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### Universität für Musik und darstellende Kunst Graz



# Graz Studies in Ethnomusicology

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### Institute of Ethnomusicology
### University of Music and Performing Arts Graz

**GERD GRUPE (Ed.)**

*Virtual Gamelan Graz*

Rules – Grammars – Modeling

Gerd Grupe

## *Introduction: Musical Knowledge and Computer-based Experiments in Ethnomusicological Research*

### or

## *Can a Virtual Gamelan Ensemble Help Us in Understanding Karawitan?*[1]

### Musical structure and emic conceptualization

When looking back at the development of our discipline, ethnomusicology, during the last decades, the enormous success of the anthropological turn in the mid of the 20th century – initiated particularly by Alan Merriam's landmark book on *The Anthropology of Music* (1964) – cannot be underestimated. As we know he advocated a two-pillar model of ethnomusicology balancing elements of both musicology and anthropology. A long line of earlier research frequently associated with the Berlin school of Comparative Musicology and characterized by focusing on structural analyses of the music under investigation combined with an often surprising lack of interest in the cultural context from which the musical samples were taken had been fittingly criticized by Merriam as armchair ethnomusicology (Merriam 1964:39). While it soon became standard practice for ethnomusicologists to adopt fieldwork as the main procedure for obtaining data in order to see for themselves how the music they want to study is performed *in situ* and in which way it is integrated into the life of people, the crucial balance between musicological and anthropological aspects seemed to be somewhat of a challenge for many scholars resulting in Mantle Hood's claim that "the primary *subject* of study in ethnomusicology is *music*" (1971:4; italics in the original). Obviously, already at that time some ethnomusicologists seemed to feel uncomfortable with a notion of ethnomusicology as being primarily an anthropological endeavor where the relevance of understanding the musical features and practices of the cultures being studied seemed to be open to question.

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[1]    I would like to thank Sophie Clark for proof-reading and correcting my English.

It is not my intention to recap this development in any detail here (cf. Nettl. 2005:215-231). Suffice it to say that there have been many studies over the years that skipped any discussion of "the music itself" (Merriam) altogether in favor of a more cultural studies-like approach. On the other hand, while musical "structure" should not be thought of as an outdated object of inquiry, dealing with it without taking into account indigenous concepts related to music and music making is, of course, no longer feasible. The interpretive turn in anthropology (cf. Geertz 1973), the interest in indigenous cultural concepts, and the emics/etics debate (cf. Headland/Pike/Harris 1990) all led to new studies that potentially integrate the diverging approaches stemming from the various sister disciplines of ethnomusicology in an attempt to come to grips with the challenges of a culturally informed musical analysis which acknowledges that music i s culture and at the same time worthy of detailed scrutiny of its processes and features – as has been convincingly demonstrated in the recent book edited by Michael Tenzer entitled *Analytical Studies in World Music* (2006) to which one of the authors of the present volume, R. Anderson Sutton, also contributed. Especially intriguing to me is the fact that any ethnomusicological study excluding these aspects of a culture will inevitably ignore the creativity of indigenous musicians and the potential insights one may gain from investigating local (musical) knowledge.

## Implicit and explicit knowledge

Employing participant observation in fieldwork has shown that not only in predominantly "oral" traditions but even in those societies which share our inclination to verbalize musical concepts in a more or less specialist terminology, there always remain aspects of musical knowledge that are beyond verbalization. No matter whether we are dealing with a traditionally literate society or not, the existence of non-verbalized knowledge which nevertheless shapes musical practice reminds us that the notion of an "oral" tradition can be misleading and that we should rather speak of aural transmission in many cases. Drawing on psychological parlance, the difference between explicit or declarative, and implicit or procedural knowledge (cf. Aitchison 2003) needs to be accounted for in our research strategies. When a musician knows exactly what to play but cannot explain it in any abstract manner, this does not imply any arbitrariness but rather

calls for ways on behalf of the researcher of elucidating the underlying concepts by appropriate means. The idea behind this is the assumption that a musician can express his or her musical knowledge most comprehensively through his/her performance. Therefore, the main challenge for the ethnomusicologist consists in carefully guiding the musician to a musical behavior which can be meaningfully interpreted.

In order not to overlook this kind of elusive information ethnomusicologists have tried various methods including what Hood called bi-musicality or learning to perform (cf. Hood 1971:39). Becoming a student of a local musician and may be even performing with local ensembles has proven to be a rewarding research strategy in ethnomusicology. By circumventing the need for verbally expressing musical concepts and procedures an additional dimension of gaining insights is opened up for the researcher. What it is exactly that the musician does in a certain musical situation can, thus, be determined and especially if settings can be arranged where the musician is obliged to make particular choices within the musical process, these decisions may be quite instructive for an understanding of the underlying implicit principles.

## Interactive experiments

Assuming that provoking this kind of decision is most telling if individual parameters can be systematically singled out – and the feedback of the musicians to a plausible musical stimulus can be evaluated by the ethnomusicologist – experimental settings which go way beyond typical participant observation provide an opportunity to deal with issues which otherwise might prove inaccessible to normal research methods. This is by no means a new idea. To cite only two examples[2], Simha Arom, for instance, has employed a then (1989) state-of-the-art commercial synthesizer to investigate musical scales in Central Africa (Arom 1991). He let local musicians themselves fine-tune the interval size of scale steps by using the microtuning feature of a modified Yamaha DX7 synthesizer. Ulrich Wegner presented samples of *amadinda* xylophone slabs played through a Synclavier system to investigate how members of the culture respond to the phenomenon of inherent patterns in kiGanda music (Wegner 1993).

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[2]  See further Fernando-Marandola 2002.

## Computer-based systems

It is only a small step, and a question of advances in computer technology, from such interactive experiments to computer-based tools for ethnomusicological research. While attempts at using computers for ethnomusicological databases and melodic analyses already reach back to the early 1980s (cf. the ICTM study group on computer-aided research), another aspect has fascinated scholars early on, namely the potential of using computer software to simulate musical rules or grammars of a given repertoire. One case in point, where another one of the contributors to the present volume participated, has been Bernard Bel's collaboration with James Kippen in the development of a computer tool that would simulate the playing of a North Indian *tablā* (cf. Kippen/Bel 1989). Bel had already been involved with the ISTAR project that originally focused on the automatic transcription and notation of Hindustani music (cf. Bor/Arnold/Mott 1984/85).

## Central Javanese gamelan as a case study

Compared to other musics of the world Central Javanese gamelan music (*karawitan*) certainly ranks among the best-documented non-Western musical traditions and has attracted many scholars, beginning with the pioneering work of Jaap Kunst (cf. Kunst 1973), until today. As several of the present authors point out in their papers, *karawitan* is often said to be a musical idiom that should be particularly well suited for an attempt at simulating it because of its seemingly obvious regularity. Whether one would prefer to speak of rules and grammars or rather of constraints (cf. Sutton's paper in this volume) is open to debate, but at least a considerable portion of what goes on in such a gamelan ensemble appears to be governed by principles that might be expressed in a formal manner suitable for conversion into computer programming code. Several reasons can be given that motivate such a project; among them the above-mentioned idea of elucidating cognitive concepts that are hidden in the musicians' implicit musical knowledge and the possibility to test hypotheses regarding musical features and processes by observing the musicians' response to a virtual ensemble playing in an idiomatically and sound-wise acceptable way according to indigenous standards. Moreover, the notion of analysis by synthesis

can be viewed as a further motivation because the system would supposedly demonstrate the level of knowledge of the principles behind *karawitan* that we have achieved. Another – though by no means central incentive – is the option of combining real and virtual musicians in a real-time performance for didactic or, thinking of contemporary compositions, artistic reasons.

### The interdisciplinary research project *Virtual Gamelan Graz (VGG)*

Drawing on the experience gained in the course of an earlier research project, a pilot study on the acoustic modeling of *mbira* lamellophone keys of the Shona (Zimbabwe)[3] jointly carried out by two institutes of the University of Music and Performing Arts Graz/Austria, namely the Institute of Electronic Music and Acoustics and the Institute of Ethnomusicology, a new collaborative effort between the two institutes was envisaged in 2005 with the intention of bringing together approaches and methodologies from the humanities and the sciences and also of laying the basis for a fruitful cooperation between scholars and artists. Since 2004 the Institute of Ethnomusicology owns a complete set of Central Javanese gamelan instruments, both *sléndro* and *pélog*, made by the famous Solonese gamelan builder Bp. Tentrem[4], which served as the basis for a minute assessment of the acoustic properties of these instruments. The following background information was given to the participants of the symposium where the original versions of the papers in the present volume have been delivered:

> In collaboration between colleagues from the Institute of Ethnomusicology and the Institute of Electronic Music and Acoustics at the University of Music and Performing Arts Graz/Austria we are currently attempting to develop a computer-based system which would allow us to generate idiomatically meaningful renditions of pieces from the repertoire of Central Javanese gamelan music (*karawitan*) focusing on the style of Surakarta.

> We intend to put together rules describing the behavior of various parts in a Central Javanese gamelan. These rules are going to be implemented by using software called

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[3]  It has been presented at the Conference on Interdisciplinary Musicology CIM04 in Graz/Austria (cf. Grupe/Sontacchi/Höldrich 2003)

[4]  Bapak, or Pak, is the local term of address that can roughly be translated as "Mister" or "father".

SuperCollider which can control sound output in real-time (http://en.wikipedia.org/ wiki/SuperCollider). Our acoustics colleagues recommended this programming environment and they are going to implement a sound module which will emulate the actual sounds of gamelan instruments in real-time (no samples). At this point, we are not going to include those parts which would be more difficult to model in this way like all the non-idiophonic parts (*rebab*, vocals, *suling*, etc.), although as far as rules are concerned these parts will definitely have to be considered. Adopting an analysis-by-synthesis approach we want to find out how far we have actually understood how gamelan music works. This concerns particularly the *garap* instruments. We would like to pin down examples of pieces where "generic" vs. "idiosyncratic" behavior of *garap* can be found. Also, we would like to emulate the interaction of pertinent parts within a performance. For the time being the parts excluded from virtual modeling (*rebab*, vocals, *suling*) will have to be supplied by competent live performers until it is possible to model them as well.

Apart from being a very powerful instructional (for academic purposes) and artistic tool (for contemporary composers and musicians) such a computer-based system would also enable us to tackle issues that may be hard to deal with in verbal discourse with Javanese musicians. For instance, the evaluation of various tunings for a gamelan set or the specific sound characteristics of individual instruments might be dealt with by directly manipulating the relevant parameters interactively in real-time – preferably by local music specialists themselves – without the need to verbalize underlying musical concepts. Also, aspects like the idiomatic "width" of variation (or "improvisation"?) could be evaluated by looking at the reaction of Javanese experts listening to a virtual ensemble whose behavior can be controlled by the researcher in real-time.

## The Symposium *Virtual Gamelan Graz: Rules – Grammars – Modeling*

In order to discuss the possibilities and problems of such an implementation we invited several scholars with expertise in *karawitan* and/or virtual modeling (rule-based systems) of non-Western musics. What we hoped to achieve was to discuss examples of "generic" vs. "idiosyncratic" behavior of parts and how this might be formalized, to utilize the participants' specific expertise with individual *garap* instruments and their knowledge of interactive processes within the ensemble in order to refine the necessary rules, and to determine ways of implementing this knowledge with the help of a dedicated programming language. The symposium, organized by the Institute of Ethnomusicology, took place on October 27-28, 2006 at the University of Music and Performing Arts Graz

(KUG). Among the seven invited speakers were three internationally renowned experts in gamelan music, R. Anderson Sutton (University of Wisconsin, Madison), Benjamin Brinner (University of California, Berkeley), and Marc Perlman (Brown University, Providence/Rhode Island). Furthermore, Bernard Bel (Université Aix-en-Provence/CNRS), who has been mentioned above already, was invited as one of the pioneers regarding the use of computers in ethnomusicological research particularly in his work with James Kippen. Sophie Clark (City University London) and Rainer Schütz (KUG) are both Ph.D. candidates working on aspects of *karawitan* and have studied this music for several years. Julian Rohrhuber had been chosen because of his profound experience with the SuperCollider programming language.

## The papers

The following papers were presented, listed here in alphabetical order:
- Bernard Bel: The *Bol Processor* Project: Musicological and Technical Issues
- Benjamin Brinner: Interaction in *Gendhing* Performance with Special Reference to *Panerusan* Parts
- Sophie Clark: The Role of Notation and its Impact on the Aesthetics of Gamelan Performance and Musical Creativity in Surakarta, Central Java
- Marc Perlman: Regularity and Irregularity in the Interpretation of Javanese Gamelan Compositions
- Julian Rohrhuber: Algorithms for Ethnomusicology. An Introduction to SuperCollider
- Rainer Schütz: *Garap* and *Balungan*
- R. Anderson Sutton: Towards a Theory of *Gambang* Performance in Central Javanese Gamelan Music

At the suggestion of Benjamin Brinner, we also held a panel entitled "How to Think about a Machine Trying to Sound like a Human Ensemble: Some Challenges" and there was, of course, a final discussion at the end of the two intense and inspiring days. I would like to sincerely thank all participants for their valuable and constructive input to this project that will hopefully develop into a

useful tool open to anybody willing to use it. As you will see from the written versions submitted for this volume, the basic idea behind *Virtual Gamelan Graz* was met with some caution but also with considerable enthusiasm regarding potential merits and new opportunities of such an endeavor. There already are commercial solutions for generating the music of a particular musical idiom as a didactic tool for aspiring musicians, like *Band in a Box* for jazz and other musics[5], but as far as gamelan is concerned no fully-fledged attempt at emulating a complete ensemble has ever been made. Ventures such as a British educational software package on gamelan[6] or a French website visualizing a performing gamelan ensemble[7] are obviously not intended to assist in scholarly research. Whether constructing a virtual gamelan ensemble has to be dismissed as an impossible feat is open to debate, but according to our contributors there seem to be at least some potentially positive outcomes of such a project that may merit its efforts.

## The contributions to this volume

Some readers may find some of the issues discussed in the following pages rather technical. In fact, in reviewing ethnomusicological publications of recent years, dealing with structural and conceptual aspects of a musical tradition in greater detail has not been too prominent in the literature, notable exceptions being not only Tenzer's abovementioned *Analytical Studies in World Music* (2006), but also the works of Sutton, Brinner, and Perlman on *karawitan*.[8] In spite of the high standards which – as a consequence of the authors' high level of familiarity with *karawitan* – were demanded of the audience at the symposium (and are now required of the readers) giving some of the leading experts in a particular musical tradition the opportunity to engage in a lively discussion of its features without the time constraint of 20-minute papers read at overcrowded conferences has been a fascinating enterprise for all present at this occasion.

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[5]   http://www.pgmusic.com/bandbox.htm

[6]   http://www.imusic.org.uk/modulegamelan.asp

[7]   http://www.cite-musique.fr/gamelan/shock.html

[8]   For instance, to give only one reference each, Sutton 1991, Brinner 1995, Perlman 2004.

Therefore, this volume is not only the attempt to advance our insights into Central Javanese gamelan music and discuss the potential of computer-based research strategies in ethnomusicology. At the same time, this volume tries to demonstrate that culturally informed musical analyses taking into account emic concepts may substantially further our understanding of the world's musics.

The papers have been arranged in an alphabetical order, rather than organizing them into thematic complexes. Nevertheless, I would like to provide some hints regarding the focus of the papers here. Bernard Bel ("The *Bol Processor* Project: Musicological and Technical Issues") puts this new endeavor in the field of computer-assisted research in the context of his own work in the same domain and describes his ongoing work in this field. Except for Bel and Rohrhuber who deal with issues sort of beyond the field of ethnomusicology proper, all the other contributions discuss *karawitan* from a specialist point of view. Any reader not too familiar with this idiom may want to consult some of the easily available general introductions to Central Javanese gamelan music first.[9] Readers with some previous knowledge in *karawitan* might also start with Sophie Clark's paper ("The Role of Notation and its Impact on the Aesthetics of Gamelan Performance and Musical Creativity in Surakarta, Central Java") which, in addition to its primary theme, also addresses some fundamental issues and introduces the *kepatihan* notation, now a quasi-standard for representing Central Javanese gamelan music. What are or have been the consequences of using notation for or within an originally oral/aural tradition?[10] What are the implications of the notated form of a piece for an actual performance? In discussing these issues, Clark also introduces the concepts of *garap* (see below) and *céngkok* (special melodic formulae leading from one goal-tone to the next) illustrating some important examples by using *kepatihan*. The abbreviated format of this notation may remind some readers of the way so-called lead sheets are used by jazz musicians. Thus, *kepatihan*, as she points out, obviously does not limit an actual performance as much as a Western score does, which, incidentally, points

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[9] See, for instance, the respective entries in *The New Grove Dictionary of Music and Musicians* (Sadie/Tyrrell 2001 or the online version at www.oxfordmusiconline.com) or in *The Garland Encyclopedia of World Music Vol. 4: Southeast Asia* (Miller/Williams 1998). Another good introduction is Sorrell (2000), while a comprehensive manual with an extensive glossary has been published by Pickvance (2005).

[10] I have reviewed some of the relevant literature on this subject elsewhere (cf. Grupe 2005).

at the controversy over whether these processes in gamelan music should be considered improvisation or rather variation (cf. Sutton 1998).

Before turning to the paper by Schütz and Rohrhuber describing the actual implementation of the *Virtual Gamelan* prototype using the SuperCollider programming language (see below), one may want to consult the contributions by Benjamin Brinner and R. Anderson Sutton discussing particular problems of a virtual gamelan ensemble vis-à-vis what is known as *garap* in Central Javanese gamelan music. Whether, or how, certain instrumental parts can be derived from the melodic core and the compositional form of a gamelan piece, in other words the relationship between the *balungan* of a *gendhing* and the formal construction of the piece (sometimes called *bentuk*) on the one hand, and the actual melo-rhythmic patterns played by those instruments which are supposed to apply this "treatment", as *garap* may be translated, to the basic melody, on the other hand, is described in these papers in great detail. Ben Brinner ("Interaction in *Gendhing* Performance: The *Panerusan*") in particular highlights various aspects of interaction within a performing gamelan ensemble – including the time factor – and considers these processes a particular challenge for the VGG project. His argument is put forth accompanied by extensive musical examples illustrating the musical behavior of relevant instruments in detail. His identification of potential obstacles and suggestions for possible solutions are particularly valuable and helpful for any future work on the VGG prototype.

This is also true of R. Anderson Sutton's contribution ("Towards a Theory of *Gambang* Performance in Central Javanese Gamelan Music") drawing on his profound experience with the xylophone, one of the instruments that have to work out their parts during performance. He presents substantial evidence of how two renowned musicians go about this task. In comparing their approaches Sutton points to the similarities as a common ground of idiomatic playing but also highlights individual options which an accomplished musician may explore in his playing. He also proposes concrete steps of how the computer program should deal with the necessary decision making process.

Marc Perlman ("The Continuum of Regularity. Prolegomena to the Computational Modeling of Javanese Gamelan Music") explores the parallels between language and music, or linguistics and ethnomusicology, by discussing the behavior of relevant instrumental parts as forming a continuum between adhering to clear rules, or constraints, on the one hand and being to a certain extent almost

unpredictable on the other hand. In doing so, he has chosen to limit the submitted version of his paper to the more general considerations drawing also on ideas discussed in the realm of artificial intelligence and cognitive science. Unfortunately (in my opinion) he has dropped all the musical examples of *karawitan* and their analyses that he presented in his talk at the symposium from his paper. In keeping with the intention of the symposium, and this volume, to address both the fundamental issues of a virtual gamelan and also those actual musical features of *karawitan* which might pose problems for it as precisely and clearly as possible, as the editor I have decided to add these musical examples, which accompanied his lecture and provide a wealth of vivid information, in an appendix at the end of this book. To make this very clear, they do not form a part of the paper the author submitted for this volume but are only meant to illustrate how the ideas presented in his contribution might be related to *karawitan*.

Rainer Schütz and Julian Rohrhuber ("Listening to Theory. An Introduction to the *Virtual Gamelan Graz* Framework"), the two authors who have collaborated in the development of the VGG implementation, describe both the programming and the ethnomusicological aspects of this attempt. While one of them, Rohrhuber, is deeply engaged in the advancement of the programming language called SuperCollider that we chose for VGG, Schütz has studied *karawitan* in Solo (Surakarta) for several years and had the sometimes difficult task of putting his practical and theoretical knowledge of this tradition into verbal statements that could be transformed into computer code.

Apart from being involved in the development of the SuperCollider programming language, Julian Rohrhuber ("Algorithms in Anthropology") also has a background in cultural anthropology. He draws on that when discussing algorithmic methods as a promising option in anthropologically oriented research and attempts to draw some general conclusions from the potentially new path they may open for future projects.

### Can a virtual gamelan ensemble help us in understanding *karawitan*?

All the gamelan specialists represented in this volume have successfully employed the "learning to perform" approach in their research and, thus, demonstrated its usefulness when aiming at insights one may gain from musical analyses that take emic concepts, no matter whether these are implicit or verbalized,

into account and complement them by a cross-cultural, comparative perspective. But why do we try to emulate an ensemble of human musicians in the first place? Certainly not in order to replace them. Also, a black-box implementation employing techniques not based on musical knowledge (cf. Perlman's paper in this volume) and trying to produce an acceptable output without reflecting actual musical concepts and processes of *karawitan* would be rather meaningless for our purposes. If things work out well, the *Virtual Gamelan Graz* may serve as an additional way of eliciting procedural knowledge and musical "intangibles" that might, thus, be explored by putting Javanese musicians, again, in a central role of the research process, yet in a new way. Even if we find that human creativity might be partly beyond such formalization as is necessary for this approach, we may at least, apart from pedagogical and artistically experimental purposes, use it as a tool to bring ourselves to explicate what we know about Central Javanese gamelan music. Or, as Anderson Sutton puts it at the end of his paper:

> "I think the most beneficial result would be the revelation of artistic principles, only partially reducible to generative rules, that characterize the fascinating musical tradition we know as karawitan."

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**Internet Resources**

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