CHAPTER 12 EMBODIED COMPOSITION ONTOLOGIES, PROCESS AND TECHNOLOGY: GESTURE HEURISTICS AND CREATIVE POTENTIAL IN MUSIC

Miles Warrington

1 Introduction

Music as an art form, just like drawing, painting, photography and many others, finds itself at the interface of human beings and some form of technology. The humble pen, brush and drum are all forms of technologies and have origins in the most ancient periods of human history. Our desire, passion and creative inspiration have helped develop, mould, invent and modify these and many other tools over aeons of artistic evolution and are a fundamental part of our creative practice. It is not surprising then that in the twenty-first century we find artistic thinking, practice, innovation and, indeed, creativity itself reliant – perhaps purposefully so –on some form of technology of the age. Today these are digital technologies, and as artists our craft becomes more and more integrated with them. We see visual artists making extensive use of computer systems for digital media, photographers using advanced digital techniques to shape their craft, and musicians relying on computer technology, to such an extent that some cannot complete their creative processes without it.

Since the early 1960s human-computer-interaction (HCI) has been at the forefront of the growing need for human beings to integrate and interact with technology.[1] This need was driven by the necessity to expand the human-machine potential and over the years grew from basic input systems to far more complex, multi-modal recognition systems. Today, these systems and innovations use the latest technologies and are capable of everything from human gesture recognition, interactive communication

1 B Myers 'A brief history of human computer interaction technology' (1998) 5 *ACM Interactions* 44-54.

and adaptability in the form of machine learning and artificial intelligence.[2]

As a composer primarily of electroacoustic music, I find myself in the group of artists where the reliance on digital technology is essential to my craft. This is because electroacoustic music hails from a tradition of recording and manipulating sound. The basics have been around for a long time, such as producing works for loudspeakers with no instruments, on the one hand, and works combined with fixed accompaniment in the form of a 'tape' track and instrument(s), on the other. However, this relationship has not remained stagnant at all. On the contrary, live electroacoustic music has over the years undergone a rather meteoric set of morphologies, with particularly exciting changes since the early 2000s. This is directly proportional to the steady and sure advancement of computer technologies and our ability as artists to take advantage of that unstoppable phenomenon.

This chapter is dedicated to analysing various components of compositional approach and compositional process in order to bring to light how the development of HCI has contributed to our understanding of musical ontology through application and integration, thus contributing to artistic output. A theoretical framework is established to argue that with specific methods of sound, object and mental imagery modelling, tracing and analysis, the embodiment of sound in musical gesture spaces can create enormous creative potential for composers, performers and sound artists alike. What follows from here is a discussion of various models established in order to help outline the processes involved in compositional idea where the adoption of gesture-centred HCI is an essential element.

2 Creative spaces

Artworks across disciplines are the direct result of several key processes that are intimately intertwined. Ideation (cognition), poiesis (creation) and esthesis (reception) are the three fundamental human-centred arts-based activities that synthesise into what has been referred to as an '*aesthetic complex*'.[3] This *aesthetic complex* is something artists, by this definition,

2 See KL Norman (ed) *The Wiley handbook of human computer interaction set* (2018).

3 PF Bundgaard & F Stjernfelt (eds) *Investigations into the phenomenology and the ontology of the work of art: Contributions to phenomenology* (2015) 1 (my emphasis).

are constantly engaged with and defines and inhabits the creative space of which the artwork being produced is a part. Put another way, the artistic process produces objects that are subject to 'ideation, judgment, feeling and desire'.[4] As with any art form, thinking about music to make music is an essential part of a composer's process. Understanding how these abstract concepts can become embodied and what information these embodiments contain is a critical part of the technology-human-interface puzzle because it is where creative thought becomes embodied that unique possibilities lie in connecting technology to our thoughts in direct ways. It is at this crossing point that we have witnessed technology's osmosis into forms of both poiesis and esthesis. As Atau Tanaka puts it, 'embodiment denotes forms of participation, and the settings in which interactions occur'.[5] However, it is not as simple a task to take advantage of syncretic technology-art forms of praxis, simply because more often than not, learning the techniques involved and understanding how to process the information is difficult and time consuming and many composers and performing artists find this an enormous challenge.

In musical composition this process (from ideation with technology integration and eventual reception) undergoes several important stages, and whilst it is certainly impossible to clearly define this for every composer, there perhaps is a general sort of one-size-fits-all model or method that can attempt to describe the inner workings of the creative space. In the early 1990s a modern approach in the form of a general theory of ontological representations of art (music in this case), and specifically where the work and some form of technology are integrated was put forward. It alludes to a paradigm whereby our understanding of artistic process and, therefore creative spaces, have become emancipated from the traditional approaches to art where it exists for the 'metaphysical objective of expressing truth'. Instead, it approaches this where 'concentration has shifted to specific aspects of art, like the aesthetic use of signs, schematisation modes, or the message of art, and thus the metaphysical construct art has been separated into definable, explainable components'.[6]

4 C Siewert 'Consciousness and intentionality' in E Zalta (ed) *The Stanford encyclopedia of philosophy* (2011).

5 A Tanaka 'Embodied musical interaction' in S Holland et al *New directions in music and human-computer interaction* (2019) 137.

6 B Becker & G Eckel 'On the relationship between art and technology in

First, we can consider that musical thought generally begins as disorganised and disembodied and without form that can be externally represented. This is because it originates as priming in one's mind. The electroacoustic composer-theorist, Horacio Vaggione, made this clear, intimating that the raw musical ideas in the early stages of compositional thought are quite far removed from their organisation that comes later.[7] After this initial process, the assembly of this abstract material takes on form once it is represented in sound.[8] The creation of this sound, or what can be referred to as either a 'sonic gesture'[9] or, more generally, as a 'musical gesture',[10] can also be described as a sort of sign or 'musical semiosis'.[11] Essentially, the model supposes that a creative space exists when the components of idea/ontology, signs and their gesture-sound relationship occur together. Summarising this so far, we have the following:

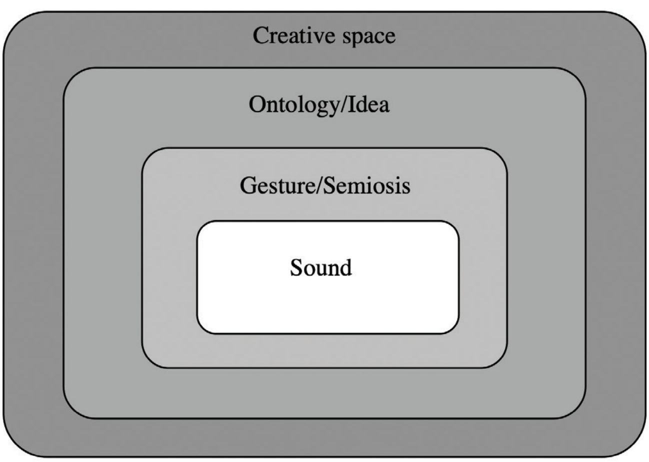

Figure 12.1: General model for creative space, idea, semiosis and sound

contemporary music' (1994), http://iem.at/~eckel/publications/becker94c.html (accessed 7 July 2021).

7 H Vaggione 'Some ontological remarks about music composition processes' (2001) 25 *Computer Music Journal* 54-61.

8 M Warrington 'The composer as technologist: An investigation into compositional process' DMus thesis, University of Cape Town, 2015 29, https://open.uct.ac.za/handle/11427/20787 (accessed 7 July 2021).

9 R Hatten 'A Theory of Musical Gesture and its Application to Beethoven and Schubert' in Gritten & King *Music and Gesture* (2006) 1.

10 M Leman & RI Godøy 'Why study musical gestures?' in Godøy & Leman *Musical Gestures Sound, Movement, and Meaning* (2010) 3.

11 J Nattiez *Music and discourse : toward a semiology of music* (1990) 3.

In terms of compositional process, sound is a product of a creative space where an ontology/idea through a process of gesture and semiosis[12] produces that sound. It can be internalised (heard-in-the-head) or auditioned (played back on an instrument or a computer). Therefore, at this point this sound can be externally represented and can take the form of a performance (live or recorded), or distributed in digital format (score file, digital audio content such as mp3, wav or other) or notated/depicted/ described in hard copy. It is here that technology can play a significant role in shaping the *aesthetic complex* and where HCI takes on a leading and supporting role. The advantages of understanding this process are numerous and many highly-innovative and well-supported projects since the 1990s around the world have been growing this important aspect of music making. HCI has done this by taking advantage of further segmented features of the gesture-semiosis-sound relationship. However, we first need to discuss in more detail compositional models as the process of composition eventually produces sound. Once we have seen these models in more detail, it will become clearer how it is the sound and its relationship with gesture and semiosis that gives rise to embodiment.

3 Compositional approaches, processes and models

My view, along with others in music compositional theory, is that the process of composition is a '*task environment*'[13] and '*problem-solving*'[14] practice. The adoption, creation and use of models greatly assist in defining the parameters of such problem-solving activities, especially where the intention of the artist/composer is to use electronic forms of technology embedded in an *aesthetic complex*. Composer-theorist Herbert Brün (1918-2000) summarised this succinctly, stating that 'the construction of models for problem-solving in the broadest and most general sense is the goal which technology and composition have in common',[15] and also where

12 The specific components of gesture and semiosis are discussed in more detail in subsequent sections.

13 J Tabor 'A pioneer in composition and research' in J Tabor (ed) *Otto Laske: Navigating new musical horizons* (1999) 7 (my emphasis).

14 B Truax 'Sonology: A questionable science revisited' in Tabor (n 9) 27 (my emphasis).

15 H Brün 'Technology and the composer'(1971) 9, https://sites.evergreen.edu/

'the composer now defines technology as the science and art of applying knowledge to the desire for problem solving'.[16] In this sense, applications of HCI and general computer-driven sound and music analysis have generously helped shape our understanding of compositional thought and also the embodied semiotics of sonic imagery in musical performance. Analysis is an important aspect of composition approached in this way because the relationship between sound and the information it contains requires a dissection if you will of the sound in order to contextualise aspects of the sound be it by timbre, frequency spectra, duration, dynamic, and so forth. These aspects can then be used as compositional parameters in HCI-music/sound applications and are extremely useful in understanding the movement/embodied/sound-energy associations we have when dealing with sonic imagery.

I should think that for obvious reasons, modelling creative approaches is a tricky affair. However, if we describe approaches where they outline artistic freedom, choice and expression, then we have definitions worthy of attention. Generally, there are two ways of defining compositional approaches or paradigms and where strong semasiological tendencies with artistic thought and procedure are possible. On the one hand, looking for ideas, innovation and technique through mimesis and adoption of existing artistic procedures and parameters gives us a 'model-based approach'.[17] On the other hand, composition can be approached by independent choices, unhinged from existing artistic ideas. Here, the composer chooses 'his/her own processes to conform with the musical idea'.[18] Each of these approaches can be visualised as follows:

arunchandra/wp-content/uploads/sites/395/2018/05/techcomp.pdf (accessed 9 July 2021).

16 Brün (n 11) 2.

17 Tabor (n 13) 3.

18 Tabor (n 13) 4.

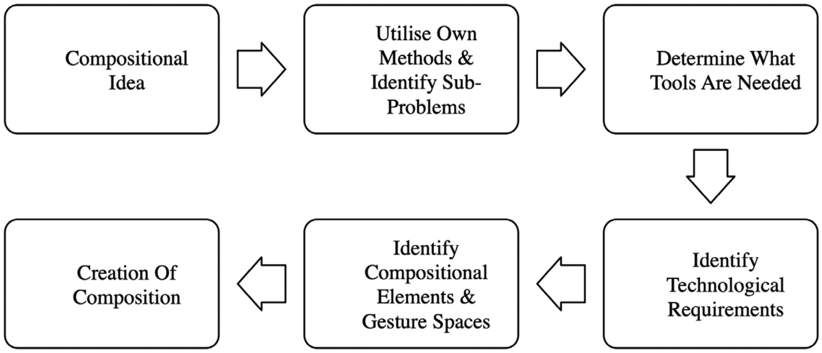

Figure 12.2a: Model-based compositional approach

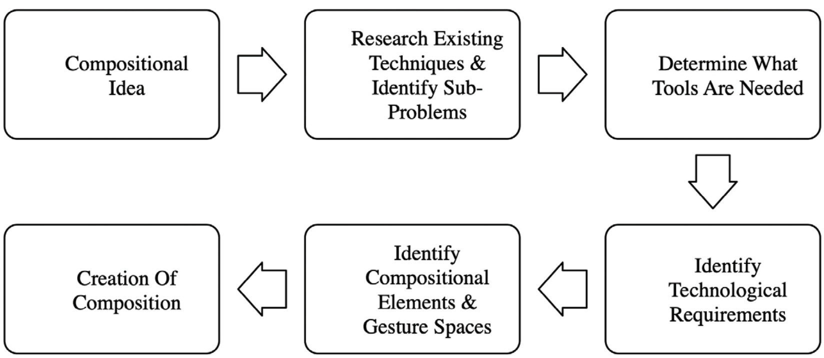

Figure 12.2b: Rule-based compositional approach[19]

Both these approaches define links between ideation, problem identification (either own method or adopted from existing technique), tool and technological requirements, musical elements and, finally, composition. Generally speaking, most compositional processes are not undertaken where either of these approaches (or variations thereof) occur in strict isolation from one another. On the contrary, creative spaces benefit from both innovation and technical adoption and a syncretic approach yields powerful results. Indeed, the history of music making, certainly from a Western perspective, has greatly demonstrated powerful links to both the approaches shown. Model-based approaches were significant prior to

19 Sources: Adapted from Warrington (n 8) 8.

the emergence of electronic forms of music; and since the mid-twentieth century, rule-based approaches have become ever-more important.[20] This is very much the case since the option for technological embedding in the *aesthetic complex* became possible, and certainly an intrinsic part of the general discussion in this chapter – that musical thought, compositional process and ideation can be informed by technologies where they assist in extending our artistic practice.

Factually evident is the realisation that understanding specific kinds of technology and their processes can be an important part of musical poiesis. The composer who wishes to take advantage of either rules-based or model-based creative approaches cannot ignore technology. This is not only applicable to the act of music making (composition and performance) but also to analysis and research. Certainly, these paradigms of compositional thought and process are among the most fruitful in cutting-edge research output and this is given strong backing by numerous publications dealing with this domain, such as that of Holland et al,[21] Cadoz,[22] Godøy[23] and many others.

3.1 Gesture schemas and embodiment of sound

Gestural forms and semiosis in human communication are ancient, persistent, wide-ranging and ubiquitous across domains, communications modes, languages and cultures. Vast amounts of studies from disparate disciplines exist that explore all of these individually and where they cross-pollinate. In the music domain, gesture studies have gained significant ground in the last 20 to 30 years with an accelerated impetus and epistemological output in the last ten years. However, before this growth, our understanding of components[24] of gesture and the space it occupies in music making was limited to sonic forms – where exploring phrases,

20 Tabor (n 13) 4.

21 Holland et al (n 5).

22 C Cadoz *Instrumental gesture and composition. Proceedings of the 1988 International Computer Music Conference* (1988).

23 RI Godøy 'Gestural imagery in the service of musical imagery' in A Camurri & G Volpe (eds) *Gesture-based communication in human-computer interaction* (2004) 55.

24 See section 3.3, Figure 12.6., for more details of gesture spaces and their components.

tropes and musical organisation in discernible packets of information was undertaken.[25] This has meant that on the whole, and until fairly recently, the links between ontology, embodiment and expression as part of our understanding of gesture in music and sound were a lot less understood; less understood because gesture is such a vast subject and the association with music often is quite abstract, even non-figurative. In a simple example, one could think of a falling sonic line that appears to stumble over itself – here the overall contour and trajectory of the sound could intimate a downward movement of an object such as a ball rolling down an uneven sloped surface. The sound's energies and the rate of their changes of inflection, dynamic and duration outline the general trajectory of the ball. In electroacoustic music, one of the more successful theories that describe sound and it's changing energies over time is that of Denis Smalley's *spectromorphology*[26] and is related to Pierre Schaeffer's concept of the *musical object* discussed later. The theory is concerned with how a sound's spectra morph (change) over time and the sonic image or footprint that is perceived by these changes. Scholars Bridges and Graham[27] have to some degree explored links between Smalley's theories and those of embodiment, however on the whole they remain only partially understood, particularly where the subtle tendencies for particular actions associated with corporeal intentionality are concerned. Corporeal intentionality is a system where ontologies are morphed into 'action-relevant' and 'action-intended'[28] expressions. A result of this lack of understanding is that sonic embodiment is not often incorporated into processes related to the *aesthetic complex*. Accordingly, studies aimed at understanding the workings of this system have thus far revealed two spaces as part of what has been referred to as an 'intentionality engine'.[29] These spaces form a coupled system of actions and perception that bridge the divide between outer and inner

25 For more information, the reader is directed to RS Hatten *Interpreting musical gestures, topics, and tropes: Mozart, Beethoven, Schubert* (2004).

26 D Smalley 'Spectromorphology: Explaining sound-shapes' (1997) *Organised Sound* 107-126.

27 B Bridges & R Graham *Electroacoustic Music as Embodied Cognitive Praxis: Denis Smalley's theory of spectromorphology as an implicit theory of embodied cognition* (2015), http://brianbridges.net/?p=851 (accessed 10 July 2021).

28 M Leman *Embodied music cognition and mediation technology* (2008) 84.

29 Leman (n 20) 85.

spaces; between 'movement' and 'sensory perception'.[30]

For musicians, this is what describes the complex interaction between sonic image, its corporeal intentionality (or articulation), and resulting action that produces sound. More specifically, it is the critical idea that ideation/ontology, as presented by a sonic image through a semiotic form, gives rise to action that establishes a *perception-action cycle*[31] which is the 'transformation of perceived patterns into co-ordinated patterns of movement'.[32]

It has been through performance-based requirements of some rather interesting compositional ideas, and not the other way around, that have, at least in the music domain, produced some of the more interesting research discoveries in this field. This is so because developing tools and techniques to overcome the problems of interface and to mediate between humans and machines as expressive constructs of the *aesthetic complex*, requires a deep understanding of the *perception-action cycle*. For example, capturing the movement of a violinist's bow, analysing it in real-time through image capture and using the information to control various musical parameters via a computer through live sound manipulation/processing. Figure 12.3 gives an outline of such a possible example in model-form, where a device is used to capture specific gestural data – the information contained is gestural in nature (movement of the bow) – this is processed and then applied in a work in whichever way the composer/artists chooses. In music, this is where 'perception is largely based on auditory image representation and gesture representation rather than attribute representations'.[33]

30 Leman (n 20) 89.

31 The perception-action cycle is a well-understood, ecologically-driven mechanism between cognition and body function. The resources defining, describing and discussing the term are numerous.

32 EE Smith & SM Kosslyn *Cognitive psychology: Mind and brain* (2006) 453.

33 M Leman 'Adequacy criteria for models of musical cognition' in Tabor (n 9) 115.

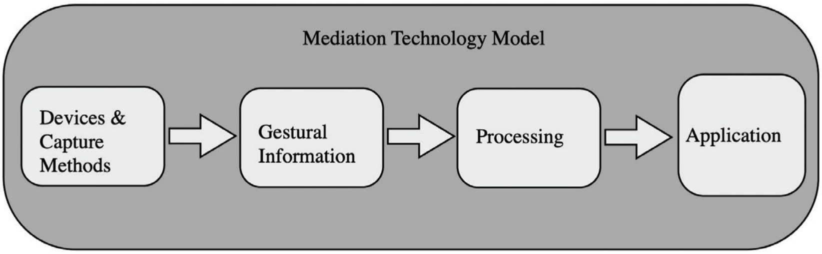

Figure 12.3: Mediation Technology Model[34]

Where the coupling of the *perception-action cycle* and the study of gesture occurs in music, we are assisted in better understanding what we hear and the resulting action behind it.[35] The HCI systems that take advantage of this fall into a category of technology-driven forms of musical expression and have collectively been referred to as the 'gestural control of music'[36] or gesture heuristics.

Schemas on the whole can help elucidate this further and the models can take advantage of musical semiotics and cognition. Cognitive musicologist and composer-performer Ole Kühl elucidates: 'The most important, stable element in musical semantics is the primary signification from musical phrase to gesture and from musical gesture to emotional content and social belongingness.'[37] Notation or the depiction of musical information plays an important role here because it acts as a system of information transmission. This is significant since in 'this context, notation may be seen as a form of semiosis – a signifier that conveys information'.[38] Thus, finally, we can generally posit that in both the cognition and poeisis stages of the *aesthetic complex*, compositional process – the amalgamation of ideation and the act of transforming the idea into material – has elements that form semantics in the shape of musical

34 Source: Warrington (n 8) 85.

35 RI Godøy 'Gestural affordances of musical sound' in RI Godøy & M Leman (eds) *Musical gestures: Sound, movement, and meaning* (2010) 119.

36 M Wanderley & M Battier (eds) *Trends in gestural control of music* (2000), http://www-new.idmil.org/publication/trends-in-gestural-control-of-music/ (accessed 9 July 2021).

37 O Kühl 'The semiotic gesture' in A Gritten & E King (eds) *New perspectives on music and gesture: SEMPRE studies in the psychology of music* (2011) 123.

38 Warrington (n 8) 58.

gestures. It is in the performance space that follows where HCI can further integrate in the *aesthetic complex* and become a form of both poeisis and esthesis. Support for this is wide ranging and has been around for some time, including examples from discussions by Hamman,[39] Tabor,[40] Laske,[41] Roads,[42] Xenakis[43] and many others. The gesture study schema model that follows outlines the various associations discussed here between the differing areas of investigation/study and their interdisciplinary nature where they are concerned with using gesture as a means for mediating human-centred embodied cognition in an *aesthetic complex*. In summary, the overall container is the 'Gesture Study Schema' and working from the bottom-up it eventually leads to the production of musical material be it a score, computer programme and/or sound output.

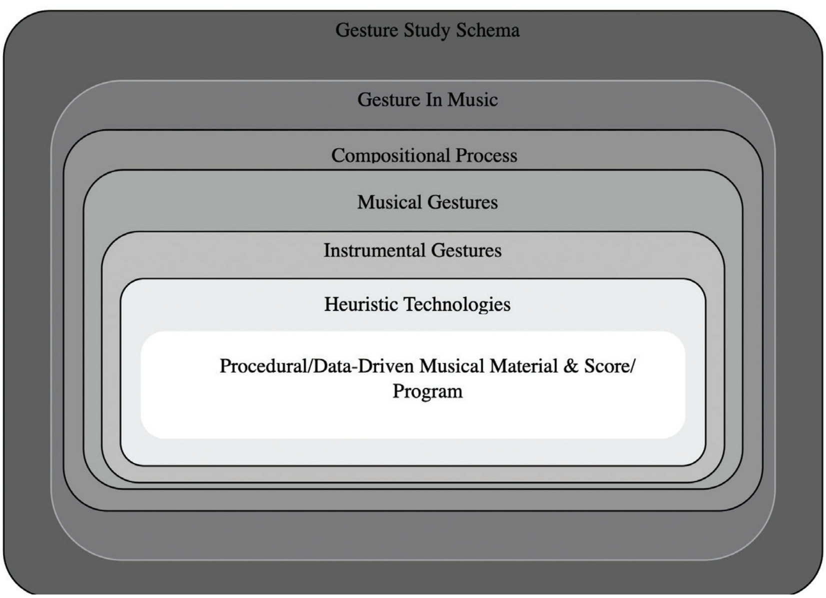

Figure 12.4: Gesture study schema[44]

39 M Hamman 'From technical to technological: The imperative of technology in experimental music composition' (2002) 40 *Perspectives of New Music* 92-120.

40 Tabor (n 12) 7.

41 O Laske 'Toward the Schoenberg Centenary, III: In search of a generative grammar for music' (1973) 12 *Perspectives of New Music* 351.

42 C Roads *The music machine: Selected readings from computer music journal* (1989).

43 M Bischof et al *Xenakis: Combining tangible interaction with probability-based musical composition* (2008).

44 Source: Warrington (n 8) 62.

3.2 Gesture signification

Apart from a general approach to studying gesture in music, it is possible to devise methods for how the information is signified and processed. So far, we have explored gesture and musical idea as containers of musical information, semiotics and images. But how is this mechanism represented? We have seen the broader context of gesture in compositional process and how this articulates with resultant gestures through musical performance and where a heuristic would be necessarily placed within such a study/ work creation to take advantage of that information.

What follows now is an outline of the signification of gesture from musical idea to gestural unit. This is a very important step in the overall framework of gesture embodiment in musical works. Below are two Gesture Signification Models[45] (A & B) devised to outline the process from compositional ideation to sound and gesture with two possible pathways:

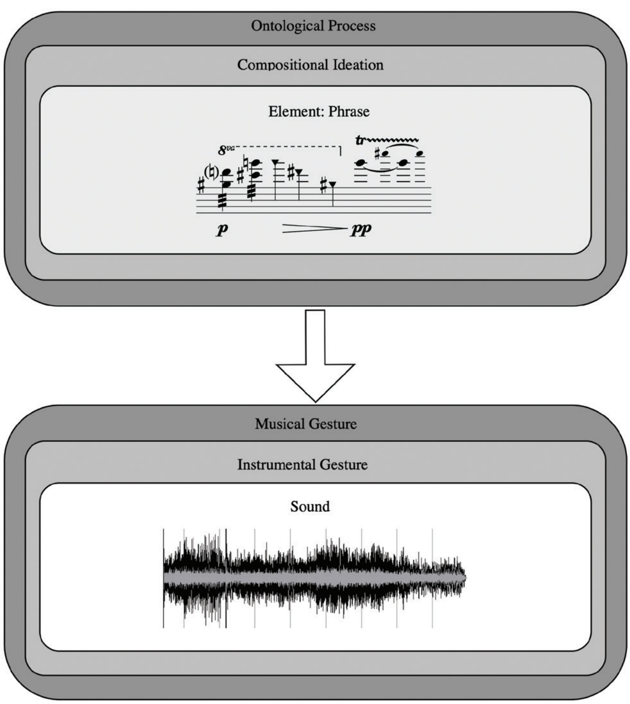

Figure 12.5a: Gesture Signification Model A

45 Source: Warrington (n 8) 66, 68.

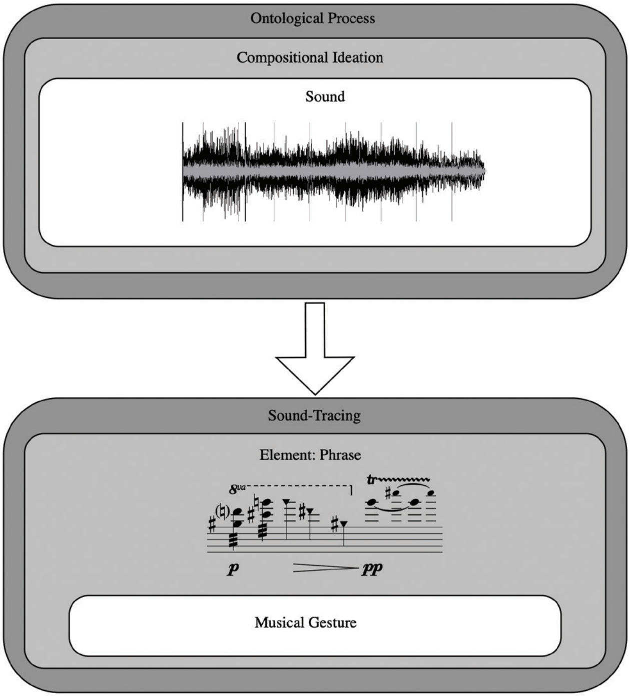

Figure 12.5b: Gesture Signification Model B

In Model A the compositional process begins with a musical element in mind consisting primarily of an already intact, somewhat completed, musical element. The composer imagines the completed phrase. What happens is that an ontology leads to a musical idea which in turn leads to the production of a phrase or element and then by using gesture spaces to obtain further information, a sound is created (as indicated) by an instrument; but this of course can also be loudspeaker(s).

In Model B the composer starts with the sound and ends with the musical gesture – in essence a reverse process of Model A, except that '*sound-tracing*'[46] is introduced to depict the associated sonic image in some form of notated paradigm, be it a score (as indicated) or text, drawing, instruction or physical mode of interaction. Godøy points out that 'musical sound has great power to make us move or to create sensations of

46 Godøy (n 26) 117 (my emphasis).

movements in our minds'.[47] Of particular interest here is the last section of this statement, 'sensations of movements in our minds', which often takes the form of mental images as part of initial ontological processes during compositional ideation. The phrase 'sensations of movements in our minds' is particularly germane since it describes how ontologies of compositional ideation can take the form of mental images of movement. In a sense, 'the composer "hears" the movement cognitively and then outlines this movement in the form of a musical gesture'.[48] Sound-tracing in this mode is describing a process of auditory perception that is an internal process, occurring without any external auditory stimulus.

Model B could then latch onto the second half of Model A, where musical gesture translates into instrumental gesture and eventually sound. Here we can see a *gesture-loop* in action. In performance, the result often is a feedback loop of gestural information from the system to the performer and *vice versa*. A circle of hermeneutic gestures,[49] both of sonic images (musical gestures) and the physical (movements) is occurring.

In both cases the boundary of translation of sonic image into gestural information and, thus, corporeal intention of embodied gestures, is where the musical gesture is read. Part 3.3 which follows details how this can be achieved.

Gesture studies in music, as thus far contextualised in this chapter, can give us a formal representation of the relationships discussed up to this point between musical thought, compositional process, gesture and technology. This is a necessary part of understanding compositional processes. Any musical meaning that is intended as part of the embodiment of sonic images generated in compositional thought through gesture, and to be used by machines such as computers, should include this type of approach. The representation shown in Figure 12.4 is devised out of all of these relationships to signify their articulations and connections with one another. It stands to reason then that this approach covers all the necessary aspects of the entire process in order to arrive at the point where some form of gesture-heuristic technology can be integrally used in a musical work and thus be partnered with the embodied musical semiosis.

47 Godøy (n 26) 103.

48 Warrington (n 8) 67.

49 Godøy (n 26) 119.

3.3 Problem solving and gesture models

In order to derive anything out of this discussion, models of interaction, analysis and processing of information are required. If we consider the outline of the basic nature of gesture in relation to musical thought as discussed so far, then the premise is that the sonic image contains all the information we need to initiate translation with systems outside of the ‘intentionality engine’.[50]

The model in Figure 12.1 was a broad representation of creative activities that produce a sonic image. More detail can now be given, particularly to the gesture/semiosis section, where the gestural qualities and components can be defined and used in mediation technology systems or gesture-heuristics. Musical gesture studies have given us definable components of the entire gesture space associated with the generation of sound in music performance environments. The discussion up to this point has relied somewhat on the transformation of the sonic image into corporeal energies, but this is not where the limits of using musical gesture spaces end. Music for loudspeakers only (acousmatic music/*musique concrète*) also contains gestural qualities and can equally viably be incorporated into a gesture recognition system for procedural[51] processing. Godøy has placed this succinctly and eloquently within the framework of Pierre Schaeffer’s ground-breaking concept of the sonorous object,[52] by stating that ‘[t]he sonorous object can be inspected, explored, and progressively differentiated with regards to features, features which often evolve or have various envelopes which can be traced, hence in my opinion actually becoming more like what I would call a gestural object’.[53]

It is clear from this that the human perception system can recognise musical gestures in fixed or procedural music for loudspeakers and engage with them in real time through either improvisation or compositional instructions in live performance. However, I am adopting the paradigm

50 Leman (n 20) 85.

51 By ‘procedural’ I mean that a system produces musical information in real-time based on a set of criteria or programmed instructions that are integrated into the composition either as part of a score, set of instructions or aesthetic decisions.

52 The reader is directed to Schaeffer’s monumental work, P Schaeffer *Treatise on musical objects: An essay across disciplines* (2017) trans C North & J Dack.

53 R Godøy ‘Gestural-sonorous objects: Embodied extensions of Schaeffer’s conceptual apparatus’ (2006) 11 *Organised Sound* 149.

of live music for the combination of electronics and any instrument here because this perhaps is an easier-to-understand, more familiar music archetype that helps to explain embodiment and the possibilities for machine communication more readily.

Because gestural components are physical manifestations of parts of the interpretative/performance framework of music systems (notation, instruction, improvisation), the actions are extremely specific and are based entirely on the information required to produce the sound associated with the semiosis. Thus, we can formally categorise these components into gestural units. Figure 12.6 is a summary of information gleaned from studies of gestural components of the gesture space in instrumental music. In the model we can see that the gesture space supports various categories of gesture functions. In turn, each of these then have components that are action-centred modes that relate to how sound is produced, modified or supported.

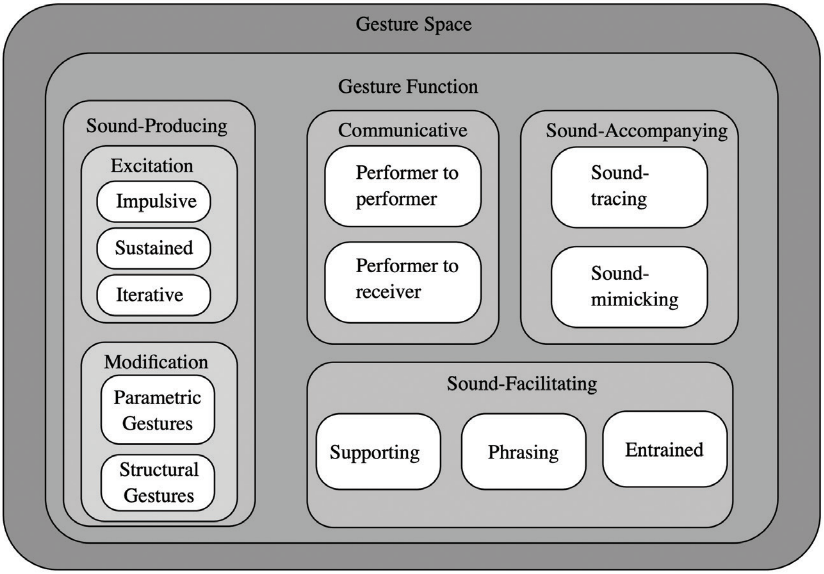

Figure 12.6: From musical gesture to instrumental gesture[54]

54 Source: adapted from A Jensenius et al 'Musical gestures: Concepts and methods in research' in Godøy & Leman (n 24) 23-28.

Out of all the unit categories shown, gestural control systems and HCI have generally made use of sound-producing, modification and sound-facilitating gesture functions as sources of information to control, manipulate and integrate computer music systems in live music making. Composers can make aesthetic judgments and base choices of which gestural unit to use based on the design and intention of the gestural control system adopted. The effectiveness of the system to capture more than just sound-producing gestural units depends on the degree to which it can simultaneously analyse and process more complex gestural information. Until roughly ten years ago, the ability for computers and motion capture to process complex gestural information from musical contexts in gesture-scene analysis was severely limited.[55] The situation today is improved and numerous applications of advanced motion capture assist composers and performers alike.[56] These more often than not take on the form of a *hyperinstrument* when used in a music *aesthetic complex*, and are discussed in the next part.

The application of these systems has also historically been developed, used and applied in most cases within the Western art-music aesthetic, and particularly that of experimental music and electroacoustic music practices and research. The lack of published articles, chapters and other sources on this subject speaks to the general infancy of this area of research in South Africa. Unpublished works include those those by Van Tonder[57] and Crossley.[58] A further three unpublished degree documents exist on this subject I am familiar with, namely, those by

55 M Leman & RI Godøy 'Why study musical gestures?' in Godøy & Leman (n 27) 3.

56 Because of limitations of this chapter to discuss all the current projects, the reader is directed to the following resource as a point of departure: J Malloch et al 'A design workbench for interactive music systems' in Holland et al (n 5) 23.

57 C van Tonder 'Music composition and performance in interactive human systems' (2004), https://www.academia.edu/1215332/Music_Composition_and_Performance_in_Interactive_Computer_Human_Systems (accessed 10 July 2021).

58 J Crossley & J Braamfontein 'The cyber-guitar system: Nuance in instrumental practice as a motivation for immediacy within gestural controllers' (2016), https://ler.letras.up.pt/uploads/ficheiros/14056.pdf (accessed 10 July 2021).

Cronje,[59] Warrington[60] and another by Crossley.[61] It therefore is clear that the application and general use of procedural-based gesture heuristics in performance, composition and research in the musical arts remains a very modest arts-based speciality in South Africa. There is enormous scope for development of this field with co-articulations in indigenous knowledge systems and ethnomusicology.

3.4 Hyperinstruments

Pursuant to various aspects of these models and schemas shown so far, at some point the composer has to deal with problem solving by the use of or adoption/creation of technology. In creative spaces this more often than not requires the composer to be highly innovative and develop solutions or heuristics in the form of technology to solve these problems.[62] The idea of the composer-technologist has been explored extensively by various scholars and contributors to the field, but particularly where the application of gesture-heuristic(s) and real-time music processing is required as part of an integrated work. The context of this becomes obvious in terms of what has been discussed so far in this chapter. More often than not, this integration of technology into a work of art (other than a musical instrument) has generally resulted in systems that extend the acoustic instrument(s) and enhance their timbre or sonic abilities. There are many examples that cross both the haptic and non-haptic interface categories. These are referred to as *hyperinstruments*. Tod Machover of the Massachusetts Institute of Technology Media Lab (MIT Media Lab) describes such acoustic instrument extension systems as tools that 'transcend the traditional limits of amplifying human gestuality, and become stimulants and facilitators to the creative process itself'.[63] In the

59 M Cronje 'Designing a hyperinstrument with gesture interface for musical performance' (2005), http://scholar.sun.ac.za/handle/10019.1/16602 (accessed 10 July 2021).

60 Warrington (n 8).

61 J Crossley 'The Cyber-Guitar System: A Study in Technologically Enabled Performance Practice' (2017), https://wiredspace.wits.ac.za/handle/10539/24601 (accessed 10 July 2021).

62 Warrington (n 8) 16.

63 T Machover 'Hyperinstruments: A progress report, 1987-1991' MIT Media Lab

most basic description, a computer system with some sort of programme takes information from a performance space and processes it in real time to generate a musical result. More or less then, *hyperinstruments* are gesture-heuristics.

The heuristic-creative process is an ideal vehicle for augmented musical works. Computer-driven technology integrated into music by adopting models of approach to composition and gesture gives technology the ability to act as a simultaneous agent of both poiesis and esthesis in the *aesthetic complex*. At this point there are two distinct pathways to achieving this: On the one hand we are dealing with compositional aesthetics and, on the other, technological processes. Composers should be aware of these possibilities at the outset when creating works that deal with the embodiment of sonic images through interaction. This is because there is an important relationship between the musical gestures as part of that composition, and the resulting instrumental gestural units from the interpretation of that composition, either from a score or instructions or other forms of musical communication. Musicologists have noted this and iterated that 'Western musical thinking often tends to ignore the fact that any sonic event is actually included in a sound-producing gesture, a gesture that starts before and often ends after, the sonic event of any single tone or group of tones'.[64]

Hyperinstruments come in many different guises and, as mentioned, these systems can be separated into two broad categories, namely, haptic and non-haptic. Haptic refers to the 'designating or involving technology (for entertainment, communication, and so forth) that provides a user interface based on stimulation of the senses of touch and movement (kinaesthesia)',[65] whereas non-haptic refers to this process of interacting, but where there is no direct link between the senses of touch or movement, such as signal following or video tracking. The choice to use either of these or even a combination again is dependent on the desired result, the compositional process and the nature of the gesture control. In summation, the overall model for the generation of a *hyperinstrument* that uses gesture and compositional process in an *aesthetic complex* is shown below:

(1992) 13, https://dam-prod.media.mit.edu/x/files/publications/machover_hyperinstruments_progress_report.pdf (accessed 8 July 2021).

64 Godøy (n 26) 110.

65 'haptic, n.' OED Online. Oxford: Oxford University Press (2021).

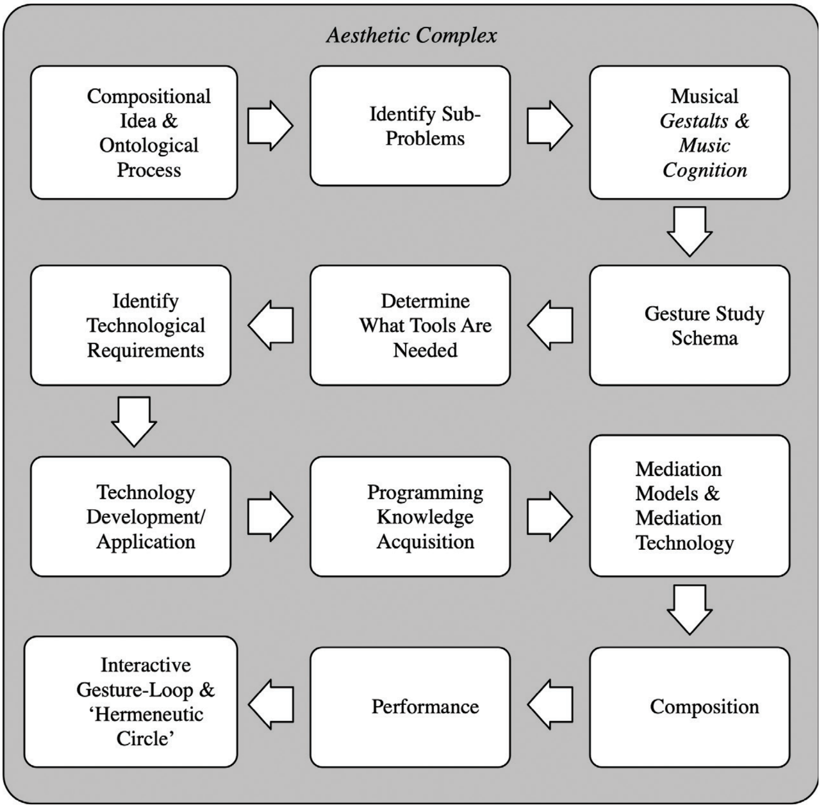

Figure 12.7: Aesthetic complex summary and compositional process with gesture heuristics[66]

4 Conclusion

Gesture heuristics, composition and music performance at best are a difficult journey for most practitioners. To this day, most of the systems developed are done so at university level research spaces and projects, with only a handful developed in the commercial environment that are usually not sound/music-specific.

In the music *aesthetic complex*, sonic interaction and the embodiment of gestures are a fascinating, challenging and technically-exciting domain of music making both from a compositional and performance perspective.

66 Source: adapted from Warrington (n 8) 187.

The possibilities for creative output, research and development are astonishing. This has become more so the case today as recent technologies, systems and computing capability have shifted many of the problems out of the way that, to a large extent, were prohibitive hurdles to artistic idea. The problem is that the choice of paths offered in the compositional approaches and models discussed – the development and implementation of HCI systems to process and generate effective results in the sonic-image embodiment space – is completely reliant on how the composer/performer approaches the work. Composers and performing musicians who want to work in this space have to work very hard to mould the conceptual apparatus of a gesture controller around their creative thinking and, of course, this creates a proportional increase in the workload. However, these should not be regarded as prohibitive factors, but rather as unique and exciting challenges because the results speak for themselves. The *embodiment* of sound in musical gesture spaces and human-computer-interaction can and *does* create enormous creative potential for composers, performers and sound artists alike.

References

‘haptic, n’ 2021. OED Online. Oxford: Oxford University Press

Becker, B & Eckel, G ‘On the relationship between art and technology in contemporary music’ (1994), http://iem.at/~eckel/publications/becker94c.html (accessed 9 July 2021)

Bischof, M, Conradi, B, Lachenmaier, P, Linde, K, Meier, M, Pötzl, P & André, E *Xenakis:* ‘Combining tangible interaction with probability-based musical composition’ in *Proceedings of the 2nd International Conference on Tangible and Embedded Interaction* (ACM 2008)

Bridges, B & Graham, R *Electroacoustic Music as Embodied Cognitive Praxis: Denis Smalley’s theory of spectromorphology as an implicit theory of embodied cognition* (2015), http://brianbridges.net/?p=851 (accessed 10 July 2021)

Brün, H ‘Technology and the composer’ (1971), https://sites.evergreen.edu/arunchandra/wp-content/uploads/sites/395/2018/05/techcomp.pdf (accessed 9 July 2021)

Bundgaard, PF & Stjernfelt F (eds) *Investigations into the phenomenology and the ontology of the work of art: Contributions to phenomenology* (Springer 2015)

Cadoz, C 'Instrumental gesture and composition' Proceedings of the 1988 International Computer Music Conference (1988)

Cronje, M 'Designing a hyperinstrument with gesture interface for musical performance' (2005), http://scholar.sun.ac.za/handle/10019.1/16602 (accessed 10 July 2021)

Crossley, J 'The Cyber-Guitar System: A Study in Technologically Enabled Performance Practice' (2017), https://wiredspace.wits.ac.za/handle/10539/24601 (accessed 10 July 2021).

Crossley, J & Braamfontein, J 'The cyber-guitar system: Nuance in instrumental practice as a motivation for immediacy within gestural controllers' (2016), https://ler.letras.up.pt/uploads/ficheiros/14056.pdf (accessed 10 July 2021)

Godøy, RI 'Gestural-sonorous objects: Embodied extensions of Schaeffer's conceptual apparatus' (2006) 11 *Organised Sound* 149

Godøy, RI 'Gestural imagery in the service of musical imagery' in Camurri, A & Volpe, G (eds) *Gesture-based communication in human-computer interaction* (Springer 2004) 55

Godøy, RI 'Gestural affordances of musical sound' in Godøy, RI & Leman, M (eds) *Musical gestures: Sound, movement, and meaning* (Routledge 2010) 119

Hamman, M 'From technical to technological: The imperative of technology in experimental music composition' (2002) 40 *Perspectives of New Music* 92

Hatten, RS 'A Theory of Musical Gesture and its Application to Beethoven and Schubert' in Gritten, A & King, E (eds) *Music and Gesture* (Ashgate 2006) 1

Holland, S, Mudd, T, Wilkie-McKenna, K, McPherson, A & Wanderley, MM (eds) *New directions in music and human-computer interaction* (Springer 2019)

Kühl, O 'The semiotic gesture' in Gritten, A & King, E (eds) *New perspectives on music and gesture – SEMPRE studies in the psychology of music* (Ashgate 2006) 123

Laske, O 'Toward the Schoenberg Centenary, III: In search of a generative grammar for music' (1973) 12 *Perspectives of New Music* 351

Leman, M & Godøy, RI 'Why study musical gestures?' in Godøy, RI & Leman, M (eds) *Musical gestures: Sound, movement, and meaning* (Routledge 2010) 3

Leman, M 'Adequacy criteria for models of musical cognition' in Tabor, J (ed) *Otto Laske: Navigating new musical horizons* (Greenwood Press 1999) 115

Leman, M *Embodied music cognition and mediation technology* (MIT Press 2008)

Malloch, J et al 'A design workbench for interactive music systems' in Holland, S, Mudd, T, Wilkie-McKenna, K, McPherson, A & Wanderley, MM (eds) *New directions in music and human-computer interaction* (Springer 2019) 23

Myers, B 'A brief history of human computer interaction technology' (1998) 5 *ACM Interactions* 44

Nattiez, J *Music and discourse : toward a semiology of music* (Princeton University Press 1990)

Norman, KL & Kirakowski, J (eds) *The Wiley handbook of human computer interaction set* (Wiley Blackwell 2018)

Roads, C *The music machine: Selected readings from computer music journal* (MIT Press 1989)

Schaeffer, P *Treatise on musical objects: An essay across disciplines* trans C North & J Dack (University of California Press 2017)

Siewert, C 'Consciousness and intentionality' in Zalta, EN (ed) *The Stanford encyclopedia of philosophy* (2011)

Smalley, D 'Spectromorphology: Explaining sound-shapes' (1997) *Organised Sound* 107-126

Smith, EE & Kosslyn, SM *Cognitive psychology: Mind and brain* (Pearson 2006)

Tabor, J 1999. 'A pioneer in composition and research' in Tabor, J (ed) *Otto Laske: Navigating new musical horizons* (Greenwood Press 1999) 7

Tanaka, A 'Embodied musical interaction' in Holland, S, Mudd, T, Wilkie-McKenna, K, McPherson, A & Wanderley, MM (eds) *New directions in music and human-computer interaction* (Springer 2019) 137

Truax, B 'Sonology: A questionable science revisited' in Tabor, J (ed) *Otto Laske: Navigating new musical horizons* (Greenwood Press 1999) 27

Vaggione, H 'Some ontological remarks about music composition processes' (2001) 25 *Computer Music Journal* 54

Van Tonder, C 'Music composition and performance in interactive human systems' (2004), https://www.academia.edu/1215332/Music_Composition_and_Performance_in_Interactive_Computer_Human_Systems (accessed 10 July 2021)

Wanderley, M & Battier, M (eds) 'Trends in gestural control of music' (2000), http://www-new.idmil.org/publication/trends-in-gestural-control-of-music/ (accessed 9 July 2021)

Warrington, M 'The composer as technologist: An investigation into compositional process' DMus thesis, University of Cape Town, 2015, https://open.uct.ac.za/handle/11427/20787 (accessed 8 July 2021)