

Adapting and Applying Central Javanese Gamelan Music Theory in Electroacoustic Composition and Performance

Part II of II: Appendices

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Charles Michael Matthews

School of Arts

Middlesex University

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Appendix 1: Composition process and framework development

In this chapter I will present an outline of my own composition process, providing an introduction to the more detailed description and analysis in §3. The development of works presented here took place over the course of three years, in three main stages:

Table 1-1: Stages of composition development.

Stage	Period	Software	Main output
1) Initial experiments and aesthetic development	2010-2011	<i>Bonangan</i>	<i>Bonang Study (AV1.1; §3.1)</i> <i>Tenuous Links (AV1.2; §3.2)</i>
2) Development of the <i>Augmented Gamelan</i> concert set and related works	2011-2012	<i>Cengkokan</i>	<i>Monggangan (AV1.3; §3.3)</i> <i>Augmented Gamelan (AV1.4; §3.4)</i>
3) Development of the <i>Mipilan</i> software and <i>Response to ShoutCry Room</i>	2012	<i>Mipilan</i>	<i>Response to ShoutCry Room (AV1.5; §3.5)</i>

The aims of the practical work evolved over the course of the research and were key to the development of the conceptual and theoretical framework exposed in the first part of this thesis. The overarching aims were as follows:

- To explore practical considerations for working with gamelan instruments and electronics, and their influence on development of material.
- To develop a composition framework extending beyond individual pieces.
- To adapt and extend traditional playing techniques in ways that would not be possible for instrumental performers.
- To find appropriate methods of integrating electronics in instrumentally oriented performances.
- To explore a notion of *garap* in electronic music and to create a situation in which software and live performers share the same melodic framework.
- To create formats for representation (e.g. notation) accommodating both traditional and electronic *garap*.
- To ensure that pieces represent a respectful approach to tradition and Javanese culture, while considering that these works may provide a first point of contact with central Javanese gamelan for some audiences.

These aims were explored through the following practical objectives:

- To develop at least one public concert performance.
- To work with musicians and composers in both the UK and Indonesia.
- To create electroacoustic-oriented arrangements of traditional material.
- To create a library of electronic *cengkok* with appropriate notation.
- To create software for computer-aided composition and performance, to be accessible for both gamelan and electroacoustic-oriented composers.

1.1 Framework

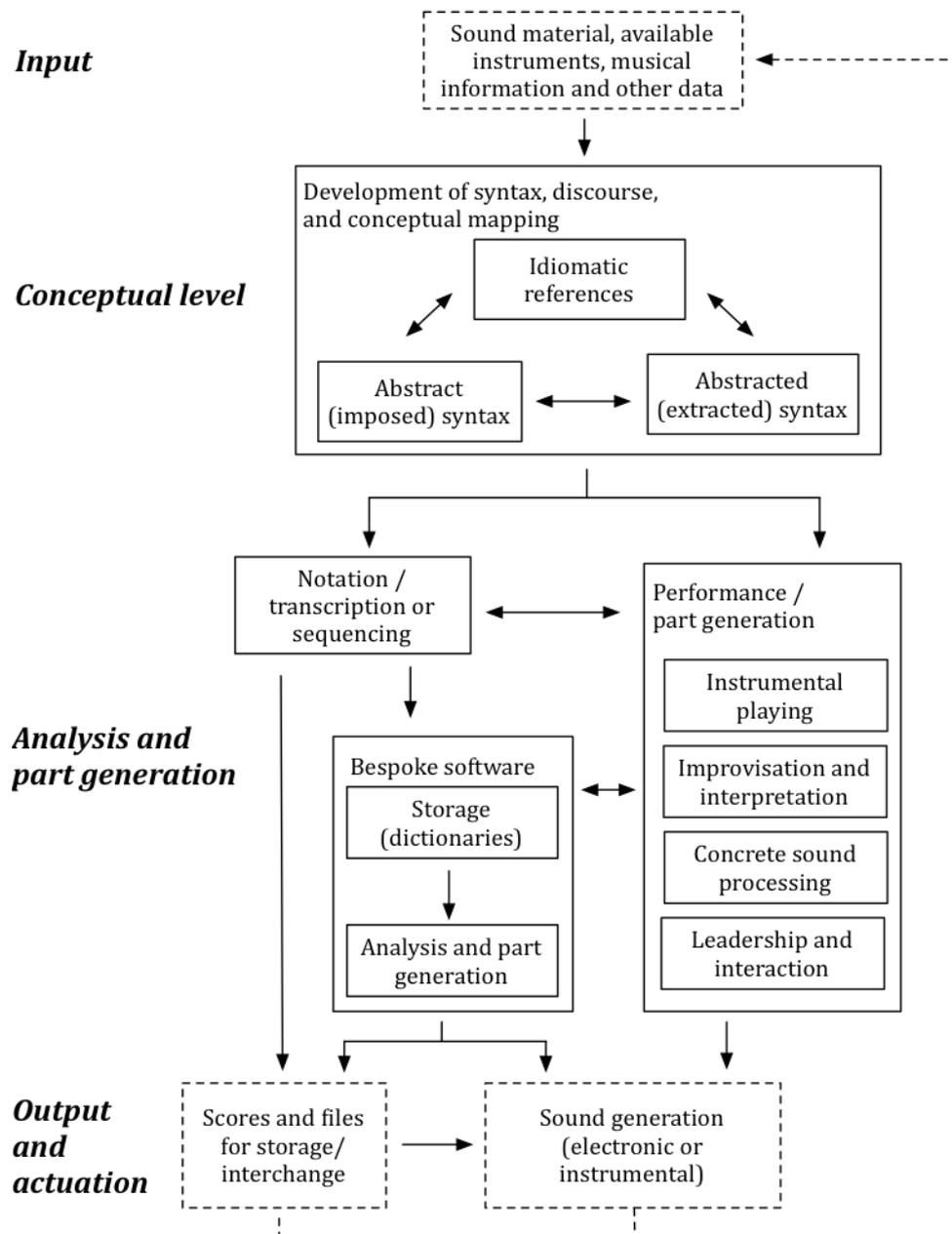


Figure 1-1: Various stages of the composition process and feedback.

The composition process was initially characterized by the desire to establish a formal framework for composition. Throughout the practice I shifted back and forth between treating compositional output as as examples of this framework and focusing on the development of pieces themselves. In particular I found that in abstract the concepts I borrowed from gamelan in my earlier work became generic processes that did not give rise to the qualities that had initially inspired me as a musician and composer. I thought it best to address this problem by working on a more practical level. In doing so it is my opinion that a more natural interaction with the constraints of the instruments and software frameworks has evolved, enhanced by maintenance of a conceptual awareness throughout the development of the pieces.

Figure 1-1 (an expansion of the model presented in **Part I: §5**) represents an attempt to break down and illustrate my own compositional processes, identifying a place for the development of custom software.

1.2 Aesthetic development

Throughout the pieces developed in the research I have attempted to play on the border between recognizable instrumental sources and electronic parts, creating an impression of stretching out, anticipation and elaboration of instrumental textures and timbres. The aesthetic qualities of the electronic parts has been influenced by a notion of creating sympathetic resonance, a phenomenon in which an object responds to external vibrations at frequencies that correspond to its own resonant profile. I had previously noticed instruments resonating in response to singing in a gamelan in an enclosed space, and my early conception of gamelan music upon encountering instruments such as the *gender* for the first time was that it appeared to be a set of elaborate metallic resonances responding to and twisting around the vocal parts, gongs and drums. During the development of my own compositions I noticed that when I played samples of a *gender* or sine waves around certain frequencies, the instrument sitting on the other side of the room appeared to sing back to me¹.

My intention in the use of sine waves and granular synthesis linked to the *cengkok* played on the *bonang* and *gender* is to give the impression of sympathetic

¹ I also found inspiration in Alvin Lucier's piece *Music for Gamelan Instruments, Microphones, Amplifiers and Loudspeakers* (1994), which features feedback and beating tones from the manipulation of feedback generated through the resonances of the instruments.

resonances displaced in time, forming anticipatory patterns in a similar manner to the *bonang* or *gender* anticipating the notes found in the *saron* or the vocal parts (see **Part I: §3.3.2; 3.3.3**). In cases where I have attached transducers to the instruments themselves, I have tried to give the impression that the sonic structures of the instruments themselves are being drawn apart, moving back and forth between natural and unnatural textures.

I deliberately opted for a rough, “DIY” aesthetic, embracing the collision of instruments from different ensembles and concomitant differences in tuning, background noise generated from electronic equipment or the environment, and associated visual qualities. I felt that embracing this type of attitude early on would enable a more free, experimental, and most importantly honest approach. In particular I was keen to distance my work from notions of a divide between human players and electronic elements, or that material from gamelan might be treated as abstract information, reduced to a series of “note events”. I was also concerned that an electronic approach in the digital age might imply a cold, clinical approach (whether in terms of sound quality, synthesized timbre or timing), or the fixing of recorded sounds or tuning systems.

Where appropriate I have situated myself as a performer on the floor amongst the gamelan, and use acoustic blending of electronic and instrumental elements as much as possible. Since I consider musicians as forming as much a part of the audience as a passive listener, I have attempted to consider their experience as a priority. I feel this is consistent with gamelan practice in its traditional context, where music is sometimes played for its own sake or in ceremonies where no audience is present. This focus is reflected in the positioning of transducers and conventional speakers around and inside the instruments themselves, which sometimes only provides a marginal sense of acoustic integration for an observer².

1.3 Idiomatic reference

I have attempted to investigate the application of various types of idiomatic material in a direct manner through remapping of parameters, as well as wider conceptual mappings. The clearest connections lie in the use of direct vocal parts, of adaptation

² The performer’s experience of playing the *bonang* with transducers and spatial correspondences is represented in **AV1.1**.

of traditional instrumental techniques, and of *balungan* in various forms as both an idiomatic melodic device and a medium between computer and human players. The notion of *garap* is represented through the use of electronic *cengkok*.

Throughout the compositions I have attempted to create further references to *garap* in the form of adaptation of parts and interaction based on performance context and various other factors. This is observable on a base level through cases of rhythmic leadership and *irama*, in which the electronically generated parts follow the musicians through timing determined by a slider (§2.2.2). In other instances the influence of external factors on concretization of parts has taken place through means appropriate to the medium. Many electronic parts employ audio-based modulation from other instruments (virtual or otherwise), ranging from subtle coherence in textural details to more distinct musical gestures. This may be heard in the influence between generators in the *Bonang Study*, in which the pitch of a sustained drone played through the *bonang barung* is modulated by a virtual representation of its partner instrument, the *bonang panerus* (AV1.1, 1:36-2:00). In other cases I have used side-chained compression and envelope following from a microphone input to reinforce the connection between transducer-based parts and the rest of the ensemble (AV2.7.A).

Beyond remapping abstract note information, the works have generally been arranged with wider reference to frameworks from *karawitan* such as *pathet* and *irama*. I have also developed sections based on the exaggeration of certain gestures such as *irama* changes and *sirepan* that have required modification of instrumental parts in addition to creation of electronic elements (e.g. §3.1.3.c; 3.4.3.c).

1.3.1 Electroacoustic music references

Throughout the development process I have aspired to approach electroacoustic processes with gamelan as a sole idiomatic reference point, particularly in the domain of rhythm and pitch. In my own capacity as a composer and performer I felt that manipulation of these parameters was my weakest resource, and it represented one of the primary reasons I had become interested in studying gamelan: to find a melodic framework that I could apply to my own compositions. The aesthetic development was largely determined by my own personal idiom, which in turn was influenced by the works of composers such as Alvin Lucier, John Cage, Karlheinz Stockhausen, and Bernard Parmegiani. The production aesthetic was influenced by a

series of recordings made by Yantra Productions with musicians from ISI Surakarta (e.g. *Gamelan of Central Java*, 2007; 2009), in which instrumental sounds are frequently isolated in sparse, unusual combinations, and recorded at close range.

The compositions and mappings are often characterized as much by the avoidance of idiom and cliché from other genres as it is the deliberate invocation of idiom from gamelan. In particular the combination of a prominent and steady pulse along with certain electronic processes and textures has the potential to evoke the aesthetic of electronic dance music³. This point was raised in verbal feedback from various workshops in the UK in the initial development process. Combined with a desire to grant musicians more freedom, this formed part of the inspiration to work with the looser timing associated with the *macapat* and *pathetan* forms. This has in turn led to focus on development of balance between creating clear pulses for musicians, obfuscating a pulse, or finding ways for the computer to follow.

1.3.2 Musical time

The first stages of the research were dominated by a desire to explore musical time as it relates to Javanese gamelan. I was particularly interested in exploring the use of *garap* across established *irama* levels to maintain rhythmic and melodic coherence, while the role of other parts shifts from melodic or rhythmic to structural. This concept resonated with my own interest in unity across time-scales in electroacoustic music, particularly in works by Cowell (1930) and Stockhausen (1972), who suggest that greater coherence can be achieved through treatment of pitch and rhythmic intervals in a similar manner, as part of a continuum.

Consequently the initial pieces were based on the same structure: a movement from a fast central pulse to a slow *irama wiled*. This is taken to the extreme in *Tenuous Links*, in which the central pulse moves from approximately 66Hz to 0.13Hz. This movement is inspired by the moment in Stockhausen's *Kontakte* (1960) in which a synthesized tone rapidly transforms from a pitched, coherent sound object into audible iterations, eventually taking on the characteristics of note events and joining

³ At times I have embraced influence from electronic dance music, particularly rhythmic patterning sometimes called *drill 'n' bass* (e.g. AFX, 1995). This is most apparent in *Monggang Alit/Ketawang Subakastawa* (AV1.4.A; AV2.7), where I attempted to de-emphasize the mechanical qualities of the rhythm by offsetting it with a more fluid *gender* part, combined with the aesthetic of the *keprak* used in dance and *wayang*.

instrumental tones as a part in the rhythmic domain. The realization in my own work is relatively superficial, serving as a preliminary indication for the connection between the domains in gamelan-related composition.

As my focus moved from algorithmic composition to a more intuitive and physically oriented approach, it became apparent that the impression of such transitions and coherency would be sufficient for the purposes of the current research. Rather than attempting to create a literal or direct connection between the tuning of the instruments and rhythmic parts, I explored the substitution of other processes such as existing audio time-stretching algorithms and editing MIDI sequences by hand to experiment with an aesthetic that might be transferred to a more coherent method at a later point (§3.4.3.b). With this shift in attitude came the exploration of events outside a central clock, which I had previously considered vital in maintaining coherence of rhythmic intervals. In later works several clock sources were used: a central clock either controlled by hand through a MIDI slider or through a virtual metronome, and various other events generated through absolute timing values and pre-determined rhythms in pre-prepared material (§1.4.2).

The movement between different levels of rigidity and passing of rhythmic leadership between human and computer performers has also emerged as a theme in the conceptual development of the pieces. In the *Augmented Gamelan* set in particular, the movement between highly quantized and free rhythm in the instrumental parts forms an over-arching structure of tension and release (§3.4.4).

In the interest of creating smooth transitions between clock sources and rhythmic leadership, I embraced the problem of disparities in timing and created prominent moments in which the rhythm of an ensemble appears to fall apart. This is most clearly audible in *Durma*, the final part of the *Augmented Gamelan* set. In the transcription of the introduction shown in **Figure 1-2**, the collective rhythm of the humanly played *gender*-type instruments disintegrates (AV2.6.B, 10:25).

Gender A:	56123211216535	5	6	1	2	3	2	1	1	2	1	6	6	
Gender B:	56123211216535	5	6	1	2	3	2	1	1	2	2	2	2	
Slenthem:	56123211216535	5	6	1	2	3	2	1	1	2	1	6	6	6

Figure 1-2: Transcription of improvised disintegration in *Durma* (studio version, traced from waveforms of multi-track recording).

Here the musicians deliberately slow down independently of each other, forming a diffuse texture through which a second pulse can be introduced. The use of rhythmic and melodic dissolution was inspired by processes developed in my solo electronic work, which I first explored in the current research during the development of the *bonang panerus*-inspired part in *Bonang Study* (AV1.1.A, 1:20) and subsequently applied in *Response to ShoutCry Room* (AV1.5.A, 4:00)⁴.

The disintegration of ensemble rhythm and gradual stabilization of a computer-based clock is also audible in a workshop recorded at the University of York, in which the main tempo gradually ascends (AV2.1.A, 3:45; clock begins to stabilize audibly at 7:28), and in the workshop version of the *Bonang Study* (AV2.2.A, 0:05; texture appears at 1:30). A similar process occurs on a micro-sound level in the probability-based crossfades between grains in *Monggangan*, as the instruments implied by samples gradually take over from each other (see §3.3.2.f).

1.3.3 Electronic *cengkok* and envelopes

Through the composition process I developed a set of techniques and patterns that I collectively refer to as “electronic *cengkok*”. These range from *mipil*-type patterns referring to a *balungan*, to collections of events intended to complement the more complex divergence in other elaborating parts. Although some sequences emulate established playing techniques for traditional instruments – in particular the *bonang* and the *gender* – the majority of the patterns developed are based on the modulation of individual parameters rather than discrete note events. While not generally adhering to the notion of a melodic unit, the use of the term retains its Javanese meaning in the sense that it refers to an abstract pattern that is modified in the course of performance, becoming *wiletan* (see Part I: §3.3.3).

Each set of electronic *cengkok* was developed through a combination of idiomatic reference, conceptual and parameter mappings to enable movement in texture and timbre, and the affordances of various available frameworks. In the first stage of the research, the form of the *cengkok* was influenced by grounding in *Kepatihan* notation and text-based commands. During this period I was most interested in exploring the types of notation used for loud-style parts of the gamelan,

⁴ The application of this fairly generic process was inspired in turn by György Ligeti’s *Poème Symphonique* (1962), in which one hundred metronomes are gradually allowed to slow down independently of each other (see Clendinning, 1993 p. 193).

and in creating direct and observable correspondences between domains. Furthermore I aspired to place the computer as an autonomous player in the ensemble rather than acting as an instrument, with limited human input in the sense of triggering note events. The most logical approach to this situation appeared to be the creation a set of electronic commands forming equivalents to the events in abstract notation often used in explanations of these patterns (see Pickvance, 2005 p. 147; Schütz & Rohrhuber, 2008 p. 161).

In particular this led to a close interpretation of the pulse of the *bonang* and its reference to various notes of a *balungan*. In place of a sequence of note events, I used this to create equivalent movements in amplitude and spectral content. **Table 1-2** shows a *mipil* pattern from the *Bonang Study*, illustrating links between the instrumental and synthesized parts (see §3.1; AV1.1).

Table 1-2: Example of *mipil*-type patterns in the *Bonangan* software.

Entry	Balungan position	Bonang	Synthesizer
1		a	ramp a 1 0 1000
2	a	b	ramp b 1 0 1000
3		a	ramp a 1 0 1000
4	b	.	to a 0 100
5		c	to b 0 100
6	c	d	to d 0.5 0 1000
7		c	ramp c 1 0 1000
8	d	.	to c 0 100

This resulted in a powerful set of commands with potential for great variety, but with interdependencies between events that only a computer was capable of realizing. Furthermore, due to their high level of abstraction the patterns themselves became unwieldy to represent graphically, and hence difficult to edit in an intuitive manner or explain to collaborators (see N1.C).

The next stages of development were influenced by a desire to reintroduce a sense of human interaction, experimentation and playfulness to the compositional process. The *cengkok* themselves grew from a combination of accompaniment for vocal parts and integration with the more complex idioms of the *gender*. Here I drew on the affordances of faders and dials as a familiar set of controls to me as an electroacoustic performer, which led me to smooth, precise movements, and

limitations on the simultaneous manipulation of channels⁵. The development of graphic notation cemented the simplicity of the parts as abstract objects, using minimal triangles to represent generalized, often less linear, movement in various parameters, as illustrated in **Figure 1-1**⁶.

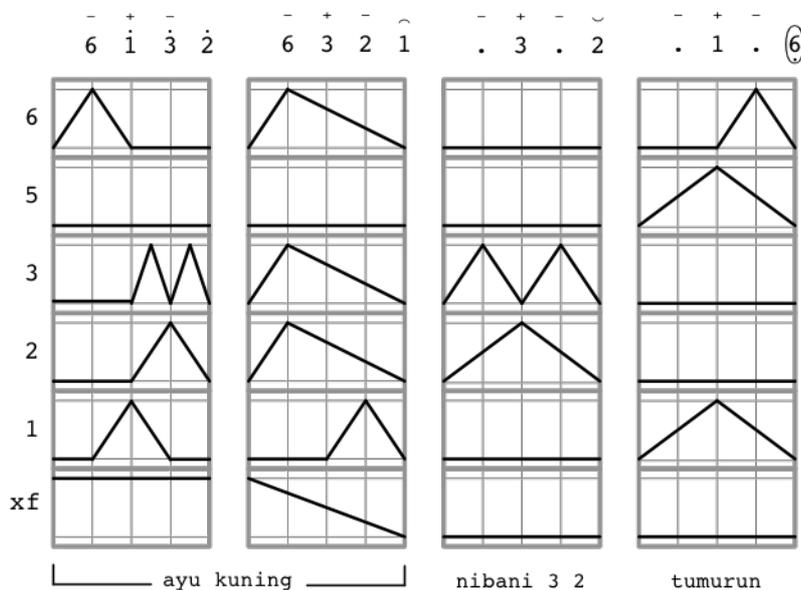


Figure 1-3: Ramp-based *cengkok* in the final *gongan* of *Pangkur Paripurna*.

This approach held the potential to develop more complex parts through concretization, drawing on the performance situation to create modulation of timing, timbre, and various other parameters. Through the development of these parts I chose to impose constraints on the number of note channels involved, both in order to match the interface I was using and to create a reference to the idiom of the *saron* and other gamelan instruments of limited pitch range. A further channel (*XF*), used as an overall crossfade between sources for each note, allowed for the exploration of spectral manipulation; through this it was my intention to create a further layer of “timbral *cengkok*”. Furthermore, by assigning differently pitched material to each side of the crossfade, it was possible to create general movement between registers.

The initial set of patterns was based on the process of *pipilan*, adapted from the realization of a *bonang* part with modification through the slow attack afforded by the faders. In the case of *balungan nibani* I chose a slower interpretation to match the density of the *balungan* rather than the more common instrumental approach of

⁵ For discussion of the affordances of faders and other frameworks for music technology see Mooney (2010 pp. 149-150).

⁶ See **Part I: §3.3.3** for instrumental versions of the *ayu kuning cengkok* used here.

convergence and divergence, giving a greater impression of space. These patterns provided a vocabulary for interpretation of sequences of varying idiomatic integrity that was augmented with more specific patterns as development progressed.

The set of more specific *cengkok* in the later stages of the research was developed on a piece-by-piece basis, with the intention of forming a generalized set later. The use of traditional pieces such as *Pangkur* and *Srikaton* provided an opportunity to cover the majority of traditional named *cengkok*; in lieu of a definitive library of patterns, the notation for these pieces provides a basic vocabulary (N3.E; N4.B; also see §2.4.5). My choice of plain *mipil*-type patterns, *nibani*-type patterns or named *cengkok* (including structurally significant patterns such as *tumurun*) depended on the aesthetic focus of each piece.

1.4 Instruments and interfaces

The majority of instrumental techniques used were either traditional or exist in new compositions including *komposisi baru* developed in Indonesia (see Roth, 1986 pp. 86-95). Amongst the extended techniques used, musicians were asked to strike instruments with a variety of hard and soft beaters, and to use *rebab* or violin bows on the edge of keys or upturned *pencon*. Some techniques were chosen for varying emphasis on the combination of tunings from different gamelan in the *Augmented Gamelan* set and subsequent works (§3.4.2.b). Further sound generation and interaction with the computer parts came through the use of transducers attached to the instruments.

1.4.1 Transducers

My use of transducers was initially connected to aesthetic integration. I wished to find a way that the computer could share an instrument with a human player, which quickly became blurred with compositional devices. I chose speaker-style devices over other actuators (e.g. solenoids or servo motors) for the range of timbres and ability to move fluidly between pitched, rhythmic and textural activity that they afford⁷.

⁷ For precedents of this type of activity see Collins (2009 pp. 51-54); Driscoll & Rogalsky (2004). The use of electronic devices to stimulate gamelan instruments was pioneered by Suwardi as early as 1982 (Roth, 1986 p. 91).



Figure 1-4: Iron *bonang* pots with a combination of output transducers and piezoelectric contact microphones.

During the initial development process I experimented with several types of transducers. The first recordings (e.g. AV2.7.A) were made with the Feonic Soundbug (<<http://www.feonic.com/>>, accessed 30/09/13), which allowed stimulation of the resonance of the instruments without risk of damage due to the lack of physical movement in actuation through magnetostriction. These devices proved impractical for various reasons including cost, weight, and output volume. I eventually settled on a generic speaker-type design that I was able to buy in bulk, but which required greater caution and hence less flexibility. The visual aspect of these devices, loose wires, gaffer tape, and crocodile clips contributed to a subtle theatricality and general unrefined aesthetic I wished to bring to the project.

The acquisition of my own set of instruments in 2011 and 2012 (pictured in **Figure 1-4**) brought expanded possibilities. I had been cautious about damaging instruments and the understandable concerns that my activities might bring about through use of existing sets of instruments in institutions. Use of my own instruments primarily allowed me to test techniques in advance to ensure that no harm would

take place, but also led to experimentation with more radical methods that I would only use with my own resources.

The contact of the transducers to the instruments via protective padding affected their timbre and resonance to varying degrees. In some cases the transducers did not stimulate the pitches associated with the instruments. By playing various idiomatic parts as noise through transducers (as in the *slenthem*-type parts in the *Bonang Study* and *Tenuous Links*), they were treated as abstract information with limited bearing on perceivable pitch material without intense dedicated listening. In the *Augmented Gamelan* set I explored ways of physically manipulating the transducers to modify the sound created; in particular I found that by playing a rich, noisy texture and proceeding to press the transducers into the instrument, I could create modulation perceivable as pitch glissandi.

Where instruments were to be recorded or amplified directly I used piezoelectric contact microphones attached to the instruments through Blu-tack. This setup amplified minute details that would be lost in a larger performance space, enabling subtle textural manipulation. However, I found the discrepancy in volume between speaker-driven sound and beater strokes was too great when sharing instruments between the computer and human player, as I had originally intended⁸. For this reason, instruments were not played with traditional beaters while connected to contact microphones with the exception of works created in non-real-time (e.g. *Gong Genthra Study*; **AV2.4.A**).

1.4.2 Clocks

During development process I experimented with methods of generating timing for the electronic parts. This process was coloured by my initial desire to place the computer as an autonomous entity in the ensemble, capable of leading or following the *irama* of an ensemble. Even in the *Augmented Gamelan* set when I considered myself a player as much as a technician operating the electronics, I was reluctant to engage with interfaces that would lead me into an instrumental situation, avoiding percussive pads or keyboard-type controllers.

⁸ I have used this to setup to perform exaggerated gestures in other collaborations. For example, in an improvised performance with Charlotte Pugh (2012) I played a *kethuk* with contact microphones to produce intentional distortion. Further integration might be enabled through coordination between electronic and human-played parts, and dynamics processing such as gates and compression.

Four types of timing were used for the computer-based parts:

- **Internal clock** either from Max/MSP or generated by Ableton Live, disseminated to musicians via headphones or integrated in synthesized parts audible in the performance space⁹. Variation and jitter is provided through variable random delays on note events, parameter smoothing, and non-linear scaling and interpolation of envelopes.
- **Independent clocks** generated through absolute and random timing values of synthesized events (see §2.4.2) and through the timelines of pre-prepared materials (as in portions of *Monggangan* and the *Augmented Gamelan* set).
- **Free timing** through manual manipulation of individual parameters and events via controllers, onscreen interfaces, and analogue equipment, either developed independently or in interaction with live musicians.
- **Scrubbing**: timing generated by moving back and forth through a continuous sequence using a fader or similar controller – a technique I named “*maju/mundur*” during development after the Javanese term for the back-and-forth movement of a bow used to play the *rebab*.

The scrubbing technique that characterized later works was developed from my initial concept through practice in recording and development sessions with Joko Purwanto in 2012 (AV2.5.A). In order to create a continuous sequence using a single fader, I assigned the end-points of the control range to move forward by a *gatra* and invert the output to the control sequence (see §2.2.2).

1.5 Conclusion

It was necessary to modify my initial goals, both due to practical and time constraints, and to a general shift in focus of the research towards conceptual development. At

⁹ During the *Wayang Lokonanta* production (University of York, 2012) I collaborated with *kendhang* player John Pawson on synchronizing a sequence using a click track in my own headphones. The tempo of a sequence was manipulated using the “nudge” feature in Ableton Live in a manner similar to a DJ beat matching with a record deck. With this technique I was able to stabilize a synthesized ensemble with a full gamelan though a particularly lively action scene. The problem of changing *irama* was handled by switching leadership of the pulse to the computer’s internal clock, which was disseminated on *kendhang* by Pawson through a click track in his own headphones once the action on the *wayang* screen had settled.

various stages I have had to choose between the integrity of the research and my own integrity as a composer, or the interests of working with musicians and meeting targets for performances; in these cases the achievement of performances has taken priority. For these reasons elements originally intended as proof of concept or temporary fixes have often been retained. Many of these concessions have enriched the research, forcing me to address the integration of wider processes and a more realistic placement of the work in wider composition and performance practice.

The focus of the compositional process gradually expanded beyond what could be considered “abstract musical” relationships oriented around note events, towards a more concrete approach and reinterpretations of Javanese music theory. This was reflected in my approach to software development, as I would often find myself working on the structural elements of the software in preparation for a recording session or performance, either using existing traditional material or generating it at the last minute, often through chance procedures. Consequently, rather than developing a robust framework applicable to a variety of compositional systems, the focus shifted to a personal idiomatic and stylistic approach, with elements such as the electronic *cengkok* and simplified *garap* remaining transferrable to other compositions.

This development will be illustrated in **§2**, in which I provide details for software development and more concrete examples of the electronic *cengkok*. **§3** provides a chronological account of the composition and performance activities, including further description of technical development. All of the works presented here relate to sounds produced by physical gamelan instruments or vocal parts in some form, whether played live, sampled, or stimulated by transducers.

Although they are broadly presented as compositions, the majority of works draw heavily on traditional Javanese repertoire and gradual reiterative development between pieces. Upon closer inspection it may be more accurate to define them as arrangements or *garapan* [interpretation] of existing material. Furthermore, due to the cross-domain nature of this activity it is necessary to ask where the work itself exists – whether it is in the abstract musical information (for example, what can be notated), in the development of a performance framework and algorithms, or perhaps inseparable from a concrete whole in the form of a recording or performance experience. This discussion will take place through the analysis methods introduced in **Part I: §5**.

Appendix 2: Software and electronic garap

This section provides a practical and technical explanation of the manner in which software was developed over the course of the research, and an introduction to the electronic *cengkok* used. The focus is on *Mipilan*, the version of the software presented in the digital portfolio. Descriptions of *garap* in *Bonangan* and *Cengkokan* have been included to illustrate the compositional process and the techniques employed in the compositions discussed in §3.

2.1 Development process

My preliminary aim was to create a framework for writing and annotating traditional notation, which could later be adapted for organization of non-idiomatic material. I chose this approach as I was unsatisfied with the affordances presented by commercial piano-roll based MIDI sequencers such as Logic or Ableton Live, which I felt guided the user towards a particular approach to tuning systems and metric weighting (see Mooney, 2010). Above all, my experience was that conventional sequencers were suited to creating fixed parts, and required excessive work when composition centered on changing melodic information in a central framework (i.e. a *balungan* or similar part). Instead, I wished to explore the affordances presented by a) a cipher-based notation system and b) a system based on real-time interpretation and principles of elaboration. Although my ultimate goal was to work with more complex frameworks, it was my intention that an abstract sequence such as a *balungan* might form a bridge between the different idiomatic and conceptual spaces¹⁰.

The decision to use the patching environment in Max/MSP over more flexible text-based languages was largely based on accessibility and an acknowledgement of

¹⁰ This was a progression from the work towards my master's degree at Middlesex University, in which I created a system for recreating performance techniques in the loud-style gamelan ensemble called *Automatic Gamelan* (Matthews, 2009). This was developed through a combination of Max/MSP and Java, using an object-oriented model in which a hierarchy of classes for generating instrumental parts are used to interpret a *balungan* with fixed *garapan* for the *bonang*, *saron*, *peking*, *gong*, *kempul*, and *kenong*.

my own ability; from experience I found that I was able to troubleshoot and create workarounds in Max/MSP in the run-up to performances, or in some cases on stage or in the studio, with greater ease than with text-based code. In turn this also enabled experimentation and a more concrete approach to synthesis and part generation.

The first stage of development was oriented around the computer as an autonomous player. I attempted to set up complex sets of instructions for the computer to perform with reference to a *balungan* (either functioning as a *saron* part or a more abstract element) that could be shared with human players. The resulting code, while effective, was idiosyncratic and cumbersome to edit (see §2.4).

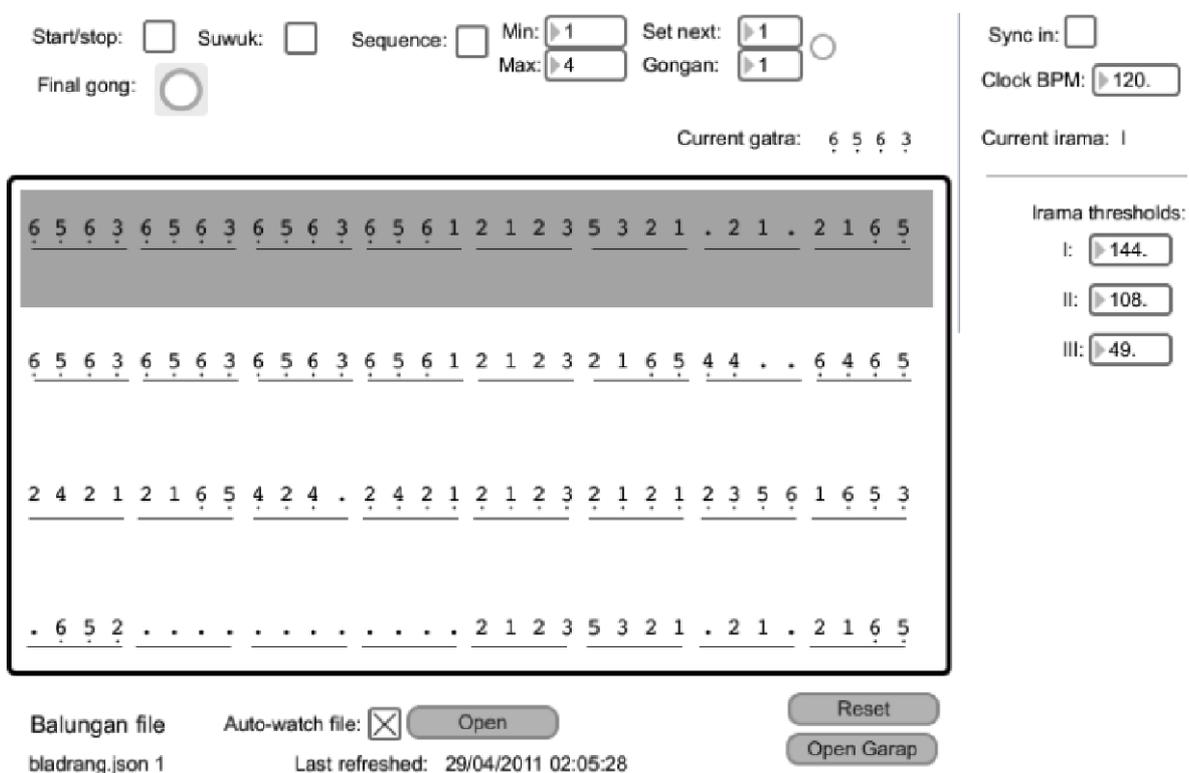


Figure 2-1: Screenshot from *Bonangan* taken during work on *Bonang Study* (2011).

The inspiration for the subsequent versions of the software (*Cengkokan* and *Mipilan*) came through my desire to create accompaniment for traditional vocals, and to reintroduce an element of “play” to the process. Due to my renewed interest in improvisation with mixing desks and controllers from previous practice, I wished for parts to be playable manually using commonly available interfaces. I also attempted to create parts that could be notated graphically for ease of explanation, and that could be projected onto a screen during performances. Although the software was largely used by myself in specific performance contexts, it was influenced by feedback

from testers and collaborators: notably Charles Mollet, Steven Mason, and Ben McDermott (see AV.2.9).

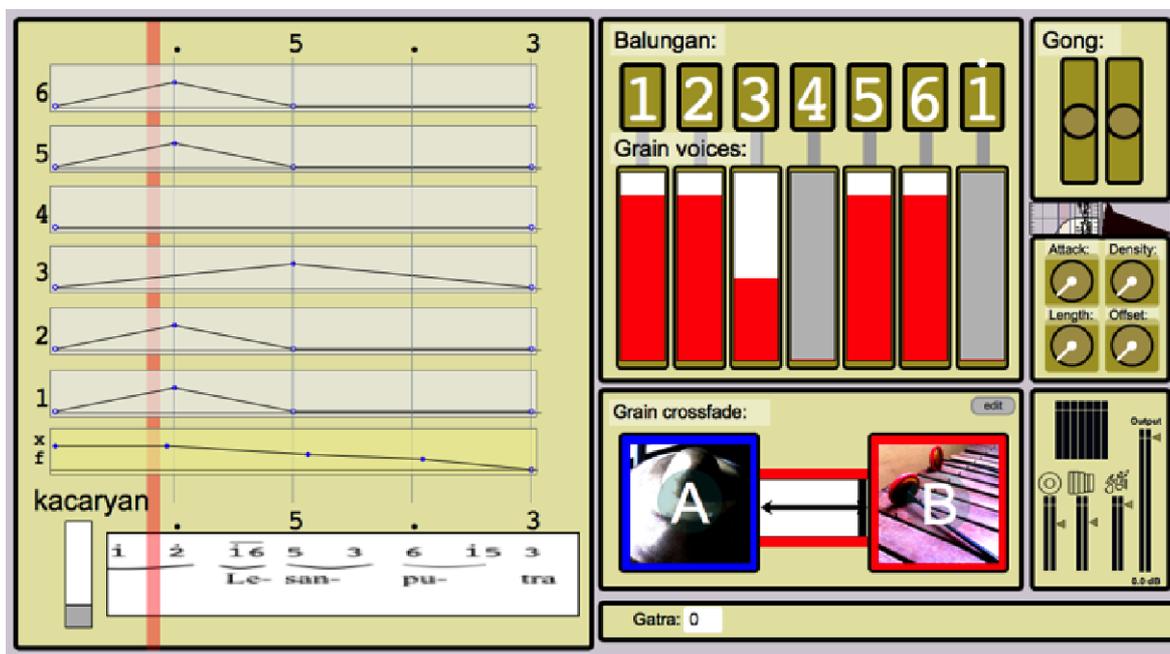


Figure 2-2: *Cengkokan* as projected on stage during performance (2012).

I later became interested in the interpretation of other sources such as other tonal systems, the mapping of non-musical data sources, and randomly generated streams of numbers. A loud-style *balungan*-oriented model proved effective to generate parts in real-time, although I often found myself referring to a more abstract framework involving the vocal parts and soft-instruments (see Part I: §3.2).

While exceptions in standard loud-style *garap* of pseudo-idiomatic material may be identified and specified on a case-by case basis, I became concerned that the work required to interpret non-idiomatic material might prove impractical for a casual user. This led to the creation of a simplified *garap* system, which forms the basis of part generation in the *Mipilan* software (see §2.3.2). This basic algorithm allowed a range of information to be elaborated upon, with the potential to expand beyond the *slendro* and *pelog* scales without significant modification. Furthermore, with reliance on only two patterns per *irama*, it became practical to edit the *garap* as text in real-time as part of a performance (see AV2.8.A). In later development the real-time manipulation of sequences became the primary intended function¹¹.

¹¹ This approach was inspired by live-coding performances I had observed, and in particular the *ixi lang* language for accessible live-coding developed by Thor

2.2 Software outline

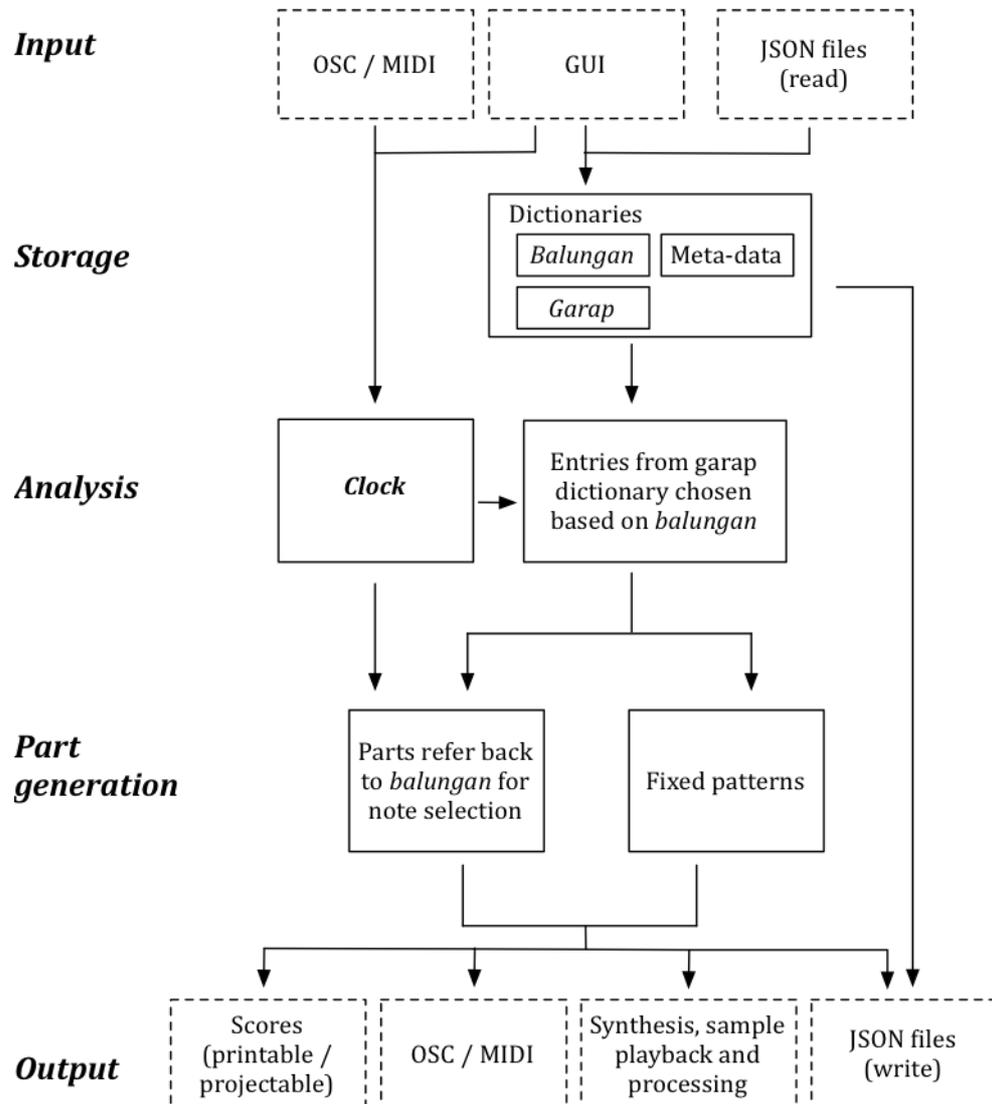
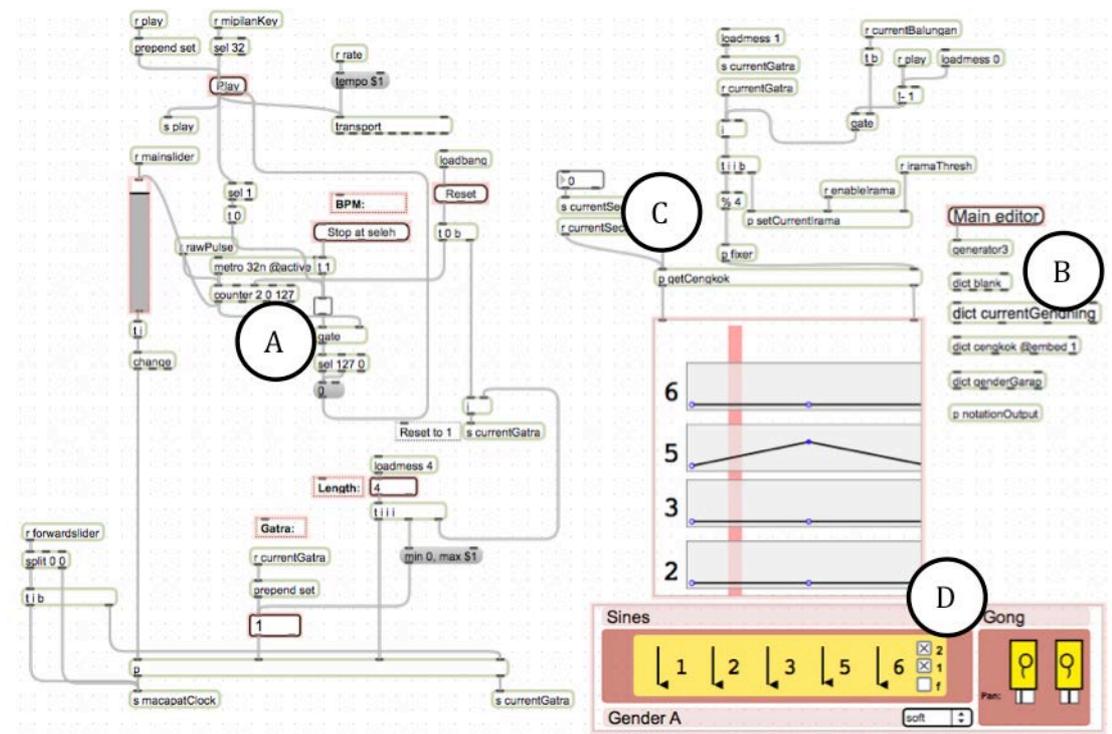


Figure 2-3: Outline of the software framework.

Figure 2-3 shows the structure and flow of events common to all three stages. My intention is that through its modularity this framework might accommodate various techniques at a later date. For example, the analysis and part generation stages (see **Figure 2-12** and **Figure 2-13**) may be replaced by machine learning systems, Markov chains, or formal grammars. The inclusion of chance processes for part generation in *Mipilan*, while far from the complexity and involvement of these methods, is intended to illustrate the potential placement of real-time part generation and interaction.

Magnusson (2011). The editing of *garap* and *balungan* as text formed the basis for subsequent performances (Matthews, 2013).



Area	Description
A	Clock and transport control
B	Dictionaries and editor for <i>balungan</i> and <i>garap</i>
C	Analysis and part selection
D	Part generation and output

Figure 2-4: *Mipilan* framework in Max/MSP (screenshot from development).

The structure of the software is reflected in **Figure 2-4**. As is common practice in Max/MSP, most objects represent several levels of sub-patchers. With the exception of interdependencies developed during time-sensitive development for performances, most of the elements are self-contained and may be replaced by different methods. Send and receive paths are used throughout the structure to enable integration of supplementary patches and information from third-party software.

2.2.1 Input

2.2.1.a GUI

The interface is divided into two main windows: the **editor** and the **performance window**. In the initial stages of development the editor provided a front end for editing JSON information as text. As the focus of the research moved towards real-time development of pieces, the affordance of real-time manipulation of sequences and synthesis parameters became more integrated and prominent.

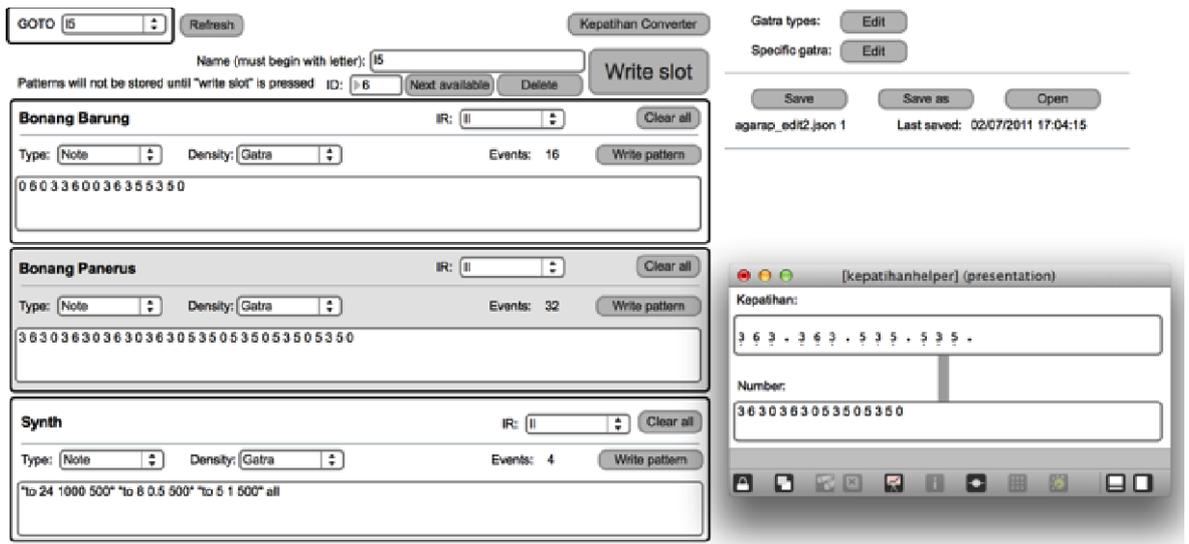


Figure 2-5: Screenshot of the editor window in *Bonangan*.

The interface for part generation in *Mipilan* (Figure 2-6) is based on *Kepatihan* notation and the common practice of annotating *balungan* with names of *cengkok* for study purposes (e.g. Brinner, 1985; Polansky, 1993)¹². The *balungan* is editable via a series of drop-down menus, alongside manual placement of gong strokes. The choices of notes in the individual *garapan* are available to edit in a similar manner, or may be determined by various chance-based processes. Simplified *garap* is created automatically upon *balungan* entry, or may be edited manually as text in the JSON-based dictionary.

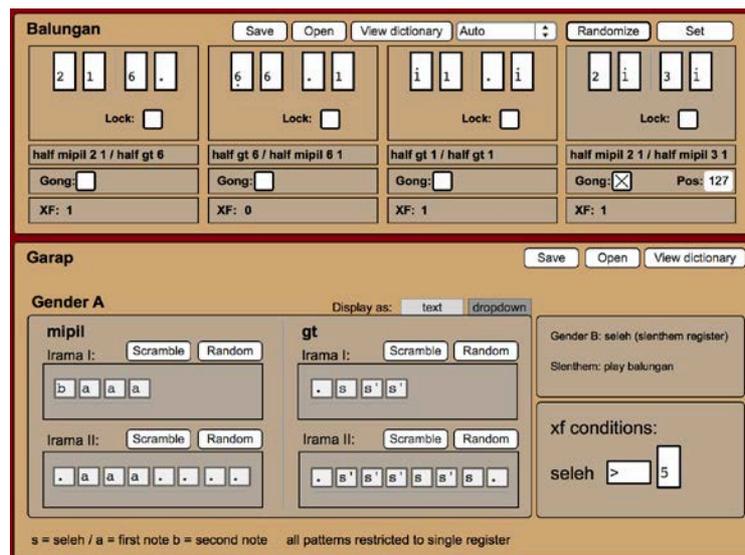


Figure 2-6: Editor window in *Mipilan*.

¹² The majority of GUI elements use the standard *KepatihanPro* font. Later versions include generic graphical elements to improve accessibility for non-gamelan players.

The performance window in *Cengkokan* and *Mipilan* (**Figure 2-7**) shows the envelopes and *balungan* for the current *gatra* alongside representations of the instruments. The interface was designed to encourage experimentation with random patterns, transport controls, mixing, and effects rather than editing note sequences.

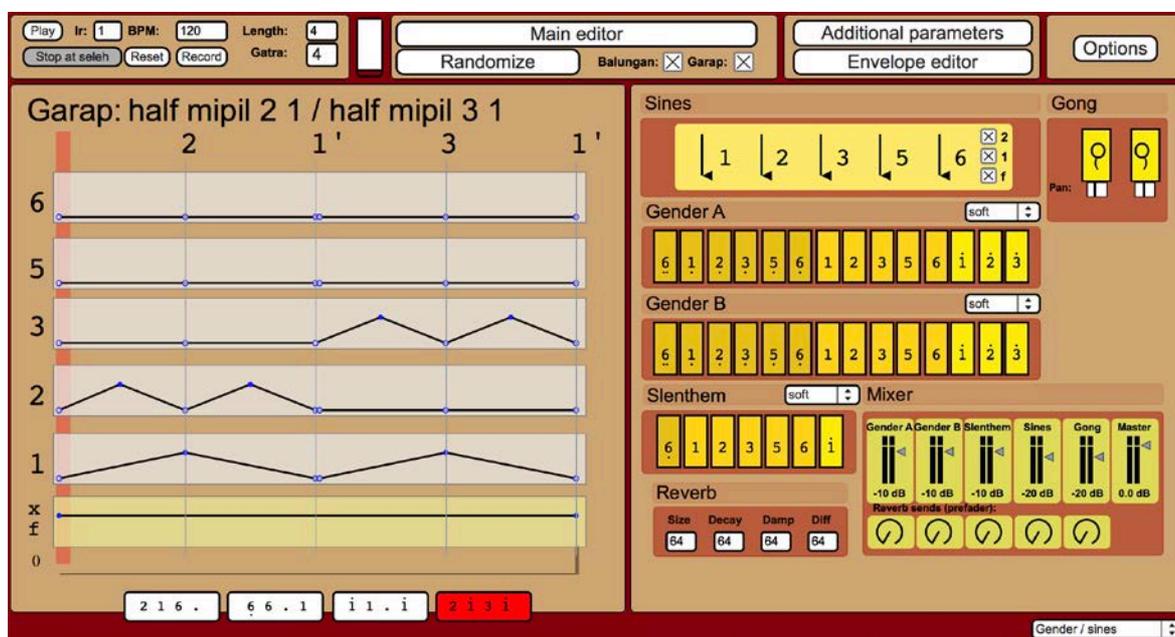


Figure 2-7: Performance window in *Mipilan*.

2.2.1.b OSC/MIDI

MIDI input is generally restricted to controlling transport and timing. All send and receive paths are accessible via OSC commands (see <<http://opensoundcontrol.org/>>, accessed 18/09/13) to enable flexible communication with mobile devices and other supporting software such as SuperCollider.

2.2.2 Clocks and scrubbing

Timing information for the central sequences in *Cengkokan* and *Mipilan* comes either from a MIDI slider, which is used to scrub the sequence, or an internal clock. Further timing arises from independent ramps, smoothing, and random delays (see §2.4.2).

The method of playing a MIDI slider, dubbed *maju/mundur* during development, relies on the user reaching a certain threshold before moving the slider in the opposite direction¹³. If the value is reached, then the sequence will switch to

¹³ The lower threshold was introduced to *Cengkokan* through discussion with Joko Purwanto, who, upon trying the controller, commented that it felt unnatural to have to reach the end of the slider in order to move the sequence forward (p.c. 2012).

the next *gatra*; otherwise the sequence will be played backwards. In **Figure 2-8** the sequence moves forward in the first two *gatra*, but is extended in the third as the movement back occurs before the threshold. Further examples of transcribed human timing and MIDI automation are available in **Figure 2-19** and **Figure 2-20**.

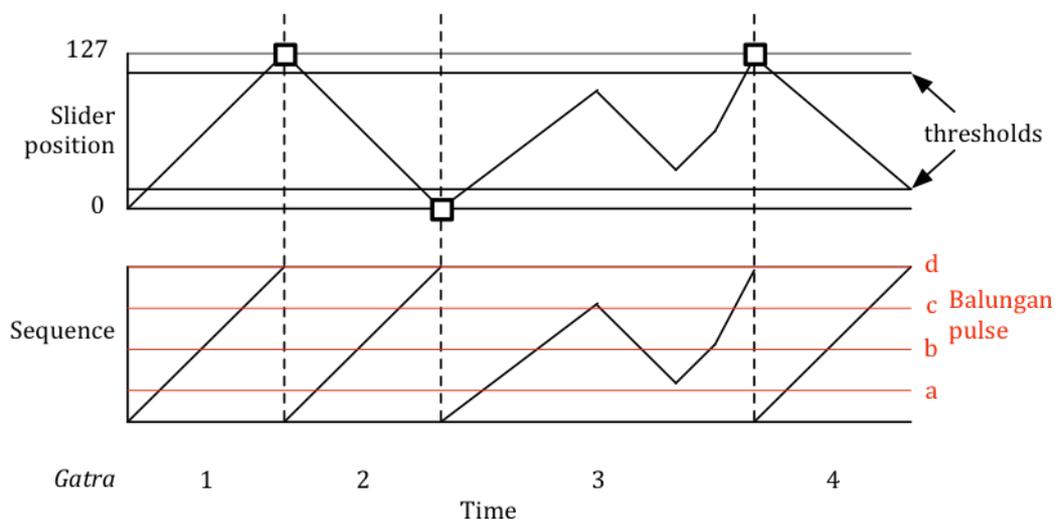


Figure 2-8: *Maju/mundur* style scrubbing of a sequence.

Although this method takes inspiration from the movement of the *rebab* bow, given the difference in output there is no obligation for idiomatic playing techniques to be emulated. In addition to synchronization with an ensemble and expression through manipulation of the timing of a sequence, this approach opens up an array of possibilities. For example, pre-recorded MIDI may be used to create interpolation between organic rhythmic points, such as the individual strokes of a *gender*, in non-real-time. Movement back and forth may be employed to imitate the hanging/*seleh* movement employed by the *gender* in *irama rangkep* (see Sumarsam, 1974 p. 164). A linear sequence for synchronization with an external clock may be created in a DAW such by drawing a zigzag pattern in a MIDI automation lane, (see **Figure 2-20**).

The optional internal clock used in *Mipilan* is based on a central counter, working with 128 steps per *gatra* to emulate the data provided by the MIDI fader. While this range provides limited resolution for more complex patterns or denser *irama*, the use of Max/MSP's central *transport* object presents the opportunity to add audio-rate control at a later date. The timing information for the *cengkok* themselves is generated through two methods: discrete note-type events use a subdivision of the clock based on a combination of modulo and division operators, whereas envelopes are scrubbed directly and interpolated through the native *function* object (see §2.4).

2.2.3 Storage

2.2.3.a Dictionaries

All user-generated information is stored in dictionaries: data structures involving a hierarchy of keys and values. Dictionaries are also used to store information generated dynamically by the software (see §2.3). **Figure 2-9** is adapted from information used in *Bonangan*, showing nested values for different instruments and *irama*¹⁴. The dictionaries in *Bonangan* were based on a workaround using the *patrr* object pending the release of a native solution. *Patrr* uses the JSON format described in this section but provides limited flexibility for nested storage (see **N1 – N2**); conflicts in approaches prevented compatibility with later versions of the software.

```
"bonang" :      {
  "barung" :    {
    "LCR" : [ 1, 0, 1, 2, 3, 4 ],
    "I"  : [ 0, 0, 3, 6, 3, 0, 5, 5, 3, 5 ],
    "II" : [ 0, 0, 0, 6, 0, 3, 3, 6, 0, 0, 3, 6, 3,
             5, 5, 3, 5, 0 ]
  },
  "panerus" :  {
    "LCR" : [ 1, 0, 1, 2, 3, 4 ],
    "I"  : [ 0, 0, 3, 6, 3, 0, 3, 6, 3, 0, 5, 3, 5,
             0, 5, 3, 5, 0 ],
    "II" : [ 0, 0, 3, 6, 3, 0, 3, 6, 3, 0, 3, 6, 3,
             0, 3, 6, 3, 0, 5, 3, 5, 0, 5, 3, 5, 0,
             5, 3, 5, 0, 5, 3, 5, 0 ]
  }
},
"synth" :      {
  "LCR" : [ 1, 0, 1, 2, 3, 4 ],
  "I"  : [ 0, 0, "to 6 1 1000", "all" ],
  "II" : [ 0, 0, "to 24 1000 500", "to 3 0.5 500",
           "to 6 1 500", "all" ]
}
```

Figure 2-9: “Low 5” pattern used in *Bonang Study*, represented in JSON format.

The dictionaries in *Cengkokan* and *Mipilan* are based on the native set of *Dict* objects introduced in Max 6 in 2011, which in turn use the pre-existing JSON specification. All user-generated information may be imported and exported as JSON files, enabling interchange between other applications including Max/MSP and SuperCollider¹⁵. Three types of dictionaries are used in *Cengkokan* and *Mipilan*: the main ***gendhing***, instrumental ***garap***, and data for **envelopes**.

¹⁴ All patterns in *Bonangan* are preceded by a pair of integers, which act as flags to indicate pattern type (note/refer) and density (*gatra*/colotomic cycle).

¹⁵ See <<http://www.json.org/>> (accessed 17/09/13).

(A)	<pre>"balungan" : ["1", "2", "-", "3", "6.", "5", "1", "-", "-", "2", "3", "-", "1", "-", "2", "6."],</pre>
(B)	<pre>"garap" : { "synth 1" : ["half mipil 1 2 / half mipil 2 3", "half mipil 6 5 / half gt 1", "half mipil 1 2 / half gt 3", "half gt 1 / half mipil 2 6"], "xf" : { "0" : [0, 0.0, 127, 0.0], "1" : [0, 0.0, 127, 0.0], "2" : [0, 0.0, 127, 0.0], "3" : [0, 0.0, 127, 0.0] }, }</pre>
(C)	<pre>"gong" : [".", "127", ".", "127"]</pre>

Figure 2-10: JSON data from *Response to ShoutCry Room*.

Figure 2-10 shows a typical *gendhing* file in *Mipilan*. The *balungan* (A) provides raw information to be interpreted. The *garap* (B) is divided between information generated automatically from the *balungan* at the point of entry (also manually editable), and additional information provided by the user in the form of the gong positioning (C). The dedicated dictionaries for the *garap* follow a similar format, with nested dictionaries providing information for each *irama* level:

```
"half" : {
  "gt" : {
    "type" : "refer",
    "I" : [ "s", "s", "s'", "." ],
    "II" : [ "s", "s", "s'", ".", ".", "s'", ".", "." ]
  },
  "mipil" : {
    "type" : "refer",
    "I" : [ "a", "b", "a'", "." ],
    "II" : [ "a", "b", "a", ".", "a", "b", "a", "." ]
  }
}
```

Figure 2-11: JSON data for default *garap* in *Mipilan*.

The contents of these dictionaries are cross-referenced with each other in the course of performance. In addition to note information, JSON-based dictionaries may also store performance notes, attribution to composers, section titles, and other meta-data.

2.2.3.b Numbering systems

Three types of numbering systems are used within the software, which I will refer to as *Kepatihan* (**kep**), *VGG* and **integer** (**int**). The *Kepatihan* font, while maintaining a

link with contemporary practices of creating notation, can cause difficulties in processing information if used directly (Schütz and Rohrhuber, 2008 p. 134). In the interest of accessibility I opted to maintain its use for display purposes and notation output, using VGG and integer as alternatives for internal processing.

Note data is stored using a system derived from the *Virtual Gamelan Graz* (VGG), which in turn builds on the format used in the popular online repository *Gendhing Jawi* (Schütz and Rohrhuber, 2008 pp. 135-138; Drummond, 2013). Integer-based numbering has been maintained in some processes retained from the *Bonangan* software, in which I used a limited range of 1-21 to represent the notes of *slendro* and *pelog*. **Table 2-1** shows the central range used to represent *balungan* and various other note events in each one system, including the raw form of *Kepatihan*-based information as displayed in other fonts.

Table 2-1: Comparison of notation systems.

Kep	.	ḡ	ḡ̇	ḡ̈	ḡ̉	ḡ̊	ḡ̋	ḡ̌	ḡ̍	1	2	3	4	5	6	7	ḡ̎	ḡ̏	ḡ̐	ḡ̑	ḡ̒	ḡ̓	ḡ̔
Int	0	N/A	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
VGG	-	ḡ..	ḡ̇.	ḡ̈.	ḡ̉.	ḡ̊.	ḡ̋.	ḡ̌.	ḡ̍.	1	2	3	4	5	6	7	1'	2'	3'	4'	5'	6'	7'
Raw K	.	86	q	w	e	r	t	y	u	1	2	3	4	5	6	7	!	@	#	\$	%	^	&

2.3 Electronic garap

Garap in all three versions of the software takes place in three stages:

- **Part selection** (analysis)
- **Creation of *cengkok*** (part generation)
- **Actuation** (output)

2.3.1 Part selection in *Bonangan*

Part selection in *Bonangan* takes place through classification of *gatra* according to placement of unique notes, followed by comparison to specific patterns. If no recognized *gatra* are matched, a referring pattern (*mipil*) is assigned. This process is similar to the rewrite system (named *Tafsiran*, after a Javanese term for interpretation) in the *Virtual Gamelan Graz* framework discussed by Schütz and Rohrhuber (2008 pp. 160-161). **Figure 2-12** shows a simplified flow of events.

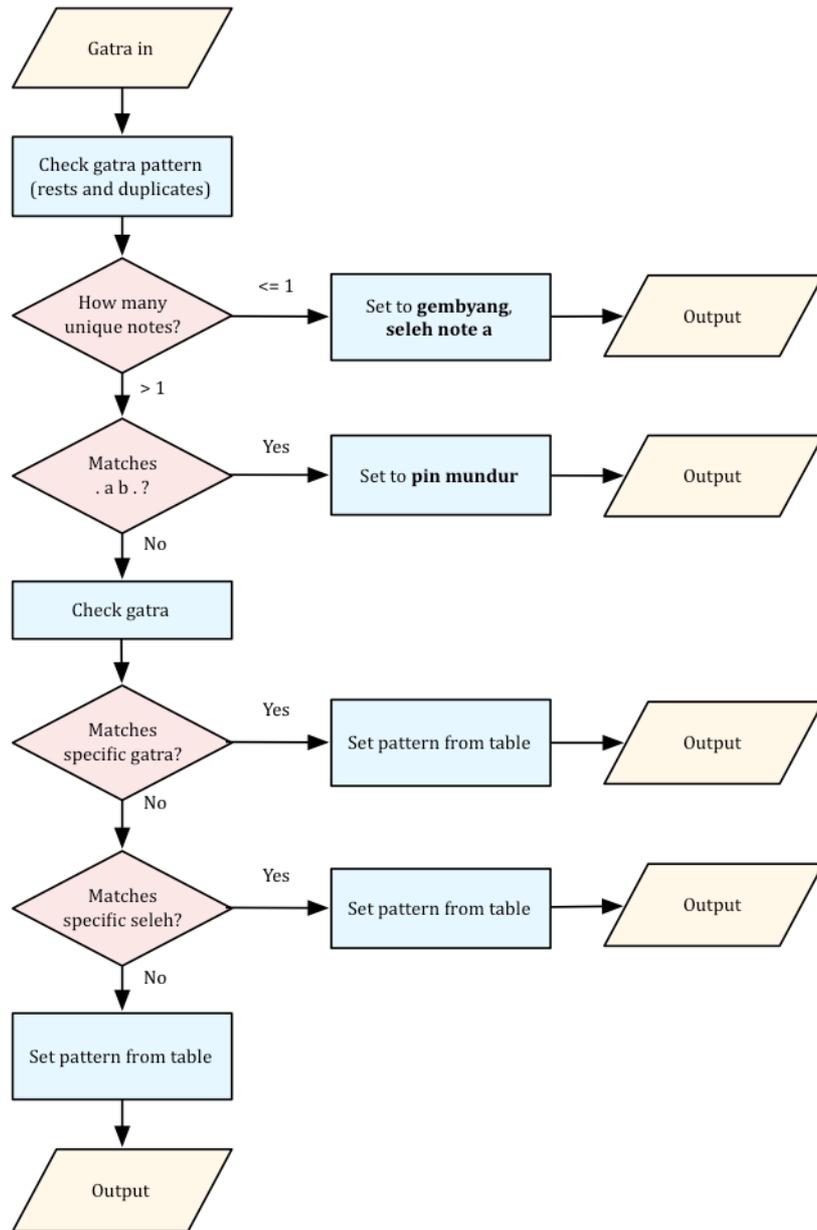


Figure 2-12: Flow for selection of *bonang* and synthesizer patterns in *Bonangan*.

This system is broadly suitable for loud-style *bonang* parts; however, in order to ensure idiomatic integrity, the user must add a variety of exceptions such as *balungan nibani*, *pin mundur*, or named *cengkok* such as *puthut gelut* or *tumurun* (see **Part I: §3.3**). Due to the analysis at the level of a whole *gatra*, extra rules or specific patterns must be included for placement of *gantungan* and *pathet*-specific activity.

2.3.2 Part selection in *Cengkokan* and *Mipilan*

Part selection in *Mipilan* is determined in real-time, the results of which are stored in the main dictionary: a process that was emulated through manual editing in the

transitory *Cengkokan*. **Figure 2-13** represents the simplified *garap* system used in *Mipilan*, which may be applied to any *balungan mlaku* comprising sets of four notes¹⁶.

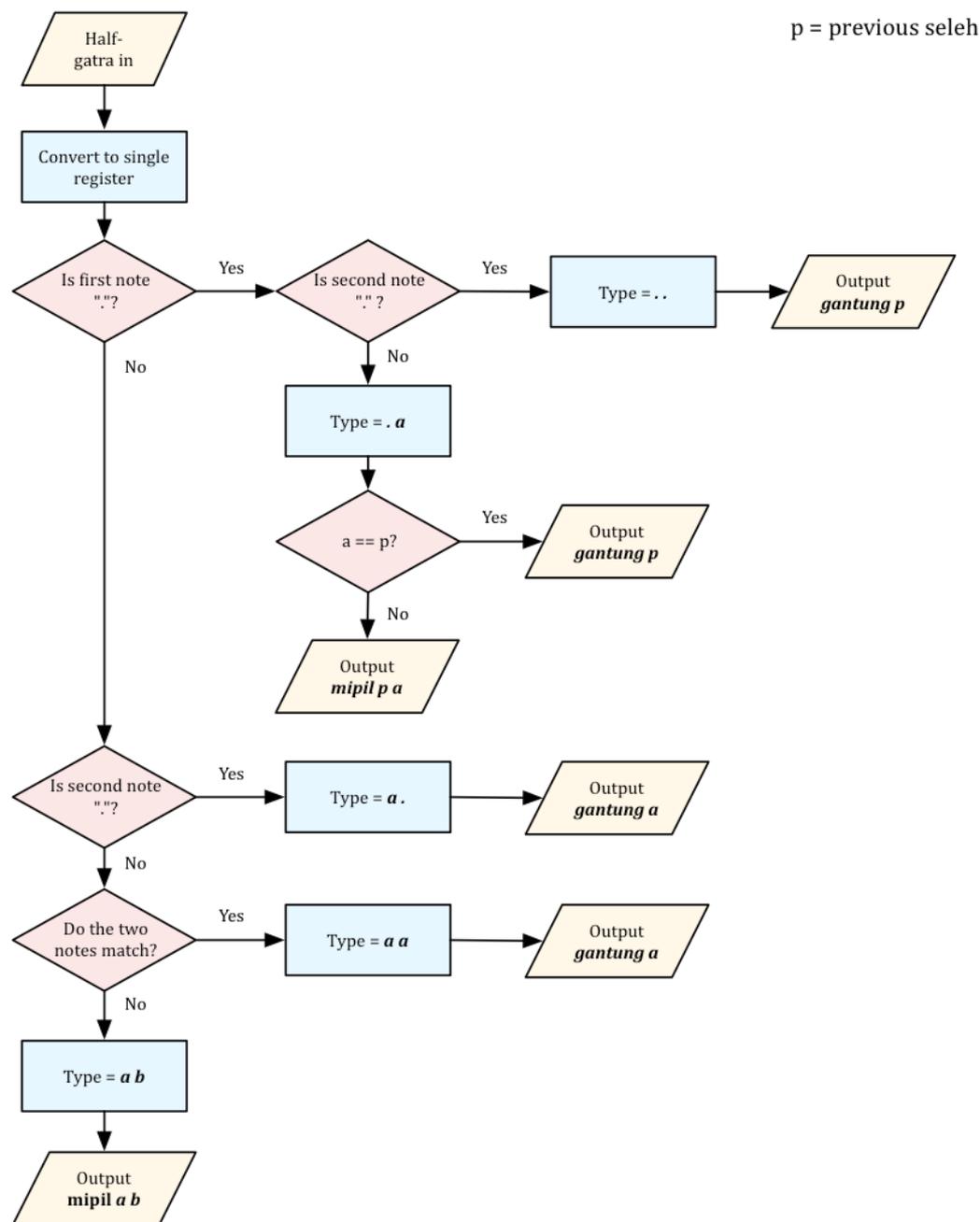


Figure 2-13: Flow for selection of *mipil* and *gantung* patterns as used in the *Mipilan* software (simplified *garap*).

The simplified *garap* used in *Mipilan* draws on a combination of *garap* from the *bonang* and the *peking*. The core process is based on note selection in the *mipil* and *nacah* techniques used respectively in the *garap* of these instruments. Rather than

¹⁶ Examples of resulting pattern selections are available in the notation for *ShoutCry Room (N5.A)* and video documentation of improvisation with *Mipilan (AV2.8.A)*.

attempting to address all four notes of the *gatra* as in *Bonangan*, the *gatra* is split into halves for analysis. The *seleh* note is retained from the previous half-*gatra*, allowing for substitution in cases starting with pin (e.g. 1). The output is divided into two patterns borrowed from the *bonang*: *mipil* and *gembyang*, the latter of which is represented by the more generic term *gantung*. This is achieved without the need for specifying exceptions; however, further specification may be added to the chain and given priority, as in the flow for *Bonangan*.

The result is a part that, while not representative of the idioms of any particular instrument, grants basic compatibility with the wider idiom of *karawitan*. In addition to the affordances this brings to composition, this process might be useful in pedagogical situations where it can be helpful to describe patterns in abstract. The ignorance of register, while occasionally producing unusual patterning, ensures broad compatibility. Provided that a sequence of numbers may be divided into pairs, the process may be applied to values outside the range of the *slendro* and *pelog* scales.

2.4 Note events, electronic cengkok and envelopes

The syntaxes of both note and envelope-based approaches are intended to be generic enough to be used with the native objects available to Max/MSP as well as other environments such as SuperCollider, either through the direct use of the JSON dictionary files or through OSC. The dictionaries may also be edited manually using a text editor or third party JSON reader.

In the pieces presented here outputs of the *cengkok* are typically used for the direct control of amplitude and filter cutoff (as in *Bonang Study*, *Monggangan*, and *Pangkur Paripurna*). In some cases they have been used to control less clearly observable parameters such as grain density and the probability of sample selection (as in *Monggangan*)¹⁷.

2.4.1 Note events in *Bonangan*

Patterns in *Bonangan* are classified as *refer* or *note*. *Refer*-type patterns rely on the *balungan* for their notes, whereas *note*-type patterns use absolute values. The rate of playback is relative to the length of the pattern, which always spans a *gatra*; a pattern

¹⁷ I have explored less obvious mappings in related collaborations and performances. For example, at an *Algorave* event (Matthews, 2013), I generated a rhythmic part at a frequency controlled by the sum of the various envelope values in *Mipilan*.

lasting eight events is played at half the rate of a pattern lasting sixteen. This enables changes in *irama* to take place without changing the rate of the central clock provided that the length of the patterns do not exceed the number of pulses used per *gatra*.

Each note in the *mipil* pattern cross-references the *balungan*¹⁸:

Table 2-2: Arrays for *mipil* patterns in *Bonangan*.

<i>Irama I</i>		<i>Irama II</i>		<i>Balungan</i> position
Entry	Value	Entry	Value	
1	a	1	a	a
		2	b	
2	b	3	a	
		4	0	
3	a	5	0	
		6	b	
4	0	7	a	b
		8	0	
5	c	9	c	
		10	d	
6	d	11	c	c
		12	0	
7	c	13	0	
		14	d	
8	0	15	c	d
		16	0	

These abstract patterns may be concretized as follows (see **AV1.1.B**, 0:43; 1:13):

Table 2-3: Examples of various *gatra* interpreted as *mipil* in *Bonangan*.

<i>Gatra</i>	<i>Irama I</i>	<i>Irama II</i>
<i>Pattern</i>	a b a . c d c .	a b a . . b a . c d c . . d c .
2 1 2 3	2 1 2 . 2 3 2 .	2 1 2 . . 1 2 . 2 3 2 . . 3 2 .
5 3 2 1	5 3 5 . 2 1 2 .	5 3 5 . . 3 5 . 2 1 2 . . 1 2 .

The “low 5” pattern shown in **Table 2-4** and **Table 2-5** bypasses the constituent notes of the *balungan*, providing a fixed sequence (see **AV1.1.B**, 0:53; 1:40).

¹⁸ In the following examples I have used letters *a*, *b*, *c*, and *d* to refer to various note positions in the *gatra* for clarity and consistency; in the JSON examples presented in **N1 – N2** these are represented by numbers to call positions in an array. In this and subsequent examples, array positions start at 1 rather than the conventional 0.

Table 2-4: Arrays for “low 5” (*tumurun*) pattern in *Bonangan*.

<i>Irama I</i>		<i>Irama II</i>		<i>Balungan</i> position
Entry	Value	Entry	Value	
1	3	1	0	a
2	6	2	6	
3	3	3	0	
4	0	4	3	
5	5	5	3	b
6	5	6	6	
7	3	7	0	
8	5	8	0	
		9	3	c
		10	6	
		11	3	
		12	5	
		13	5	d
		14	3	
		15	5	
		16	0	

Table 2-5: Output of the “low 5” pattern in *Bonangan*.

Data	<i>Irama I</i>	<i>Irama II</i>
Int	3 6 3 0 5 5 3 5	0 6 0 3 3 6 0 0 3 6 3 6 6 3 5 0
Kep	3̣ 6̣ 3̣ . 5̣ 5̣ 3̣ 5̣	. 6̣ . 3̣ 3̣ 6̣ . . 3̣ 6̣ 3̣ 5̣ 5̣ 3̣ 5̣ .

2.4.2 Envelope cengkok in *Bonangan*

The syntax for synthesizer parts in *Bonangan* is based on behavior of the native Max/MSP *line* object, which generates ramps between two specified values or to a target from a previously stored value:

Table 2-6: Ramp generators in *Bonangan*.

Command	Description
<code>ramp a 0.5 0 1000</code>	Generate a ramp to move the amplitude of note <i>a</i> (the first note in the <i>gatra</i>) from 0.5 to 0 in 1000ms.
<code>to d 0 500</code>	Move the amplitude of note <i>d</i> (the last note in the <i>gatra</i>) from its current value to 0 in 500ms.

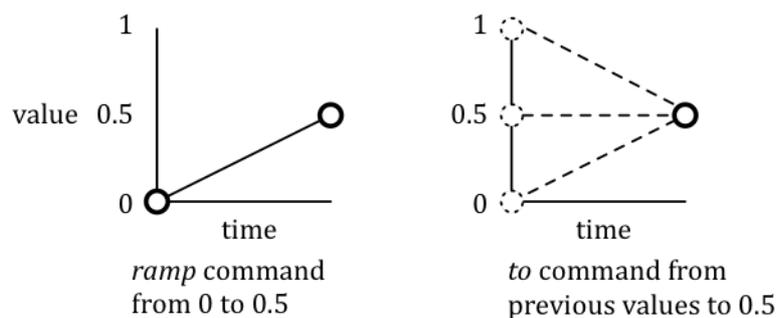


Figure 2-14: Visual representation of *ramp* and *to* commands in *Bonangan*.

These commands open sustained envelopes that are subsequently “damped” by other event triggers, either using the “to” command or by initiating a new ramp. In this case only one event takes place per beat. I found this constraint interesting in the composition process, drawing parallels with constraints given by physically interfacing with an instrument via a single beater.

Table 2-7 shows a pattern for *mipil* developed for the *Bonang Study*. The first notes of the *gatra* are opened using one-second ramps, which are damped in succession. The *seleh* note (d) opens gradually, and continues playing until retriggered or damped in another pattern.

Table 2-7: Arrays for ramp generation (*mipil* pattern) in *Bonangan*.

<i>Irama I</i>		<i>Irama II</i>		<i>Balungan position</i>
<i>Entry</i>	<i>Value</i>	<i>Entry</i>	<i>Value</i>	
1	ramp a 1 0 1000	1	ramp a 0.5 0 2000	a
2	ramp b 1 0 1000	2	ramp b 0.5 0 2000	
3	ramp a 1 0 1000	3	ramp a 0.5 0 2000	
4	to a 0 100	4	to a 0 100	b
5	to b 0 100	5	to b 0 100	
6	to d 0.5 0 1000	6	ramp b 0.50 2000	c
7	ramp c 1 0 1000	7	ramp a 0.5 0 2000	
8	to c 0 100	8	to a 0 100	
		9	ramp c 1 0 2000	
		10	ramp d 0.5 0 2000	d
		11	ramp c 1 0 2000	
		12	to c 0 100	
		13	to d 0 100	
		14	to d 0.3 2000	
		15	ramp c 1 0 2000	
		16	to c 0 100	

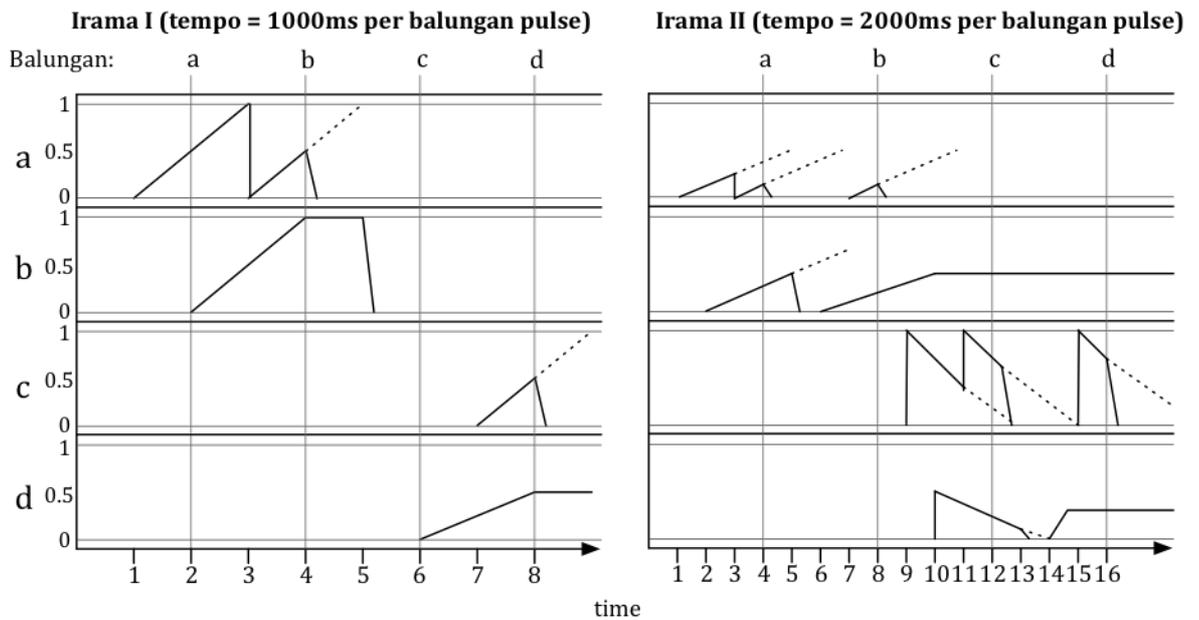


Figure 2-15: Linear representation of a *Bonangan* synthesizer pattern relative to its reference notes from the *balungan* (*mipil*, *irama I & II*).

Figure 2-15 shows linear interpretations of these ramps; their potential trajectories before their cutoff are marked as dotted lines¹⁹. The use of absolute timing in milliseconds yields a subtle effect; as the *irama* and its relative tempo (*laya*) slows down, more of the simulated resonances are allowed to build up.

Key patterns break the conventional density of the part, enabling smoother textural movement:

Table 2-8: Arrays for ramp generation (“low 5”/ *tumurun* pattern) in *Bonangan*.

<i>Irama I</i>		<i>Irama II</i>		<i>Balungan</i> position
Entry	Value	Entry	Value	
1	to 6 1 1000	1	to 24 1000 500	a
		2	to 3 0.5 500	b
		3	to 6 1 500	c
2	all	4	all	d

In *irama I* the above pattern lasts two events; the first event occurs half way through the *gatra*, triggering a build-up of the oscillator tone in note “6”. The second event occurs on the last beat of the *gatra*: the “all” command, which fades out all oscillators. In the pattern for *irama II* this buildup starts earlier, on the first note of the *balungan*.

¹⁹ The central clock in this example is slower than in practice in order to demonstrate the full lengths of the envelopes as found in transitions between *irama* levels.

Timbral variation is implemented through routing parts to send channels, the amplitude of which are determined via note numbers outside the *pelog* range. The “to” ramp on a modulation channel (indicated here as 24) draws on activity in the *bonang panerus* part (AV1.1.B, 1:44-2:00).

2.4.3 Note events in *Cengkokan* and *Mipilan*

Note events in *Mipilan* use a combination of fixed and user-defined patterns, which refer directly to the *balungan*²⁰:

Table 2-9: Roles of instrumental parts in *Mipilan*.

Instrument	<i>Garapan</i>
<i>Slenthem</i>	Direct <i>balungan</i>
<i>Gender A</i>	<i>Pipilan</i> (user-defined)
<i>Gender B</i>	<i>Seleh</i> (<i>slenthem</i> register)

2.4.3.a *Slenthem* and *Gender B*

Since *balungan* input is limited to the *slenthem* range, no further interpretation is necessary in the *slenthem* part. The note for *gender B* is generated from the final available note in the *gender A* part according to the simplified *garap* process and transferred to *slenthem* range. If the half-*gatra* is empty, the *seleh* value is generated from the previous *gatra*.

Table 2-10: Examples of *seleh* derived from various *gatra*-types.

<i>Gatra</i>	Position	<i>Seleh</i>
1 2 3 5	d	5
. 2 1 6	d	6
. 2 3 .	c	3
1 . . .	a	1

2.4.3.b *Gender A*

User-defined patterns are limited by default to a monophonic part in the upper register of *gender A*. In some case the letters *a* and *b* in the *balungan* position column may be considered arbitrary; *note a* may also be taken from a previous half-*gatra*.

²⁰ *Cengkokan* is restricted to envelope output and does not generate note events directly. During development of *Mongganggan* various MIDI notes were associated to each *gatra* to trigger samples within Ableton Live (see video in AV1.3.A).

The default *mipil* pattern and resulting parts are shown in **Table 2-11** and **Table 2-12**.

Table 2-11: Array for *gender A* patterns (*mipil*) in *Mipilan*.

<i>Irama I</i>		<i>Irama II</i>		<i>Balungan position</i>
Entry	Value	Entry	Value	
1	a	1	a	a
		2	b	
2	b	3	a	
		4	.	
3	a	5	.	
		6	b	
4	.	7	a	
		8	.	b

Table 2-12: Examples of various *gatra* interpreted as *mipil* in *Mipilan*.

<i>Gatra</i>	<i>Irama I</i>	<i>Irama II</i>
<i>Pattern</i>	a b a .	a b a . . b a .
1 2	1 2 1 .	1 2 1 . . 2 1 .
5 3	5 3 5 .	5 3 5 . . 3 5 .

Gantung patterns are modeled after a traditional *gembyangan* pattern played on the *bonang*, in which the *seleh* note is played in alternation between medium and combined medium and high registers. The default *gantungan* pattern is as follows:

Table 2-13: Arrays for *gender A* patterns (*gantungan*) in *Mipilan*.

<i>Irama I</i>		<i>Irama II</i>		<i>Balungan position</i>
Entry	Value	Entry	Value	
1	s	1	s	a
		2	s	
2	s	3	s'	
		4	.	
3	s'	5	.	
		6	s'	
4	.	7	.	
		8	.	b

The rhythm of the *seleh* note in the electronic interpretation is determined by a combination of *pin* (.) and *seleh* (s) strokes. Higher strokes are denoted using a

modifier (e.g. “s’”). In lieu of the combined register strokes conventionally played by the *bonang*, the *gender* either plays in a register above or below the central range:

Table 2-14: Examples of *seleh* interpreted as *gantungan/gembyang* in *Mipilan*.

<i>Gatra</i>	<i>Irama I</i>	<i>Irama II</i>
<i>Pattern</i>	s s s' .	s s s' . . s' . .
1	1 1 $\dot{1}$.	1 1 $\dot{1}$. . $\dot{1}$. .
2	2 2 $\dot{2}$.	2 2 $\dot{2}$. . $\dot{2}$. .
3	3 3 $\dot{3}$.	3 3 $\dot{3}$. . $\dot{3}$. .
5	5 5 $\dot{5}$.	5 5 $\dot{5}$. . $\dot{5}$. .
6	6 6 $\dot{6}$.	6 6 $\dot{6}$. . $\dot{6}$. .

2.4.4 Basic envelope cengkok in *Cengkokan* and *Mipilan*

The envelopes used in *Cengkokan* and *Mipilan* have closer ties to a central timeline (which might either be controlled by a central clock or scrubbed) than the absolute timing values triggered by *Bonangan*. The generation of envelopes relies on the *function* GUI object in *Max/MSP*, which allows interpolation between sets of values based on a numeric input²¹. This enables both linear and non-linear calling of the data (see **Figure 2-8**; **Figure 2-19**).

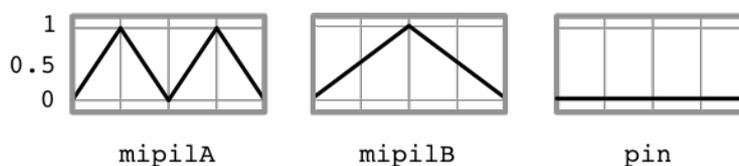


Figure 2-16: Ramps forming the basic building blocks for *mipil* and *cengkok*.

The *cengkok* are based on three key patterns: *mipilA*, *mipilB* and *pin*, shown here using notation as used throughout the rest of the thesis²². The placement of each point is based on a reference to *pipilan* as played the on the *bonang barung*, in which the *seleh* note is rarely played at the same time as the *balungan* (see **Part I: §3.3.2b**).

²¹ The *function* object uses CPU power for redrawing each selection, sometimes resulting in a brief gap in envelopes. I retained this method for visual clarity, and accepted the glitches as a characteristic of the *garap* in the *Augmented Gamelan* set.

²² Linear interpretations are shown throughout for clarity in the manner of simplified *cengkok* found in collections of notation (e.g. Martopangrawit 1973). The images presented here have been drawn manually and represent a development of the potential notation output from *Max/MSP* to be reintegrated at a later date (**N3.G**).

Rather than being restricted to a metric series of points in relation to the *balungan*, data is presented in pairs to indicate time and value. The length of a *gatra* ranges from 0-127, and the value range (typically mapped to amplitude) is 0.0-1.0. The following example of whole-*gatra* patterns shows JSON data for the building blocks shown above, with optional reference to previous values (as in **Figure 2-14**):

```

"mipilA" : [ 0.0, 0.0,      -or-      0.0, "prev",
            31.0, 1.0,
            63.0, 0.0,
            95.0, 1.0,
            127.0, 0.0 ]

"mipilB" : [ 0.0, 0.0,      -or-      0.0, "prev",
            63.0, 1.0,
            127.0, 0.0 ]

"pin"    : [ 0.0, 0.0,      -or-      0.0, "prev",
            127.0, 0.0 ]

```

Figure 2-17: Building blocks for *mipil* and *gantung* patterns in JSON format.

The envelopes are combined according to the selection process detailed in §2.3.2, which generates a list of envelopes per *gatra* for the corresponding *function* objects. **Table 2-15** shows the commands generated by the *gatra* 2 1 2 3 and 5 3 2 1, using half-*gatra cengkok* separated by the “/” symbol; **Figure 2-18** shows the same *mipil* patterns as displayed on-screen.

Table 2-15: Entries used to construct envelopes in *Mipilan*.

<i>Gatra</i>	Output
<u>2 1 2 3</u>	6 pinHalf_1 / pinHalf_2
	5 pinHalf_1 / pinHalf_2
	3 pinHalf_1 / mipilHalf_B_2
	2 mipilHalf_A_1 / mipilHalf_A_2
	1 mipilHalf_B_1 / pinHalf_2
<u>5 3 2 1</u>	6 pinHalf_1 / pinHalf_2
	5 mipilHalf_A_1 / pinHalf_2
	3 mipilHalf_B_1 / pinHalf_2
	2 pinHalf_1 / mipilHalf_A_2
	1 pinHalf_1 / mipilHalf_B_2

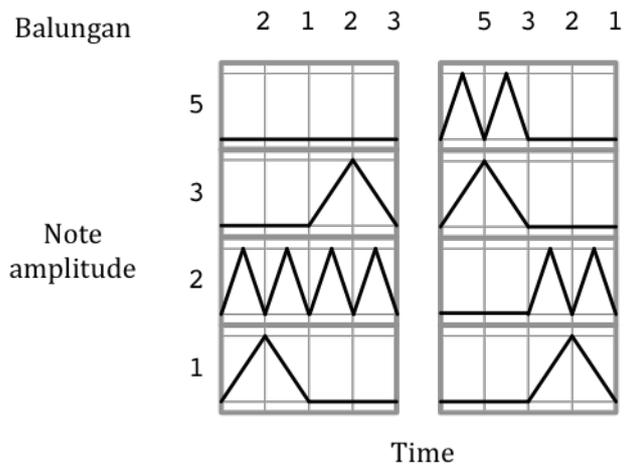


Figure 2-18: *Balungan* phrase 2 1 2 3 5 3 2 1 with abstract envelope *cengkok*.

These patterns do not fully represent the output of the software; in practice, each *cengkok* is concretized according to the timing generated by the *maju/mundur* control system, non-linear interpolation, and additional parameter modulation, smoothing, and jitter within the software and external sound generators (see **Figure 2-19**, traced from MIDI data generated in **AV2.6.B**).

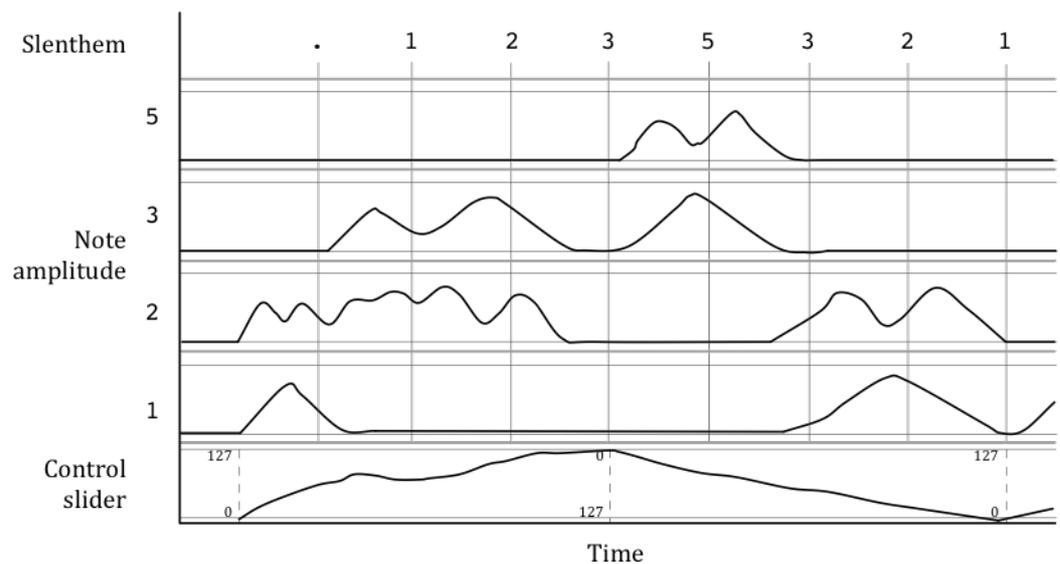


Figure 2-19: *Balungan* phrases as performed via the *Cengkokan* patch in *Pangkur Paripurna* (traced from recorded MIDI data and *slenthem* audio).

An additional control called *floor* determines the lowest value output by the envelope generators; this can be used to create a dense drone out of which the *Mipilan*-generated patterns emerge (see **AV1.5**, 9:30; **AV2.9.B**, 2:07; **AV2.9.B**). **Figure 2-20** shows a version of *Pangkur Paripurna* used during the development of *Response to*

ShoutCry Room (sections 5 & 6; see §3.5.2.a). Since the part is quantized to a central clock it is not subject to the same variations in timing shown above.

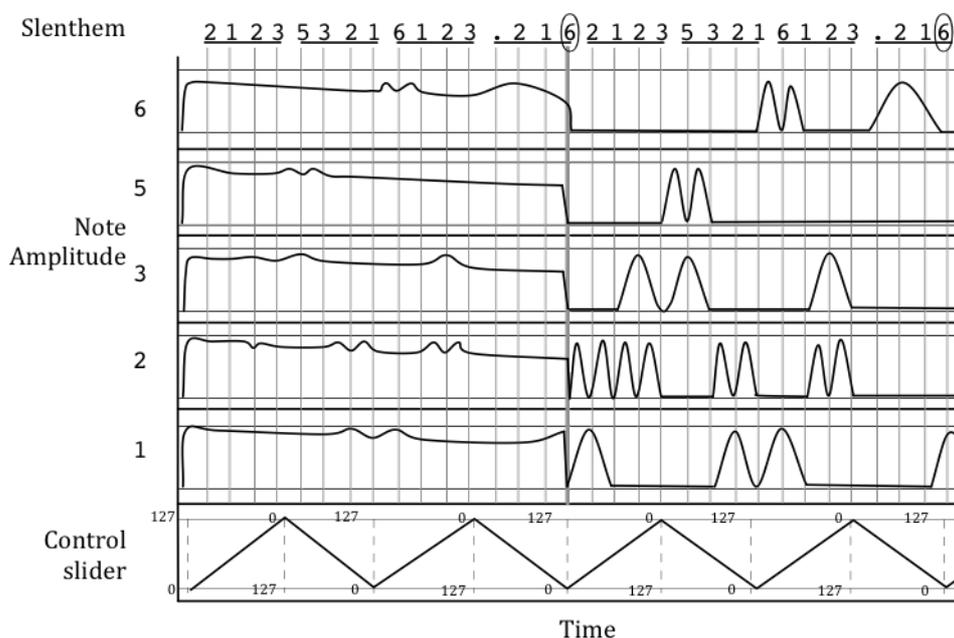


Figure 2-20: *Ompak of Pangkur Paripurna* with and without *floor* modulation (automated, traced from recorded MIDI data).

Here the envelopes start open, gradually gaining room to accommodate the *mipil* patterns. Upon the first stroke of the gong the *floor* parameter drops to zero and the recognizable *mipil* patterns appear in full.

2.4.5 Named envelope cengkok in *Cengkokan* and *Mipilan*

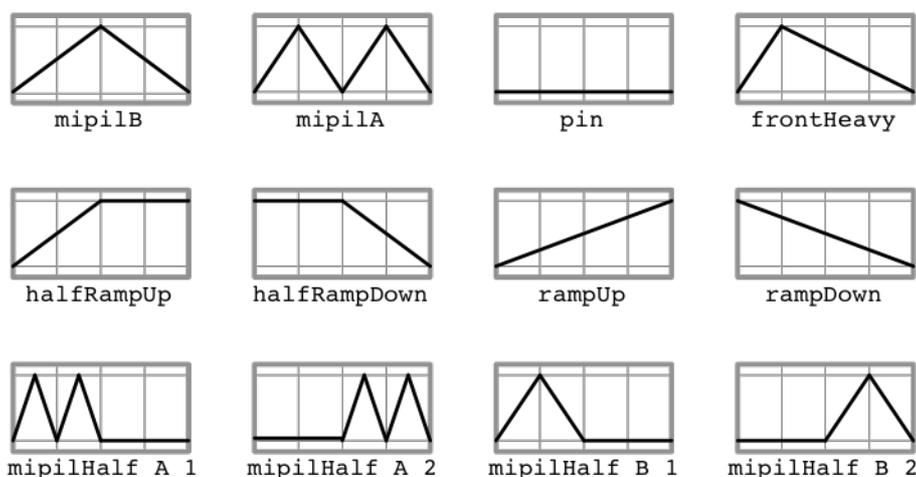


Figure 2-21: Ramps forming additional building blocks for realization of *cengkok*.

In order to represent the variety of *gender cengkok*, an array of more complex shapes complements the basic *mipilA* and *mipilB* building blocks. **Figure 2-21** shows the core patterns for *cengkok* used in composition portfolio.

Figure 2-22 shows the *cengkok* data for *kacaryan* in *pathet manyura*²³. Examples of these patterns in context may be found in notation presented in the portfolio (e.g. **N3.E**; **N4.B**). Further experimental selections of envelopes and concretization methods may be found in the *Mipilan* software (see **AV2.8.A**).

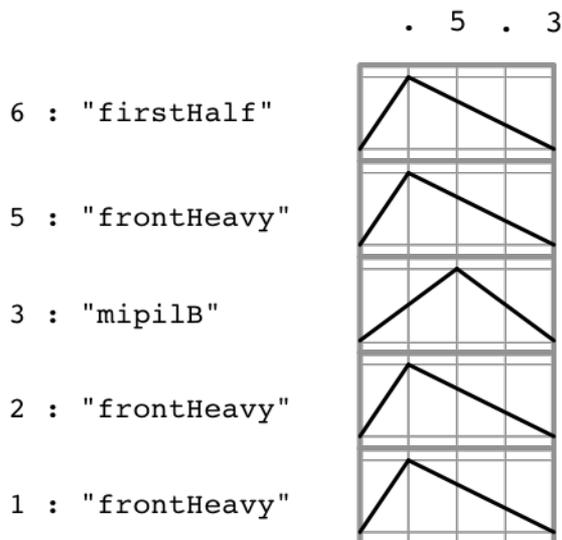


Figure 2-22: Envelopes for the *kacaryan cengkok* as found in *Ladrang Srikaton*.

2.4.6 Crossfade channels in *Cengkokan* and *Mipilan*

The software also uses a selection of processes in order to produce the timbral equivalent of *cengkok* (see §1.3.3; §3.3.2.e), ranging from probability-based grain selection to conventional audio crossfades. These are driven by simplified versions of the envelopes presented above, which were either determined manually (as in *Pangkur Paripurna* and *Monggan*), or automated (as in *Mipilan*).

The automated crossfade generation in *Mipilan* is based on comparison of the *seleh* to a threshold (set to note 5 by default). Through use of the larger range of the *balungan*, this offers the potential to represent shifts in register through the single octave provided by the envelope-based parts. The process is based on operators specified by the user (“>” or “<”), returning a value of 0 or 1. A crossfade ramp is

²³ Alongside my interpretation of *ayu kuning*, this *cengkok* is representative of the “swelling” of resonance or reverb mentioned in §1.2, as the *gender* plays a descending pattern in *gembyang* (**AV2.5.A**, 1:13).

generated starting with the value from the previous *gatra*, and is stored as information readable directly by the *function* object alongside other *garap*.

Table 2-16: Example of ramp sequence generated by the *XF* function.

<i>Seleh</i>	Value	Ramp
6	0	[0, 0.0, 127, 0.0]
5	1	[0, 0.0, 127, 1.0]
6	1	[0, 1.0, 127, 1.0]
3	0	[0, 1.0, 127, 0.0]

2.5 Additional software

During the development process I created several modules to complement the main framework, either to run as supplementary patches or as standalone devices in *Max for Live* (<<http://www.ableton.com/en/live/max-for-live/>>²⁴). These include:

- A re-tunable bank of sine waves (*slendro*, *pelog*, and *gong kemedhong*).
- A granular synthesizer based on the GMU BufGranul object (Bascou & Pottier, 2005) for the probability-based cross-fade between instrumental textures.
- A re-tunable set of low frequency sine waves for use as a *gong kemedhong*.
- White noise generators with envelopes to serve as *kenong* parts and additional texture in *Pangkur Paripurna*.

Some of these items have been integrated into the standalone version of *Mipilan*; a selection of additional synthesis modules is available in the portfolio in the form of supplementary Max patches. Additional processing and sound generation took place through the following software:

- **Ableton Live** (<<http://www.ableton.com/>>) – recording, MIDI routing and sequencing (including tempo automation to drive Max/MSP), and sampler channels. This also enabled recording of automation data from controllers and Max/MSP for analysis and some of the graphic examples presented here.
- **Sound Forge** (<<http://www.sonycreativesoftware.com/>>) – destructive editing and DSP, facilitating a set of idiosyncratic processes I had previously

²⁴ All URLs in this section available at 30/09/13.

developed in my practice as an electroacoustic composer. This included non-real-time feedback created by overlaying reverb processes, and an approximation of granular synthesis created by manually overlaying short samples (stage 2 onwards).

- **Spear** (<<http://www.klingbeil.com/spear/>>) – spectral analysis, identifying partials for resynthesis. (*Tenuous Links, Response to ShoutCry Room*).
- **Soundhack** (<<http://www.soundhack.com/freeware/>>) – time-stretching through phase- vocoding (*Monggangan, Pangkur Paripurna*).
- **Metasynt** (<<http://www.uisoftware.com/MetaSynth/index.php>>) – spectral filtering and synthesis of textures (*Monggangan, Pangkur Paripurna, Response to ShoutCry Room*).

2.6 Conclusion and further development

In the software presented here I have focused on two main approaches: *mipil*-type patterns that refer directly to a *balungan*, and ostensibly fixed *cengkok*. These have been explored with the aim of interpreting both idiomatic and non-idiomatic material in relation to gamelan, with the intention of creating a stable framework in which both may coexist. In doing so I have adopted a simplified approach, which forms a framework for the software comparable to an unique instrumental idiom. In keeping with the notion of *balungan* as mediating information, a composer wishing to work from a more complex melodic framework may choose to create an abstracted part for the computer accordingly. By working with various levels of abstraction it is possible to develop the patterns further while staying within this framework. For example, users may generate their own envelope data on a low level and with more real-time processes, or choose to generate their own methods based on the higher-level *cengkok* names that form the output of the pattern selection stage.

In order to produce this framework within the time available, and due to the evolving emphasis on concrete performances, it has been necessary to restrict the scope of the software. I have not attempted to address more complex *cengkok* or other techniques such as the various types of *imbal*, which may yield more appropriate and flexible results when mapped to non-idiomatic information. The software presented here handles *balungan* on a basic level of density (i.e. *balungan mlaku* and *balungan nibani*, with little distinction between the two), and is restricted to *gatra* of even-numbered lengths. I feel this limitation is sufficient for

demonstration purposes and that it is suited for the role of the *balungan* as a mediating parameter. The majority of interpolation presented here has been linear; further exploration of non-linear interpolation in the realization of *cengkok* and movement away from a central clock is likely to bring further life to the work.

The next stages of development will be based on re-integrating concepts from the previous iterations of the software into *Mipilan*. In particular this should include the ability to analyze *gatra* in an *idiomatic* manner, and a return to a wider selection of instrumental idioms including named *cengkok*. The flexibility of non-idiomatic part generation and interpretation will remain central; further development may include flexibility across multiple *irama*, and interpretation of patterns exhibiting different lengths and densities. Due to the modular design of the system, these developments may take place over the course of an iterative process while maintaining existing functionality for continued development of compositions. It is my intention that the JSON format may also be used for further development on other software platforms, and enable compatibility with other music-making frameworks.

Appendix 3: Compositions and arrangements

3.1 *Bonang Study* (2011, AV1)

Bonang Study is an arrangement of a pseudo-traditional *gendhing* in *ladrang* form for a flexible ensemble of loud-style instruments and computer generated sounds. At minimum the ensemble should incorporate one *bonang barung* augmented with output-type transducers, accompanied by *gongs*, *kempul*, and *kenong*. Additional instruments using traditional *garap* may be added at the performers' discretion.

Development of this piece and its more general technical setup took place in the gamelan room in the Southbank Centre in London over the course of several sessions, culminating in the finalization of the recorded version over the course of an intensive weekend. The *balungan* and variations of the techniques developed here also formed the basis of various other workshops (AV2.1; AV2.2).



Figure 3-1: *Bonang* shared between computer and live player through transducers.

3.1.1 Description

The *Bonang Study* is loosely based on the format of *gendhing soran*, a repertory of pieces often used on ceremonial occasions, as part of dance suites, or when no soft-style instruments or singers are available. Performances of *gendhing soran* either stay in the faster *irama* I (*tanggung*) throughout, or employ a process of expansion and contraction whereby the melodic cycle is slowed down from *irama* I to II (*dadi*)

for several cycles, before returning to *irama* I. The expanded *irama* II section often gives an opportunity for more elaborate *garap* on the *bonang*, and may feature other ensemble *garap* such as *pinjalan*²⁵.

The arrangement of the *gendhing* forming used in the *Bonang Study* relies on an exaggeration of this process of expansion, slowing down a further level to *irama* III, and returning to *irama* II to finish. This additional expansion provides the foundation for manipulation of timbre in addition to more conventional instrumental *garap*.

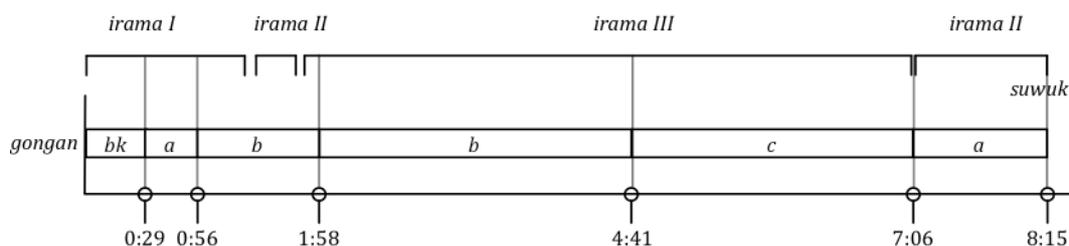


Figure 3-2: Timeline of *Bonang Study* (electronic and instrumental versions).

The *bonang* may either be played solely by the computer through transducers, or shared with a human player. Both parts refer to the same *balungan*, which is treated as a melodic framework but is not necessarily played directly by any instrument. The individual *garap*, based on conventions for *laras pelog pathet nem*, may vary.

Two versions of the piece are presented here²⁶:

- The **electronic version (AV1.1.A)** uses only the signal from the transducers, accompanied by gongs, *kempul*, and *kenong*. This version may be presented in a concert setting or cycled as a standalone installation.
- The **ensemble version (AV1.1.B)** adds the live *bonang* part along with *slenthem*, *kempyang*, and *kethuk*, which give more of a sense of the piece as it relates to a traditional context.

3.1.1.a Electronic version

The electronic *bonang* part is split into three components, sharing the transducers and resonance of the instrument while retaining their own timbral identities:

²⁵ For examples of *gendhing soran* see *Condong Raos* (1992), which alongside rehearsals at the Mangkunegaran provided the initial inspiration for this piece.

²⁶ Excerpts of a third workshop-based version of the piece, employing markedly different *garap* in both the electronic and instrumental parts, are available in **AV2.2**.

- **Generator A** plays a variation of the traditional *bonang barung* part, using sine waves tuned to the resonance of the instrument and varying envelopes.
- **Generator B** plays an approximation of the traditional *bonang panerus* part at twice the density of generator A, using filtered percussive impulses that stimulate the ample resonances of the instrument.
- **Generator C** plays the notes of the *balungan* through sustained bursts of white noise, again coloured by the resonance of the instrument.

After a brief introduction – a bed of resonant noise played by *generator C* – the acoustic gong and *kenong* signal the start of the *ladrang* cycle. The *garap* played through the electronic parts is instantly recognizable as an idiomatic texture. The sine waves played by *generator A* present a predominantly pitched part, featuring fragments of *mipil* patterns that blend into a sustained drone, as the *bonang panerus* part played by *generator B* provides a steady pulse.

As the *irama* of the piece descends from I through to III, the instrumental texture disintegrates; the rhythm of the *bonang panerus* appears to fall apart as the sine waves are extended and blend together, occasionally wavering in sympathy with the scattered rhythm of the *bonang panerus* or performing textural modulations. The *bonang panerus* part gathers resonance, transforming into a sporadic texture akin to popcorn hitting the lid of a saucepan, with moments of coherence as it moves through the more recognizable resonances of the instrument. The continued presence of the gong, *kempul* and *kenong*, at this point around twenty seconds apart, serve as a reminder of the traditional foundation of the piece, drifting in and out of focus. Gradually the piece returns to *irama* II and more distinct phrasing. The piece ends with a traditional *suwuk* marked by the final gong and *kenong* strokes.

3.1.1.b Ensemble version

The initial pitched activity is more recognizable as a traditional style *buka*, as the instrumentalist joins in to lead into the gong. The sine tones played by *generator A* form subtle extensions of the instrumental texture, providing grounding for the *bonang panerus*. The erratic nature of the *bonang panerus* part is revealed before the change in *irama* as it drifts in and out of phase with the rhythm of the main part. The

slenthem elucidates the connection between the *balungan* and *generator C*. The white noise adds a shimmering, brittle quality to the *slenthem* part with which it coincides.

The live *bonang* player maintains *mipil lamba* as the *irama* drops to level III. Through this technique the part does not appear to change its relative density, maintaining space for the electronic parts. Despite this, the presence of the instruments and their idiomatic activity is enough to establish clearer movement between *irama*. The combined presence of the *bonang* and *slenthem* highlight the relationships between the shifts in texture and the underlying melodic structure.

3.1.2 Development process and technical notes

The initial premise for the arrangement was to create a *gendhing bonang* (a larger scale loud-style piece typically lasting between ten and thirty minutes) that would descend beyond the conventional *irama II* into *irama III* to provide space for electronic parts to perform *garap*. The *ladrang* form was chosen for brevity and simplicity for repeated attempts in workshops and recordings.

I wrote the *balungan*, along with the *bonang* interpretation, in isolation from the instruments. I worked with aural feedback from samples of a similarly tuned set of gamelan instruments (Yantra Productions, 2008), which I organized using the *Bonangan* patch. The more detailed electronic *garap* – in particular the elaborate textural *irama III* parts – was developed further with the specific sounds of the physical instruments and their interaction with the transducers in-situ.

3.1.2.a Balungan

The conventional *balungan* in this piece takes two forms: as an abstract framework shared between the computer and live instrumental player, and as the concrete realization in both the white noise played through the transducers and the optional *slenthem* part. Although the melodic line is obfuscated in the electronic version, the note events can be determined from their interpretations in the electronic parts.

The *balungan* as a sequence of notes, while transferable to other instrumentation, does not constitute the entire composition and may be modified or replaced by other pieces. During development I invited a small group of musicians to perform traditional pieces (*ladrang Gleyong* and *ladrang Eling-Eling*) using the modified setup and electronic *garapan*, with a clock generated internally by the computer and mediated by live *kendhang*. I developed an original *balungan* in

response to a sense that the traditional pieces sounded out of place or more obviously “wrong”, both in terms of the intrusion of the electronic parts and the unconventional use of *irama III*; this matched the feedback I received during these sessions. The creation of a *balungan* enabled me to explore potential for interesting moments of interaction between the traditional *bonang* part and the new electronic *garap*, seeking patterns requiring deviation from standard *pipilan*. The *balungan* used in this version of *Bonang Study* is in parts an amalgam of various traditional loud-style pieces in *pelog nem*, including *ladrang Raja Manggala* and *ladrang Babar Layar* (Sutarja, 2004 p. 2). The repeated phrase 6 5 6 3 is reminiscent of the gamelan *Monggang* that provided inspiration for work developed later in the research (§3.3).

3.1.2.b Technical setup

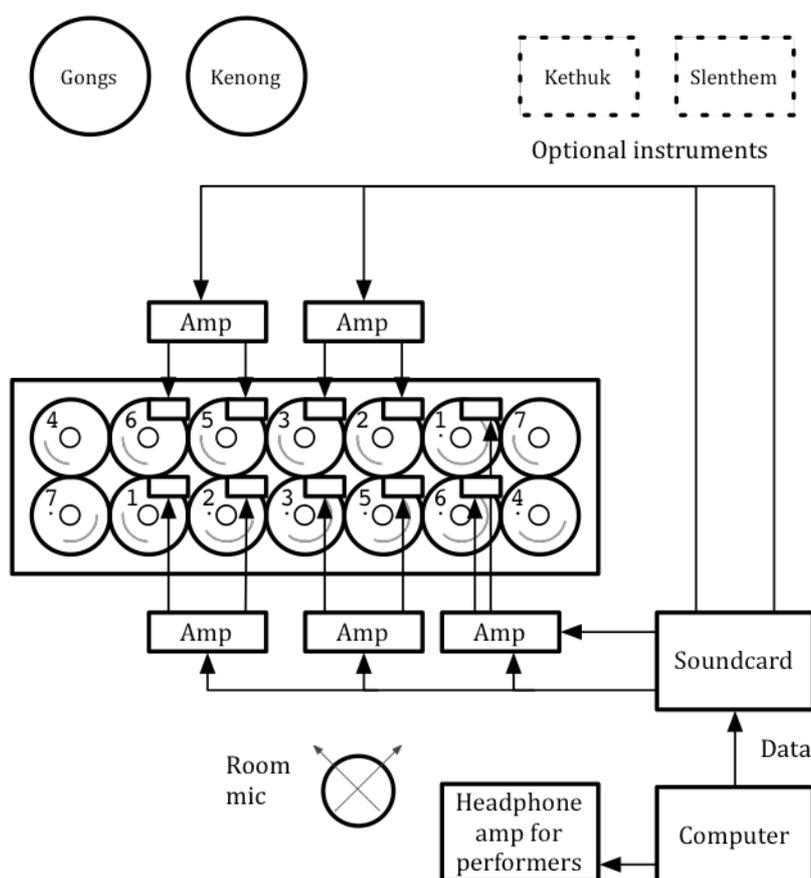


Figure 3-3: Technical and instrumental setup used in *Bonang Study*.

Figure 3-3 shows the technical layout for the development sessions and potential performances. Following an initial period of experimentation with various devices (§1.4.1), this was my first significant attempt at using output-type transducers. Each pair of transducers is driven from the output of a multichannel soundcard with a small car amplifier, and attached to the individual *pencon* with tape and protective

padding to ensure that the driver does not come into direct contact with the instrument. With the exception of a headphone click track, all the electronic sounds are generated in real-time through the resonances of the *bonang barung*.

The various *pencon* required different levels of volume in order to stimulate the pitches associated with the instrument. I also encountered difficulties with the loudness of the instrument; through a desire to avoid damage I found it difficult to raise the volume to a level suitable for performance, especially when competing with the strokes of the instrument with traditional beaters. Consequently the piece was restricted to the confines of the studio or smaller performance spaces.

I opted to create a solo multi-track recording due to circumstances related to timing and availability of the space. This contradicted my initial ideal of the piece existing in real-time, as something to be performed. However, the flexibility of the multi-track allowed me to create multiple versions for reference, including the option of primarily instrumental or electronic recordings presented here. The *bonang* parts were recorded with a handheld recorder placed underneath the instruments, allowing for a high level of detail from the transducer parts and an opportunity to hear the spatial movement of the parts as might be experienced by the *bonang* player.

3.1.2.c Timing

Central timing is generated via the computer's internal clock and disseminated to musicians via the transducer parts and a headphone track generated dynamically in Max/MSP, including an algorithmically generated traditional *bonang* part as a guide (§2.3.1; §2.4.1)²⁷. Further layers of timing take place through absolute time values, with jitter provided by random delays to note events linked to *irama*. The *irama* changes are triggered dynamically within Max/MSP, based on tempo thresholds.

3.1.2.d Tuning

I attached output-type transducers to the *pencon* representing the central range of the *bonang*, excluding notes 4 and 7 (see **Figure 3-3**). Through these connections I tuned a set of sine waves by ear to frequencies close to what I felt were the fundamental pitches of the instruments, which caused the pots to resonate strongly.

²⁷ In absence of higher-density parts such as the *gender* and *bonang panerus*, during the initial development workshops a *kendhang* part played by a musician with a click track was sufficient to disseminate the tempo from the computer-generated clock. The timing changes in the recorded version of the piece were generated via MIDI automation from Ableton Live to ensure consistency in multi-tracking.

A second oscillator for each note sounded the next prominent, typically inharmonic partial, helping provide a more characteristic representation of the instrument's timbre. These are represented in **Table 3-1** as oscillators **I** and **II** respectively.

Table 3-1: Frequencies (Hz) derived from the *bonang* in the Southbank Centre.

Note	Oscillator I	Oscillator II
1̣	295	472
2̣	319	477
3̣	347	507
5̣	437	698
6̣	468	683
1	596	920
2	644	474
3	699	1200
5	879	1331
6	942	1236

3.1.2.e Synthesized parts

The synthesizer parts described below represent the default behaviour of the *Bonangan* software (§2.4.2), and are based on traditional *garap* and instrumental idioms. Each part ostensibly retains its traditional rhythmic relationship with the *balungan*, although this is not always audible:

Table 3-2: Ratio of the event densities of generators to *balungan*.

Irama	A	B	C
I	2:1	4:1	1:1
II	4:1	8:1	1:1
III	8:1	8:1 (16:1 including retriggered strokes)	1:1

Generator A (*bonang barung*)

The sine waves used in Generator A are tuned to prominent partials of the instrument and played through the appropriate *pencon*. In contrast to the noise signals used in *generators B* and *C*, the pitches associated with the instrument are generally audible. The patterns are primarily based on *pipilan* techniques, with special material for *seleh* notes in the lower register and *gembyang* (§2.4.2). In these latter cases direct

reference to the notes of the *balungan* is abandoned to make way for a general swelling of resonance, with a damping of all active oscillators at the end of the *gatra*.

The sine tones are introduced using envelopes with varying lengths of attack. The *seleh* note of each *gatra* is sustained until all oscillators are damped at the end of key phrases. Some patterns involve cross-modulation from the *bonang panerus* part (AV1.1.B, 3:48) and more extreme frequency modulation to give the impression of the instruments bending pitch (as can be heard in *gatra* ending with “low 4”; 4:04).

Generator B (*bonang panerus*)

The *bonang panerus* part is played using short bursts of white noise through low-pass filters, stimulating the resonance of the *pencon*. At times the pitches traditionally represented by the *pencon* can be heard clearly (e.g. at 6:21- 6:29). The notes are also distinguishable through spatial position and incidental variation in timbre and volume determined by the location of the transducers.

The timing of the part is subject to several levels of randomization. In *irama I* and *II*, each note event is subject to a brief delay (10-100ms), scaled with an inverse relationship to the tempo in beats per minute. Additional delays lead into the gongs, creating a more diffuse part. Further randomization is applied in *irama III*; the part retains a basic density of eight beats to the *balungan* pulse, but each impulse is retriggered two or three times. The resonance and random range of cutoff of the low-pass filter for each note are also determined by the current *irama*.

Generator C (*slenthem*)

The notes of the *balungan* trigger a sustained burst of white noise through the appropriate *pencon*, stimulating the resonance of the instrument but not necessarily the fundamental frequencies. The amplitude envelope is fixed to an arbitrary time, lasting roughly the length of a *balungan* beat in *irama III*. The part is not restricted to the range of the *slenthem* due to the use of transducers across the full range of the *bonang*.

3.1.3 Discussion and analysis

The composition takes place on several levels, namely:

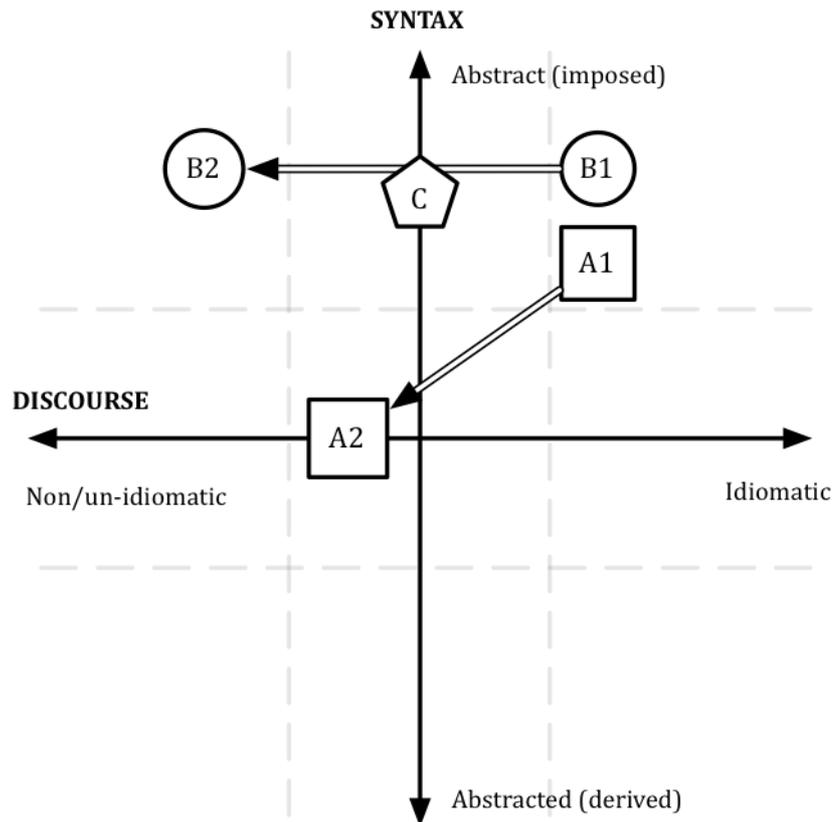
- The **conceptual level**: the conceptual mapping of idiomatic references, application of transducers, and software development.
- The ***balungan***: a central abstract melodic line, which is subject to interpretation by the players and computer.
- The instrumental and synthesizer ***garap***: flexible rules for idiomatic interpretation based on traditional practice.
- The **arrangement**, or **ensemble *garap***: the use of instrumentation, parameter mapping, *irama*, and specific techniques such as the dissolution of stable rhythm, which may vary between performances.

In an idiomatic context this piece might be regarded as pastiche, and be subject to criticism accordingly²⁸; however, I consider the main composition to lie on the conceptual level, as will be explored in the following analysis. In the development of this work I attempted to create a framework for *garap* that might be applied to a variety of *balungan*, traditional or otherwise. However, the recording as it is presented here represents a concrete work that might be considered a composition in its own right. In the absence of a stable and accessible means of recreating the work, I have opted to present it in this state.

3.1.3.a Syntax and discourse

The movement of syntax and discourse of the electronic parts is represented in **Figure 1-1**. Parts have been placed relative to the overall degrees of idiomatic reference and derivation of syntax from materials; the instrumental elements of the ensemble may be imagined in the upper-right hand corner as abstract and idiomatic parts.

²⁸ Feedback from musicians in Solo indicated that the *balungan* could be accepted as a contemporary piece, as long as there was no vocal part involved. Upon asking for further comment it became apparent that material taken from other pieces were unproblematic as to be expected, whereas the new phrases required significant modification to become idiomatically acceptable.



Generator	Positions	Irama
A: <i>Bonang barung</i> part (sine waves)	A1	I / II
	A2	III
B: <i>Bonang panerus</i> part (resonant impulses)	B1	I / II
	B2	III
C: <i>Slenthem</i> part (white noise)	C	I / II / III

Figure 3-4: Syntax and discourse (idiomatic reference) through three electronic parts in *Bonang Study*.

Both *generator A* and *B* move from relatively idiomatic positions in *irama I* and *II* to non-idiomatic in *irama III*. In both cases the pitched and rhythmic aspects of the parts are recognizable, particularly when combined with the live *bonang* part in the instrumental version. Upon the dissolution of the instrumental texture, the sine parts played by *generator A* maintain a close connection with the *bonang* part and the *balungan*, although this is not generally expressed in an idiomatic manner.

The placement of the parts on the axis representing syntax is also based on the manner in which they were developed. The patterns in *irama I* and *II* were developed in my home studio as plain sine wave and impulse parts, using sampled instruments as a reference point; this led to a predominantly note-oriented approach. In *irama III* the patterns for *generator A* were largely developed in response to the resonance of

the instruments, as I found ways to blend interesting timbral modulation with key points in the *balungan*. Although *generator B* undergoes a similar degree of transformation, the syntax of the part largely remains unchanged; it retains the same reference points with the *balungan* (see **N1.C**), but gains its variation through the application of randomization of timing and filter cutoff, which combine with the resonances of the instrument and degree of contact with the transducers.

Generator C remains stable throughout the piece, following the abstract information of the *balungan* directly. The part is derived from the sound materials to a limited extent, in that it has been modified in reaction to the textural sounds of the synthesizer and uses the complete range of the instrument rather than the restrictions of the *slenthem* part that it accompanies in the ensemble. Although the part is based on idiomatic information, it may not be considered entirely idiomatic, as the pitches are not played directly.

3.1.3.b Idiomatic reference

The following table shows a breakdown of the idiomatic references and conceptual mappings involved in the development of the piece:

Table 3-3: Idiomatic reference table for *Bonang Study*.

Instrumental idiom (including instrument-specific phrasal idioms)			
Source	Application	Interpretation	Modification
<i>Bonang barung: pipilan</i> playing techniques.	Synthesized <i>bonang barung</i> part (generator A)	Equivalent events on a note-by-note basis, assigned to sine waves and noise played through associated <i>pencon</i> . Pitch values retained where possible.	Patterns developed based on slow envelopes and anticipation of <i>bonang</i> part. Specific patterns play textural role, sustained tones.
<i>Bonang panerus: pipilan</i> playing techniques.	Synthesized <i>bonang panerus</i> part (generator B)	Equivalent events on a note-by-note basis, assigned to sample triggers through transducers attached to associated <i>pencon</i> .	Random delays and additional strokes in <i>irama III</i> . Indeterminate pitch based on resonance of <i>pencon</i> and positioning of transducers.
<i>Slenthem</i> or	Synthesized	Equivalent events	Range is expanded to

<i>saron</i> family: <i>mbalung</i> playing technique.	<i>slenthem</i> part (generator C)	on a note-by-note basis, assigned to white noise through transducers attached to associated <i>pencon</i> .	that of the <i>bonang</i> (both registers are played). Note “4” is mapped to “3”. Indeterminate pitch based on resonance of <i>pencon</i> and positioning of transducers.
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Structuring and general phrasal idiom			
Source	Application	Interpretation	Modification
<i>Balungan</i> (note sequence).	Shared melodic line as reference for player and computer.	<i>Slenthem</i> part Arrays for <i>bonang</i> parts.	-
Expansion of structure and note relations through <i>irama</i> .	Synthesized <i>bonang barung</i> part (generator A)	Conventional <i>irama</i> relationship. Extended / anticipated tones (conceptual mapping).	Inconsistent density ratio across <i>irama</i> . Extension of envelopes rather than increased note event density.
	Synthesized <i>bonang panerus</i> part (generator B)	Conventional <i>irama</i> relationship. Rhythmic space filled by texture.	Randomized timing.
<i>Ladrang</i> structure	<i>Balungan</i> structure and punctuating instruments.	Phrasal influence on construction of <i>balungan</i> , including quotation from traditional works. Traditional gong cycle.	Unconventional use of <i>kenong japan</i> (borrowed from Jogja style) and <i>kempul</i> “4”.
<i>Laras pelog</i>	Tuning of oscillators and selection of traditional instruments.	Oscillators tuned with concrete reference to strong partials in <i>bonang barung</i> .	Discrepancies based on aural interpretation of tuning.
<i>Pathet nem</i>	Pathet-specific patterns e.g. “low 5” and “1”.	Phrasal influence on construction of <i>balungan</i> .	Use of unconventional phrasing.

Ensemble idiom

Source	Application	Interpretation	Modification
Loud-style ensemble.	Choice of instrumentation and synthesized parts.	Within-domain (choice of instruments), appropriate synthesizer parts.	Omission of <i>bonang panerus</i> to create space for electronic part, <i>kendhangan</i> optional due to computer-generated clock.
	Choice of <i>kendhang(kalih)</i> for <i>irama III</i> .	Related mapping in <i>bonang</i> parts (<i>mipil lamba</i>).	-

Further mapping of note information may be examined through the JSON files used for this piece (N1.B; N1.C).

3.1.3.c Cues to indicate discourse

The inclusion of particular instruments in each version of this piece provide opportunities for different listening modes. The presence of the humanly played *bonang* and *slentem* in the instrumental version are likely to shift the listener's expectations towards an abstract note-oriented discourse. However, they may also serve to clarify the roles of the electronic parts and their relationship to the traditional patterns. The electronic parts are first bonded with the *pipilan* techniques, presenting elaborated versions of the textures when given more space.

While strictly following the *ladrang* format is restrictive, I found this useful for providing an established framework for the listener. Through an extreme change in *irama*, the listener may be drawn into hearing the change in electronic parts as an expansion of the sound objects created by the strokes of the *bonang barung*. **Figure 3-5** shows the relationship between formal levels of *irama* and the movement between types of perceived discourse – a continuum between the textural and the “abstract musical” (primarily pitch and rhythmically-oriented) information.

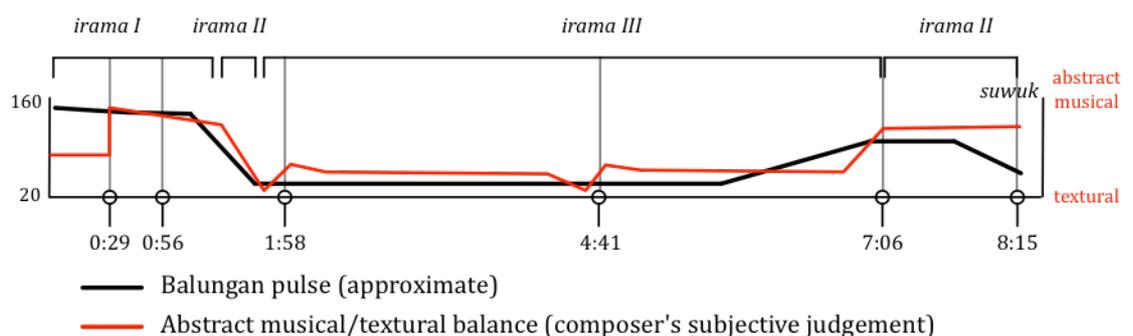


Figure 3-5: *Irama* and musical discourse in *Bonang Study* (electronic version).

The gong stroke holds the potential to ground the listening experience, bringing the textural play back into a musical context. Upon closer inspection a more subtle movement between idiomatic note-oriented discourse and textural discourse might also be observed as the subdividing *kenong* and *kempul* strokes provide structural and pitched information. This movement in discourse is most apparent in the electronic version; in the instrumental version a stronger pitch relationship is maintained, as the traditional *bonang* part remains dominant, and a sense of the gong cycle is reinforced by the constant *kempyang* and *kethuk* part.

Here it is my intention that the listener develops an association between a change in *irama* and a change in discourse. Just as the listener's perception may be drawn away from the *balungan* as a continuous melodic pattern towards the undulating textures of the soft instruments in a shift from faster to slower *irama* in traditional pieces, it is possible that the listener is prompted to move from listening to abstract pitch-oriented material, through to a more textural, concrete experience. The move to *irama III* represents a pseudo-traditional shift in playing technique but also in compositional approach, as parts move from those developed in isolation in my home studio to those developed in a feedback relationship with the physical properties of the instruments and attached transducers.

3.2 *Tenuous Links* (2011, AV2)

Tenuous Links is a semi-improvised piece for solo live electronics featuring a collection of small gongs augmented with transducers. It was originally developed for the Placard Headphone Festival in Sheffield, and was performed in a small, informal setting, in addition to being streamed with audio and video over the Internet²⁹. The original length of the piece, at twenty minutes, was determined by the format of the festival. I subsequently recorded several versions in my home studio, including several shorter versions for playback in seminars. One of these recordings is presented here with video (AV1.2.A) alongside the Placard performance (AV1.2.B).



Figure 3-6: Performance of *Tenuous Links* at the *Placard Headphone Festival* (photo by Alex McLean).

²⁹ This formed part of an international series of events in which audience members are invited to bring their own headphones to plug into a distribution amplifier, or listen at home (see <<http://www.leplacard.org/>>; <<http://lurk.org/placard/>>, accessed 14/09/13). I had previously played at a Placard event in London in 2005, where I triggered predominantly random samples of gamelan through a system developed in Max/MSP, with timing triggered by the sounds of the ticking and winding mechanism of an alarm clock (Matthews, 2005).

3.2.1 Description

Tenuous Links opens with a harsh metallic tone generated by impulses sent through a pair of *gwaengari* [small un-bossed Korean gongs]. Starting rich and coherent, it gradually unravels, slowing down from frequencies in the pitch domain, through an iterative texture, into a rhythm. Reverberation, strands of feedback, and noises generated from environmental sounds of the performance space swell and drift away.

The rhythm proceeds to dissipate into an underlying structural pulse, creating space that is filled by other parts, using the resonance of collected found objects: a regular rhythm reminiscent of a *kempyang* and *kethuk*³⁰ or a pair of *kemanak*, soft sine tones, and scraping, sustained metallic resonances, underpinned by a deep, pulsating gong tone. A *kendhang* part drifts in and out of focus, played by percussive metallic resonances and giving an indication of a *ladrang* structure in *irama I*. The pulse slows down further, reaching *irama III*, at which point there is space for increased activity in manipulating EQ, reverb and feedback. Upon a return to *irama II* the piece reaches a traditional *suwuk*, ending on a gong stroke.

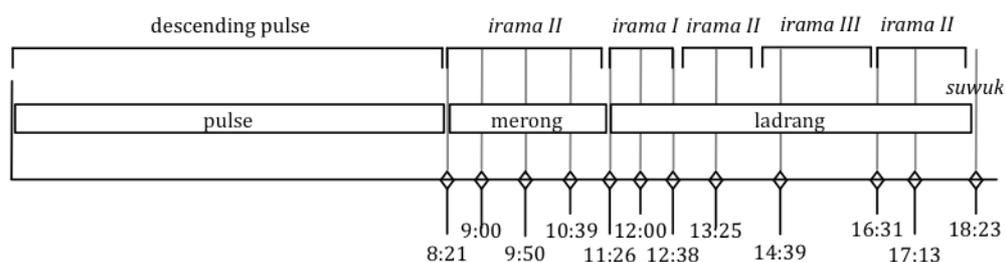


Figure 3-7: Timeline of *Tenuous Links* (Placard performance)

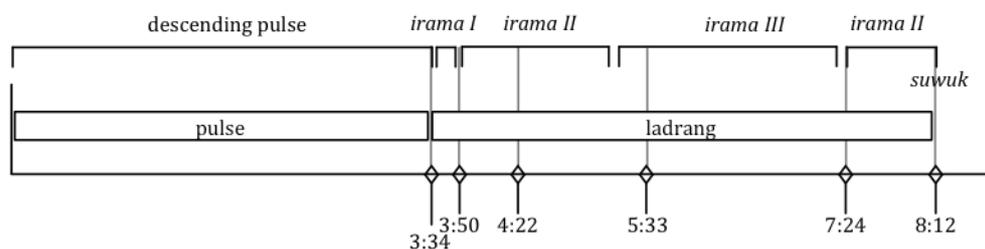


Figure 3-8: Timeline of *Tenuous Links* (studio version)

The “abstract musical” aspects of *Tenuous Links* are similar to those of the *Bonang Study*; the underlying structure follows the general format of a *ketawang gendhing*,

³⁰ This part exhibits the rhythmic density of the related *engkuk/kemong*, but does not sit in the structural context in which they would be used (see Purwanto, 2010 p. 211).

moving from a *merong* section to *inggah ladrang*. The *gwaengari*, played throughout, mark the underlying pulse of the piece in alternation.. This helps elucidate the movement from the pitch domain in the initial section to the rhythmic, and ultimately structural level, as the rate of the central clock drops to the slowest *irama wiled* (see **Figure 3-12**). The *kendhang* part provides further confirmation of the traditional structure and formal levels of *irama*.

3.2.2 Development process and technical notes

Development of *Tenuous Links* took place shortly after the recording of the *Bonang Study*. The time slot determined by the festival combined with a focused but informal listening environment provided an opportunity to try the longer time-scale of a full *gendhing* within which I had originally planned to work.

A set of found gongs provided a portable alternative to the traditional instruments, which in turn greatly influenced the development of the piece. With unlimited access to these instrumental resources at home, I was able to spend significant periods of time developing the software with direct aural feedback from the materials. Rather than attempting to create a new set of *garap*, I decided to work with extant *mipil*-style patterns from the *Bonang Study*, working instead with mapping and processing of the note output. This led to a more concrete approach to the composition and sound generation.

Beyond continued software development, my aims for this piece were to extend the focus on the notion of expansion of musical time in traditional gamelan music while introducing an element of “play” in the performance. I attempted a different approach to the real-time realization of the piece, in which I improvised with sound processing based around the parametric EQ and effect sends of an analog mixer. The abstract idiomatic components such as the *balungan*, leading into the more intuitively mapped synthesizer parts, served as starting points to generate raw material for these processes.

3.2.2.a Technical setup

The performance setting dictated that I could not continue with my desired method of having instrumental and electronic sounds share an acoustic space. I attempted to preserve coherence of acoustic and synthesized spaces by using contact microphones attached to the instruments and a live stereo microphone to pick up the

environmental sounds of the performance space as well as a the general acoustic setup. I maintained a rough, dirty aesthetic for the performance, allowing earth hum generated by the combination of the output transducers and piezoelectric microphones, and environmental sounds to become part of the sonic palette.

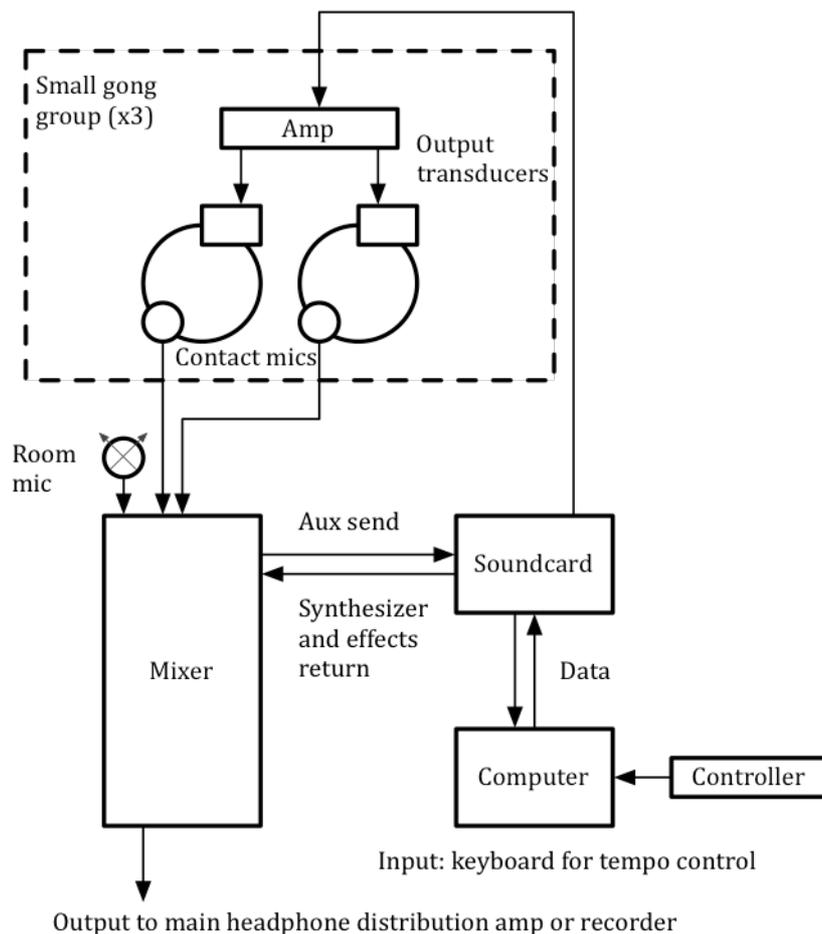


Figure 3-9: Technical layout of *Tenuous Links*.

The various computer-based parts may be broken down as follows:

- **Transducer-based parts** (returning to mixer via contact microphones):
 - A **central pulse** played through the main gongs, which emerge through the left and right speakers in the main mix.
 - A **kempyang/kethuk**-style part (only in studio version)
 - Traditional **kendhang** patterns as synthesized impulses.
 - **Sine tones** (equivalent to **generator A** in *Bonang Study*)
 - **White noise** (equivalent to **generator C** in *Bonang Study*)
- **Direct synthesis** (to the mixer via soundcard output):
 - **Kenong** parts in a traditional role.

- **Kempul** parts in a traditional role (barely audible in studio version).
- **Gong** parts in a traditional role, with slow attack.
- **Effects** (including feedback via send and receive paths)
 - **Reverb**
 - **Delay**



Figure 3-10: Mixer, transducer and gong setup for *Tenuous Links* in home studio.

3.2.2.b Balungan

As in the electronic version of the *Bonang Study*, the *balungan* in *Tenuous Links* is mapped to a part of relatively indistinct pitch: white noise played through the resonances of the set of gongs. The strongest pitched sequence becomes that played by the sine wave-based *pipilan* patterns, which to an experienced listener may give a hint at the abstract line upon which it is based. A sparse pitch sequence is also audible through the synthesized *kenong* and *kempul*.

The *balungan* as a sequence of notes forms an even more arbitrary part of the composition than before, to the extent that it was typically not saved during the recording process. Since the pitch intervals of the found objects do not match an existing tuning system, the various *garap*-oriented patterns (such as those played towards a low “5” or “6”) become artifacts that may be manipulated through placement of *seleh* without concern for compromising idiomatic integrity.

The *balungan* used in the Placard performance maintains traces of idiom from *karawitan* on a *gatra*-by-*gatra* basis, but does not comply with established *pathet* (N2.B). Other recordings use sequences based on repetition of basic upwards or downwards motion (e.g. entire *gongan* consisting of the repeated *gatra* 5 3 2 1), or figurations based on aural feedback from the computer’s interpretation.

3.2.2.c Transducers and tuning

As with the *Bonang Study*, the note information in *Tenuous Links* is mostly played through short percussive impulses, streams of white noise, and sine tones based on the resonance of the instruments. The tuning was determined by sweeping through frequencies until slight beating was encountered. Only one frequency was used per object in this case, as with the exception of the *kempyang* and *kethuk* the found set of gongs did not exhibit the same acoustic properties as the *bonang barung* previously used. The resulting set of frequencies have no deliberate connection to the *pelog* scale suggested by the *kepatihan* information in the software and notation; the *kempyang* and *kethuk*, playing the roles of notes “2” and “6” in their traditional context, take on the roles of “1” and “6” at either end of the new scale:

Table 3-4: Frequencies (Hz) used in *Tenuous Links*.

Note	Oscillator I
1 (<i>kethuk</i>)	507
2 (<i>gwaengari 2</i>)	603
3 (dinner gong)	752
5 (<i>gwaengari 1</i>)	810
6 (<i>kempyang</i>)	909

Due to the artificial acoustic situation presented by contact microphones, the timbres of these notes are not instantly identifiable as coming from the resonances of the instruments. Through close listening the stereo positioning of the tones may be determined as coinciding with the more diffuse white noise of the *balungan* that they

predict. The heavy use of reverb blends the sounds into the mix further. Occasionally the metallic nature of the sounds becomes apparent through mild distortion, contrasting with the purer tones of gong and *kempul*.

3.2.2.d Direct synthesis and effects

In the absence of traditional instruments, the *kenong* and *kempul* parts are generated using a selection of sine waves based on the tuning system established above, with added modulation from various noise sources and low frequency oscillators.

Additional frequencies for the *kenong* were established through analysis of the prominent, generally inharmonic, partials of *kenong* samples, transferred to the fundamentals of the main tuning. Played at a similar volume to the fundamentals and without consideration for appropriate enveloping, these developed into chord-like sounds rather than bonding to form a coherent spectrum. The gong part is played through two low-frequency sine waves, tuned to 50Hz and 47Hz to create a beating tone. I chose 50Hz to establish a connection with mains power frequencies of the piezoelectric contact microphones, which, while barely audible in the versions presented here, generally manifested as harmonics of this frequency³¹.

The various delay-based effects used in performance were generated through Max/MSP in a supplementary patch. This created the opportunity for various parameters of the effects (including delay time) to be modulated using information from the *balungan* and *kendhang* sequences. Ultimately these connections played a minor role in the performance, overwhelmed by manual manipulation of a feedback loop through the auxiliary send paths of the analog mixer.

3.2.3 Discussion and analysis

Although *Tenuous Links* based on the same initial framework as the *Bonang Study*, there is greater focus on a concrete level: in this case, the mapping and manipulation of texture and space without necessarily attempting to create or work within a distinct syntax. While this fluid improvisation – based on the affordances of the mixer, effects, and sound objects themselves – might not transmit musical values in Schaefferian terms, it is nonetheless essential to the work.

³¹ This practice follows on from my previous electroacoustic experiments outside gamelan. The tuning of instruments to mains electricity frequencies has previously been used in the Berkeley Gamelan created by Daniel Schmidt (Ayers, 1996 p. 8).

The various other aspects of the piece may be broken down as follows:

- The ***balungan***, while still playing a vital role in the piece, is variable between performances; it becomes a concrete characteristic of the piece rather than holding any specific abstract value.
- The synthesizer ***garap*** maintains roughly the same weighting, remaining fairly constant between performances, albeit now isolated from the traditional *garap* of the physical *bonang*.
- The **conceptual level** remains a key consideration in the composition; the mapping of the traditional form and the exaggeration of expansion of musical time form vital aspects of the piece.
- The **arrangement**, (what might still be referred to as a virtual **ensemble *garap***) becomes relatively stable, as the structure of the piece is largely determined by the overarching concept. The introduction of different parameter mappings does not greatly affect the integrity of the piece, and various synthesizer parts were modified between performances.

3.2.3.a Syntax and discourse

Figure 3-11 shows an assessment of syntax and discourse in three parts, as the dominant discourse moves from the initial textural movement of the descending pulse (1), to the introduction of the pitched sounds and rhythmic markers (2), and the mixture of *kendhangan* and sonic manipulation in *irama III* (3).

The syntax is predominantly imposed (abstract) throughout. Although the basic vocabulary – the collection of tuning and timbres – is determined by the resonances of the collection of found objects and the affordances of the technology, the pitch and rhythmic structures are essentially based on idiomatic processes from Javanese gamelan. The various elements are united by the aim of moving from a pitched frequency to a low-frequency rhythmic pulse, eventually reaching a structural scale. Once the piece has reached *irama III*, there is greater movement based on the direct relationships between sounds, but this does not significantly affect the imposed traditional structure³².

³² There is a further practical link between the musical structure and the shift in discourse: more room for textural manipulation slower *irama* appears as the

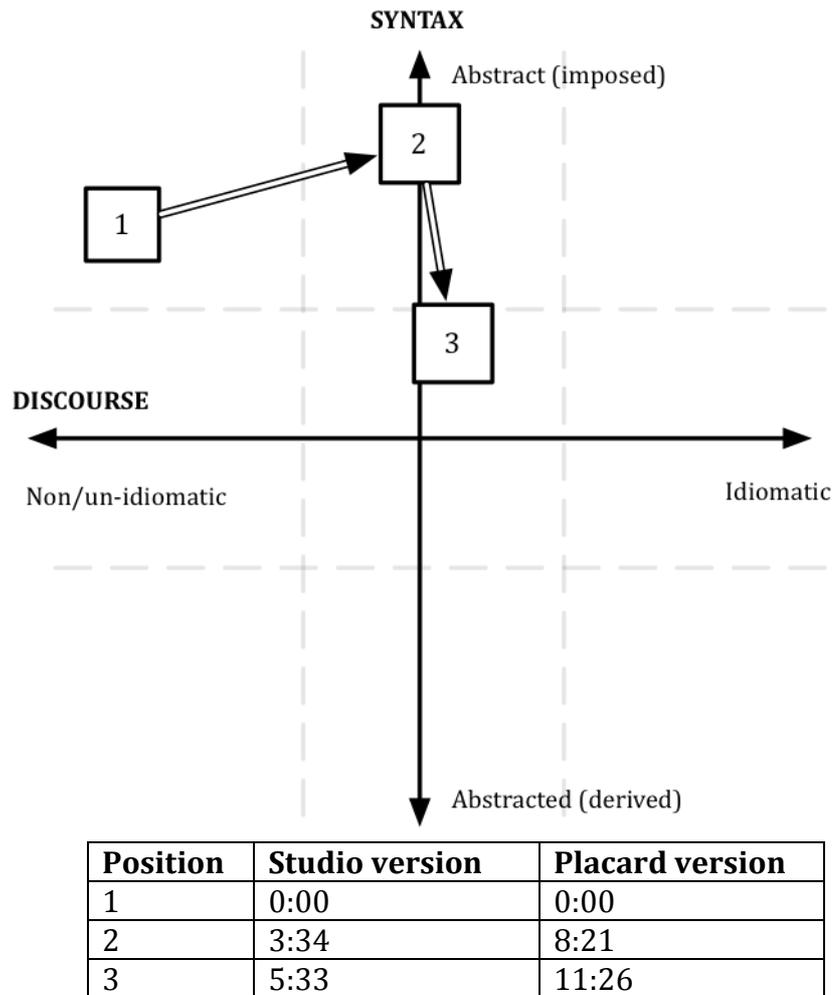


Figure 3-11: Overall movement of syntax and discourse in *Tenuous Links*

3.2.3.b Idiomatic reference

The following table shows a breakdown of the idiomatic references and conceptual mappings involved in the development of the piece:

Table 3-5: Idiomatic reference table for *Tenuous Links*.

Instrumental idiom			
Source	Application	Interpretation	Modification
<i>Bonang barung</i> : <i>pipilan</i> playing techniques.	Synthesized <i>bonang barung</i> part (generator A).	Equivalent events on a note-by-note basis (from <i>Bonang Study</i>).	As in previous piece.
<i>Slenthem/saron</i> family: <i>mbalung</i> technique.	Synthesized <i>slenthem</i> part.	Equivalent events on a note-by-note basis.	Primarily textural/unpitched part.

keyboard input on the computer requires less attention. This may be observed to a limited extent in the video of the studio version. Due to the use of a single cycle of *irama wiled* there is limited time for experimentation before the transition to *suwuk* requires a return to the keyboard (AV1.2.A).

<i>Kendhang kalih.</i>	Synthesized part played through transducers.	Rhythm mapped to note events of roughly equivalent pitch to traditional <i>kendhang</i> part.	Timbral modification throughout the piece through modulation of synthesis parameters and effects.
<i>Kempyang / kethuk or engkuk / kemong.</i>	Synthesized part played through transducers.	Rhythm mapped to equivalent note events.	Strokes occur during <i>merong</i> section.
<i>Gong, kenong and kempul</i>	Synthesized part played directly into mixer	Pitches based on note information, timbre and texture loosely modeled on traditional instruments.	Extension of envelopes.

Structuring and general phrasal idiom			
Source	Application	Interpretation	Modification
<i>Balungan</i>	Abstract melodic line for part generation.	<i>Slenthem</i> part.	Played as un-pitched part.
Expansion of structure and note relations through <i>irama</i>	Synthesized <i>bonang barung</i> part (generator A)	Conventional <i>irama</i> relationship and use of extended / anticipated tones.	Inconsistent density ratio. Occasional extension of envelopes rather than increased note event density.
	Influence on overall structure of piece.	Arrangement of virtual ensemble parts.	Pulse moves from the pitch domain to conventional <i>irama</i> throughout the course of the piece.
<i>Ketawang gendhing / ladrang</i> structure	<i>Balungan</i> structure and punctuating instruments.	Influence on construction of <i>balungan</i> and mapping to synthesized punctuating instruments.	<i>Kempyang/kethuk</i> – type part appears during <i>merong</i> section.
<i>Laras</i> (general)	Tuning of oscillators	Frequencies derived from strong partials in concrete sounds.	Tuning based on found objects.
<i>Pathet nem</i>	Pathet-specific patterns, e.g. low 5 and low 1 patterns.	Influence on construction of <i>balungan</i> , particularly use of <i>tumurun</i> .	Arbitrary patterns also based on aural feedback from tuning described above.

3.2.3.c Cues to indicate discourse

Visually, the performance set up does not bring the same expectations of traditional gamelan performance as *Bonang Study*. The visual cues presented in the performance, particularly the approach to the mixing desk, evoke an experimental “live electronics” setup. For some listeners this may serve to indicate that the intended discourse is based around exploration of texture and more direct sound relations (e.g. feedback, beating tones).

The auditory cues for discourse in *Tenuous Links* are an inversion of those found in the *Bonang Study*: the listener is guided into textural listening first, as elements from *karawitan* gradually drift in, as may be seen in **Figure 3-12**.

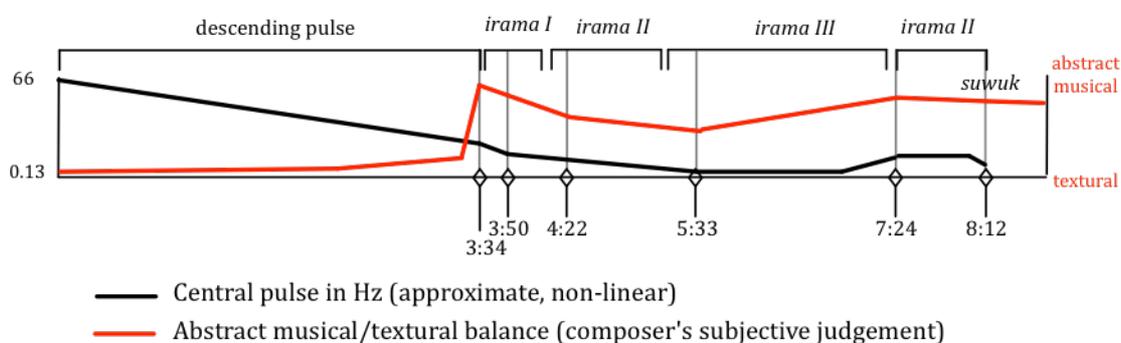


Figure 3-12: *Irama* and musical discourse in *Tenuous Links* (studio version)

The initial sustained metallic pulse may serve to confirm the audience’s expectations that this is a primarily textural piece. This part was developed consciously to avoid perception of the piece a pastiche gamelan work, to frame it as predominantly textural, and to establish a theme of a pulse expanding in time.

Later the appearances of sine tones and the additional *kempyang* and *kethuk* pulse – more recognizably “note events” – provide a cue for a more idiomatic, note-oriented discourse. The repetition of the gong tone, perhaps the next strongest idiomatic element, helps establish the weighting of the rhythmic cycle. If listeners are familiar with the idioms of gamelan then they may pick up the gong cycle and attempt to follow the *garapan* of the various parts. The identification of a *kendhang* sequence confirms that a traditional structure is at play here; this part may be used as a reference point to explore relations to the structure of the piece. However, the *garap* is vague enough that listeners may find themselves drifting back and forth between the two modes of listening.

3.3 *Monggangan* (2012, AV3)

Monggangan is a piece for a full *gamelan Monggang*, *penggerong* [male chorus], and electronics. It was developed in Solo in 2012 through consultation with composer Joko Purwanto, and remains a work in progress. The recording of documentation for the version of the piece presented here took place in the television studio at ISI Surakarta in March 2012.



Figure 3-13: Video still from *Monggangan* recording and development session.

Two recorded versions of the piece are discussed here:

- The **ensemble version (AV1.3.A)** features the full gamelan and vocals, as recorded in the last development session, captured through a stereo pair of room microphones with minimal post-production. The electronic parts are boosted through a direct multi-track signal recorded through the computer.
- The **electronic version (AV1.3.B)** is derived from the same multi-track recording. The electronic parts are presented in isolation, without further manipulation beyond level balancing. Although it could potentially serve as a “tape” part for a performance of the piece, this version is intended to be heard separately, as a kind of *gadhon*-style rendition.

3.3.1 Description

Monggangan features three main elements:

- A **gamelan Monggang**, (*bonang*, *kenong*, *gongs*, *kendhang*, and *kecer*).
- **Penggerong** (chorus), a role shared in this instance by the instrumentalists.
- A set of **electronic** parts played through speakers placed amid the ensemble.



Figure 3-14: The *gamelan Monggang* in the *pendopo* at ISI Surakarta.

A *gamelan Monggang* is typically used to play a single piece (*gendhing Monggang*) based on a cycle of three tones: in this case, notes “1”, “6”, and “5” in *pelog* (see Hastanto, 1976; Supanggih, 2011 pp. 30-33). As in the wider practice of loud-style pieces, the *irama* of the piece typically either stays in a fast *irama* or moves from *irama seseg* (which I will refer to as *irama I*) to *irama tamban* ([lit. slow], II). This slower version, in which the *kendhang* is the only instrument to change density, is played for several cycles. A set of cymbals called *kecer* join in to reinforce the underlying pulse. This section might last for a considerable amount of time depending on the performance context, before returning to the faster *irama* to reach a *suwuk*.

The arrangement presented here uses a less common version referred to as *Monggang Patalon* ([opening]; Martopangrawit, 1972c pp. 98-102), which is sometimes played in the Mangkunegaran palace. Here, after the conventional transitions, the *irama* is slowed further, to a pace resembling *irama wiled*. As in *irama II*, the only instrument to change density is the *kendhang*, leaving a sparse framework

played by the other elements. The piece typically returns to *irama* level I with a smooth transition guided by the *kendhang* in order to finish. In this case the move to *seseg* happens suddenly, triggered by two loud strokes of the *kendhang* to signal the new pulse³³.

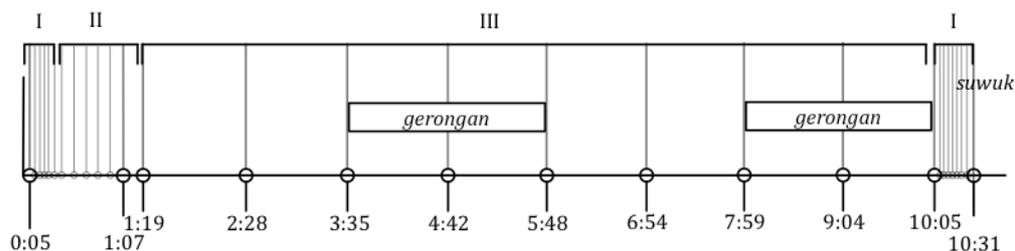


Figure 3-15: Timeline of *Monggangan*.

Due to their shared origin the electronic and ensemble versions retain roughly the same timing; the electronic version continues after the final implicit gong stroke with a reverberant tail that had been cut off during the studio recording.

3.3.1.a Instrumental version

The piece opens as if in a traditional performance of *gendhing Monggang*: following several sharp taps to the side of the drum from the *kendhang* player and two introductory beats, the gamelan bursts into life in a dense, short, ostinato. A soft electronic drone develops underneath the *kenong*, reinforcing the repeated *seleh* 5, and growing while the *irama* slows down and space gathers. As the piece reaches *irama* level III, the drone expands to anticipate the notes of the *Monggang* pulse, forming a stratified layer of *pipilan* as a *bonang panerus* does to the *bonang barung* (see **Part I: §3.3.2.b**).

Several cycles into *irama* III, the electronic parts expand into an iterative wooden texture, leading into the gong. A high note signals the emergence of a *gerong* part, singing to a familiar text from the *Kinanthi macapat* metre. The notes of the electronic parts shift to accompany the vocals, providing guiding tones amongst washes of reverb. Through the progression of the vocal part, various timbral modulations take place; the more the vocals deviate from the notes of the central cycle, the more the texture moves away from the original metallic timbre to something resembling tremolos played on a *gambang* or similar wooden instrument.

³³ This signal is more commonly used in *Kodhok Ngorek*, a *gamelan pakurmatan* with a similar function (Martopangrawit, 1972c p. 103).

Upon reaching the end of the *gerong*, the electronic parts settle back into the metallic texture of the *Monggang*. The cycle starts again, as subtle manipulation occurs in the background; what had started as a smooth extension of the tones from the gamelan becomes a grating texture. Reaching the end of the second verse of the *Kinanthi* text, the *kendhang* subtly speeds the ensemble up before returning to *irama seseg* to finish.

3.3.1.b Electronic version

The electronic version is markedly different, benefitting from the space formed by the absence of the gamelan. Reverberation plays a prominent role. The initial *kenong* notes resemble distant bells, gradually slowing and expanding, exposing fluctuating textures and wavering beating tones. Upper mid-range resonances come to the foreground. As the texture expands, the electronic parts play a less rhythmic role. Without the guiding tones from the *Monggang* itself, the *mipil* patterns seem to come from nowhere, a soft, undulating line that only occasionally hint at the original context. As the piece progresses without the pulse of the gamelan, the rhythms become tentative, slowing down into nothing before a clattering note lands on the *seleh*. The piece returns to *irama seseg* without warning. It takes a moment for the pulse to be recognizable as the same faster cycle from the start of the piece. The sound of the *kenong* gradually dissolves into a long resonant reverb.

3.3.2 Development process and technical notes

The conceptualization of this piece took place over the course of several development sessions with Joko Purwanto. Development began with an arrangement of the piece *ladrang Srikaton* in *irama II* for solo gender and electronics, which provided the foundation for the electronic *cengkok* and *maju/mundur* scrubbing techniques (§2.2.2). *Monggangan* was a progression from this, borrowing electronic techniques and also elements of the instrumental *garap*. Versions of both pieces were recorded in the final session³⁴.

In the development of *Monggangan* I was interested in using a set of instruments that I would not have access to in the UK. My goal was to create

³⁴ Recordings of *Srikaton* with Joko Purwanto and from the main session are available in the in the digital portfolio (AV2.5). *Srikaton* also formed the basis of a demonstration performance, with *gender* played by Charlotte Pugh in a concert and paper presentation at the Gathering of the Gamelans symposium later in 2012.

something bold and loud in contrast to the subtle textures of the previous *Bonang Study* – a setup in which the electronic elements could stand out in a spacious and reverberant performance environment such as a pendopo – and to incorporate vocal parts³⁵. I had developed an interest in using the *gamelan pakurmatan* [ceremonial gamelan], inspired by various experiences at the time including the weekly rehearsals at the Mangkunegaran that I attended, and occasionally joined alongside other students³⁶. There was a certain appeal to the combination of modern electroacoustic processes with a type of gamelan reputed to be the oldest in existence. The arrangement was also a logical progression from my previous arrangements of *Ketawang Subakastawa* upon (see §3.4.3.b).

The aesthetics of the piece were influenced by the experience of hearing the gamelan *pakurmatan* from various positions as the same cycle repeated for significant periods of time: of the billowing reverb of the instrumental texture as it bounced off the ceiling of the pendopo, particularly in the slower moments. Here the sounds appeared to take on a life of their own, dancing and intertwining in the air before coming back to earth at the next stroke. I was also influenced by experience playing the *kecer* in the gamelan *Monggang*, and the *rojeh* in the *Kodhok Ngorek* at the Mangkunegaran (in both cases sets of large cymbals hit with a mallet). The sound of these instruments was so loud at close proximity that it became a powerful experience in which I seemed to be temporarily deafened upon every beat, followed by a swirling sensation a second later as the aural world shifted back into focus.

The combination of vocals with *gamelan pakurmatan* was inspired by Stanley Hoffman's article on epistemology in Java, in which he treats the *Monggang* as an archetypal example of the colotomic structure over which linear vocal parts are layered in contemporary practice (1978). In contrast to Hoffman's example, the use of *macapat Kinanthi* in this arrangement remains in phase with the underlying

³⁵ My work during this period was influenced by the varied soundscape of Solo, attendance of traditional rehearsals, and starting to learn *rebab*. I also discussed the possibility of working with *Planet Harmonics* and *Gamelan Genta* created by Aloysius Suwardi. It was not possible to follow through on this project due to technical difficulties. However, the initial sketches proved pivotal as I found myself working with non-real-time processes to be integrated into live performance, and exploring the affordances of the instruments through non-idiomatic improvisation (AV2.4).

³⁶ My first experience of *Monggang Patalon* was at one of these rehearsals. The instruments at the Mangkunegaran can be heard on *Gamelan of Central Java II* (2002); the sleeve notes also provide further context for the piece.

structure. The combination of vocals with similar ceremonial instruments or patterns derived from them has been explored in various existing combinations, including Aloysius Suwardi's *Nunggak Semi* (2008), an arrangement of *Kodok Ngorek* by various musicians from ISI (2007 track 1), and a similar arrangement involving material from the related *gamelan Carabalen* by John Pawson for the Southbank gamelan players (as played in a suite preceding *Rubber Time*, 2011). In particular Danis Sugiyanto's *Arus Monggang* (2010) demonstrates how much variety can be created from the omission of tones in the traditional sequence (*Mahabara*, 2013).

3.3.2.a Technical setup

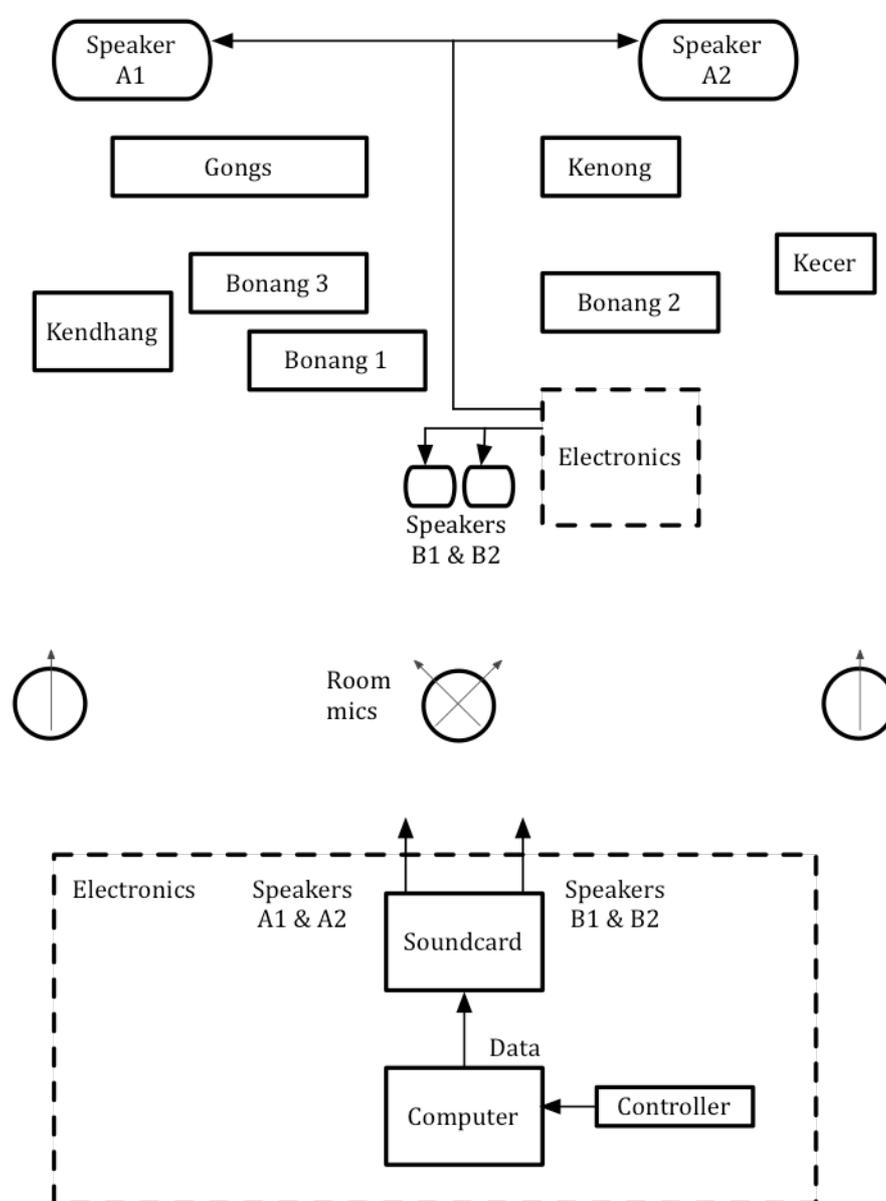


Figure 3-16: Technical and instrumental setup for *Monggang*.

Figure 3-16 shows the technical setup as used in the recording session at ISI.

I had opted not to use transducers as in previous pieces due to concerns around their stability and setup time. Instead I used a set of large PA speakers placed within the gamelan (A1 & A2) and a smaller set of computer-type speakers at the front (B1 & B2), with the intention of blending the sounds in the same acoustic space.

3.3.2.b Vocal parts

The vocal part used here is based on the *gerongan* from *ladrang Srikaton* in *irama wiled*, which uses the *Kinanthi macapat* metre. The part is transposed from the original *laras slendro pathet manyura* to *pelog nem* in order to match the fixed *seleh* “5” of the gamelan. The choice of *macapat* was determined by practical considerations. I was interested in overlaying a vocal part entirely out of phase with the *Monggang* cycle, but felt that establishing a metric relationship between the two parts at first might form a more accessible part for the development process. The use of a *gerongan* from an established *ladrang* also enabled the immediate use of a chorus that could cut through the dense sound of the instruments and electronics combined³⁷.

Srikaton has an established relationship with the gamelan *Monggang*, essentially using the same pattern throughout (2 1 2 6)³⁸ but diverging in the *ngelik* to accompany the vocals. The line from *irama wiled* (level III) provided a rhythmic connection between the pre-existing pulse of the *balungan nibani* and the rhythm of the *Patalon* version of the ceremonial piece. I made the initial transposition from *slendro manyura*, which Joko Purwanto subsequently reworked in order to fit *pathet nem*.

3.3.2.c Balungan

Several parts may be assigned the role of *balungan* in this work. The most audible of these is the *Monggang* cycle, a concrete line that underpins the piece, and is essentially reduced to the function of a colotomic structure. The *balungan* borrowed from *Srikaton* is not ever played directly in the sense that a *saron* line is. Rather, it is an abstract part to form a bridge between the instrumental parts, the vocals, and the

³⁷ I also considered a *palaran*-type structure, which given more development time may provide more scope for interaction with the instrumental parts through established conventions.

³⁸ *Gendhing Monggang* may use the same pitch sequence transposed to various sets of notes, in either *slendro* or *pelog* (Supanggah, 2011 p. 33).

parts generated by the computer. A further sequence, based on the divergence of the vocal parts from the central *Monggang* cycle, provides a kind of textural *balungan*. It is the combination of these elements, working on increasing levels of abstraction, which forms the basis for the electronic parts.

3.3.2.d Electronic cengkok

The electronic *cengkok* selected for use in this piece are deliberately minimal: each *gatra*, effectively *balungan nibani*, is treated with a single *mipil* pattern as follows:

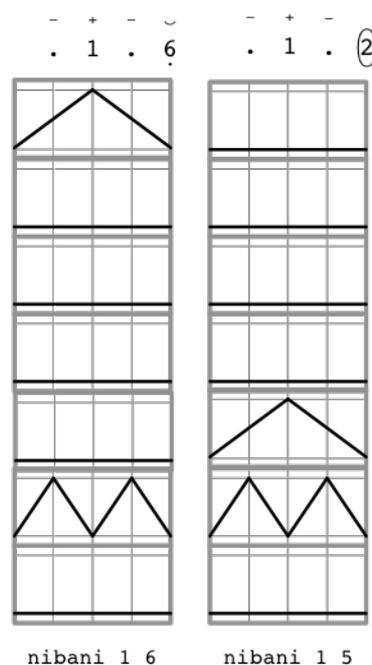


Figure 3-17: Example of sparse *nibani*-style *cengkok* in *Monggangan*.

The *cengkok* used are notated in full in **N3.A**. These longer patterns emphasize the sense of space created in the unusual *irama* level III while anticipating the notes of the un-played *balungan*. Although they provide a certain degree of melodic movement, it is my intention that they remain simple enough to allow the listener's attention to drift towards the textural aspects of the part.

My initial methods were based on the manner in which I had accompanied the loosely timed *macapat* with vocalist Cathy Eastburn prior to coming to Solo (see **§3.4.3.a**). In these sessions I attempted to follow every note of the vocals by manipulating the channels in a reasonably subtle manner. The resulting patterns were subsequently sequenced by hand and scrubbed with a slider, as illustrated in **Figure 3-18**, a screenshot from the software used in the first recording session.

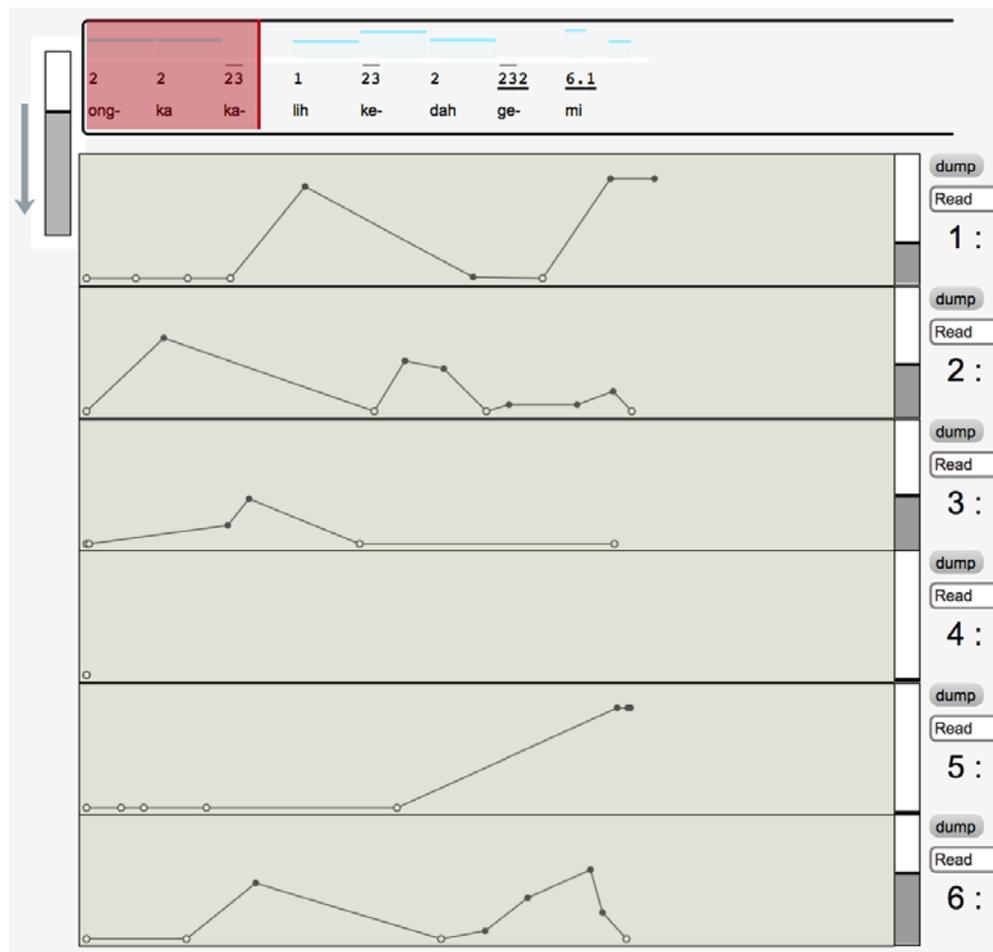


Figure 3-18: Initial approach to accompaniment of *macapat* vocals.

The unsuitability of this approach when accompanied by the full gamelan became apparent in the first development sessions. The changes either became lost in the texture of the instruments, or stood out as arrhythmic and jarring; it was difficult to find a middle ground. A metric framework fitting directly into the structure of the *gendhing*, provided by the pre-existing *balungan* from *Srikaton*, partially solved this problem. More subtle references to vocal contours are retained in the crossfade part.

The process of *cengkok* selection in this work was established through manual editing of the JSON-based dictionaries, creating a pre-determined sequence. This enabled creation of a stable proof of concept for the purposes of recording, which was later replaced with dynamic part generation in *Mipilan* (see §2.3.2).

3.3.2.e Crossfading

The crossfading of instrumental timbres via granular synthesis provides an additional layer to the “abstract musical” (scale-oriented) interpretation of the vocal parts and *balungan*. Through this piece I wanted to explore a distinct movement between

timbres with direct influence from the central melodic framework without resorting to a one-to-one mapping of note information (e.g. *klangfarbenmelodie*; see **Part I: §3**). I decided that this might be best achieved by assigning a mediating parameter to movement between two instrumental timbres, the movement within which could be determined by analysis of the vocal part, or use the *balungan* as a simplified guide.

My initial ambition was to apply analysis on the basis of *pathet* and *padhang/ulihan* structuring. As this typically influences the choice of *kempyung* or *gembyang* strokes for *seleh* played on the *gender*, one potential solution was to create the crossfade information based on this binary relationship. The use of convergence and divergence of the notes of the vocal part from the *Monggang* pattern was settled upon as a parameter that could be determined more reliably, and one that would not necessarily rely on the source material being idiomatic. In this case the information was determined through my own subjective judgement, and is based on the *seleh* and half-*seleh* notes of the vocals as they relate to the notes of the gamelan. This includes the sustained notes of previous *gatra*, as demonstrated in **Figure 3-19**.

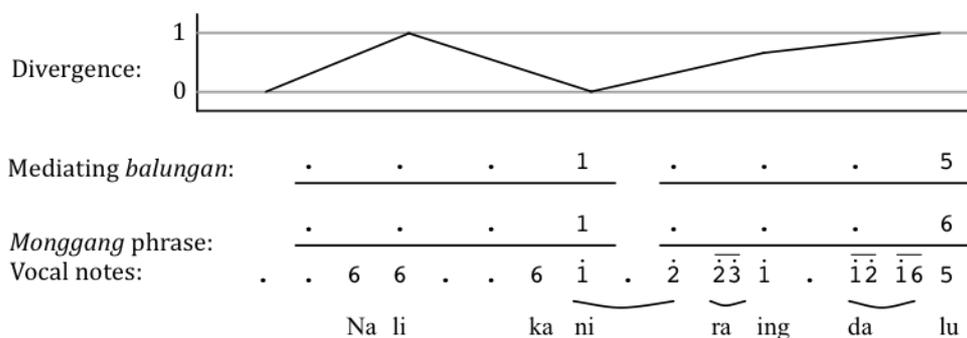


Figure 3-19: Example of abstracted divergence ramps in *Monggangan*.

The movement between the points is a linear interpolation, although the articulation and general feel of the part can be modified in the course of performance through the timing of the scrubbing controller and further modifications in the mapping process.

3.3.2.f Synthesized parts

The sounds generated by the computer are organized into two categories: **granular synthesis** (anticipating the *balungan*) and **pre-prepared sounds** (played on the *seleh* notes). The source material for the sounds comes from a pre-existing set of samples of a full conventional gamelan (*A Javanese Gamelan sound library*, 2008), that was retuned to the *embat* of the *gamelan Monggang*. Each synthesis channel was also

- **Density** – the playback rate of the grain stream, used for leading into gongs and sound files that would carry the movement across into their own more complex textural domain.

Pre-prepared samples (speakers B1 + B2)

The pre-prepared samples were created from the same source sounds as the granular parts. Variations were developed based on aural feedback, through a combination of the main granular synthesis engine and non-real-time editing and processing. These sounds were placed at the front of the gamelan in order to provide some separation from the rest of the ensemble.

The more practical purpose of these sounds was to provide a confirmation of the timbral movement generated by the cross-fader, which would then adopt their own life, gradually receding into the instrumental texture. This activity also provided an opportunity for expression within the different mode of non-real-time sound manipulation. Amongst a play based on aural feedback my intuitive response to the relationships between the sounds and the affordances of tools I was using, I chose to mimic some of the sounds that had originally inspired the piece: the movement of sounds in the acoustic space of the pendopo. This is most audible in the electronic version (e.g. **AV1.3.B**, 6:15).

3.3.2.g Timing and sample triggers

The *kendhang* player determines the irama of the ensemble, which the computer operator follows in turn. The movement through the *cengkok* is determined by a clock using the *maju/mundur* input method via a MIDI controller (see §1.4.2). The pre-recorded samples are cued through a combination of events triggered by the outer limits of the control slider, and dedicated buttons. Samples coinciding with the *kenong* notes are triggered through three paths: a general button for triggering of files selected according to the current *gatra*, and dedicated buttons for the kenong notes “5” and “6” (see below).

My original intention was for the computer operator to start using the *maju/mundur* method in *irama lancar*, retaining the same relationship to the central pulse throughout and causing interpolation between events at a micro-time level. In this manner the click of the fader hitting the extreme ends of its lane could provide tactile feedback to the computer operator. This approach was abandoned due to

frequent computer crashes during the initial recording session, and led to the development of the samples to be played on *seleh* notes that would follow through into *irama* level III³⁹.

3.3.3 Discussion and Analysis

Monggangan represents a return to a more note-oriented approach to composition, with concrete sound manipulation creating a layer in what is essentially an idiomatic piece. The distribution of compositional parameters may be broken down as follows:

- The majority of the compositional process, in terms of creation of a new work, takes place on a **conceptual level**: in the mapping of idiomatic material and the modification of playing techniques. The electronic parts are divided into two main groups – those that anticipate the virtual *balungan*, and those that play on the *seleh* notes, the latter of which extend in time arbitrarily according to their individual structures.
- The various forms of *balungan*, most of which are never played directly, take a more prominent role than in previous pieces. However, it is the selection of these pre-existing sequences and the vocal patterns from which they are derived rather than the creation of new material that forms the compositional activity in this area.
- Similarly, the **instrumental *garap*** is derived from pre-existing patterns; beyond the choice of the slower *irama* wiled parts, the gamelan *Monggang* is played as it would be in a traditional context. The use of vocal *garap* and the choice of text is unusual, but not necessarily original.
- The **concrete sounds** are likely to play a secondary role to the idiomatic material, providing colour to the abstract values it provides. A more texturally-oriented discourse may be perceived when the sounds are heard independently in the electronic version.
- The **arrangement** is fixed, in part determined by the overarching process, but may be developed to accommodate structural and dynamic changes without significant compromise to the concept, or form part of a wider work.

³⁹ The manipulation of the envelopes at this faster pace was subsequently used in the pre-recorded grain part in *Monggang Alit* in the *Augmented Gamelan* set (see **AV2.6.A**, 9:00 onwards).

This piece represents a combination of the approaches from the first stage of development in the wider research, in which a rigid idiomatic framework provides the basis for expression of textural parameters. With the addition of direct control over the position of the sequence, the electronic parts move closer to a hybrid instrument than an autonomous computer part. The version played in the development session does not leave much room for expression by the live musicians beyond inflections in vocals and rhythmic leadership from the *kendhang*. However, the current arrangement may accommodate more expressive *garap* without compromising the central concept.

3.3.3.a Feedback from musicians

I asked the musicians to comment on the experience during the final development session⁴⁰. I attempted not to lead the discussion beyond questioning whether the players felt their performance was affected – helped or “disturbed” (*dirusak*) – by the inclusion of the electronics. Those involved generally agreed that the piece was an interesting experiment, and one that would benefit from further development. The comments presented here have been chosen to highlight suggested improvements.

The musicians were mostly undisturbed by the electronic parts, instead focusing on the instrumental arrangement. The instrumental parts had been discussed beforehand, and so were unproblematic. Most of the musicians commented that the act of playing the gamelan at the same time as singing made the parts less comfortable, and that the addition of a dedicated chorus with some distance from the ensemble may yield better results (Rusdiyantoro).

The role of the electronic parts was sometimes unclear, but they were generally regarded as instrumental-type textures. One musician, having heard my previous work involving *macapat* (see §3.4.3), compared the style of accompaniment of the vocals to a *pathetan*, with the electronic sounds providing additional colours (“*memberikan warna di sekitarnya*” – Prasadiyanto). However, as another suggested, the *gerong* part often “seemed to go alone” in the arrangement (“*gerongannya itu kaya nggak ada temannya*”); despite the presence of similar pitches in the electronic parts, the filling did not function as a melody and sometimes was not in harmony with

⁴⁰ Joko Purwanto facilitated the discussion, which took place in a combination of Bahasa Indonesia and Bahasa Jawa; the summary of comments here was made possible through transcription and translation by Lukman Aris.

the vocals (Supardi). It was suggested the inclusion of other gamelan instruments such as *saron* or *gender* might help integrate the parts.

Many found that despite the inclusion of pitches in the electronic parts the gamelan *Monggang* maintained its melodic role, creating conflicts in the *seleh* notes of either part. The coincidence of notes “6” in the gamelan and “5” in the *gerongan* proved distracting for most musicians (see **N.3.B**); pitches falling outside the set “1”, “6”, and “5”, or forming *kempyung* could be accepted. Some commented that this overlapping of pitches was a distinctive quality of *karawitan*, suggesting that the *Monggang* cycle could be used as a background for other folk and popular music without any problems.

Some musicians noted that the piece was uncomfortable to play at times due to the unusual temporal expansion of the gong structure in addition to keeping track of vocal parts; the addition of the *kecer* part helped. However, most concurred that the space created in the instrumental parts was vital for the electronics.

It was generally agreed that the piece, while unusual, was not necessarily new in terms of the *rasa* or the *garapan*, and that similar compositions had been performed before with other instruments (see **§3.3.2**). The arrangement was generally regarded as static or monotonous. Suggestions arose that more dynamics could be added through loudness and tempo, which could be performed through the instruments or the electronic parts (Rusdiyantoro; I Ketut Saba). However, as one musician commented, “if the piece demands stability, it’s no problem” (“*kalau tuntutan karyanya yang stabil, rata . . . tidak ada masalah*” – Rusdiyantoro)⁴¹. One player noted that the choice of instrumentation and exclusively male vocals came across as unbalanced and predominantly masculine in the context of Javanese music, and might benefit from the addition of *sindhenan* (Sri Joko Raharjo).

A similar discussion took place after playing through an arrangement of the traditional piece *Srikaton*, which alternated between traditional *gender*-based *garapan* in *irama II* and a “*sirep*” section featuring sine wave-based *cengkok* tuned by ear and played on faders (see **N3.E**)⁴². The responses to the electronic parts were

⁴¹ This matched feedback from listeners in the UK. While I had intended to create a feeling of stillness and expansion, expectations created by the inclusion of musicians and the possibilities of the instruments changed my perception of the piece and was significant in helping me move towards more dynamic work.

⁴² An excerpt can be heard in **AV2.5**; the arrangement and electronic setup was later used as the basis for *Pangkur Paripurna* in the *Augmented Gamelan* set, with granular

similar to those in *Monggangan*. The timbre of the electronic parts – in particular the synthesized gong – was generally well received. However, the tuning of the sine tones was regarded as not quite fitting that of the gamelan, at times abrasive (“*nadanya nggak pleng*” – Purwanto). Some of the singers commented that they were unsure of whether to follow the tuning of the electronics or the gamelan parts, especially in the *sirep* section where, without the *gender*, the range of the octaves appeared to be getting wider (Rusdiyantoro).

The electronic parts did not particularly help or disturb the musicians in performance, as they were already familiar with the piece in its traditional context. To some musicians the electronic parts were perceived as leading or overtaking the *balungan* (“*mendahalui*”), but not anticipating them in the sense of traditional *cengkok*; instead some notes appeared to arrive too early (Purwanto; Prasadiyanto). Nonetheless, the *slenthem* player commented that they might at least help him find his place if he became distracted (“*membantu paling tidak kalau saya mengantuk . . . ‘oh ya*” – Prasadiyanto).

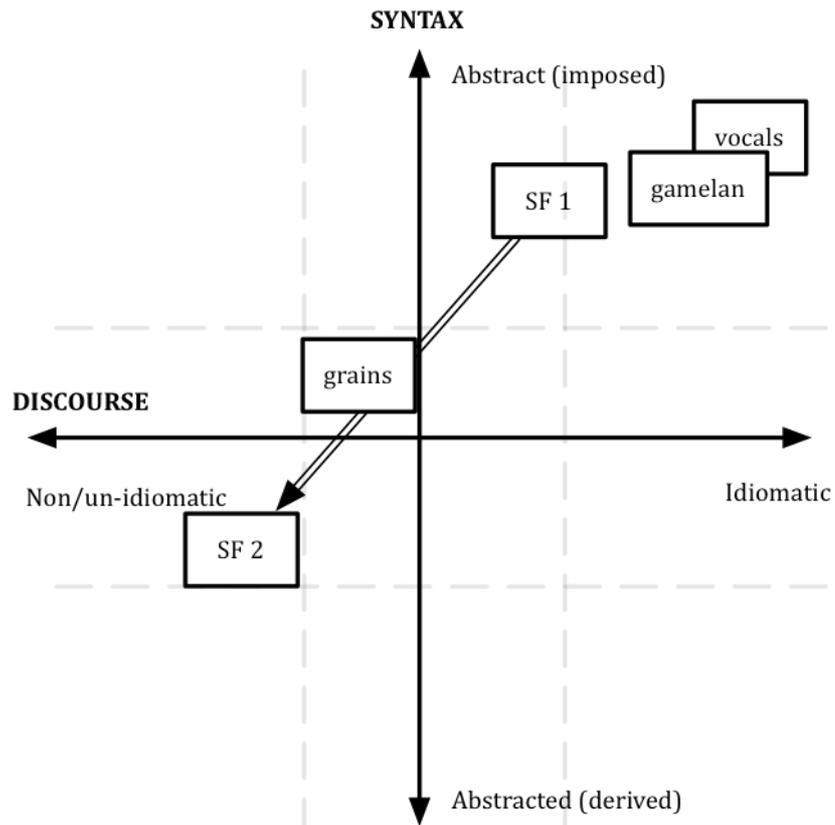
Due to constraints on my time spent in Solo it was not possible to develop the arrangements further with response to this feedback. However the comments were vital in the development of the subsequent *Augmented Gamelan* set, particularly in terms of integration dynamics, tuning, and establishing roles for the electronics. It is my hope that these arrangements will be revisited in the future with a more collaborative approach.

3.3.3.b Syntax and discourse

The audience’s perceived discourse is likely to vary depending on the version of the piece. **Figure 3-21** shows the various elements of the ensemble version (**AV1.3.A**).

The vocals inhabit the upper-right hand corner of the grid, as they are based on traditional material and therefore may be regarded as *imposed (abstract)* and idiomatic. The same applies to the rest of the gamelan ensemble.

synthesis taking the place of the sine waves. Apart from Joko Purwanto the musicians were unfamiliar with the arrangement, and it was played without rehearsal.



Element	Timing (AV1.3.A)
gamelan	Throughout
vocals	3:35-5:48, 7:59-10:05
SF1	1:05-, 1:19, 10:05-end
SF2	1:19-10:05
grains	1:19-10:05

Figure 3-21: Syntax and idiomatic reference in *Monggangan*.

The electronic parts are divided here into grains (real-time synthesis) and sound files (pre-prepared samples). The sound files initially play a part closely related to the rest of the gamelan and employing a recognizably instrumental timbre; they may be considered fairly idiomatic and as taking on the abstract syntax of the larger structure of the piece. Upon moving to *irama III* the part becomes less perceivably idiomatic as heavily processed samples are brought in. Although the organization of these sounds is still based on the central abstract structure, the internal movement of the sounds becomes increasingly complex, and was developed in a close aural feedback situation away from the gamelan. Therefore the part may be considered to use a combination of *imposed (abstract)* and *derived (abstracted)* syntax.

The grains, which only come in to play during *irama III*, employ a combination of abstract and abstracted syntax. The part is based on an abstract melodic

framework, including both the balungan adopted from *Srikaton* and the timbral crossfade triggered by melodic divergence, but developed with aural feedback and influenced by the affordances of the granular synthesizer. Beyond the movement between smooth and iterative sounds described above, the part remains stable.

In the electronic version (AV1.3.B), the discourse is more clearly based on the texture and spatialization of the sounds, and movement between reference to the real world and more clearly electronic processes. The electronic elements gradually move from smooth to iterative sound objects, illuminating their inner life and breaking into streams of instrumental note events (see **Figure 3-22**).

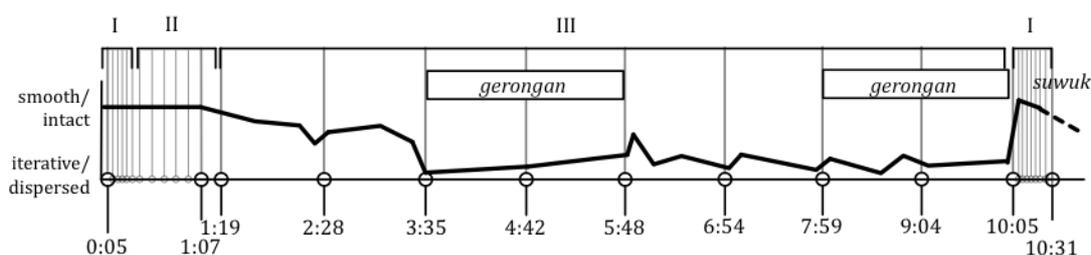


Figure 3-22: Generalized movement between intact instrumental sounds and iterative textures in *Monggangan*.

This movement was not intended as integral to the concept of the piece, but evolved gradually through a feedback relationship with the materials in the non-real-time parts. Variations of the movements between textural and instrumental sounds or the breaking up of timbre may be established through further development of the arrangement.

3.3.3.c Idiomatic reference

The following table shows a breakdown of the idiomatic references and conceptual mappings involved in the development of the piece:

Table 3-6: Idiomatic reference table for *Monggangan*.

Instrumental idiom (including instrument-specific phrasal idioms)			
Source	Application	Interpretation	Modification
<i>Gamelan Monggang</i> (ensemble)	Ensemble parts	Instrumental roles maintained.	Combination and juxtaposition with other elements.
	Synthesized parts	Conceptual mapping in selection of samples and creation of	Sample from other unrelated ensembles used, creating a distinct difference in timbre.

		appropriate instrumental parts.	Divergence in pitches based on vocal part.
<i>Gender cengkok</i>	Envelope parts for synthesizer	Selection of generalized envelopes based on subjective perception of strong parts in combination with <i>pipilan</i> .	Movements based on affordances of sliders and clarity for visual notation. Modification at performance level through timing input and additional parameter smoothing.
<i>Pipilan</i> playing technique (<i>bonang</i>), notion of moving between notes.	Crossfade for granular part.	Concept of note pairing mapped to movement between samples (mediated by crossfade parameter).	Playback rate extended to range far beyond <i>bonang</i> part. Note selection based on probability.
Leading instruments (e.g. <i>bonang</i> , <i>rebab</i>)	Cue to move to <i>lik</i> (<i>gerongan</i> section).	Conceptual mapping: use of <i>balungan</i> sequence cuing <i>lik</i> in <i>Srikaton</i> (<i>puthut gelut</i>), which in turn cues a crossfade pattern.	Substitution in place of more idiomatic cues in the context of the arrangement.
<i>Gerongan</i>	Vocal part.	Notated and sung vocals, information used for <i>balungan</i> and further part generation.	Used outside traditional context. Transposition (<i>slendro</i> to <i>pelog</i>) and related modification.
<i>Rebaban</i> (bow movement)	<i>Maju/mundur</i> slider.	Conceptual mapping used to determine timing of sequence.	Basic left-right movement used, other parameters ignored.

Structuring and general phrasal idiom			
Source	Application	Interpretation	Modification
<i>Balungan</i>	Instrumental sequence (<i>Gendhing Monggang</i>).	Traditional mapping to instruments	Juxtaposition with other melodic elements to the point that role is unclear.
	Source for pitch-oriented electronic <i>cengkok</i> .	Information from <i>Ladrang Srikaton</i> transposed and stored as array for generation of envelopes and crossfades.	Transposition (<i>slendro</i> to <i>pelog</i>).

	Selection of <i>timbre</i> in pre-recorded sounds.	Sequence created from crossfade parameter.	Degree of accuracy influenced by personal expression.
<i>Padhang/ulihan</i> phrase structuring	Grain crossfade (attempted “timbral <i>cengkok</i> ”)	Conceptual mapping from <i>padhang/ulihan</i> to use of generalized divergence from <i>Monggang</i> structure. This parameter is in turn mapped to control a granular crossfade (probability of sample selection) and timbre of pre-processed sounds.	Substitution of simpler parameter for ease of further development.
<i>Irama</i>	Expansion and contraction of piece including instrumental textures.	Conceptual mapping: general approaches to musical time and time stretching.	Substitution in electronic parts with granular synthesis. Once <i>irama</i> is established, the space between notes is emphasized through breakdown into iterative textures.

3.3.3.d Cues to indicate discourse

The instrumental setup, the *buka* and subsequent opening passages suggest that this is a traditional piece; visually, even the presence of the speakers and electronic setup is fairly innocuous. The electronic parts at the beginning are subtle enough to be barely noticeable.

For the most part there is very little to suggest a significant textural discourse in the ensemble version. The clattering reverb-based sounds may be regarded as sound effects, additional emphasis for the gong strokes. As one musician noted, the granular texture of the *gambang* and *bonang* may be perceived as tremolos, maintaining an instrumental paradigm in many of the electronic parts.

The electronic version starts with a steady texture, but the manipulation of resonance and movement in space implies quite a different piece. The absence of the instrumental framework makes it harder to perceive the roles of the various parts until *irama* level III, in which the dominating pitched qualities of the instruments

come into play. Even then, unless the listener has received background information on the piece, the textures may not be recognizable as gamelan *monggang* or even in terms of the idiom of gamelan in general. An idiomatic discourse is confirmed where the piece diverges in what would be the *gerongan* section. However, as there are no continuous melodic lines the listener may continue to perceive equal weighting on “abstract musical” and fluid textural discourse.

3.4 *Augmented Gamelan* (2012, AV4)

Augmented Gamelan is a set of pieces for a custom *gamelan gadhon* and electronics, developed for the Daylight Music series of lunchtime concerts in the Union Chapel in June 2012 (AV1.4). The name has been retained by the ensemble, and variations of the set have since been performed elsewhere (2013a; 2013b).



Figure 3-23: *Augmented Gamelan* at the Union Chapel (photograph by Diana Jarvis).

The set was also recorded a month later at Hampstead Music and Voice Studios in order to capture multi-track audio and MIDI information for analysis, and to record a version of the set for general release (AV2.6). In this session we attempted to recreate the material from the Union Chapel set. Subsequent versions were tailored to performance spaces; for example, a performance in an empty swimming pool provided opportunities to blend raw instrumental and processed sounds, and to experiment with acoustic feedback loops (2013a).

3.4.1 Description

The *Augmented Gamelan* set is primarily based around arrangements of *macapat*, incorporating instrumental pieces and sections of free improvisation. The set uses a small group of instruments and musicians:

- A *pesindhén* sings the *macapat* that form the basis for the majority of idiomatic material in the set, and doubles as a *kethuk* player.

- Two *gender barung* players (**A** and **B**) alternate between leading roles through traditional material, supporting roles marking structural elements in the manner of loud-style and punctuating instruments. The two instruments are tuned slightly differently, creating beating textures.
- The *slenthem* predominantly plays its idiomatic role through linear interpretation of a *balungan*.

The instrumental parts alternate between traditional and extended techniques, but generally maintain a base level of mechanical and phrasal idiom. The computer parts span a range of techniques, each associated with a method of actuation:

- A set of **sine waves** tuned to *slendro* and *pelog* provide accompaniment for the vocal part and general texture.
- A set of tones created through **granular synthesis** using samples of gamelan instruments provide further melodic and textural enrichment.
- Low frequency sine waves play the role of various **gongs**, occasionally augmented with samples of acoustic instruments.
- Filtered **noise** and **percussive impulses** are played through transducers attached to various *bonang*, which return to the mixing desk through piezoelectric contact microphones.
- Various delay-based **effects** are played through a feedback loop in the desk, applied to the various contact microphones and raw audio from the computer.
- A set of **pre-prepared sound files** is used sparingly to add texture to the set.

The set is grouped into two parts according to *pathet*. **Part 1** features predominantly *slendro sanga* material (**AV1.4.A**), while **Part 2** features *slendro manyura* and *pelog barang* (**AV1.4.B**). Each half runs as a continuous suite, featuring primarily textural improvised transitions. The timeline in **Figure 3-24** spans the complete set. Parts acting as gongs are shown with two types of markers: a circle indicates a traditional-style gong, whereas a diamond indicates the fading in and out of low frequency sine tones. Dotted lines indicate gong strokes implied by the *gender* parts, as in the first verse of *Dhandhanggula* and the initial decelerating cycles in *Monggang Alit*.

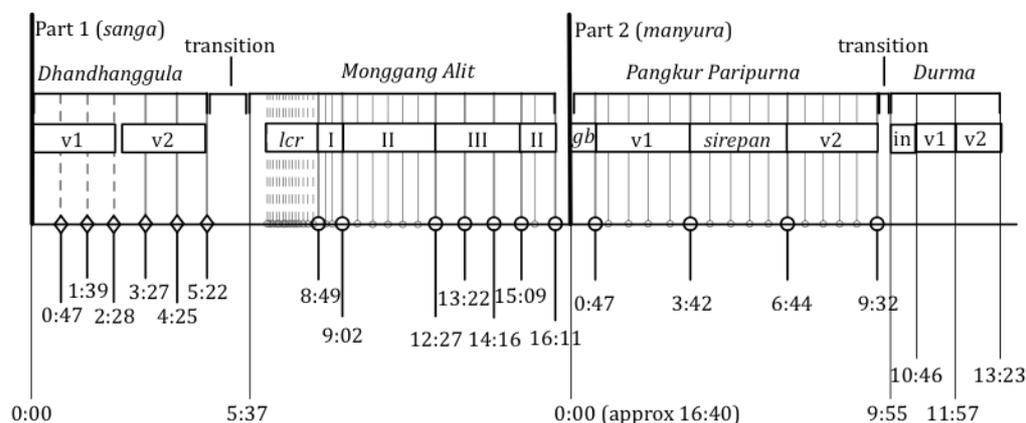


Figure 3-24: Timeline of the *Augmented Gamelan* set in the Union Chapel.

3.4.1.a *Dhandhanggula* (Part I, 0:00)

The set opens with a series of notes played by *gender A*, anticipating the initial vocal phrasing of *macapat Dhandhanggula*. The computer takes up the notes through a set of sine waves, apparently extending their resonance, and forming a foundation for the ensuing song. The *pesindhen* sings *Dhandhanggula* in free but brisk rhythm as the sine waves shift from note to note. At the strongest *seleh* notes, the *pesindhen* pauses as the three *gender*-type instruments join with bowed notes in unison.

Additional textures are introduced through sound files triggered on the computer. Extended, bright reverb cuts through the dense reflections of the space to accompany a descending figuration. This thin reverb develops into a resonant, metallic sound, continuing in the background as the sequence is repeated for a second verse. There are longer pauses at the *seleh* as the bowed *gender* are joined by low, beating sine tones fading in to represent a gong. The extensions of the vocal part in its descending pattern become thicker, gradually developing into a wall of sound as the final gong of the second verse is sustained, falling in pitch. An improvised transition ensues, as the players explore notes beyond the constraints of the *macapat*, experimenting with the beating created by differences in the tuning of the *gender*. The *bonang* join for the first time, playing an indistinct, glitchy stream of noise.

3.4.1.b *Monggang Alit* (Part I, 5:37)

A pair of sine waves playing a note “5” in tune with the two *gender* announces the start of the next piece. A rhythm formed of alternating impulses grows out of the *bonang* part, starting in sync with the beating of the two tones. The pulse decelerates, becoming recognizable as a regular pattern of four strokes along the lines of the interlocking *klenang*. The musicians, having donned headphones to follow the

computer pulse, start a sequence based on *gendhing Monggang*. The parts are divided between the instruments, played in octaves on the two *gender* on a combination of hard and soft beaters, with the *seleh* “5” provided in the lower register by the *slenthem*. The *pesindhén*, who does not sing during this piece, joins with a *kethuk* (tuned to note “2” as is common in *slendro*) on the offbeat.

The sound of the *bonang* increases in complexity as the central pulse continues to decelerate. A buzzing joins on the strokes of the *kethuk*, gradually breaking down into an iterative texture, then a rhythm, a triple-time feel across the underlying beat. A similar, higher pitched stream of impulses emerges in the usual place of a *kempyang*. Further metallic clanging joins the instruments, this time through samples played directly through the speakers, starting with a high and predominantly inharmonic spectrum: *kenong*, *kempul*, and *gongs* emerge as lower partials are added. Ultimately the deepest tone of the *gong ageng* rings through the space. At this point the ensemble has slowed down enough for *gender B* to break into traditional *cengkok*, elaborating on the tones of the *Monggang* cycle as in the *ompak* of *ketawang Subakastawa*. The *slenthem* player adds notes to each cycle until it too is recognizable as the *balungan* of the *ketawang*. *Gender A* maintains a percussive offbeat, matching the *kempyang*. The *kethuk* part gains a second, lower note (a “6”, borrowed from *pelog*), placed to coincide with the *kempul*.

The *irama* stabilizes upon reaching level II (*dados*). The *gender* leads the ensemble through the *ngelik* as the *bonang* is subjected to subtle timbral manipulation through the mixer. A further transition to *irama* level III takes place, ostensibly led by *gender B*. Here the *gender* switches to more elaborate *wiletan*, as would typically be found in sections accompanied by the *kendhang ciblon*. The rhythm of the *bonang*, rather than continuing to slow down, imitates the change in rhythmic density of the *gender* and evolves into a stream of elaborate rhythmic gestures, playing around the central pulse and associated intervals of the *kempyang* and *kethuk* converted from pitch to the rhythmic domain. The strongest points in the cycle are marked through the two parts converging in a solid, clear, beat of three against two before disintegrating again. *Gender A* continues a basic rhythmic pattern but adds a slow melodic part to the left hand, anticipating and repeating notes above the *slenthem* part in the manner of Jogjanese *demung imbal*.

Following a complete run through the *ngelik* in *irama wiled* the tempo appears to drop further, but re-settles in level II (*dados*); the central structure doubles up but

returns as a spacious cycle complemented by samples of *saron* that immediately fade into the distance. The piece proceeds to *suwuk*, concluding the first half of the set.

3.4.1.c *Pangkur Paripurna* (Part II, 0:00)

The second half of the set begins with a *grambyangan* played by *gender A*, placing the *gender* in a traditional role and establishing the *pathet* as *slendro manyura*. From here the piece moves to a conventional *buka* – a standard solo introduction to *gendhing* such as *ketawang Puspawarna*, or in this case *ketawang Pangkur Paripurna*. The rest of the ensemble joins on the gong note.

The gong is provided by a pair of low frequency sine waves in the same range of those played in *Dhandhinggula*, this time using percussive envelopes in imitation of a *gong kemodhong*. The *slenthem* plays its traditional role, playing the *balungan*. *Gender B* mimics the strokes of the *kenong*, *kempul* and gong with soft and hard beaters in the left and right hands respectively.

Once the ensemble has settled in *irama* level II (*dados*), a set of smooth grain streams based on the stretched-out sound of the *gender* joins in, organized by a similar set of envelope patterns to those developed in *Monggangan*. These are joined by the *pesindhén*, who sings the *macapat Pangkur Paripurna*, cutting through the soft texture of the instruments. This time, with the *gender* present, the relationship of the electronic parts to the *cengkok* is clearer; the movement towards the *seleh* notes is accompanied by a swelling in the equivalent electronic parts.

Upon the end of the first verse the *gender* and vocals drop out, giving the impression of a *sirepan*. The *slenthem* continues, this time playing a sparse *balungan nibani*; *gender B* covers the resultant gaps with a *kempyang/kethuk* pattern played with a hard beater in the upper range of the instrument while maintaining the other colotomic strokes. The electronics fill the remaining space with further processed *gender* on a note “6”, stretching out into a drone, which gradually dissipates into indistinct resonances. *Gender A* re-joins after a few *gatra*, maintaining the new sparse feel by playing a *pinjalan*-type pattern on the lower register of the instrument. The electronic *cengkok* continue in an unstable manner, appearing to break up at times with a crackling texture. White noise played through the *bonang* gradually fades in on the *kenong* notes, using *kempyung* relative to the *balungan* where the direct notes are not available.

The ensemble returns to normal upon the gong stroke, pushing into a subtle *seseg* led by *gender* A. A second verse of the *macapat* is played; this time the timbral modulation of the electronic *cengkok* may be associated more clearly with the higher notes of the vocal part. The piece slows to reach a traditional *suwuk* in the last line, as the noise played through the *bonang* continues through the final gong.

3.4.1.d *Durma* (Part II, 9:55)

The *bonang* noise surges, subjected to LFO-driven amplitude modulation in increasing frequency and intensity. The *gender*-type instruments re-enter suddenly, in unison, playing a short *balungan* cycle in *irama lancar*. After the end of the second cycle the piece disintegrates as each player slows down independently of the others. The instruments are joined by sine waves, which gradually shift from *slendro* to *pelog*. Each player settles on either a note “2” or “6”, which match their *pelog* equivalents, continuing their deceleration.

Once the sine waves reach *pelog barang*, the fading in of an ascending set of notes provides a cue for the *pesindhen* to commence *macapat Durma*. The shifts between the sine wave notes follow broader strokes than in *Dhandhanggula*, giving a general indication of movement up or down. The *gender*-type instruments continue with dispersed notes until the end of the first verse, where the *bonang* also drops out. In the second verse the sine waves gradually fade away, leaving a subtle backdrop for the *pesindhen* to conclude the set in near silence.

3.4.2 Development process and technical notes

The *Augmented Gamelan* set presented an opportunity to blend the various approaches used thus far, and to work with the rich acoustic space of the chapel⁴³. I was inspired by the challenge of tailoring some of the material – which had thus far been based on playing out processes over long periods – to a more diverse audience.

The set was created in consultation with the musicians involved, all of whom had significant experience studying in Java and working with contemporary music. Much of the development took place in isolated sessions with one or two members of the group, and was put together in a single rehearsal. The sine wave accompaniments for vocal parts were developed over the course of several sessions with Cathy

⁴³ I attended several performances in the concert series during the development process to gauge the space, which influenced the sound files described in §3.4.1.a.

Eastburn. Some of the *gender* parts were developed in consultation with Charlotte Pugh during sessions in York; Pugh's *gender garap* for *Subakastawa* in *irama* III dated back to sessions from the start of the research (AV2.7). Robert Campion provided invaluable advice on developing the programme and extended techniques.

3.4.2.a Technical setup

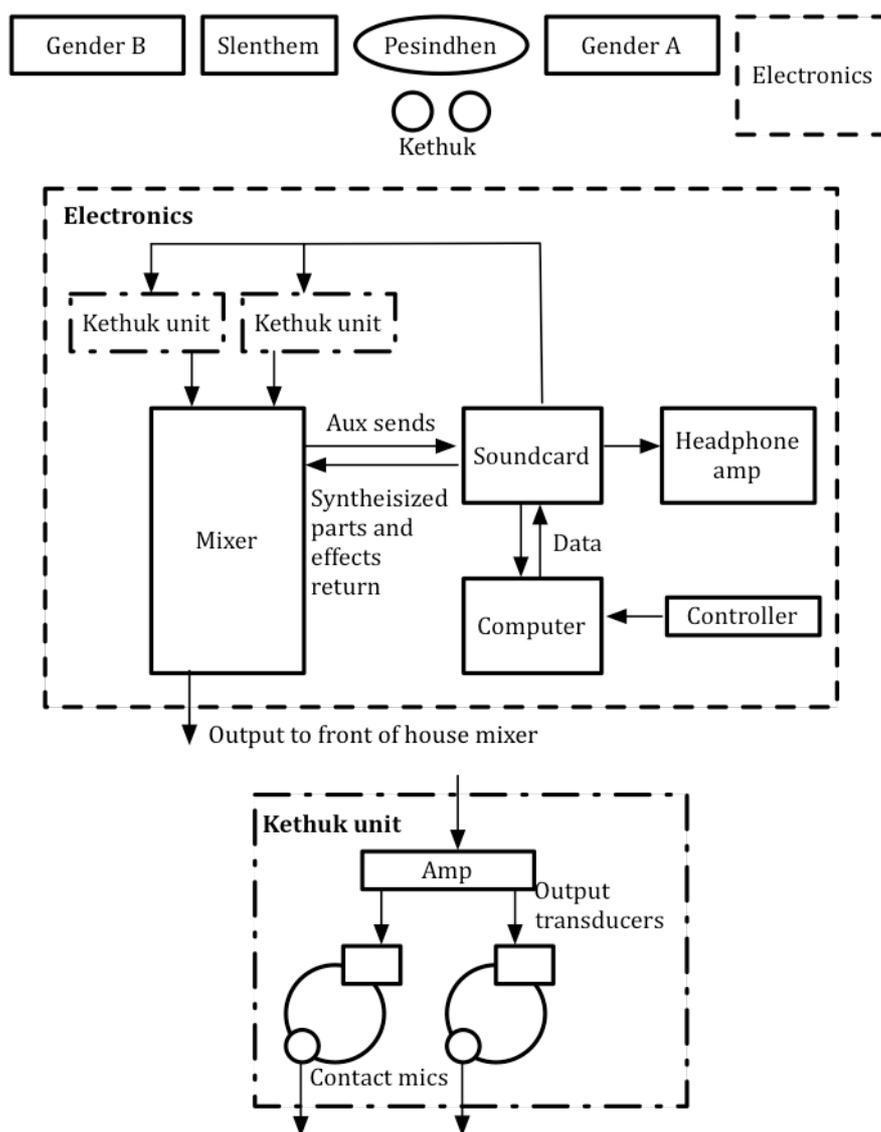


Figure 3-25: Technical and instrumental setup for the Union Chapel set.

Figure 3-25 shows the technical layout for the set and the signal flow of electronic parts. Although the use of microphones contributed to separation of the instruments, the reverb of the space maintained the acoustic blending to which I had aspired. The instrument microphones were omitted from creative processing due to the limitations of the mixer; future performances incorporated real-time manipulation of the vocals and instrumental parts (*Augmented Gamelan* 2013a; 2013b).



Figure 3-26: Overhead view of *Augmented Gamelan* performance at the Union Chapel (photograph by Diana Jarvis).

3.4.2.b Instruments and tuning

The Union Chapel set used a mismatched collection of *slendro* instruments: *gender A* and the *slenthem* come from the same set, while the *embat* of *gender B* is slightly higher⁴⁴. The primary tuning for accompaniment of the vocals throughout the set is based on *gender A*. The combination of these *embat* created a shimmering texture akin to Balinese gamelan (see Tenzer 2000 pp. 31-33). I attempted to use the beating

⁴⁴ I am grateful to Richard Pickvance for the loan of his *gender barung*, and Alec Roth for the sale of his *gadhon* set that facilitated this stage of development. The set may theoretically be played with any similar collection of instruments, with some modification to the *garap* according to differences in tuning. I used a similarly tuned set of instruments without adjustments to the sine wave parts for a subsequent performance (*Augmented Gamelan*, 2013b).

tones in moderation through rhythmic placement of strokes and a variety of extended techniques. My experimentation with hard beaters, including attachment of coins and other metal objects, was intended to lessen the beating by emphasizing higher partials. The vibraphone beaters ultimately used yielded limited results on this front, but the resultant timbre was more consistent and aesthetically pleasing.

Table 3-7: Sine wave frequencies based on *gender A* and *B*, alongside the new *pelog barang embat* created for *Durma*.

Note	Gender A	Gender B	Note	New pelog
6̣	116	116	6̣	119
1̣	135	138	7̣	132
2̣	157	158	2̣	160
3̣	181	185	3̣	175
5̣	208	215	5̣	219
6̣	237	240	6̣	236
1	275	277	7̣	262
2	315	321	2	322
3	361	360	3	348
5	414	419	5	438
6	474	483	6	474
ī	550	561	7	527
2̣	632	639	2̣	646
3̣	721	730	3̣	699

A set of sine waves was tuned by ear to provide material that would complement the instruments (see **Table 3-7**). I attempted to match the tuning more closely than in previous work, due to the presence of pre-existing beating and in response to the feedback from the *Monggangan* recording session. I also created a *pelog barang* scale based on the Southbank tuning, which was subsequently transposed so that the note

“6” would form a *tumbuk* with the tuning of *gender A* and the *slenthem*. The note “2” of *gender B* also bridged the two tunings.

Table 3-8: Sine wave frequencies used for gong parts.

Piece	Note	Oscillator I	Oscillator II
Dhandhanggula	2 ...	80	78
	1 ...	67.5	69
Pangkur Paripurna	3 ...	87	90

3.4.2.c Samples and granular synthesis

The majority of sample-based parts were created in the studio in non-real-time, using time-stretching, layering, and reverb to create shifting textures. The source material was taken from recordings of the instruments and vocal parts alongside existing recordings retuned by ear (Yantra Productions, 2008; Gamelan Sekar Petak, 2012). This established a palette of sounds, each with their own inner life, which could be organized in relation to the idiomatic material. The loss of real-time control of the granular synthesizer was compensated for by a more sophisticated tone colours I was capable of producing in the studio. Additional expression was imposed on the sounds through subtle filters and panning controlled by the envelopes.

3.4.2.d Balungan

In this set the *balungan* functions both as a part played by the *slenthem* and as a bridging parameter for the computer. In the case of the three *macapat*-based pieces, this part serves to mediate between the vocals and the rest of the ensemble. In contrast to the other pieces in the portfolio, this application is close to the conventional conception in traditional *karawitan* (**Part I: §3.2**). Most *balungan* and their interpretations are based on traditional works, with minimal alterations in the form of transposition between *pathet* and the creation of *balungan nibani*.

3.4.2.e Cengkok

The approach to electronic *cengkok* builds on the foundations laid out in *Monggangan*, using the *maju/mundur* slider as an input. The *garap* of *Monggang Alit* and the realization of *Subakastawa* therein are based on the plain *pipilan* techniques used in

Monggangan. Instead of forming the basis of a central discourse, it becomes more of a textural element to be faded in and out in the mix. In *Pangkur Paripurna* the electronic parts are oriented around the “named” *cengkok* played by the *gender* (**Part I: §3.3.3**). Instead of attempting to mimic the contours of the parts, I aimed for a general impression of the intensity of notes through swelling granular resonances.

3.4.2.f Crossfading

The crossfade used in *Pangkur Paripurna* is based on a note threshold rather than measuring divergence from a central framework (see **§3.3.2.e**). The movement of the *seleh* above note “5” triggers the start of a ramp towards a second channel of granular material, which is based on the upper pitch register (see **§2.4.6**). This generates smooth transitions between registers in the *cengkok* according to the current register of the vocal melody. Since the electronic *garap* was determined by manual manipulation of JSON files at this stage of software development, I was able to maintain influence from my own aesthetic judgement. I used shorter envelope times leading into certain notes, aiding greater distinction between registers (see **N4.B**).

3.4.2.g Transducers

With the acquisition of my own set of *bonang pencon* I was able to attach the transducers directly to the instruments, and became more confident in manipulating their positioning in the course of performance. A set of piezoelectric contact microphones brought the audio signals directly into the mixing desk, providing opportunities for further timbral manipulation.

I chose not to use the sine-based synthesizers from previous work (**§3.1.2.e**), concentrating on filtered white noise and percussive impulses to stimulate the general resonance of the instruments. This reflected a desire to use the instruments as sources of texture of indeterminate pitch while retaining some semblance of their original role, alongside the more practical consideration of unpredictable resonances occurring through the use of contact microphones on stage.

3.4.3 Development of individual pieces

3.4.3.a Dhandhanggula

The arrangement for the traditional *macapat Dhandhanggula* grew out of an early attempt at accompanying vocals with a computer part in the autumn of 2011, and was

developed with Cathy Eastburn over the course of several sessions in the Southbank Centre. My principle intention was to explore an electronic interpretation of the type of accompaniment a *gender* might provide for a solo vocal piece⁴⁵.

The use of fading sine waves came about through the convergence of several sources of inspiration. On a practical level, I was interested in finding an intuitive way of playing that would incorporate the affordances of a mixing desk, including the faders and effects sends. The aesthetics of this activity were influenced by my own experience experimenting with sympathetic resonances, Alvin Lucier's piece for gamelan instruments and feedback (1994), and a concert coordinated by Robert Champion in which vocalists and *gender* players were placed around the reverberant space of a museum, creating washes of reverb throughout the corridor (Cambridge Gamelan Society, 2011). My ambition was to create the accompaniment with feedback – either acoustic or based on routing of electronic effects – but a setup with sine waves and a controller developed in the first sessions provided greater stability for performance. This presented a further advantage in that the material may be transferred to a sequence triggered through scrubbing (*maju/mundur*), and perhaps manipulated by other performers or driven by live analysis of the vocals.

The movement of the sliders, initially based on dense references to every note in the sequence and oriented around the vocal notation, gradually became more intuitive as I learned the piece. While intended to refer to the *gender*, aided by the initial strokes added in the performance, the part developed its own identity.

Just as the *gender* responds to vocal phrases in the performance of *macapat* as *bawa*, I wished to create a reaction in the electronic parts that could be re-incorporated into the accompaniment. In order to distinguish this from the pitch-oriented sine wave parts, I explored the possibility of a timbral or spectral reaction from the electronics. The part was first realized through real-time application of reverb and feedback, but moved into the preparation of samples as the desire to create a specific effect in the space, cutting through the acoustics, and emphasizing vocal fragments I felt were prominent. Thus the vocal accompaniment developed two layers in a similar manner to *Monggangan*: the anticipating electronic *garap*, based on idiomatic principles, and punctuating sounds that created textural events.

⁴⁵ In performances of *macapat*, the *gender* may provide reference tones and play brief patterns to strong notes in response to the song. The accompaniment presented here is typically used in the accompaniment of *bawa* (see Hastanto, 1983 pp. 121-122).

3.4.3.b *Monggang Alit*

The core material used in *Monggang Alit* was created in 2010. The piece shares the general structures of my initial work, exploring movement through a vast expanse of time-scales, from the pitch domain, through rhythm, with the possibility of extending to larger scale structures. The focus is on a *kempyang/kethuk* part played through transducers as a stream of impulses, which was written as a MIDI sequence. The rhythmic intervals were based on a ratio of 2:3, an idealized version of a *kempyung* transferred from the frequency domain to a series of note events⁴⁶:

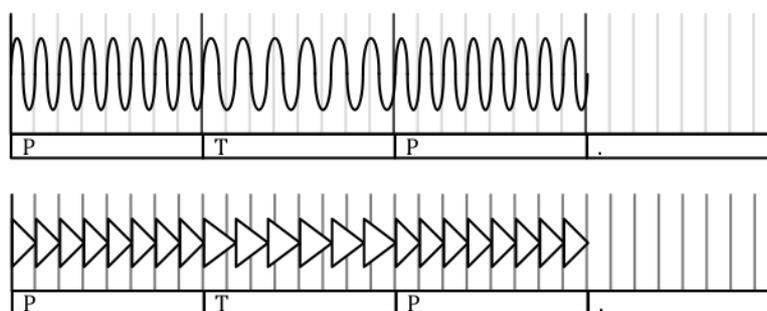


Figure 3-27: Mapping from the frequency domain onto note events.

This sequence was played in several *irama*, from a high frequency buzzing, where the interval was audible in terms of pitch, to a slower combination of pulses, where it remained intelligible as rhythm. Upon reaching *irama III*, I manipulated the individual notes of the sequence by hand, exploring a notional reference to the *cengkok* of elaborating instruments. This activity was based almost entirely on aural feedback as an iterative process, drawing on techniques I had developed in my previous experience with electronic dance music production.

Through manual sequencing I attempted to recreate an approximation of the movement towards and around a *seleh* note in pitch-oriented *cengkok*. Rather than aiming for shifts to discrete pitches or their equivalents, this movement took place as a more fluid process, moving in and out of rhythmic coherence. The screenshots from Ableton Live in **Figure 1-1** show examples of these MIDI sequences (played with the *ketawang* colotomic structure in **AV2.7.A**); the gradual divergence from the original

⁴⁶ This approach was in part inspired by Henry Cowell's notion of "scales of rhythm" (Cowell, 1930 pp. 98-104). The use of the ratio 2:3 was based on my conception of the pitch relationship between the *kempyang* and *kethuk* at the time; until recently the Southbank gamelan used note "6" for its *slendro kempyang*. For discussion of tuning intervals found in wider practice see Purwanto (2010 pp. 212-214).

interval can be seen in *irama* II, followed by more elaborate movement in *irama* III. The rhythmic *kempyung* provides the equivalent of a *seleh* note.

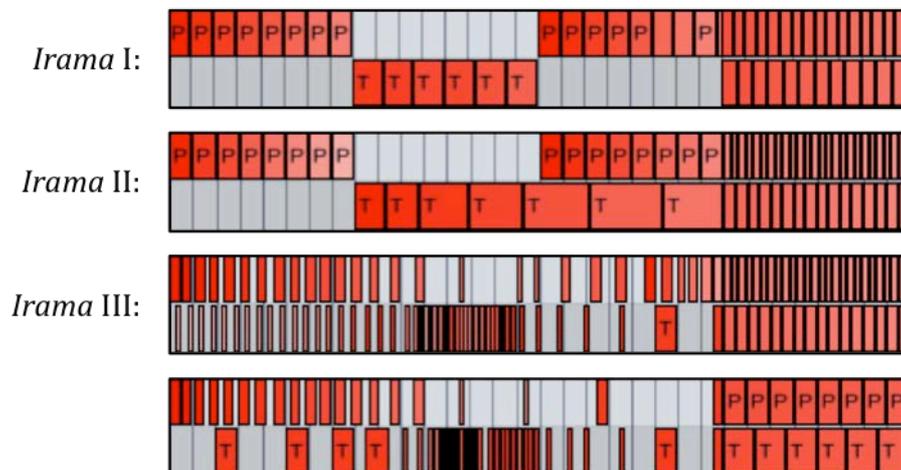


Figure 3-28: MIDI sequence for *kethuk* parts in *Monggang Alit/Subakastawa* through various *irama* levels.

Over several sessions I added instruments to explore similar movements between *irama* based on a simple *balungan*: the *ompak* of *ketawang Subakastawa*, which could also be represented at faster tempi as *gendhing Monggang*. The *gender* provided aesthetically pleasing results, moving from simple pitch sequences to undulating textures along the lines that I had been attempting to emulate in the *kethuk* part. My initial experiments involved a *gender* part following the *monggang* cycle through various time-scales, playing *mbalung* and elaborating *cengkok* through to *irama wiled*.

The expansion of the *ketawang* to incorporate the *ngelik* section was developed with input from Charlotte Pugh, who suggested that *garap* for the *gender* could be created for the piece in *irama wiled*. This segment of the piece was performed at the Gathering of the Gamelans symposium in 2012, featuring solo *gender*, computer parts, and live gong (AV2.7.B). Other arrangements, including an attempt to incorporate a full gamelan (AV2.7.C), were cut short as I attempted to replace the MIDI sequence with the output of an algorithmic system.

Upon embarking on the development of the *Augmented Gamelan* set, the existing sequence provided a source of material for the instrumental resources available, and a showcase for the transducer parts. The central arrangement was updated with granular material taken from *Monggang*, with the electronic *cengkok* modified to fit the *balungan* of *Subakastawa* (N4.D). The core MIDI sequence was also adapted to accommodate the extra *bonang* available, with the *kethuk* taking a

prominent role to give the impression of interplay with its humanly played counterpart⁴⁷. The other instrumental parts serve to emphasize the structure and maintain a connection with the main *Monggang* pulse.

Use of a click track allowed for minimal interaction with the computer. Liberated from maintaining the sequence or synchronizing with musicians, I was able to engage with the mixer and effects in the same manner as in *Tenuous Links*. Subsequently my input as a performer became oriented towards processing and feedback on the mixer. I also experimented with modifying the position of the transducers on the *bonang* in response to the musicians and the acoustic space.

3.4.3.c *Pangkur Paripurna*

This piece features the popular *gendhing Pangkur*, more commonly encountered as a *ladrang* (see **Part I: §3.3.3**). The arrangement presented here was inspired by a recording of a *ketawang* version in which the *macapat* features prominently (Gamelan of Java, 2010 track 4). The *balungan* came from various notation sources (Supadmi, 1999; Drummond, 2013), which I transposed from *sanga* to *manyura* to bring variety of *pathet* to the set.

The use of the traditional *gendhing* proceeded from *Monggangan* and *Srikaton* (§3.3). Through this piece I hoped to explore a more explicit relationship to the *balungan*, with emphasis on *gender cengkok*, and subsequently with a wider reference to a traditional gamelan ensemble. The *sirepan*, in which the *gender* drops out, was also developed from a similar section in *Srikaton*. Although it was initially intended to highlight the shape of the *cengkok* and related timbral movement in isolation, the development of additional instrumental parts proved too enticing, maintaining an emphasis on note events. Additional textural manipulation in the drone part developed through experimentation, masking the *cengkok* parts further and contributing to a more balanced, atmospheric experience.

3.4.3.d *Durma*

The electronic parts in *Durma* are similar to the sine wave accompaniment created for *Dhandhanggula*, featuring broader movements of groups of faders in keeping with the simpler contours of the *macapat*. The wider arrangement incorporates elements

⁴⁷ My intention was for the player to share the *kethuk* with the transducer as in the *Bonang Study*; this was rendered impractical by the use of contact microphones.

of improvisation and indeterminacy alongside reinterpretation of traditional material. It was developed more on the basis of intuition than other pieces in the set, coming together quickly in the final stages of development.

The *gender* and *slenthem* introduction emerged as an instrumental bridge from *Pangkur Paripurna*; the use of a disintegrating ensemble rhythm had proved successful as a way of swapping leadership between the computer-generated and live instrumental parts in previous workshops (see §1.3.2). The disintegration in *Durma* facilitated switching from the tuning of the instrumental part to the electronics, which largely took place through controller-based improvisation with aural feedback.

The *balungan* was adapted from the *ompak* of *ketawang Durma pelog barang*, a *gendhing sekar* based on the *macapat* of the same name. The notes cycled upon reaching the end of the dissolution (“2” and “6”) are based on the overlap between *slendro* and a new *pelog* scale, and are intended to give the impression of the whole ensemble bending in tuning. The continuation of the repeated notes as apparently coherent with the subsequent vocal and computer-based came about unintentionally, providing a *kempyung* leading into the note “5” that finishes the piece.

3.4.4 Discussion and analysis

Due to the central use of existing traditional material, the compositional activity in this set primarily takes place on a **conceptual level**. Although there is substantial concrete manipulation of sound, an “abstract musical” – generally idiomatic – discourse tends to dominate. Depending on the listener’s perspective, the note information from familiar pieces might be regarded as stable parameters, drawing attention to textural and non-idiomatic aspects of the work. Other aspects of the composition may be broken down as follows:

- The ***balungan*** and **vocal parts** are based on pre-existing material with minor modifications. Although the melodic information is less arbitrary than in the previous works, most of the *gendhing* and *macapat* may be replaced and re-interpreted within the set without compromising its integrity.
- The **instrumental *garap*** is mostly idiomatic or based on traditional parts from other instruments. Interplay between instrumental and electronic interpretations of the same part is often audible, as in the *kethuk* parts in

Monggang Alit and the *gender* and electronic *cengkok* in *Pangkur Paripurna*. However, most apparent interaction is emulated or pre-agreed.

- The **arrangement** (the sequencing of the pieces and the choice of *irama*) is more considered than in previous work, progressing from the rigid playing-out of processes that characterized my previous works.
- The manipulation of **concrete sounds** is prominent, rooted in both real-time and non-real-time processes. Sounds are generally organized in relation to the idiomatic framework, but include intuitive improvisation (e.g. manipulation of feedback-based effects and positioning of transducers on the *bonang*).

The wider structure of the set is grounded by the movement of leadership and pulse between the musicians and the computer, as well as the colotomic subdivision and *irama* of the various *gendhing*. Fluidity and mechanicity are also intensified by the addition of minimally altered samples in *Monggang Alit* and fading of gong-type tones elsewhere. This creates a subtle tension and release relationship, as illustrated in **Figure 3-29**. The improvised transitions play a similar role to *pathetan*, in contrast to the rhythmic regularity of the *gendhing*-based pieces (see Brinner, 1981). The *macapat* bookend the set in a similar manner, with *Dhandhanggula* providing a gentle introduction in the style of a *bawa*, and *Durma* drifting into silence.

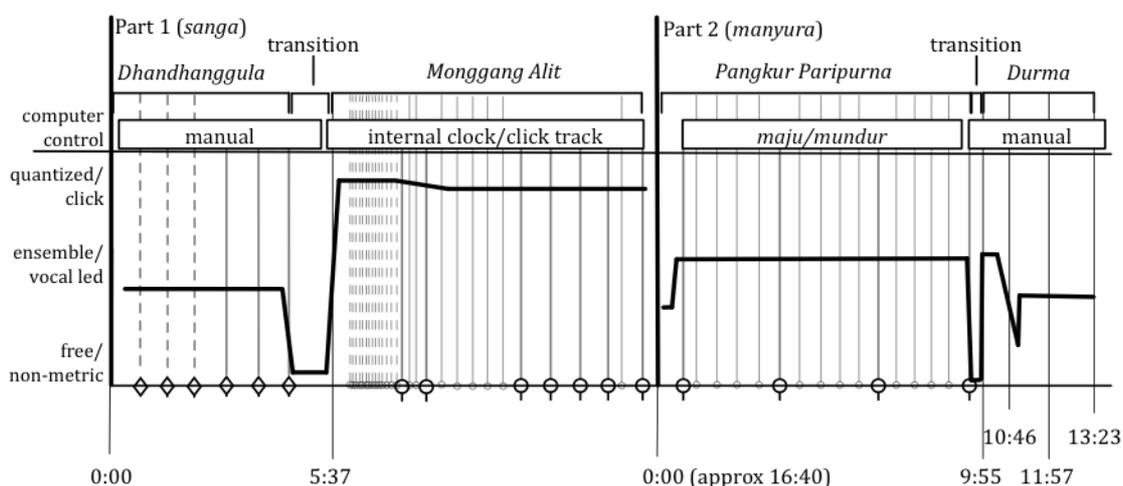
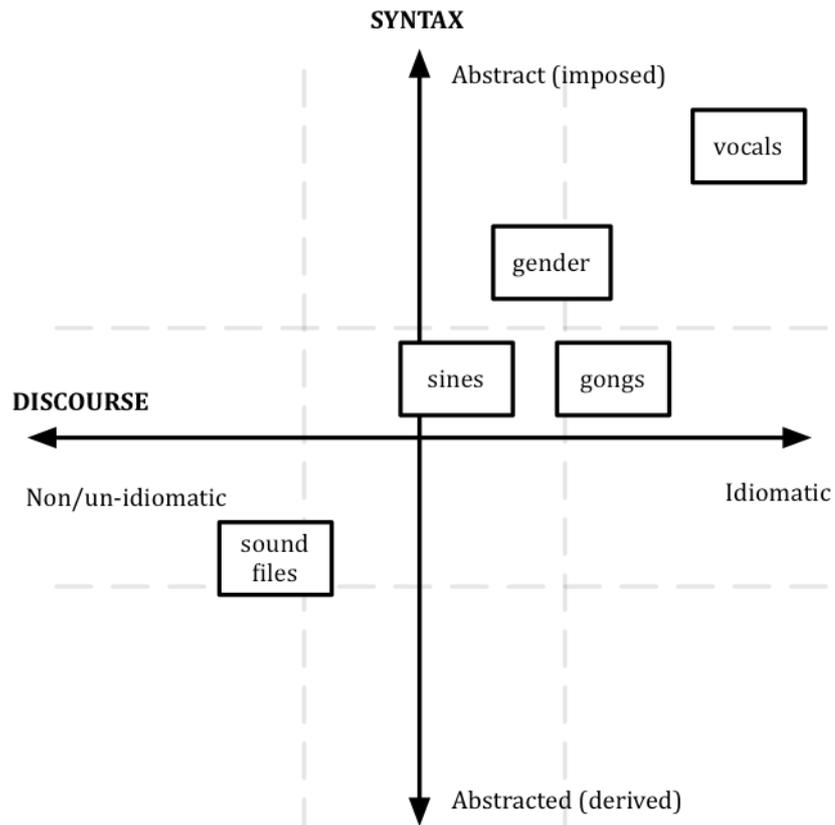


Figure 3-29: Rigidity of instrumentally oriented parts in the *Augmented Gamelan* set.

3.4.4.a Syntax and discourse

Dhandhanggula

Here the idiomatic identity and nature of syntax generally remain the same throughout for all parts, which appear in stages:



Element	Timing (AV1.4.A)
vocals	Throughout
sines	Throughout
gender	0:47 onwards
gongs	3:27 onwards
sound files	1:45~4:25, 4:40 onwards

Figure 3-30: Syntax and idiomatic reference in *Dhandhanggula*.

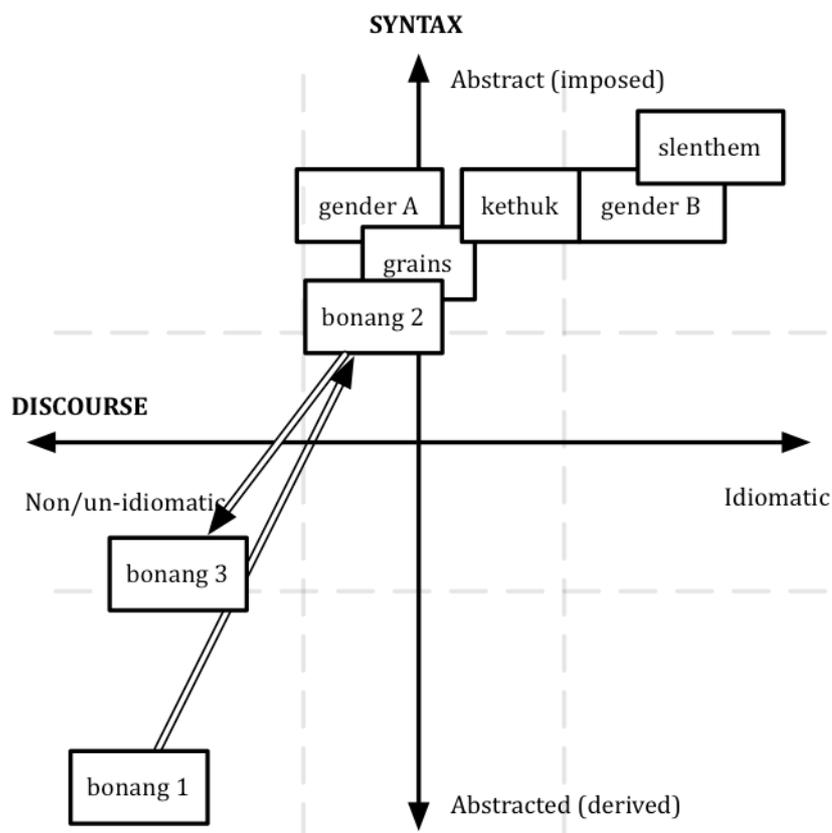
The vocals, taken directly from traditional material, use an abstract syntax and present an idiomatic discourse. The collective *gender* part plays a pseudo-idiomatic role, as the instruments play the *seleh* note in a manner unusual in their traditional context but conceivably appropriate in the wider idiom. The part is almost entirely imposed from pre-existing conventions, but is also influenced by a search for an appropriate syntax based on the affordances offered by bowing of the instrument.

The mid-range sine waves and gong parts played through the computer use a mixture of imposed and derived syntax; the parts are based on accompaniment of the pre-existing vocal part, but also rely heavily on the affordances of the faders and aural feedback. These parts may be considered a mixture of idiomatic and un-idiomatic for similar reasons. The low-frequency waves are more recognizable in their role as a gong and hence are placed further right on the grid. The pre-prepared sound files are

situated towards the bottom-left of the grid, as they are based on sonic relationships developed in the studio and bear little resemblance to traditional instrumental or vocal textures. Due to their close relationship to the vocal sequence their organizing syntax may be considered a mixture of imposed and derived.

Monggang Alit

With the exception of the computer-generated *bonang* part, the instrumental elements in *Monggang Alit* retain their positions on the grid throughout the piece:



Element	Timing (AV1.4.A)
slenthem	7:11 onwards
gender A	7:11 onwards
gender B	7:11 onwards
grains	7:11 onwards (barely audible)
bonang 1	6:05~7:11
bonang 2	7:11-12:10
bonang 3	12:10 onwards

Figure 3-31: Syntax and discourse in *Monggang Alit*

Gender A and *B*, while both based on “abstract musical” (note-oriented) parts, exhibit different degrees of idiomaticism. Both parts start with a sparse pattern appropriate

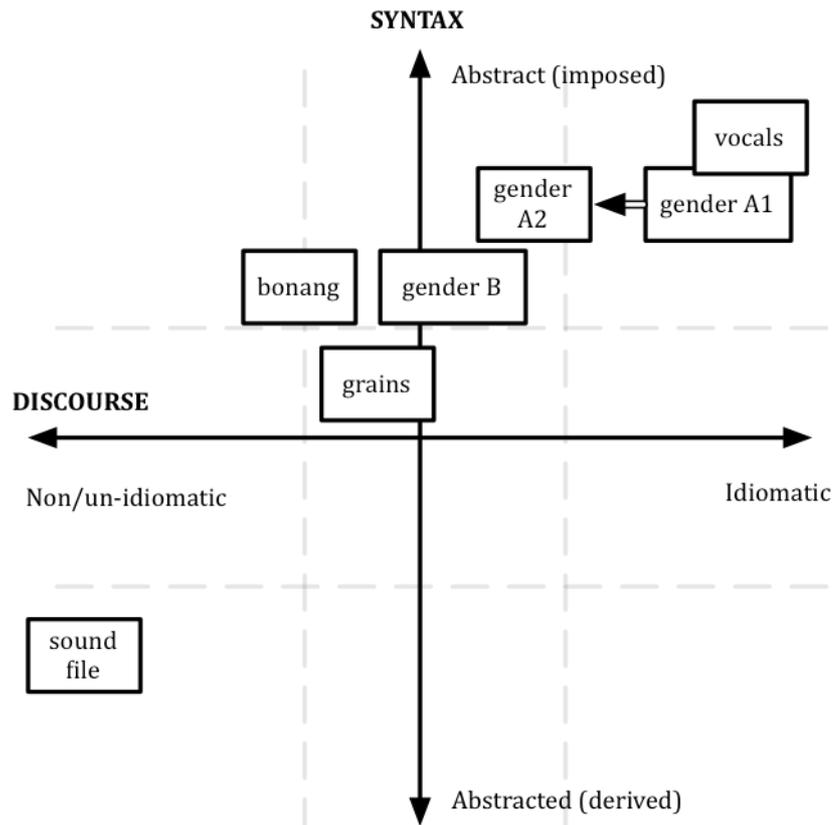
to the fast *irama* borrowed from the gamelan *Monggang*; as the *irama* slows down, this part becomes uncharacteristic for *gender A*, although retaining a base level of idiom in terms of playing technique and relation to the rest of the piece. Conversely, *gender B* switches to an appropriate idiomatic pattern, retaining a conventional rhythmic density throughout. The *slenthem* part is played in a manner appropriate to the instrument in a traditional context through the course of the piece. The *kethuk* is generally idiomatic, playing an abstract part based on the traditional gong cycle, in an attempt at appropriateness to the unusual configuration of the instrument.

The *bonang* part, played through transducers, moves from textures developed with aural feedback through a combination of granular synthesis and the resonance of the instrument (1) to an abstract, relatively non-idiomatic part based on the transposition of the *kempyung* interval into the rhythmic domain (2). The rhythmic elaborations played in *irama III* are even less idiomatic, using syntax developed through aural feedback (3). The grain part, a simplification of that developed in *Monggangan*, retains a position in the middle of the grid⁴⁸. Although the part is no longer strictly derived directly from the materials, it remains based on interpretation of the idiomatic framework in relation to the affordances of the granular synthesizer.

Pangkur Paripurna

The *grambyangan* and *buka* played by the *gender* set the tone for the rest of the piece, which is generally based on an idiomatic discourse. *Gender A* subsequently plays two parts based on reference to the vocal parts and *balungan*: traditional *cengkok* and *pinjalan*. Its discourse remains relatively idiomatic, but may be recognized as playing on the borders of tradition to an experienced listener. *Gender B* and the *bonang* part play similar roles based on interpretation of traditional *kenong*, *kempul*, and *kempyang* and *kethuk* parts. In both cases they have been developed with some degree of aural feedback, but retain an essentially abstract syntax. While the *gender* retains much of its idiomatic identity in a similar manner to the *gender A* part in *Monggang Alit*, the *bonang* is barely recognizable as relating to the rest of the ensemble or a traditional role beyond its coincidence with key points in the structure.

⁴⁸ While barely audible on the Union Chapel recording, this part featured prominently in the studio version (AV2.6.A, 8:46 onwards) and subsequent performances.



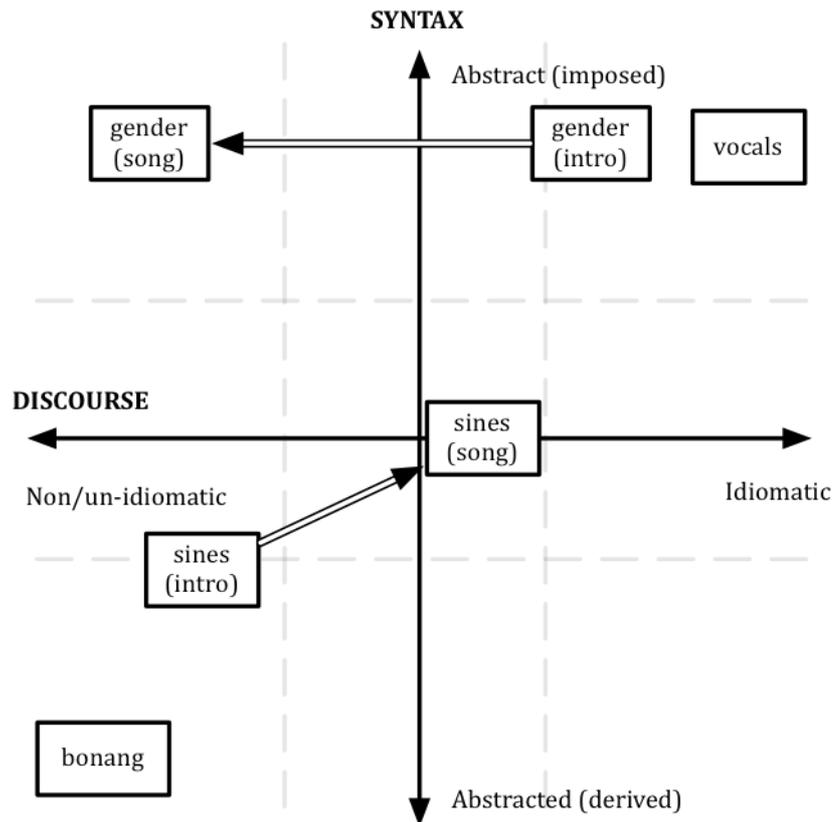
Element	Timing (AV1.4.B)
vocals	0:00-3:42, 6:44 onwards
gender A1	0:00-3:42, 6:44 onwards
gender A2	4:40-6:44
bonang	3:42 onwards
grains	1:10 onwards
sound file	3:42-6:44

Figure 3-32: Syntax and discourse in *Pangkur Paripurna*.

The sound file played during the *sirepan* does not exhibit a clear syntax, but has been developed based on aural feedback and is decidedly non-idiomatic, and so has been placed at the extreme bottom-left-hand corner of the grid. The vocal and grain parts retain their positions from previous pieces.

Durma

The collected *gender* parts maintain an imposed (abstract) syntax throughout, essentially playing the same melodic line based on the *macapat*, until settling on a single repeated note. As the collective part dissolves during the introduction, the perceivable discourse moves from idiomatic to unidiomatic.



Element	Timing (AV1.4.B)
vocals	10:46 onwards
gender (intro)	9:55~10:46
gender (song)	10:46-11:57
sines (intro)	9:55-10:46
sines (song)	10:46 onwards
bonang	9:32-11:57

Figure 3-33: Syntax and discourse in *Durma*.

The vocals serve as an idiomatic grounding for the piece. The *bonang* part, a sustained texture to be manipulated intuitively, is almost entirely derived from the materials and un-idiomatic. The sine wave part is initially based on free improvisation and aural feedback, playing on beating tones created in combination with the various *gender*-type instruments. The part is not entirely unidiomatic, as its movement is based on interpolation between the *slendro* and *pelog* tuning systems. Upon settling in *pelog*, the sine tones take on the position inhabited by those in *Dhandhanggula* as they accompany the vocals.

3.4.4.b Idiomatic references

The following table shows a breakdown of the idiomatic references and conceptual mappings involved in the development of the piece:

Table 3-9: Idiomatic reference table for the *Augmented Gamelan* set.

Instrumental idiom (including instrument-specific phrasal idioms)			
Source	Application	Interpretation	Modification
<i>Gender</i> (reference tones and accompaniment of vocals)	Sine wave parts in <i>Dhandhanggula</i> and <i>Durma</i> .	Amplitude of fixed sine waves.	Timbre generalized to pure sine tones. Movements based on personal expression and affordances presented by sliders. Slow attack, simplified parts.
<i>Gender cengkok</i>	Envelope parts for stretched <i>gender</i> samples (<i>Monggang Alit</i> and <i>Pangkur Paripurna</i>).	Selection of generalized envelopes based on subjective perception of strong points.	Timbre modified in granular processing and substitution of other instrumental textures (e.g. <i>slentho</i>). Movements based on affordances of sliders and clarity for visual notation. Modification at performance level through timing input and additional parameter smoothing.
<i>Pinjalan</i> (from <i>demung</i> and <i>slenthem</i>)	<i>Gender</i> A part in <i>sirepan</i> of <i>Pangkur Paripurna</i> .	<i>Demung</i> and <i>slenthem</i> parts mapped to right and left hand of the <i>gender</i> respectively.	Timbral variation from original instrumental part lost. Variations in rhythm and pitch selection based on personal expression.
<i>Gong ageng</i> and <i>suwukan</i>	Sampled gong	Sample retuned to complement instruments. Placed at key moments including traditional place in <i>ketawang</i> structure.	Timbral modulation, as instrumental parts are introduced during <i>Monggang</i> cycle.
	Sine wave gong	Low sine tones paired to create beating, amplitude controlled by faders and automation.	Modified timbre (spectral content and attack).

		Frequencies influenced by aural feedback in development.	
<i>Rebaban</i> (bow movement)	Scrubbing slider used in <i>Pangkur Paripurna</i> .	Notional mapping to indicate timing of sequence.	Basic left-right movement used, other parameters ignored.
<i>Kempyang / kethuk</i>	<i>Gender</i> parts in <i>Monggang Alit</i> and <i>Pangkur Paripurna</i> .	Note values transferred to keys of <i>gender</i> with hard beaters.	Octave restriction, loss of associated timbre.
	<i>Kethuk</i> part in <i>Monggang Alit</i> .	Traditional part with additional lower <i>kethuk</i> (note “6” borrowed from <i>pelog</i>).	Impression of offset part (placement of <i>pelog kethuk</i> on <i>kempul</i> strokes).
<i>Kenong and kempul</i>	Sampled parts in <i>Monggang Alit</i> .	Direct mapping from traditional <i>ketawang</i> structure. Random delays applied to match delayed strokes in traditional <i>irama</i> .	Addition of <i>kempul</i> in space of <i>wela</i> (as sometimes found in Jogja style). Note sequence does not match <i>balungan</i> in <i>Subakastawa</i> , instead referring to the <i>Monggang</i> sequence.
	Instrumental parts in <i>Monggang Alit</i> and <i>Pangkur Paripurna</i> .	Abstract note values mapped to keys of <i>gender</i> .	Selection of register in relation to mapping of <i>kempyang</i> and <i>kethuk</i> part.
	Transducer parts in <i>Pangkur Paripurna</i> .	White noise stimulating resonance of <i>bonang</i> and <i>kethuk</i> . Note values mapped to limited range of <i>pencon</i> (notes “1”, “2”, and “6”), using <i>kempyung</i> where necessary.	Primarily textural part with slow attack.

Structuring and general phrasal idiom			
Source	Application	Interpretation	Modification
<i>Pathet</i>	Ordering and overall feel of set, part selection.	Selection of instrumental parts, envelope <i>cengkok</i> and <i>kempyung</i> for	Break from <i>pathet</i> in improvised sections. <i>Rasa</i> of interpreted

		<i>kenong</i> and synthesized gong.	pieces not taken into account.
<i>Laras slendro</i>	Sine wave part in <i>Dhandhanggula</i> and introduction to <i>Durma</i>	Frequencies based on concrete pitches from the <i>gender</i> .	Discrepancies in tuning via aural feedback.
<i>Laras pelog</i>	Sine wave part for <i>Durma</i>	Intervals based on existing <i>pelog</i> tuning. Notes played on <i>slendro gender</i> restricted to new <i>pelog embat</i> .	Transposition of existing tuning within traditional bounds and matching selected notes from <i>slendro gender</i>
<i>Ketawang</i> structure	<i>Balungan</i> structure and punctuating instruments.	Influence on construction of <i>balungan</i> and traditional mapping to punctuating instruments.	Additional strokes played on sampled <i>kempul</i> .
<i>Macapat</i> vocal parts / patterns	Vocals in <i>Dhandhanggula</i> , <i>Pangkur Paripurna</i> , and <i>Durma</i> .	-	Modification and dynamics of parts based on personal expression
<i>Palaran</i> structuring	Instrumental parts.	<i>Gong</i> notes for <i>macapat</i> accompaniment	Mapped to pitch range of instruments, <i>kempyung</i> used where appropriate.
<i>Irama</i> (expansion of structures and material)	Deceleration in <i>Durma</i> .	Tempo modulation performed by musicians.	Parts slow down independently of each other.
	Extended vocal sounds in <i>Dhandhanggula</i> and other textural parts.	Notional reference through phase vocoding, reverb feedback, and granular synthesis.	Processes replaced with equivalents in target domain.
	Extended structures and <i>kethuk</i> part in <i>Subakastawa</i>	Pre-sequenced tempo automation in Ableton Live. Notional mapping to pre-sequenced material (<i>kethuk</i>).	Unnaturally linear tempo changes based on computer clock. Sequences based on aural feedback and personal expression.
<i>Sirepan</i>	Quiet section in <i>Pangkur Paripurna</i> to make space for electronic parts.	Removal of instrumental parts.	<i>Gender</i> drops out where it would traditionally lead the <i>irama</i> . Space heightened

			through adaptation of <i>balungan</i> to <i>nibani</i> -type patterns.
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3.4.4.c Cues to indicate discourse

From the start of the set, the use of a traditional vocal part suggests an idiomatic discourse. A listener familiar with the *gender* may take the initial reference notes as indication of the relationship between the vocals and the pitched material subsequently played by the sine waves. The connection is cemented through anticipation and coincidence between the vocal parts, providing an almost unmistakable accompaniment. However, the unusual envelope shape and timbres of the sounds maintain a texturally oriented discourse. This is confirmed by the pre-recorded textures that appear to grow out of the vocal part, adding a layer of manipulation of the acoustics, and eventually the introduction of the textures in the *bonang* that signal the move into *Monggang Alit*.

The subsequent discourse is generally determined by the balance of the electronic and instrumental parts, the latter of which are for the most part idiomatic. When the instruments drop out, the discourse tends to move towards un-idiomatic textural areas. At times the idiomatic framework borrowed from *karawitan* provides an indication of how to hear the electronic parts; for example the *irama* change to level III in *Monggang Alit* helps the listener perceive the relation to the idiomatic framework of what might otherwise be regarded as a primarily textural part (as in the earlier *Monggangan*). The *sirepan* in *Pangkur Paripurna* serves a similar role.

Occasionally the listener is led between discourse types as a compositional device; this is most prominent in the dissolution in *Durma*. In this case, a texture is established, growing out of the final note of *Pangkur Paripurna*. The *gender*-type instruments enter with an unmistakably melodic line, shifting into an “abstract musical” (note-oriented) discourse, which is quickly dissolved, running into textures and play on beating tones as the sine waves enter. The shift back into idiomatic territory is tentative as the sine waves move into *pelog barang*, confirmed by the re-appearance of the vocal part. Here the underlying – now indeterminate – texture of the *gender* may gradually shift back into perception as an idiomatic element, as the notes appear to support the vocal line.

3.5 Response to ShoutCry Room (2012, AV5)

Response to ShoutCry Room represents a collaboration with dancer Rebecca Woodford-Smith, involving pre-recorded audio and solo movement. The piece was developed in response to a set of sumi-e paintings and text created by the visual artist Oi Nuen Sprunt. A public performance took place in October 2012 as part of an event entitled *Art and Healing* at the New Diorama theatre in London. Sprunt's paintings were hanging in the space and provided the visual backdrop for the performance. Audio and video recordings are available in the portfolio (AV1.5.A).



Figure 3-34: Rebecca Woodford-Smith amongst paintings by Oi Nuen Sprunt (still from video by York Woodford-Smith).

3.5.1 Description

The audio elements of the work are based on the collection of *gender* and *bonang*-type instruments I had gathered for the *Augmented Gamelan* set. The electronic parts comprise various sounds played through transducers, granular synthesis organized by electronic *cengkok*, low frequency sine waves, and various other textures generated through signal processing and editing.

The piece is divided into three parts according to discourse and syntax (see §3.5.3.a), and subdivided into overlapping sections according to the narrative text used in development. **Figure 3-35** depicts events as recorded in the New Diorama Theatre; the divisions between sections are approximate. Low frequency tones with a similar function to gong strokes are marked as in previous timelines (**Figure 3-24**).

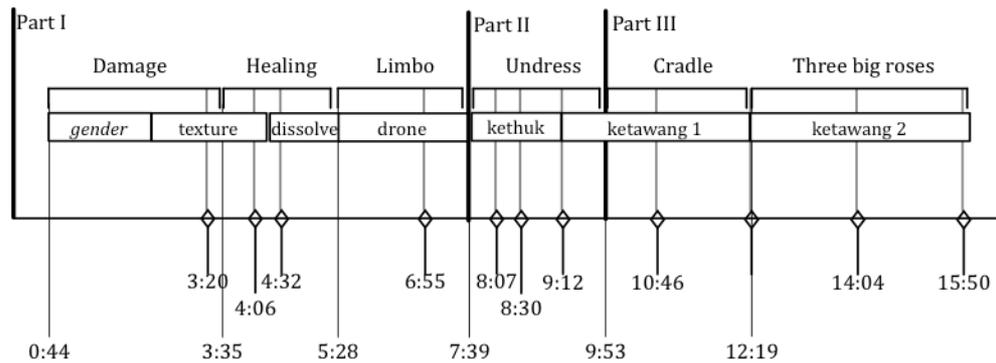


Figure 3-35: Timeline of events in *Response to ShoutCry Room*.

3.5.1.a Part I

Damage (0:43~3:35)

Following an initial silent passage as the dancer enters the space, a solo *gender* starts the piece. A *gembyang* 6 is played with soft beaters. The notes repeat in a slow cycle, with subtle variations in timing increasing with each iteration. The space between the strokes gradually fills with processed reverberation and filtered white noise.

The timbral and pitch content gradually develop through additional strokes with hard beaters and the introduction of digital processing. Small sine waves derived from the spectrum of the instrument play in the background (2:06), emphasizing the higher partials as the *gender* becomes stretched beyond recognition. A deep bass tone and burst of high noise mark the end of the section; the *gender* recedes to the background, developing into a drone that sits underneath the movement in the subsequent sections.

Healing (3:35~5:45)

Further bursts of sound appear, formed from bowed notes; these are treated with amplitude modulation, interweaving with processed metallic textures sent through the *bonang*. A pulse builds in the background, culminating in a clattering, metallic rhythm that immediately destabilizes, slowing into near silence.

Limbo (5:45~7:40)

The drone from the initial *gender* strokes continues to develop into a distant, subtle texture reminiscent of crickets. Swelling bass eases into a new space: an indistinct metallic texture.

3.5.1.b Part II

Undress (7:40~9:50)

Two *bonang* (notes 2 and low 6) play alternating strokes in a double-*kethuk* part. The rhythm shifts erratically between *gatra*, doubling and halving its pulse. Distant drones, undulating white noise, and soft metallic rattling build in the background. Bass tones appear to play the role of a gong, stretching out and forming beating tones.

3.5.1.c Part III

Cradle (9:50~11:40)

The *kethuk* gives way to a rich texture with prominent pitched content from the *slendro* scale, wavering subtly. Several notes are played by a bowed *slenthem* and pair of *gender*, creating beating tones. These mimic the notes of *kenong*, *kempul*, and gong as they are played in alternating combinations. A distant *kendhang* appears to cue a gong part, emerging as a beating texture out of the low bass tones.

Three big roses (11:40-end)

Upon the second stroke of the virtual gong, the dense texture dissipates, giving way to a pitch sequence. A gentle metallic texture fades in and out, growing in prominence, reinforcing the stabilizing structure. The piece finishes gently on a gong and a bowed note "6", accompanied by the sound of rain on a windowpane.

3.5.2 Development process and technical notes

The collaboration primarily took place over the Internet over the course of several months, with one rehearsal in the studios at Middlesex University before running through it in the venue on the day of the performance. Due to limited rehearsal time and a shared desire for consistency the audio was pre-recorded, but the various channels were mixed to fit the performance space on the day and section transitions were triggered in response to movements on stage.

Rebecca's creative and performance processes are linked to embodiment of images and emotional stimuli - what she describes as "finding ways of using the body to give form to memory" (Woodford-Smith, 2013). Having started with the paintings and Sprunt's description of her experience creating them, we worked from a further selection of written images, paintings and photographs that Rebecca had chosen as

sources to draw on for movement. I created several audio sketches, largely based on an exploratory approach, from which we chose sections for further development⁴⁹.

My aim for this project was to move away from arrangements of traditional material towards what I could call an original composition, finding ways to integrate non-idiomatic material while maintaining links with the traditional aesthetic and roles of the instruments. I made a conscious effort to work texturally, concentrating on deconstructing the sounds of the *gender* with various beaters, bowing and computer processing, in keeping with the given theme of damage and attempting to respond to the various images provided by Oi Nuen and Rebecca. My approach to the *bonang* and transducers was more intuitive than in previous works, free from the self-imposed idiomatic restrictions. I found myself incorporating the extraneous sounds of traffic and rain into the composition alongside the processed *gender* sounds, and amplifying them through the metallic resonance of the instruments⁵⁰. Chance operations also played a major role in the composition process, initially as a way to break free of referring to traditional gamelan structures. The timing for *section 4* was created using dice to determine the pace of otherwise regular parts such as the *kethuk*, which were subsequently elaborated upon using patterns derived from traditional techniques within the *Mipilan* software.

It was sometimes difficult to deny convention; the low sine tones suggested punctuation for key moments, mimicking the deep sound of a gong in a gamelan that usually signifies the end of a phrase or cycle. I attempted to explore the borders of the sounds' established functions, extending them in time, introducing their constituent frequencies gradually, and juxtaposing them with bursts of white noise.

3.5.2.a Balungan and bentuk

The *balungan* as an audible melodic line plays a minor role in this piece, primarily functioning as the medium linking the computer and instrumental parts. *Balungan* exist in various other forms, from the framework established early on, to the

⁴⁹ Placement of timed comments on the audio sharing website SoundCloud (<<http://www.soundcloud.com/>>, accessed 26/01/14) proved invaluable in discussing the audio sketches, which Woodford-smith worked with independently in her studio space to create the movement parts. The notation presented in **N.5** was developed for illustrative purposes later.

⁵⁰ In further development of this collaboration I have continued to explore the construction of sounds by stimulating resonances in gamelan instruments with field recordings, deriving abstract structures from wind and rustling of clothes.

sequence of notes played by the various bowed *gender*-type instruments in their roles assumed from the *kenong* and *kempul*.

The main structure focuses on movement around the note “6”, from the initial notes and their fluid breaking-down in *part I*, to the more idiomatic movement in *part III*. The piece starts diverging from note “6” around 1:48, moving through an indeterminably pitched noise that gradually stabilizes as a note “3”. A brief cycle is established, which through subsequent analysis I conceptualized as movement through the sequence: 3 . 5 6. The order of pitches developed from my own exploratory approach, both in real-time improvisation and non-real-time sound sculpting, and based on the affordances of the instruments and the relationships between the sounds. In some respects the pitch movement was incidental, a by-product of a more focused timbral deconstruction and re-imagining of the instrumental texture.

The *ompak* from *ketawang Pangkur Paripurna* as used in the *Augmented Gamelan* set matched this structure, which served as a temporary framework during the development of the piece. This provided grounding for the resolution of the piece as a whole, developing from textural movement to the idiomatic discourse implied by the first *gender* notes. I kept the *seleh* notes intact, which formed the basic *balungan*: 3 1 3 6 to be played on the various *gender* instruments (N5.B).

A further *balungan* for the synthesizer envelopes and various other instrumental parts was based on chance procedures generated in the *Mipilan* software. Having fixed the key points in the sequence, I experimented with randomizing the mediating notes. This took place without regard for *pathet*, and was principally based on aural feedback from the granular parts.

3.5.3 Discussion and analysis

The discussion in this section focuses on the audio aspects of the piece in isolation, but the narrative and relationship to the movement is important to note. Although the piece maintains its own discourse in isolation and is based on exploration of a set of processes, this belies a more complex dialog through verbal communication and response to visual images.

Of the works presented in the main portfolio this is the only one intended to be experienced inflexibly, as a concrete recording, from the start of development.

Nonetheless most sections have prominent instrumental parts and may be adapted for real-time performance.

- The ***balungan*** as a melodic framework or concrete *saron*-style part played a minor role. What would be salient musical information in a traditional context was generally considered arbitrary during development. Much melodic movement was borrowed from existing work or created unintentionally through textural manipulation and chance processes, and subsequently adapted and manipulated in a concrete manner.
- The overall **arrangement** is more important, with movement between non-idiomatic and idiomatic material forming tension and release.
- The instrumental and electronic ***garap*** are a continuation of the previous stages of compositional development, incorporating extended techniques and building on instrumental idioms such as *pipilan* and the *kethuk* part.
- The wider **conceptual level** plays a prominent role, and differs from the other pieces presented so far. Through this work I have been less concerned with the interpretation of idiomatic material and placement in a cultural context, instead engaging with a narrative framework, providing atmosphere, accompaniment and counterpoint to the physical movement.

3.5.3.a Syntax and discourse

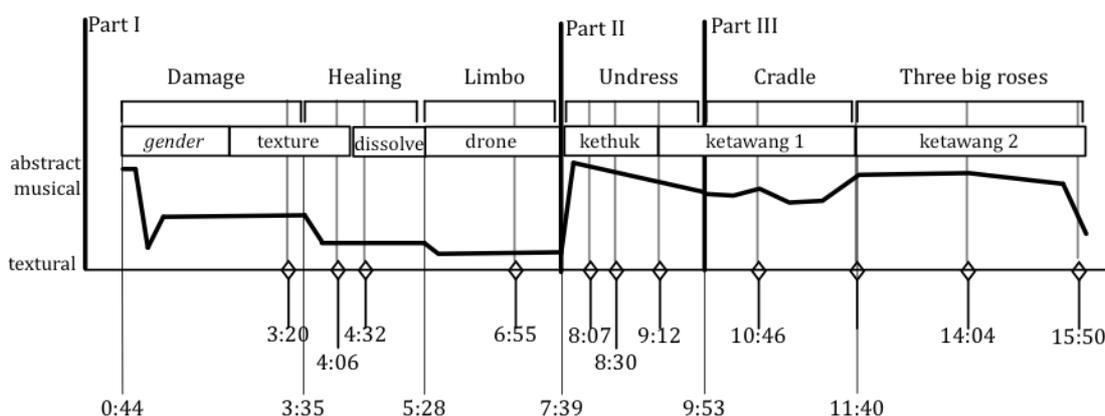


Figure 3-36: Abstract musical and textural discourse in *Response to ShoutCry Room* (composer’s subjective judgement).

Figure 3-36 shows the movement between “abstract musical” (in this case note-oriented) and textural discourse, the latter of which includes mimetic elements. In contrast to the examples presented by the *Bonang Study* and *Tenuous Links*, this movement occurs as a result of the fluid development process and narrative structure

rather than a link with a more easily measured parameter such as *irama*. The general movement of syntax and discourse follows piece's division into three parts, as illustrated in **Figure 3-37**.

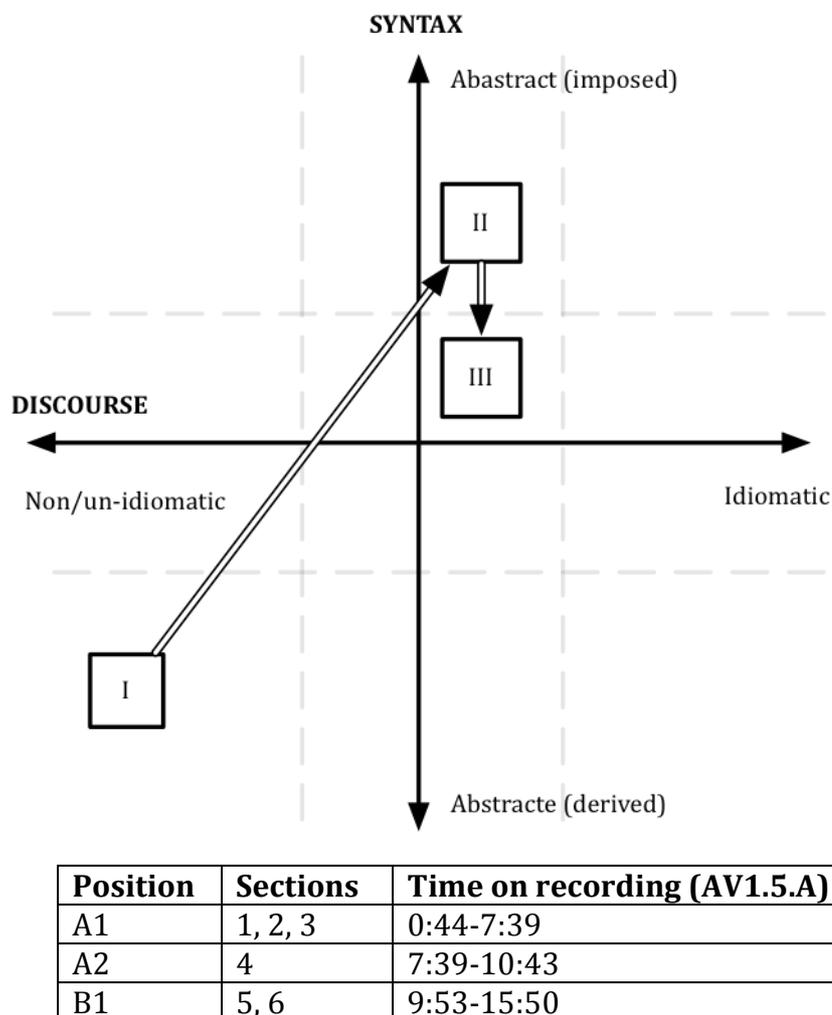


Figure 3-37: Syntax and idiomatic reference in *Response to ShoutCry Room*

Following a brief instrumental introduction, *part I* presents a primarily non-idiomatic, textural discourse, based on the deconstruction of instrumental timbres and spatial movement. Occasional mimetic elements appear, such as the apparent sound of crickets in *section 3*. The syntax is mostly based on intrinsic sound relations, with occasional base-level idiom borrowed from playing techniques associated with the *gender* and gong-type tones for accents.

In *part II* the discourse takes a more idiomatic turn as the *kethuk* provides grounding in a gamelan-related structure, while bass tones play on the border of the function of a *gong ageng* and non-idiomatic textures play in the background. The

syntax in this section is primarily imposed (abstract). The placement of the *kethuk* and gong are borrowed from traditional structures and additional techniques from previous work (such as the colotomic placement of a lower-pitched *kethuk* developed during *Monggang Alit*), and subsequently modified with abstract information generated by chance processes.

The relationship between discourse and syntax is less clear in *part III*. As in previous pieces, this ambiguity occurs through the layering of approaches and the organisation of non-idiomatic material with idiomatic processes. An experienced listener may identify the *ketawang* structure, but might not associate the slow-attack envelopes with traditional-style techniques, perhaps relating them to the predominantly textural un-idiomatic movement in the previous sections. Here the syntax is a combination of imposed and derived, as the mapping and manipulation of sounds sit with equal importance to the musical elements based on idiom and chance procedures. A paradoxical movement takes place in which a part appears to be less idiomatic in mechanical terms, but develops a stronger musical discourse.

3.5.3.b Idiomatic reference

The following table shows a breakdown of the idiomatic references and conceptual mappings involved in the development of the piece:

Table 3-10: Idiomatic reference table for *Response to ShoutCry Room*.

Instrumental idiom (including instrument-specific phrasal idioms)			
Source	Application	Interpretation	Modification
<i>Bedhug</i>	Drum part indicating gong in final section	-	Concrete audio part (Balinese <i>kendhang</i>) is pitch shifted.
<i>Gong ageng / kemodhong</i>	Extended bass drones. Placed at key moments including traditional place in <i>ketawang</i> structure.	Low sine tones paired to create beating, amplitude controlled by faders or automation.	Component tones are manipulated independently. Envelopes are manipulated beyond limitations of physical instrument.
<i>Gender</i>	Instrumental part used throughout.	Simple phrases based on playing techniques (<i>gembyang</i> , delayed strokes)	Concrete manipulation of timbre and pitch.
<i>Kempul</i> and	Bowed <i>gender</i>	<i>Kenong</i> strokes	Pitches mapped to

<i>kenong</i> (<i>ketawang</i> form)	parts.	mapped to <i>gender</i> A. <i>Kempul</i> and gong strokes mapped to <i>slenthem</i> .	instrument range, modification through personal expression (based on techniques developed in <i>Augmented Gamelan</i>).
<i>Pipilan</i> technique (<i>bonang</i>).	Envelope parts for stretched <i>gender</i> tones.	Selection of generalized envelope <i>cengkok</i> based on formalized principles from instrumental idiom. Note pairs mapped to library of pre-determined envelope shapes.	Traditional part selection substituted with <i>simplified garap</i> process. Movements influenced by affordances of sliders and graphic notation. Modification in performance through timing input and parameter smoothing.

Structuring and general phrasal idiom			
Source	Application	Interpretation	Modification
<i>Balungan</i>	Generation of instrumental and synthesizer parts.	Basis for envelope generation in <i>Mipilan</i> software.	Sequence not played directly (<i>seleh</i> notes played by <i>gender B</i>).
	Conceptual grounding for development of piece.	Classification of parts generated through concrete experimentation.	Abstraction of pitched elements without regard for rhythm.
<i>Laras slendro</i>	Base tuning for piece.	Selection of pre-tuned granular material.	Alternation and combination of <i>embat</i> of two instruments.
<i>Pathet manyura</i>	Tonal organization identified during development process (not stated in the title or presentation of piece).	Influence on construction of <i>balungan</i> , including quotation from existing material (<i>Pangkur Paripurna</i>).	Movement outside <i>pathet</i> resulting from randomized <i>balungan</i> and personal expression.
<i>Kempyang / kethuk structure</i> .	Pulse played in <i>Part II</i> .	Traditional <i>slendro kethuk</i> with added lower <i>pelog kethuk</i> .	Lower <i>kethuk</i> part in extension of traditional rhythmic relationship (from <i>Monggang Alit</i>).

	Underlying pulse in <i>Part III</i> (subsequent conceptualization following aural experimentation).	Volume of concrete traffic sounds shaped by <i>kethuk</i> pulse through volume automation.	Uniform slow attack and release in relation to central clock.
<i>Ketawang</i> structure	<i>Balungan</i> structure and colotomy in <i>Part III</i> .	Influence on construction of <i>balungan</i> and <i>gender</i> parts.	Additional gong midway through cycle.

In contrast to the other pieces presented in the portfolio, many of the idiomatic references in *ShoutCry Room* occurred as a result of experimental activity that was later identified as complementing the traditional parts. Although the idiomatic parts are overly simple, they serve a more considered narrative and structuring based on the juxtaposition of discourse-types and sonic relationships.

3.5.3.c Cues to indicate discourse

The initial use of the *gender* provides an indication that this is to be a musical, perhaps instrumentally oriented accompaniment to the movement on stage. The lingering on a single class of note and deconstruction of the instrumental sound suggests an un-idiomatic, textural discourse. The *kethuk* part, albeit influenced by random timing, suggests a more idiomatic discourse in the second part, guiding the listener to search for abstract musical information. This in turn helps ease into the final section. Although the enveloped granular parts not clearly idiomatic at first, the use of the bowed *gender* and gong at key points help establish that an idiomatic discourse is taking place.

Appendix 4: Digital portfolio

This section lists the audio/video files as referred to in the thesis. The information presented here is duplicated on the data DVD alongside the relevant files.

AV1 Main audio/video

AV1.1 *Bonang Study*

28th March 2011.

Recorded at the Royal Festival Hall, Southbank Centre, London.
All parts: Charles Matthews, overdubbed with handheld recorder.

AV1.1.A Electronic version

- **Audio (08:56)** 1-1-A-Bonang_Study-Electronic-Audio.aif

AV1.1.B Ensemble version

- **Audio (08:56)** 1-1-B-Bonang_Study-Ensemble-Audio.aif

AV1.2 *Tenuous Links*

July - September 2011

Recorded at the Placard Headphone Festival at Access space, Sheffield (14/09/11),
and at home in London (16/07/2011).

All parts: Charles Matthews

AV1.2.A Studio version

- **Audio (09:20)** 1-2-A-Tenuous_Links-Studio-Audio.aif
- **Video (08:56)** 1-2-A-Tenuous_Links-Studio-Video.mp4

AV1.2.B Placard performance

- **Audio (19:21)** 1-2-B-Tenuous_Links-Placard-Audio.aif

AV1.3 *Monggangan (development session)*

9th March 2012

Development/recording session at ISI Surakarta, Indonesia.

Performers:

Gamelan *monggang* and vocals:
Joko Purwanto
Sri Harta

I Ketut Saba
Supardi
Rusdiyantoro
Prasadiyanto
Sri Joko Raharjo

Computer: Charles Matthews

AV1.3.A Ensemble version

- **Audio (11:01)** 1-3-A-Monggangan-Ensemble-Audio.aif
- **Video (11:01)** 1-3-A-Monggangan-Ensemble-Video.mov

AV1.3.B Electronic version

- **Audio (12:37)** 1-3-B-Monggangan-Electronics-Audio.aif

AV1.4 *Augmented Gamelan* (concert set)

30th June 2012

Recorded at the Union Chapel, London.

Performers:

Vocals, *kethuk*: Cathy Eastburn

Gender A: Robert Campion

Gender B: Charlotte Pugh

Slenthem: Malcolm Milner

Electronic parts: Charles Matthews

Live sound engineer: Chris Gomersall

Additional mastering: Paul Chivers

AV1.4.A Union Chapel performance part 1 (*pathet sanga*)

- **Audio (16:40)** 1-4-A-Augmented_Gamelan-Union_Chapel-Part1-Audio.aif

AV1.4.B Union Chapel performance part 2 (*pathet manyura*)

- **Audio (14:32)** 1-4-B-Augmented_Gamelan-Union_Chapel-Part2-Audio.aif

AV1.5 Untitled (*Response to ShoutCry Room*)

28th October 2012

Recorded at the New Diorama Theatre, London, UK.

Audio developed at home and in the Middlesex University recording studio, London.

Movement: Rebecca Woodford-Smith

Sumi-e images: Oi Nuen Sprunt

Audio: Charles Matthews

Video by York Woodford-Smith

AV1.5.A New Diorama Theatre performance

- **Audio (15:51)** 1-5-A-Response_to_ShoutCry_Room-Audio.aif
- **Video (16:37)** 1-5-A-Response_to_ShoutCry_Room-Video.mov

AV2 Additional recordings

AV2.1 Untitled York workshop

25th July 2011.

Recorded with members of Gamelan Sekar Petak at the University of York.

Performers:

Bonang: John Jacobs

Kethuk: Ginevra House

Gongs: Jon Hughes

Gender: Charlotte Pugh

Electronic parts: Charles Matthews

AV2.1.A Section 1

- **Audio (09:38)** 2-1-A-York_Workshop-Section_1-Audio.mp3

AV2.1.B Section 2

- **Audio (04:43)** 2-1-B-York_Workshop-Section_2-Audio.mp3

AV2.2 *Bonang Study* (group version)

25th November 2011

Workshop at the Southbank Centre featuring the rhythmic dissolution of a *gangsaran*. This is followed by an interpretation balungan used in *Bonang Study*, with granular synthesis replacing the parts played through the transducers.

Performers:

Robert Champion

Andrew Channing

Isabelle Carré

Charlotte Pugh

Electronic parts: Charles Matthews

AV2.2.A Development session

- **Audio (04:16)** 2-1-A-Bonang_Study-Workshop-Audio.mp3

AV2.3 *Sunday* (solo development)

27th November 2011

Solo development session with transducers, various gongs and granular synthesis.
Recorded in the Southbank Centre, London.

All parts: Charles Matthews

AV2.3.A Development session

- **Audio (09:48)** 2-3-A-Solo_Development-Audio.mp3

AV2.4 *Planet Harmonics* sketches

February-March 2012

Recorded in Grogolan, Surakarta, Indonesia.

Instruments used with kind permission from Aloysius Suwardi.

All parts: Charles Matthews

AV2.4.A Gong Genthā Study

- **Audio (07:39)** 2-4-A-Gong_Genthā_Study-Audio.mp3

AV2.5 *Srikaton*

January - March 2012

Recorded at ISI Surakarta, Indonesia

Performers:

Gender: Joko Purwanto

Kendhang: Supardi

Slentem: Prasadiyanto

Gerongan:

Sri Harta

I Ketut Saba

Rusdiyantoro

Sri Joko Raharjo

Electronic parts: Charles Matthews

AV2.5.A Solo gender version (development session)

- **Audio (04:53)** 2-5-A-Srikaton_Development_JP-Audio.mp3

AV2.5.B Group version (excerpt from development session)

- **Audio (04:40)** 2-5-B-Srikaton_ISI_Ensemble-Audio.mp3

AV2.6 *Augmented Gamelan* (studio version)

4th August 2012

Recorded at Hampstead Music and Voiceover Studio, London, UK.

Performers:

Vocals, *kethuk*: Cathy Eastburn

Gender A: Robert Champion

Gender B: Charlotte Pugh

Slentem: Malcolm Milner

Electronic parts: Charles Matthews

Engineers: Paul Chivers and Mick Ritchie

AV2.6.A HMVS session part 1 (pathet sanga)

- **Audio (18:10)** 2-6-A-Augmented_Gamelan-HMVS-Part1-Audio.mp3

AV2.6.B HMVS session part 2 (pathet manyura)

- **Audio (14:24)** 2-6-B-Augmented_Gamelan-HMVS-Part2-Audio.mp3

AV2.7 *Ketawang Subakastawa*

Autumn 2010, April 2012

Various versions of *Ketawang Subakastawa*, based on the same central sequence. Includes a concert performance from the Gathering of the Gamelans symposium, recorded on the 26th April 2012.

Gamelan:

Robert Champion

Andrew Channing

Gender (concert version): Charlotte Pugh

Electronic parts and *kendhang*: Charles Matthews

AV2.7.A *Ketawang* structure

- **Audio (06:07)** 2-7-A-Ketawang-Audio.mp3

AV2.7.B *Subakastawa* (Gathering of the Gamelans symposium)

- **Audio (07:04)** 2-7-B-Subakastawa-GotG-Audio.mp3

AV2.7.C *Monggang/ Subakastawa* (excerpts from development session)

- **Audio (02:08)** 2-7-C-Monggang-Southbank.mp3

AV2.8 *Mipilan* demos (Charles Matthews)

March-September 2013

Demos of the *Mipilan* software created during the development process. Includes default setup (video) and various abstract mappings to filtered field recordings, gamelan samples, and granular synthesis in Max/MSP.

All parts: Charles Matthews

AV2.8.A *Mipilan* improvisation

- **Video (11:52)** 2-8-A-Mipilan_Improvisation-Video.mov

AV2.8.B Various mappings

- **Audio (15:14)** 2-8-B-Mipilan_Mapping_Demo-Audio.mp3

AV2.9 *Mipilan* demos (Ben McDermott)

15th October 2012

Improvised pieces made by Ben McDermott using an early version of the *Mipilan* software in Sydney, Australia.

AV2.9.A *Mipilan* 1

- **Audio (03:56)** 2-9-A-Ben_McDermott_Mipilan_1-Audio.mp3

AV2.9.B *Mipilan* 4

- **Audio (07:23)** 2-9-B-Ben_McDermott_Mipilan_2-Audio.mp3

3 Notation

See **Appendix 5** below.

4 Software

A standalone version of *Mipilan* is presented here with accompanying user guide and samples. The project source has been included for illustrative purposes and is not intended for assessment; some comments, test patches, and temporary workarounds remain in place from the development process.

Appendix 5: Notation

The following notation has been included to illustrate the composition processes described within the text, and is reproduced from printouts and JSON data used for performance and development sessions. All items are available in the data DVD; some JSON files have been shortened in this print version.

N1 *Bonang Study*

N1.A Balungan with *Bonangan garap*

Buka . 6 5 2
2 1 2 3 5 3 2 1 . 2 1 . 2 1 6 (5)

A ||| 6 5 6 3 6 5 6 3 6 5 6 3 6 5 6 1
 p6563 p6563 p6563 mipil
2 1 2 3 5 3 2 1 . 2 1 . 2 1 6 (5)
 mipil mipil pinmundur l5

B 6 5 6 3 6 5 6 3 6 5 6 3 6 5 6 1
 p6563 p6563 p6563 mipil
2 1 2 3 2 1 6 5 4 4 . . 6 4 6 (5)
 mipil l5 gembyang4 l5

C 2 4 2 1 2 1 6 5 4 2 4 . 2 4 2 1
 mipil l5 p4240 l1
2 1 2 3 2 1 2 1 2 3 5 6 1 6 5 (3) |||
 mipil l1 l6 l5

N1.B Gendhing in JSON (patrr) format

```
{
  "patrrstorage" : {
    "name" : "gendhing",
    "slots" : {
      "1" : {
        "id" : 1,
        "data" : {
          "gd_name" : [ "Nothing" ],
          "gd_laras_pathet" : [ "Pelog Nem" ],
          "gd_balungan" : [ 9, 11, 9, 8, 9, 8, 6, 5, 4,
                           2, 4, 0, 2, 4, 2, 1, 2, 1, 2,
                           3, 2, 1, 2, 1, 2, 3, 5, 6, 8,
                           6, 5, 3 ],
          "gd_bentuk" : [ "Ladrang" ],
          "gongan1" : [ 6, 5, 6, 3, 6, 5, 6, 3, 6, 5, 6,
                        3, 6, 5, 6, 8, 9, 8, 9, 10, 12,
                        10, 9, 8, 0, 9, 8, 0, 9, 8, 6,
                        5 ],
          "gongan2" : [ 6, 5, 6, 3, 6, 5, 6, 3, 6, 5, 6,
                        3, 6, 5, 6, 8, 9, 8, 9, 10, 9, 8,
                        6, 5, 4, 4, 0, 0, 6, 4, 6, 5 ],
          "gongan3" : [ 9, 11, 9, 8, 9, 8, 6, 5, 4, 2, 4,
                        0, 2, 4, 2, 1, 2, 1, 2, 3, 2, 1,
                        2, 1, 2, 3, 5, 6, 8, 6, 5, 3 ],
          "gongan4" : [ 0, 6, 5, 2, 0, 0, 0, 0, 0, 0, 0,
                        0, 0, 0, 0, 0, 9, 8, 9, 10, 12,
                        10, 9, 8, 0, 9, 8, 0, 9, 8, 6,
                        5 ],
          "buka" : [ 0 ],
          "things::thisgendhing" : [ 1 ]
        }
      }
    }
  }
}
```

N1.C Garap in JSON (patrr) format

The patterns selected here represent examples used in the text. The full *garap* file is available in the digital portfolio.

```
{
  "patrrstorage" : {
    "name" : "anotherPatrr",
    "slots" : {
      "1" : {
        "id" : 1,
        "name" : "mipil",
        "data" : {
          "bonang::LCR" : [ 1, 0, 1, 2, 3, 4 ],
          "bonang::I" : [ 1, 0, 1, 2, 1, 0, 3, 4, 3, 0 ],
          "bonang::II" : [ 1, 0, 1, 2, 1, 0, 0, 2, 1, 0,
                           3, 4, 3, 0, 0, 4, 3, 0 ],
          "bonang::III" : [ 1, 0, 1, 2, 1, 0, 0, 2, 1, 0,
                            3, 4, 3, 0, 0, 4, 3, 0 ],
        }
      }
    }
  }
}
```

```

"bonangpanerus::LCR" : [ 1, 0, 1, 2, 3, 4 ],
"bonangpanerus::I" : [ 1, 0, 1, 2, 1, 0, 1, 2,
                        1, 0, 3, 4, 3, 0, 3, 4,
                        3, 0 ],
"bonangpanerus::II" : [ 1, 0, 1, 2, 1, 0, 1, 2,
                        1, 0, 1, 2, 1, 0, 1,
                        2, 1, 0, 3, 4, 3, 0,
                        3, 4, 3, 0, 3, 4, 3,
                        0, 3, 4, 3, 0 ],
"bonangpanerus::III" : [ 1, 0, 1, 2, 1, 0, 1,
                        2, 1, 0, 1, 2, 1, 0,
                        1, 2, 1, 0, 3, 4, 3, 0,
                        3, 4, 3, 0, 3, 4, 3, 0,
                        3, 4, 3, 0 ],
"synth::LCR" : [ 1, 0, 1, 2, 3, 4 ],
"synth::I" : [ 0, 0, "ramp a 1 0 1000", "ramp
                b 1 0 1000", "ramp a 1 0 1000",
                "to a 0 100", "to b 0 100",
                "to d 0.5 0 1000", "ramp c 1 0
                1000", "to c 0 100" ],
"synth::II" : [ 0, 0, "ramp a 0.5 0 2000",
                "ramp b 0.5 0 2000", "ramp a
                0.5 0 2000", "to a 0 100", "to
                b 0 100", "ramp b 0.5 0 2000",
                "ramp a 0.5 0 2000", "to a 0
                100", "ramp c 1 0 2000", "ramp
                d 0.5 0 2000", "ramp c 1 0
                2000", "to c 0 100", "to d 0
                100", "to d 0.3 2000", "ramp c
                1 0 2000", "to c 0 100" ],
"synth::III" : [ 0, 0, "ramp a 0.7 0.1 2000",
                "ramp b 0.7 0.1 2000", "ramp
                a 0.7 0.1 2000", "to a 0 100",
                "to b 0 100", "to b 0.2 1000",
                "ramp a 0.7 0.1 2000", "to a
                0 100", "ramp c 0.7 0.1 2000",
                "ramp d 0.7 0.1 2000", "ramp
                c 0.7 0.1 2000", "to c 0 100",
                "to d 0 100", "to d 0.5 2000",
                "ramp c 0.7 0.1 2000", "to c
                0 100" ]
}

}

"3" :
{
  "id" : 3,
  "name" : "15",
  "data" :
  {
    "bonang::LCR" : [ 1, 0, 1, 2, 3, 4 ],
    "bonang::I" : [ 0, 0, 3, 6, 3, 0, 5, 5, 3, 5 ],
    "bonang::II" : [ 0, 0, 0, 6, 0, 3, 3, 6, 0, 0,
                    3, 6, 3, 5, 5, 3, 5, 0 ],
    "bonang::III" : [ 0, 0, 0, 6, 0, 3, 3, 6, 0, 0,
                     3, 6, 3, 5, 5, 3, 5, 0 ],
    "bonangpanerus::LCR" : [ 1, 0, 1, 2, 3, 4 ],
    "bonangpanerus::I" : [ 0, 0, 3, 6, 3, 0, 3, 6,
                          3, 0, 5, 3, 5, 0, 5, 3,
                          5, 0 ],
    "bonangpanerus::II" : [ 0, 0, 3, 6, 3, 0, 3, 6,
                          3, 0, 3, 6, 3, 0, 3, 6,
                          3, 0, 5, 3, 5, 0, 5, 3,
                          5, 0, 5, 3, 5, 0, 5, 3,
                          5, 0 ],
    "bonangpanerus::III" : [ 0, 0, 3, 6, 3, 0, 3,

```


N2 Tenuous Links

N2.A Colotomic structure

Central pulse: R L R L R L R L R L R L R L R L

"Merong":
 +- -+- +- -+- +- -+- +- -+-

 +- -+- +- -+- +- -+- +- -+-

"Ladrang":
 +- -+- +- -+- +- -+- +- -+-

 +- -+- +- -+- +- -+- +- -+-

N2.B Balungan from Placard performance

Central pulse: R L R L R L R L R L R L R L R L

"Merong":
 . 1 . 6 . 1 . 5 . 1 . 6 . 1 . 2
 6 1 2 3 2 6 5 3 . 1 . 6 . 1 . 5

"Ladrang":
 || . 2 1 . 2 1 2 3 2 1 3 2 . 1 6 5
 1 2 3 5 1 2 3 5 6 5 3 5 3 2 1 6
 2 3 2 1 3 2 1 2 3 5 3 2 3 2 1 2
 1 3 2 1 . . 1 . 2 1 2 3 2 1 6 5 ||

N2.C Balungan from Placard performance in JSON (patrr) format

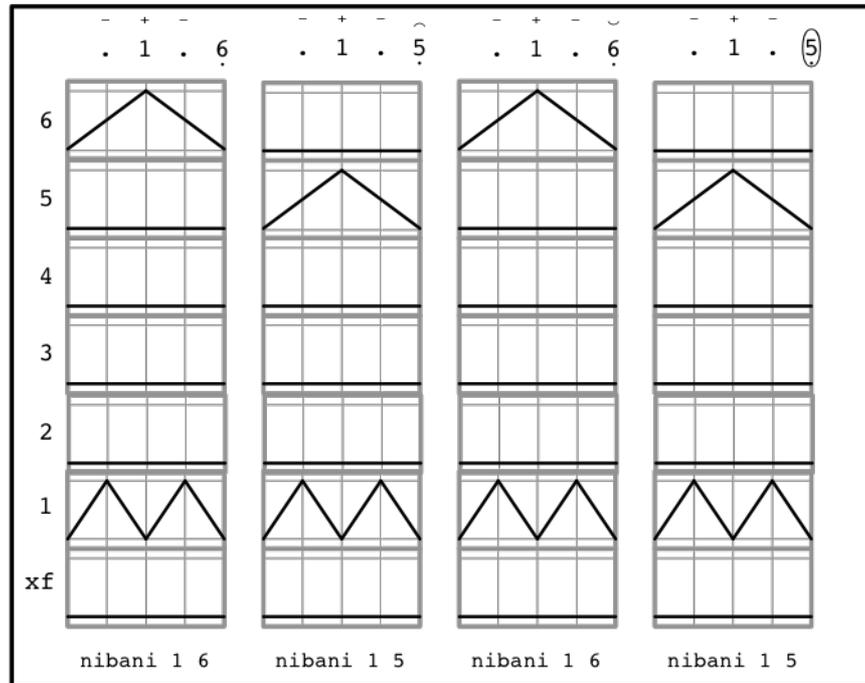
```
{
  "patrrstorage" : {
    "name" : "gendhing",
    "slots" : {
      "1" : {
        "id" : 1,
        "data" : {
          "gd_name" : [ "Nothing" ],
          "gd_laras_pathet" : [ "Pelog Nem" ],

```

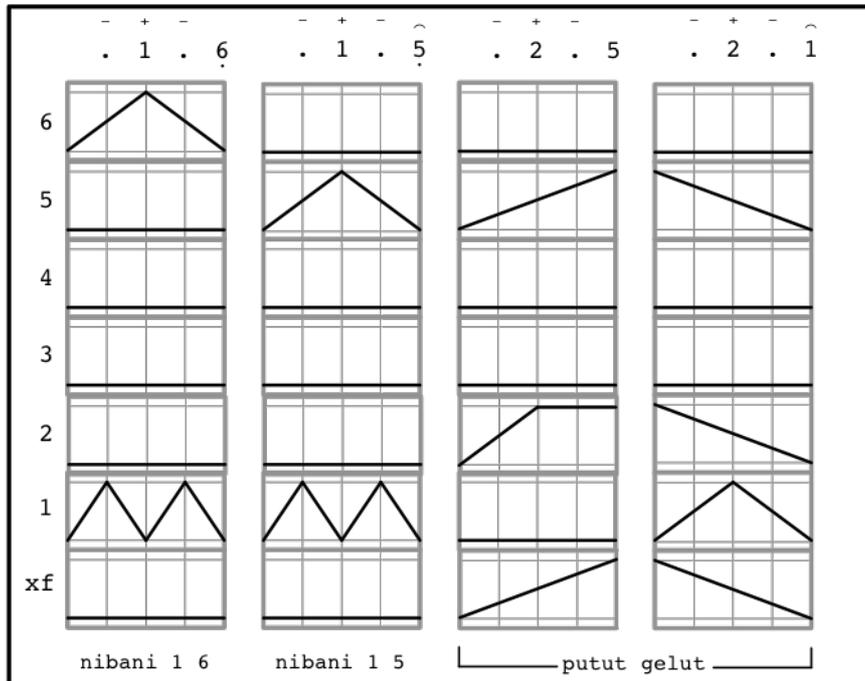

N3 Monggangan and Srikaton

N3.A Monggangan envelope cengkok

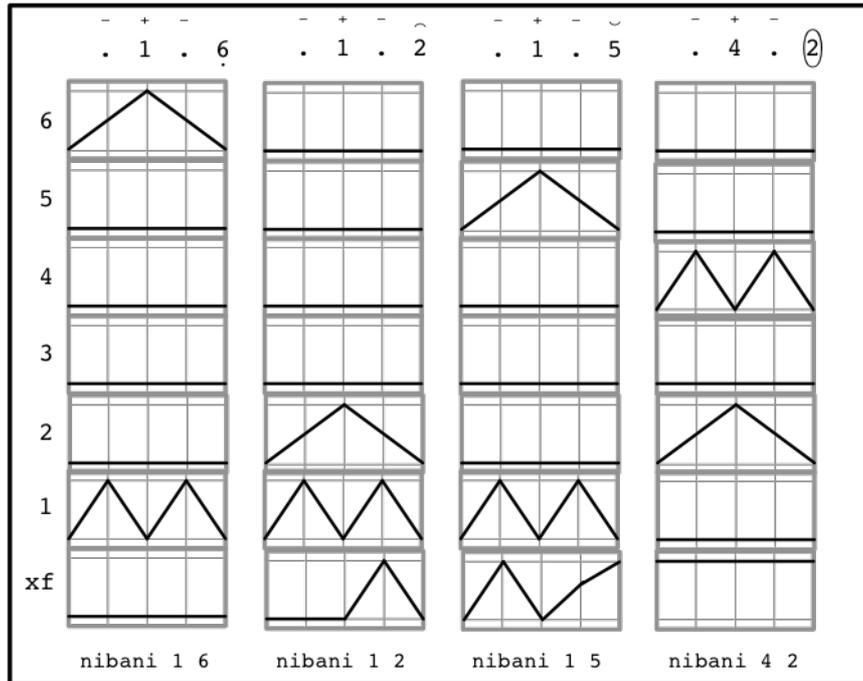
Gongan 1



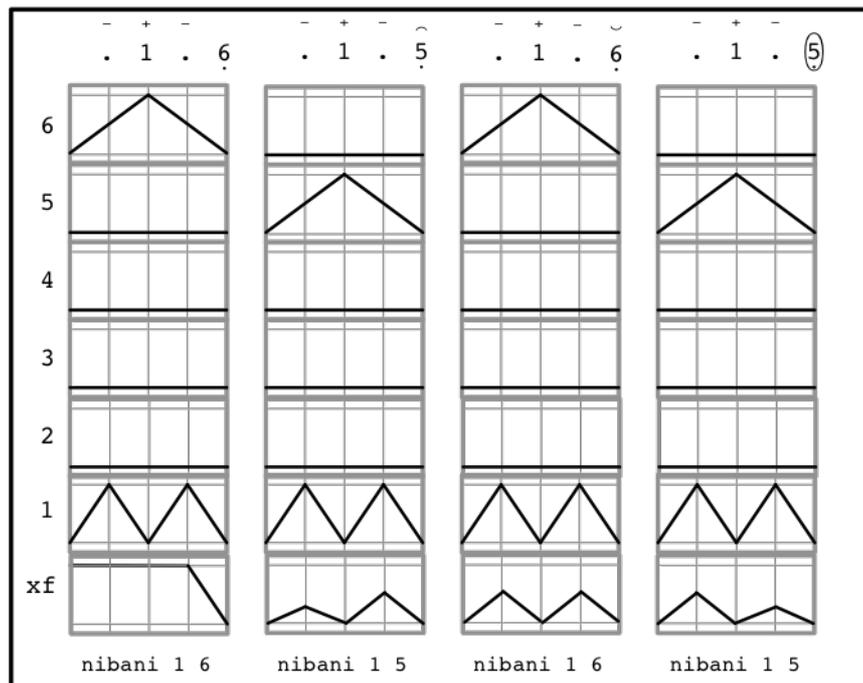
Gongan 2



Gongan 3



Gongan 4



N3.C Monggangan gendhing in JSON format

```
{
  ". 1 . 6" : {
    "1" : "mipilA",
    "2" : "pin",
    "3" : "pin",
    "4" : "pin",
    "5" : "pin",
    "6" : "mipilB"
  }
,
  ". 1 . 5" : {
    "1" : "mipilA",
    "2" : "pin",
    "3" : "pin",
    "4" : "pin",
    "5" : "mipilB",
    "6" : "pin"
  }
,
  ". 2 . 5" : {
    "1" : "pin",
    "2" : "halfRampUp",
    "3" : "pin",
    "4" : "pin",
    "5" : "rampUp",
    "6" : "pin"
  }
,
  ". 2 . 1" : {
    "1" : "mipilB",
    "2" : "rampDown",
    "3" : "pin",
    "4" : "pin",
    "5" : "rampDown",
    "6" : "pin"
  }
,
  ". 4 . 2" : {
    "1" : "pin",
    "2" : "mipilB",
    "3" : "pin",
    "4" : "mipilA",
    "5" : "pin",
    "6" : "pin"
  }
,
  ". 1 . 2" : {
    "1" : "mipilA",
    "2" : "mipilB",
    "3" : "pin",
    "4" : "pin",
    "5" : "pin",
    "6" : "pin"
  }
,
  "balungan" : {
    "1" : [ ". 1 . 6", ". 1 . 5",
             ". 1 . 6", ". 1 . 5",
             ". 1 . 6", ". 1 . 5",
             ". 2 . 5", ". 2 . 1" ],
    "2" : [ ". 1 . 6", ". 1 . 2",
             ". 1 . 5", ". 4 . 2",
             ". 1 . 6", ". 1 . 5",

```

```

        ". 1 . 6", ". 1 . 5" ]
    }
,
    "XF" : {
        "2" : {
            "0" : [ 0.0, 0.0, 128.0, 0.0 ],
            "1" : [ 0.0, 0.0, 64.0, 0.0, 96.0, 0.72,
                    128.0, 0.0 ],
            "2" : [ 0.0, 0.0, 32.0, 1.0, 64.0, 0.0, 96.0,
                    0.72, 128.0, 1.0 ],
            "3" : [ 0.0, 1.0, 128.0, 1.0 ],
            "4" : [ 0.0, 1.0, 96.255997, 1.0, 128.0, 0.0
                    ],
            "5" : [ 0.0, 0.0, 31.743999, 0.8, 64.0, 0.0,
                    96.255997, 1.0, 128.0, 0.0 ],
            "6" : [ 0.0, 0.0, 32.256001, 0.56, 64.0, 0.0,
                    97.024002, 0.52, 128.0, 0.0 ],
            "7" : [ 0.0, 0.0, 32.768002, 0.32, 64.0, 0.0,
                    97.536003, 0.52, 128.0, 0.0 ]
        }
,
        "1" : {
            "0" : [ 0.0, 0.0, 128.0, 0.0 ],
            "1" : [ 0.0, 0.0, 128.0, 0.0 ],
            "2" : [ 0.0, 0.0, 128.0, 0.0 ],
            "3" : [ 0.0, 0.0, 128.0, 0.0 ],
            "4" : [ 0.0, 0.0, 128.0, 0.0 ],
            "5" : [ 0.0, 0.0, 128.0, 0.0 ],
            "6" : [ 0.0, 0.0, 128.0, 1.0 ],
            "7" : [ 0.0, 1.0, 128.0, 0.0 ]
        }
    }
}

```

N3.D *Monggangan envelopes in JSON format*

```

{
    "mipilB" : [ 0.0, 0.0, 64.0, 1.0, 128.0, 0.0 ],
    "pin" : [ 0.0, 0.0, 128.0, 0.0 ],
    "mipila" : [ 0.0, 0.0, 32.0, 1.0, 64.0, 0.0, 96.0, 1.0, 128.0,
                0.0 ],
    "halfRampUp" : [ 0.0, 0.0, 64.0, 1.0, 128.0, 1.0 ],
    "halfRampDown" : [ 0.0, 1.0, 64.0, 1.0, 128.0, 0.0 ],
    "rampUp" : [ 0.0, 0.0, 128.0, 1.0 ],
    "rampDown" : [ 0.0, 1.0, 128.0, 0.0 ],
    "firstHalf" : [ 0.0, 0.0, 32.0, 1.0, 64.0, 0.0, 128.0, 0.0 ]
}

```

N3.E Srikaton envelope cengkok

Gongan 1 (ompak)

	$\begin{matrix} - & + & - \\ \cdot & 2 & \cdot & 1 \end{matrix}$	$\begin{matrix} - & + & - & \smile \\ \cdot & 2 & \cdot & 6 \end{matrix}$	$\begin{matrix} - & + & - & \smile \\ \cdot & 2 & \cdot & 1 \end{matrix}$	$\begin{matrix} - & + & - & \smile \\ \cdot & 2 & \cdot & 6 \end{matrix}$
6				
5				
3				
2				
1				
xf				
	nibani 2 1	nibani 2 6	nibani 2 1	nibani 2 6
	$\begin{matrix} - & + & - & \smile \\ \cdot & 2 & \cdot & 1 \end{matrix}$	$\begin{matrix} - & + & - & \smile \\ \cdot & 2 & \cdot & 6 \end{matrix}$	$\begin{matrix} - & + & - & \smile \\ \cdot & 3 & \cdot & 6 \end{matrix}$	$\begin{matrix} - & + & - & \smile \\ \cdot & 3 & \cdot & 6 \end{matrix}$
6				
5				
3				
2				
1				
xf				
	nibani 2 1	nibani 2 6	putut gelut	putut gelut

Gongan 2 (ngelik)

	- + - · 5 · 6	- + - () · 5 · 3	- + -) · 1 · 6	- + - · 5 · 3
6				
5				
3				
2				
1				
xf				
	nibani 5 6	kacaryan	nibani 1 6	kacaryan
	- + -) · 2 · 1	- + - () · 2 · 6	- + -) · 2 · 1	- + - () · 2 · 6
6				
5				
3				
2				
1				
xf				
	nibani 2 1	nibani 2 6	nibani 2 1	nibani 2 6

N3.F Srikaton gendhing in JSON format

```
{
  ". 2 . 1" : {
    "1" : "mipilB",
    "2" : "mipilA",
    "3" : "pin",
    "5" : "pin",
    "6" : "pin"
  }
,
  ". 2 . 6" : {
    "1" : "pin",
    "2" : "mipilA",
    "3" : "pin",
    "5" : "pin",
    "6" : "mipilB"
  }
}
```

```

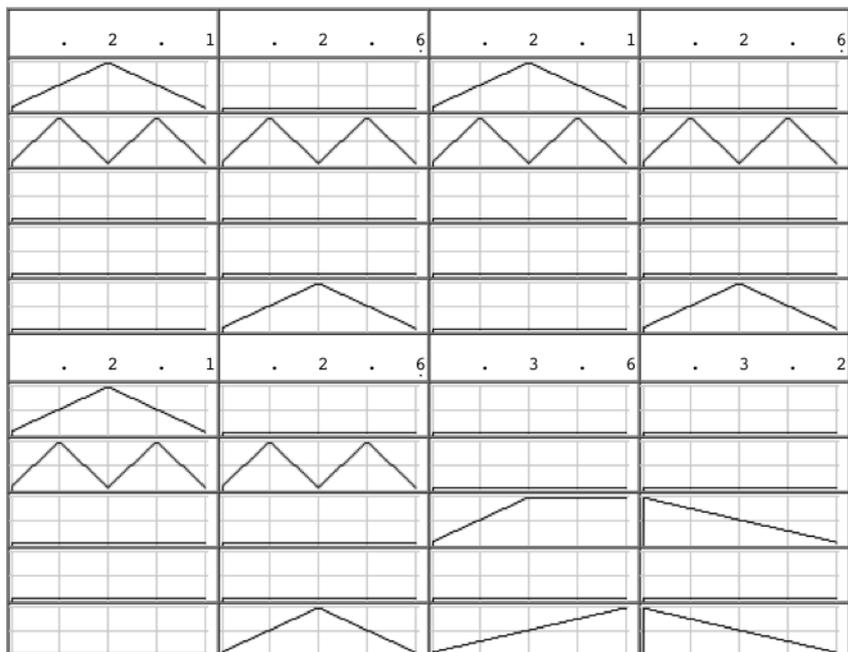
    }
    ,
    ". 3 . 6" : {
        "1" : "pin",
        "2" : "pin",
        "3" : "halfRampUp",
        "5" : "pin",
        "6" : "rampUp"
    }
    ,
    ". 3 . 2" : {
        "1" : "pin",
        "2" : "mipilB",
        "3" : "rampDown",
        "5" : "pin",
        "6" : "rampDown"
    }
    ,
    ". 5 . 6" : {
        "1" : "pin",
        "2" : "pin",
        "3" : "pin",
        "5" : "mipilA",
        "6" : "mipilB"
    }
    ,
    ". 5 . 3" : {
        "1" : "firstHalf",
        "2" : "firstHalf",
        "3" : "mipilB",
        "5" : "firstHalf",
        "6" : "firstHalf"
    }
    ,
    ". 1 . 6" : {
        "1" : "mipilA",
        "2" : "pin",
        "3" : "pin",
        "5" : "pin",
        "6" : "mipilB"
    }
    ,
    "balungan" : {
        "1" : [ ". 2 . 1", ". 2 . 6",
                ". 2 . 1", ". 2 . 6",
                ". 2 . 1", ". 2 . 6",
                ". 3 . 6", ". 3 . 2" ],
        "2" : [ ". 5 . 6", ". 5 . 3",
                ". 1 . 6", ". 5 . 3",
                ". 2 . 1", ". 2 . 6",
                ". 2 . 1", ". 2 . 6" ]
    }
}

```

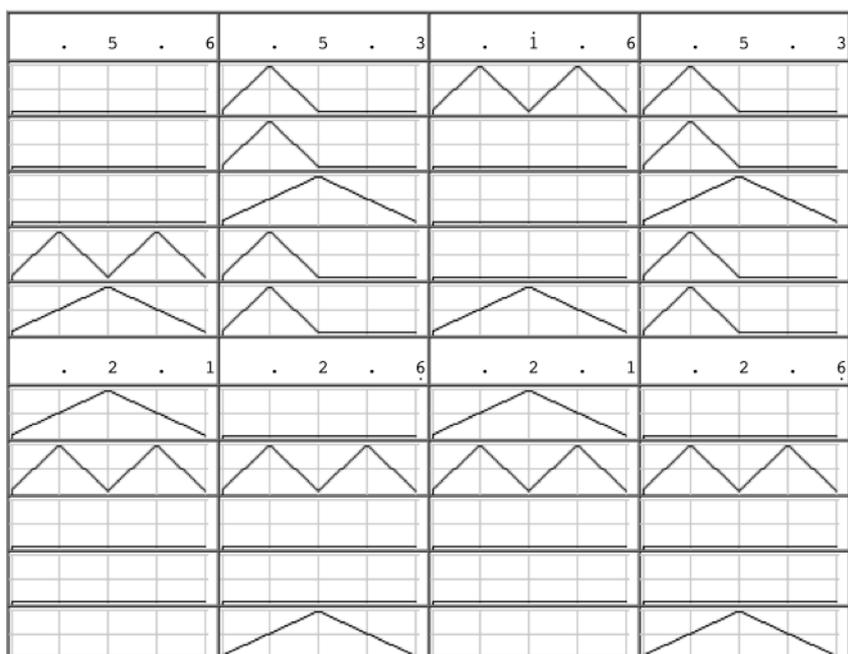
N3.G Initial HTML score generated through *Cengkakan*

Ladrang **Srikaton** Slendro Manyura

Ompak



Ngelik



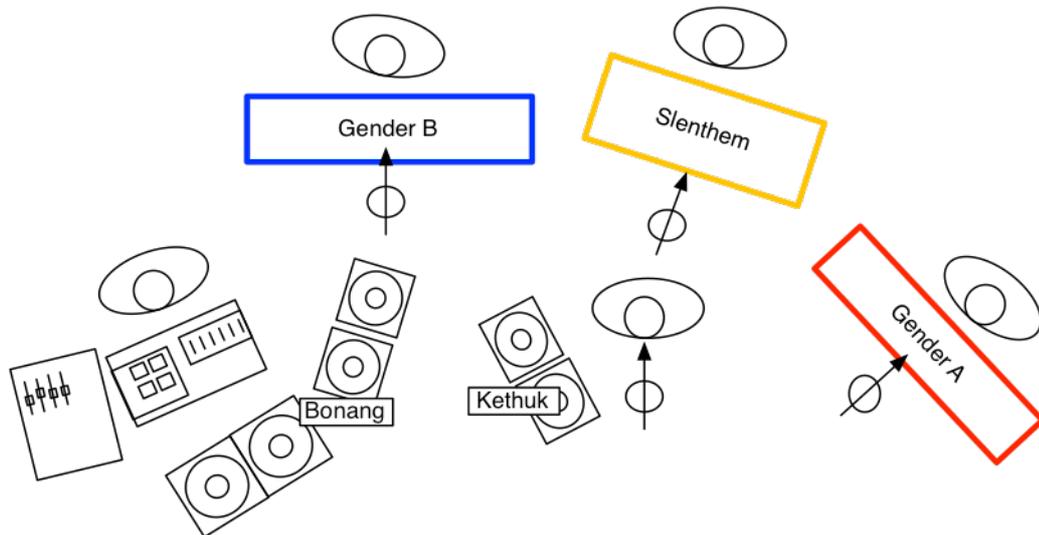
N4 Augmented Gamelan

N4.A Ensemble notation for Union Chapel

The following notation is presented with minimal editing from notes gathered for performance and is not intended as a definitive version. The vocal parts are adapted from versions by Supadmi (1992; 2005).

- 1) **Dhandhanggula** (slendro sanga) (8min)
- 2) **Monggang Alit / Subakastawa** (slendro sanga) (10-12min)
- 3) Ketawang **Pangkur Paripurna** (slendro manyura) (8min)
- 4) **Durma** (pelog barang) (3-6min)

Provisional layout:



Cathy Eastburn: Vocals
Robert Campion: Gender A
Charlotte Pugh: Gender B
Malcolm Milner: Slenthem
Charles Matthews: Computer etc.

1. Dhandhinggula (slendro sanga)

Sine waves (notes 2, 5, 6) fade in slowly from silence; **gender A** could play these notes first. Allow some space before vocals start; sines continue to fade in gradually throughout the piece. Both gender and slenthem bow notes 5 or low 2 where gongs are marked.

Verse 1 (cakepan decided by pesindhen):

- 1) 2 5 6 6, 6 i 2 2 2 2
Pa- me- dha re wa- si- ta- ning a- ti
- 2) 2 2 6 i 6, 6 6 6 6 6 6 5 6
Cu- man- tho- ko a- ni- ru Pu- jang- ga
- 3) 5 6 6 6 6 6 6.i 6.5
Da- hat mu- dha ing ba- thin- e
- 4) 6 i 2 i, 6 i 5 6
Na- nging ke- dah, gi nung- gung
- 5) 5 5 2 2 5 6 1.6 1 2..1.6
Tan wruh la- mun keh kang nge- se- mi
- 6) 2 2 2 2 2, 232 2
A- mek- sa an- grum- pa- ka
- 7) 1 1 6 2 6 1 6..5
Ba- sa kang ke- lan- tur
- 8) 2 2 2 2 2 2 2 2
Tu- tur kang ka- tu- la tu- la
TRIGGER SOUND FILE 1
- 9) 5 3 2 1.6 6 6 6 6 6 1 2 2
Ti- na- la- ten ri- nu- ruh ka la wan ri- rih
TRIGGER SOUND FILE 2
- 10) 2 2 2 2 3 2.1 6.5 6.1
Mrih pa- dhang-ing sas- mi- ta

2. Monggang Alit (Ketawang **Subakastawa** Slendro Sanga)

Computer part starts with burst of noise from the kempyang and kethuk – this gradually expands, slowing down from a pitch into a rhythm – instruments play monggang patterns until it is slow enough for **gender B** to play cengkok, which continues until irama wiled.

The gong/kenong/kempul are synthesized/sampled.

^ Indicates second kethuk (low 6).

Monggang

	.	⁺ 1	.	[△] 6	.	⁺ 1	.	[∧] 5	.	⁺ 1	.	[△] 6	.	⁺ 1	.	[∧] 5
Gender A:	.	.	.	.	.	.	.	5	.	.	.	6	.	.	.	5
Gender B:	.	1	.	.	.	1	.	.	.	1	.	.	.	1	.	.
Slenthem:	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5

Ompak

	.	⁺ 1	.	[△] 6	.	⁺ 1	.	[∧] 5	.	⁺ 1	.	[△] 6	.	⁺ 1	.	[∧] 5
--	---	----------------	---	----------------	---	----------------	---	----------------	---	----------------	---	----------------	---	----------------	---	----------------

Ngelik

	.	⁺ 2	.	[△] 1	.	⁺ 6	.	[∧] 5	.	⁺ 2	.	[△] 1	.	⁺ 6	.	[∧] 5
	.	⁺ 2	.	[△] 1	.	⁺ 6	.	[∧] 5	.	⁺ 2	.	[△] 1	.	⁺ 6	.	[∧] 5
	.	⁺ 2	.	[△] 1	.	⁺ 2	.	[∧] 6	.	⁺ 2	.	[△] 1	.	⁺ 6	.	[∧] 5

3. Ketawang **Pangkur Paripurna** Slendro Manyura

Gender A plays grambyangan and buka (similar to Puspawarna), and leads irama – scheme as traditional, straight into irll. **Gender B** plays kenong and kempul notes in in right and left hand respectively, with hard beater in right hand. **Slenthem** plays balungan. The computer parts are slow-fading tones, sometimes breaking out into bright textures. The gong is synthesized.

Second time through is like a “sirep” – **slenthem** plays the balungan nibani version, and could substitute the dados version of ladrang Pangkur here. **Gender A** should play something along the lines of pinjalan in lower register, joining where desired. Attention is drawn to the computer part here.

Buka: $\underline{\cdot 1 2 3} \quad \underline{5 3 2 1} \quad \underline{\cdot 3 \cdot 2} \quad \underline{\cdot 1 \cdot \widehat{6}}$

First and third time

$2 1 2 3$	$5 3 2 \widehat{1}$	$\underset{\cdot}{6} 1 2 3$	$2 1 2 \widehat{6}$
$\cdot 1 2 3$	$5 3 2 \widehat{1}$	$\underset{\cdot}{6} 1 2 3$	$\cdot 2 1 \widehat{6}^1$
$1 1 \cdot \cdot$	$6 6 \dot{1} \widehat{2}$	$\dot{3} \dot{2} 6 3$	$\cdot 2 \cdot \widehat{1}^3$
$3 3 \cdot \cdot$	$6 5 3 \widehat{2}$	$3 2 5 3$	$6 5 3 \widehat{2}$
$6 1 \dot{3} \dot{2}$	$6 3 2 \widehat{1}$	$\cdot 3 \cdot 2$	$\cdot 1 \cdot \widehat{6} \text{ \$}$

Second time (**gender B** starts kempyang/kethuk)

$\cdot 2 \cdot 3$	$\cdot 2 \cdot \widehat{1}$	$\cdot 3 \cdot 2$	$\cdot 1 \cdot \widehat{6}$
$\cdot 2 \cdot 3$	$\cdot 2 \cdot \widehat{1}$	$\underset{\cdot}{6} 1 2 3$	$\cdot 1 2 \widehat{6}^1$
$1 1 \cdot \cdot$	$6 6 \dot{1} \widehat{2}$	$\dot{3} \dot{2} 6 3$	$\cdot 2 \cdot \widehat{1}^3$
$3 3 \cdot \cdot$	$6 5 3 \widehat{2}$	$3 2 5 3$	$6 5 3 \widehat{2}$
$6 1 \dot{3} \dot{2}$	$6 3 2 \widehat{1}$	$\cdot 3 \cdot 2$	$\cdot 1 \cdot \widehat{6}$

Ketawang **Pangkur Paripurna** Slendro Manyura (*slenthem/gender b*)

Notes falling on kenong/kempul/gong to be delayed. Vibraphone beater can be used in right hand, or notes in bold to be played with hard side of beater.

Ompak

$$\left(\begin{array}{cccc} 2 & 1 & 2 & 3 \\ 5 & 3 & 2 & \hat{1} \\ \underset{\cdot}{6} & 1 & 2 & \overset{\sim}{3} \\ 2 & 1 & 2 & \hat{\hat{6}}^1 \end{array} \right)$$

$$\left(\begin{array}{cccc} \underline{i} & 2 & i & . \\ \underline{i} & 2 & i & \mathbf{1} \\ \dots & \dots & \dots & \mathfrak{3} \\ \dots & \dots & \dots & \mathbf{6} \end{array} \right)$$

Ngelik

$$\left(\begin{array}{cccc} . & 1 & 2 & 3 \\ 5 & 3 & 2 & \hat{1} \\ \underset{\cdot}{6} & 1 & 2 & \overset{\sim}{3} \\ . & 2 & 1 & \hat{\hat{6}}^1 \end{array} \right)$$

$$\left(\begin{array}{cccc} \underline{i} & 2 & i & . \\ \underline{i} & 2 & i & \mathbf{1} \\ \dots & \dots & \dots & \mathfrak{3} \\ \dots & \dots & \dots & \mathbf{6} \end{array} \right)$$

$$\left(\begin{array}{cccc} 1 & 1 & . & . \\ 6 & 6 & i & \hat{2} \\ 3 & 2 & 6 & \overset{\sim}{3} \\ . & 2 & . & \hat{\hat{1}}^3 \end{array} \right)$$

$$\left(\begin{array}{cccc} \underline{i} & 2 & i & . \\ \underline{i} & 2 & i & \mathbf{2} \\ \dots & \dots & \dots & \mathfrak{3} \\ \dots & \dots & \dots & \mathbf{1} \end{array} \right)$$

$$\left(\begin{array}{cccc} 3 & 3 & . & . \\ 6 & 5 & 3 & \hat{2} \\ 3 & 2 & 5 & \overset{\sim}{3} \\ 6 & 5 & 3 & \hat{\hat{2}} \end{array} \right)$$

$$\left(\begin{array}{cccc} \underline{i} & 2 & i & . \\ \underline{i} & 2 & i & \mathbf{2} \\ \dots & \dots & \dots & \mathfrak{3} \\ \dots & \dots & \dots & \mathbf{2} \end{array} \right)$$

$$\left(\begin{array}{cccc} 6 & 1 & 3 & 2 \\ 6 & 3 & 2 & \hat{1} \\ . & 3 & . & \overset{\sim}{2} \\ . & 1 & . & \hat{\hat{6}} \end{array} \right)$$

$$\left(\begin{array}{cccc} \underline{i} & 2 & i & . \\ \underline{i} & 2 & i & \mathbf{1} \\ \dots & \dots & \dots & \mathfrak{2} \\ \dots & \dots & \dots & \mathbf{6} \end{array} \right)$$

4. Durma (pelog barang)

Played in unison on **both gender** and **slenthem**, counted in visually by **gender A** from the unplayed gong note, starting softly:

. . 5 6 1 2 3 2 1 1 2 1 6 5 3 5

On third time all players slow down independently of each other, repeating the final notes in their respective phrases. All parts should continue to slow down and play until the end of the first verse.

Gender A & slenthem:

. . 5 6 1 2 3 2 1 1 2 1 [:6:]

Gender B:

. . 5 6 1 2 3 2 1 1[:2:]

Verse 1 (cakepan decided by the pesindhen):

- 1) 3 5 6 7, 7 7 7 7 6 6.7 5 3.23..2
Ri- du ma- wor, ma- nga- wur a- wur wi- ra- han
- 2) 2 3 5 6 7, 7 6.56..5
Te- nga- ra- ning a- ja- rit
- 3) 5 6 6 6 7 5 6
Gong ma- gu- ru gang- sa
- 4) 6 6 6 6 6.7 7.65 6
Te- tek ka- di bu- tul- a
- 5) 5 3 5 2 2 3 5 5
Wor pang- grik- ing tu- rong ges- ti
- 6) 5 6 7, 5.7..65 3.23.2
Re- ka- tak ing- kang
- 7) 2 3 5 6 7 5 7.656..5
Dwa- ja le- la- yu se- bit

N4.B Envelope cengkok for *Pangkur Paripurna*

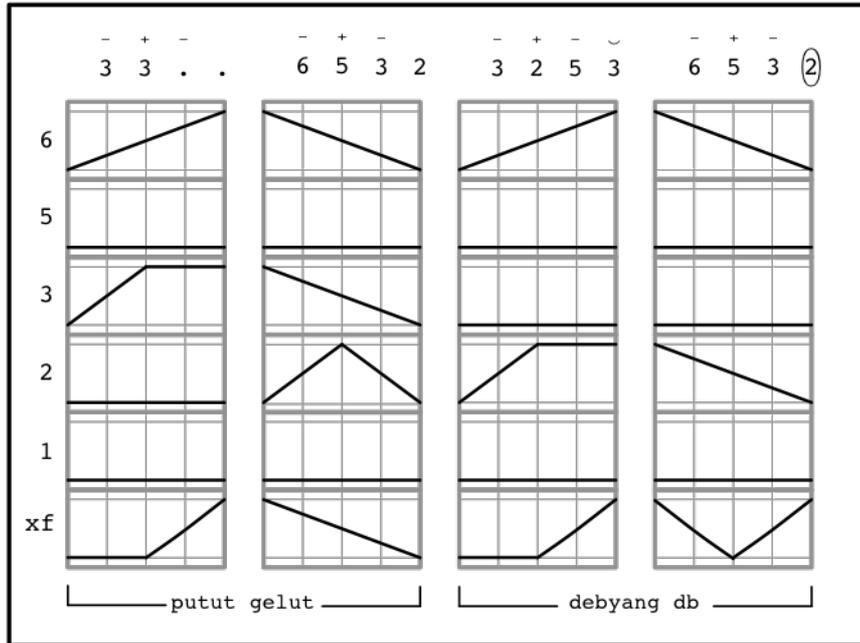
gongan 1

	$\overset{-}{.}$ $\overset{+}{1}$ $\overset{-}{2}$ 3	$\overset{-}{5}$ $\overset{+}{3}$ $\overset{-}{2}$ $\overset{\sim}{1}$	$\overset{-}{6}$ $\overset{+}{1}$ $\overset{-}{2}$ $\overset{\sim}{3}$	$\overset{-}{2}$ $\overset{+}{1}$ $\overset{-}{2}$ (6)
6			▲	▲
5		▲		
3		▲		
2	▲		▲	
1	▲		▲	
xf				
	mipil 2123	mipil 5321	mipil 6123	plesed 6-1

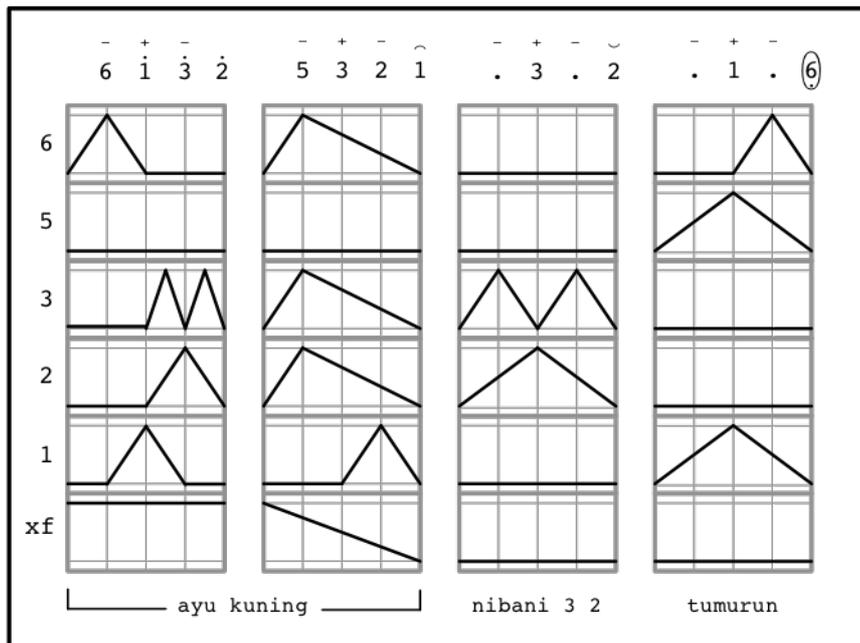
gongan 2

	$\overset{-}{1}$ $\overset{+}{1}$ $\overset{-}{.}$ $\overset{-}{.}$	$\overset{-}{6}$ $\overset{+}{6}$ $\overset{-}{1}$ $\overset{\sim}{2}$	$\overset{-}{3}$ $\overset{+}{2}$ $\overset{-}{6}$ $\overset{\sim}{3}$	$\overset{-}{.}$ $\overset{+}{2}$ $\overset{-}{.}$ (1)
6		▲		
5				
3			▲	▲
2			▲	▲
1	▲			▲
xf				
	gt 1	gt 6 / mp 12	gt 2 / mp 63	mipil 2321

gongan 3



gongan 4



N4.C Pangkur Paripurna gendhing in JSON format

```

{
  "pathet" : "manyura",
  "bentuk" : "Ketawang",
  "sections" : {
    "1" : {
      "balungan" : [ "-", "2", "-", "3", "-", "2", "-", "1", "-",
                    "3", "-", "2", "-", "1", "-", "6." ],
      "garap" : {
        "synth 1" : [ "mipil 2 1 2 3", "mipil 5 3 2 1", "mipil 6.
                      1 2 3", "nibani 1 6." ]
      }
    }
  }
}
  
```

```

    }
    '
    "2" : {
        "balungan" : [ "1", "1", "-", "-", "6", "6", "1'", "2'", "3",
                       "2", "6", "3", "-", "2", "-", "1" ],
        "garap" : {
            "synth 1" : [ "gt 1", "half gt 6 / half mipil 1 2", "half
                          gt 2 / half mipil 6 3", "nibani 2 1" ]
        }
    }
    }
    '
    "3" : {
        "balungan" : [ "3", "3", "-", "-", "6", "5", "3", "2", "3",
                       "2", "5", "3", "6", "5", "3", "2" ],
        "garap" : {
            "synth 1" : [ "putut_gelut_a", "putut_gelut_b",
                          "debyang_debyung_a", "debyang_debyung_b" ]
        }
    }
    }
    '
    "4" : {
        "balungan" : [ "6", "1'", "3", "2", "5", "3", "2", "1", "-",
                       "3", "-", "2", "-", "1", "-", "6." ],
        "garap" : {
            "synth 1" : [ "ayu_kuning_a", "ayu_kuning_b", "nibani 3 2",
                          "nibani 1 6." ]
        }
    }
    }
    '
    "name" : "Pangkur Paripurna",
    "pt" : [ "- = - 0", "- = - n", "- = - p", "- = - ng" ],
    "config" : {
        "phraseMode" : [ "array" ]
    }
    }
}

```

N4.D Envelope cengkok for *Subakastawa*

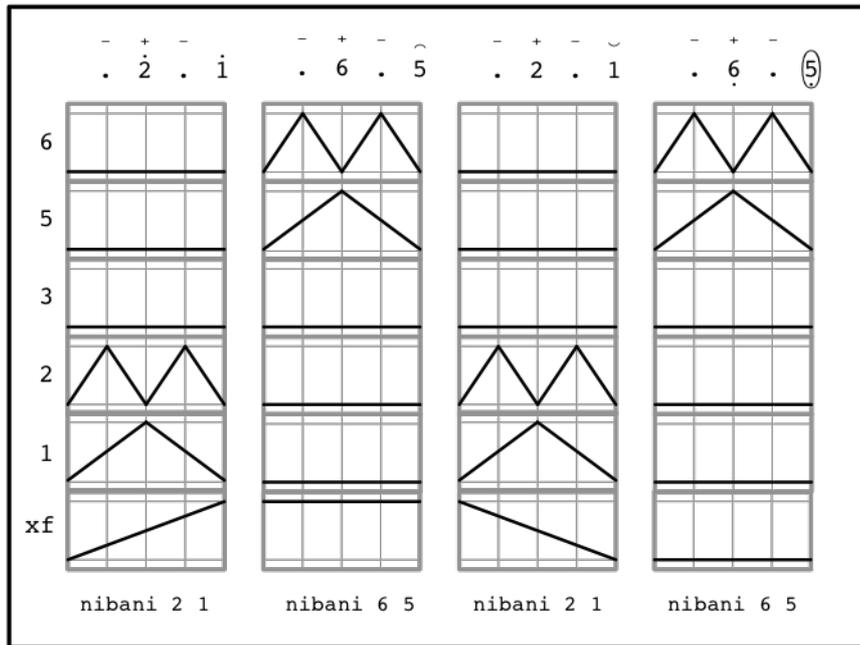
gongan 1

	- + - · 1 · 6	- + - ^ · 1 · 5	- + - ^ · 1 · 6	- + - ^ · 1 · ⑤
6				
5				
3				
2				
1				
xf				
	nibani 1 6	nibani 1 5	nibani 1 6	nibani 1 5

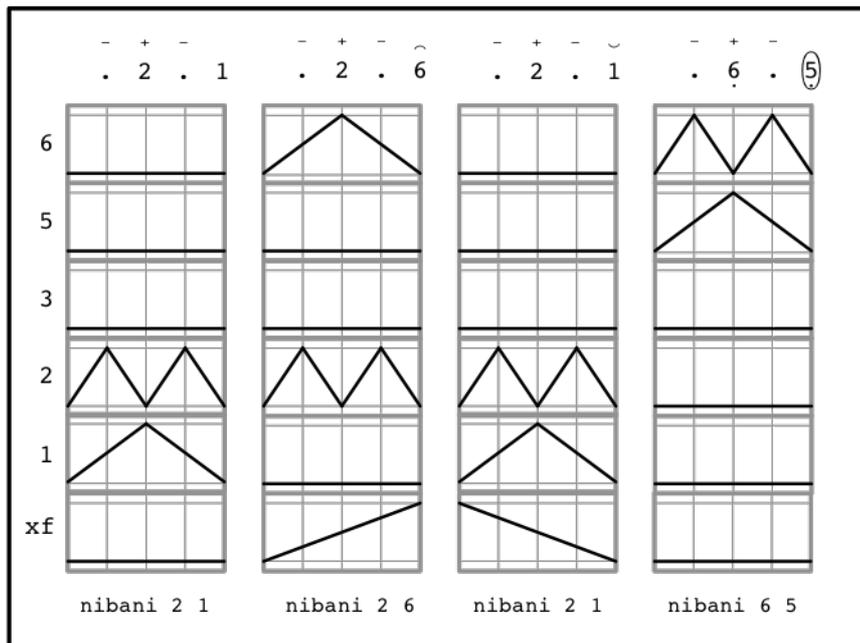
gongan 2

	- + - i · 2 · 1	- + - ^ · 6 · 5	- + - ^ · 2 · 1	- + - ^ · 6 · ⑤
6				
5				
3				
2				
1				
xf				
	nibani 2 1	nibani 6 5	nibani 2 1	nibani 6 5

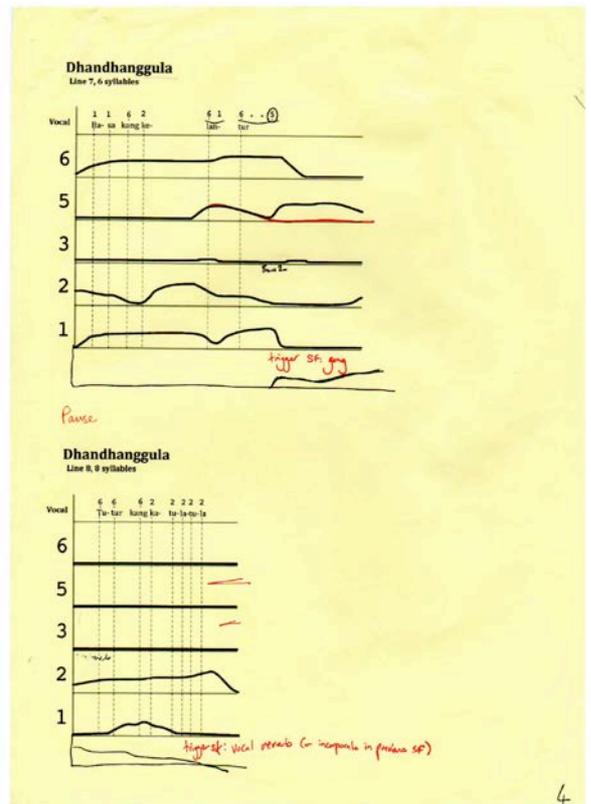
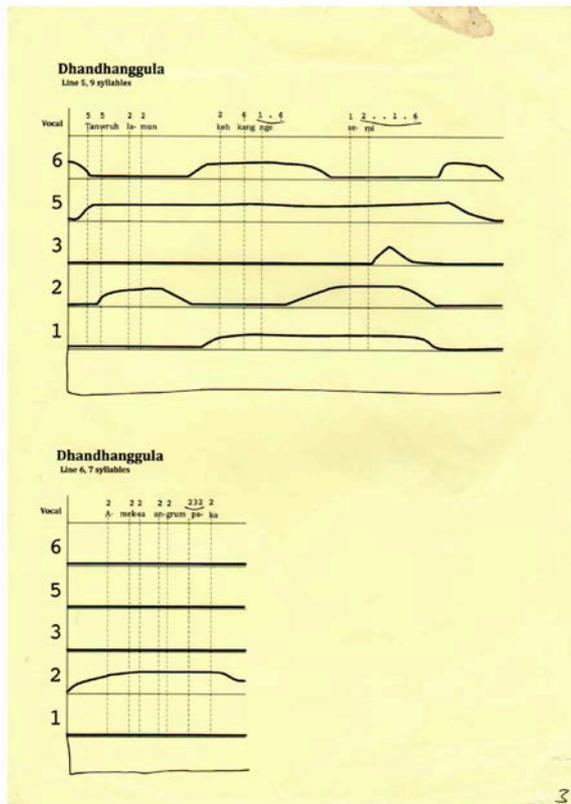
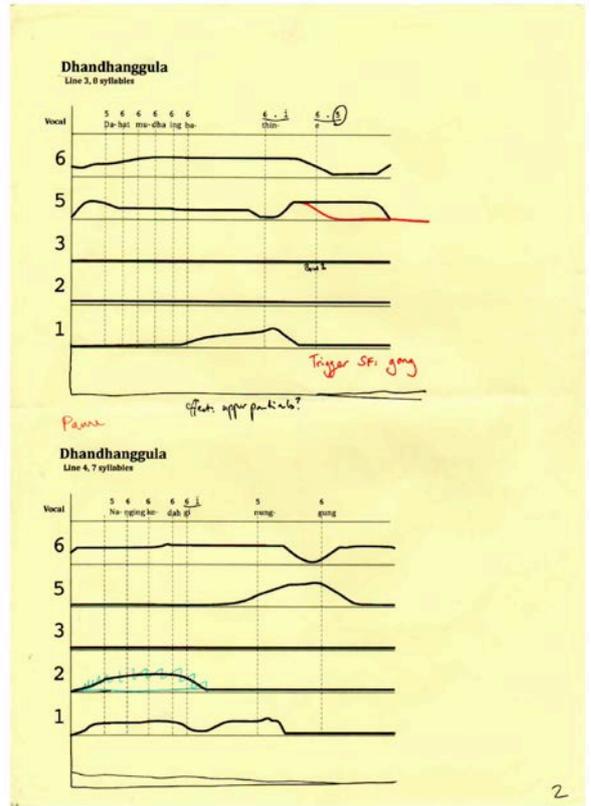
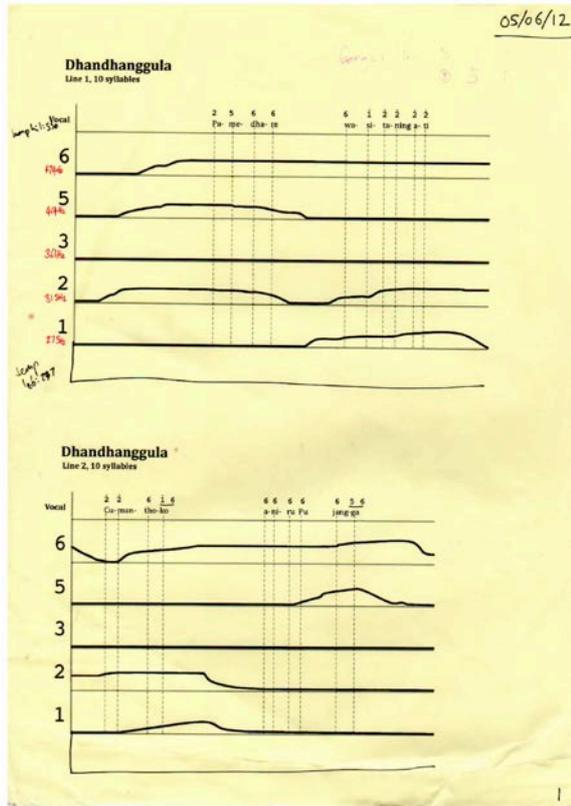
gongan 3



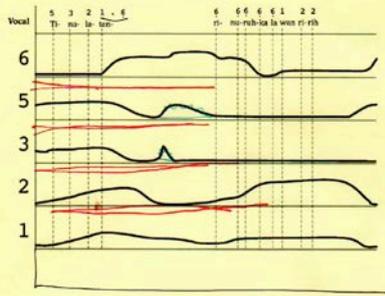
gongan 4



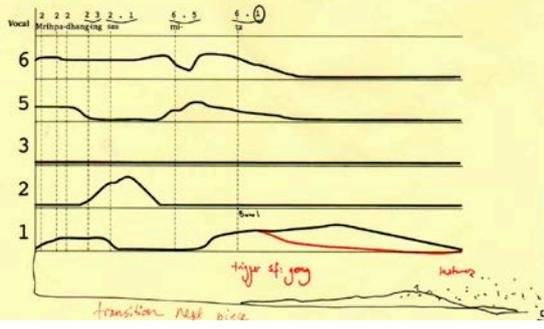
N4.E Transcriptions for development of *Dhandhanggula*



Dhandhanggula
Line 9, 12 syllables

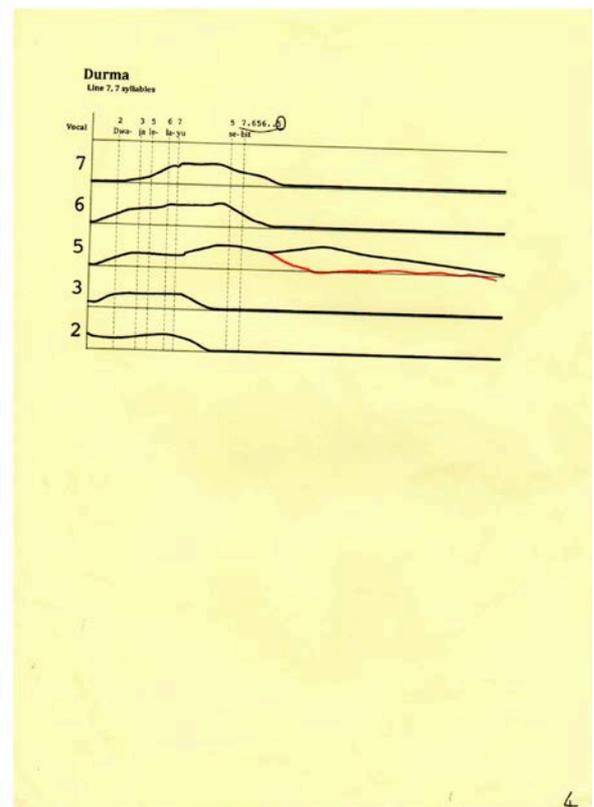
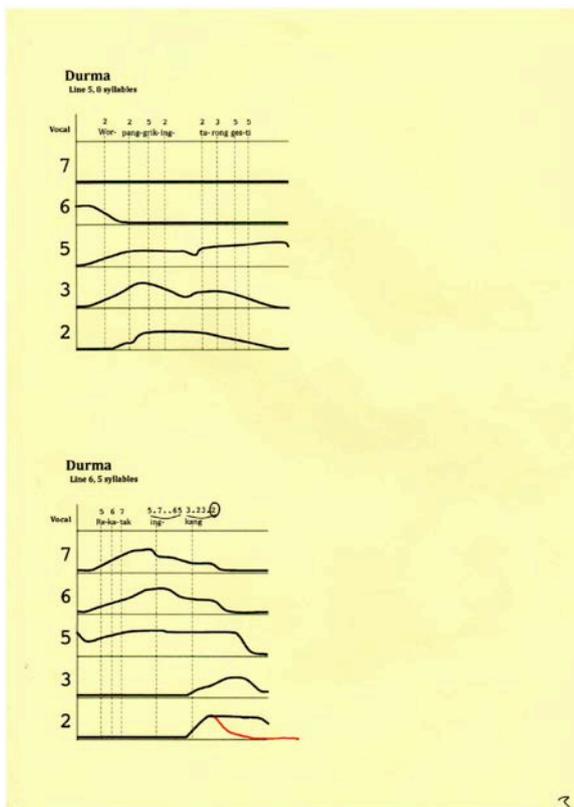
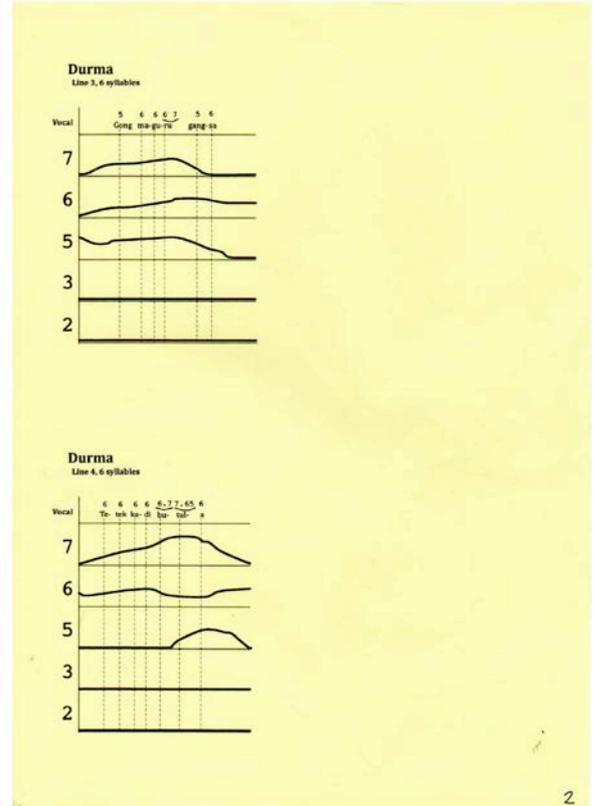
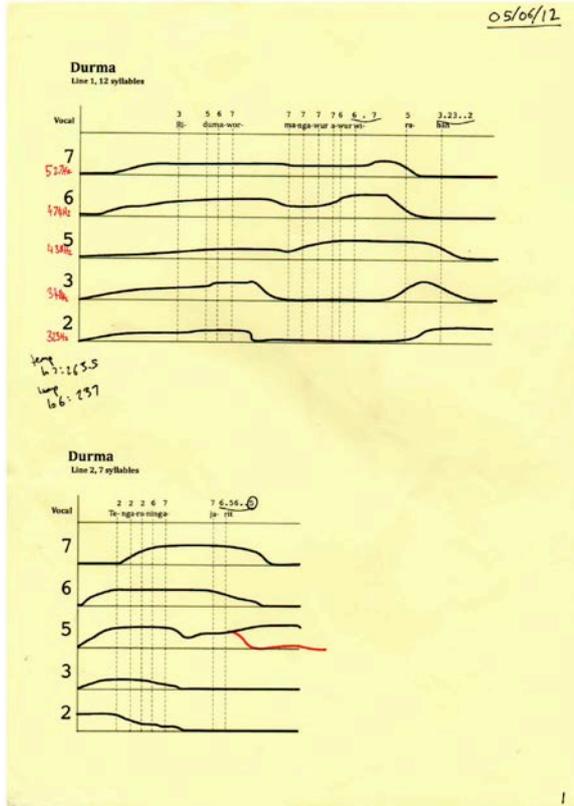


Dhandhanggula
Line 10, 7 syllables



N4.F Transcriptions for development of *Durma*

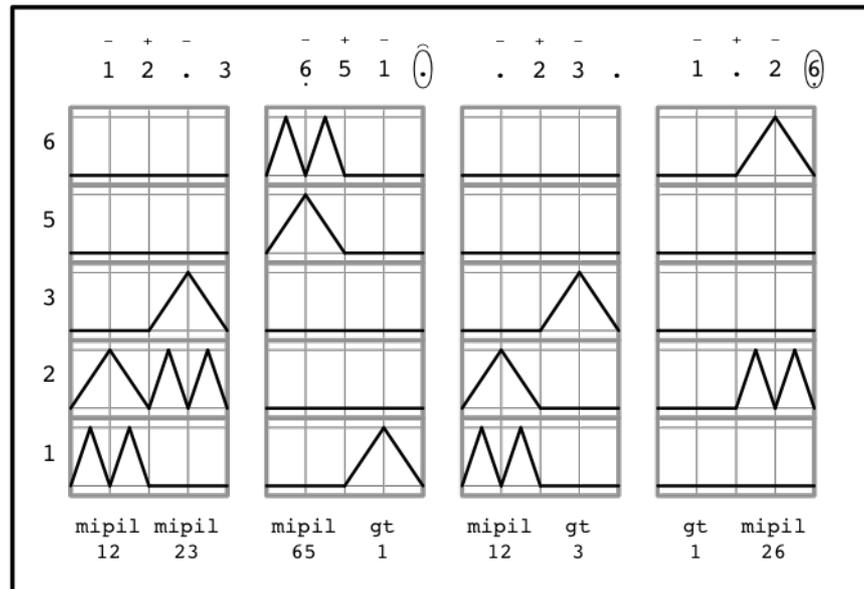
05/06/12



N5 Response to ShoutCry Room

N5.A Envelope cengkok

Gongan 1



N5.B Instrumental parts

Balungan: 1 2 . 3 6 5 1 (6) . 2 3 . 1 . 2 (6)

Envelopes: mipmap 12 mipmap 23 mipmap 65 gt 1 mipmap 12 gt 3 gt 1 mipmap 26

Gender B: . . . 3 . . . 1 . . . 3 . . . 6

Gender A: 1 6

Slenthem: 3 6

N5.C Gendhing in JSON format

```
{
  "sections" : {
    "1" : {
      "balungan" : [ "1", "2", "-", "3", "6.", "5", "1",
                    "-", "-", "2", "3", "-", "1", "-",
                    "2", "6." ],
      "garap" : {
        "gong" : [ ".", "127", ".", "127" ],
        "synth 1" : [ "half mipmap 1 2 / half mipmap 2
                      3", "half mipmap 6 5 / half
                      gt 1", "half mipmap 1 2 /
                      half gt 3", "half gt 1 /
                      half mipmap 2 6" ],
        "xf" : {
          "0" : [ 0, 0.0, 127, 0.0 ],
          "1" : [ 0, 0.0, 127, 0.0 ],
        }
      }
    }
  }
}
```

```
    "2" : [ 0, 0.0, 127, 0.0 ],  
    "3" : [ 0, 0.0, 127, 0.0 ]  
  }  
}  
}  
}
```

Appendix 6: Glossary of gamelan-related terms

Letters after glossary entries indicate their position in **Figure 6-1**. Abbreviations are included where commonly used in notation.

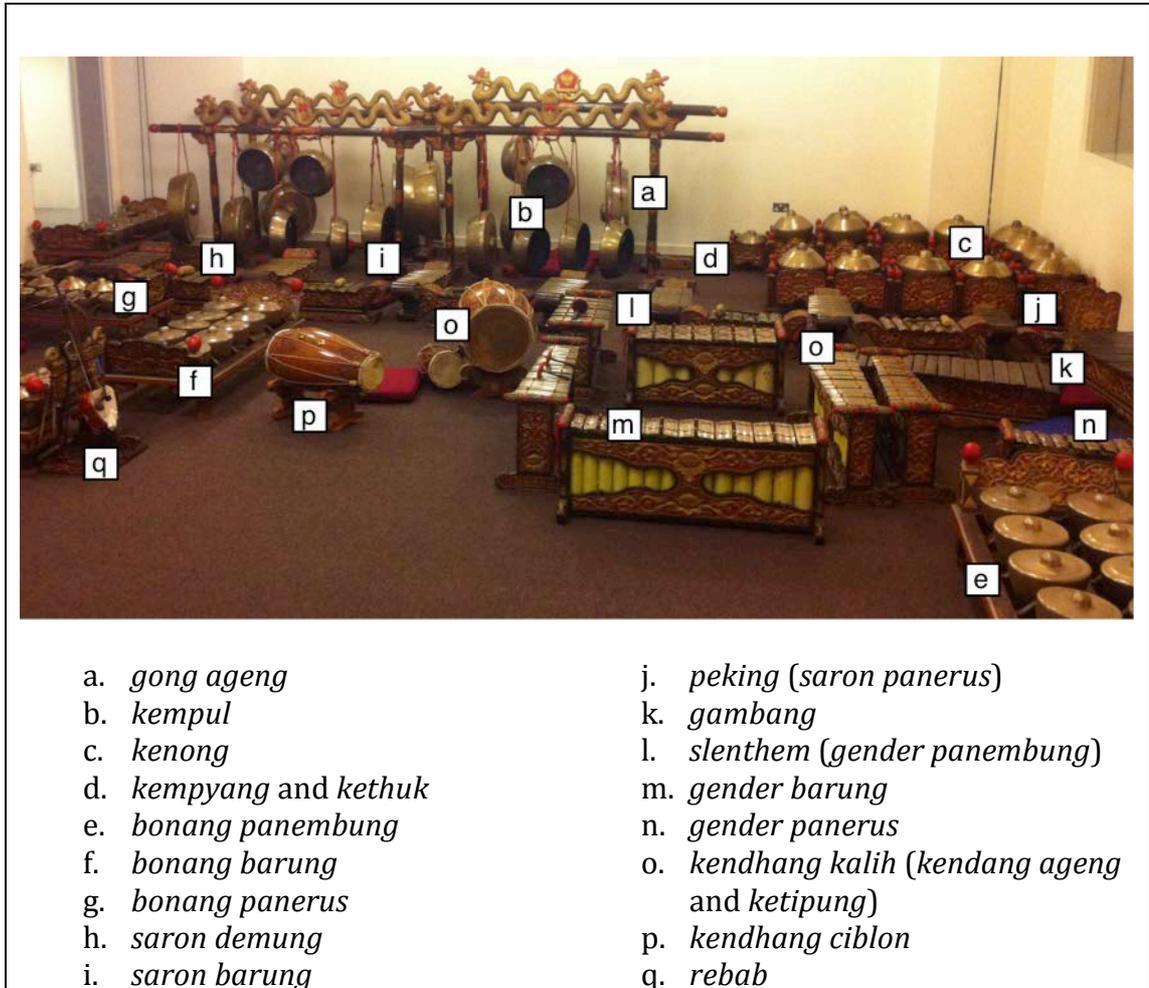


Figure 6-1: *Kyai Lebdajiwa*, the gamelan housed at the Southbank Centre in London, marked with names of instruments.

Ayu Kuning. A named *cengkok* based around a vocal melody, often fitting the *balungan* contour 6 1 3 2 5 3 2 1 (*manyura*).

Bawa. Vocal introduction to a piece, sometimes based on *macapat*. Frequently played with *gender* accompaniment.

Balungan. [Skeleton]. The melodic framework of a *gendhing*, often used as a reference point for *garap* of other instruments and very similar to the part

typically played by the *saron*. Can also be used as a generic term for any framework in a composition.

--**nibani**. *Balungan* in which every other note is a *pin* - e.g. . 2 . 1

--**mlaku**. *balungan* using a combinations of notes and *pin*, sometimes incorporating elements of *balungan nibani* e.g. 2 3 2 1 . 3 . 2

--**pulse**. Abstract conception of the pulse of the *balungan* (e.g. including *pin* in *balungan nibani* as a beat)

Bentuk. [Shape]. a word used to describe the placement of gongs and other punctuating instruments in a *gendhing* (e.g. *ladrang*, *ketawang*).

Bonang. A horizontally mounted set of between ten and fourteen gong-chimes (see *pencon*; also commonly referred to as pots in English). The term *bonang* by itself is commonly used to refer to the *bonang barung*.

--**panembung**. Lowest register *bonang* usually only found in Jogja-style gamelan. Typically restricted to playing a part that can be likened to *balungan nibani*. **(e)**

--**barung**. Medium register *bonang* instrument typically used to play an elaborating part, serving as leader of the loud-style instruments. **(f)**

--**panerus**. High register *bonang* instrument typically used to play an elaborating part at twice the rhythmic density of the *bonang barung*. **(g)**

Bonangan. A “loud-style” ensemble (or its associated repertoire) led by the *bonang*, typically including several *saron*, *slenthem*, *kendhang*, gongs, and *kenong*.

Buka (abbr.: **bk**). [Open]. The introduction to a *gendhing* typically played by a solo instrument and joined by the *kendhang* player, who sets the *irama*.

Cakepan. Text of a traditional song, often the specific words used to fill a fixed meter such as a *macapat*.

Campursari. [Mixed essence]. A mix of styles first developed in the 20th century, typically played on gamelan and instruments from other traditions (sometimes including – or more recently entirely based around – synthesizers and drum machines), and drawing on repertoire elements of *keroncong*.

- Carabalen.** A gamelan *pakurmatan*, consisting of *pencon*-type instruments and *kendhang*.
- Celempung.** A plucked zither used to play elaborating parts.
- Colotomic.** A term used to describe the structure of punctuating instruments (e.g. gongs, *kenong*, *kempul*)
- Cengkok.** An abstract melodic pattern or formula, often named (e.g. *ayu kuning*, *tumurun*), and concretized as *wiletan*.
- Dhangdhut.** Popular music with strong influences from mainland Asia.
- Dhalang.** A storyteller and puppeteer in *wayang* performance.
- Embat.** The set of intervals relating to the individual tuning of a group of instruments.
- Engkuk/kemong.** A pair of *pencon* similar to the *kempyang* and *kethuk* that replace the *kempyang* strokes in *inggah* and *wiled* sections at double the density.
- Gadhon.** See *gamelan gadhon*.
- Gambang.** A xylophone used to play elaborating parts in rapid figurations; typically one of the most rhythmically dense instruments in the ensemble (shortened from *gambang kayu* [wooden *gambang*]) **(k)**
- gangsa.** Bronze version of the *gambang*.
- Gamelan.** A traditional instrumental ensemble found throughout Indonesia, usually comprising a selection of gongs and tuned metallophones and often including drums, flutes, stringed instruments and vocal parts.
- gadhon.** [An accompanying dish without rice]. A gamelan consisting of soft-style instruments.
- pakurmatan.** [Honour]. An older-style ceremonial gamelan.
- Gantung.** [Hanging]. A pattern that stays around the same note, typically represented in *balungan* through repetition or through extension by *pin* [rests], e.g. 1 1 . . or . . 5 .
- Garap.** [Work]. Ways of working out instrumental parts, based on a central melodic framework (e.g. the *balungan*), *irama* and conventions of instrumental idiom.

Gatra. Subdivision of the *balungan*, lasting four *balungan*-pulses.

Gembyang. Pitch interval of approximately 2:1 i.e. the difference between low 6 and 6 in the medium register. In practice the actual frequency ratio may vary from instrument to instrument. Also used to describe a style of playing the *bonang* with simultaneous strokes spanning said interval.

Gembyung. A pitch interval spanning three notes (e.g. 3 and 6), also called *salah gumun*. Can be used to describe a style of playing the *bonang* with simultaneous strokes spanning said interval.

Gender. Keyed metallophone typically played with soft beaters. The word *gender* by itself is commonly assumed to refer to the *gender barung*.

--**panembung.** More commonly known as *slenthem*. An instrument in low-register, played with a single beater, that shares the range and generally the function of the *saron* family. **(l)**

--**barung.** The medium-sized and registered instrument the *gender* family, typically used to play an elaborating part and assist the *pesindhen* in finding tones. **(m)**

--**panerus.** The smallest and highest-pitched instrument in the *gender* family, similar in construction to the *gender barung* and used to play a faster, simpler part. **(n)**

Gendhing (abbr.: **gd**). Traditional composition for gamelan; sometimes used to refer to larger scale pieces that do not use the *kempul*.

--**bonang.** Loud-style piece (generally of the larger-scale variety) in which the melodic leader of the group is the *bonang*.

--**dolanan.** [Games]. Children's songs adapted for gamelan.

--**sekar.** Accompaniment of sung poetry, such as *macapat*, by a gamelan, adapted to fit existing metric forms (in contrast to *palaran*).

--**soran.** Loud-style repertoire, encompassing *gendhing bonang* and including smaller scale *gendhing* such as *ladrang*.

Gerong. Male chorus.

Gong. A bossed metal disk, suspended vertically generally capable of producing low frequency tones and involving some beating (*ombak*). May be used to refer to another type of instrument designated with the same role.

-- **ageng.** Largest of the gongs in a gamelan, played to mark the end of melodic cycles. **(a)**

-- **kemodhong.** A pair of keys suspended over resonators in a box, tuned slightly apart in order to create a beating tone, and played simultaneously or in immediate alternation.

Gongan. A cycle marked by the striking of a gong.

Grambyangan. A short melodic unit indicating the pathet of a piece, played by a solo instrument (typically *gender*, *bonang*, or *rebab*).

Imbal. Interlocking parts shared between two or more instruments of the same type (often *bonang barung* and *bonang panerus* or two *saron barung*).

Inggah. Second section of larger-scale *gendhing*, typically livelier than the *merong*; may also be in *ladrang* form.

Jineman. A repertoire of songs played with gamelan *gadhon*, typically lighthearted.

Kacaryan. [Spell]. A named *cengkok* ending in note 3 (*manyura*) or 2 (*sanga*).

Kecer. A set of cymbals, either played with another pair of downwards-facing cymbals or with a mallet.

-- **rojeh.** A set of metal disks found in gamelan pakurmatan, beaten with a mallet.

Kemanak. Banana-shaped bronze instruments played in alternation in a similar pattern to the *kempyang* and *kethuk*.

Kempul. Bossed gong, suspended vertically and played to subdivide melodic cycles. **(b)**

Kempyang. *Pencon*-type marker instrument typically played on the weak (first and third) beats of a *gatra*, between strokes of the *kethuk* and gong, *kempul* and *kenong*. **(d)**

Kempyung. Pitch interval providing a frequency ratio of approximately 3:2, e.g. the difference between 2 and 6. The actual frequency ratio may vary from instrument to instrument and between pairs of notes on the same instrument.

Kendhang (abbr.: **kd**). Double-headed drum or set of drums the player or players of which acts as the rhythmic leader of a gamelan ensemble, cueing changes in *irama* and dynamics.

--**ciblon.** Medium-pitched *kendhang* used for dance drumming and lively sections of *klenengan*-style *gendhing* (**p**)

--**ageng** (also **I**). [Lit. large]. Large, low-pitched drum typically used for refined pieces or in combination with the *kendhang ketipung*.

--**kalih** (also **II**). [Lit. two]. Combination of small and large *kendhang* (*ketipung* and *ageng*) (**o**)

--**ketipung.** Small, high-pitched drum typically only used in combination with the *kendhang ageng*.

Kenong. A set of large, horizontally mounted gong-chimes (**c**)

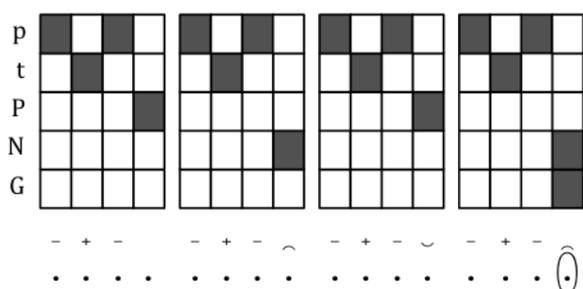
--**japan.** A single low-pitched *kenong*, typically tuned to note five and only used in loud-style playing in Jogja and in ceremonial gamelan.

Kenongan. A subdivision of a gong cycle lasting the time between two *kenong* strokes.

Kepatihan. A numeric notation system for gamelan developed in a district of Solo of the same name in the late 19th century.

Keprak. A small wooden box struck with a mallet during dance performances, often forming syncopated rhythms against the central pulse.

Ketawang (abbr.: **ktw**). Traditional gong-cycle structure consisting of two *kenongan* and typically used to describe a formal *bentuk* lasting sixteen *balungan*-pulses:



--**gendhing**. A larger scale *gendhing* played without *kempul*, in which the *merong* is divided into two *kenongan*.

Kethuk. A *pencon*-type marker instrument played to subdivide melodic cycles on the second beat of a *gatra*, sometimes played with several strokes in rapid succession with rhythm resembling a bouncing ball. **(d)**

Kinanthi. A *macapat* metre commonly used for *gerongan* due to the consistent use of eight syllables in each line.

Kinthilan. Interlocking part played by two *saron barung*, similar to the *nacah lamba* part played by the *peking* in *irama I*.

Klenengan. Music played for its own sake, i.e. not to accompany dance or theatre.

Kodhok Ngorek. A gamelan *pakurmatan* consisting of *pencon*-type instruments, *kendhang*, *gender*, and *gambang gangsa*.

Kraton. Royal palace.

Keroncong. Term used to describe a three-stringed instrument resembling a ukulele and the music played on it, based on a style introduced by Portuguese traders in the 16th century.

Irama (abbr.: **ir**). [Rhythm]. A term used to describe the relative density of elaborating instruments to the *balungan* but also, depending on context, *laya*. There are four commonly recognized *irama* that are referred to either with numerals or names: *lancar*, *tanggung*, *dados* [happening, established] and *wiled*. *Rangkep* may be used to double up *irama dados* or *wiled*, and is commonly thought of as another level of *irama*. It is common to describe *irama* in terms of the number of strokes played by the *peking* to the *balungan*-pulse, as demonstrated below.

--**lancar (½)**. One *peking* stroke per *balungan*-pulse.

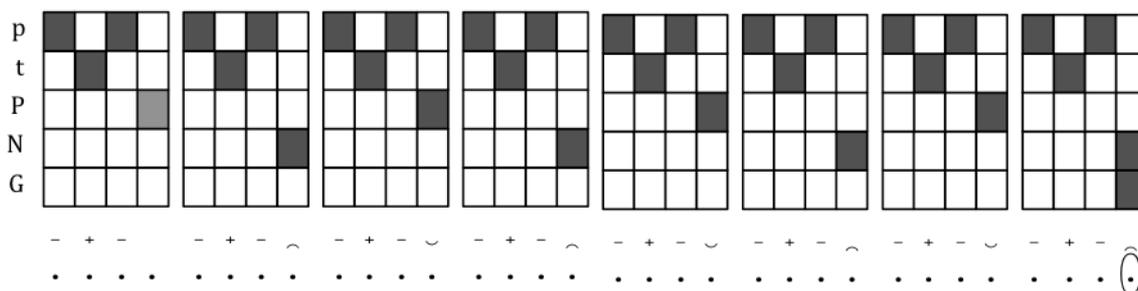
--**tanggung (I)**. Two *peking* strokes per *balungan*-pulse.

--**dados (II)**. Four *peking* strokes per *balungan*-pulse.

--**wiled (III)**. Eight *peking* strokes per *balungan*-pulse.

--**rangkep (IV)**. Doubling of *dados* or *wiled*; from *wiled*, sixteen *peking* strokes per *balungan*-pulse.

Ladrang (abbr.: **ldr**). A gong-cycle structure related to *ketawang*, consisting of thirty two *balungan*-pulses:



Lagu. Generic term for melody, typically sung. Can also refer to popular songs developed in the late 20th century to be accompanied by gamelan or *campur sari* ensembles.

Langgam. Pieces from the *keroncong* repertoire, sometimes played on gamelan instruments.

Laras. The abstract tuning of a set of instruments, either *slendro* or *pelog*.

Laya. The closest term equivalent to tempo; used to describe relative rate of playing within the bounds of a level of *irama*.

Lik. [Small, indicating high pitch]. Section of a *gendhing* played after the *ompak*, usually using a higher-register *balungan*.

Macapat. Sung poetry used as the basis of some gamelan composition, more specifically used to specify the number of syllables, final sounded syllable and melodic contour.

Maju/mundur. [Lit. forth/back]. Term used to describe the direction of bowing and associated weighting of phrases played on the *rebab*.

Merong. First section of a larger-scale *gendhing*, typically played in a refined manner.

Mipil. A style of playing the *bonang* in which pairs of notes from the *balungan* are repeated in various patterns, the length of which is determined by *irama*. For example, 6 5 3 2 may be played as 6 5 6 . 3 2 3 . in *irama I* and 6 5 6 . 6 5 6 . 3 2 3 . 3 2 3 . in *irama II*.

Monggang. A gamelan *pakurmatan* consisting of *pencon*, *kendhang*, and *kecer*.

Ombak. [Waves]. Beating tones found in the *gong ageng* and to a lesser extent in other instruments.

Ompak. The opening section of a small-scale *gendhing* (e.g. *ketawang* or *ladrang*) generally consisting of one *gongan*.

Nacah. A pattern played by the *peking* with reference to the notes of a *balungan*.

--**lamba.** Repetition of the tones of the *balungan* as typically played by the *saron barung*. For example, 6 5 3 2 may be played as 6 6 5 5 3 3 2 2 in *irama I*.

--**rangkep.** A technique similar to *mipil*, in which the notes of the *balungan* are repeated in alternation in a figuration appropriate to the current *irama*. For example, 6 5 3 2 may be played in *irama II* as:

6 6 5 5 6 6 5 5 3 3 2 2 3 3 2 2

and in *irama III* as:

6 6 5 5 6 6 5 5 6 6 5 5 6 6 5 5

3 3 2 2 3 3 2 2 3 3 2 2 3 3 2 2

Ngelik. See *lik*.

Nyacah. Rhythmically dense melodic ornamentation played on the *saron barung* or *saron wayang* that only coincide with the *balungan* on the *seleh* note.

Padhang-ulihan. Types of phrasing that may be described respectively as “question and answer” or “tension and release”.

Palaran. *Macapat* accompanied by soft instruments, *kenong*, *kempul*, *kethuk*, and *gong* in *srepegan* form. *Palaran* use flexible *gongan* lengths cued by the *kendhang* player, who follows the vocalist.

Pathet. A term often likened to “mode”: the pitch-range of a *gendhing* with connotations of strong and weak notes. See *pelog* and *slendro*.

Pathetan. A type of piece played by the soft-instruments in relatively free rhythm and typically led by the *rebab*, or sung by a *dhalang* if present. Often used to precede or follow a larger *gendhing*.

Pinjalan. An anticipating part similar to the *nacah* pattern played by the *peking*, typically spread between *demung* and *slenthem*.

Peking. See *saron panerus*.

Pelog (abbr.: **pl**). A heptatonic tuning system, whose constituent fundamental frequencies and ratios may vary slightly between ensembles. Divided into three *pathet*: *barang*, *nem* and *lima*, shown with their basic vocal ranges below.

--**barang**. Low 3 to high 3; often the same as *slendro manyura* with 7s replacing 1s.

--**nem**. Low 2 to high 3.

--**lima**. Low 1 to high 2.

--**nyamat**. Low 2 to high 3. Used to describe pieces in *pelog nem* in which the *garap* is the equivalent to what would be played in *slendro manyura* (i.e. like the more common transposition from *slendro manyura* to *pelog nem*, without converting 1s to 7s).

Pendopo. A type of pavilion with a raised roof, which frequently serves as a venue for gamelan and *wayang* performances.

Pencon. A bossed gong-type instrument, suspended either vertically (*gong*, *kempul*) or horizontally (*kenong*, *kempyang*, *kethuk*, *bonang*; also referred to as a gong-chime in this case).

Pesindhen. A solo female singer.

Pin. Sometimes referred to as a rest; a space in which no note is played and the last note is typically allowed to continue resonating.

--**mundur**. Balungan phrase in which a *pin* occurs on the strong beat –e.g. the second or fourth beat of *balungan mlaku*: . 6 2 .

Plesed. [Slipping]. Anticipation of a forthcoming note in melodic parts, most frequently played by the *rebab* and *kenong*.

Rangkep. [Double]. Lively and elaborate *garap*; also used to denote a further expansion of *irama wiled* or *irama dados*.

Rasa. [Feeling, taste]. The feeling invoked in musicians and listeners of gamelan music.

Rebab. A two-stringed fiddle that plays an elaborating part similar to that of the vocal lines. **(q)**

Rojeh. See *kecer rojeh*.

Saron. A keyed metallophone played with a mallet. The word *saron* by itself is commonly used to refer to the *saron barung*.

--**demung.** Largest of the *saron* family, in the lowest register **(h)**

--**barung.** Medium-register instrument. **(i)**

--**wayang (saron sanga).** Version of *saron* with extra keys for use in lively embellishment found in wayang

--**panerus (peking).** Highest-register *saron* that plays an elaborated version of the *saron barung* part. **(j)**

Sekaran. [Flowering]. Ornamental patterns at the end of a regular melodic pattern or *imbal* sequence, leading to the *seleh*.

Seleh. The resting point of a phrase, often characterized as a goal-tone. Often the last note of a *gatra*.

Seseg. [Tight, short of space]. A quickening of pace (*laya*), typically leading to the ending (*suwuk*), or a change of section in suites and larger-scale *gendhing*.

Sirepan. A moment where the majority of loud-style instruments drop out, typically leaving a focus on vocals, *gender*, *slenthem*, *rebab*, and punctuating instruments.

Siter. A plucked *zither*: a simplified version of the *celempung*.

Slendro (abbr.: **sl**). A pentatonic tuning system, whose constituent fundamental frequencies and ratios may vary slightly between ensembles. Divided into three *pathet*: *manyura*, *sanga* and *nem*, shown with their basic vocal ranges below.

--**manyura.** Low 3 to high 3.

--**sanga.** Low 5 to high 2.

--**nem.** Low 2 to high 3.

Slenthem. See *gender panembung*.

Slentho. A rare keyed instrument in the same register as the *slenthem*, sometimes used as equivalent to the *slenthem* or *bonang panembung*.

Srepegan. An editable form typically used for action and transition scenes in *wayang* and *dance*, also found in *klenengan*.

Suwuk. The end-point of a gendhing, in most cases marked by the gong-*ageng* (also used as a verb to indicate the common slowing down leading to this event).

--gropak. Ending involving an acceleration of tempo into the final gong stroke.

Stratification. The distribution of a melodic framework across instrumental parts of various registers.

Tamban. [Slow]. A term used to describe slower *irama* or *laya*.

Tumurun. A descending pattern, typically to a note 6 (*manyura*) or 5 (*sanga*).

Tumbuk. A note shared between *slendro* and *pelog* in the tuning of a gamelan set.

Wayang. Story-telling or drama typically involving puppets, led by a *dhalang*, and accompanied by gamelan instruments.

Wiletan. The concretization of a *cengkok* in performance, involving the personal idiom of the performer, current *irama*, and various other factors.

Wela. A moment in which a punctating instrument is omitted for clarity of sound - usually the place where a *kempul* would be played shortly after a gong.