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From tacit to verbalized knowledge.

Towards a culturally informed musical analysis of Central Javanese karawitan[1]

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Abstract

In the music cultures of the world we encounter both tacit and verbalized musical knowledge to various degrees. In order to reconstruct emic views on musical concepts and practices which are a prerequisite of any seriously culturally informed musical analysis we need to disclose local knowledge by appropriate means even if it is not directly open to verbal discourse. Current computer technology enables us to set up interactive experiments where local experts can verbally address relevant musical features in discussing audio examples which have been prepared by the researcher. The performance of virtual musicians can be evaluated by the local experts and various relevant parameters may be investigated individually if suitable versions of customary pieces are available. Thus aspects which seem to be tacit knowledge because they usually elude verbal discourse can be made accessible and transformed into verbalized, declarative knowledge. The paper presents preliminary results of a case study on Central Javanese gamelan music (*karawitan*) where renowned Javanese musicians commented on computer-generated versions of traditional compositions regarding the idiomatically appropriate performance practice of the virtual ensemble as well as the tuning and sound of various virtual gamelan sets emulated by the computer.

Key Words: ethnomusicology, computer-assisted research, gamelan, Central Java

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[1] This paper is based on a lecture given at the Universitat Autònoma de Barcelona on July 3rd, 2015 as a contribution to the *1st Conference in Ethnomusicology and Anthropology of Music (CEAM): Methods, approaches and perspectives for the study of music within culture*. I would like to express my sincere thanks to the organizers, Prof. José Luis Molina, Director of the Department of Social and Cultural Anthropology, and Sara Revilla Gútiez, for inviting me to this conference. Some of the issues addressed in the present paper are also dealt with in another forthcoming one (Grupe, forthcoming).

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Background

As ethnomusicologists we encounter different settings in our research as far as musical knowledge is concerned. The music cultures and traditions we study may be characterized by a continuum ranging from those with a detailed, verbalized music theory to those where musical concepts are only partially verbalized. In the former case we may speak of mainly declarative knowledge, i.e., people can verbally explain their musical behavior and the underlying musical concepts and theories. In the latter case we have to deal with mainly tacit or procedural musical knowledge, i.e., people know exactly how to perform their music but the underlying principles are largely implicit and not open to verbal discourse (cf. Polanyi 1966; Aitchison 2003). As far as local music experts do not verbally explain what they do, although idiomatic constraints obviously shape their performances, we need to find ways to disclose this tacit musical knowledge because its comprehension is a prerequisite for any culturally informed musical analysis which we aim for today. It is a generally acknowledged objective of current ethnomusicological research to include such an emic perspective (cf. Headland et al. 1990) in our musical analyses and interpretations of cultures, so we need to take local knowledge into account – be it tacit or declarative.

In addition to standard ethnographic methods such as participant observation including the learning-to-perform approach (cf. Hood 1971, Baily 1995) we may also employ computer-assisted research strategies (see further Grupe, forthcoming). Relevant studies have used various means such as commercial synthesizers, digital sampling, sequencer software, and the development of dedicated software. Famous examples include Simha Arom's study of xylophone tunings in Central Africa (Arom 1991), Ulrich Wegner's listening experiments concerning the perception of *amadinda* xylophone music from Uganda (Wegner 1993), Jim Kippen's and Bernard Bel's development of the so-called "bol processor" software which produced Hindustani *tablā* patterns (Kippen & Bel 1989), and Nathalie Fernando-Marandola's study of the vocal polyphony of Bedzan pygmies in Cameroon with the help of digitally modified multi-track hard-disc recordings (Fernando-Marandola 2002).

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Interactive experimental settings with artificially produced or modified audio examples which are presented to local experts have proven to be particularly useful when trying to investigate musical concepts without the need for abstract verbalization. They also underscore the active role of local collaborators in the research process and facilitate an immediate testing of hypotheses and the control of individual musical parameters in the field. Digital technology also lends itself to the presentation of results in the form of audio examples. Based on the promising experiences of other scholars we initiated the research project *Virtual Gamelan Graz* funded by the Styrian *Zukunftsfonds* (2006-2008) and the Austrian Science Fund FWF (2012-2015).

Karawitan, the classical gamelan music of Central Java

Karawitan, the classical music of Central Java[3], has its roots in the court traditions of Surakarta and Yogyakarta, the two main cultural centers of that region. Today it is formally taught at the Academy of the Arts (ISI) in Surakarta and practiced also outside of the courts. Noticeable differences exist between the Yogyanese tradition (*gaya Yogya*) and the Surakarta style (*gaya Solo*) which has come to be the dominating one in recent years. Considerably more significant differences can be found when comparing *karawitan* to similar traditions in neighboring regions such as West Java (Sunda) and the islands of Madura and especially Bali. *Karawitan* is closely connected to other arts, namely poetry, dance, and *wayang* shadow-puppet theater. It is performed by large gamelan orchestras consisting of metallophones, gongs and gong chimes, drums, and other musical instruments including a spike fiddle, zithers, flutes, and xylophones. In addition there are also female and male vocals.[4] It is useful to divide gamelan instruments into four groups according to their musical function: 1) instruments playing the main melody (*balungan*); 2) instruments embellishing this main melody; 3) instruments marking the

[3] As a comprehensive source on *karawitan* I recommend Pickvance (2005).

[4] In order not to overburden the text with too many Javanese terms I refrain from giving all the original names here. See Pickvance (2005) for a glossary and detailed explanations.

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compositional form of a given piece (punctuating instruments); and 4) the drums which control the tempo and tempo changes[5]. There are three typical line-ups: the full ensemble; an ensemble consisting only of so-called "loud" instruments, i.e., excluding "soft" ones such as spike fiddle, zither, flute, xylophone, and vocals; and a small "chamber music"-like one of only "soft" instruments plus one low metallophone (but excluding additional metallophones and gong chimes).

Two tonal systems exist in *karawitan*: a more or less equipentatonic one called *sléndro* and a heptatonic one called *pélog*. Both comprise three different modes (*pathet*) each. There is no standard pitch. The interval sizes especially in the *pélog* system are not standardized, but differ from one gamelan set to another and contribute to each one's specific sound (*embat*). For more than a hundred years musical notation has been used, but usually only the core melody is notated using ciphers, which represent the scale degrees[6], and additional diacritical marks for some, but usually not all, of the punctuating instruments indicating the form of the piece. This information is also contained in the extended title of a composition which lists its form, title proper, tonal system, and mode.

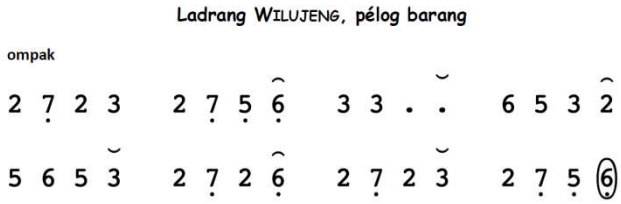

Fig. 1: Excerpt from the notation of a traditional *karawitan* composition[7]

It has intrigued ethnomusicologists for a long time to determine whether – or if so how – the performance of such a piece may be derived from this kind of notation

[5] The drummer therefore has a leading function within the ensemble.

[6] They are numbered 1, 2, 3, 5, and 6 for *sléndro* and 1 to 7 for *pélog*.

[7] *Ladrang Wilujeng [laras] pélog [pathet] barang* means that the piece "Wilujeng" has the standard form called "ladrang" (which consists of 32 beats per gong cycle arranged in four segments of eight beats each and a certain distribution of punctuating instruments) and that this is a version using the mode *barang* of the heptatonic *pélog* system. *Ompak* is the name of the first of two parts of a piece using the *ladrang* form. The dot underneath a cipher indicates the lower octave.

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especially as far as those musical parts are concerned which are not notated. Javanese musicians call this process "treating" (*garap*) a given piece, i.e., deriving embellishing melodic patterns from the main melody. Is it based on the application of musical rules? Are there further constraints which need to be taken into account in order be able to predict an idiomatically acceptable performance? It might seem somewhat surprising to draw on *karawitan* as a case study in the context of discussing tacit knowledge. Given the substantial stock of technical terms available and the existence of treatises on musical concepts of *karawitan* why not simply let local experts answer these questions? While theoretical statements by Javanese musicians and theorists exist and certain aspects of performance practice may also be dealt with by employing the aforementioned learning-to-perform approach on behalf of the researcher it seems advisable to adopt a methodology of analysis-by-synthesis: In order to check whether or how far we have understood the musical rules and constraints governing an idiomatic performance of *karawitan* we could present a rendition of a piece which incorporates all we know to Javanese experts and let them determine the successful as well as the not so successful or even unacceptable aspects of that performance. The assumption is that aspects which may be taken for granted or have eluded closer scrutiny will come to the fore if the musicians comment on an actual performance instead of discussing isolated parameters of performance practice. Furthermore, the sound and tuning (*embat*) of individual gamelan sets, which is a specific feature of this tradition, can only be seriously assessed when actually listening to various ones in direct aural comparison. However, various parameters of a musical performance (different sets of musical instruments, musicians, selected pieces, etc.) should not be mixed so that it is preferable to present digitally prepared audio examples where each of these parameters can be controlled and altered individually instead of using live recordings.

The *Virtual Gamelan Graz* (VGG) project

In the course of our *Virtual Gamelan Graz* project we have put this idea into practice. Virtual versions of several pieces from the traditional *karawitan* repertoire have been prepared by emulating a Central Javanese gamelan ensemble. Original

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sounds of a gamelan set housed at the University of Music and Performing Arts in Graz (KUG) were digitally sampled and played back using commercial sequencer software. The audio examples were prepared by applying known principles of *karawitan* practice. The selected compositions covered both tuning systems and their respective modes as well as various compositional forms. In most cases specific information on the respective pieces was available from our previous experience under the guidance of Javanese and/or European gamelan experts. In some cases, however, we deliberately chose compositions without such prior knowledge in order to determine whether the acquaintance with general principles and generic rules and constraints is sufficient to create an idiomatically acceptable rendition of such a piece. In December 2014, during several working sessions at the Southbank Centre in London[8], these audio examples, which incorporated only instruments with fixed pitches (metallophones, gongs, and gong chimes) as well as drums, were discussed by three renowned senior musicians from Surakarta concerning the idiomatic musical behavior of the musical parts. They also commented on the tunings of several gamelan sets, some of them modeled on famous ones from Surakarta and Yogyakarta, others representing various experimental ones. Since the collected data have not been fully analyzed yet I will now present some preliminary results.

Musical rules and constraints

At first, I would like to give a few examples of how certain musical parts embellishing the main melody (*balungan*) of a piece can be explained as being based on the application of musical rules. One central feature of *karawitan* must be taken into account here. The time it takes to complete a given gong cycle, which is the main large-scale structural building block of a composition, is typically stretched and contracted respectively in a way that the tempo of the *balungan* beats is halved

[8] I would like to thank the following people for their support: Bp. Suraji, Bp. Suyoto, and Bp. Prasadiyanto (ISI Surakarta); Sophie Ransby, Jonathan Roberts, John Pawson (Southbank Centre, London); the Southbank Gamelan Players (London); Babak Nikzat (KUG). N.B.: Bp. is the abbreviation of "bapak" which is the formal term of address in Javanese for an older or higher-ranking male person.

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or doubled respectively. Thus, reducing the speed by half will usually imply that the embellishing parts double their density in relation to the *balungan* beats and these relationships always involve multiples of 2 (2:1, 4:1 and so on). These levels of *balungan* tempo vs. density of embellishing parts are called *irâmâ*. We will now look at standard settings for which the typical musical behavior of a certain instrument can be expressed in a paradigmatic form. At first, let us consider the highest metallophone, called *peking* (fig. 2).

Fig. 2: the metallophone *peking* (photo: Gerd Grupe)

If a density of two *peking* notes per *balungan* beat is required the following paradigms apply. As long as two consecutive *balungan* tones differ from each other they will simply be doubled as in figure 3.

paradigm:	*balungan*	a		b		c		d	
	peking	a	a	b	b	c	c	d	d
example:	*balungan*	6		5		3		2	
	peking	6	6	5	5	3	3	2	2

Fig. 3: doubling *balungan* tones in *irâmâ tanggung* (density 2:1)

If the melody is "hanging" (*gantungan*) however, i.e., the melodic motion rests on one scale degree, the *peking* will need to insert neighboring notes as in figure 4.

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paradigm:	*balungan*	a		a	
	peking	(a+1)	(a+1)	a	a
	or	(a-1)	(a-1)	a	a
example:	*balungan*	3		3	
	peking	5	5	3	3
	or	2	2	3	3

Fig. 4: adding neighboring notes in *irâmâ tanggung* (density 2:1)[9]

If the tempo is reduced to approximately half of the original speed the *peking* will double its density to four notes per *balungan* beat. In this case the *peking* part is often formed by both doubling and alternating two consecutive *balungan* notes as in figure 5.

paradigm:	*balungan*	.		a		.		b
	peking	a	a	b	b	a	a	b	b
example:	*balungan*	.		6		.		5
	peking	6	6	5	5	6	6	5	5

Fig. 5: the *selang-seling* pattern in *irâmâ dados* (density 4:1)

Next, let us look at the melodic patterns of the gong chime *bonang barung* (fig. 6).

Fig. 6: the gong chime *bonang barung* (photo: Gerd Grupe)

[9] According to Javanese music theory even in the case of the heptatonic *pélog* system neighboring notes are conceived of as those of a pentatonic scale omitting the 4 and – depending on the mode – either the 1 or the 7, so that "a+1" results in 5 as a tone next to 3.

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If a density of 2:1 is called for it will usually perform a technique called *mipil låmbå* which consists of alternating between two consecutive *balungan* notes as shown in figure 7.

paradigm:	*balungan*			a			b
	bonang barung	a		b	a		b
example:	*balungan*			6			5
	bonang barung	6		5	6		5

Fig. 7: *mipil låmbå* in *iråmå tanggung* (density 2:1)

However, certain goal tones, e.g., low 6, sometimes require special melodic gestures (*mipil lumpatan*). An example is given in figure 8.

example	*balungan*		2		7̣		5̣	6̣
	bonang barung	2	7̣	5̣	.	6̣	6̣	7̣	6̣

Fig. 8: *mipil lumpatan* in *iråmå tanggung* (density 2:1)

For a density of 4:1 the *bonang barung* will apply the principle of diminution to the patterns shown above resulting in the following melodic gestures (fig. 9-10).

paradigm:	*balungan*				a			b
	bonang barung	a	b	a	.	.	b	a	.
example:	*balungan*				6			5
	bonang barung	6	5	6	.	.	5	6	.

Fig. 9: *mipil rangkep* in *iråmå dados* (density 4:1)

example	*balungan*			2			7̣			5̣			6̣		
	bonang barung	2	7̣	5̣	5̣	5̣	7̣	.	.	5̣	7̣	5̣	.	6̣	6̣	7̣	6̣

Fig. 10: *mipil lumpatan* in *iråmå dados* (density 4:1)

If the melody is "hanging" (see above) the *bonang barung* will play special ternary patterns often involving simultaneous octaves (*gembyangan*). One such pattern is shown in figure 11, where the underline marks simultaneous octaves. The dots in the *balungan* are no rests but indicate the prolongation of the last note.

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paradigm:	*balungan*		a		a		.		.
	bonang barung	a	a	a	.	a	a	.	.
example:	*balungan*		3		3		.		.
	bonang barung	3	3	3	.	3	3	.	.

Fig. 11: *gembyangan* pattern in *iråmå tanggung* (density 2:1)

Karawitan **as a rule-based system: scope and limitations**

In certain musical contexts, e.g., when the drummer switches to the dance drum *ciblon*, two gong chimes will execute an interlocking technique called *imbal* which is usually combined with performing melodic formulae (*sekaran*) leading to a given goal tone. They are taken from a stock of such phrases which the musician knows and he/she will vary them from one instance to another within certain limits. Similar techniques, namely the use of melodic gestures (*céngkok*) which can be extemporized during the performance, shape several other parts in the ensemble, among them those of the spike fiddle *rebab* and the multi-octave metallophone *gendèr barung*. Many more examples could be given including more sophisticated ones for specific musical contexts. But those shown above already demonstrate why scholars have been intrigued early on by the idea of looking at *karawitan* as an at least partly rule-based musical system (cf. Becker & Becker 1979; Sutton 1979; Hughes 1988). However, while the listening experiments we carried out with three Javanese experts in the course of our VGG project surely corroborated this notion it also revealed the necessity to look at *karawitan* performance from a wider perspective beyond specific instrumental techniques and pattern construction. Not only did they identify several mistakes that had been made when preparing the computer-generated versions of the pieces we presented. They also criticized the phrasing and timing of some virtual instruments. Especially the drum part and the performance of the gong chime *bonang barung* were considered to be executed in a too mechanical fashion. As far as the *bonang barung* is concerned this is relevant for non-metered sections of a piece such as the various introductory phrases of a

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composition where the *bonang barung* functions as melodic leader, namely *gendhing bonang*, but also applies to its timing in general which can often be described as "laid back". Figure 12 illustrates the timing differences between my computer-generated version (lower diagram) of the opening phrase (*ådångiyah*) for the composition entitled "Gendhing bonang Dènggung Turularé pélog limå" and the live rendition by Bp. Suraji on *bonang barung* who repeats it as expected (the two upper diagrams). The horizontal position of the vertical lines indicates the onset of a stroke on the time scale (horizontal axis). The dynamics (intensity) are indicated by the height of these lines and highlighted by the curve connecting their upper ends. For the sake of convenience the phrase is notated underneath in the conventional way. Obviously, the performance by Bp. Suraji does not completely stick to this notated model but adds an embellishing 5 at the beginning while dropping one 3 in the middle of the phrase and the actual timing cannot be derived directly from the notation. Apart from being too uniform the dynamics of the virtual version also emphasize just that one note (2) which Bp. Suraji strikes rather softly.

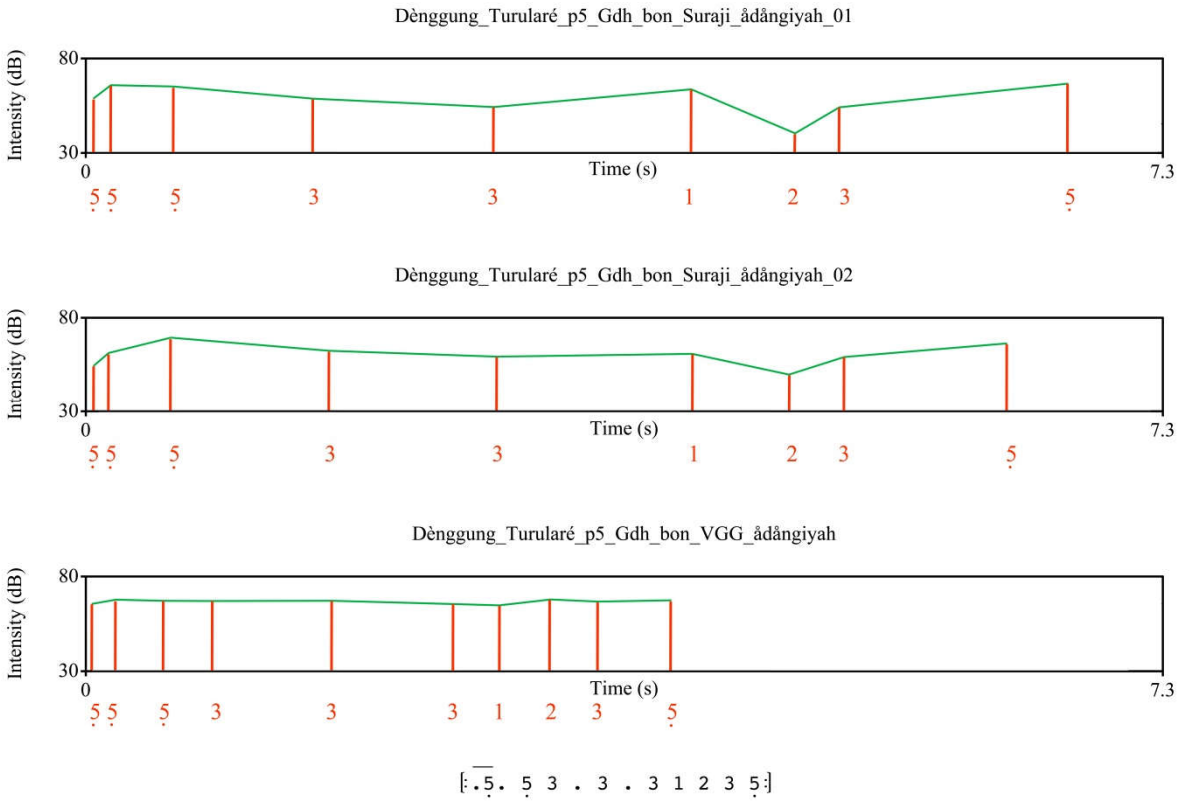

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Fig. 12: comparison of timing and dynamics between virtual and live versions of the *bonang*'s opening phrase for the piece "Gendhing bonang Dènggung Turularé pélog limå"[10]

Also, the three experts found the timing of some of the punctuating instruments not always appropriate for instance regarding the desired delay of certain gong strokes. Depending on the musical context the smaller hanging gongs called *kempul* should sound slightly later than the corresponding *balungan* note. The amount of delay, however, is a typical case of tacit knowledge because it will hardly ever be verbally defined in any more precise way, so that the observation of actual performance practice and the practical instruction by experienced gamelan teachers is more informative. There are also two types of gong "behavior" when it comes to its exact timing. The large *gong ageng*, the most highly esteemed instrument of a gamelan, is actually hit either slightly after the corresponding *balungan* tone, e.g., in the middle of a piece at the end of a gong cycle, or slightly before it, as is usually the case at the end (*suwuk*) of a piece. There are, however, instances in large compositions where the latter alternative is required by custom during the piece as well.

Another case in point is the seemingly simple issue of how to realize a *balungan* melody regarding the register of its notes. Very often the melody has a range of more than one octave and therefore needs to be adapted to the smaller range of the metallophones which are nevertheless supposed to play it. The result is a melodic contour that differs from the intended one and is only present in the parts of the instruments with a suitable range. Furthermore, the metallophone player needs to make a choice in pieces using the pentatonic *sléndro* system. Metallophones tuned in *sléndro* not only have five keys for the scale degrees of one octave but an additional high 1 and very often also a low 6 as well (cf. the seven-keyed *peking* in fig. 2). Some sources claim that the performer should simply ignore all register marks in the notation (indicated by a dot below or above the cipher), while others suggest quite elaborate ways on how to come to an

[10] I would like to thank Babak Nikzat for providing this diagram created with the *Praat* program (http://www.praat.org).

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appropriate rendition of the melody potentially including one or both of the outer keys, i.e., low 6 and high 1, of the instrument (see further Pickvance 2005: 111-112). Our three Javanese collaborators very often had concordant opinions in this matter but there were also some pieces where they disagreed so that a certain degree of personal choices obviously has to be taken into account.

As far as further constraints for an idiomatically appropriate rendition of traditional compositions beyond correct notes and melodic patterns as well as suitable phrasing and timing are concerned it proved to be particularly instructive to present computer-generated versions of a few pieces which had been prepared without prior knowledge of their common performance practice. They evoked mixed reactions and were generally judged much less favorably than the other ones. It turned out that conventional performance contexts such as shadow-puppet theater as opposed to weddings or concerts for instance may call for a specific treatment of a piece which may override generic "rules". In one case the musicians told me that the particular piece of which I had presented a virtual version would never be played in the way I had prepared it on the computer: My version was simply not conforming to current practice although my "treatment" of this piece might have been acceptable for another one.

Tuning and sound

A further aim of the project was to discuss the issue of tuning and sound (*embat*) of various gamelan sets. As has been mentioned these differences are a typical feature in this tradition and highly appreciated but it is usually quite difficult to discuss it because the gamelan sets are not only located in different parts of two large cities but they are also not easily accessible especially as far as famous court gamelans are concerned. Therefore any discourse would have to rely on the memory of the participants. In order to facilitate a more direct assessment several gamelan sets were emulated by digitally retuning the one available at our university. It has been built and tuned by one of the most famous gamelan makers, Bp. Tentrem. Only the tuning and pitch of the various instruments could be emulated while their sound structure remained the same, just as would be the case

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if a gamelan tuner were to retune our instruments without any further adjustments of beats or harmonics. Figure 13 lists 14 of the 18 gamelan sets which have been commented upon by our experts. They encompass various very renowned sets which traditionally have specific names as listed in the table. In addition some sets were modeled which are based on non-Javanese principles of tuning, e.g., the two American sets which employ Western concepts. In the right column "s" stands for a set with *sléndro* tuning, "p" for *pélog*, and RRI is the abbreviation of Radio Republik Indonesia, the name of the national radio station.

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Name of gamelan	**location**	
Lebdhå Jiwå	Southbank Centre, London	s + p
Kanyut Mèsem	Mangkunegaran, Surakarta	s + p
Madu Murti Madu Kusuma	Kraton Yogyakarta	s p
Mardi Swara	Mangkunegaran, Surakarta	s + p
Sadad Pengasih	RRI, Yogyakarta	s + p
Prècèt	Mangkunegaran, Surakarta	s
Udan Arum	Mangkunegaran, Surakarta	p
Si Darius	Mills College, USA	s
Si Madeleine	Mills College, USA	p

Fig. 13: emulated gamelan sets

The comments by our experts have been very instructive and to the point but a more detailed analysis of these conversations still needs to be carried out. Typical issues were the absolute pitch of a set and its consequences in relation to the vocal range of singers, the suitability for a certain mode (*pathet*) or type of pieces, and the general character of a set as conveyed by its intervallic structure. One particularly interesting aspect we are going to look into will be the terms that were used to make these statements. Especially concerning the latter issue these

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expressions seem to constitute a kind of technical vocabulary and they were employed to make comparisons with gamelan sets all three know well, for instance some which are used by famous puppeteers (*dhalang*).

Conclusion

Generic rules can explain *karawitan* to a certain extent and some aspects of a performance are thus partly predictable. To be sure, we did not expect the gamelan musicians we worked with to formulate additional or more sophisticated rules in the course of our project. This kind of abstraction is a rather scholarly, not an artistic approach. But our analysis-by-synthesis, attempting to put as much as possible of what we know about this music into the creation of virtual renditions of traditional pieces, rests primarily on explicit knowledge insofar as only those features were modeled by VGG which we were aware of as being relevant. One immediate result of the musicians' critique has been to realize that an inappropriate playing style can be equally disturbing to them as a few wrong notes. Thus, the "surface structure", i.e., embellishments, phrasing, microtiming, articulation etc., must be given more attention without of course neglecting the "deep structure" of "correct" notes and patterns. As a consequence of these findings one might want to establish more precise and elaborate additional rules describing for instance the appropriate timing and the dynamics of the musical parts involved. Furthermore, depending on the context in which a composition is performed (e.g., shadow-puppet theater, weddings, concerts) a certain "treatment" or version of the piece may be conventionally expected.

Such factors very often seem to be taken for granted or considered of secondary importance by gamelan experts, i.e., musicians and scholars alike, and in this respect the necessity to model virtual pieces without relying on such implicit knowledge has led to new insights about *karawitan* performance practice beyond its musical grammar. In addition, the immediate aural comparison of various virtual gamelan sets by Javanese experts has proven to be a useful device in highlighting specific features of each set much more clearly because being able to actually listen

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to different (virtual) gamelan considerably fostered verbal discourse on issues usually considered implicit local knowledge.

Thus, computer-assisted experiments have proven to be a useful tool in the study of an already fairly well documented musical tradition especially as far as customary practices and conventions are concerned which put constraints on actual performances and so far have not been sufficiently acknowledged in research on *karawitan*. It seems to be essential to develop a more holistic concept of proper *karawitan* performance practice which includes both structural features and contextual aspects. This would be a prerequisite for culturally informed musical analyses and contribute to a deeper understanding of this art.

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