Symposium

Computeranwendungen in der Musikwissenschaft. Konzepte, Methoden, Resultate

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On Methods and Methodology of (Computer-Assisted) Music Analysis

Music analysis is very often practiced and taught without reflecting on the method used. One of the very few *methodological* writings in this area published by Wolfgang Horn (1996) points out that analysis is not possible without language and concepts. If "pure" cognition of composition does not exist, then practicing analysis and teaching analytical methods must include some reflection on its purposes. Music analysis is not an independent discipline, nor is it an activity to be defined once and for all. Rather, music analysis is a *method* in the original and emphatic sense of the term, which means it is a way to a goal, a means to an end.

One (f i r s t) way to handle these problems of music analysis is to reflect on different methods; methods of music analysis need to be classified and described. While this task is partly done for "traditional" methods of music analysis (e. g., by Hermann Beck 1974, Diether de la Motte 1987, and Jonathan Dunsby & Arnold Whittall 1988), comparisons are still lacking for new (especially computer-assisted) music analytical methods. (An exception is, certainly, Ian Bent's monograph *Analysis* from 1987.) Also, a *c r i t i c a l* evaluation is urgently needed.

So, why – in more detail – is a rather methodological approach to music analysis necessary? This question must be answered with some more theoretical considerations.

For Wolfgang Horn (1996, 12), analysis is, first of all, neither a doctrine nor a theory. It is not a formal-logical activity, but it has to do with the application of concepts to objects of experiences. And this is the reason why it is so hard to reveal it. As a nomen actionis, the term "analyzing" is singular. This activity is further explained by objects, which are supposed to be resolved "*into simpler constituent elements*" (Bent 1987, 1), and by the m a n n e r of resolving. Using this word as a nomen acti, a n a l y s i s, it is possible to form a plural: a n a l y s e s. (See Horn 1996, 12)

But what is "music analysis" supposed to resolve? Ian Bent's definition just quoted here, continues: "*Music analysis is the resolution of a musical structure into relatively simpler constituent elements, and the investigation of the functions of those elements within that structure.*" (Bent 1987, 1) But the "*resolution of a musical structure*" into "*constituent elements*" is n o t the resolution of an u n k n o w n object,

but of an internalized experience. Acoustical events, or their notation, function as a result of experiences and concepts. (Horn 1996, 12)

Results of analytical resolutions are usually communicated via language. Here, language rules need to be applied. The product, the analytical text, can be verified with the help of logic. Also important, the choice of the concepts on which the analysis will be based, needs to be in conformation with the goals of the analysis. The (logical) terminologic-conceptional frame is most crucial.

Wolfgang Horn distinguishes between two main approaches possible: the first would be answering the question "*How is this done?*"; the second one answers the question "*What is this?*". "*The results have, in both cases, only illustrating character, because the theory 'knows' concepts*" but you apply concepts, but within a frame regarding this specific object. These kinds of analyses are important in historical research for getting an overview, but it is rather cataloging and typologizing. Generally, analyses are dependent on their frame: "*Only if the frame of an analysis is discovered, can you ask for the relevance of the analysis, even if it is only the relevance for your current subjective interest.*" (Ibid., 13)

Conclusion: Analyzing music should not only be done "right" and "logically," but the framework of the analysis needs to be justified. "*We should not only talk about analysis, but also, and especially, about its terms and conditions!*" (Ibid., 14) Reflections on the framework of music analysis, its purposes, and its goals are most important, which then require the application of certain methods.

Classifications of Music Analysis can be done with regard to the music analyzed, the methods used, the general approach taken, etc. Any classification needs to be based on a logical framework, that means, a certain classificational level has to be on the same epistemological level. Dieter de la Motte, for instance, distinguishes the following analytical categories:

a) Large Form → Detail Structure
b) Measure-by-Measure Analysis
c) Analysis of a Word-Tone-Composition
d) Category Analysis
e) Comparative Analysis
f) Special Analysis
g) Tendency Analysis
h) Statistical Analysis
i) Analytical Details
j) Analysis with no Prerequisites

Here, different epistemological levels are mixed, like musical categories (e. g., form, structure), kind of music (word-tone-composition), certain methods (statistics), etc.

Ian Bent, on the other hand, is with his analytical categories within the same epistemological level, since he only aims at specific theories. To support that notion, he mentions the author of each theory in parentheses:

a) Fundamental Structure (Schenker)
b) Thematic Process (Réti) and Functional Analysis (Keller)
c) Formal Analysis
d) Phrase-Structure Analysis (Riemann)

e) Category and Feature Analysis (Lomax; LaRue)
f) Musical Semiotics (Ruwet and Nattiez)
g) Information Theory
h) Set Theory

However, if he would really want to regard to each specific theory, his list is far too short and eclectic. Other theories would have to be added: different theories of harmony, melody, rhythm, and so on.

For this reason, another classificational system of music analysis with regard to musical elements, at which the analysis is aimed, shall be suggested here:

a) Form Analysis
b) Melodic Analysis
   Thematic Analysis
   Motivic Analysis
   Phrase Structure Analysis
c) Harmonic Analysis
d) Contrapuntal Analysis
e) Rhythmic Analysis
f) Analysis of Word-Tone-Relations
g) Analysis of Instrumentation

Each of these categories can be sub-divided (indicated here already for "melodic analysis"). Musical categories as range, type of motion, certain patterns, timbre, texture, sound, etc. are included.

To classify with regard to the approach used – always depending on the goal of the analysis – the following categories could be distinguished:

a) Schenkerian Analysis
b) Transformational Grammar Analysis
c) Comparative Analysis
d) Measure-by-Measure Analysis
e) Statistical Analysis
f) Information Theoretical Analysis
g) Semiotical Analysis
h) Category and Feature Analysis
i) Cognitive and AI Analysis
j) Process Analysis

This list is certainly not complete. In some of these categories, specific theories are implied; however, since these are very broad and established analysis areas, a classification under "analytical approaches" seems to be justified. An additional sub-category could distinguish between the basis of the analysis: whether it is notational based or performance based (i. e. is the object to be analyzed notated music or performed music).

Another classification would be possible within the epistemological level "kind of presentation" of the analysis. Here, de la Motte's "Special Analysis" would fit in, which is – in the beginning – not supposed to reveal what the analysis will to show, but will have a surprising result in the end. However, there are so many different kinds of presentation possible that a classification in this respect does not seem appropriate. The more interesting question would be if there is a classificational system possible with regard to g o a l s of analyses, since this is the ultimate aim of any ana-

lytical work. This, coupled with the unification of these different classification levels in o n e model, remains for further research.

A separate point addresses the use of technology for music analysis. All analytical methods can be supported by the use of computers, which leads to the main topic of this symposium. Computer-assisted music analysis provides analytical tools to help solving problems which cannot be solved with traditional methods of music analysis. For instance, it clarifies stylistic characterizations and questions of unclear authorship, it helps investigating musical (historical) developments, and it is useful for further developments of theoretical systems, for acoustical and performance research, as well as for cognitive and artificial intelligence research.

Introductory reading materials for the history of computer-assisted music analysis, such as overview articles by Bo Alphonce (1980, 1989) present only the 'tip of the iceberg' of these approaches; dozens of dissertations and numerous American as well as European articles are excluded. Also, most articles fail to reflect on the subject critically. More specifically, they do not show the limits of these applications. Thus, early applications, for instance, are not complex enough and without using enough musical material to support their findings.

To rephrase this problem: From today's point of view, the first approaches seem relatively simplistic, strongly emphasizing the computer more so than the m u s i c research. They usually dealt with only a few compositions, or single voice melodies, or even with short phrases of single voices, and this strongly effected the outcome of the research and its academic value. However, the simplistic nature of the research was mainly determined by the capacities of the computers in these early years. Negative evaluations of computer-assisted music analysis in the 1960s and 1970s were then responsible for reservations against computer applications in music research.

A classificational system of methods of computer-assisted music analysis could be outlined as follows:

- Statistical & Information-Theoretical Analyses
- Set Theoretical Analyses
- Other Mathematical Analyses
- Hierarchical Analyses
  - Transformational Analyses
  - Schenkerian Analyses
- Spectral Analyses
- Cognitive & AI Analyses
- Combined Analyses

Each of these categories can be subdivided into "notation-based" and "performance based." Finally, these applications can be distinguished with regard to the kind of music:

- Western Art Music
- Not Western Art Music
  - Western Folk Music
  - Non-Western Music
    - Non-Western Art Music
    - Non-Western Folk Music
- Pop / Jazz Music

Thus, the classification model for computer-assisted music analysis suggested here comprises three different (epistemological) abtraction levels:

1. Methods Used
2. Kind of Representation of the Music
3. Kind of Music

Coming back to the problem of historizing computer-assisted approaches of music analysis on the one hand and classifying those on the other leads to the main epistemological problem. Even though of a short history, computer-assisted music analysis has been developing in a variety of streams, under a variety of methodical prerequisites. For that reason, it is almost impossible to talk about a real "history" of computer-assisted music analysis. Rather, approaches of computer-assisted music analysis has to be seen within the classificational system of their methods given above. On the other hand, the development of the classificational system was only possible after a thorough study of all existing approaches; here, historical aspects play an important role also.

For the reason of lack of space, historical remarks have to be omitted here. However, a brief outline is given in the appendix. Instead, these reflections here will be limited to conclusions of the study of computer-assisted music analysis:

First Conclusion

A critical thinking needs to be established. Beyond the euphoria of the use of technology, only a few computer-assisted music analysis applications have made important contributions so far. Even with the newest cognitive and AI research, the proportion of expenditure to benefit is in most cases unsatisfactory.

Second Conclusion

The productive use of elementary statistical and information-theoretical measurements (frequencies and resulting probabilities, entropies, etc.) seems to be independent of the musical genre. More complex analyses in the sense of interactive methods – comprising traditional, sociological, psychological and historic-cultural aspects – show that, for certain goals, neither a pure 'traditional' nor a pure statistical analysis will bring valuable results. Instead, computer-assisted music analysis needs to use both computational a n d traditional analytical methods – certainly always dependent on the general goal of the analysis.

Third Conclusion

Using methods derived from linguistics, theories of structural levels, and set theory, computer-assisted music analysis is based on 'traditional' music theory – in the sense of studying musical structures. The computer makes it possible to verify the results / algorithms by using the reverse process, synthesizing the composing.

Fourth Conlcusion

Finally, computer-assisted music analysis in the field of Artificial Intelligence is much more interdisciplinary. Especially the strong integration of psychological and cogni-

tive aspects of music perception allows one to focus on basic human activities, the creation of knowledge as well as processes of composition and perception. With this, it focuses more on the question: How can I know, or how can I discover, myself and the world?

Literature

Bo H. Alphonce: *Music Analysis by Computer – A Field for Theory Formation*, in: Computer Music Journal 4 (1980) 2, pp. 26-35.

———: *Computer Applications: Analysis and Modeling*, in: Music Theory Spectrum 11 (1989) 1, pp. 49-59.

Hermann Beck: *Methoden der Werkanalyse in Geschichte und Gegenwart*, 3. Aufl., Wilhelmshaven 1981.

Ian D. Bent: *Analysis*, with a Glossary by W. Drabkin, London 1987.

Diether de la Motte: *Musikalische Analyse*, Kassel 1987.

Johnathan Dunsby & Arnold Whittall: *Music Analysis in Theory and Practice*, London 1988.

Wolfgang Horn: *Satzlehre, Musiktheorie, Analyse. Variationen über ein ostinates Thema*, in: Zum Problem und zu Methoden von Musikanalyse, ed. by Nico Schüler, Hamburg 1996, pp. 11-31.

Nico Schüler: *Zum Problem und zu Methoden computerunterstützter Musikanalyse*, Magister-thesis, Greifswald University 1995.

———: *Methoden computerunterstützter Musikanalyse – ein historischer Überblick*, in: Zum Problem und zu Methoden von Musikanalyse, ed. by Nico Schüler, Hamburg 1996, pp. 51-76.

Appendix: History of Computer-Assisted Music Analysis – Outline

1941 first functioning electro-mechanic computer by Konrad Zuse

1946 first fully electronic computer ("ENIAC") by John P. Eckert and John Mouchly

1949 Bertrand Bronson used an electronic calculator to effectivate a typologizing procedure with British-American ballads

1949 Claude E. Shannon defined "entropy"

1958 first statistical and information theoretical analyses of art music by Willhelm Fucks

1960 first American dissertation by Joseph E. Youngblood on information-theoretical analysis of music

1960s foundation of "Information Aesthetics" by Max Bense and Abraham A. Moles

1964 first American dissertation with an actual use of a computer, by Gilbert H. Roller

1966 following Bartók, Alica Elschekova developed computer-assisted methods of Analysis and classification of folk songs

1968 first larger study on classification and typologies of folk songs, including analyses of similarity, by Reiner Kluge

1968 first American dissertation on computer-assisted set theoretical analyses by Donald M. Pederson

1970s foundation of "Cognitive Musicology" by Otto Laske

1971 first computational study in the area of structural levels in music by John E. Rothgeb

1974 computational foundation of set theory by Bo Alphonce

1974 first dissertation in the area of Artificial Intelligence by Denis L. Baggi

1977 first personal computers: the Apple II

1980 discussions on a system for computer-assisted Schenkerian Analysis

1982 first computer-assisted analysis of Jazz by James K. Williams

1995 psycho-acoustical AI model for tone center recognition by Mark Leman

1997 start of the large "Music, Mind, Machine" project by Peter Desain and Henkjan Honing at the Nijmegen Institute for Cognition and Information