any modern technology. They all have an important role to play in the creation of electroacoustic music. Technology can contribute to the creation of “instrumental thought” but it requires more subtlety than the simplistic assertion that studio devices are instruments. The instrument or *pseudo-instrument* should now be transferred from the actual to the virtual. With the concept of *genres* the manner in which instruments function in the real-world is acknowledged but not merely imitated in a naively mimetic manner. Instead it is surpassed and elaborated as sound objects from any source - real or virtual - create the impression of common sound sources.

## 6 Conclusion

What, therefore, is new in Schaeffer's theories? By reasserting the original meaning of the term "timbre" he emphasised not only the perceived importance of a sound source but the techniques by which sounds are created. Because *genres* of Schaefferian *pseudo-instruments* need not originate from the same source they consequently encourage many more types of interaction and mediation. Furthermore, by developing the skills of analysis in PROGEMU a more informed use of aspects such as grain, allure and their structural functions is possible. For example, a "metallic resonant genre of definite pitch" could be created by collecting and modifying suitable sound objects. Creating members of the *genre* according to registers of pitch, duration and dynamic levels would lead to a rich vocabulary and many potential abstract relationships. It is also likely that some sound objects could be synthesised with, for example, more complex spectra or different types of attack. These sound objects might gravitate towards the periphery of the genre. Their membership might even be ambiguous and other genres could be produced such as a "metallic dampened genre" or a "metallic complex pitch genre". A true form of virtual orchestration will then occur as genres merge or separate. According to Chion "Le genre remplacerait alors le timbre des instruments" (Chion, 1983: 104).

I acknowledge that this article can do no more than present a brief sketch of Schaefferian theory in relation to the "instrument". The implications of the *sons excentriques* and the *sons homogènes* also deserve extensive consideration. Due to their excessive durations and complex spectra, they do not contribute directly to an understanding of the "instrument". Nevertheless, such sounds are common not only in the electroacoustic medium but also contemporary instrumental/vocal music. Schaeffer suggested that such sounds gave rise to "plastic" musical languages based on continuous rather than discontinuous relationships. The listener is drawn into the internal behaviour of the sound or how its trajectory through pitch-space is perceived. This contrasts with the comparison of constituent features between discrete sound objects which characterises "instrumental" musical languages. I must also reiterate that my comments regarding the use of the term instrument are often deliberately provocative and, I hope, not taken too seriously. Schaeffer's great contribution is the clarity and precision he brought to bear on the subject. Schaeffer says more about instrumental thought by starting from sound and how it might be organised than any investigation of a physical instrument. In fact, musicians of the GRM are themselves not averse to a metaphorical use of the word. In a quasi-religious parody Chion cites Schaeffer's second "commandment": "travaille ton oreille comme ton instrument" (Chion, 1983: 12).

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<sup>i</sup> There are, naturally, fewer commentaries on Pierre Schaeffer in English or German than in French. The acousmatic composer Denis Smalley has elaborated many Schaefferian notions in his writings (see Smalley). The German musicologist Rudolf Frisius is also an excellent writer on this area of French music (see: Frisius). In addition, in September 1998 a symposium "Inventionen '98. 50 Jahre Musique Concrète" was organised in Berlin with contributions from (amongst others) Helga de la Motte-Haber, Sylvie Dallet, François Bayle, Daniel Teruggi, Elena Ungeheuer and Rudolf Frisius. Thus Schaeffer's works are undergoing an examination.

<sup>ii</sup> Examples of such comments are: "Like Gibbons, Russell played the studio as an instrument (...)" (Toop, 1995: 119), "Die Instrumente, die dem Komponisten ein solches Denken aufzwingen (wobei der Begriff Instrument oder das, was wir durch unsere sprachliche Vereinbarung im musikalischen Sinn unter Instrument verstehen, beibehalten werden kann), sind im elektronsichen Studio Funktionsgeneratoren, die, wenn sie diskret benutzt werden (sich nicht gegenseitig modulieren), die einzelnen Schallquellen (Instrumenten) eines Orchesterapparates vergleichbar sind." (Reith, 1981: 101)