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Abstract

The use of computers has continued to increase within interactive performance over the last 25 years, evolving the need for understanding performer system interaction. Performers in the disciplines of Music, Dance, and Theatre produce works incorporating autonomous computer systems programmed to "listen" and contribute material. Interaction with such systems commonly relies on computers sensing the performer’s physical and/or sonic gesture. However, this sense-respond model does not easily accommodate the concept of intuition, which fosters the development of performer trust, synchronization and collaboration within interaction. Performance practitioners interact using embodied-knowledge that is developed through training and experience of the body. Although it is an innate part of performing, intuition is seldom considered and has been under theorized and under-researched in the context of performer-system interaction models. Intuition as a parameter of interaction has significant relevance to the interaction between an autonomous system and a performer. I have conducted three case studies on performers’ sense of intuition within interactive performance by designing and testing an interactive system that provides information cues of the system’s internal state. The system’s intention to act and the quality of gesture will was explored by simulating breath as an intentional cue. By altering the timbre and duration of the simulated breath, the system can indicate the quality of intended gesture. The model was evaluated by collecting performer interview data, third person observation of performer interaction, and first-person accounts of the system designer testing the system as a part of the design process. The information resulting from this study can be used to further develop models of interaction with autonomous generative systems in performance.

Keywords: Interactive Performance; Breath as Cue for Interaction; Phenomenological Methods: Intuition; Embodied Agents; Human Computer Interaction
Dedication

To my wife who is my partner in everything I do;

and to my family for their unending support and patience.
Acknowledgements

I would like to thank my senior supervisor, Dr. Thecla Schiphorst, for her support and guidance throughout the production of this thesis and my research process. I am grateful for her care and persistence in challenging me to articulate my ideas.

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I am grateful to all the performers who helped me with this project, both during the pilot studies and the final session. Their expertise, work and openness is what has made the research possible.

I am also grateful Dr. Gabriella Minnes Brandes whose expertise in Alexander Technique has provided me with a fresh view of movement; and to Renee Anne McCallum for her tireless copy editing.
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List of Acronyms

SFU  Simon Fraser University
HCI  The discipline of Human Computer Interaction
**Glossary**

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<tr>
<td>Hough Transform</td>
<td>A computational method for finding lines, circles or simple forms in images.</td>
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<td>Embodied Knowledge</td>
<td>Knowledge constructed and accessed through the body in association with experience in the physical world.</td>
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<tr>
<td>Autonomous system</td>
<td>A computer system that is able to respond in its environment without direct input from a human operator or user.</td>
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<td>Anticipation</td>
<td>A rational expectation of actions that will happen in the future</td>
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<tr>
<td>Intention</td>
<td>A plan to act in the near future</td>
</tr>
<tr>
<td>Intuition</td>
<td>A sense of actions that will happen in the near future that avoids rational consideration</td>
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<td>Viewpoints</td>
<td>A training philosophy for theatre that focuses on developing awareness of elements (viewpoints) in the performance environment including within the ensemble.</td>
</tr>
<tr>
<td>Offer</td>
<td>A term used in theatre improvisation literature. The term refers to parameters of objects, or other’s actions that are recognizing by a performer as providing inspiration for their own actions.</td>
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1. Outlining an Approach to Exploring Breath as an Embodied Cue for Intuition in Interactive Performance

In the last three decades, the use of computers has continued to increase in many domains including their use in live stage performances. Contemporary Performers in the disciplines of Music, Dance, and Theatre now produce works incorporating more specialized autonomous computer systems that are programmed to ‘listen’ or sense on-stage activity and to contribute performative material in the form of sound, image and even kinetic movement to the overall performance (Broadhurst & Machon, 2007; Lewis, 1999; Weinberg & Driscoll, 2007). I use the term ‘autonomous’ to describe a computer that is influenced by external data as well as its internal state. Though some exceptions exist, the design of the performer’s interaction within digitally mediated performance commonly focuses on the computer system’s ability to sense the performer’s physical and/or sonic gesture. With this real-time input, the system responds by generating or modifying digital material it outputs into the performance space. This sense-respond interaction model accounts for a simple level of give and take experienced during human interactions. However, the model does not easily accommodate the development of features of performer-performer interaction such as trust, synchronization and collaboration. I claim that there is a rationale for incorporating features of trust, synchronization and collaboration into autonomous performance systems. Performance practitioners describe these features of interaction as rooted in knowledge that is developed through experience in the body (Lockford & Pelias, 2004; Pallant, 2006; Chvasta, 2005). Research in cognitive science and performance practice suggests that
human intuition\(^1\) is a significant element of this body knowledge (Pressing, 1987; Powell, 2007; Gallese, 2001). Yet, in the context of performer-system interaction, intuition is seldom considered and has been under theorized and under-researched. Intuition as a parameter of interaction has significant relevance to the interaction between an autonomous system and a performer. This is because in most cases the system’s internal state, which influences the system’s response, is hidden from the performer, and therefore is not explicitly knowable to the performer. I am proposing an interaction model that provides information cues of the system’s internal state by engaging the performer’s sense of intuition. My research study evaluated this model using studio tests. Studio tests were conducted by inviting pairs of physical theatre performers to improvise with an interactive autonomous music system over several sessions. As a contribution of the research, I developed the computer system based on the proposition that an interaction model incorporates a performer’s sense of intuition can provide insights into developing greater intelligence in performer-system interaction.

The computer system used to evaluate the model was designed to test two proposed methods that enabled the computer system to leverage the performer’s sense of intuition. First the system was designed to have a simulated attention to objects in a space including the ability to shift its attention within its visual sensing area. Second, the system design included the use of simulated breath sounds that represent the inhalation, formation of an air stream and tapering of breath pressure at the end of the exhalation. The simulated breath was designed explicitly to leverage the performer’s embodied understanding of breath as a preparatory activity, and to trigger the performer’s intuition with regard to the upcoming musical gesture. This interaction is modeled on a set of physical cues, selected as part of performer-performer interaction based on two areas: 1) research in cognitive science and embodied perception that is recognized in the performance practice literature and 2) through the personal experiences of the performers. While intuition encompasses a wide area of experience, this study focuses

\(^1\) I use the term intuition to mean an embodied sense of immediately upcoming events, in particular the intended actions of others. During this performer-participants on occasion substitute the term Anticipation. At these time I use the language of the participant. However, in my own use of the terms, intuition implies a shorter time frame and an embodied knowing where as I use Anticipation to imply a more rationally developed expectation and a longer time frame
on the performers’ intuitive experience concerning three aspects of the system’s gesture: 1) the performer’s intuition of the system’s intention to act, 2) the performer’s intuition of the quality of the system’s gestures, and 3) the performer’s intuition of the system’s focus of attention. These aspects are explored in three stages of this study. The first two stages were concerned with the performer’s intuition of the system’s intention to act as well as the quality of gesture. These were explored by focusing on the breath cues provided by the system. It is my expectation that through simulating an inhalation breath, the system indicates it is preparing to act. Furthermore, by altering the timbre and duration of the simulated breath, the system can indicate the quality and duration of the intended gesture such as tempo or articulation. The final stage of this study employs a simple simulation of the system’s focus of attention. The system is design to respond to motion in the environment recognized as simple shapes detected in a moving subsection of the camera field. The moving subsection enables the system to shift its focus, which also shifts its response. This study explores if the system’s shifting focus can then be perceived by the performer. During preliminary studies, several mappings (discussed in Chapter 3) were explored over a period of a month to provide a basis for the system’s designed response. Three definitive mappings were chosen for use within the final study. These three mappings allowed a further in depth exploration and implementation for the study and will be discussed in Chapter 3 and Chapter 5.

The success of the model was evaluated primarily by interviewing groups of performers after their interaction with the system. These interviews were conducted and analyzed using techniques based on methods validated in cognitive science research that explore intuitive experience (Petitmengin-Pugeot, 1999). The interview data was triangulated with first person data of the researcher and with participant observation data to produce an analysis of the performer’s intuitive experience while improvising with the system. The outcomes of this research contribute to developing more articulate interaction models for performance with autonomous generative systems, and may also be extrapolated to scenarios within human-computer interaction in general.
1.1. Context for Research Project

In the past decades, research in performer-system interaction has focused on developing computational systems that sense the performer’s gestures and map this data to responses (Rowe, 1999; Weinberg & Driscoll, 2007). This approach has laid a solid foundation from which a variety of interaction models have been developed. In some instances these models have included making qualitative and semantic inferences from the performer’s gestures (Camurri, De Poli, Friberg, Leman, & Volpe, 2005). Such research points to an interest in developing an understanding between the system and the performer modeled on performer-performer communication. However, the cognitive and embodied ways in which the performer may construct their understanding of the system’s gestures is seldom researched and not well understood in the literature of interactive performance.

Literature in performance practice and cognitive science, corroborated by the researcher’s experience in performer-performer interaction, suggests that intuition is an essential part of performer-performer communication (Lockford & Pelias, 2004; Melrose, 2006). Within the training practices of the performer, intuition is not only valued, but is also considered as a skill that can be developed. Intuition is particularly useful in improvisational forms of performance, such as improvised dance, or improvised music, and is used in choreography and theatre directing as a creative source for movement generation. Performers often use their intuitive understanding of each other to synchronize movement, negotiate their collaboration and build trust while improvising. Because it is widely valued and utilized as a skill, it is reasonable to expect that incorporating intuition into a system-performer interaction model would enable the performer to employ this skill to experience the effect of negotiating collaboration and building trust with the system. In similar research in robotic systems, there is a increase in efficiency in task completion (Hoffman, Kubat, & Breazeal, 2008) when the robot’s ability to anticipate the users’ responses are designed into the system. My own research study explores the reverse case, in which the performer may anticipate the system through cues provided through a simulated breath. Related research in synthetic speech has shown that the addition of a simulated breath leading into a sentence increases the user’s recall of the sentence. The synthetic speech research has also shown that the
simulated breath sound has a much greater effect on recall than other non-embodied sounds used to precede the utterance of the sentence. I claim that this evidence links an empathetic connection to body-based cue, and that this empathic connection is at the root of the reported result. I similarly propose to leverage the embodied knowledge of a performer, the knowledge developed in the performer’s body through experience, through the design of the performer-system interactions. My hypothesis is that by incorporating breath as a part of the system’s feedback, the interaction design can leverage the performer’s sense of intuition, allowing for an expanded sense of connection and understanding towards the system leading to synchronization, collaboration and trust during their interaction with the system (see Chapter 6 for a full description).

1.1.1. **Research Question:**

To test this hypothesis, the study will explore the core question:

How can the interaction between physical performers and an autonomous generative music system leverage the performer’s sense of intuition?

A more focused version of this question was developed during the study question reflecting the literature review which suggests breath is an innate social cue used by human in various situation to anticipate the actions of people around them. The original question was addressed by focussing on breath there by re-stating the question as:

Can a simulated breath designed into an autonomous music system leverage a performer’s perception intention during their interaction with the system?

Through investigating this core question, the study advances knowledge needed to enhance models for performer-system interaction by:

- Identifying specific characteristics of how the system engages performer intuition.
• Comparing the effect of different gesture characteristics on intuitive processing by performers (including the comparison between precognitive and rational performer response).

• Identifying and analyzing the effect of offering predictive cues to performer’s experience.

1.2. Research Methods

Three different sources of data were used in this study: Researcher’s experience collected through journaling, Participant experience collected through interviews, Participant experience collected through video.

1.2.1. Three Sources of Data

1. First person data, of the researcher’s experience, based on improvising with an autonomous music system during the design process incorporating an intuition based interaction model. This data is collected using notes and journaling.

2. Participant’s experience based on improvising with an autonomous music system incorporating an intuition based interaction model. This first-person data is collected using second-person interviewing techniques discussed below in section 1.2.2. The interviews will focus on:

   • Participant’s experience of responding to predictive cues produced by the system concerning its next gesture.

   • Participant’s experience of responding to predictive cues given by the other performer in the sessions.

   • Participant’s process for understanding predictive cues and the effect these cues have on their sense of trust, synchronization and collaboration.

3. Third person observations of performer pairs improvising with each other and the system. This data was collected using video recordings of the improvisation sessions (see appendix 2).
By collecting this data concurrently, one data source can be used to bring attention to issues in one of the other two sources. In this way the study may be refined during the course of data collection to ensure its precise focus on the research question. Triangulation between the data from the three sources will help ensure validity of the results.

1.2.2. Interview Technique

The data on the performer-participant’s experience was collected mainly through interviews conducted after improve sessions with the system (see Chapter 5 for full description). The interviewing technique used is based on a protocol developed by Petitmengin and Varela (Petitmengin-Peugeot, 1999) and has been adapted to address issues specific to researching performance. The protocol developed by Petitmengin and Varela focuses on the researcher facilitating the participant in articulating a description of their experience (phenomenological description). Care is taken in the use of language to ensure the participant is kept focused on describing their experience and is not lead by the researcher. The adapted protocol is discussed in detail in Chapter 4. This protocol was first used in an earlier project “Illusion of Togetherness” and the results presented at the Digital Resources in the Humanities and the Arts conference in Brunel 2010 and again at Creativity and Cognition conference in Atlanta Georgia 2011 (Greg Corness, Carlson, & Schiphorst, 2011).

1.3. Data Analysis

The concepts of synchronization, collaboration, and trust are of special interest in this study and were used as theme guides from which to start the analysis (see Chapter 6) since they are recognized as key qualities of performer-performer interaction. For this study I have constructed the following description as a starting point for recognizing of these theme guides in the improvisations.

Synchronization The performer is working in parallel or in counterpoint to the system. This work may be evident as a parameter of time or quality of gesture.
Emphasis will be given to actions that initiate from the performer’s core (torso) since these gestures require more effort and commitment.

**Collaboration** The performer is aligning their ideas with the system. The performer works with the gestures of the system to give context to their own gestures or to give context to the system’s gestures. Emphasis will be given to actions that initiate from the performer’s core (torso) since these gestures require more effort and commitment.

**Trust** The performer freely initiates moments and expresses a sense of comfort in the environment. They explore and develop their ideas while remaining engaged in the interaction.

The above descriptions reflect the initial understanding of the three theme guides. However, during the study of these theme guides, were found to be too general to act as themes in the later analysis of the performer comments. In Chapter 6, I describe how new themes were developed out of the interview transcripts and how the new themes related to these three theme guides and provide a map of the performer’s process of interacting with each other and the system.

### 1.3.1. Video Analysis

All improvisational sessions were videotaped. These tapes were analyzed using a form of phenomenological hermeneutics described by Fraleigh (Fraleigh & Hanstein, 1999). For this study, three types of moments are of special interest:

- Moments that demonstrate a synchronization of actions between performers or between a performer and the system.
- Moments that demonstrate a collaboration between the two performers or a performer and the system
- Moments that demonstrate a development of trust between the two performers or between a performer and the system.
The above moments reflect the initial application of the three theme guides to the analysis of the video data. During the study these concepts, though descriptive of the interaction, were found to be difficult and unreliably as indicators for analysis of the interaction. To provide reliability and accuracy, an expert in Alexander Technique was consulted to crosscheck the analysis of the video. Alexander Technique is a somatic practice focused on teaching awareness of (kinaesthetic decisions-making) how and where body movements/gestures are initiated. I discuss in Chapter 6 how body use and tension were found to be related to these three elements of the interactions during the improvisation scenes.

1.3.2. Interview Analysis

The interview and video data was analysed using a series of processes described in detail in Chapters 4, 5, and 6. The basic structure of the analysis follows a pattern suggested by Claire Petitmengin in her paper “Intuitive Experience” (Petitmengin-Peugeot, 1999) and adapted for a performance research project “Illusion of Togetherness” (Corness et al., 2011). The analysis process focuses on using the data to construct models of the performers experience through a five-step process:

1. Consider comments through a process of close reading.

2. Identify interior gestures that make up the experience. (eg. I was pulled into motion by the system.)

3. Construct a synchronic (a single point of a state in time) model representing structures within the experience other than temporal.

4. Construct a diachronic (concerning development through time) model representing the temporal structure of the experience.

5. Compare diachronic and synchronic models to construct a generic model for each performer.

A key component to the analysis of the interviews was dividing statements into three categories:
1. Comments made concerning the experience communicating/negotiating with the other performers.

2. Comments made concerning the general experience interacting/improvising with the other performers

3. Comments made concerning their experience interacting/improvising with the system.

The statements were also flagged with two descriptors:

1. Comments as description of events happening during the experience

2. Commentaries, judgments, and beliefs about the experience or intuition.

These procedures helped provide a context and priority to the performer-participant’s comments.

After all statements from each performer-participant were flagged, the relationship between other statements made by the same performer-participant was considered in order to construct a ‘map’ of experience for that performer. These models were compared to other performer-participants to construct a general model of performer experience. The entire process is described in detail in Chapters 4, 5, and 6.

1.4. Structure of the Study

The study follows a basic user-testing structure of implement and observe. The basic structure of the research design tests two conditions in three phases of intuition. An intuition-based interaction model is implemented in an autonomous music generative system. This model has been tested by inviting pairs of performers to improvise with the system over several sessions. During this time the study moves through a variety of conditions, including no breath, loud breath, soft breath, and no resting just prep breath. These conditions provided a structure to explore the performers intuition of 1) the system’s intention to act, 2) the quality of the action and 3) the theme or content of the
action. The conditions were alternated several times to address issues of familiarity and fatigue that are made present by the performer’s continued work with the system.

![Diagram of interaction model incorporated into autonomous generative music system]

**Figure 1. Structure of the Study Exploring Performer's Intuition**

### 1.4.1. Two Conditions for the Study

The two conditions (see Figure 1) being tested in each phase of the study are:

1. The system providing simulated physical cues concerning its next gesture.
2. The system providing NO simulated physical cues.

In the first set of improvisational scenes during the study, the performers were not informed which condition was being tested. During later improvisational scenes
performers were aware of the condition being tested. When the performers were not informed of which condition was being tested the interviews were guided to explore their awareness of the simulated breath and its general effectiveness as a cue. But when informed about the condition being tested, the performer-participants were able to focus their attention to their perception of the system’s simulated breath, providing a more nuanced articulated description of how they were perceiving it.

1.4.2. Three Phases of the Study

Intuition encompasses a wide variety of experiences. This study will focus on the performer’s intuitive experience concerning three aspects of the systems’ upcoming response. These are addressed in three phases of the study (see Figure 1). Each phase builds on the previous phase in a subsumptive structure.

1. The first phase will focus on the performer’s intuition concerning the system’s intention to act. This exploration of the performer’s ability to perceive the system preparing to play and preparing to stop is considered a base level for the intuitive experience.

2. The second phase of the study considers the performers intuition concerning the quality and type of gesture the system is going to generate. This phase focuses on the performer’s ability to predict qualities such tempo, volume, and articulation, as well as structures such as scale passages, large intervals, and arpeggios.

3. The third phase considers the performer’s perception of the system’s focus. The term system’s focus is used to indicate an area or object on the stage perceived by the system and an expressed (output) quality of that object. For example, the system may be focused on the angle of straight lines in the upper corner of the stage and may be generating music in response to this focused data.

The three phases of the study were allowed to run together keeping the continuity of the work for the performer consistent. The shift between phase 1 and 2 was enacted as a shift in the conversation and the reflection of the performers. As will be discussed in Chapter 6, the improvisational scenes were designed to facilitate the
performers in comparing their experience between the system in breathing and non-breathing modes, the two conditions. In phases 1, the first discussion with each group focused on their experience of surprise in the responsiveness of the system and the shift of their experience from scene to scene. Once they had explored this quality of the experience (the timing was difference between the groups) their reflections and articulations around their experience became more nuanced. As their comments shifted the discussion tended to address the phase 2 of the study; however, some comments continued to address phase 1. Phase 3 of the study, considering the performer’s awareness of the system’s attention, was enacted as a behaviour mode. Switching to this mode was worked in to the general protocol for the session. As such, comments on the breath continued to be part of the discussions, continuing to address phase 1 and 2 of the study. In this way each stage overlapped the other two. And since the study focused on the performer’s experience, the depth of investigation for each phase was guided by the interest and reflective comments made by the performers-participants.

1.5. System Design

While there are many bodily cues that are part of performer-performer communication (Bogart & Landau, 2005; Lockford & Pelias, 2004; Pallant, 2006; Wirth, 1994), this study focuses on the effect of simulating breath cues to indicate the system’s intention to act (phase one) and its intended quality for the gesture (phase two). As discussed earlier, breath is a fundamental bodily process with connections to action, expression and internal state. In performance it often acts as an unconscious form of communication. This bodily cue is integrated in the interaction model by designing the system to produce a ‘breath cue’ as it prepares to play a musical phrase. The system’s simulated breath is achieved by manipulating parameters of a physical model for synthesizing flute sounds. The synthesis of the ‘preparation breath’ is controlled by parameters linked to the up-coming musical phrase such as duration, volume, tempo, and general articulation. The quality, timing and duration of the ‘preparation breath’ provide audible cues that help predict the instigation and character of the next musical phrase.
The third phase of this study (described in Section 1.4.2) examines the performer’s perception of what is influencing the system. This phase is based on concepts practiced in Viewpoints theatre improvisation. Viewpoints training teaches performers to use their awareness of focus and attention to guide their choice of material by empathizing with other performers in the space (Bogart & Landau, 2005). This practice is implemented in the system’s interaction model by enabling the performer to perceive a connection between the system’s response and the environment. Creating a perceivable connection is approached in two ways:

1. External data is mapped to a response using simple metaphors. For example, a focus on straight lines in the space would map to direct/constrained gestures in the music such as limited rhythmic variation.

2. The system’s focus is designed to move. This allows performers to track differences in the system’s responses, and therefore develop an intuition of what it is focusing on.

These design parameters enable the system to:

1. Provide breath cues indicating when the system is about to play or stop.

2. Modify the timbre of the breath cue in relation to the quality of the upcoming musical gesture.

3. Respond to motion or architecture in the performance space with in a dynamic flow, balancing the external data with its own internal state.

1.5.1. **System Sensing and Expressing**

The system’s sensing process was developed using computer vision algorithms implemented in MAX/Jitter and OpenCV. These algorithms include:

- Analysis of a performer’s movements through motion detection and blob tracking techniques.
• Analysis of simple architectural and body shapes using algorithms for shape recognition, Hough transform, and moments.

These algorithms analyze a wide view of the performance space as well as a subsection of the view. This structure enables the system to respond to localized phenomena. It also allows the system greater possibilities for finding new points of focus.

1.5.2. System’s Gestures

The system’s musical gestures are based on music generative algorithms modeled on 20th century composition theory. The generative engine for the system is designed around stochastic processes. The theoretical approach to musical structure implemented in the generative system is based on atonal prolongation (M. A. Forte, 1977; Lerdahl, 1989). This design of a generative music system was tested in earlier research conducted by the researcher (Corness, unpublished Master’s thesis). The system’s instrument sound was a flute sound generated using a physical modeling library in Max/MSP (Trueman & DuBois, n.d.).

1.6. Overview of Dissertation

This study focuses on how an understanding of the performer’s embodied knowledge of social interaction, used in contemporary performance practice, may be leveraged to inform the design of interaction with autonomous systems in interactive performance. Chapter 2 sets up the context for the study in the field of interactive performance. I start my exploration with a discussion on Performer-Performer interaction, focusing on the role of intuition in improvisation, and exploring the intersection between theories in performance, Cognitive Science and Human-Computer Interaction (HCI) that discuss the experience of humans as social inter-actors.

The second chapter continues with a discussion on the earlier approach to designing interaction for performance, presenting the concept of turn taking and responsive action as the basic premise of interaction and follows through the Instrument
and Player models of interaction set out by Rowe (Rowe, 1999). In this chapter I also consider three main models for discussing interaction in performance.

The final section of the second chapter discusses how the model explored in this study expands on these three prior models of interaction, by leveraging performer’s intuition and sense of presence and trust to move towards a relationship of collaboration with a generative autonomous system.

Three pilot studies of the model are presented in Chapter 3. The first pilot study, a workshop, explored performer interaction with a media agent. The media agent in this study was a moving light controlled by an operator off stage. The results of this session focused on the auditory phenomena and use of a simulated breath sound as the primary interface with the system. In particular, this session also informed the final methodology and protocol for the project. The second pilot was presented at NIME 2008 (Corness, 2008). The study examined two systems that used media output to project the intention of a computational system: one visual, one auditory. The final pilot study tested the proposed system utilizing breath as intentional agent, utilizing the adapted research protocol (which was the basis for the final research data collection and analysis).

Chapter 4 provides a discussion of the methodology for the study. In this chapter I illustrate how the methodology developed by Claire Petitmengin (2007) served as a template for my own methodology. I then explain the modifications that were made to the template methodology. Of special note is the discussion on conducting interviews with participants. This adaptation of the methodology is a secondary contribution from this project.

Chapter 5 explains the methods used to enact the methodology, describing the recruitment of performer-participants, the design of the system, the protocol for the sessions and the process for collecting data.

Chapter 6 presents the process for analysis of the data and provides the results of the study. The chapter concludes with the construction of a general model of performer’s experience improvising with the system.
Chapter 7 “Conclusion” provides a summary of the results and contributions from this project. A discussion is presented on how the findings are related to findings and model of human-human and human-system interaction acknowledging intuition and social cues from other disciplines.
Figure 2. Navigation Map of All Chapters in the Dissertation
2. Intersection of Theories for Contextualizing the Study in Interactive Performance Research

This chapter lays out the theoretical context of the proposed model for Interactive Performance. I begin the discussion with the presentation of theories from Performance practice, Cognitive Science and Human Computer Interaction (HCI) that address performer-performer interaction. These theories provide the grounding for the theoretical approach behind the interaction model proposed. This chapter continues with a discussion of previous models for interactive performance practice. This discussion focuses on the concepts that have guided the design and analysis of systems to date. This chapter concludes with a discussion of how the model presented in this study is situated in the context of work done in interactive performance and how it addresses issues rarely directly explored in interactive performance systems.
2.1. Interaction in Performance and Human Experience

Any stage performance is a web of social interactions (Corness, 2011; Auslander, 2006; Schechner, 1977). For performers and audience alike, engaging with a performance is a process of perceiving the presence the performer. This perception is enacted through the use of several senses working simultaneously within a moment and continually over time (Corness, 2011; Pallant, 2006; Argyle, 1969). Prior research has explored how the audience perceives the interaction of performers, constructing an understanding of their relationship (Glass, 2005) the intention of the performer (Camurri, 2004) and the authenticity of the interaction (Pesquita, 2013). This prior work has illustrated the importance of social interaction in connection with an audience, but has not addressed how the social cues effect the connection between the performers or their experience. Understanding the effects of social-cues on performer experience would be instrumental for advancing the design of performer-system interactions.

Previous research into performer-system interaction demonstrates an interest in developing models of interaction for interactive performance that places a computer agent as a performer on the stage. David Saltz has expressed that the Holy Grail for interactive performance is to have performers and computers interacting as equals on the stage (Saltz, 2001; 2003). However, the research has tended to focus on the perception and response of the system with limited consideration given to research in performer-performer communication. This study presents a studio exploration that expands the traditional models of interaction particularly those that are appropriate for improvisatory performance. I have referred to this in earlier publications as the “Performer Model” (Corness, 2008a). My Performer Model has been developed based on an examination of theories taken from Performance Practices and Cognitive Science. These theories place strong importance on a performer’s ability to perceive the intention of other performers on stage. I am interested in how cues can be designed into an interactive system to model social embodied interaction (Foster, 2007). In particular, I am interested in how these simulated system cues can leverage the human communication cues common among performers, and ultimately affects the performer’s experience while interacting with the system. The implementation of the Performer Model being explored in this research study focuses on two aspects of embodied social
cues in performance: 1) breath as a sonic and kinaesthetic cue of the system’s preparation to act, and 2) the performer’s perception of where the system is placing its attention.

The study starts with the understanding that communication in performance is an inter-subjective phenomenon where understanding, and connections, are continually constructed and ‘agreed’ upon by the performers involved in the moment (Lockford & Pelias, 2004) (Bogart & Landau, 2005) (Pallant, 2006). As Lockford and Pelias explain (Lockford & Pelias, 2004):

Even when faced with the challenge to perform in an unscripted moment, performers understand that they are engaged in an ongoing communicative exchange. This exchange is a process best conceived, not as an act of information transmission or shared understanding, but as communication scholar H. L. Goodall, Jr. would have it, as an act of ‘boundary negotiation’. (Lockford & Pelias, 2004, p433)

The act of “boundary negotiation” that Goodall refers to is the process of the incrementally building the ‘performer’s self’ within the context of a performance. In a theatrical sense, this is the build-up of a ‘character’ supported by the performer’s intentions, developing as new information is revealed in the scene. In a musical sense, this negotiation may be observed between soloist and accompanist over harmonic extensions and rhythms that occur during a particular solo. Such negotiations imply that the agent must be able to respond to new information while simultaneously presenting information to contribute to the ‘self’ of other agents. What is important in boundary negotiation is how the negotiation process happens throughout the duration of the improvisation. As Lockford and Pelias (2004) imply by describing the process of “boundary negotiation” which is differentiated from a mere act of information transfer, is that boundaries not only define an area, defined as the self, they are also being dynamically created and modified by the performers in the moment. For this dynamic negotiation to happen the performer needs to respond to new information while simultaneously presenting information. The information the performer presents not only defines themselves but also contributes to the self of other performers, as they are incrementally developed. Negotiation in these terms is a coordination between the interaction among agents in the moment. The immediacy involved in such coordination
makes it preferable that all agents are able to track the intention of the others, as this facilitates aligning the group’s actions at a root level.

The importance of the performer’s ability to track intention also brings attention to the notion of trust. While the performer works to develop their own sense of self in the performance, blocking or interrupting the development of partners on stage is often considered rude or in bad form. The balance is found in how the performers constitute themselves and each other through their individual actions (Bogart & Landau, 2005). This understanding of the group and inter-subjective communication is based on opening up through trust. For a performer to be open to constituting their performance identity anew in negotiation with others on the stage, they must trust the environment. A sense of support and mutual trust is established when their actions both affect and support other performers. The performer’s perception that their action affect and are affected by the other agents on stage accentuated a sense of presence and connection with the others that fosters an intersubjective understanding of the moment. This understanding keeps the ensemble synchronized, and is founded in the performer-agent’s ability to track the intention of the others. Therefore, it becomes imperative that agents in the performance be able to project their own intentions.

2.1.1. Agencies and State Knowledge

Bogart and Landau coach students of improvisation to trust in letting something occur onstage, rather then making it occur (Bogart & Landau, 2005). Applicable to both sonic and physical gestures, this mantra from their coaching does not mean that nothing should be started but rather to avoid ‘forcing’ a start, initiating an action purely for the sake of starting an action. We might call this an additive approach where additive suggests that the agency is added to the state of the system whether it is in a steady state or a dynamic state. However, a view of simply ‘adding to’ the moment could be misinterpreted as favouring an interaction based on ‘piling on’. But simply ‘responding to’ is a form of making your own action happen. Trusting in letting something occur aims at finding a shared intention with in a group, what improvisers in the practice of Viewpoints call simultaneous impulse - the responding as a group to a single intention or impulse. This cannot be done in response to macro actions but occurs through the sharing of
intention through subtle body cues. In this way the improviser moves beyond the cognitive into the intuitive (Lockford & Pelias, 2004).

2.1.2. Intuition and Intention

A common notion of intuition is that of a ‘gut feeling’ or ‘hunch’. Herbert Simon extends this notion by describing intuition as the result of cues that allow experts to access information stored in memory (Simon, 1995; Franz, 2003). Kahneman cites Simon, extending the concept of cue-based intuition accessed from memory in his definition of ‘System 2’ processes (Kahneman, 2013). Kahneman uses the terms ‘System 1’ and ‘System 2’ to discuss a variety of mental processes in expert knowledge. System 1 describes the mental process of a tentative plan that comes to mind by the automatic function of associative memory, and System 2 describes plans mentally checked or consciously decided upon through an analytic process (Kahneman, 2013). These two systems do not relate to specific functions or areas of the brain but are considered models in the discussion of what Kahneman refers to as self-observed “quirks” (Kahneman, 2013). Kahneman combines Simon’s position on expert intuition and his own notion of System 2 thought processing to argue that expert intuition is a form of recognition, linking intuition to memory and recognition processes.

A different approach is offered by Russel and Bergson who suggest that intuition may be discussed as a perception that attends to the present moment of becoming (Russel, 1912; Boundas, 1996). Russel claims that this perception, though unnatural to the intellect is the essence of intuition (Russel, 1912). Although there is an implied separation between intuition and intellect it is reasonable to assume that perception has the effect of cueing information as in Kahneman’s System 2 and yet may not evoke conscious decisions (System 1) (Melrose, 2006). By not separating Kahneman’s two systems of thinking, Russel and Bergson provide an understanding of intuition that allows for integrating System 1 and System 2. I have applied this integrated understanding of intuition for this study. This understanding addresses the performers’ developed skill of sensing their partner’s intention, and addresses how social cues perceived by the performer can trigger or support their intuitive experience (Pressing, 1987).
In my research, I focus on intuition as the *recognition* of intention. This approach has also been used in domains such as Artificial Intelligence and Natural Language Processing, where the recognition of intention includes the recognition of an agent’s commitment to achieve a goal within an environment (Subramanian, 2006). In considering ‘commitment’, a stack of sub-goals is constructed providing a hierarchy of intentions. By constraining my research to improvisatory performance I focus on the performer’s intent in action, and their action in the moment as the primary goal.

Research in the field of neuroscience has recently suggested links between *intuition* and *intention*. Neurons found in pre-motor areas of the brain have been shown to fire not only when the subject is producing a sound or action, but when they hear the sound or observe others doing the action as well (Gallese, Eagle, & Migone, 2007; Iacoboni et al., 2005; Kohler et al., 2002). The firing of these neurons allows the subject to predict the outcome of their own actions but more interestingly, the intention or goals of other’s actions. “This implicit, automatic, and unconscious process of motor simulation enables the observer to use his/her own resources to penetrate the world of the other without the need of theorizing about it” (Gallese, 2001). What is crucial to this phenomenon is that the action observed must be goal oriented, that is it must have intention (Gallese et al., 2007; Iacoboni et al., 2005; Kohler et al., 2002). The actions of a performer fit this criteria since a performer’s actions are infused with intention. As such the interaction among improvisers is a prime example of the new models being proposed in neuroscience on the working of mirror neurons. This theory of mirror neurons being proposed by researchers in neuroscience is reflecting the kinaesthetic and empathetic knowledge performer’s have already discovered and explored as part of their traditional practice (Bogart, http://siti.groupsite.com/post/april-1st).

However, there is some question as to the usefulness of mirror neurons in human-computer interaction. The findings to date concerning a person’s ability to perceive intention in others suggest that the ability diminishes in correspondence to the physical similarity with the other. This means that a human subject, through their mirror neurons, perceives the intention of other humans, but perceives the intentions of apes less so, only slightly perceived the intention of other animals and do not perceive the
intention of machines (Gallese et al., 2007; Gallesse, 2001). To date, studies have shown there is no firing of mirror neurons when observing robots. The prevalent reason given for this distinction is a perceived similarity of motion (Gallese et al., 2007). It is then unclear whether a system’s response-actions would affect the pre-cognitive process of a subject if accurately modeled on human action.

Still, the presence of the pre-cognitive function of mirror neurons implies that the human cognitive system as a whole works in connection with this mechanism, and that even at a cognitive level, the process of interacting is governed by the prediction of events as much or more than being a simple process of reaction to events. This interpretation is supported by the presented theories on improvisational performance (Powell, 2007; Pressing, 1987). All these findings suggest that as social beings we have developed the ability to intuitively predict the actions and sounds of those around us enabling us as to understand the intention of others. The significance for understanding performer-performer interaction is that the theories point to the key element in the interaction being based on the performer’s ability to understand the intention of their partner, thereby starting the negotiation process before observing the action.

We may consider the idea that human action and intention happens before the act has been shown. This notion has been demonstrated in several studies. Wegner (2003) presents the work of Kornhuber and Deecke (1965) as well as Libet (1983) as some of the researchers who have measured a rise in brain activity up to 800ms before an action took place. In the case of Libet’s experiments, brain activity was recorded over 300ms before the subject was even aware they wanted to act. Such findings suggest that humans do not live in a static present moment but rather in a moment becoming the next. Our bodies are preparing to act long before the actions is take, in some cases even before we are aware of our decision to act. Our social engagements are informed by an embodied empathy that allows minor predictions of those around us. We react not IN the moment but TO the coming moment. Since the literature suggests that our interaction with other human agents in our environment incorporates our ability to predict their actions, this study explores how our interaction with computer agents, in the context of performance, might leverage this intuitive aspect of human-human interaction.
2.1.3. **Precedence for Interfaces Modeling Human Body**

Research in fields such as robotics and natural language interfaces have already been considering the effect of anticipation, empathy and social cues on user’s experience with computer systems. Several approaches have been explored, many based on designing interfaces that model the human body in some way and use the model in a natural manor as a primary feature in the interaction. Foster undertook a project of comparing embodied cues in conversational agents (Foster, 2007). She reports in her paper *Enhancing Human-Computer Interaction with Embodied Conversational Agents* that adding an expressive embodied interface agent to a computer system can often have a positive effect on users’ interactions with that system (Foster, 2007). In a similar project, Whalen, Hoequist and Sheffert (1995) focused on the affects of synthesized breath on the perception of synthesized speech. Their findings state that preceding a statement by the generated speech system with the sound of a breath increased participant’s recall of the statement significantly. The study also explored the relationship between the preceding sound and the presented sentence. The findings showed that the breath sound enhanced the participant’s recall more effectively than other similar sounds (Whalen, Hoequist, & Sheffert, 1995). In a project exploring interactions between human drummers with a robotic drummer, Weinberg, and Driscoll (2007) note that participant drummers commented on the limited motion of the robot’s hands. The comment suggests that the human drummers were using the motion of the hands as part of their intuitive understanding of the robot’s ‘intention’. These findings, combined with the findings from cognitive science mentioned above, to suggest that even when interacting with computer system our interactions are guided by physical and behavioural cues that inform us of the intention of other agents.

These projects point to a growing interest and realization of the importance of the body in non-verbal interaction with computational agents. They illustrate that designing interfaces that attempt to leverage empathetic cues such as facial expressions, kind words and even breathing can affect the user’s perception of the system even when all other parameters of the system remain the same. Furthermore, the studies suggest that perception is somehow linked to the modeling of the body gesture. In the case of the increased recall of synthetic speech, it was the breath sound that had the most effect.
The simulated gesture of breathing in before speaking leveraged the user's ability to engage with a speaker and increase their understanding.

The implications of the above research and theories are especially important for interactive performance. Based on the above discussion it is reasonable to suggest that intuitive understanding of other performers on stage is an integral part of the interaction between performers. Also, that the modeling of body cues can enhance performer's engagement with a computational agent. Intuition and the modeling of embodied cues as a part of performer-computer interaction is seldom researched, and the ideas are only incidentally addressed in the models of interaction commonly used in interactive performance systems. This study explores how designing systems to incorporate these ideas may affect the experience of the performer.

2.2. Models for Interactive Performance

Figure 4. Navigational Map for Models of Interactive Performance

Interaction has long been understood as a large aspect of performance as evidenced by performer-performer interaction and the interaction between performer and their instruments, environments and audience (Salter, 2010; Dixon, 2007; Rowe, 1996). As developments in technology have made the designing of responsive systems
accessible to performance practitioners, systems have been created for real-time interaction among performers and technology with increasing focus on performance quality and extension or affordance of expression (Murphie, 2003). These may be in the form of re-usable performance systems such as Lewis’s Voyager and Rowe’s Cypher, instruments such as hyper-instruments, or performance specific systems such as Broadhurst’s Jeremiah, or Pinhanez’s I/IT. Work being done by researchers and practitioners has developed increasingly complex and nuanced computational systems. These systems often work off line, such as Cope’s EMI program (Cope, 1996). The development of these systems has gone hand in hand with the development of technologies. Over the past decades several computational as well as conceptual models of interaction in performance have been developed In the following sections of this chapter I will discuss how these models are very similar to each other in some respects while in other respects remain very different in their underlying premise or concerns. In discussing these different models in the context of this study, I will consider each in terms of affordances directed to the performer’s knowledge of the system’s internal state or intention. I have chosen to use the performer’s knowledge of the system’s state as the lens for examining the models to remain focused on the premise that performers interact based on intuition of each other’s actions or intention. This focus place my study in the context of the an expanded literature that not only includes past research in interactive systems for performance but also research in performance pedagogy, Human-Computer Interaction and Human-Human interaction by way of neuroscience.

2.2.1. Conversation and Turn Taking Models of Interaction

The common models of interaction for interactive performance are strongly influenced by the general definition of Interaction: “Act reciprocally, act on each other” (OED). This definition reflects common understandings and assumptions towards interaction, and often brings up associations with conversation and “turn taking”. Early researchers such as Myron Krueger, Brenda Laurel and William F Walker have focused on the concepts of conversation and turn taking and demonstrate the relevance of these models for the interaction in performance contexts (Krueger, 2003; Laurel, 1993; Walker, 1997). The logic of conversation and turn-taking as appropriate models for interactive
performance is apparent when considering common improvisation situations in which the musician improviser steps forward to take their turn as soloist, setting up a musical structure likened to a conversation. A second example can be found if we view two actors improvising a conversation as them purely taking turns responding. Such surface analogies and understandings of these common moments in performance improvisation have helped perpetuate conversation and turn-taking as a fundamental models for interactive performance.

The turn-taking view of improvisation also has strong support as a well defined and workable model for computation. The procedure of taking turns implies a perceive-respond-perceive process. This process may be seen as the underlying process for an interactive system. The system receives data, runs a program and produces a result, relating back to the idea of reciprocal action. It is not difficult to apply this model to a possible cognitive model based on one’s personal experience of ‘I sense-think-respond’, a model focused on the perception response to completed stimuli and often understood as involving turns. The sense-process-respond can be re-stated as ‘listen-assess-respond’ linking it back to conversation. So the sense-process-respond structure has become an enticing model for human-computer interaction with its implied progression and focus on processing.

The sense-process-respond model portrays the process of interaction as a conversation following the pattern of sensing the action, processing and identifying the action, then responding to the action. Each agent in their turn listens to the other, analyses what was said and responds in a manor befitting the input. By viewing the interaction as a conversation, the model implies that the response needs to be constrained to a context indicated by the response gesture of the other agent. This logic places importance on the analysis of the sensed response gestures. So to increase the level of interaction requires increasing the analysis capability of the artificial system (Rowe, 1996). The logic being that by better understanding the context of the interaction the system would respond in a more complex and appropriate manor, keeping the conversation on track and allowing the human user to respond in a natural manner.

The ‘conversation’ inspired logic is not completely without merit and has lead to very complex interaction designs for performance as indicated by many of the systems
mentioned above. Still a deeper understanding of conversation and the role of social embodied cues can point to new approaches that might be valuable in expanding the design of performer-system interactions. One point to be explored is the notion that understanding is acquired purely through theme analysis of the incoming statement within the context of the overall conversation. Laurel quotes Susan Brennan’s characteristics of human conversation as suggesting the system should not continue until a sufficient understanding is constructed (Laurel, 1999). By suggesting that the system should hold, not continue, until an understanding is constructed, Laurel and Brennan place a strong emphasis on the linear order of sense ‘then’ respond. I believe that this emphasis stems from the common view that the main gesture, the spoken word or codified dance move, contains the information being responded to. This understanding of communication and interaction has influenced the design choices evident in systems for interactive performance by focusing the interaction on the performative gestures. In dance this means tracking the dancer, and in music tracking the musical line of the performer (discussed in detail later in this chapter). Even in systems where multiple channels of sensing are used, such as Camurri’s Mega system constructed in his EyesWeb programming environment (Camurri, 2005), the approach is often to track multiple parameters of the performative gestures in order to understand what is being expressed.

In contrast we may consider that part of communication is understanding through body cues that someone is ‘going to’ speak to me and that their statements are going to be short and positive. Research on embodied communication agents suggests user’s understanding and connection with a system can be improved by designing into the system embodied cues that model social interaction which imply empathy and intention and whose effect is independent of the information in the response (Whalen, 1995; Foster, 2007). Research in the effects of social cues is expanding beyond multi-sensory systems which has been based largely on examining what constitutes an input. The question of what constitutes an input includes questioning the focus of the target input, for example on what part of the gesture should be focused upon, when the gesture starts and what is its duration (how small is the action to be concerned with). Foster’s work with embodied conversational agents indicates that subtle cues modeled on non-verbal/embodied human gestures such as facial expressions and body posture have a strong
influence on the users experience with the system. These cues may not be considered a part of the expressed information, (that is the actual sentence being stated), but their affect on user’s understanding of the conversational agents is significant (Foster, 2007). While cues, such as facial expressions, may be explained as part of a multi-sensorial perception of the expressed statement, there is more information presented while a sentence is stated. Cues that are not present during the expressed statement as well as cues presented before or after the main statement have also been explored. For example, Whalen’s research considers the effect of breath sounds added to synthesised speech not during the speech but as a cue before the sentence is presented. The presence of a breath cue was found to improve user’s understanding and retention of the sentence even more effectively than similar sounds (Whalen, 1995). The effect was found to be increased when the quality of the breath cue was modeled to have a relationship with the sentence that followed the cue. This research suggests that the breath is not simply providing a cue to prepare the listener to the sentence coming up, but is providing other information aiding in the comprehension of the sentence. The research suggests that humans respond to subtle actions that project the intention of others, including what they are planning to do and the intended goal or context for their action. Such findings are in line with the work of researchers in neuroscience such as the work on mirror neurons (Gallese, 2001) and Libet’s work that a gesture in humans starts not with the first motion but with the intention to move (Wagner, 2003). In the light of the research that performers are sensing information even before the performative gesture starts, as in Whalen’s experiments, it is reasonable to reconsider the definition of ‘turn-taking’ and consider when one turn starts and one finishes. The significance for performer’s working across disciplines is in understanding the communication that is not tied to the performative gesture. Instead we may consider a performer’s ‘turn’ to start when they are preparing to take an action. Throughout my research study, I propose that by considering the preparation phase as part of the ‘turn’ or statement in the conversation, we can begin to model the more social aspects of human-human interaction and expand earlier models used in interactive performance.
2.2.2. **Instrument | Player-Paradigm Systems**

Robert Rowe (1996) suggests a categorization of interactive computer music systems by dividing systems into ‘Instrument-paradigm’ and ‘Player-paradigm’. His discussion around these categories references the traditional forms of interaction found in music: performer-performer and performer-technology, and heavily relies on the sense-process-respond paradigm in both categories. The primary difference between the two categories lay in the complexity of the system’s responses. In discussing the Instrument and Player paradigms, I will be focusing on how the complexity affects what the performer knows about the system’s response and how this affects their interaction with the system. This discussion will show that even ‘Player-Paradigm’ systems do not strongly address the effect of social cues as part of communication among players, and do not illustrate how integral social cues are to the quality and experience of the interaction.

**Instrument Paradigm**

Rowe’s use of the term instrument in describing his ‘Instrument-Paradigm’ is broad and can be applied to many forms of interactive music systems. At its core the term implies a direct response to the action of the performer. Direct response is a simplistic approach to interactive performance (Birringer, 2006), but in the context where interactive performance is a ‘performance media made responsive by a computer’, this model is quite influential and warrants consideration. The direct, often one-to-one mapping means that the performer knows the response of the system through knowing the design of the system. The system is normally designed to respond to a restricted set of performance gestures and consistently produces a predictable response. In this way the performer can guide the construction of the material produced by the system. The design of the mapping for the system ensures that the relationship between a performer’s gesture and a given response by the system is set and appropriate. The interaction between the performer and the system may be said to resemble a strictly scripted interchange more then a collaborative development enacted in the moment.

The Instrument-Paradigm covers a wide range of systems. These systems form a continuum of complexity in the mapping (see Figure 5) but for the sake of discussion I
will divide them into three sub-categories: 1) Simple-Instrument, 2) Trigger, and 3) Translation.

![Figure 5. Gradient of Instrument Models](image)

**Simple-Instrument: Subcategory 1 of Instrument Paradigm**

I use the term ‘Simple-Instrument’ for the first sub category since at a fundamental level this category refers to systems that are treated as musical instruments. These systems resemble acoustic instruments in that a single sound is produced for a given action. The common approach for achieving this is to embed sensors in a device connected to a computer. The computer runs a synthesis and/or DSP program that produces a given sonic response to the input from the sensors. The system responds consistently to specific gestures performed by the performer providing access to a known sound palette. Because the relationship between the action and the response can be arbitrary, these systems require the performer’s actions be considered in the design of the instrument. This need to consider the mapping of arbitrary action to a system’s response gives the design process strong connections to HCI and interface design where the mapping between users actions and the product’s response is a key component of the design. The design process in HCI often considers what actions the performer can remember and perform accurately balancing the training of the user against the designing of the system (Dourish, 2001). In designing instruments for interactive performance, the approach is often to focus on affording the performer the ability to select desired responses from the system. Because the system can be designed to respond to any actions performed by the performer/user, learning the mapping between action and response is often undertaken in rehearsal, and this mapping is chosen from performers prior experience with the system. The design of the
system may often leverage previously learned action (such as the case of electronic key boards), or consider actions that the performer is taking for an external compositional reason, (such as the case of a system designed to respond to specific choreography). In these examples, the key is that the performer knows precisely what the system is going to do next. Being in full control means the performer does not need to consider how the system’s material might effect their own future actions. The performer’s primary concern is to elicit from the system the responses they desire. What typifies the Simple-Instrument is that there is a very specific action being sensed and a very deterministic process to produce a simple response. However, the general Instrument-Paradigm does not restrict the complexity of the response

**Trigger: Subcategory 2 of Instrument Paradigm**

At a slightly more complex level than the Simple Instrument is the designed response of a sequence of notes rather then a single sound. In this case the model might be more accurately referred to as *Triggering*. This interaction is an expansion of the traditional player-instrument interaction common in music but reflects more effectively the theatre’s tradition of off-stage technicians responding to cues on stage by starting (triggering) a set of technical sequences such as a change of lights or a musical cue. By designing the system to directly sense the actions of the performer, this ‘triggering’ approach attempts to move the triggering of the media from off-stage technicians, to the direct control of the performer on-stage. This *triggering* approach can be designed to expand on the traditional theatre cue example toward performances in which dancers | performers trigger successive phrases in the music through their choreographed movements. As with traditional stage cues, the *trigger-gestures* are ideally designed to be very specific; and though the response may be complex and have a set duration beyond the *trigger-gesture*, in this context it is most often predictable and generally fully constructed in advance. As such the performer still has knowledge/expectation about the response, but due to the extended duration has the option of changing their action throughout the system’s response. Examples of this type
of system can be seen in a number of works by the dance group Palindrome\(^2\) such as Talking Bodies (2005), E-Touching (2001 - 2005), and Human Conversation (2006) (Palindrome, http://www.palindrome.de/). These pieces are typified by a direct mapping where dynamic sounds (that change over a significant duration) or musical phrases are initiated by a gesture or shapes performed by a dancer. During a performance with such a system, the performer can be confident if the system is working, that the material presented by the system will be consistent with the predetermined design. The design of the performance involves the performer enacting gestures that trigger responses from the system. Even though the system’s response might be a complex gesture on its own it is performed in response to the performers action and not to elicit a new response from the performer. The performer does not need to consider how the system’s response might unexpectedly change their next action, but rather, the performers are able to change their action in response, as the system’s response plays out.

**Translation: Subcategory 3 of Instrument Paradigm**

By increasing the complexity of the sensing and processing done by the system, enabling the system to track not just a gesture but a quality of the gesture such as speed, enables this qualitative data to be mapped to the quality of the response, translating the quality of the performer’s actions in to the quality expressed in the media response. The context of the system’s response is still predictable but the specifics are predetermined in so far as they mirror some aspect of the performer’s action. The system’s processing of the incoming data is designed to ‘translate’ the performer’s expression into the domain of the system’s response media. Such systems are modeled after the traditional translation relationship dance has with music (and other media) where the dance acts as a translation of the sound, or other medium, into movement and ideally into emotional expression. A dancer and musician do not often interact on a direct event by event or movement to note interaction, instead the energy or tempo of the two

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\(^2\) Palindrome is a dance company based out of Germany specializing in interactive dance. Besides producing numerous productions, the company has worked with Frieder Weiss to develop the motion tracking software EyeCon.
provide the primary parameters in the mapping. The dance performance Glow\(^3\) (footnote explain performance) by Chunky Move from Australia is an example of this model. The dancer’s position and movements are translated into graphic designs projected on the stage. *Translation* systems are typified by a mapping between the performer’s actions and the manor in which the system performs a pre-composed response. In this way the quality of the response can change in accordance with the performance as lead by the performer. The fact that the mapping still assumes a direct correlation between performance gesture and the change in a parameter, such as speed, volume, and density, means that the performer still is able to predict the response quality of the system, and more importantly when it will play and the quality of the gesture since it is a direct translation of their own gesture as interpreted consistently by the system.

**Comparing the Subcategory of Instrument Paradigm**

These different forms of the instrument model are distinguished by the amount and type of control the system allows the performer, and knowledge the performer has concerning the system’s response. In the *Simple-Instrument* category the performer controls each note and therefore knows most aspects of the system’s response. In the *Translate* category the performer may not know the précis content to be played but they are aware of the direct connection to their gesture and therefore know the timing and the arc of the response gesture. Still in all these systems the performer’s knowledge of the system’s response is based on their understanding of the design behind the mapping, knowing the system’s response to a given gesture. When the mapping is simple and explicit the trust the performer has in the system is their trust in the robustness of the technology to work, and their experience of the interaction is that of working with a tool.

But as the performer or performance interaction design ‘lets go’ of controlling the system and focuses on acting in a performative manner, more effort is put on the design aesthetics of the mapping to ensure that the system responds in an appropriate way. A continuum is started in which the relationship between the performer’s gestures and the

\(^3\) Glow is a dance performance produced by the Australian company Chunky Move for solo performer. The dance is lit by a data projector and the dancer’s movements are tracked by an IR camera. The data from the dancer’s movements is cued to control algorithms producing
system’s become less direct and explicitly known. The performer focuses more on performing and less on eliciting the correct response from the system. The system is afforded more autonomy and as a consequence provides the performer with a limited knowledge of what the system is going to do.

**Player-Paradigm**

Although the instrument model accounts for many systems used in performances advertised as ‘Interactive’, many researchers and practitioners of interactive performance have attempted to move beyond intentional predictable interactive systems (Birringer, 1999; Rowe, 1999). Rowe (1999) offers a second paradigm, which he refers to as ‘Player-Paradigm systems’. These systems still incorporate the sense-process-respond paradigm in which the sensing and processing stages have a level of complexity that generates a response related to the performer’s action without being predictable. These systems are described as having more agency and some autonomy since they are generating new material for the piece. The system’s contribution is not constructed through pre-composed cells explicitly accessed by the performer but through algorithms designed to generate desired responses. A complex processing stage allows the system to include compositional parameters along with sound parameters (Winkler, 1995). These systems are typified both by focusing less on direct intentional control of the system and putting less emphasis on the causal relationship between the performer’s gestures and the system’s response.

For Rowe (1999) the Player-Paradigm describes many systems including those discussed later in this chapter. What makes a discussion of the general Player-paradigm important is the relationship to the sense-analyze-respond paradigm. In the 1980’s and 1990’s when Rowe was writing about Player –paradigm systems the interest was in how these systems contributed to the musical environment, especially in the context of improvisations. Rowe divided the components of these systems into the Sensing Stage, Processing Stage and Response Stage, and suggested that the key component was the system’s ability to analyze the input and respond in the moment. For this reason Rowe graphic effects around the dancer’s body. The performance is intended to be viewed from above to make the effect more visible.
(1996) suggested that Player-Paradigm systems profited from improved musical intelligence. Rowe’s comment “It is apparent that player-paradigm systems could profit from better levels of musicianship then they currently achieve…” illustrates the focus on the musical gesture and the knowledge imbedded in it as the foundation of the communication and therefore the interaction (Rowe, 1996). The comment implies that a improved connection between the performer and the system would come from the system better understanding the musical gesture of the performer. What was not common in the discussions at the time when Rowe was presenting his Player-Paradigm was any discussion on the influence of human interaction as a model. Music and it’s syntax was seen a providing the sole mode of knowing and interacting between musical performers and therefore the focus of interactions with performing systems. In this approach, the interaction is reduced to a transfer and analysis of musical information. When a conversation becomes just a back and forth, the foundation of the interaction goes from being cooperative to being a power struggle (Laurel, 1993). As was discussed earlier, communication between performers is not an exchange of information but a coordinating of intentions. Although a shared context is important, the research discussed earlier concerning user’s engagement with systems that incorporating non-verbal embodied cues suggest a more complex issue when considering human-agent interaction.

2.2.3. Agent Based Model

Rowe’s Player-Paradigm includes systems that map the received input to parameters in a compositional algorithm, but it also includes systems that incorporate more autonomy. As the design of a system moves from mappings that only account for sensory input and start incorporating data from internal data, the material they are adding is no longer directly tied to the actions of the performer (Sparacino, 2000, 1997). The internal state of the system may alter the expected response. Because the internal state of the system may not reflect any state in its environment, it has the it has the ability to enact more agency in the space. By moving away from the expected response, the system may offer new possibilities into the performance for the performer to respond to. In this way they start the movement away from ‘simple response’ behaviours towards collaboration. Lewis took this approach in his Voyager system. Performances using the
system have been described as two parallel streams of music one generated by the system and one generated by the human each informed by the other (Lewis, 1999) The system still senses the actions around it and generates a response, but Lewis has extended the senses-process-respond paradigm by trying to make the system as autonomous as possible.

There is no built-in hierarchy of human leader/computer follower, no "veto" buttons, pedals, or cues. All communication between the system and the improviser takes place sonically. A performance of Voyager is in a very real sense the result of a process of negotiation between the computer and the improviser.

If an improviser wishes to hear the program play in a certain way, the most direct route is to actually play in that way. After that, it's up to the system to deal with what it finds. This can be viewed as "getting the system's attention." If the improviser can get the system's attention, not only is it possible for the improviser to guide the system when needed, but the improviser feels better about having the system take apparently independent initiatives, because the fact of the improviser's influence has been established (Lewis, 1999, p 104).

This discussion addresses several issues around interaction. What is of greatest significance is the implication that the system has its own musical ideas, an intention that can be influenced by the performer, but not dictated or vetoed implying a high degree of interaction. Unlike in the instrument model, the performer can no longer confidently predict the gesture of the system. As mentioned in the general discussion on Player-Paradigm systems, the sense, analyze, and respond steps focus on the performative gesture. But in Lewis' quote, he refers to the performer trying to get the system's attention and trying to get it to do something, to respond (Lewis, 1999). Here the system is starting to be discussed as an agent with an attention and intention that can be modified by the human performer but in the end that the performer needs to contend with.

The perception of the system as an agent with intention is evident in Lewis' use of language like "feeling better", "influence" "the system's attention" in discussing the interaction and brings in the issue of how the performer knows the system's intention. The notion of the performers actions trying to influence the system to do something specific is also discussed by Broadhurst in reference to interaction with Jeremiah, an AI agent based system used in her production of Blue Bloodshot Flowers (Broadhurst & Machon, 2007). In her papers, Broadhurst describes how cast and crew often tried to get
Jeremiah to smile. Broadhurst’s and Lewis’ systems are still at one level sensing, analyzing, and responding, but the underlying design paradigm has shifted and now includes how to influence the system’s response. In such systems, the system’s possible response palette is increased to include ‘distracted responses’, ‘no response’, or even ‘contradictory responses’ (Broadhurst & Machon, 2007; Corness, 2000) moving the system towards a position where it has its own intentions which are being enacted and influenced. Though they have shifted the interaction to include a somewhat wider range of responses, what is not discussed by Lewis or Broadhurst is if the system ever tries to get the performer to do something and more importantly, HOW the performers know they were ABOUT to get the system to follow them. This feedback, the ability of performer perceiving their influence on the system before the system enacts its intention, is an important issue. As discussed earlier, performers engage with each other through a mutual understanding of intention. It is the mutual understanding, of what each is planning to do, that facilitates coordination of the group. If the performer is to engage with the system in the same way the system must project its intention in a similar manner.

The root of this how performers know issue is illustrated in a research project involving a robotic drummer interacting with several human drummers (Weinberg & Driscoll, 2007). Although the intent of the project was to explore embodiment in musical robots the system design ended up focusing on algorithms for beat recognition and motivic development (ibid). The design choice was taken to help ensure a common perception between the human drummers and the robot concerning the musical context, beat structure etc. The choice is consistent with Laurel’s discussion around conversation as an interaction model and the need for a common ground (Laurel, 1993). It is arguable that the beat recognition and motivic development addressed this Laurel’s concerns by giving the robot and musicians a musical common ground, shared understanding of the beat patterns. Interviews with drummer participants indicated that the beat recognition was perceived as accurate, but the interaction was still perceived as unnatural with participants citing the lack of body gestures and cues as the reason (Weinberg & Driscoll, 2007). The user’s comment suggests that simply increasing the complexity of the processing or analysis stage is not sufficient to provide a interaction that approaches the interaction between performers. Attempting to computationally model the domain
knowledge required for an autonomous agent, such as musicianship, does not create an experience in the performer of a reciprocal interaction, even when the system demonstrates intention and a common context, such as engaging in a common beat pattern. The social cues that are part of human communication remain integral to the performer’s experience of the interaction.

2.2.4. **Role and Relation Model Of Interaction**

The difference between Rowe’s discussion of interaction with Player-Paradigm systems and the discussion of Voyager and Jeremiah as Agent systems is largely based on conceptual framing. The interaction with the Voyager system could be discussed in terms of the mapping among inputs and parameters, however the language Lewis chooses to use indicates a conceptual shift towards modeling the interaction involved in the relationships with a media agent. Considering alternative conceptual framing of interaction modes, such as the Role of the media in the performance, or the performer’s relationship with the media, provides an interesting view of designs for interaction in performance.

Pinhanez developed a system used in the production of I/IT\(^4\). Though he refers to Rowe’s Player-paradigm as the model behind his design, he describes the system as a ‘Media Actor’ (Pinhanez & Bobick, 1998). In Pinhanez’s writing on the I/IT system he switches between a somewhat computational or technical description of the interaction and a relational or experiential based description. Pinhanez uses the role given to the system, that of second performer, as a basis for discussing the interaction. For example, in the strict sense, the system does not generate new material but rather manipulates the timing and enacting of pre-scripted actions. In this sense the system fulfills the role of second actor, reciting lines and enacting the blocking. And, in the context of scripted theatre, the timing and quality of the system’s action as new material since they are unpredictable but remain with in the context of the performance. In this way Pinhanez has adapted Rowe’s model by re-examining what the performative material is in the

\(^4\) I/IT is a theatre performance in which the progression and actions of media elements are controlled in real-time by a system responding to the actions of the human performer. However the human performer does not consciously activate/trigger the media elements.
context of a scripted moment. But He has also tried to address the importance of relationship in the interaction. Consistent with the theatrical tradition, Pinhanez is not as interested in the system adding ‘new ideas’ but in developing a relationship with the performer. This relationship is based not so much on what is going to happen but when and with what quality the script is enacted. Unfortunately, the listen-respond paradigm behind the player model does not account/allow for the performer to have knowledge of the system’s timing, when it will add in the material. In I/IT the performer is constantly surprised by the system’s responses. The surprise is worked into the character’s relationship in the show but is in a broader sense a limitation since the actor must always respond to the system, the system and actor can never (or only with great difficulty) respond at the same time to a single or simultaneous impulse.

Working in the domain of theatre where relationship is a traditional focus, David Saltz presented a typology of roles and relationships among the media elements (the system) and the performers (Saltz, 2001). In his typology of interaction all media agents on stage have a role within the performance and a relationship with the other agents on the stage (see Table 1).

<table>
<thead>
<tr>
<th>MODEL FOR SYSTEM</th>
<th>RELATIONSHIP TO PERFORMANCE/PERFORMER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Scenery</td>
<td>Media providing a backdrop, environment for performers</td>
</tr>
<tr>
<td>Diegetic Media</td>
<td>Media justified/ or existing in the world of the play used by performers</td>
</tr>
<tr>
<td>Interactive Costume</td>
<td>‘Opposite’ of virtual scenery. Media used to ‘paint’ actors’ costumes</td>
</tr>
<tr>
<td>Alternate Perspective</td>
<td>Offers new visual perspective of onstage action</td>
</tr>
<tr>
<td>Commentary</td>
<td>Serves as a commentary on stage actions</td>
</tr>
<tr>
<td>Affective Media</td>
<td>Adds or manipulates emotional effect</td>
</tr>
<tr>
<td>Subjective Perspective</td>
<td>Depicts character’s thoughts</td>
</tr>
<tr>
<td>Illustration</td>
<td>Illustrates performer’s words</td>
</tr>
<tr>
<td>Synesthesia</td>
<td>Mirrors the performance in a different sense modality</td>
</tr>
<tr>
<td>Instrument</td>
<td>Used to create an new type of instrument</td>
</tr>
<tr>
<td>Virtual Puppetry</td>
<td>Media used to create a virtual double of the performer</td>
</tr>
</tbody>
</table>
### Table 1. Saltz’s Typology of Interaction in Performance

The models presented in Table 1 illustrate how using relationship as a criterion creates a fine distinction between modes of interaction. Each model extends or modifies the basis of the one before. For example, the ‘Synaesthesia’ model implies an iconic relationship between the action and the response since the role is to illicit a sensorial response. The instrument is symbolic; the relationship may be arbitrary as long as it is predictable (Saltz, 2001). From a technical standpoint, both these models may involve a similar type of sensing, level of analysis and even similar response, however the role the media plays changes the relationship and there by the interaction between the performer and the system.

For this study I have been focusing on systems modeled the reciprocal interaction found between performers. This model of interaction is addressed in what Saltz refers to as a Dramatic Media model. Saltz discusses hi Dramatic Media model by describing a system developed for his production of *Tempest*. But because the model is largely dependent on the relationship between the performer and the media, the same system can be described using two models depending on which performer’s perspective is being addressed. He explains that in the production an actor plays Ariel by controlling the mediated Ariel avatar from off stage. This relationship constitutes what Saltz refers to as a Virtual Puppetry relationship. At the same time, the performers on stage are interacting with the Ariel avatar and so are in a Dramatic Media relationship with the avatar. Here the relationship-based model allows for a system, known by the designer or user to be reacting by rules, to be viewed as reciprocating agent by an unknowing performer. The Actor playing Ariel knows the rules of response sees the system as an instrument, while the performers acting with the avatar on stage as a performer. In contrast with Rowe’s model’s, which depends fully on the abilities of the system to determine the level of interaction, Saltz’s model focuses on the role set up between of the human performer. The role implies a relationship and points towards an experience of the performer as a criterion of interaction.

Though it is possible in the Dramatic Media model to acknowledge experience as part of interaction, experience is not the focus. Saltz is interested in the dramatic role of
the agent, what role the agent’s serves in the play. This perspective is really a Director’s perspective more then a performer’s perspective. Saltz gives another description of a Dramatic Media system in which the performer acts along side a video projection. The live actor is able to produce the illusion of an interaction but the pre-composed linear nature of the media limits the amount of reciprocation possible in the interaction. So though in some sense the interaction is modeled on human interaction, this modeling is presented by the illusion of the theatre rather then embedded in the design.

2.2.5. Action–Perception Models

When considering concepts around interaction in performance we might also consider that an action may be viewed as a performance through its intention or perception. Based on this understanding, we may construct a model of interaction based on Action-perception-reflection. Birringer (2007) uses this paradigm to construct four models: 1) ‘Sensory environments’ (focusing on sensors to provide audience agency, encouraging reflection on agency); 2) ‘Immersive environments’ (virtual Reality-based installations, providing exploration in a virtual space); 2) ‘Networked environments’ (telepresence giving audience the experience of a dispersed body); and 4) ‘Derived environments’ (re-animations of bodily movements encouraging reflection self). Although ‘to reflect’ is similar to ‘to process’ (sense-process-respond) the implication of this new framing is that the performer familiarizes themselves with an environment. By considering the performer’s process of coming to know the environment through their movement and perception of their own agency we construct models of interaction that include Pleasure of Navigation and Participation (Dixon, 2007; Murray, 1998). This framing suggests that the perception of the system’s feedback provides the experience of a ‘give and take’. In this way the model extends the sense-process-respond paradigm by adding the notion of reflection such that we again speak of the model as a conversation but also as a collaboration (Dixon, 2007). We can discuss this extension as a act-perceive-reflect paradigm. However, we would still need to consider the perceived partner in the conversation.

And yet, the act-perceive-reflect paradigm does bring to light one further interaction mode with a system, that of imperfect mirror. Consider a system that reflects the actions of the performer/audience in some media (visual or sonic). On a technical
level such a system could be described as an Instrument-Paradigm, or Virtual Puppetry, or Derived Environments depending on the view you wish to take. But if we were to incorporate a simple process such as delaying the signal we can dramatically change the experience. This is because when the causal link between a performer’s actions and the system’s response is eroded, a digital ‘other’ is experienced by the performer (Kozel, 2007). Moments of reciprocal interaction may be generated and become part of the experience through exploring and developing an intuitive understanding of the system, but these momentary experiences do not constitute a sustained reciprocal interaction. It is of interest how a shift in perception, the delay and minor manipulation of the input data can make a simple system be perceived as a digital other. This supports the idea that relationship is influential in the experiencing of interaction. And yet the interaction experience is still shallow, since at some level the experience is aware that the other is just reflecting their own information back.

2.3. A Practical Look at Performer Interaction

As a practical look at interaction I want to offer two examples scenarios. First, consider a performer (dancer or actor) and musician improvising together to generate a moment that culminates in a frenzied gesture rising in intensity to an abrupt stop. Neither performer has signalled this pause, and neither can say what will happen next. Yet,
together they break from this pause to a new moment, their impulse to continue perceived as a single unified intent, their individual intentions aligned and guiding one moment into the next through a simultaneous impulse. In my experience as a musician improvising with dancers and actors, this scenario illustrates the level of connection, of interaction that performers set out to achieve with other performers.

I present a second example scenario that caught my interest when I first started working to incorporate computers on stage and had become interested in the interaction involved in these improvisatory moments. At this time I had the opportunity to watch a choreographer attempt to get a group of inexperienced dancers to sit as a single mass on the last note of the music. The group rehearsed the same ending movement several times, with the choreographer reminding to the group to “listen” and “count” to “sit on the beat”. She did not explain how or why, and though the group claimed to be counting and listening, they invariably ended up sitting like dominoes well after the last beat. After a few rounds of this, I made the suggestion to have them sit on the beat before. The result was that this time the dancers were able to sit down as a group with the LAST beat of the song. What I had noticed was that the young dancers were starting the gesture of sitting when they ‘noticed’ the music had ended. The gesture then took some time... and was late. I suggested they try sitting on the second to last beat. The change aligned their sitting gesture to end with the end of the musical gesture. The problem had been that the dancers needed to sense the last beat, and then start to sit by which time they were late and the music was over. By giving the instruction to act the beat before, they still started when they noticed the beat but modified their sitting to align with the next and final beat of the music.

These experiences raised my interest in how performers align their gestures. Music does create a context of structured time, but the dancers were too inexperienced to use it to anticipate where their gesture should end. A key idea on aligning events became apparent. Consider first that an event A instigated by event B will always happen after event B by a duration equal to the response time of the system. Although this statement seems obvious, experienced performers are able to synchronize the start point of gestures. In questioning how this alignment is achieved I noticed that experienced improvisers are able to adjust their gestures to end together with out being perceived as being cut short. The notion of coordination of the end can also be stated as
negotiating to a point in the immediate future. This is a key concept since the coordinating of the end moment enables the alignment of the next start. I realized that the idea of anticipation was fundamental in how I interacted with other performers. Performers often interact by working towards an elision, a feeding forward of further information (Bogart & Landau, 2005).

2.4. Putting the Approaches Together

![Figure 7. Navigational Map for Putting the Approaches Together](image)

Many of the models discussed above may be viewed as being based on a three stage process, often with a direct relation to the concept of sense-analyze-respond. This is not surprising when considering that at a basic level sense-analyze-respond simply describes the three basic components of any interactive system, including humans. A system requires (senses) certain information that it takes into consideration (analyzes) in order to respond. As a result, conversation models, as a simple form of the sense-analyze-respond paradigm of interaction, have been highly influential in many successful systems. But the compelling connection between a simple conversation, the process of listen-think-respond and the base computational process of sense-analyze-respond has tended to have two strong unintended lingering influences on interaction design in performance: 1) an implied temporal structure and 2) the focus on the context/domain specific information. An expanded examination of the literature suggests that
reconsidering the understanding of conversation and performer relationships could lead to new insights and approaches to interaction design in performance.

Considering Lockford's suggestion that communication between performers is a continuous negotiation or coordination of intentions that happens in the moment, then the elements of sense, analyze, and respond remain key components of the interaction. However, the sequence of these elements might be worth questioning (Lockford & Pelias, 2004). The communication among the performers still involves listening (sensing)-thinking (analyzing)-responding but there are two other notions implied in this understanding: 1) that these elements are not seen as sequential but as concurrent, and 2) that the information being sensed and analyzed is not focused solely on the domain of the conversation (ex. music, text of the scene) but also involves the analysis of cues for social interaction including intention. Researchers such as Camurri and groups such as Palindrome who are looking at systems that recognize gestures in the user have started addressing this notion (Camurri, 2004; Camurri & Ferrentino, 1999; Camurri et al., 2000, 2005; Wechsler, n.d.). But this research is largely focused on the system recognizing the gesture of the performer. We need to acknowledge that the idea of communication and conversation is that the information is offered into the interaction is from both sides. A system that understands social gestures is a start to such an interaction design but enabling the system to project its intention through social gestures, to leverage the performer’s ability to read social cues of intention completes the conversation (Quinn, 2003).

This extended understanding of conversation and interaction to include social cues and the projection of one’s intention is supported by many of the theories and models discussed. The simple conversational model has long held that the system has to respond appropriately in the context of the interaction to be understood, But how the performers perceive the relevance of the response may not be solely dependent on the contextual information. Evidence demonstrates that perception is a strong influence on human’s experience with a system, and that that perception includes the perception of cues modeled on non-verbal human communication. System designed to incorporate embodied cues such as facial expressions, breath, what Foster (2007) refers to as embodied communication agents, has demonstrated that these elements have a significant affect on the experience interacting with the system. The effect of such body
cue is not limited to modifying the context of the expression while it is being said like smiling while talking. Research into the effect of preparation gestures shows that human communication incorporates the perception of intention through intuition and anticipation.

The notion that humans interact in anticipation of other’s actions and even intentions has been evident in neuroscience research (Gallese, 2001; Wegner, 2003). It has even been explored with positive results in HCI research. Anticipation inspires more perception of human qualities and a positive attitude towards the robot. “For robots to act fluently with a human partner, in a real-world situated teamwork scenario, they must overcome strict turn-taking behaviour, which induces delays and inefficiencies, and can cause frustration (Hoffman et al., 2008, pg.6). And though trust was not seen to increase, this may be attributed to the low expectations people have of robots as collaborative agents (Hoffman et al., 2008, pg.5).

To date these more embodied approaches to interaction have seldom been explored in systems for interaction performance. Even when performance theory and pedagogy discuss the importance of intuition and empathetic connection between performers, and HCI research indicates the increased engagement between users and systems when embodied cues are incorporated in the design, intuition and empathy are rarely considered in system design for interactive performance. This would require the system to project its intention in some manner modeled on embodied cues. Based on the literature, breath and weight-shifting are valid starting points for exploring embodied communication agents in interactive performance. This conclusion was based both on the above literature and on my personal experience as a performer and resulted in the design to the preliminary studies discussed in Chapter 3 and 5.
3. Preliminary Studies on Designing Systems that Project Intention

Figure 8. Navigation Map for Chapter 3 on Preliminary Studies

Chapter Three presents three pilot studies that lead up to the final version of the Ariel system, the system used in the final study. A short description for all three of the pilot studies is included (see Table 2). For Studies 1 and 2, the discussion outlines the methodology and results. The discussion around pilot study three focuses on its function as a test workshop for the system used in the study. Included in the discussion for each of the studies is an explanation of how the results influenced the final Ariel System and the final research design and session protocol.
### First Pilot Study

<table>
<thead>
<tr>
<th>Sessions using two participants improvising as a group</th>
<th>Exploring experience in a system that providing visual cues of intention</th>
</tr>
</thead>
</table>

### Second Pilot Study

<table>
<thead>
<tr>
<th>Sessions using First person and Single performer improvisations</th>
<th>Exploring experience in two systems one providing visual cues one providing audio cues of intention</th>
</tr>
</thead>
</table>

### Third Pilot study

<table>
<thead>
<tr>
<th>Group of four performers improvising as a group</th>
<th>Exploring final audio system</th>
</tr>
</thead>
</table>

**Table 2. Outline of Preliminary Studies**

#### 3.1. First Pilot Study: Visual Media Agent

![Figure 9. Navigational Map for the First Pilot Study](image)

An initial pilot study was conducted to explore and collect feedback on performers experience improvising with a visual media agent that exhibits spatial motion. This first study focused on the performers’ experience improvising with a visual media agent. The study used a light projected on the floor in the performance space to represent a media agent in the space (see Figure 10). In this way the media agent had a visual presence in the same physical space as the performers.
3.1.1. **Setup for First Pilot Study**

For this workshop two performers were asked to improvise with an ‘intelligent’ light acting as a third performer on stage. The light was projected on the floor using an I-CUE dmx controllable mirror. A human controller operated the movement of the light. For this initial study there was no design in place to facilitate the projection of the controller’s intention to act. The design of the study allowed for the exploration of how the performers worked with a media agent that has full cognitive ability to understand the performers but is not able to project its intention to the human performers. There was no provision in the design for the performer to notice the light preparing to move. It might be noted that since the performer controlling the light was not on stage and not moving their entire body (was sitting at a control board) as the other performers were, that there remained a disconnect between him and the performers on stage. So although the contextual reasoning between the performers and the system was made similar through the use of the human operator, kinaesthetic empathy was disrupted.
3.1.2. Discussion

After a lengthy discussion with the performers, several issues were identified. Comments made by the performer-participants suggested that at the root of these issues was the persistent perception of the system as a media element in the environment. The system, even with access to human reasoning through the operator’s control, never took on the presence of a third performer for the performers. This issue was first raised when performers were asked about moments when the light occasionally crept up a wall or curtain. The group had agreed on rules for the improvisation but here the light was clearly, though not breaking a rule, not acting as the others were. The discussion started to reveal that through their experience with the light, they were treating it not as light but also not as an equal performer. The light became a new type of agent and this affected their connection with it in comparison to the connection with the other performer.

Further discussion suggested two contributing factors to the performer’s experience of the light as ‘media’ performer yet still separate as an ‘equal performative partner’. One contributing factor was that the light only had a presence on the floor. This meant that a special effort had to be made to look down to perceive that light. The second contributing factor involved the performers being confused about the light’s position. The lighting rig required that it be projected from some point on the ceiling onto a surface such as the floor or wall. The implication of this setup is that there is an invisible beam between the ceiling and floor and the light will ‘appear’ in this intermediary space if an object (such as a performer) moves within the beam ‘interrupting’ the light beam. This physical property of the light projected through the vertical space became a factor in interpreting a basic rule for the improvisation. The performers worked from the basic principle that if you touched another performer you immediately stopped. The rule is a common measure put in place to avoid injuries from collisions, but for this study we decided that it should apply to all performers even the light. What made the rule confusing and hard to interpret was that the light beam, when moving between the light source and the projected circle would ‘hit’ the performer above the floor, in a space where there was no visual indicator/presence of the light agent. This sudden appearance of the light out of thin air brought into question “where is the light performer?” This question alienated the light as a presence for the other performers. However, one of the key ‘discoveries’ during this workshop study was the ambiguous physical presence of
the light was also the root of the closest connection between a performer and the light. At one point in an improvisation the light ended up directly on the performer inspiring the duet between the two. The performer commented that in this moment she considered herself in a contact improvisation with the light.

3.1.3. Influence of Findings on Final Study

Based on this first pilot study, I decided to continue to explore performer’s experience with media agents by considering intuition as a key aspect of interaction guided by 4 of the main finding. First, as mentioned above (Section 2.1.1), the system did not present its intention to the performers but was controlled by an operator, myself, from off-stage. My observations resulting from this design choice can be summarized by stating that there continued to be a disconnection between the performers and the media agent even though the agent was controlled by a human. For me this was most evident in times when the performers were ‘hit’ by the light, suggesting they were not able to anticipate its movement, even when the lights movement was controlled from within the logic of a human operator/performer. From this observation I decided to further explore the role of body-cue in performance. To explore this question I decided to design the system to represent its own process for acting/choosing its responses. Secondly, the confusion regarding the projected beam of the light influenced my decision to expand the design to explore sonic as well as visual agents. Although visual presence is a very powerful connection for improvisation it can also be considered literal, while the sonic (sound) agents may offer a closer physical embodied presence to a human sound performer. By utilizing a sonic agent (instead of a visual agent) the performers would have an analogue in their bodily experience to compare the system to. Thirdly, after observing the balance between the two performers’ interactions with each other and with the system, I decided to consider a single performer working with the system in order to be able to observe performer-system interaction more clearly. However, I kept under advisement the suggestion that a single performer working with a system would tend to form a connection with the system since it is the only other agent in the environment. Finally, I also kept under advisement that the system was not going to become equal to a human and that there would be a learning process to enable participants to get used to
a new partner. These design decisions guided the design and implementation of the second pilot study.

### 3.2. Second Pilot Study: Autonomous Visual and Breath Agents

Building from the first pilot study, I conducted a second pilot study using a first-person methodology to explore models for presenting intention through media (visual and sonic) to leverage performer’s intuition. In the second pilot study I constructed two systems that explored how a performer’s sense of intuition could be engaged by a media system, a visual and sonic version. The designs of the two systems were influenced by the research from the fields of performance pedagogy, and cognitive science discussed in Chapter 2 that suggests humans do not live in a static present moment but rather in a moment becoming the next. Rather then focusing on the responsiveness of the systems, I decided to focus on how social engagements are informed by an embodied empathy that allows minor predictions of agents around us. The systems did not respond to the performer but rather explored how the system could project its intention to the performer. The results from this study provided the ground work for a framework for interaction between autonomous agents published in the NIME 2008 proceedings (Corness, 2008b).
3.2.1. **System Design**

This study considered two forms for the system’s presence in the space, visual and sonic. Both systems were constructed through an iterative design process using a first person methodology. In order to focus the study on methods for modeling an embodied projection of the system’s intention, gestures in both systems were generated with simple random processes, avoiding any signifiers that may come from structure or syntax, and allowed the system to enact its own “intention” with no sense of the performer. The response paradigms chosen for both test systems were informed by human response and perception behaviours but were not meant to mimic them. Finally, the research was set up as studies into the experience of a subject being afforded the ability to move with the system. No expectation of creation or performance was imposed.

**Visual System**

![Concentric Circles with Displacement Indicating Direction and Speed of Motion](image)

*Figure 12. Concentric Circles with Displacement Indicating Direction and Speed of Motion*

The visualization for the system in the second pilot study was based on a top down view (bird’s eye) of a cylindrical (physical) object. The shift of the object from a
center point modeled the tipping of the cylinder off balance. The gestures in the visual system were realized using an image of two concentric circles generated in MAX/Jitter (see Figure 12). This image was projected onto the floor of the performance space using an I-CUE dmx controllable mirror. The behaviour of the system was designed so that the inside circle needed to move off center for the entire image to move in the space. The system’s process for stopping required the circle to return to the center. The direction and displacement of the circle’s movement off center corresponded to the direction and speed at which the image was about to move. The time required for the inner circle to reach its maximum point was set at 200ms, in line with the research presented by Wegner (2002). The movement of the light object was constrained using a dynamic weighted random algorithm. The probability of the light moving in any direction was a function of its position in the space. These design elements provided visual cues to a performer improvising with this visual version of the system as to its up coming direction and speed (see Figure 13).

Figure 13. Dancer Interacting with Light Agent
Sonic System

The sonic version of system used the second pilot study was modeled on the common idea that breath can be used to synchronize a group. The system used a physical model of a flute constructed in the PeRColate synthesis library for MAX/MSP (Trueman & DuBois, n.d.). Each session explored different approaches to perceiving information embedded in different parts of the breath sound. The information was embedded by manipulating the parameters of the flute model to get different of qualities breath sounds before and after the tone. The timings of these different breath qualities in each session were functions of the generated gesture’s length, density and speed.

3.2.2. Qualitative Data

Visual System

I spent a number of sessions working in the system to experience the physical sensation of being and moving in the space with it. As might be expected, it was easy to anthropomorphize the light. I perceived its motion as a nervous exploring intention, even though I knew the movements were random. Still, it quickly became apparent that the system had no sense of my presence. This had been part of the design, however, it was interesting to note how easily I perceived the design as experience. Furthermore, this perception profoundly changed the quality of the interaction from the intended design model of tag to one of ‘playing in ocean waves’ or ‘taunting a blindfolded partner’. My perception of the system’s movement intention, stalking and lunging with no focus on me, inspired a sense of teasing. I noticed myself considering which way the system was ‘thinking of moving’ and circling to the other side just out of ‘reach’. The random process used for starting and stopping also produced occasional motions perceived as ‘fakes’ in which the Light Actor moved it’s ‘weight’ in one direction then immediately moved it back to a center position. This emergent behaviour was of special interest. The perception that I could tell where it was ‘thinking’ of moving encouraged me to get close but the impression that it could ‘change its mind’ kept up my interest in the engagement.

Test with Non-Projecting System

Some time was spent comparing the system with and without the center circle active. With out the center active I noticed I was not inspired to get close to the light, and
my willingness to engage with the system was shorter. Similarly, I noticed when the response behaviour was tuned to give less fakes the movements became easier to predict, but the interaction became less engaging in the context of a tag paradigm.

**Moving with the Light**

During a second session I focused on moving with the light rather than avoiding the light. At first I changed only my behaviour, the system’s behaviour pattern remained the same as before; however, I found this interaction very unsatisfying. Although I could predict where the light was going, I had very little time to coordinate my own movements. The interaction quickly became a dodging rather than a moving with.

The behaviour settings of the system were then changed to generate movements that tended to be longer with less ‘fake’ motions. These changes were modeled after mirroring exercises in which human partners try to mimic each other’s motion with out a sense of leading. In these exercises, fluid, often slow predictable motions are emphasized. With the system’s behaviour modeling mirror exercises, I found the interaction with the light more of a ‘moving with’ experience. However, the quality of my movement remained at a proof of concept level, that is that I was aware of these elements in the interaction but the interaction in general did not inspire flow or exploration in my own movement.

**Shape of the Light Agent**

As a final note, I noticed that the concentric circle based design had more the top down look of a joystick then a human. I explored redesigning it to have a more human shape by using ovals rather than circles, but found the oval shape less engaging than the circles. Though this can be explained by the fact that an oval implies a direction and the system was not programmed to take direction of the image into account, my experience suggests that the circle configuration, though endowed with behavioural characteristics, remained a spot of light. My perception of the object combined “lightness” with behaviour and did not need to construct a new humanoid entity.
Sonic System

The sonic system had a different initial impact. Where as the visual system had inspired an avoidance response and only after being re-modeled, produced a moving with response, my experience was that the breath model in the audio based system immediately inspired a moving with response. The randomness of the gestures had less of an effect, perhaps because there were no fake gestures produced by the sonic system. The breath sound in the first session was linked to the duration of the generated phrase and produced a feeling of lift into tone of the sound. This feeling of lift encouraged my motion with the onset of the sound even though I had no knowledge of when it would happen.

Through reflecting on my response I noticed two parts to the breath generated by the physical model: the inhalation and the stream focusing. I was lifting on the inhalation but moving on the focusing change of breath just before the flute tone. This discovery inspired a series of sessions exploring the breaking of the breath sound into three parts: inhale, focused – airstream, and breath trail-off. By considering that a breath into a beat is often used to signal a down-beat, and that more air is needed to play longer phrases, I mapped inhale duration to tempo and inhale volume to phrase duration. This mapping frequently allowed me to anticipate the tempo of the phrase and move with it but only within a small range of values. However, when inhale duration was a function of phrase length I found that I moved with out much thought with the sound. The mapping of duration to tempo affected in me a more rational approach to moving.

3.2.3. Discussion

The result of this second pilot study indicated that both visual and sonic systems provide the opportunity to embed information in the system’s response media, projecting the system’s general intention. Analyses of the results indicate further that the two systems share many of the same issues. The cognitive load imposed on the performer when trying to predict the action of the system was revealed as an issue. These models were most prevalent in the sonic system, and yet, a similar effect was observed in the visual system. Both systems indicated an experiential difference between “natural” and analytical interactions; however, the parameters for separating these qualities were not
isolated in this study. This became a guiding interest for the overall project. The study did indicate that the perception of the breathing around the musical phrase could be modeled and perceived as stages of inhalation, air-stream focus, and air-stream support. The parameter of volume was also flagged as significant.

Based on these findings I decided to continue the study focusing on sound. The foundations of the mapping was constructed on ‘duration of preparation breath’ relating to the duration of the phrase, and breath timbre relating to the articulation and tempo of the phrase. These were refined later (see Chapter 5). Since the focus was on the response of the performer, the system would need a rudimentary level of responsiveness and the ability to generate musical gestures focused on goals. I chose to continue the study using more than one performer in a session in order to explore performer-performer interaction as well as performer-system interaction.

A final result from this second study was a preliminary indication that the manner in which the system expressed its intention did not need to be ‘truly’, modeled on a human gesture. However, there is some indication that a stronger reference to signifiers already part of the performer’s body-knowledge reduced the performer’s need to rationally analyze the intention of the system. Of prime importance was the observation that a feeling of trust and sharing of space was created in the system projecting its intention that was not present in the earlier response only system.
3.3. Third Pilot Study: Preliminary Test of Final Design

After the initial design of the music-generative and breath generative portions of the system were completed, several further iterations of the design were undertaken in conjunction with the studio tests. This process helped refine the implementation of the interactive model being explored in the study. The tests allowed for preliminary assessment of the simulated breath, the musical gestures, and the mapping of the sensing-to-control parameters. These tests involved several configurations of performers ranging from single performers to a group of performers improvising with the system. Participants included performers from dance and theater and even included a musician. During these sessions assessments were made of the mappings and motion analysis, musicality as well as the protocol for the research sessions.

3.3.1. Setup for Third Pilot Study

The research procedure during this phase of the study was to concurrently conduct first-person solo sessions and group sessions allowing time for programming in between. This process was conducted over approximately three months. Along with first-person solo sessions, the test sessions included sessions 5 different group compositions:

- a solo viewpoints performer,
3.3.2. System Refinements

Engine for Generating the Musical Gestures

The Music generative engine for the third pilot study used concepts I had developed in my Masters thesis in Computer Music at the University of Victoria. The generation of musical gestures in the second pilot study was based on random note constrained to a octa and a half. For pilot study three, a generative engine was constructed modeled around generating goals, a pitch or rhythm variation, and the interim martial for achieving the goal. A full description of the algorithms are provided in Chapter 5 in the system design section. The basic structure is based on a hierarchical structure of figurations as used in Schenkerian analysis (Forte, et al., 1982). These levels are referred to as Foreground, Midlevel, and Ursatz. Although Schenkerian analysis traditionally focuses on analyzing pitch content, I have adapted the concept for use in generating pitch and rhythmic material. For generating pitch material the system chooses a goal pitch and a number of events preferred for the gesture. The Engine references the current pitch-set/scale being used and determines an interval for the first step towards it’s goal pitch. The distance interval between the current pitch and the goal pitch is updated as is the number of steps left for the gesture and the process is repeated. In this way the engine can produce gestures with complex interval patterns. gestures For generating rhythmic gestures a duration is determined for the whole gesture. The engine then divides the whole gesture into a number of shorter duration either equally or isolating one segment as contrasting. This process is repeated to generate note durations. As with the process for generating pitches, the process for generating rhythms is iterative in real time, continually updating the duration to the projected end of the gesture and updating its calculations accordingly. I used this structure for generating musical material in several earlier works including my work at
the University of Victoria when I received a Masters of Music in Computer Composition. The process involved adapting models that I had used in earlier works, assessing these through repeated listening while noting my own and other’s responses, including interest levels and physical responses. I then made changes as necessary in an iterative process. The hierarchical structure facilitates possible control parameters at numerous places in the algorithm. The control parameters considered for this study are listed in Table 3.

<table>
<thead>
<tr>
<th>Parameters Selected of the Generative System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability of playing a phrase</td>
</tr>
<tr>
<td>Mean Duration of distribution for short gestures</td>
</tr>
<tr>
<td>Weighting for distribution of short gestures</td>
</tr>
<tr>
<td>Mean Duration of distribution for long gestures</td>
</tr>
<tr>
<td>Weighting for distribution of short gestures</td>
</tr>
<tr>
<td>Rhythm low level proportion</td>
</tr>
<tr>
<td>Rhythm low step number A (val)</td>
</tr>
<tr>
<td>Rhythm low step number A (mag)</td>
</tr>
<tr>
<td>Rhythm low step number B (val)</td>
</tr>
<tr>
<td>Rhythm low step number B (mag)</td>
</tr>
<tr>
<td>Rhythm foreground proportion</td>
</tr>
<tr>
<td>Rhythm foreground number A (val)</td>
</tr>
<tr>
<td>Rhythm foreground number A (mag)</td>
</tr>
<tr>
<td>Rhythm foreground number A (mag)</td>
</tr>
<tr>
<td>Rhythm foreground number B (val)</td>
</tr>
<tr>
<td>Rhythm foreground number B (mag)</td>
</tr>
<tr>
<td>Pitch midlevel gesture</td>
</tr>
<tr>
<td>Pitch midlevel step number (val)</td>
</tr>
<tr>
<td>Pitch midlevel step number (mag)</td>
</tr>
<tr>
<td>Pitch foreground gesture</td>
</tr>
<tr>
<td>Pitch foreground step number A (val)</td>
</tr>
<tr>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Pitch foreground step number A (mag)</td>
</tr>
<tr>
<td>Pitch foreground step number B (val)</td>
</tr>
<tr>
<td>Pitch foreground step number B (mag)</td>
</tr>
</tbody>
</table>

Table 3. Control parameters for the Generative System selected to creating an desired range of musical/ sonic gestures

**Weighted Random Process**

Weighted randomness provided the key to the Ariel system’s process for selecting attributes for the sonic gestures. Weights reflecting the possibility for each element were assigned then compared to a random number. Lists of attributes (decisions) could be re-weighted easily through the use of distribution curves. By using two or more curves, a decision could easily be influenced by multiple input streams or pre-program weightings. Each stream of input data or pre-programmed set was mapped to an individual curve. The sum of the curves then produced a complex set of probability for guiding the decision.

**Figure 15. Two Distribution Curves**

Figure 15 show an example of two distribution curves imposed on each other using a \( X = \text{maxA:maxB} \) routine. This routine produces an array of relational probabilities used to select the attribute. The mean, distribution, and height of the curve can be separately controlled or preset. Much of the testing time was setting the presets of these values for parameters that used internal data.
Implementing Computer Vision Sensing

The first step for incorporating the sensing (computer vision) engine into the rest of the system was to identify the most affective places to control the music gestures and what possible data could be acquired using the computer vision engine. This process involved exploring the range of sonic gestures that could be generated by the composition engine (see Table 4).

The elements detectable by the computer vision system were also identified. These are listed in Table 5.

<table>
<thead>
<tr>
<th>Possible Data From Computer Vision Component of the Ariel System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total lines</td>
</tr>
<tr>
<td>Longest length</td>
</tr>
<tr>
<td>Shortest length</td>
</tr>
<tr>
<td>Average length</td>
</tr>
<tr>
<td># of lines up</td>
</tr>
<tr>
<td># of lines side</td>
</tr>
<tr>
<td># of lines diagonal</td>
</tr>
<tr>
<td>Total circles</td>
</tr>
<tr>
<td>Largest diameter</td>
</tr>
<tr>
<td>Smallest diameter</td>
</tr>
<tr>
<td>Average diameter</td>
</tr>
<tr>
<td># of moving points</td>
</tr>
<tr>
<td>Average amount of motion</td>
</tr>
<tr>
<td># of points moving up</td>
</tr>
<tr>
<td># of points moving right</td>
</tr>
<tr>
<td># of points moving left</td>
</tr>
<tr>
<td>Largest amount of motion</td>
</tr>
<tr>
<td>Direction of largest amount of motion</td>
</tr>
<tr>
<td>X position of largest motion</td>
</tr>
<tr>
<td>Y position of largest motion</td>
</tr>
<tr>
<td>Smallest amount of motion</td>
</tr>
<tr>
<td>Direction of smallest movement</td>
</tr>
<tr>
<td>X position of smallest movement</td>
</tr>
</tbody>
</table>
Y position of smallest movement

Table 4. Data Accessible from the Computer Vision Component of the Ariel System

<table>
<thead>
<tr>
<th>Possible Input Data reflecting movement Duration of Movement Phrase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sort phrase duration (val)</td>
</tr>
<tr>
<td>Short phrase duration (mag)</td>
</tr>
<tr>
<td>Long phrase duration (val)</td>
</tr>
<tr>
<td>Long phrase duration (mag)</td>
</tr>
<tr>
<td>Possible step number A</td>
</tr>
<tr>
<td>Possible step number B</td>
</tr>
<tr>
<td>Proportion (relationship between long and short gestures)</td>
</tr>
<tr>
<td>Short period of not moving</td>
</tr>
<tr>
<td>Long period of not moving</td>
</tr>
</tbody>
</table>

Table 5. Data that could be derived from the computer vision component to reflect duration of Performer’s movement phrases

During the third pilot study, work was done to find suitable routines for analyzing the data from the computer vision. Two methods for considering the performers gestures were explored. One focused on the amount of movement on stage, how consistent it was and how pockets of motion (different performers or body parts) differed in their amount of motion. The second method considered change of direction as a means of parsing gestures.

The analyzed data was normalized to provide values from 0 – 127. The normalized data could then be easily mapped to any parameter of the musical gesture generator by imposing response curves to the normalized data. This was accomplished using simple function or lookup tables (see Figure 16). This structure allowed different data streams to be quickly remapped to different parameters for testing and later during the final study. The use of the tables also allowed the sensitivity of a parameter to be quickly adjusted enabling fine tuning of the response characteristics of the system.
Testing was done to find the most salient parameters and most effective (strongest connection) and stable input data. This work resulted in a final mapping shown in Table 5. Multiple inputs are listed for gesture parameters to accommodate the two sensing modes of the Ariel system, motion and shape.

<table>
<thead>
<tr>
<th>Process Data</th>
<th>Gesture Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motion/Stillness</td>
<td>Probability of playing a gesture</td>
</tr>
<tr>
<td>Motion/Stillness</td>
<td></td>
</tr>
<tr>
<td>Presence of Lines</td>
<td></td>
</tr>
<tr>
<td>Long Duration (general motion)</td>
<td>Mean for overall gesture length long</td>
</tr>
<tr>
<td>Long Duration (direction of motion)</td>
<td></td>
</tr>
<tr>
<td>Length of Longest Line</td>
<td></td>
</tr>
<tr>
<td>Long Duration (general motion)</td>
<td>Weigh for long gesture to be chosen</td>
</tr>
<tr>
<td>Long Duration (direction of motion)</td>
<td></td>
</tr>
<tr>
<td>Length of Longest Line</td>
<td></td>
</tr>
</tbody>
</table>
### Table 6. Mapping in Ariel_Flute_ResponseTool2 for Final Study

<table>
<thead>
<tr>
<th>Formula</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3(long duration/long+short) + 0.7(long/total)</td>
<td>Mean for overall gesture length short</td>
</tr>
<tr>
<td>Long Lines /Total Lines</td>
<td></td>
</tr>
<tr>
<td>Short Duration (general motion)</td>
<td>Weight for short gestures to be chosen</td>
</tr>
<tr>
<td>Short Length Compared to Average</td>
<td></td>
</tr>
<tr>
<td>0.3(long duration/long+short) + 0.7(long/total)</td>
<td>Mean of phrase duration of phrase length</td>
</tr>
<tr>
<td>Maximum Length in Window</td>
<td></td>
</tr>
<tr>
<td>Long Duration of Large Motion</td>
<td>Change of probability of long events --- used at both levels</td>
</tr>
<tr>
<td>0.3(Long Length/Long+Short) + 0.7(long/short)</td>
<td></td>
</tr>
<tr>
<td>Short Duration of Large Motion</td>
<td>Change of probability of short events (based on number of events) used on both levels</td>
</tr>
<tr>
<td>0.3(Long Length/long+short) + 0.7(short/long)</td>
<td></td>
</tr>
<tr>
<td>Short Lengths</td>
<td>Gives preference for number of short steps</td>
</tr>
<tr>
<td>0.3(Long Duration/long+short) + 0.7(long/short)</td>
<td></td>
</tr>
<tr>
<td>Short Lengths</td>
<td>Gives preference for number of long steps</td>
</tr>
</tbody>
</table>

#### 3.3.3. Discussion

Early in the third pilot study, issues concerning the range of musical texture or gestures that the system generated were limited. This was first noticed during a session with the single viewpoints performer then again in a later session involving the single viewpoints performer and the live musician. The general texture of the musical response tended to remain in a limited range, not ‘choosing to play in the extremes (fast or slow, long or short). This issue was addressed by changing the tables containing the internal preference for the response curve for the probability to play and the preference weighting for short events compared to long events. Also related to the range or variety of musical textures being generated, one performer commented that the vocabulary offered by the system was quite large. Although this comment seemed to be contradicting the earlier comments, the comment is really about the repeating of gestures and not the range of gestures. This issue was addressed by changing values
for the system’s tendency to repeat individual note, phrases and gestures. These changes provided the setting for the Ariel system’s music generative engine.

The third pilot study also helped solidify the general research design for the final study. In the final test sessions, I found through my own experience that I was able to use the simulated breath designed into the system to anticipate when the system was going to start or stop a gesture. I was able to anticipate the entrance and exit of the system. From this first person data I started to formulate the protocol for the semi-structured sessions that would be used in the final study. I also found that comments made by other performers supported my own experience. From this observation I started to gather topics for the semi-structured interviews. The discussions in the group started to focus on the role the computer was playing in the group, what material it was adding as well as how and when it was the focus of individual’s attention. These discussions added to the topics used during the final study. These conversations also finalized the decision to use more than one performer for the final study. Listening to the comments, experiencing the interaction myself, and observing the negotiations taking place among the performers and the system all brought attention to the contrast and dynamics provided by the combination of interacting with the system and interaction with a human and how this complex environment seemed to encourage deeper reflection on the experience in interaction as an improviser in general. So the environment of performers working with each other and with the system became the base scenario for this study.
4. Methodology: Adapting Phenomenology and Grounded Theory to Interactive Performance

4.1. Methodological Concerns in the Study

4.1.1. The Problem

In order to expand on the current model of interaction used in interactive performance, further development in the understanding of a performer’s experience when interacting with others in improvisatory performance is required. How the performer experiences the interaction is a large component of how the Performer approaches their interaction with the system. Understanding the experience is critical to
understanding how to design a computational model that can engage this experience. However, the subjective and complex nature of experiential phenomenon makes it difficult to investigate (Logan, 2005). Since experience is personal, its investigation is not well suited to empirical methods of inquiry. Art and practice based methods of inquiry are able to provide significant, in-depth information, but these methods are often seen as subjective and the knowledge is difficult to relate to knowledge from other fields.

I articulate a methodology for accessing the cognitive process within experience, which has a similar hypothesis as first-person research in neurophenomenology. Neurophenomenology places as a working hypothesis the tenant that disciplined, first-person phenomenological descriptions of an experience can provide information about mental activity (Thompson, 2005) (Andrieu, 2006). My methodology incorporates the understanding that the performer's has developed expert knowledge and practice develop through performance training, which enables the performer to provide coherent, and articulate descriptions of their first-person experience.

Precedence for Phenomenology as a Methodological Approach

Researchers in the field of Cognitive Science, who are exploring the related phenomena of general human experience, have developed methods that allow experience to be explored in controlled situations with a recognizable level of rigor and validation (Varela, 1993; Varela & Shear, 1999; Petitmengin, 2006; Petitmengin-Peugeot, 1999). Of particular interest for this study is the work of Claire Petitmengin who outlines a method using second-person phenomenology for researching participant's experience of intuition (Petitmengin-Peugeot, 1999). Researchers in HCI and Interactive Performance have been discussing and developing similar methods for use in design processes, Design for Interactive Art within Human-Computer Interaction by Schiphorst (2008; 2011) and in Dance by Kozel (2008) and Fraleigh (Fraleigh & Hanstein, 1999). This chapter discusses how these methods from Cognitive Science and Performance practice may be adapted and combined to provide a methodology for investigating performer experience when interacting with computer systems. While the performer’s experience is a large part of Interactive Performance practice, research processes seldom focus directly on the performer’s experience of interacting with a computer system (Logan, 2005). More often, the literature reports on the technical aspects of the
system or the assumed perception of the audience. This study considers a method for directly investigating the experience of a performer as they interact in a collaborative relationship with an autonomous computer system. The method developed allows experientially based questions to be investigated in a direct and rigorous manner and provides new knowledge in the performing arts, which can be extrapolated to other disciplines such as human computer interaction and cognitive science.

4.2. Source of the Method

Phenomenology provides a base methodology for exploring first-person experience by focusing the research on a small number of participants and engaging the participants over an extended period of time (Creswell, 2003). By focusing on prolonged engagement with a small number of participants, the data collected centers on the participants detailed descriptions of the experience or phenomena (Creswell, 2003). In this study, I refer to the participant’s accumulated detailed description of their experience as a “thick description”. In analyzing the descriptions, the researcher looks for patterns...
and relationships among the comments made by participants. The focus on the participant's thick description requires the subject to both reflect on their lived experience, and verbally articulate their experience to the researcher.

My use of the term *Phenomenology* acknowledges a lineage the follows from the work of philosophers such as Heidegger, Merleau-Ponty, and Sartre as well as psychologists and sociologists such as Schütz and Garfinkel (Depraz, 2002). The use of Phenomenology as a methodological framework evokes a concern for experience through praxis (Meleau-Ponty, 1964; 1968; 1962; Depraz, 2002; Gallager, 2002; Kozel, 2007) and an inter-subjective relationship between the researcher and the participant (Sartre, 2004; Finlay, 2005). The inter-subjective relationship includes a second–person relationship in which the researcher and the participant share a level of training and or experience. The shared training enables the researcher to understand the participant's description of their experience through such elements as specific use of empty or ericksonian language that aid in the interview process (Varala, 1999; Stawarska, 2006; Bavidge, 2006; Ericsson, 2003).

For this study I adopt the term *thick description* stemming from ethnography, which describes the researcher’s process of describing and interpreting an observed social action in a particular context. The goal is to describe social action while including the purpose and intentionality of these actions (Ponterotto, 2006). Using interpretation to address ‘purpose and intentionality’, is described by Clifford Geertz in a way that carefully considers an *unobscured connection* to the original data:

“My own position in the midst of all this has been to try to resist subjectivism on the one hand and cabbalism on the other, to try to keep the analysis of symbolic forms as closely tied as I could to concrete social events and occasions, the public world of common life, and to organize it in such a way that the connections between theoretical formulations and descriptive interpretations were unobscured by appeals to dark science.” (Geertz, 1973, p29)

The interview and journaling data collected by researchers such as Clair Petitmengin, Francisco Varela and Susan Kozel parallel Geertz’s view on how to provide a full description of a phenomena (Kozel, 2007; Petitmengin, 1999; 2006) .However, Varela and Petitmengin suggest that 'lay participants' may have trouble providing the detailed description outlined by Geertz and Ponterotto. (Petitmengin, 1999; 2006; Varela, 1999;
Depraz, 2002). Specialized interview techniques, such as used in this study, ensure that descriptions provided by the participants are as unobscured as possible by including description of the kinaesthetic expression of their experience as well as the purpose, intentionality and process behind the experience (insofar as the performer is able to articulate these nuances). This adherence to Geertz’s description of interpreting phenomena aligns with his use of the term ‘Thick descriptions’.

The difficulties encountered by a participant in providing reliable thick descriptions of their experience have been identified and addressed by researchers in cognitive science such as Sean Gallagher, Francisco Varela and Claire Petitmengin (Gallagher, 2003b; Varela, 1999b; Petitmengin, 2006). These difficulties stem from difficulties in the participant’s ability to reflect on their experience and articulate a thick or detailed description of the experience. Petitmengin and Varela identify five main issues experienced by participants that inhibit their thorough and accurate reflection on their experience: 1) dispersion of attention, 2) absorption in the object, 3) confusion between experience and representation, 4) what dimension of the experience to attend to and 5) degree of precision (Petitmengin, 2006). Each of these issues is evident throughout one’s attempt to reflect on their own actions.

The ‘dispersion of attention’ is commonly experienced when one is trying to focus attention on an inner representation, such as an imagined object, an experience or the cognitive process, involved in the present activity. I experience this absorption in experiences where after attending to an image for a few moments other thoughts spring up to disperse or absorb my attention. For example, if I stand still and focus on the cognitive processes involved in standing still, after a while my attention may drift to sounds in the room or even aching muscles. As a result I fail to notice that I am no longer attending to the original image or activity, which is the process of standing still (Petitmengin, 2006). Even if I am able to stabilize my attention to a given activity or object, ‘standing still’, I may become absorbed in the what of the activity, the fact that I am standing still, and am only slightly aware of how the activity or object is achieved or perceived, the experience of standing still, the perception of balance, breathing and small muscle movements.
The ‘absorption into the object’ distracts from attending to the process or experience. Although my activity involves cognitive processes that are precise, such as my actions to balance myself, these processes largely elude my consciousness while my attention remains focused on the goal or the what in the activity, that I am remaining still (Petitmengin, 2006). Despite this lack of attending to the how of our cognitive process, in many cases we “have a mistaken representation of our cognitive activities” (Petitmengin, 2006, pg. 235). Since our held representation, the image in our mind, is believed, it masks or interferes in our attempts to reflect on our object, the experience. This can lead to confusion between the experience and the representation of the experience.

The interference imposed by our beliefs affects the reliability of our description for exploring the cognitive process involved in the experience. Our belief about our experience is also affected by "knowing what to look for" (Petitmengin, 2006, pg. 236). Our experience consists of various dimensions and layers of sensations that affect how we perceive our sensed experience. “Without training, we only have in the most favourable cases a partial and vague consciousness of these various dimensions” (Petitmengin, 2006, pg. 236). When reflecting on an experience, the awareness we have of the dimensions, the associated sensations, which are elements of the cognitive processes may be limited by the habit of attending to what usually matters. We need to adjust our attention to bring the various levels, dimensions of sensation, and structure into focus. This requires not only a stabilization of attention, but “a certain knowledge of the degree of precision (5) which is possible, and which we wish to achieve” (Petitmengin, 2006, pg. 237). The participant’s habitual attention to their experience can be expanded in order to facilitate their ability to find a thicker description of their experience.

Petitmengin (2006) has similarly identified two primary issues that participants experience when attempting to articulate their reflection. First, we have limited vocabulary for precisely describing sensations associated with an experience. This is especially true of internal sensations both physical and cognitive. Second, the verbalizing of an experience can introduce a disruption in the description, where the words used start to support their beliefs, overshadowing experience as it was sensed or perceived (Petitmengin, 2006).
Two main approaches have been suggested to address these issues in collecting thick descriptions from participants: 1) training the participant’s ability for reflecting on and articulating their experience, and 2) helping the participants in reflecting on and articulating their experience through interviewing techniques.

The approach of training participants begins with the notion that awareness of one’s own cognitive processes is a trainable technique described as a process for ‘having the mind present in embodied everyday experience’ (Depraz, Varela, & Vermersch, 2003). Depraz, in his book “On Becoming Aware”, presents one technique referred to as Mindfulness or Becoming Aware. Its purpose is to teach individuals to “become mindful, to experience what one’s mind is doing as it does it, to be present with one’s mind” (Varela, 1992 p23). This may be achieved by calming the mind to enable it to be present with itself, to gain insight (Varela, 1992). Through practice, the mediator develops the ability to “interrupt the flow of discursive thought” and re-gain presence with their breath and activity (Varela, 1992). The training can be likened to training a muscle to work longer and harder and as a breaking of habitual distractions. Like other activities that require training, practice to become aware of one’s own cognitive process takes time. For this reason, a researcher may not be able to rely on a participant’s individual ability to focus their awareness on their cognitive process. The research then relies on their own awareness of the experience and, as discussed above, uses their awareness of the phenomena being explored to guide the participant in reflecting on and articulating their own experience.

The alternative or supplemental approach to using participants trained in techniques for reflection advocated by Petitmengin, focuses on the researcher practicing interviewing techniques designed to facilitate the participant’s reflection on, and articulation of, their personal experience. The interview technique she outlines in her paper Describing First-Person Experience (2006) is referred to as “Interview of Explicitation”. Her interview technique addresses the main issues identified by herself and Varela that inhibit participants process of reflection such as stabilizing the interviewee’s attention, keeping them focused on the their cognitive process during the reflection on their experience, and guiding them to explore the various dimensions of their sensations themselves. Her interview technique also addresses the issues of participants articulating their experience by facilitating the interviewee in constructing a
vocabulary for describing their experience. Her methodology and interview technique provide the template for my own methodology and interview technique.

4.3. Interview of Explicitation: The Template for Performer Experience Methodology Verified by Claire Petitmengin

The interview technique developed by Petitmengin contains 4 elements to address the difficulties identified in gathering Phenomenological data. Petitmengin suggests the researcher use interviewing techniques that: 1) facilitate the participant re-enacting the experience in “an inner way”, 2) guide participant’s attention to the experience, 3) facilitate the participant in articulating their experience into words. She then 4) outlines a technique for analyzing the interview data through the construction of individual synchronic and diachronic models, which are then combined into a general model of the experience.

Figure 19. Navigational Map for Methodology Template
4.3.1. The Relationship Between Interviewer and Interviewee in the Interview of Explicitation Technique.

Petitmengin’s Interview of Explicitation technique is based on a second person relationship between researcher and subject, meaning the researcher and subject share a base knowledge (Petitmengin, 2006; Varela, 1999). The second-person relationship serves as the basis for the trust and understanding between the interviewer and interviewee. The shared knowledge implicit in the second-person relationship enables the researcher to facilitate participants in reflecting on their experience (Petitmengin-Peugeot, 1999; Varela, 1999b; Gallagher, 2003a). The situation of being interviewed acts as a “container” for the participant’s attention “helping them remain in the boundaries of the experience being explored” (Petitmengin, 2006, pg. 239). For the interviewer-interviewee relationship to act as a container the interviewer needs to cultivate a relationship of trust by responding to the interviewee without judgment or expectation and conveying a sincere air of interest and collaboration. The building of trust encourages the interviewee to openly engage with the interviewer.

Once trust is established, the interviewer can then use interviewing techniques to guide the participant to reflect more deeply on the experience. The interviewer helps the interviewee avoid assumptions or statements of belief by guiding them to focus on articulating a single experience, as it is re-lived. Petitmengin (2006) suggests that the interviewer is able to help the interviewee by remain open to all their own senses and social perceptions while engaging in observing the interviewee. By observing body and language cues, the interviewer determines when the interviewee is re-living and when they need help returning to the experience. The interviewer may also use their own experience to give suggestions to the subject on where to place their attention. This technique helps ensure a more thorough reflection. However, care must be taken to avoid judging or categorizing the experience of the interviewee or leading their description. Even though the interview technique acknowledges an inter-subjective experience, while collecting the data, the experience must remain personal to the interviewee so that the truly subjective and the inter-subjective may be analyzed later.

In order to remain focused on the interviewee’s experience, the interviewer needs to acknowledge and remain aware of their personal relationship to the
phenomena being observed. They need to avoid their own assumptions and be aware of opportunities for exploration. For this reason the researcher needs to develop their own ability in personal awareness. Furthermore, by letting go and trusting to let things happen, to let the interviewee explore their experience in their own way, the interviewer can facilitate the interviewee in reflecting on and articulating their experience with a minimal amount of judgment or selection. By not trying to understand an observation or elicit and explanation during reflection, the interviewer avoids assumptions and internal statements of belief, which allows attention to focus on the lived experience.

4.3.2. **Interview of Explicitation: Experiencing in an Inner Way**

The key to the interview technique is the concept of re-enacting the experience in “an inner way” (Petitmengin, 2006) or re-living. Re-enacting the experience in an inner way or re-living is the cognitive state in which the participant re-experiences a moment in their mind in order to provide a more detailed description of it as if narrating. The implication here is that remembering a moment is filtered through the participant’s constructed understanding of the moment, including influences of belief and self-image. When a participant is asked to re-live a moment they are asked to recall physical sensations, moments of perception, internal and external, without judgment or explanation. The interviewer can recognize when the interviewee is re-enacting, re-living, by observing their body (Petitmengin, 2006). For example, breaking eye contact often indicates a state of re-living. The interviewer may also recognize the state through verbal cues such as the interviewee switching to the use of present tense in describing their experience.

The techniques for guiding the participant to re-enact or re-live the experience in “an inner way” are addressed in two stages of the interview process. First, Petitmengin (2006) suggests starting interviews using phrases such as ‘lets go back together as though we had a video recording’ to guide the interviewee to re-live the experience. Then throughout the interview, the interviewee is required to re-live their experience repeatedly. The interviewer facilitates the interviewee repeatedly re-living their experience by guiding them to recall a sensory experience that is associated with the cognitive experience to be re-lived. For example, recalling what one first thought when waking up can be facilitated by first recalling the sensation of feeling the covers on the
bed (Petitmengin 2006). Similarly, the interviewer guides the interviewee to recall sensory elements in their experience to facilitate the repeated experiencing “in an inner way”.

The interviewer may also insert the protocol markers or flags to help the interviewee return to the experience. This marker may be oral or gestural. For example the interviewer may tell the interviewee to “remember back to when you heard me ask you to imagine…. ” (Petitmengin, 2006, pg.245). Here the interviewee uses the aural sensation of their voice as a marker for the beginning of the interviewee’s cognitive process of imagining a specific object. The interviewer can then continue to guide the interviewee’s reflection on their experience by guiding them to explore different sensations such as visual, auditory, tactile and kinaesthetic.

4.3.3. Interview of Explicitation: Techniques for Guiding Participant’s Attention of an Experience

The next stage in the Interview of Explicitation laid out by Petitmengin is to guide the interviewee’s attention while they re-live the experience. The techniques used in this stage include:

- Stabilizing the performer’s attention.
- Turning the interviewee’s attention from ‘what’ to ‘how’, to heighten their awareness of their experience.
- Facilitating the interviewee to move from describing representations of the experience to direct descriptions of their experience.
- Directing the participant’s attention to various dimensions of the experience.

These technique were developed by Petitmengin to address the difficulty identified in interviewee’s dispersion of attention, their absorption in the object, and their confusion between experience and representation, as well as facilitate the interviewee in developing a vocabulary for use in the confines of the interview for describing the experience.

The stabilizing of attention is approached through three basic techniques aimed at reinforcing the trust and personal connection with the interviewer. One method for reinforcing the connection is done by using a phrase such as “we are here together for a given time, with a specific objective, which is to gather a description of this particular
experience” (Petitmengin, 2006, pg 239). Giving a context helps settle the interviewee. The interviewer will also repeat what the interviewee has just said, using “empty language’ (Ericsson, 2003; Petitmengin, 2006) rephrasing it as a question to indicate their attentiveness and to encourage further reflection. The researcher may also repeat phrases to encourage the interviewee to check their own statements. This is done with phrase such as ‘I am going to repeat what you just said……is this correct’. A similar approach is used when re-formulating a statement.

Turning or redirecting the interviewee’s attention from “what” to “how” is used to facilitate the interviewee in becoming aware of the new aspects of their re-lived experience. The process involves “a break with customary attitude to focus on what the object is with out being conscious of how the object was perceived”. (Petitmengin, 2006, pg. 240). “The re-directing may be triggered by obstacle, failure or training” (pg.240). The use of questioning is employed to redirect the description away from the object to the process implemented in achieving it (Petitmengin, 2006).

The interviewer must also facilitate the interviewee to move beyond their believed representation of their cognitive process. This movement is made by helping the interviewee to “shift from a general description to a description of a particular situation” (Petitmengin, 2006, pg 242). The shift from general to specific descriptions is achieved by bringing the interviewee back to their own experience. To achieve this, the interviewer may use phrases or questions such as “how do you know that”. The interviewer may also focus the interviewee back on to sensorial experience to re-establish their focus on their experience (Petitmengin, 2006).

One further difficulty identified in having the interviewee reflect on their experience is their tendency to focus on a primary sensation (Petitmengin, 2006). To address this difficulty the interviewer phrases their questions to direct the interviewee’s attention to various dimensions of the re-lived experience such as auditory, kinaesthetic, emotional, olfactory, and gustatory. The selecting of which dimensions to explore can be drawn from the interviewee’s verbal response or body response, what they directly say or small movements they make while describing their experience. Their movements or comments may imply a hidden or slight awareness of an experience in an alternative dimension that they may not think to explore. This is the issue of interviewee’s not
realizing the possible depth of their experience, the dimensions of their experience. To help the interviewee find these hidden experiences, the interviewer needs to be sensitive to the interviewee’s gestures and body posture and verbal descriptions. The interviewer then may repeat these to the interviewee in order to bring the experience to awareness and encourage the interviewee to explore the sensation fully so as to provide a detailed thick description. For example the interviewee may hold their breath while describing the experience prompting the interviewer to ask, “what is happening with your breath?”. The interviewee can then reflect on the experience again shifting their attention to their breath and try to become aware of the experience in the dimension of breath.

4.3.4. **Interview of Explicitation: Facilitating Interviewee Putting Their Experience into Words**

To address the issues identified in the interviewee’s ability to put their experience into words, Petitmengin suggests that the interviewer encourage the interviewee to find their own words. And yet in practice, the process of finding words for the experience is effectively taken on by both the interviewee and the interviewer. The interviewee is encouraged to use words differently, use the words that come into their head without worrying if they make sense, or that the grammar is correct. The priority during the interview session is always on their connection to their experience. The interviewer then repeats statements made by the interviewee to check the interviewer’s own understanding and give the interviewee the chance to check the precision. By hearing their words and the way they are using their words, the interviewee is engaged in refining their language, providing an articulate description of their experience.

4.3.5. **Petitmengin’s Outline for Analysis of the Interview Data**

The process laid out by Petitmengin for analyzing the interview data focuses on 5 steps. The first step is to separate the text into direct descriptions of the experience, and comments expressing judgments, beliefs, and opinions about the experience. The second step is to identifying interior gestures that make up the experience. The third step identifies temporal structure of the experience to construct a diachronic model. This
step is undertaken in parallel with the construction of a synchronic model, and implied fourth step. The synchronic by considering relations between comments not address by the temporal dimension. The diachronic and synchronic models are constructed for each individual participating in the research study. The final fifth step is the comparison of the models of individuals to construct a single ‘general’ model for the experience, incorporating the diachronic and synchronic models of all the participants (Petitmengin, 1999).

4.4. Adapting the Source Method

4.4.1. Identifying Concerns Inherent to the Context of Performance

The performer’s first-person experience improvising with the interactive autonomous music generative system provides the primary data for the research. Since the research is focused on the first-person experience of the performers, Phenomenology provides a suitable methodology for the research. Furthermore,
Petitmengin’s *Interview of Explicitation* provides a template interview method to address possible difficulties in collecting data on the performer’s experience. However, Petitmengin developed the *Interview of Explicitation* for use in researching specific experiences that are centered on an identifiable climatic moment such as intuitive insight and epileptic seizures. The technique is also developed to accommodate using the general public as participants. Researching the experience of performers during improvisation performances constitutes a slightly different context concerning the training in awareness of the participants (trained performers) and the duration of the experience being reflected on, a 5-15 min improvised movement scene. I have adapted Petitmengin’s Methodology and interview technique to address the context of performance research including the participant-performer’s training and the sustained nature of the experience.

4.4.1.1 Participant-Performer’s Training in Awareness

Petitmengin’s interviewing technique is developed to help the participant achieve an authentic reflection and articulation of their experience that mimics the reflection in first person phenomenological description (Kozel, 2007) and methods for *becoming aware* of one’s own cognitive processes (Depraz et al., 2003; Varela, 1993). And yet the performance context of this study affects the assumptions that can be made regarding the participant’s ability to reflect on their own experience. The participants used in this study all had some level of performance training. One difficulty identified by Petitmengin and Varela in collecting thick descriptions of first-person experience is breaking the participant’s customary tendency to act without being conscious of their way of going about it (Petitmengin, 2006). Petitmengin briefly mentions that shifting the interviewee’s attention to *how* the task was achieved can be accomplished through interview techniques but can also be part of the interviewee’s training. While Petitmengin developed her interview technique for working with untrained participants in a Cognitive Science setting, my study focuses on skilled performers trained in their ability to reflect on their experience.

A parallel is evident between training undertaken by performers and the training for *becoming aware* of one’s own cognitive processes (as outlined by Depraz in his book *On Becoming Aware*). The process of *becoming aware* involves three stages:
Suspension, Redirection and Letting Go. The full process can be described as suspending your personal attachment to a thought, re-directing your attention from the exterior to the interior, and letting go of the active search and accepting what comes to your attention (Depraz et al., 2003). Similarly, performers specifically trained to let go of ‘rational decision making’ as their impetus and expand their attention to become aware of other influences, such as tracking the origins of the impulse, the tendencies and intentions to act creatively/ intelligently in the present moment. This process is often referred to as being ‘open to offers’ (Wirth, 1994). The concept of accepting what comes (to mind/ from the space/from others) is a key aspect of a performance training regime called Viewpoints performance training (Bogart & Landau, 2005). Part of Viewpoints training develops the performer’s trust in letting moments ‘happen’. The performer is encouraged to let go of their ownership or judgement of ideas as a way of opening up to offers made by the group or the environment. The process described for becoming aware focuses more on explicit personal reflection then Viewpoints training does, but the overlap suggests the core element of personal reflection is an easy shift for a performer to make.

**General Training**

Performers are skilled in their body interaction with other performers and their reflection on the quality of the interaction, but are not trained in articulating the cognitive processes they enact when performing. This social connection between performers involves body cues that produce an empathetic and embodied experience. However, in order to examine performer interaction experience fully, there is a need to develop a method for accentuating performer’s awareness and facilitating description of their experience as articulately as possible.

**Viewpoints Training**

The Viewpoints approach to movement training was developed by Mary Overlie as a way of structuring dance improvisation in time and space [Bogart]. Theater practitioners have, since then, adapted Overlie’s approach for discussing and developing movement in theater performance. Anne Bogart and Tina Landau describe Viewpoints as a philosophy translated into a technique for (1) training performers; (2) building ensemble; and (3) creating movement for stage; as well as points of awareness that a
performer or creator makes use of while working (Bogart & Landau, 2005). The training includes developing the performer’s awareness of physical structures, space, time and other participants. This is done through identifying a set of conceptual perspectives, referred to as Viewpoints, that serve to focus the performer’s perception and discussion around a given dramatic interaction or environment. The collection of Viewpoints presented by Bogart and Landau includes: tempo, duration, kinaesthetic response, repetition, shape, gesture, architecture, spatial relationship, and topography. These are the elements that Bogart and Landau suggest an actor should practice being aware of. Most of the terms are self-explanatory; however, a complete definition can be found in their book “The Viewpoints Book” (Bogart & Landau, 2005).

The significance for performance research of the training provided by performance methods such as Viewpoints has two aspects. First the advantages are made apparent in the training’s similarity to the training in awareness for researchers suggested by Varela, Vermersch and Depraz in their book On Becoming Aware. Their suggestions, inspired by meditation practice, focus on procedures for the researcher to develop skill in becoming aware of their own body experience. Performance practice has a long tradition of developing personal awareness of experience. And yet the second aspect lies in how performance practice tends to approach knowledge as an embodied skill, focusing less on the verbal articulation of knowledge in propositional discourse and argument (Parviainen, 2002). Although the focus on embodied knowledge in performance practice enables detailed inquiry into experience, at the same time the articulation of the knowledge can be limiting. The ability to do this is at times valued over the ability to discuss rendering the accumulated knowledge inaccessible by communities that place emphasis on verbal articulation of knowledge. While Viewpoints training supports reflection, not all Viewpoint research subjects are able to verbally articulate lived experience well. The difficulties identified by Petitmengin, Varela and Depraz still holds true for performer-participants. The researcher/interviewer still needs to facilitate the performance participants in articulating their lived experience while avoiding statements of belief or assumptions. For this reason, the interview technique outlined by Petitmengin still serves as a useful method for obtaining reliable thick descriptions of the performer’s first-person experience.
4.4.1.2 Performance is a Sustained Experience

The researching of performer experience also needs to address the sustained nature of an improvised scene. An improvised scene may have several moments of interest, moments of no connection, or no identifiable climax of the experience. The nature of improvisation means that predicting the experience or even accurately assessing the performer’s experience from the outside is risky. Where as in Petitmengin’s research on intuitive insight, the interviewer uses the moments leading up to and immediately after the insight as a macro structure for the interview. In contrast no such identifiable climax may be fixed in the improvisation. There is no reliable manner to anticipate or identify moments that resonate as important to the experience. Furthermore, the improvisation may last 5 – 15 min, much longer then the experiences discussed by Petitmengin. During this time more then one climax may occur. This subtle difference in the structure of the experience as well as the level of training common to the participant-performers necessitates modifications to the Interview of Explicitation for use in performance research. Modifying the Interview of Explicitation has lead to the development of the Interview for Performer Experience.

4.4.2. Interviewing for Performer Experience: Adapting Claire Petitmengin’s Interview of Explicitation

In addressing these two key differences between the context of this study and the context Petitmengin developed her Methodology and interview technique for, I have developed a related Methodology and interview technique I will refer to as the Interview for Performer Experience.

<table>
<thead>
<tr>
<th>Interview of Explicitation</th>
<th>Interview for Performer Experience</th>
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</thead>
<tbody>
<tr>
<td>Relation to Petitmengin’s Implementation</td>
<td>Modification used in study</td>
</tr>
<tr>
<td>Re-enacting in an “inner way”</td>
<td>Same</td>
</tr>
<tr>
<td>Metaphor of video to guide reflection</td>
<td>Same</td>
</tr>
<tr>
<td>Modified Marker provided by performer</td>
<td></td>
</tr>
<tr>
<td>Focus on selected Sensory Triggers</td>
<td>Same</td>
</tr>
<tr>
<td>Sensitive to Body cues of Reliving</td>
<td>Same</td>
</tr>
<tr>
<td>Sensitive to verbal cues of reliving</td>
<td>Same</td>
</tr>
</tbody>
</table>
When developing the Interview for Performer Experience, I still focused on the 4 elements developed by Petitmengin but applied minor modifications (see Table 7). As in Petitmengin’s Interview of Explicitation participant-performers were guided to re-enact in “an inner way”, what I will refer to as re-living their experience of the improvisation. Interview sessions were started using phrases to encourage the performers to let go of pre-constructed understandings of their experience and to help them place themselves back to the moment of experience using similar phases as prescribed by Petitmengin (details in Chapter 5). The reflective state of the performer-participant, if the performer was re-living the experience, was assessed by the interviewer by noting the performer-participant’s body and verbal cues. This process is consistent with Petitmengin’s technique. The primary modification made to this part of the Interview of Explicitation is the process for facilitating the interviewee in re-entering their experience.

The interviewee/participant-performer was required to repeatedly re-live their experience. Petitmengin discusses several methods the interviewer may use to facilitate the interviewee in achieving re-entering the experience. In the Interview of Explicitation a main method employed by the interviewer is to incorporated oral or gestural markers/flags into the interview protocol. It was originally expected that a similar method could be implemented for interviews in the context of performance research. I expected that the audience’s experience of connection with a dancer could similarly be tethered to a
moment with in the longer performance. When exploring the audience’s experience connecting with the performer, I explored using choreographic elements in a similar way but found during preliminary sessions that these moments did not resonate with the participants as moments of interest (Corness et. al 2011). Instead, audience members were asked to identify specific moments in the performance when discussing an experience. This stage in the interviewing process is part of facilitating the participant in re-living the experience. A similar approach to facilitating the performer’s reliving of the improvisation experience was used in this study. The improvisational nature prevented the possibility of adding structural markers such as choreographed gestures of changes in the environment. Instead the scenes were kept relatively short\(^5\) to facilitate the performer’s recall.

4.4.2.2 Modifications Made to Address Performer-Participant’s Attention of an Experience

The interview technique prescribed in the Interview of Explicitation for guiding the attention of the interviewee was continued in the Interview for Performer Experience. The technique of stabilizing attention, moving from representation and directing attention, remains largely the same as in the Interview of Explicitation technique. The modification made to Petitmengin’s interview technique draws on the base training of the performer-participants. In the context of performance research, the interviewee is a trained performer with some level of training as described earlier. Their training provides the participant-performer with a certain degree of ability in directing their attention within their experience. More importantly, in this study, the Viewpoints training method was used as not only a base training for the participants but to inform the improvisations as well. As a training method for the awareness of ensemble, the Viewpoints method has developed games/tasks that may be given to groups of performers to guide their awareness of each other, the space and how they are interacting. These tasks were used to shift the performer-participant’s attention during the improvisation. During the

\(^5\) The end of the scene was called by the performer’s either by leaving the space or calling ‘end’. Within the group it was acknowledged that the scenes needed to be short to facilitate discussion but long enough to allow for the experience.
interviews the performer-participant was able to attend to the awareness highlighted by the task or reflect on the difference tasks in subsequent improvisations.

**Modifications Made in Facilitating Performer-Participants in Putting Experience into Words**

How the interviewer facilitates the interviewee to put their experience into words is similar in both the *Interview of Explicitation* and the *Interview for Performer Experience*. The development undertaken focused on two changes induced by the context of performance research. First, the performer-participants in describing their experience often revert to gestures and sounds. Their experience is situated strongly in their body and involves elements for which there are no words. For this reason simple sounds or gestures became part of the language used in the interviews. Still, when possible, the performer-participant/interviewee was encouraged to describe, thereby understanding the nuance of the sound/gesture they used. Their repeated explorations in re-articulating the experience ensures the interviewee’s full understanding of their experience, their ability to articulate the experience, and thereby the understanding of the interviewer.

**Using Method for Group Interviews**

Interviews were conducted with the whole group. This format is again a departure from Petitmengin’s interview process and with the interview process used in the Illusion of Togetherness project (Corness et. al., 2010). During the preliminary studies, it was found that the performers were able to support and contradict the other performers’ experiences, which added to the open discussion. At times performers were able to help each other recall an experience. The support given by the group is most evident in the process of *re-entering* the experience, one of the key elements of the method discussed earlier. For myself, as an outside viewer, to find moments that resonated with the performer’s experience of connecting or trusting was difficult. The performers themselves were much more successful at accomplishing this for each other since a comment made by one performer would resonate either positively or negatively with the other performer helping to re-live the moment.
Modifications Applied to Include Video Data

The *Interview for Performer Experience* modifies the method outlined by Petitmengin in the use of video data. The video data pays two roles in the developed method. First it captures the gesturing of the performer-participants during interviews to enable the inclusion/interpretation of these expressions when transcribing the data. Second, the video take during the improvisation acted as a second data source to triangulate with statements made during the interviews. As was identified by Petitmengin, interviewee's are not always aware of their actions. Even when performers are trained to become aware of their actions and their interactions with their environments, they remain prone to describing their process in generalities and assumptions. For example believing actions happened together or that their focus was on their partner. Such comments can be checked in the video adding information as to how the experience is being sensed, perceived and the understanding being constructed.

Modifications Applied to Expand the Analysis Procedures

The analysis used on the data collected in the interview for performer experience follows the basic structure outlined by Petitmengin. The stages of reducing the text is extended to include not only belief and descriptions of the experience but elements specific to the context of the project such as human communication, improvisation, and interaction with the computer system. Petitmengin’s stages of constructing diachronic and synchronic models are also followed. However, the process outlined by Petitmengin focuses largely on Thematic Analysis (Petitmengin, 1999). I have extended the analysis by incorporating aspects of Grounded Theory such as Axial Coding where comments are re-assessed using varying axis or elements of the themes identified in earlier analysis (Strauss & Corbin, 1990). The key aspect of the analysis was to allow new insights, that were developed in earlier procedures, to inspire new procedures for analysis. This analysis structure is used in Grounded Theory to allow a theory to emerge from the data (Strauss & Corbin, 1990) (See Figure 21). The extended analysis process developed for this study facilitates a deeper investigation of the data while continuing to reflect the process outlined by Petitmengin.
Figure 21. Illustrations of Series of Procedures Used in Analysis
5. Methods Used to Implement Research Design and Methodology

The goal of this study was to explore the experience of performers improvising with an autonomous agent designed to project its intention through and embodied cue, a simulated behaviour of breathing. This goal is facilitated through the use of the methodology, outlined in Chapter 4, which is based in phenomenology. By using a phenomenological approach, the research design focused on providing an in depth analysis of the experience of small number of participants. The research design needed to 1) facilitate the performer-participants in experiencing an phenomena, the improvising with an autonomous incorporation a model of a breathing behaviour congruent with/related to the research question 2) facilitate the collection of data concerning the performer-participant’s experience. In this chapter I outline the overall research design, and how these two requirements were achieved. I start with a discussion around
facilitating the experience by describing the process for selecting participants, the design of the system, Ariel, and the protocol for the improvisational sessions. I then discuss how the group interview process facilitated individual performers in providing detailed articulation of their experience exploring performer interaction with the Ariel system. I provide a description the process for collecting the interview and video data. I then provide a summary of the research design.

5.1. Methods and Considerations for Facilitating the Study Experience

Studio tests of the final implementation of the Performer Interaction model were conducted by inviting two groups of performer-participants to improvise with an interactive autonomous music system over the period of a month. Each group was made up of three performers. One group consisted of two theatre performers and a musician and the second group consisted of three dancers. Each group of performers worked separately with the computer system, Ariel, over multiple sessions. Each session lasted between 1.5 and 2 hours and consisted of several improvisational scenes (see Figure 23). Each improvisational scene lasted 5-10 minutes. A loose structure for the progress of sessions was applied to help guide the groups in exploring their experience with the system. These structures included having both groups explore their experiences improvising scenes, as a group and as solo performers, with the Ariel system.
Each of the improvised scenes was followed by a semi-structured interview. During these interviews the performers were asked to describe their experience improvising with each other and with the system. Questions were used to guide the performers in reflecting on their experience in order to provide a thick description of the experience.

The semi-structured interviews as well as the improvisational scenes were video taped to facilitate analysis later. The interviews were transcribed for text analysis while the video data was analyzed in consultation with a movement expert (see Chapter 6). The analysis of the interview data and the video data of the interaction of the performers during the improvised scenes was compared to provide added validity for the study (see Chapter 6).

5.1.1. Selecting Performers to Work With the System

Participants were chosen to include a range of experience and training. For this study, I was interested in exploring the process for interacting of both theater and dance performers, and how the concerns of the two disciplines might change performers’ approach to interacting with the Ariel system. Furthermore, based on the results from the pilot studies I had decided to work with groups of performers working as an ensemble with the system rather than individuals working as soloists. This aspect of the research design provided the performer-participants with the experience of interacting with a
partner as well as the system, facilitating comparison and providing possibility for the system to be accepted as part of the ensemble. In this way the study focused on the performer’s processes of negotiation with in an ensemble.

5.1.1.1 Participants with Performance Training

The two performer groups were constructed independently taking into account type and levels of training, and familiarity with each other (See Table 8). The familiarity of group members with each other was considered important in facilitating the group in acting as an ensemble. The final construction of the groups also included one performer in each group who had not worked with the other two members before. Such composition of an ensemble was within the group’s professional experience, as they all had experience working with new partners in performance. The composition of the group created an environment that had a mixture of familiar and new. This structure encouraged the participants to explore their experience interacting with a known partner, where the social communication was already in place, and with an unfamiliar partner where the interactions were being developed. These experiences could then be compared to their experience interacting with the system under the two conditions, with or without the simulated breath.

<table>
<thead>
<tr>
<th>Group</th>
<th>Training in Viewpoints</th>
<th>Training in Improvisation</th>
<th>Familiarity with Interactive Technology</th>
<th>Familiarity among the Performers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group 1</strong> Dancers</td>
<td>Some exposure</td>
<td>Minimal experience</td>
<td>Some experience</td>
<td>High between two One performer new</td>
</tr>
<tr>
<td><strong>Group 2</strong> Actors</td>
<td>Extensive training</td>
<td>Extensive experience</td>
<td>Minimal experience</td>
<td>High between two One performer new</td>
</tr>
</tbody>
</table>

*Table 8. Performer Group Construction*

5.1.1.2 Keeping the Group’s Membership Consistent

The membership in the two groups was kept consistent in that all members attended all the session for that group. The two groups were also kept independent, neither group was aware of the work being done by the other group. The consistency of
the group’s members helped promote a feeling of collaboration behind the study. The consistency, including the presence of myself helped build a trust within the whole group. This approach worked towards constructing what Petitmengin describes as ‘the study becoming a container for participant’s experiences’ (see Chapter 4). The idea of the study becoming a safe container from which to examine experience was further developed by encouraging performer-participants to engage in asking questions and suggesting improvisatory explorations. A greater sense of collaboration and thereby trust was built up in the sessions, strengthening the study as a container for their experience.

5.1.2. **Criteria for the System**

The key element in the performer-system interaction being studied was the performer’s intuitive experience concerning three aspects of the system’s gesture: 1) the intuition of the system’s intention to act, 2) the intuition of the quality of system’s gestures, and 3) the intuition of the system’s focus. The system used in the study engaged in the group improvisations by generating sonic gestures as part of the scene (see Chapter 3). To facilitate the performer-system interaction, the criteria for the system required that the performer perceived the sonic gestures generated by the system as not being controlled by their own actions, that the system acts autonomously having an intention of its own.

I use the term ‘autonomous’ in discussing the system to bring attention to the system’s ability to generating its response using a combination of external and internal data. The internal component of the system’s generative processes are based on a process involving various distribution functions linked to weighted random functions (see Chapter 3). The distribution functions are either controlled by data from the environment, the performer’s actions or the internal state of the system. The weighted random process reports an integer as an indicator of the decision that is then rendered as a sonic gesture. This process acts as an internal state for the system. Including this internal state as a significant part of its generative process insures that there is an aspect of the system’s response that is not directly linked to the performer’s actions or the sensing of the environment. The disconnect provides an ‘unknowable’ element that may be addressed by the performer’s intuition.
Based on the results from the pilot studies (see Chapter 3) I decided to design the system to have a level of responsiveness to the actions of the performers. This means that the environment and the motions of the performers continue to have an influence on the generative process. To achieve this design requirement, a variety of computer vision techniques (see section 5.1.2.3) were designed into the system to allow it to sense the performance environment. The system senses several sets of external data and responded with simple mappings (see Chapter 3). This structure is designed to simulate a moving awareness while focusing attention on a given aspect of the environment such as motion or architecture.

These aspects of the system, autonomously generated material and sensing of its surrounding environment, situate the design of the system in what Rowe refers to as a Player-paradigm. However, the design of the Ariel system used in this study extends the basic concept of the Player-paradigm (see Chapter 2) by incorporating the ability to project its intention through a simulated breath. By simulating a breath, the system was designed to indicate it is preparing to act. This addition was focused on leveraging the performer’s intuition concerning the system’s upcoming sonic gesture. The initial designing and testing of this model was undertaken using a first-person method then tested during the third pilot study (see Chapter 3).

5.1.2.1 Breathing Process

At the root of the system’s simulated breath and musical gestures is a physical model of a flute. The physical model is part of the PeRColate collection of objects for Max/MSP (Trueman & DuBois, n.d.). Parameters of the physical model were manipulated to generate a discernable inhale, exhale, breath into preparing to play, and musical flute tone. The constructed breathing patterns were designed to mimic a human’s breathing at rest as well as an inhale breath when preparing to play. The ‘preparing to play’ breath or ‘preparation inhale’ was smoothly linked to the upcoming musical gesture by ramping the parameter settings from one state to the next.

Resting Breathing Pattern

The decision to include a breathing pattern for ‘resting’ was based on information from my pilot studies that suggested that the ‘resting’ breath gesture would be an
important component of the interaction and the sense of presence experienced by the performer. Comments made by participant-performers in the final study confirmed the importance of the ‘resting’ breath and are discussed in Chapter 6. The timber for the resting breath was constructed by controlling the Breath Pressure (BP), Jet Pressure (JP), White Noise (WN), and Pitch Parameters (PP) of the physical model. The BP and JP were kept at levels that did not allow the model to resonate to a dominant pitch. White noise was added to increase the airy quality of the sound. Since the model was not producing an isolated frequency, the PP provided a sense of timber more then of pitch. Basic settings for these parameters were derived to produce a timber for the inhalation and the exhalation of the breathing pattern. It should be noted that over the duration of the inhalation or the exhalation the parameters were being ramped to the next state. The envelope of these parameters became a part of the dynamic nature of the system’s breath. This model was based on preliminary (first person) tests. During the design phase and in sessions, the breath was found to provoke a sympathetic breathing response.

A key aspect of the system’s breathing pattern was the rhythm of the breath. The duration of a breath was generated using a Brownian walk coupled with data from the tempo derived for each gesture. The Brownian walk was used to provide a sense of the breath changing from one tempo to another. The tempo of the breathing could progress faster or slower in a smooth fashion. The data from the Brownian walk was combined with the system’s current tempo to model the influence of the musical tempo on the player’s breathing. In turn, the derived breath duration was used to generate a new tempo for the musical gesture creating a loop (see Figure 24). The breath duration was divided by 4 and averaged using a smoothing filter to generate the duration for the tempo. It may be noted that dividing by 4 implies a 4/4 bar with a resting breath taking one bar. Where as in some cases a breath intake may only last one beat. However, on reflection of personal experience I concluded that a single beat breath was a breath gesture used largely in situations such as conducting or other times where precise rhythmic communication is required. My experience of a relaxing breath or a preparation breath is not so restricting. Therefore dividing by 4 was used to provided a simple set calculation to connect the duration of the inhale breath and the tempo of the upcoming musical gesture/ phrase.
The breathing pattern at rest contains the final element of an intermediate hold. The hold is modeled on the slight pause naturally found between the inhalation and exhalation of a breath. For the system, this hold is a consistent 500 ms. The result is a pattern of breathing in with a given timbre and varying duration, a 500ms pause followed by an exhale with a given timbre and varying length all modeled to mimic a resting breathing pattern.

**Preparation and Playing Breath**

When the system is about to play, the *rest inhale* is converted to a *preparation inhale*. The parameter settings for the *preparation inhale*, including the duration and the timbre, are controlled by the upcoming musical gesture. The duration of the upcoming musical gesture affects the duration of the *preparation inhale* (see Figure 25). The duration of the first event in the musical phrase is used to calculate the timber of the inhalation. So if the musical phrase starts with a long note followed by quick notes the *preparation inhale* reflects that quality of the long note by sounding less 'rushed'.

---

**Figure 24. Diagram of Process for Generating Breath Duration**

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As the system starts to play the musical gesture, the parameters of the physical model are ramped from the breath state to a state for producing the flute tone. The timbre shift and duration of the ramp were linked to the duration of the first event in the phrase and the choice of articulation for the gesture. The result is that the Bite, the transition between the breath and the flute tone, changed with the duration of the upcoming note within the bounds of the articulation being used. So if the system is working with a legato articulation and is a long duration, the bite will be drawn out in comparison to a legato short duration.

5.1.2.2 Musical Decisions

While the key to the system was the link between the simulated breath and the parameters of the upcoming musical gesture, it was also important that the performer perceive the musical gestures of the system as having an intention within the improvisation. One participant commented:

"it feels like …ah… It feels musical, as in…what feels

This comment suggests that the musical gestures were at times experienced as intentions within improvisation and so the music generative engine of the Ariel system was considered to have been sufficient for this study. I discuss in the Chapter 7 factors beyond the construction of the musical gestures that contributed to this experience.
The ‘intentional’ aspect of the musical gestures was in part related to the relationship between its responsiveness in the performance environment and its inner state. The connection between the system’s musical decisions and the performance environment was provided by a computer vision system. The computer vision system tracked the change of various aspects of the performance environment and performers’ movements. Events in the environment could be used to change the weighting of probabilities concerning decisions for constructing the musical gestures through the use of distribution functions. These changing probabilities were combined with preset probabilities. The structure allowed decisions to be influenced by the performance environment while still being perceived as originating in the system. The width and combining of the distribution functions were designed to give the system an autonomous feel since the final decision, most importantly the timing of the next gesture, could not be predicted.

Rhythm Parameter

Behind all the design decisions was the concept of moving towards a point. This design element is in aspects such as the breath moving towards the note, and the gesture moving towards an end. One key concept in the design theory is the idea that a gesture has an accent event that other events act as steps either towards or away from. When focusing purely on the parameter of duration, an accent event can be understood as an event that is different in duration from the other events. This premise led me to generate rhythmic gestures based on short and long events, where either can act as the accent. By layering this structure at varying resolutions (duration of events) any number of rhythms can be produced.

The system generates the rhythmic component of the musical gesture in three stages. The length of the gesture is generated by randomly determining a preferred gesture length, influenced by elements in the performance environment (depending on the mapping being used). The preferred length is divided by the tempo to determine the number of ‘beats’ for the gesture. The actual duration of the gesture is then calculated by multiplying the number of ‘beats’ by the tempo. The calculated, actual, duration of the gesture is then used to calculate the total number of possible short events and long
events in the gesture. This is done by randomly determining the durations of what will be considered a long and a short event. This process is influenced by the sensing of the performance environment. The sensing of the environment also produces data mapped to the calculation determining the number of short and long sub-gestures, phrases that make up the whole gesture. The number of events and number of sub-gestures are compared. The lower number, events or sub-gestures, for both the short and long are used to control the distribution function for determining the number of sub-gestures in the gesture. This process allows for sub-gestures that are one event long gives preference to sub-gestures of multiple events. Each sub-gesture is divided in a similar manner to produce the duration of individual events.

Pitch Parameter

The pitch content of each gesture is generated using a similar process over three levels. The structure is modeled on Schenkerian Analysis (Forte et al., 1982). The Fundamental gesture (Ursatz) is generated by the system randomly providing a guiding plan for a series of foreground gestures. This process involves constructing a pitch set for the Fundamental gesture (a separate but related set is constructed for the other two levels). The pitch set is constructed using a combination of four elements: ‘Long set’, Accidentals, ‘Short set’, and Extensions. The Long set is the collection of pitch classes that make up the general pitch environment for the gesture such as a major scale. Accidentals are the possible/common chromatic notes in the intended environment. The Short set is the basic pitches in the main chord for the gesture or section. The Extensions are the additional pitches for the chord. Once the pitch set is constructed the system determines the number of steps in the Fundamental gesture. An algorithm is put in place to limit the number of steps to within a range relative to the current position in the instrument’s range and the density of the pitch set (sparse pitch sets are limited to fewer steps). The Fundamental gesture is generated using purely internal random processes. It provides the structure for the Midlevel and Foreground gestures that are responsive.

The Midlevel gesture is generated by first constructing a pitch set. The system also determines if the Midlevel gesture involves steps away from a pitch in the fundamental gesture or towards the pitch. When generating a gesture into the pitch
point, an algorithm is used to calculate the start pitch that will allow for the desired number of steps for the gesture. A similar process is used to generate the Foreground gestures in or out of the Midlevel pitches. A separate algorithm is run to allow for repetitions and pitches that are returned to.

All three levels are updating as the piece progresses. The Foreground gesture responds immediately to the environment through the generated rhythm providing figurations around pitches from the mid-level which in turn provides responsive figurations around the internally generated fundamental gesture. The structure allows the system to respond to the moment while still being guided by an internal plan. The method used by the system for choosing pitches and constructing rhythms was constant throughout the study. It is interesting that depending on other factors such as the existence of the preparation breath or the rules imposed on the performers, the performer’s perception of the system’s musicality, responsiveness and creativeness varied.

5.1.2.3 The Tracking System

To ensure a certain level of reciprocal action, the system was designed to respond to changes in the performance environment. The sensing of the system was designed around two paradigms: performer motion and architectural shapes (lines and curves). This approach is modeled on viewpoints, a perception based approach to teaching, practicing and analyzing movement improvisation. Switching between these two modes was one of the conditions explored in the study.

One mode of the tracking system sensed the number of lines and curves in the environment. The system returned statistical information such as the number of straight lines in the environment (on the floor, around doors, in folds of drapes or dancer’s bodies), angle of each line, the length of each line, the average length, the longest length, and the shortest length. To provide variation in this data, the system was given a narrow ‘view’ by analyzing only a portion of the full video screen. The portion of the screen being analyzed moved randomly around the screen using a Brownian walk (see Figure 26).
The second mode enabled the system responding to movements of the dancers in the performance space. However, the system did not distinguish between two the dancers, instead the system tracked any moving point in the camera view. It reported the number of moving points, the direction motion for each point, the speed of each point, and a general direction of motion in the space. This data was further analyzed to report the duration of all motion, duration of still moments, and duration between direction changes.

Figure 26. Screen shot of the Ariel system’s tracking process. Showing is the detection of lines in the system’s area of attention (left) as well as the amount and direction of the motion (right).
5.2. Facilitating Group’s Attention to All Dimensions of Their Experience

The study required that each group of performer-participants experience improvising with the system and describing their experience. As discussed in Chapter 4, there are possible issues in relying on participants to provide articulate descriptions of their experience. Once the participants had been selected and the system constructed, the protocol for the study was designed to address these issues with two procedural choices: 1) improvisation sessions were designed to guide the performer’s attention to various dimensions of their experience, and 2) semi-structured interviews were conducted to facilitate the performer in articulating their experience.

5.2.1. Focusing Performer-Participant’s Attention to Dimensions of Their Experience

The process for focusing the performer-participant’s attention on different dimensions of the experience was approached using two methods 1) designing the system to operate in various modes facilitating the performer’s comparison of
experience, and 2) providing tasks for the improvisational scene to guide performer-participants away from their habitual approach to a situation such as performing with technology or media.

5.2.1.1 Conditions Designed into the System Facilitate Attention to Experience

The breathing and attention models designed in to the Ariel system were an exploration of developing a interactive system for performance that considered social cues and the projecting of intention as part of the interaction with the performers. The research design for testing the effectiveness of these models focused on providing the performer-participants with experiences that encouraged reflection and comparison among various instantiations of the models. For this reason the Ariel system was designed to be able to switch between different modes of interaction, incorporating combinations of elements from the models being tested. In this way the study could explore how the models were affecting the experience of the performer-participants and possible links of individual aspects of the models on their sense of intuition.

While intuition encompasses a wide area of experience, the study focuses on the performers’ intuitive experience concerning three aspects of the system’s gestures: 1) the intuition of the system’s intention to act, 2) the intuition of the quality of the system’s gestures, and 3) the intuition of the system’s focus. These three phases provided a macro structure for guiding the study.
All three phases were explored using two basic conditions: 1) the system not providing any simulated physical cue such as breath or attention, and 2) the Ariel system providing a simulated physical cue. The simulated cue was always modeled to imply a relationship to the upcoming cue (see section 5.1.2.1). However, during the study some further adaptations on elements of the cues such as volume and consistency of the breath were introduced creating variations that could be reflected on and explored. This structure of varying the system’s manner of projecting its intention was the prime focus of the study.

The Ariel system was also designed with two paradigms for sensing its environment: 1) sensing parameters of the performer’s movement, 2) sensing shapes,
lines and curves, in the performance environment. The system was kept in one of these two modes throughout the study, so it was always responsive to either the performer’s movements or the performance environment. The switching between these sensing modes was independent of the breathing behaviour of the system. In this way it was possible to explore the effect of using the simulated breath for the projecting of cues concerning the system’s intention in either sensing mode, motion or shape.

**Breathing Behaviour**

In the case of the breathing behaviour, the two basic conditions were 1) the system providing a preparation breath, and 2) the system providing no simulated breath. During the pilot studies, two variations on these conditions were identified and worked into the session protocol: 1) the simulated breath volume, and 2) the presence of a resting breath. As a result, the study explored 5 variations of the basic two conditions (see Table 9).

<table>
<thead>
<tr>
<th>Presenting a Simulated Breath</th>
<th>Simulated Preparation Breath with Resting Breath</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Simulated preparation breath no resting breath</td>
</tr>
<tr>
<td></td>
<td>Simulated preparation breath no resting breath at lower volume</td>
</tr>
<tr>
<td>No Simulated Breath</td>
<td>System with out breath</td>
</tr>
<tr>
<td></td>
<td>No system at all</td>
</tr>
</tbody>
</table>

*Table 9. Behaviour modes designed into the system for use as conditions in the study*

During the sessions, the system mode was continually switched between the first four of these conditions so as to always provide a comparison even while the performer-participants became comfortable with the system and the study as a whole (see Table 10). The condition was at times switch with out informing the performer-participants and at other times with informing them of the change. By not informing the performer-participants, they were able to reflect on the experience with out judgment or expectations. While by informing them they could place their attention on the change and sensitize their awareness to more nuanced aspects of their interactions. A third unexpected result of this structure was that performers at times thought the system was in one mode while it was in fact in another. At these times their assumptions and expectations were made even more apparent.
Both groups also found it useful to improvise a few scenes in which the system was not involved. These improvised scenes provided comparison for discussion around interaction only with human performers and served to bring awareness to prejudices and expectations – real and imagined.

<table>
<thead>
<tr>
<th>Scene</th>
<th><strong>Group 1</strong></th>
<th><strong>Group 2</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Modes</td>
<td>Modes</td>
</tr>
<tr>
<td>1</td>
<td>Open/w breath</td>
<td>Open/w breath</td>
</tr>
<tr>
<td>2</td>
<td>Constructing duets/w breath</td>
<td>Open /No breath</td>
</tr>
<tr>
<td>3</td>
<td>Constructing duets/w breath</td>
<td>Open/no breath</td>
</tr>
<tr>
<td>4</td>
<td>Trading solos/w breath</td>
<td>Open with breath</td>
</tr>
<tr>
<td>5</td>
<td>Trading solos/w breath</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Trading solos/NO breath</td>
<td>With breath/solos</td>
</tr>
<tr>
<td>7</td>
<td>Trading solos/NO breath</td>
<td>No system</td>
</tr>
<tr>
<td>8</td>
<td>WITH breath</td>
<td>Resting is soft</td>
</tr>
<tr>
<td>9</td>
<td>NO SYSTEM – passing motion</td>
<td>Passing with breath</td>
</tr>
<tr>
<td>10</td>
<td>NO SYTEM passing motion</td>
<td>Passing without breath</td>
</tr>
<tr>
<td>11</td>
<td>WITH breath passing motion</td>
<td>Passing with breath</td>
</tr>
<tr>
<td>12</td>
<td>just prep breath</td>
<td>Resting breath soft</td>
</tr>
<tr>
<td>13</td>
<td>just prep breath</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>just prep breath</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>No Breath</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>(skipped)</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>WITH breath – open</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Breath - architecture</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Breath - architecture</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>With breath – response to motion</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>No breath</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Breath – volume down</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>W breath – moving into sound</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>W breath – moving into sound</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>full breath? soft</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Passing motion with prep-breath</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>full breath</td>
<td></td>
</tr>
</tbody>
</table>

Table 10. Table of Session Progression
Attention

There was an optional mode for the behaviour of the system shifting the mapping of the system’s response to elements in the environment rather than movements of the performers. This remapping still accessed the same breathing modes and will be discussed separately. This mode of the system presenting its intention was only briefly explored since all the performers had a very strong reaction of disconnection with the system regardless of the breathing behaviour. In order to keep the performer-participants engaged in the session and the study in general I decided leave the full exploration of this mode to a future study.

5.2.1.2 Guiding Performer’s Attention to their Experience Through Applying Tasks in Improvisational Scenes

Tasks Based on Exercises from Viewpoints Training

Although the performer-participants involved in this study had training that facilitated their attending to their experience during the improvisational scenes, I developed ‘tasks’ for the interactions that would encourage certain approaches as to how they would interact with each other and with the system. These task have been developed out of exercises used in Viewpoints training for developing attention in ensembles.

Two main tasks were used throughout the study: 1) ‘one-up-one-down, and 2) solo/accompaniment. One-up-one-down was a simple game of having only one ‘agent, performer or system, gesturing at a time. This meant that the performers needed to be aware of the intention to act by either their partners of the system. They also had the opportunity to become aware of how they projected that they wanted to act. Solo/accompaniment was simply having the ensemble focus on letting on agent, including the system, have a solo and to have the solo position move through the ensemble throughout the improvisation. By reminding performer-participants to focus on attempting to move ‘one at a time’ or drawing their attention to moving from soloist to supporting role encouraged them to engage with the whole environment including the media a new.
Specific tasks were given for the improvisation more often then using open improvisation (see Table 11) even though the open improvisation could be seen as more true to the situation being researched. One participant spoke to this structure with her comment that the system was more enjoyable to work with in the tasks then in open improvisation. In context to other comments made during the study, this comment seems to illustrate that, though a certain level of connection with the system was afforded by the breath, the system response was still often experienced as limited in its ability to develop and be emergent.

<table>
<thead>
<tr>
<th>System Modes</th>
<th>Open Improvisation</th>
<th>One moving at a time (focus on quality of motion)</th>
<th>Solo/duet performer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No System Involved</td>
<td></td>
<td>[9, 10] {7a, 7b}</td>
<td></td>
</tr>
<tr>
<td>No Breath</td>
<td>{2}</td>
<td>[7, 15, 21] {10}</td>
<td>[6]</td>
</tr>
<tr>
<td>Breath only in prep</td>
<td></td>
<td>{(12, 13, 14, 26)} {5}</td>
<td></td>
</tr>
<tr>
<td>Full breath</td>
<td>{1, 2, 16, 17} {1, 4, }</td>
<td>[8, 11, 20]</td>
<td>{(3, 4, 5)} {6a, 6h}</td>
</tr>
<tr>
<td>Resting breath soft volume</td>
<td></td>
<td>[22, 23] {8, 11,12}</td>
<td></td>
</tr>
<tr>
<td>Full breath soft volume</td>
<td></td>
<td>[25, 27] {9, 9b}</td>
<td></td>
</tr>
<tr>
<td>Response to architecture</td>
<td></td>
<td>[18, 19] {13}</td>
<td></td>
</tr>
</tbody>
</table>

*Table 11. Chart of tasks performed for each improvisational scene. Numbers refer to the scene sequential scene number.*

Consistency Between Studies

The protocol for the study had each group work with the system over multiple sessions over the course of a month. Each session contained several improvisational scenes, and each scene was followed by a semi-structured interview concerning the experience. The sessions were designed with a loose structure that reflected the three stages of the study. The loose structure allowed for the groups to discover the three elements of intuition, intuition of intent, intuition of quality, and intuition of attention that
were at the heart of the study. However, to provide some consistency between the groups, the structure enabled me to use questions to the group or tasks given for the improvisations to guide their attention. Also in the interest of consistency between groups, the first improvisation for each group was open improvisation (no explicit task given). Performers were instructed to improvise freely with each other and the system with no explicit limitations. The system performed in its full breath mode responding to the quality of motion (speed direction timing) of the performers. This protocol for the opening improvisational scene allowed the participants to get acquainted with each other, the space and the system providing a baseline for the rest of the sessions.

**Modifying Sessions to Reflect the Interests and Discoveries of the Group**

After the first improvisational scene, the semi-structured design of the sessions allowed for the interests and discoveries of the group to influence how they progressed through the study. In designing the study, topics for discussion were identified and organized to progress through the three stages of the study. Although this loosely designed structure guided the overarching direction that the groups would take through the study, issues, ideas and awareness that came up during the interview/discussions were at times used to augment the pre-scripted trajectory of the sessions. The influence of the previous improvisational scenes could take the form of observations made by myself or comments made directly by the performer-participants. For example:

G: *lets do a shorter one, same setup to start but this time really think about trying to make duets… and so the 3rd person try to be aware of the duet and find a supporting outside role so the duet can come forward. We'll do that for a couple of minutes. [−1.39]*

In this example I perceived the performers to be working individually even though the whole group was improvising together. To fully explore if this observation was their experience, I encouraged them to interact more by giving them a task to make duets. This task was chosen to foster dependences between the performers, to bring awareness of their interdependencies to the performer, and to start the conversation of their dependence on the system.
I also used this technique of perception/observation to judge when to guide the group to explore experiences repeatedly or to progress through the phases of the research. For example:

G: The idea that just came up, that the breath is almost ...too relaxing to go into the next (gesture) ...there also seems to be a little bit of a conversation of it preparing you for what is coming up... it also relaxes you so there is this push pull that is coming out of the breath. How loud the breath is I have worked on my self but haven’t really worked on with other people. ... I am interested in doing is just letting you play for a little bit and we will change the volume of what the inhale breath is. [--.21.28]

This second example demonstrates how I could bring attention to the group’s ‘discovering’ of an issue. In this case the group has been discussing qualities of the breath that are having an affect on them. I offer possibility of changing the volume of the breath since they are still thinking of the system as set and not really able to imagine changing aspects of it. The exploration of the breath volume was planned in the study design. What the example shows it is being worked into the session at this point because the group’s own discussion had lead them it.
5.3. Facilitating Thick Description

As identified by Petitmengin and Varela, participants can have trouble articulating their experience. The selected participants had training in performance, which provided a certain facility for reflecting on their experience and a base vocabulary for discussing their movements and interactions in a performance space. Despite the performance training of the participants, three general precepts needed to be addressed: 1) participants with a similar experience may not describe it with the same language, 2) participants may not be aware of or have attention on the same aspects of an experience as another participant (due to previous training, experience etc. – trained vs. students), and 3) participant may not be aware of the depth of variety of dimensions from which they may explore their experience. As was discussed in Chapter 4, the interview technique used, Interviewing for Performer Experience, facilitate performer-participants in providing a thick description of their experience by addressing these issues.

5.3.1. Constructing a Container that Builds Trust

The general overarching structure for each group in the study was to start the first session with a short discussion of the research and the procedure that would follow,
including discussing how question would be used to encourage them to thoroughly reflect on their experience. This discussion served two purposes: 1) to inform the performer-participants what to expect, and 2) to encourage them to approach the sessions as collaborators. This second purpose is perhaps the more important. It is through developing a rapport with the performer-participants, letting them know that their ideas, interests, comments and concerns would be acknowledged, that the trust is created so that the sessions can act as a container for their experience and encourage deep exploration. The trust was continually cultivated during the study through acts of listening and showing flexibility in the structure and questioning.

5.3.2. Questions Facilitating Reflection

After the first discussion, the session continued with the group engaging in a series of improvisational scenes. In this way each session containing several scenes (see Figure 23). Each scene was followed by semi-structured interviews employing questions phrased to encourage the performers to reflect upon and attempt to relive their experience using language first introduced by the participant. For example:

G: so less flute…when you put yourself back into the experience, how are you experiencing the flute? [2.2.3]

A: (looks at the floor for a while)… it felt like more background to me this time…like …it was more like a track of music playing.. like it felt more….ya…. (still looking away) . but it…but it felt like it gave more space for us.[2.2.4]

In this example, the participant had made a comment of there being “less flute”. The question by G, myself, encourages the performer to ‘re-experience’ the moment. The performer’s act of looking at the floor helps indicate that they are concentrating on putting themselves back in the moment of experiencing, what is often termed re-experiencing or re-living. In other cases the performers would move, in part or in full, while describing an experience. They would often look away either to a neutral spot or a spot on the floor they associate with the experience. All these gestures were noted as indicators that the comment was based on a description while re-living the experience.
5.3.2.1 How Questions

Within the semi-structured interviews with the group, consideration was also given to the wording of questions so as to facilitate the performer’s focusing on describing their process of experiencing. The wording of the questions focused on following Petitmengin’s technique for focusing the participant’s attention on the ‘how’ instead of the ‘what’ of the experience (see Chapter 4). This technique of wording questions concentrates on phrasing questions as “how...”. The technique helps the performer-participant articulate a thick description of their experience and avoid their assumptions or beliefs. For example, in the above example the participant A is asked ‘how’ she is experiencing the flute. Her response begins with her looking at the floor, a physical indicator that she is likely re-living her experience in order to articulate it. She continues the physical indicator while comparing her experience to a ‘backing track’ and having space, giving a concrete example of how the experience is sensed. In the following example the ‘how’ question is used as a follow up question to get a clearer description from the performer-participant.

| M: 7.7 I felt like when I went against the music that I had more intention in my movements than with the silence because with the silence you don’t necessarily know when its coming again but with the silence its propelling you rather than being still its ... (fades off) |
| G: 7.8 so your intention - how do you know you’re moving with more intention? |
| M: 7.9 when you think but you don’t have to think hard about it because you know exactly where... you want to go - the direction. Like when I was moving in the silence I felt like I knew where I wanted to go and I went to go there. |

In this example the researcher uses the question “how do you know...” to get the performer to expand on their idea of ‘intention’ they brought up in their first statement. In response to the my, G’s, question, the performer starts trying to explain their thoughts but ends off with a description of their experience of making the decision. By phrasing the question as “how do you...” the performer-participant is encouraged to reflect on and describe their cognitive process. While reflecting, the participant often moves as well. This is illustrated in the example:
In this example the performer again tries to describe their cognitive process. Her attempt to demonstrate as she is talking indicates her *re-living* of the experience. This is also shown in how she starts a comment then corrects herself saying “but I wasn’t aware of that...” and ends with the description that implies she noticed, “someone else was doing it”. As Petitmengin (2006) points out, pauses and actions while speaking, such as M's, suggests participants are reflecting with unusual attention to all the influences on their decision making process in the moment.

### 5.3.3. Forming Questions for the Group

As the form of the questions was intended to facilitate the performers in reflecting critically on how they chose to describe their experience, the discussions were done as a group allowing the group to check each other and comment on or contradict each other. Three different effect of this structure can be seen in the discussions.

In this example performers S and M are able to remind each other of moments they shared, facilitating the *re-living* of the experience. Performers were also encouraged by others to reflect in a similar way but reference details and differences that make their experience their own.
A: this time I felt I was more in my head. I though it might happen because it was the second time in and now that I'm settling in... I can.... I'm starting to be more... you can think about things more rather then responding to the immediacy...but I did feel like I was more in my head... and when I was interacting with it felt more...intellectual then emotional [2.2.19]

G: do you have any comments [2.2.20]

H: I don't know if I felt as much of a contrast. I think I was a...consciously trying to let the architecture give a bit more vocabulary in order to have something to funnel the response to the movements through...so a...so I was a little less ahhh... visually focused on A or C then the first time...I think is a good thing for me in terms of being more spontaneous in my impulse to changes. So I felt like I was a bit more warmed up impulse wise ...and...but I did feel the presence of the flute was a little muted. And I wasn't sure if that was if my attention had shifted slightly or... ya I didn't hear as many big inhales so I wasn't as a... I wasn't consciously tracking when is the next one coming. Oh there's one let's go. I was ...I was... responding more a little bit in the moment so there wasn't as much of a sense of anticipation. [2.2.21]

This example illustrates how performer-participants would contradict or provide new information that separated their experience from the others in the group. Performer A is comparing the last two improvisational scenes. Performer H starts her comment as a comparison but brings in details, such as visual focus and the flute's presence being muted, which gives information of 'how' the comparison is experienced. In some cases the differences among the performers could be quite extreme. For example:

G: how was that? [2.12.1]

H: I didn't hear the breath [2.12.2]

G: – I wasn’t sure if I did behind the speakers [2.12.3]

H: I didn't consciously [2.12.4]

A: I could hear it a tiny bit [2.12.5]

G: and how was that were you responding to that [2.12.6]

A: ya it made me realize that I liked a bit of indication. It is how Ariel indicates that a start is coming and I appreciate that. [2.12.7]

G: So you know Ariel is about to do some thing and... give it room [2.12.8]

A: ya it is a cue and we take cues off of each other. I like that [2.12.9]

However, even in these extreme cases the performer-participants did not seem influenced to deny any aspect of their experience that did not fit in with the experience of others. In the above example performer H did not experience hearing the breath where as performer A heard the breath and found it a quite strong experience and was able to describe it in contrast to H's experience.
Still, even though the protocol of interviewing the performers as a group had the effect of allowing the performers to contrast their experiences, more often the performers had similar experiences and the effect of the protocol was to facilitate performer’s to expand on each other’s comments adding detail to the overall description. For example

| H 2.1.12 | but there is all so just the physical feeling of moving and the pleasure of exploring physical impulse stretching and ahm….ahh. responding to somebody else’s vocabulary. |
| A 2.1.13 | those moments that you describe… the extremes and that click, that feels like an emotional satisfaction for me |
| G: 2.1.14 | when you point to the chest. How are you feeling that? |
| A: 2.1.15 | it is reminding me of when I use to smoke. It is that kind of “hahhc of getting” felling of satisfaction exactly what you need. I don’t know if that is over the top. |
| G: 2.1.16 | so you are saying that it is a physical sensation |
| A: 2.1.17 | (confused look on her face looks away)… I guess it is both emotional and physical |
| H: 2.1.18 | ya I would say it is both too. Physical and emotional and kind of intellectual |
| G: 2.1.19 | intellectual |
| H: 2.1.20 | intellectual seems disengaged in some way but it’s more…about recognition. Like there is the satisfaction of the feeling of it and a second later, recognition that that feeling was a thing |

Performers often used comments made by each other to help them find words to describe their experience. In the above example, performer H describes the connection between an impulse and the physical feeling of responding. From this performer A describes her experience as emotional and physical. From this performer H adds the concept of intellectual, which provides a departure point for both performers to further refine what was meant by emotional and physical. Although there might be some aspect of the performers leading each other their comments were still showing the body signs discussed earlier (looking away, subtle body movements) that suggest a description of an experience.

5.4. Summary of the Research Design

The methods used to enact the Methodology outlined in Chapter 4 focused on ensuring the study addressed the issues in doing research in experience as identified by Petitmengin and Varela (see Chapter 4). By selecting performer-participants with
performer training the issue of participants being able to reflect and articulate their experience is partially addressed. However, to ensure a full reflective thick description, techniques for interviewing were also put in place. To provide an environment that could offer the experience of interest for the study, the Ariel system was designed using a first-person experience design process and testing the final design with participants in a pilot study. Still, to facilitate the performer-participants in the final study to experience the behaviour of the system while having a fresh comparison of interacting with a more traditional system and with humans, protocol for the sessions included changing the behaviour of the system and even at times leaving it out of the improvisation all together. Finally, the improve sessions were followed directly by semi-structured interviews. By interviewing directly after the improvisational scene, the experience was kept fresh, but more importantly it allowed issues that came up to be investigated by the group in the next improvisation. This structure added to the trust and collaborative relationship between myself (the researcher) and the performer-participants. Also key in the interview protocol was the technique for phrasing questions. The technique of phrasing questions as “how…” helps participants to move from representational to descriptive, in other words moving from describing what the experience was to how they were experiencing it. This shift helps participants avoid reciting their beliefs and assumptions that they have been ‘taught’ about how interaction works and describe their experience interacting. Finally the interview protocol included the whole group, acknowledging that the group has shared in the experience and that the other performer-participants are able to help each other re-live and articulate their individual experiences. Through this procedure the comments collected were considered to reflect the performer’s experience. The analysis of the comments is discussed in Chapter 6.
6. Constructing a General Model of the Effect of the Ariel System’s Simulated Breath on the Performer’s Experience

6.1. Overview Statement

Through the process of analysis presented in this chapter, I have constructed a ‘General Model’ of the simulated breath’s affect on the performer’s experience interacting with an autonomous music generative system. This model suggests that a performer’s connection and understanding of the sonic gesture generated by an autonomous music system is improved by leveraging the performer’s perception of the system’s process for preparing to act, its intention. The study has been designed to isolate elements that have contributed to the construction of this claim. First, the research design for the study ensured that the process used for generating musical/sonic gestures remained constant throughout the study. Since the consistency in the music/sonic generation engine was kept consistent any change in the performer-participant’s interaction with the system or perception of the musical gestures can be
attributed to the changing variable, the addition of the simulated breath. Second, the research design incorporated repeatedly alternating between the system presenting a simulated breath and not. The switching between the conditions in the study provided the performer-participants an environment where they could compare their experience of interacting with a system presenting or not presenting its intention through a simulated breath.

By keeping the generative engine for the sonic gestures consistent and by repeatedly switching between the conditions involving the simulated breath, the research design focused the performer-participant’s attention of their experience on the effects that could be attributed to the simulated breath. Through an analysis of the performer-participant’s comments, a general model was constructed illustrating how the performer’s interaction with the Ariel system is affected by the incorporating of a simulated breath (see Figure 31). Construction of the model has followed the procedures outlined in Chapter 4. The 4 components shown in the model: Pre-Improvisation Knowledge, Reflection, New Knowledge, and Test, outline a temporal element to the performer’s experience. The model outlines how previously held knowledge is reflected upon during the improvisation as part of the interaction creating new knowledge that is then tested and reflected upon. Through outlining this process, the model presents a structure for describing how the leveraging of the performer’s ability to perceive the intention of the system is evident on three levels: 1) perceiving the system’s intention to act (see section 6.3.1), 2) perceiving the quality of the system’s intended gesture (see section 6.3.2), and 3) increasing awareness of the intentions within the group including the system (see section 6.3.3) as indicated by markers in Figure 31.
6.1.1. **Micro and Macro-actions as key concepts in understanding Interaction**

Key to the constructed General Model is the understanding that the performer perceives the simulated breath as both a macro and micro action. Here the terms micro and macro refer to the prevalence of the action in the perception of others and the relationship of the action to the perceived overall action. I use the term *macro-actions* to refer to large actions undertaken with conscious intentionality while *micro-actions* refer to small actions made and actions performed with little awareness or conscious intention. For example a *macro-action* of remaining still and relaxing may contain a *micro-action* of
small downwards motions in one’s shoulder. Micro-actions are also involved in preparing to act such as the small motions in one’s chest and neck when getting ready to speak (Behnke, 1997).

The concept of micro-actions overlaps various concepts of motion found in performance literature. For example the concept of minimal movement used in discussing ‘small dance’ as part of contact improvisation (Pallant, 2006) and in the somatic practice of Alexander Technique in discussing the small habitual movements that are part of general body use (Bouchard & Wright, 1997). Furthermore, the concept of intentional and unintentional actions discussed by Jeff Wirth (1994), has special significance to my application of the concept of micro-actions. In describing unintended actions, Wirth uses the example of an actor interacting with an audience member in an interactive improvisational scene. He suggests that by responding to the audience member’s unintended action such as yawning, or crossing arms, the actor can develop a strong connection with an audience member. The example illustrates that as with the micro movements, the unintended movements are often the small movements enacted when the audience member believes they are ‘doing nothing’, when they are being present in the space.

The general model references the concept of micro and macro to help illustrates how the simulated breath transcends the role of audio cue of the onset of the next gesture and takes on the role of an embodied connection with the ensemble, the third level illustrated by the model. The explanation considers breath as an unintended action or micro-action undertaken without conscious awareness in preparation to act. The breath is perceivable by partners outside of the performative act and so provides information concerning the presence and intention of the performer (Pallant, 2006).
6.2. Outline of Analysis Procedure

The basic structure for the analysis, as discussed in Chapter 4, is drawn from Petitmengin’s procedure. Table 12 illustrates the changes to Petitmengin’s procedure that I have implemented. These changes focus on the processes to construct the synchronic and diachronic models. Petitmengin’s method for constructing these models focuses on separating or categorizing comments in order to construct an abstracted theme or label. This process is similar to the ‘open coding’ from Grounded Theory in which similar data is grouped and conceptually labelled with categories and properties/dimensions that emerge through the process (Walker, 2006). Grounded theory offers an extension in the form of axial coding in which the themes are linked and reorganized. The elements or dimensions of the themes identified in the open coding are given multiple relationships in a process referred to as axial coding (Gasson, 2004; Glaser, 1967; Scott & Howell, 2008). By applying the process use in Grounded Theory, I have extended Petitmengin’s method of Explication by considering the video data to triangulate the interview data. However, these adaptations remain consistent to the principle of her techniques.
The incorporation of a grounded theory approach allowed the analysis process to emerge and address new questions that became apparent in data throughout the process. The resulting structure for the analysis involved a series of processes. Themes for coding emerged throughout the entire process (see Figure 33). Each subsequent process of analysis was designed to test, verify and provide further refinement on findings proposed through earlier processes.

The series of processes included transcribing the data, doing an initial close read of interview data, doing a second close read of the data including the video data, associating statements of similar topics, identifying cross links between topics, identify the process implied by themes/maps, and finding relationships for the construction of a model. The series of procedures is mapped out in Figure 33. In the Figure, rectangular fields indicate an analysis process while oval fields indicate new understandings of the

### Table 12. The development of a the analysis process from Petitmengin’s process

<table>
<thead>
<tr>
<th>Petitmengin’s Process</th>
<th>Process For This Study</th>
<th>Description of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not discussed</td>
<td>Close Reading</td>
<td>Provides preliminary understanding</td>
</tr>
<tr>
<td>Separation of statements</td>
<td>Separation of Statements</td>
<td>Addresses complexity of the phenomena of interaction during improvisation</td>
</tr>
<tr>
<td></td>
<td>Beliefs</td>
<td></td>
</tr>
<tr>
<td>Synchronic model</td>
<td>Map of performer’s knowledge</td>
<td>Process of axial coding used to construct two synchronic models</td>
</tr>
<tr>
<td></td>
<td>Synchronic Model of Performer’s prioritizing of their Environment</td>
<td></td>
</tr>
<tr>
<td>Diachronic model</td>
<td>Diachronic model of “Performer’s Process for constructing new knowledge”</td>
<td></td>
</tr>
<tr>
<td>General model</td>
<td>General model</td>
<td></td>
</tr>
</tbody>
</table>
data. Diamond shaped fields (added later in the chapter) indicate resulting findings addressing initial research questions.

**Figure 33. Progression of Analysis Process in General**

Successive processes in the analysis lead to new manifestations of the data providing new understanding and suggesting a further process to continue the analysis. The iterative and emergent nature is consistent with the general approach to analysis practiced in grounded theory. The processes used in each stage of the analysis, while based on methods used in phenomenological and grounded theory research, emerged in response to the data collected and findings observed during the analysis. Each emerging stage produced a new document or arrangement of the data implying a new understanding of the data and the phenomena. As the analysis progressed all data sources, such as the video data, were combined to check the validity of findings as clusters of significance observations slowly built up an understanding of the phenomena.
6.3. Findings as Produced by the Developed Procedures

The general model has been constructed through the process of analysis of the interview and video data collected throughout the study. The model illustrates in the ‘Reflection’ section how perception of the simulated breath is related to actions of the system and affects the perception of actions in the group (Figure 35, marker 3). The simulated breath effect on the performer’s experience can be placed into three categories. First, that the simulated breath is perceived as a cue to the start of Ariel’s next sonic gesture. The performer’s perceives the breath cue both rationally and as a feeling in their body, as an embodied knowledge/intuition to the intention of the Ariel system. Second, the performer perceives a correlation between the quality of the breath and the quality of the subsequent sonic gesture. As a result of this perception, the performer experiences an increased ability to work with the complex sonic gestures presented by the Ariel system. Third, that the simulated breath affects the performer’s understanding and connection with the ensemble, including the inclusion of the system as part of the ensemble. These three categories are uncovered in turn through the
analysis process. Each stage in the process supports the next and in turn adds validity to the earlier claim (See Table 13).

<table>
<thead>
<tr>
<th>Levels in Experience Model</th>
<th>Related Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Affordance of simulated breath</strong></td>
<td>Related Observations</td>
</tr>
<tr>
<td>Perceived as a cue</td>
<td>Responding rational</td>
</tr>
<tr>
<td></td>
<td>Responding embodied/ feeling</td>
</tr>
<tr>
<td>Coordinating with quality of action</td>
<td>Increased ability to connect with new complex material</td>
</tr>
<tr>
<td>Understanding and connecting with others</td>
<td>Attention to presence and expectations</td>
</tr>
</tbody>
</table>

*Table 13. Three Elements in the Performer-System Being Explored*
6.3.1. **The Simulated Breath Being Perceived as a Cue to the System’s Intentions**

The Simulated Breath Being Perceived as a Cue to the System’s Intentions

Figure 35. General Model of Simulated Breath Affect on Performer Experience

The first level of the experience model presents the foundation of the findings in this study, that the simulated breath designed in to the Ariel system was perceived as a cue to the intent of Ariel to enact a sonic gesture during the improvisation (see Figure 35). This foundational claim is continually supported by the analysis of the data but is first suggested in the findings developed out of close reading of the interview data, and validated through triangulation with the video data. The Study’s findings suggest further that the simulated breath is perceived as an embodied cue. Here I use the term embodied to highlight that the information is perceived by the performer-participants as a

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6 I use the term *intent* here knowing there is an implication of the system being perceived as an agent. This aspect will be discussed later.
feeling of knowing even when the rational knowing is not reported. This finding derives from the analysis through a close read of the interview data. The issues of Trust, Synchronicity and Collaboration discussed and identified in the literature as important to performer-performer interaction (Lockford & Pelias, 2004; Pallant, 2006), provided “topic guide” (Gasson, 2004) for doing a first critical or ‘close’ read of the interview transcripts.

6.3.1.1 First Close Reading - Interview Transcription

On an initial close read, the tone of the comments made by the participants agreed directly with my initial premise, that anticipation is an important part of performer-performer interaction, and that leveraging this type of interaction in the design of a media agent affects the experience including the trust the performers have with the system. This aspect of interaction was made apparent when performer-participants were guided to compare between two of their interactions with the system without being made aware of the change in the breathing behaviour of the Ariel system. As an example here are comments made by two performer-participants:

M: it feels… mmm… Understandable. You know why there was this silence… well not silence but this really soft (she pushes with her hand) you know…. You know…

G: and what did you find

S: - I find it was easier to expect. Although it was still really fast and sporadic at least you get a sense of ‘ it’s coming it’s coming it’s coming”

In this example performer M’s comments that it feels “understandable” and that she “knew why there was silence” suggesting that there is some empathy between herself and the system. This empathy and understanding can be understood as being related to trust since she relates it to knowing why there is silence. But her knowing is not her understanding of the system’s mechanics. Her reference to “it feels” as well as her hesitation and pushing of hands suggests that she knows by feeling in her body that

7 Topic guide is a stage of analysis in grounded theory where the initial research questions provides the basis for starting the process of open coding.
the system needs to breathe. Similarly performer S uses the term “sense” to describe how she knows the system’s gesture is coming. These comments are examples of how performers described their experience of trust with the system.

The process of close reading identified many comments made by participants that the simulated breath was being perceived as a cue to the system’s intention. How such comments were identified is demonstrated using a comment by performer A.

<table>
<thead>
<tr>
<th>A: I could hear it a tiny bit [2.12.5]</th>
</tr>
</thead>
<tbody>
<tr>
<td>G: and how did you know that were you responding to that [2.12.6]</td>
</tr>
<tr>
<td>A: ya it made me realize that I liked a bit of indication. It is how Ariel indicates that a start is coming and I appreciate that. [2.12.7]</td>
</tr>
<tr>
<td>G: So you know Ariel is about to do some thing and…give it room [2.12.8]</td>
</tr>
<tr>
<td>A: ya it is a cue and we take cues off of each other. I like that [2.12.9]</td>
</tr>
</tbody>
</table>

Here performer A has made a connection between how the system is providing her a “cue” to its intention in a similar manner as she is use to receiving from other performers.

The close reading process of the entire text from the interviews resulted in evidence that the performer-participants are experiencing the simulated breath as a cue to Ariel’s next sonic gesture, and suggests that this cue is experienced through their body knowledge of feeling. Furthermore, the text points to a connection between trust, empathy, and the ability to expect based on a cue. Through the repeated reference to “sense”, “understanding”, “feeling”, “knowing with body” and even comparisons made to human partners the performer-participants use of language speaks to the embodied nature of the performer-participant’s experience of the simulated breath.

Through the process of close reading, comments made by the performer-participants pointed to an element of intuition being leveraged by the design of the
simulated breath. Based on this observation I generated an initial finding towards a General Model of the performer’s experience. I have stated this finding as:

1) A simulated breath can be designed into an autonomous generative music system so as to be perceived by performers as a cue to the system’s intention, leveraging social interaction between performers.

However, the analysis does not provide an understanding of how the simulated breath is being perceived so as to act as a cue. Questions still remain concerning what parameters of the sound or situation are at play or what limitations exist. For this reason, alternate processes for further analysis of the data were developed.

It is also important to note that the close read of the data also presented comments by the participants that contradict this first proposed finding. These comments were analyzed and considered in a similar way as above. For example, during one of the improvisation scenes, a performer commented on her experience saying:

H (with breath): “ya because it felt quite unknown for me how long Ariel was going to go for when it was going to come in. I didn’t want a sense of nobody being frozen for too long so…so I wanted to pass the impulse on to somebody else…like if I was the first one to go I wanted to make sure I didn’t just go….”[2.9.35]

H’s reference to when Ariel (the system) was going to come in seems to directly contradict the comments made by performers A, S, and M. This contradiction suggested that more analysis needed to be done to understand how H’s experience could come from the same phenomena as A’s, M’s, S’s and not be explained as just a subjective preference. One clue is in her concern for “nobody being frozen too long”. The reference to “too long” suggests a concern or a concern for a larger time scale then the earlier comments of “coming in” suggesting an immediate time scale.

Contradiction among the comments suggested there is more to the experience then simply perceiving or not perceiving the breath as a cue. For example:
S (no breath): I think so - but there was more freedom than with breath. Breathing forces you to shape but in silence you can do anything. I feel like you can do really big movements as well as small ones…I don’t know…. there was one moment at the beginning that it was silent and none of us were moving and I thought that was really really cool…and K started doing small movements, so ok, we can do small movements, but there was more freedom, I don’t feel that there was more pressure.

[1.6.23]

G: freedom in the silence?

S: Ya

M: I felt…yea…No. It was more precious…”what do I do”…I felt more contained [1.6.26]

S: for me at the beginning it was the same that I didn’t want to move…. [1.6.29]

Evident in this discussion is the notion of containment by the silence – and the breath. The notion of containment could be interpreted as ‘undermining the decisions and expression of the performer.’ But the comment also makes references to the silence being “precious”, suggesting it is attracting the performer’s attention in its contrast to the moments of sound. In such a scenario, the breath is perceived as more sound that encroaches on the silence the performer is focused on. Here the contradiction lies within the comment but seems to be related to shifting needs of the performer, the balance between wanting to move and wanting to stay still.

Based on the information from the close read of contradicting comments, I propose that how the breath is perceived is determined partly on the situation and the focus of the performers. The analysis is still quite general and needs refinement.

Still, a commonality in the comments from performers is an implied reference to requiring something from the system as a partner in the moment they are commenting on. In the above example, S sees K’s small motions as possible partly because the sound of the breath is not shaping her movements into larger gestures. In the example presented earlier, H needed information to balance the duration of everyone’s solos so
no one was left frozen for too long. These two examples demonstrate how the further close reading of comments suggest a proposed finding that limits the effectiveness of a simulated breath in leveraging social interaction in to the interaction with a system:

2) The cue is limited by the framing and immediate concerns and framing of the performer and what information they feel they need in the moment.

The implication of this analysis is that some information, expected, wanted or required by the performer-participants, was not presented in Ariel’s cue. A full discussion of this limitation will be addressed in the next chapter.

The understanding of the limitation imposed by the immediate concerns of the performer is extended to include the model used for the breath. This extension is evident in other comments. For example the comment made by Performer H.

H: The time with no breath it was easy to pass qualities you don’t want a lot of for warning especially sound you can react to immediately (not shown in her actions) it feels like cheating to exaggerate the breath [6.11.20]

There are main two points in this comment. She describes feeling as if she is cheating by responding to the “exaggerated” breath of the system. The idea of the system’s breath being ‘exaggerated’ came up in a number of discussions and is part of a third proposed finding:

3) The use of a simulated breath to leverage the social interaction used by performers to the interaction with an autonomous system is limited by the model of the breath.

This finding may not be surprising but is a constant understanding within the discussions with the participants.

These three proposed findings instigated a second critical read of the interview and video data.
Figure 36. Progression of Analysis Processes Showing Findings 1 through 3

6.3.1.2 Second Close Reading – Interview and Video Data

Video recordings of all the improvised scenes provided a second source of data. A close read of these video recordings helped address and understand some of the contradictions found through a close reading of the interview data. The analysis was done with the help of a movement expert (E) trained in Alexander Technique, a somatic practice dedicated to understanding how a mover’s use of their body as portrayed by their habits and muscle tension. This technique has connection to the mover’s intention. Using the lens of Alexander Technique the elements of Interaction, Trust and Collaboration were recognized through the tension observable in the performer’s body use. An example of this analysis is seen in the following read of the video data from an improvised scene:

**Video data** improvisation scene 10(1:11:12; 1:16:41-H_A_3a 04.mov) no breath:
This observation comes from an improvisation in which performers A and H worked with the system while the system was in the non-breathing mode. The task for the improvisation was for the performers to regard the system as a third performer and all three performers were to take turns so that only one ‘performer’ was acting at any given time. The observation that was made here concerned the development of performer A's and H's movement quality. At the start of the improvisation their motions are seen, by myself and E, as having intention and flow. When Ariel injects a musical gesture, with no preparation breath, both E and myself observed A and H as being caught off guard, which introduced a tension into their movements. At time 1:12:20 A is able to move for some time without the system interfering but at 1:13:11 is caught off guard by the system again, making her response tight again. After this point her movements remained tight for that improvisation.
Such observations in the video data are of special interest when they are compared to comments made by the performers during the interview. To demonstrate the process of comparison, consider two comments made by performer H.

**H: The time with no breath it was easy to pass qualities you don't want a lot of for warning especially sound you can react to immediately (not shown in her actions) it feels like cheating to exaggerate the breath**

[6.11.20]

**H: Connection is something we made when we move simultaneously – not me being able to predict what Ariel is going to do in any way …it is something you find together {A agrees}[5.6h.5]**

These sample comments by H indicate she does not believe that her reaction to the simulated breath is at all related to her interaction with other performers. She states that she does not want a lot of warning and claims that one can react immediately. In contrast the close read of the video indicates a tension when forced to act immediately. Furthermore, although H’s claims that she connects with others through simultaneous movement and not prediction of movement, she states this as a belief even though her movements show that she is more tense when she is not able to predict the onset of the system’s gesture. In contrast, when the simulation breath was present her movements were identified by myself and E as much more relaxed showing intention and flow and relating to the quality of A and of the system. This relationship between the video analysis and the interview data further supports the first three findings, 1) that the simulated breath is perceived as an embodied cue known through the body and at times not rationally acknowledged, 2) that it is limited by the performer’s expectations, 3) that it is limited by the modeling of the breath sound. Some limitations to Findings 2 and 3 are made apparent by taking into account the video data and comments concerning the type of information the performer believes they require. Though they may not consider it significant, performers are responding to cues of intention from their partners. In the video data, the performers show evidence of being thrown off and becoming tense by interruptions brought on by the system or their partners. This contrast points to the need for further analysis of the collected data.
6.3.2. **Examining the Embodied Perception of the Simulated Breath.**

The assertion that the simulated breath designed into the Ariel system is perceived by the performer-participants as a cue that the Ariel system is about to act is supported by the close reading analysis of the data. The data also suggests that the perception is both rational but perhaps more significantly embodied, engaging a knowing through body experience and empathy. The close reading of the interview data and the video data suggests there are limits to the perception but inconsistencies in the data (between the video data and the interview text data) point to a fuller understanding requiring further analysis. The close reading does not provide insight into how the simulated breath is being experienced. In particular, the close reading analysis did not address the three sub-questions identified in the study design (Chapter 1):

- What are the specific characteristics affecting how the system engages performer intention
- What comparisons can be made among effects of breath on different intuitive and perceptive processes of the performers
- What are the primary effects of offering predictive cues

Instead of looking for specified themes in the interview transcripts that directly reflected the topic guides, synchronicity, collaboration, and trust, a process of open coding was undertaken. The process involved three steps. Similar to the procedure presented by Petitmengin (Petitmengin, 2006, 1999), this stage of the analysis started with 1) separating comments of belief, and assumption from description of re-lived experience. Also during this stage comments concerning human communication, general improvisation, and interaction with the system were identified and flagged. In the second stage, 2) Relationships among the statements made by a single performer were examined by associating comments in a spatial relation. In the final stage, 3) themes emerge by considering the relationship between the comments clustered in a given area. These new theme were then used to begin the development of the general model.
6.3.2.1 Identifying the Commitment and Context of Each Statements

As discussed in Chapter 4, identification of comments started with identifying two basic types of statements made by the participants that reflect their level of reflection on their experience: 1) statements describing the lived experience, and 2) statements explaining a belief or assumptions based on the participant’s training or pre-held assumptions. In parallel to these two types of statements three parallel types emerged from the interview data since the discussion with the performers was not limited to just comments about their experience with the system. The open aspect of the discussions allowed the performer-participants to mention any aspect of their experience that drew their attention. In this way the discussions were not confined to themes expected to be salient but encouraged the emergence of new themes. The discussions included performers describing interactions with each other as well, when the system was involved and when the system was not. During the analysis the comments were separated into comments on 1) general human communication, 2) general interaction in improvisation, and 3) interaction with the system. The resulting matrix of comment flags is given in Table 14.

<table>
<thead>
<tr>
<th>Participant-Performer’s Statement</th>
<th>Beliefs, Assumptions</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Human Communication</td>
<td>General Improvisation</td>
</tr>
</tbody>
</table>

Table 14. Architecture for Flagging Participant-Performer’s Statements

The process of separating of the comments started by identifying each comment that did not directly reference the performer’s experience with the system or their decisions in the improvisation. For example comments such as:

–(with breath) I looked for eye contact [1.1.38]
These three comments illustrate how performers would reference concepts such as eye contact, reading others, and sensing initiation of others during the discussions. Such comments were understood to reference the getting of information and generally communicating (without words) with their partners, and through a process of aggregation (Petitmengin, 1999) were flagged as comments on general human communication.

A related type of comment is illustrated in the following example:

```
-(no system) we knew it was a conclusion but who would start [2.10.16]
```

Here the reference to “who will start” illustrates a concern for the structure of the improvisation in general and how it is to be negotiated in the group. In the above case the comment was made when the system was not involved with the improvisation. Still, similar concepts were identified even when the system was involved. The unifying character of these types of comments was a concern for the general improvisation, the structure, the satisfaction, and negotiations that happened in the moment with the partner performers. Even when the system was involved such comments were not seen as remarks on the system since the issue being referenced, such as in this case starting, is a concern for all improvisation situations. For this reason such comments were flagged as comments on improvisation in general. Identifying these types of statements helped illustrate the performer’s description of improvisation in general providing a foundation from which to consider their description of the system.

The third type of comment is demonstrated in the example:

```
-(system with breath) We anticipate when it will end and twitch when it doesn’t quite end there[2.11.4][all agree]
```

As in the last comment, this comment references stopping. However, in this example there is a direct reference to the system and how the performer is experiencing
negotiating their interaction with it. Such comments were flagged as comments on Experience with the system.

Flagging Comments as Beliefs or Descriptions

At the same time as the performer-participant’s comments were being identified as statements concerning Human communication, general Improvisation, Interaction with the Ariel system, the individual’s comments were also being flagged as comments made based on their beliefs or training concerning improvisation, and those comments made based on their lived experience improvising scenes with the partners and the Ariel system.

The performers often made comments that stated rules, theories or explanations of their experience. For example:

–“Boundaries are a form of freedom – no boundaries/rule you don’t know what to do” [1.6.32]

–(no Breath) “Normally work impulsively –body reacts with out thinking” [1.7.6]

This example demonstrates how performers-participant’s comments expressed beliefs or expectations without referencing or describing a specific moment in the improvisation. Such comments were flagged as belief statements. Belief statements can give insight into the performer’s rational intention, what they are trying to do, their training, and what they believe is happening. These comments can also help understand the language used by the performer in discussing improvisation. The danger is that these comments can tend towards justifying or espousing learned theory rather then exploring and describing the lived experience.

Comments that focus on description of their experience during the study’s improvisational scenes are flagged as comments of Lived Experience. For example:

–The harder I thought the harder it felt to respond fast enough [1.7.4]
These comments demonstrate how comments were identified as describing a single moment or cognitive action, the experience of responding or hoping for something to happen.

These two processes produced a list for each performer of comments flagged by type (see Appendix A. Link to Transcriptions of Interview Data). But the separating of comments is not always simple. It should be mentioned that a single comment by a performer often contained statements of lived experience as well as statements of belief. For example:

| H: The time with no breath it was easy to pass qualities you don’t want a lot of for warning especially sound you can react to immediately (not shown in her actions) it feels like cheating to exaggerate the breath [6.11.20] |

In this comment, performer H describes how when the system was in no breath mode her experience was that it was easy to pass the quality of motion to the other performers. In the next part of the comment she seems to try to justify or help explain her experience by stating “you don’t want a lot of warning especially sound you can react immediately”. This part of H’s statement is phrased to state a fact she believes but does not describe an experience. It is interesting to note that the close reading of the video data does not support the fact expressed in the statement. Still, the comment does conclude with a final statement beginning with “it feels….” referencing her direct experience. With this final statement H does reference her experience but is allowing her belief to temper her exploration of it. The last two statements have differing effects on the analysis. The belief statement brings up questions of why performers believe in being able to respond immediately while the final statement brings up questions of how the exaggerated breathing affects the passing of qualities between performers. This example demonstrates how the identifying of belief and description statements advanced the analysis of the interview data.
6.3.2.2 Open Coding: Associating Comments in a Spatial Relationship

The process of identifying and flagging all the comments made by each performer produced a list of flagged comments made by the individual performers. But these lists remained as unordered arrays or ‘clouds’ of descriptions made by each performer. In order to give structure to the comments with consideration to the context, a method was developed for placing comments in a special relation to comments/statements of similar context or intent. The process produced a two dimensional representation of the relationships among comments for each performer. This field of comments generated visual clusters of similar comments from which a theme for the analysis could emerge.

![Figure 37. Photo of Experience Map for One Performer](image)

The process of constructing a map for each performer was undertaken in two stages. In the first stage I constructed a spatial map based on the associations/relationships among the comments from the individual on general communication and improvisation. Once this was completed, the second stage focused on adding their comments on interaction with the system. The construction process involved placing the comments in relationship to each other in a two dimensional space. No theme axis was imposed to guide the placement. Rather simple proximity among the comments related to a perceived proximity of meaning or theme read in the comments.
Through this process comments from performer participants such as “we were starting to just take silences [2.14.15]” and “it felt wrong to make big motions on complete silence” were at a medium distance while comments such as “there was more freedom with no breath...” were placed closer. In contrast, a comments such as “taking risks can up the chaos” would be placed further away while a comment such as “breath was the safest time to move because you know the music is going to start...” would then be placed between the comment on more freedom and the comment on taking risks since there is a element of breath affecting movement but also a reference to assessing risk (see Figure 38). As the relationships became more complex and clusters began to form, comments could be shifted to better reflect their position on the individual’s ‘map of experience in the interactions’. The resulting map illustrated the performer’s approach to improvisation and what they found salient in the interaction.

![Figure 38. Example of Proximity Between Participant Statements](image)

The maps for each participant-performer’s experience were constructed in parallel. Though the comments were not directly compared among performers at this stage, thematically similar comments made by each performer were placed in the same area in their corresponding map. Keeping the positioning of similar comments consistent among participant-performers enabled easier comparison among the maps of different performers latter.

### 6.3.2.3 Themes Developed Through Spatial Clusters of Statements

The process of constructing the maps of performers’ experiences brought attention to related statements made by the individual performers. The clusters of related statements represented nodes of attention and concerns with in the performer’s experience of interacting in the environment (the system and their partners). The maps
provided an organization for the performer's comments, facilitating the use of open coding to derive the themes based on the comments in the cluster.

One cluster contained comments such as:

```
“When K moved she broke through (the rule)”[1.6.17]
“I could take charge but sometimes had to give over to others”[2.15.37]
“…kept being interrupted…finally said I’ll dance over you.”
“The rule is that you respond to changes in the environment – it feels rude not to respond”
```

These comments all have a reference to the manner of negotiation among the performers. The comments indicate a concern by the performer around incorporating the rules and skills they had been taught and what they had been told about the improvisation sessions. They also show a concern for how these obstacles will be navigated as a group. Based on this interpretation of the comments, the cluster was termed *Interpreting rules, experience and training*. The basic outline for comments in this cluster was:

- Performers are continually engaged in interpreting and negotiating expectations and rules.
  - Balanced between competition and cooperation
  - Rules provide limitations for decisions and guidelines for expectations (and anticipation)
  - Feelings between trust/ tension/ connections
- Performers will reconstruct their own expectations and interpretation of rules through negotiation/ tracking tendencies.
- Performers layer the improvisational task on top for those from training personal aesthetics and social consideration (what is rude etc.).
A second cluster was populated by comments such as:

```
“I noticed less the non-repeating vocabulary when it is there all the time – when it is coming in and not breathing in between it is playing its own game.” [5.5.3]

“I strip down the vocabulary – if it is too specific of detailed I’m too much in that and not in the space” [5.1.25].

“Compared to some of the more manic gestures between us, the flute sounded somewhat melancholic”[6.9.6]

“I assume your going to continue so it is easier to join in – if you make a decision to change and I can’t catch up I use that as a indication to repel” [1.2.25]
```

The referencing to movement vocabulary, the comparison of quality of motion, the incorporating and changing of each other’s movements were understood as focusing around the sharing, development and understanding of the movement vocabulary in the group. This interpretation of the comments led to the cluster being termed *Constructing a palette of movement*. The basic outline for comments in this cluster was:

- The performer’s / group’s attention/repetition provides focus/importance to gesture building up catalogue.

- The process of reducing gestures to catalogue focuses interaction and provides room for Development – providing meaning.

- The Simultaneous response of performers (moving in synchronization) is a prime goal.

A third cluster was typified by comments such as:

```
“my inclination is to move sharp or chose to do something different” [5.4.21]
```
“there is a question of how long a solo lasts, the flute played longer then anyone because it can’t tell the difference between us” [6.9.4]

“there were times we were waiting for the flute”[5.2.24]

“when I was dancing in the silence I was never surprised by the breath, I was in sync with it, with the music.” [3.22.16]

“I feel I follow the breath more then the notes” [4.26.39]

“my body knows the length of the gesture by learning the breathing of the system. Memory of the breath stays with you”

These comments, though still related to the movement content of the improvisation, tend to focus more on the larger scale flow of the improvisation. This interpretation comes from the use of more general descriptions like “following” rather then responding, “never” rather then didn’t. Also there is a tendency to reference long term in “learning”, “inclination” and a concern for length and composition. This interpretation of the comments led to the cluster being termed *Perceiving trends in composition*.

These three clusters were strongly represented in the discussion by all the performers and so were taken to illustrate three defining pillars around the knowledge that makes up the performer’s experience of improvising.
However, a significant number of comments provided by the performer-participants did not cluster around these themes. These outlying comments addressed topics such as:

- Noticing trends of others (this includes anticipation)
- Tracking of tendencies engages intuition/anticipation
- Holds a set of social expectations/concerns for others. Acknowledges, as part of this anticipating other’s actions/needs etc.
- Shifting their reliance to different senses

Comments related to these topics tended to form clusters in between the three ‘pillar’ clusters. It is important to remember that the comments were laid out in relation to other comments made by that performer ignoring any attempt to adhering to a pre-constructed understanding of the phenomena of improvising with others or with an autonomous system. The clustering was not an absolute but as would be expected contained grey areas where comments suggested more then one theme. In the cluster Constructing a Palette of Gestures, the comment:

“\textit{I assume your going to continue so it is easier to join in – if you make a decision to change and I can’t catch up I use that as a indication to repel}”

[1.2.25]
was mentioned as it discusses the decision of joining or repelling the gestures of the other performers. But the comment also contains, in the phrase “assume your going to...”, implying the notion of anticipation. The performer also makes several other comments such as:

“I could see and hear – and try to anticipate who was going to go next – looking for the start of the intention” [2.9.5]

“I tried to feel the intention but was often wrong” [2.10.12]

“I feel clear intentions – from others and myself- help to setup for the next thing” [2.12.23]

“I felt that with the first one there was still reaction to the rise in the breath as apposed to this one felt more grounded” [4.25.24]

Such comments are not referencing the theme of Construction of a Palette of Gestures but imply an intuitive or embodied understanding of the gestures. There is a focus in the comments by the performer-participants on how their partners are preparing to act as a way to “feel’ or understand their partner’s intention. Others provide similar comments:

“I found it easier to respond (with the breath)…you get a sense that something is coming” [1.5.4]

“(no breath) I am tense because I don’t know what to expect and that leads into the dance quality” [2.15.30]

“(no breath) I had to anticipate but had to think about it” [2.15.11]

“(with breath) you can anticipate what is coming next-even though it wasn’t patterned” [5.1.4] (time issue evident)
Here the comments reference expecting and anticipating actions. These comments were seen as a cluster of comments around *Tendencies and Intention*.

Similarly comments such as:

“(no breath) I was taking something forward and the music started and I wasn’t expecting it at all and I felt ‘aaah’ I was going somewhere” [2.15.17]

“(just prep breath) I felt more challenged” [5.5.2]

“the breath is an offer of silence—we are in sync waiting” [5.4.16]

“(with breath) I found more initiation from the system the second time (with breath) and taped into it I felt more connection and a permission for stillness within the movement” [5.4.9]

“(no breath) I felt there was more repetition that I could identify….less variation in the flute — not as demanding as a partner…” [5.2.5]

“(with breath) it feels understandable ‘you know why there was silence” [1.5.2]

“(no breath) felt more chaotic” [2.15.2]

“(with breath) I felt I was pushing boundaries” [1.8.13]

Tend to be found, during the coding process, between the *Construction of a Palette of Gestures* cluster and the *Perceived Composition* cluster. But the references to feeling of the structure and negotiations characterize such comments as a distinct cluster. The comments converge around a theme of comfort and engagement. This interpretation is based on the references to aggravation, feelings of challenge, demanding, understandable and chaotic made by the performers.
Using this method of interpretation, themes emerged for each of the nodes in each performer’s map. And since the maps for each performer were constructed using a similar layout of comments, a full ‘general map’ of experience could be compiled from all the individual performers’ experiences (see Figure 40).

![Figure 40. Illustration of Clusters Derived from Constructing Relationship Map for Performer's Comments: All Clusters](image)

6.3.2.4 Constructed Map Suggests the Simulated Breath is Responded to as an Embodied Behaviour.

As the full map for each performer started to take shape a new element to the understanding of the interaction emerged. By looking at the cluster termed *Intention and tendencies*, it becomes apparent that many of the comments refer to the volume of the breath. Some of these comments suggest that the breath provides a ramp to a climax. For example such comments as:

> “the breath provides a leading to a climax” [3.21.11]

> “(soft breath) I felt that the first one there was still a reaction to the rise in the breath as apposed to this one felt more grounded [4.25.24]
show how the breath can be experienced as guiding the performer into the gesture. In the examples, the performers’ comments make reference to the breath rising or climaxing, acting as small gesture (micro-movement) leading to the beginning of the musical gesture. Other comments by performers provide further understanding of how the simulated breath is being perceived.

“… so it was no longer a command or anything like that it was like a cue… so it cues you that the music is starting but it doesn’t impede in a way…it doesn’t command you to follow…” [22.6.--]

“When the breath is louder it is a gesture- but when it is quieter it is just a breath [6.11.9]

“When the breath is loud it sounds like an action being taken but when it is soft it sounds like a physical cue as if the flute is in the room and getting ready to act.” [6.12.19].

“When it (the breath) is quiet it is a breath but then louder I feel ‘OK GO’… and if it doesn’t it lets us down.” [6.11.10]

These comments illustrate two interesting perceptions concerning the volume of the simulated breath. Such comments suggest that the volume has an effect on the perception of the breath as a command and on whether the breath is understood as a gesture itself or a “physical cue” of intention. These comments might be summarized as suggesting that the volume affects the demanding nature of the simulated breath suggesting that:

4) Volume of breath affects how the system is perceived as demanding.

But this points to a further effect of the breath. A number of comments addressing the volume of the breath tend to use language referring to the actions of the Ariel system as behaviour. The language implies social contracts through references
such as “commands” and expectations such as “lets us down”. In this way, coupled with the indication that the volume changes the role of the breath as a cue to be more of a demand, the language implies that the breath is being perceived as a form of embodied or social cue, engaging a social contract.

It is also interesting to understand how this finding is related to the earlier finding concerning the embodied nature of the cue being limited by the model used for the breath. The volume of the breath was most often associated with the system being perceived as demanding but in some cases it was taken as an exaggeration such as H’s comment “you don’t need the breath…it feels like it is cheating”. In this comment H points out that the loud breath is not experienced as a normal preparation, it does not sound like a performer naturally breathing in. It could be that this unnatural model is being perceived as a performer trying hard to be noticed, trying to force their turn. To explore the difference in these descriptions of experience, a new approach to the analysis was taken as illustrated in Figure 23.

Within any cluster, the comments covered a range of experiences and often, on first read, contradictory descriptions. As an example here are some comments from the cluster Constructing a Palette of Gestures:

1) S: (no breath) at some point…I remember we were all doing abrupt movements…I felt that was pretty in sync…[2.15.23]

2) K: (breath) tentative things or swings had been happening in the vocabulary…I could kind of start to hear the metronome tapping underneath it that had kind of a push to it…and connected to the vocabulary that was happening…[3.17.34]

3) M: one time you did… I thought this is so me..[2.11.21]

4) H: I strip down the vocabulary…if it is too specific or detailed I’m too much in that and not in the space [5.1.25]

5) A: (soft breath) passing the qualities I am starting to think the flute has originality [6.11.21]
6) K: (no breath) I see what you mean about freedom but I feel like I don’t have anything to work off of [3.21.12]

7) H: (breath) a sort of formal satisfaction when there is synchronicity matching every one in the room

These demonstrate some of the range found in this cluster. The first comment references feeling in sync with the other performers. But this comment was made when the system was not breathing, suggesting the breath did not help in connecting with the group or the system. In contrast the second comment implies the system providing an underlying metronome, even though the system did not include a metronome or any system for ensuring a consistent beat. Where comments 3 and 4 suggest a rational approach to the development of a movement vocabulary, comments 5, 6, and 7 imply an appreciation of connecting through understanding the intention. Observing this type of disparity among comments within an identified cluster promoted applying further analysis procedures. Constructing the experience maps provided further illustration that the breath was perceived as an embodied cue and even suggests that it engages social expectations. By examining different relationships among the comments, a form of axial coding, a fuller understanding of the experience is produced (see Figure 41).
6.3.3. **The Simulated Breath Facilitated Improvisation With Complex Sonic Gestures**

The ‘maps of performer’s experience’ produces through associating comments in a spatial orientation provided an insight into how the simulated breath designed into the Ariel system was experienced as an embodied cue. The open coding points to the simulated breath being perceived as a character trait of the system and evokes expectations both social and artistic from the participant-performers. In order to further explore such aspects of the performer experience and work towards a general model of performer experience, secondary relationships among comments were used to construct a model of the performer’s *priority of attention* and a diachronic model illustrating the dynamic nature of their *knowledge used in the interaction*. These models illuminate two factors in the performer experience: 1) the importance of perceiving intention and 2) the role of intention for understanding gestures prior to a knowledge built through repetition (See Figure 42).
6.3.3.1 Axial Coding: Finding alternate Relationship among Elements in the Themes

The illustrations of the maps in Figure 40 show overlaps between the clusters. These overlaps are reminders that there are no clear boundaries among the clusters and that the comments that populate one cluster are also related to other clusters. The map illustrates relation by proximity. However, during the process of placing comments in proximity relationships to each other, arrows were also used to illustrate secondary connections among the comments. This acknowledgment of the relationship among elements within a theme can be considered similar to axial coding found in grounded theory, where comments are re-assessed using varying axis or elements of the themes.
identified in earlier analysis (Strauss & Corbin, 1990). The process of examining the elements within each theme/cluster facilitated constructing a temporal modal, or what Petitmengin refers to as a diachronic model, by first illustrating how the performer constructs a relationship between themselves and their environment (Petitmengin, 2006).

6.3.3.2 Constructing a synchronic model of performer’s priority for engagement

Through looking at the development of the performer’s perception of the system we can form a model of how that perception affects the interaction in the improvisation. A series of comments made by Performer A provide a clear example of how this analysis was approached. The comments had earlier been separated into different clusters of the experience map but all the comments contain an element related in some way to her perception of the system as a performance partner. First consider her comment:

“"I could distribute my energy to different people in the room and the system was one of them. Today I with drew that as a possibility and when the flute came in I used it as an impulse the same way I use architecture or accidental sound—but as fare as give and take I rely on partners in the room”[6.8.14]

Within this comment A references having placed, earlier, the system in with “people in the room” but is saying that she, at this time, is no longer placing the system in the category of performer. The comment is an indication of the performer’s perception of elements such as the room architecture and accidental sounds in relationship to agents in the room, that the relationships are ascribed and can be reassessed and revoked. In this way performer-participants illustrated a perception of their environment that is illustrated in a simple model (see Figure 43) The model describes the categorizing undertaken by a performers that guides her priority for where to place her engagement with expectation of reciprocation. The overlap implies that elements such as the Ariel system may move between categories, switching from moment to moment based on the performer’s expectations, or occupy a grey zone, being in two categories at once
A’s comment demonstrates the dynamic nature of the basic two categories of elements in the improvisation, the environment and the other agents by describing how she perceives her shifting understanding of the Ariel’s status based on new knowledge. What becomes interesting is trying to understand how this shift takes place. In exploring the shift we may consider two other comments by the same performer:

“I was surprised at how responsive…it felt like there was somebody…like give and take”[5.1.2]

“(no breath) it felt like background to me – a track of music playing- but it gave more space for us” [5.2.4]

“there is a responsibility I take for partners on stage but this is also a give and take – with a partner I know where to look for it” [6.8.2]

The first of these two comments was made early in the performer’s experience with the system and shows how the performer’s perception and experience is effected by the responsiveness of the system. This comment was made when the system was running in a ‘breath’ mode and is in contrast to the second comment, which was made after the next improvisation scene with the system performing in its ‘no breath’ mode. The significance of these comments is the implied perception of the system as somebody in the room taking part in a give and take. Without reading too much into the perception of the agency of the system, there is evidence of a separate category, between a track of music and a responsive object, influencing the experience of
interacting. As an extension of these two perceptions, the third comment takes the separation further illustrating a separation between objects and agents. Based on such comments a refined model was constructed (see Figure 44).

![Figure 44. Performer Perception and Beliefs](image)

Still, A provides a final comment significant to the understanding of her prioritizing the elements in the performance space.

"I heard [the flute] a bit and it made me realize that I like a bit of indication. It is how the flute indicates that a start is coming and I appreciate that – it is a cue and we take cues off of each other – I like that" [6.12.9]

She describes how the simulated breath designed into the system is perceived as a cue, and that this cue is related to the cue she uses to interact with partners. It is important here to remember that the responsiveness of the system, as well as the process used for composing gestures, did not change throughout the study. The only change implemented was the breath cue presented by the system. It should also be pointed out that A’s comments about connecting with the system are made only when the system was in its ‘breath’ mode.
Since A’s comments mention a shifting of perception of the system, the model in Figure 44 shows an overlap between architecture, object, and agent to present the possibility of moving from one category to the next. But how this movement is afforded requires a closer look. In doing this we can look at the elements within the categories and consider the discrepancies among comments around Sensing, Constructing a Palette of Gestures, Composition and Intention. During the study, performers made comments concerning the development of movements among the partners such as:

“I strip down the vocabulary – if it is too specific or detailed I’m too much in that and not in the space”[5.1.25].

“I noticed the system responding to my actions and felt a connection”[5.4.2],

“you go for mirroring with someone moving simultaneously- it is the ‘I don’t know who is leading now’ that is the highest form of Viewpointing” [5.6h.6],

I noticed a reliance on vision…I hopped someone would come into view [2.9.20].

Illustrated through these comments is an indication that performers have a focus on connecting through the actions taken on stage that are observed and responded to by their partners. The connotation of ‘observed AND responded to’ implies a building up of a vocabulary of movements through repetition.

Yet there are a variety of other comments that link the experience of connecting to smaller cues such as the breath. For example:

“if we don’t have another source in the room we have to take impulse off something else such as a blink or twitch etc.” [6.8.6]

In such comments the impulse being responded to are small gestures/ micro-actions. The size of gesture A reports responding to includes gestures so small that she is unaware of the sensation instigating the perception but is aware of her changing response. For example she comments:
Such comments illustrate how the performers are responding to the breath with a connection that is experienced differently then responding to a watched or consciously heard cue. In this example, she knows she is responding without having to consciously react. This understanding helps address some discrepancies between the interview and video data.

Furthermore, these comments combined with comments on the clarity of decisions such as:

“I feel clear intentions from myself and others helps me set up for the next thing”[2.12.23] and “trust breaks when you waffle”[2.12.21]

provide evidence that micro-actions have a large effect on the interaction and connection among the performers. A pattern starts to form in which small gestures, unintended actions, and actions taken in preparation of an intended action start to show significance. Though the intended actions are a performer’s planned actions, intended to be seen as performative, non-intended actions hold the humanity of the action. Non-intended actions are the actions the performer undertakes around their intended action, their habits, personal ticks, and even larger actions taken without consideration of being performative (Wirth, 1994). This is where performers’ descriptions of what they are doing might differ from what is observed. Still, these unintended actions are perceived in the other performers. The above comments suggest that unintended, micro-actions, are a large part of the interaction with partners. Through the analysis, there is also evidence that the system incorporating the simulated breath is engaging in that interaction, and that the performer’s response to these non-intended micro-actions is part of their evaluating the ‘partner’ statuses of the system. This view helps extend the above figure to produce a finer detailed model shown in Figure 45.
Figure 45. Varieties of Gesture Options

These fine grain elements may also be displayed as a table (see Table 15). The table still does not imply a hierarchy but more a typology of interactions in the environment.

<table>
<thead>
<tr>
<th>Typology of Interactive Environments</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Environment</td>
<td>Architecture of the room</td>
</tr>
<tr>
<td>Dynamic/responsive environment</td>
<td>Movable objects, squeaks in the floor, etc.</td>
</tr>
<tr>
<td>Dynamic Independent</td>
<td>Pre-recorded music, outside sounds</td>
</tr>
<tr>
<td>Intended sound/action from other</td>
<td>Gestures made by self intended as performative</td>
</tr>
<tr>
<td>Unintended sound/action from other</td>
<td>Habitual, preconscious, and preparatory movements</td>
</tr>
<tr>
<td>Intended sound/action from self</td>
<td>Gestures made by self intended as performative</td>
</tr>
<tr>
<td>Unintended sound/action from self</td>
<td>Habitual, preconscious, and preparatory movements</td>
</tr>
</tbody>
</table>

Table 15. Typology of Interactive Environments

This understanding of intended and unintended actions helps make sense of the disparity discussed earlier in the Construction a Palette of gestures cluster. If we look again at the seven example comments:
1) S: (no breath) at some point… I remember we were all doing abrupt movements… I felt that was pretty in sync… [2.15.23]

2) K: (breath) tentative things or swings had been happening in the vocabulary… I could kind of start to hear the metronome tapping underneath it that had kind of a push to it… and connected to the vocabulary that was happening… [3.17.34]

3) M: one time you did… I thought this is so me… [2.11.21]

4) H: I strip down the vocabulary… if it is too specific or detailed I am too much in that and not in the space [5.1.25]

5) A: (soft breath) passing the qualities I am starting to think the flute has originality [6.11.21]

6) K: (no breath) I see what you mean about freedom but I feel like I don’t have anything to work off of [3.21.12]

7) H: (breath) a sort of formal satisfaction when there is synchronicity matching every one in the room.

There is a condition were the breath is not perceived as important, such as when the performer is focused on the general collection of gestures as referenced in comments 1, 3, and 4. But the breath is perceived as significant when a connection of quality, intention or energy becomes the focus for the performer, such as in comments 2, 5, 6, and 7. This understanding provides a glimpse of the complexity involved in leveraging body knowledge and body cues into the performer-system interaction.

The importance of this new lens into the experience interaction, as offered by considering micro-actions or non-intentional actions and the connection to sensing intention, is clearly evident in such comments as:

A: (With breath open improv) you can anticipate what is coming next – even though it wasn’t patterned [5.1.4]
K: (very soft breath) I felt that the first notes of the music I could pay attention to there was breath supporting them [4.27.7]

S: (second no rest just prep-breathe) my body know the length of the gesture by learning the breathing of the system

M: (passing motion with breath) I think the breath serves as structure and gives you a sense of where you should be like a cue

There is an understanding, beyond rational categorization, that is being facilitated by the simulated breath. In both conditions, breath mode and no-breath mode, the performers comments on the musical line played by the Ariel system as being difficult to track with their movements, and yet their comments describe finding what might be described as a meta understanding, a sense of the phrase duration, the energy, the initial push when the simulated breath prepares the phrase. These comments add to the discussion of the participant-performers describing sensing the intention and anticipating Ariel. In these comments similar perceptions are linked to the performer’s ability to respond to Ariel’s complex musical gestures. I have mentioned how part of the performer’s connection with other agents is through a collected vocabulary of gestures. However, Ariel was not programmed to construct such a restricted library. Working with the Ariel system, the performers were required to respond to new material throughout the improvisation. The comments suggest that the performer’s ability to anticipate or sense intention from Ariel facilitates their interaction. This understanding points to a fifth finding that:

5) The simulated breath facilitates a connection and understanding of the system’s gestures through a perceived intention.

Construction of Diachronic Model

By constructing a model of the performers priority of engagement, insight is provided into the importance of the performer’s sense of intention and anticipation for their connections with other agents on stage (human or technical). By examining yet another set of relationships among the comments a second model can be constructed.
As discussed earlier, performers’ comments indicate that the perception of the system’s presence, and the system as an entity, was not a static state taken on by the performers. This is illustrated in their surprise to the responsiveness of the Ariel system and their change in their perception over the duration of the study. The construction of their perception happens as a function of time. The time element is both one of scale and sequence. The element of time adds a final stage to the analysis that can also be related to what Petitmengin (2006) refers to as constructing a Diachronic (time based) model considering levels of time and attention.

Deriving a time-based account of the experience is difficult since the performers rarely described their experience in terms of time or even sequence, but rather tended to refer to it more as states. Still there are some comments referencing development that point to a time element in the experience. Furthermore, by comparing comments made in different improvisation scene, the time element can be seen as a structure containing Bringing in Pre-Knowledge, Adapting Previous Knowledge, Reflecting, Constructing new Knowledge, and Testing as described in Table 16.

<table>
<thead>
<tr>
<th>Diachronic Model Implied by Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Improvisation</strong></td>
</tr>
<tr>
<td>Own expectations, training affecting interpretation of rules, tasks and environment</td>
</tr>
<tr>
<td><strong>Start Improvisation</strong></td>
</tr>
<tr>
<td>Sense presence, attention, of in the room. Affects the assigning of roles – still affected by previous experience.</td>
</tr>
<tr>
<td>Balance between initiating and giving in. Based largely on assigned role, perceived intent (comment if someone is moves give in [2.13.16]</td>
</tr>
<tr>
<td><strong>Reflection</strong></td>
</tr>
<tr>
<td>Perceive actions and states of self and others</td>
</tr>
<tr>
<td>Construct connection/meaning with actions.</td>
</tr>
<tr>
<td><strong>Construct new knowledge</strong></td>
</tr>
<tr>
<td>Develop variations of significant gestures</td>
</tr>
<tr>
<td>Develop new connection with performers</td>
</tr>
<tr>
<td>Consider composition as whole</td>
</tr>
<tr>
<td><strong>Test</strong></td>
</tr>
<tr>
<td>Act in the moment based on new knowledge</td>
</tr>
</tbody>
</table>

*Table 16. Diachronic Model Implied by Comments*
Pre-Improvisation Scene

The performer-participants discussed how their training and the rules provided when starting an improvisation scene affected their expectations and therefore their experience. Furthermore, comments such as:

“it felt like whatever rules we had made about how to start and stop had to be totally bent…” [2.15.5]

“I was surprised at how responsive…it felt like there was somebody…like give and take [5.1.2]

illustrate how the interpretation of the rules could be changed during a scene of a session. The implication of these comments is that the knowledge the performers are using to guide their interactions in the improvisation is not static but instead dynamic in that it is changeable. The dynamic nature implies that their knowledge must start at one state, the knowledge they come to a scene with. Their pre-held ideas on how the interaction is to be approached we can refer to as Pre-Knowledge. This knowledge then develops through some process.

Start of Improvisation Scene

There is evidence in the data that the development is an iterative process. As the improvisation starts and progresses, the held knowledge and beliefs from training and previous experience are put into practice and immediately assessed for effectiveness. Comments show a stage of awareness in the applying of rules and training. This awareness may assess the senses being used, for example:

“(breath open improv) I found I was responding to multiple things at once so picking up elements of what S and M and the music were doing. I also felt I could pay attention to effort and energy rather then precise movement” [3.17.30]

“I felt connected to both of you through the breath” [1.5.8]

Performer’s comments also suggest that they also engage in assessing their previously held assumptions of how they interact with partners:
“if you notice someone doing something you give over to it [2.13.16]

“trust that if I go they will let me” [2.12.19],

and their previous expectations on how to interactions with systems.

“I was surprised at how responsive (the system was)…it felt like there was somebody…like give and take”[5.1.2]

These comments illustrate how the performers had an expectation of how responsive a computer system would be, how they would take turns with partners or how they would sense the performers around them. A recurring tone of surprise when performer-participants reference these themes suggests they are re-assessing these expectations while working with the system. Comments such as: ‘I tried to figure out where it was reacting-did they trigger it or me?’ Directly reference the process of questioning. And comments such as “When K moved, she broke through” illustrate an active assessing during the improvisation. In this example a performer describes her shift in her interpretation of the improvisation task when she noticed her partner’s actions suggest, what she describes as “breaking through”. These examples illustrate a process of assessing and reflection through the reference to ‘figuring out’ and ‘comparing’.

Reflection

As the performer experiences the environment, how it responds to them, they reflect on the interaction and agency of elements in the environment and their own agency. This is seen in several comments such as:

“(no breath) we were caught off guard and interrupted in precarious spots making us tense”[2.15.31]”

Here the performer is acknowledging that in the improvisation their assumption on how the sound would be part of the environment has been tested and they are reflecting on the tension in themselves and the group.

In a similar example:
“we started a dialogue with the system more on a equal footing because one of our partners had the same handicap” – felt more like a partner[6.9.9]

the performer reflects on the similarities and differences between the system and her partners. This comment was made when the musician partner was put behind a screen. The example demonstrated the performers process of reflecting to generate new knowledge for the situation, the improvisation. She is reflecting on what information she looks for from her partners and how that may change in different circumstances; then as a result of this reflection she shifted her sensing to focus more on sound.

Construction of New Knowledge

In the comments there is further indications that this reflection leads naturally to constructing new knowledge for the situation. The constructing of new knowledge was a common part of each group’s process in developing their palette of gestures. The data in fact suggests a process beyond adapting or adjusting their awareness. For example, performer-participants made comments such as:

“Tentative things or swings had been happening in the vocabulary… I could kind of start to hear the metronome tapping underneath it had a kind of a push to it” [3.17.34]

The above comment refers to “hearing the tapping underneath it”. It might be assumed that the performer is just attending to a different part of the sound. But in the sessions no metronome or consistent pulse was generated as part of or separate from the synthesized sound of the flute and the breathing. The tapping the performer is experiencing can only be a manifestation of the group’s tempo. This interpretation is supported by other comments made by performers of feeling connected through the breath, and of the breath providing a structure to the phrasing in different scenes. The implementation is that by questioning and reflecting on the actions of the system and her partners, the performer is constructing a new knowledge of the group’s tempo, where she can perceive change in the group.

The evidence that new knowledge is being constructed is also evident in performers’ comments on their decision process. As the performer reflects, bringing
awareness to the newness of the situation, they make decisions that bend their previously held knowledge. For example:

“we kept being interrupted by the system and each other finally said I’ll dance over you” [2.15.37]

Here a knowledge of what to expect, what could be achieved, and what is necessary to achieve the goal, is constructed ‘a new’ based on the reflection on the situation.

Testing

As new knowledge is constructed it is also tested through enacting decisions based on it.

“I could distribute my energy to different people in the room and the system was one of them. Today I withdrew that possibility…” [6.8.14]

Such comments show how a new knowledge is enacted as a change in the interaction with the system. It is interesting that this performer later discusses the system still retaining some level of partner status. The Test stage brings the performer back to the Reflection stage, as this is an iterative process. On each successive loop knowledge is constructed and discarded as the performer’s perception of the situation changes.

6.3.3.3 Implications of the Diachronic Model and Environment Perception Model

Repetition vs. Empathy

The preceding discussion showed how performers’ comments lead to an understanding of their process for assessing the level of agency of elements in the environment, and how they dynamically construct their the knowledge in the situation. Yet, the elements of this discussion do not seem to be limited to the performers’ experience with the system but more general to the general experience of interacting in an improvised scene. As such, these models do provide a platform from which to
consider elements that commonly appeared in the performer comments but may not have been fully explained by the above discussions.

Earlier, the comments populating the *Constructing a Palette of Gestures* cluster were suggested to contain some discrepancies in regards to the effect of the system’s simulated breath. I have suggested that these could be explained through an understanding of intentional and non-intentional actions or *micro actions*. This discussion can be expanded using the models presented.

Certain comments made by performer-participants suggest that repetition and other focusing of attention gives certain gestures importance as part of a palette of gestures.

```
“you saw me doing something similar to you I was doing it with another part of my body” [4.25.46]
```

```
“when the group was doing something I would respond like we were all doing it…”[4.27.20]
```

In such comments there is an implied bias to observed actions that are responded to. This process often requires learning a gesture earlier to recognize it, implying a preference to repeated intentional material. In contrast, comments referencing ‘tendency’ and the need for ‘clear choices’ suggest that an aspect of interaction is happening in preparation. Performers even mentioned that they were getting use to the tendencies of their partners and the system, referencing directly the breath in such comments as:

```
S: (second no rest just prep-breath) my body know the length of the gesture by learning the breathing of the system
```

It is around such comments that the concept of *micro-actions* provides a key to understanding the described experience. Considering the comments analyzed in the above discussion and the resulting models, an assumption can be made that the performers are construction a new understanding of their interactions with their partners and the system throughout the scene. This is part of what Lockford and Pellias refer to
as the negotiation between performers. The implication is that some interaction occurs within the group before repetition can be relied upon by the group or individuals, to assess significant actions. The comments made by performers regarding their empathetic connection, their understanding of intention, and their knowing through their body, all address this stage of constructing ‘new knowledge’ and making decisions. The comments by performer-participants suggest there are moments that need to be negotiated that have no context of repetition. It is in these moments that the performers refer to intuition and anticipation with each other or the system. The reference to noticing intention through breath and reference to anticipation suggests that the repetition being leveraged is the repetition of innate body gestures, social cues that relate to empathy.

From this understanding I again suggest that the simulated breath:

6) Affords an understanding of non-patterned offerings.

It is worth noting here that the study’s use of weighted randomness, and limited structural component to the generative algorithm has contributed to this insight since macro/narrative or musical cues are not present. When the performers refer to anticipating the music there are no structural or cultural cues related to previous experience with composed music, only the simulated body cue of the breath.

6.3.4. The simulated breath encouraged the system to be perceived as a present partner.

6.3.4.1 Environment vs. Agent

The above models present a structure for understanding performers’ perception of varying agency form objects in the space and how this perception is dependent on experience through time. When considering comments through the lens of these models three more findings can be constructed.
Starting with the two previously discussed comments made by performer-participant A:

- (only prep breath – no resting breath) feels like someone leaving []
- (no breath) feels like tape

One explanation of her shift in experience could be to understand the performer as hearing the cue of the breath but needing to construct a reason for it to disappear. Since breath only disappears when the person breathing leaves, this lived experience based understanding of the information offered to the performer, constructs their knowledge. The only explanation for a breath to stop for long periods of time is if the person leaves. The problem with this simple explanation is that the later in the same session, A says that she was not experiencing the simulated breath as a breath but as a wind sound connected this the flute such as accordion billows. Still her movements, as shown in the video data, show her moving in connection to the simulated breath, indication an embodied perception of feeling of the simulated breath. That she is experiencing the Ariel system’s simulated breath by feeling is also supported by other comments such as:

A: (no rest just prep breath) I can hear the breath but I feel I don’t have time to hear it and yet I’m feeling a different experience each time [5.5.4]

Added to this line of analysis are contrasting comments made by other performer-participants concerning the perceptions of the breath. One example of these contrasting experiences is illustrated in the contrast between two comments:

S: (no breath) feels easier because silence would give a way out of awkward positions

S: (with breath) feels understandable ‘you know why there is silence (empathy) [1.5.2]

Here the contrast between S’s comments demonstrates the different perceptions of the system depending on the requirements of the performer. But the less obvious
element in evidence is how the breath can at times be a gesture in itself that takes up silence and adds to the soundscape. Below are three examples of comments addressing the effect of the sound and the presence of the system.

\begin{quote}
K: (no breath) it made me mad. It felt dead/flat”[3.21.8]

K: “I see what you mean about freedom (in silence) but I feel like I don’t have anything to work off of.”[3.21.12]

A: “(no breath) I felt I was more in my head-partly because I am settling in- but I felt more intellectual then emotional” [5.4.19]
\end{quote}

Within the limitations of the breathing model and the requirements of the performer at the time these three comments suggest that there is something in the breath that affords perceiving the system as present. This may not be attributed wholly to the sound of the breath since A believed she did not hear the simulated breath as a breath at first, but could be connected to the constant sound of the resting breath being always perceivable. Still comments such as K’s remark that the breath provided something to work off of implies the effect is more then just a background noise but a constant source of information, context, and orientation. This interpretations of the data starts to also explain the ignoring of the breath when it was not giving the information expected by the performer.

From this discussion I propose simply that:

7) The breath affects the perception of presence.

This presence can be attended to or ignored. Furthermore, removing the presence becomes distracting. The comments from performers point to their experience of constructing an explanation for the shifting perception of presence, for example H’s comment of the system ‘leaving the room’.

6.3.4.2 Social Connection
The understanding that the breath provides a constant connection with the system in a manner that conveys information also begins to relate the perception of the system’s presence with the construction of new useful knowledge and the assessment of its agency in the environment. As discussed earlier the sound can easily be perceived as part of the environment. As the performers notice during a scene that it is responding to them it becomes a responsive object, but still may not be more than a tool as expressed when performers commented on trying to control it. And yet when the breath was involved the performers’ comments shifted to a discussion of a partner, favourable or not, that was separate and more present then when the breath was not involved.

This finding is connected to performers’ comments that reference social and moral expectations. In these comments they use terms such as ‘rude’ to describe their action or the system’s actions. For example A’s comment “let her put her foot down” referencing a social consideration she expected from the system. And K’s comment concerning the group sharing “I wanted to give the system space to speak …”. These comments also suggest how the social expectations are part of the perception of the system as an entity.

This social connection was apparent through the analysis of the text in other comments as well, such as:

<table>
<thead>
<tr>
<th>Comment</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: (C hidden, mapping to quality) started a dialogue system more on equal footing because one partner had the same handicap [6.9.9]</td>
<td></td>
</tr>
<tr>
<td>A: (soft breath) the flute breaths and we say go ahead and sometimes it doesn’t and we are like ‘you let us down’ [6.11.13]</td>
<td></td>
</tr>
<tr>
<td>H: it is cheating to exaggerate the breath [6.11.20]</td>
<td></td>
</tr>
<tr>
<td>H: ….when it is coming in and not breathing in-between it is playing its own game [5.5.3]</td>
<td></td>
</tr>
<tr>
<td>M: it felt competitive with the system and the others [2.15.18]</td>
<td></td>
</tr>
<tr>
<td>S: (soft Breath) it was no longer a command…it was a cue but doesn’t impede in any way [3.22.6]</td>
<td></td>
</tr>
</tbody>
</table>
These comments illustrate a reflecting on the relationship between the system and other partners in the use of language and referencing concepts of ‘game’ and ‘commands’. There is evidence of applying social expectations and judgments. And there is evidence through the timing and overarching narrative of the comments that the Ariel system is unable to fulfill social expectations, which is why performers such as A ultimately “go back on”, stop, experiencing the system as an entity and revert to placing it in the ‘object’ category (see Figure 46). The example demonstrates how for performers, such as A, the system remains as an object. Although they can appreciate the perception of attention and the projection of intention, they do not consider the system a full partner system.

From this analysis I propose that:

8) The breath adds to the perception of the system as an entity.

But I also maintain that this perception of the system as entity/partner can be taken away when or if the system does not fulfill the performer’s other expectations for an entity which links with the social and moral criteria. The shift between entity and object is fluid, producing an experience for the performer that is complex and may or may not be appreciated.

6.3.4.3 The Simulated breath’s affect of the ensemble as a whole
The final finding uncovered through the analysis, the diachronic model \textit{Performer's process for constructing knowledge}, and the synchronic model \textit{Prioritizing of Environment}, addressed the effect of the system’s simulated breath on the interaction of the ensemble as a whole. In discussing the construction of new knowledge the model acknowledges comments that include attending to the senses and modes of knowing. What becomes evident is that the system’s simulated breath:

9) \textbf{Affects the attention of the group.}

This finding is suggested by several comments made by the performers referencing ‘breathing together’. Further to these comments, there is evidence in the
time-based analysis that the performer is encouraged by the breathing to shift their attention of sound including the breathing of partners and the system. For example comments such as:

<table>
<thead>
<tr>
<th>S: (soft breath)I feel like I'm subconsciously reacting to the other dancers [4.25.17]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: (no breath) I felt like we were breathing together [5.4.19]</td>
</tr>
<tr>
<td>M: (no system) I was conscious of group sound [2.10.25]</td>
</tr>
<tr>
<td>K: I could see and hear – and try to anticipate who was going to go next [2.9.5]</td>
</tr>
</tbody>
</table>

These examples illustrate how the human interaction is being influenced by the system. Comments such as these reference anticipation, and a heightened awareness of breath, and suggest that breath is perceived as an important source of information. The data suggests that the effect is not only in the modes of communication and perception used by the group but also affects their decision process as well. This effect is described by performer-participants in their comments such as:

<table>
<thead>
<tr>
<th>M “playful when you can go with or against but when performing with the system feels like they have to follow”[1.2.8]</th>
</tr>
</thead>
<tbody>
<tr>
<td>H: (Breath) there is a sort of formal satisfaction when there is synchronicity matching everyone in the room – same rhythm, accent,…a moment of tension or contrast are satisfying because communication seems strongest at these places [5.1.10]</td>
</tr>
<tr>
<td>M: (breath) if we go ahead find meaning with in the phrase the breath gives you a split second to decide [4.26.33]</td>
</tr>
<tr>
<td>S: you can react fast but with no setup…it goes out the window [2.15.6]</td>
</tr>
<tr>
<td>K: (breath) with the breath I felt we were as a group leading in and out of movements but we lost it when we took the breath out and totally caused sharp motions [4.26.9]</td>
</tr>
</tbody>
</table>
felt lost. Where should I start...felt fragmented [1.6.2]

Such comments illustrate that performers are experiencing an expansion of possibilities when working with each other in a manner that naturally includes their awareness of their partner’s intuition. The implications of this finding and understanding for future work will be discussed in Chapter 7.

6.4. Conclusion

Figure 47. Navigational Map for a Conclusion to the General Model

Analyzing the data was approached as a series of processes that emerged from questions and findings uncovered throughout the analysis stage (see Figure 48). The findings and models emerged through a recursive, iterated manner where the development of one finding or model was tested and validated through the development of subsequent findings and models. As a result of this series of procedures, 9 findings were identified. As well as two models: 1) performer’s prioritizing of environment, and 2) performer’s process for constructing knowledge. The models provided a high level context for performer-participants’ comments, aiding in, and supporting the identifying of
the findings. Together the findings and models were used to construct a General model of Performer-participants’ experience.

Figure 48. Progression of Analysis Processes Showing All Findings

6.4.1. Findings

The series of analysis processes produced a number of findings (see Table 8). These findings both support and expand on discussions on performer-performer interactions currently in the literature and provide elements to guide a new approach to the sense-analyze-respond paradigm moving towards a performer-performer model for designing systems for interactive performance. These connections will be discussed in more depth in Chapter 7.

<table>
<thead>
<tr>
<th>List of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) The simulated breath may be responded to as cue:</td>
</tr>
</tbody>
</table>
• Of intention
• Of simple quality

2) The effect of the simulated breath is limited by:
• The immediate framing of the performer’s perception/attention.
• The information the performer feels they require in the moment improvising

3) The model used in simulating the breath affects its perception as an embodied cue

4) The volume of breath affects the perception the system being “demanding”

5) The simulated breath facilitates a connection and understanding of the system’s gesture and intention.

6) The simulated breath affords the understanding of non-patterned offerings.

7) The simulated breath adds the perception of presence

8) The simulated breath adds to the perception of the system as an entity

9) Breath affects attention of group
• When added and taken away

Table 17. Final List of Findings

6.4.2. Two Constructed models

These 9 statements in effect summarize the findings of the study, and still, how these statements were derived may be even more important when trying to situate this work in the context of other research in performance interaction and social cues in HCI. The above discussion has outlined a map of the performer’s experience as being an interaction between 7 themes:
A model of the interactions among these aspects of their understanding was provided proposing an iterative constructing of new understandings based on their reflection and testing of new understandings.

<table>
<thead>
<tr>
<th>Performer’s Process for Constructing Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Improvisation</strong></td>
</tr>
<tr>
<td><strong>Start Improvisation</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Reflection</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Construct New knowledge</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Test</strong></td>
</tr>
</tbody>
</table>

*Table 18. Diachronic Model “Performer’s Process for Constructing Knowledge” as Implied by performer-participant’s Comments*
A primary focus of this dynamic construction of new understanding was the identifying and assessing of elements in the environment as to the level of agency. On a simple level the assessment is between elements that are perceived as architectural, objects, and agents.

Figure 50. “Performer’s Prioritizing of Environment” Model illustrating Performer Perception of Environment Through Beliefs

And yet, comments made by the performers suggest a higher resolution of agency then a simple architecture, object, and agent.

<table>
<thead>
<tr>
<th>Typology of Interactive Environments</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Environment</td>
<td>Architecture of the room</td>
</tr>
<tr>
<td>Dynamic/responsive environment</td>
<td>Movable objects, squeaks in the floor, etc.</td>
</tr>
<tr>
<td>Dynamic Independent</td>
<td>Pre-recorded music, outside sounds</td>
</tr>
<tr>
<td>Intended sound/action from other</td>
<td>Gestures made by self intended as performative</td>
</tr>
<tr>
<td>Unintended sound/action from other</td>
<td>Habitual, preconscious, and preparatory movements</td>
</tr>
<tr>
<td>Intended sound/action from self</td>
<td>Gestures made by self intended as performative</td>
</tr>
<tr>
<td>Unintended sound/action from self</td>
<td>Habitual, preconscious, and preparatory movements</td>
</tr>
</tbody>
</table>

Table 19. Typology of Interactive Environments

This increased number of categories helps explain the dynamic and varied perception of the role of elements in the environment and facilitates future explorations into the performer experience in interactive performance.
6.4.3. **General Model**

Together the 9 findings, the “Performer’s Prioritizing of Environment” model, and the “Performer’s Process for Constructing Knowledge”, combine to generate the General model for the performer’s experience of the simulated breath as an element in the performer-system interaction (see Figure 51). This model illustrates how the performer is constructing new knowledge through a process of ‘reflection’ and ‘testing’. The model illustrates how the perception of the simulated breath affects the construction of new knowledge concerning both the perception of the system but also of the human partners on stage. This new knowledge affects the prioritizing of attention in the environment, where the performer places their energy with expectations of a reciprocal engagement. This engagement is more than just a responsive interaction but is more based on a support referencing social connection. It can be likened to the difference between working with someone you enjoy working with and someone you have to work with. But the new knowledge also affects the perception of the system. As the relationship between the simulated breath and the system’s activities are attended to, this stream of information becomes relied upon. In some cases this connection is very quick, leveraging the embodied knowledge referencing such sensations as the emptying of breath. But as this knowledge is created it is tested and in some cases developed and in some cases abandoned. In particular the information provided from the breath supports decisions that are made based on micro-actions, however, decisions made by the performer that require information regarding macro-action are not supported by the simulated breath. The absence can be experienced as frustrating when the performer feels they require this level of interaction. So the simulated breath though adding to the embodied interaction does not address all aspect of the performer-system interaction.
Figure 51. General Model of Performer’s Creation of Knowledge
7. Conclusion: The Implications of Leveraging a Performer’s Sense of Intuition in Interactive Performance Systems

In this chapter I present a review of the research design including research questions and guiding sub-questions. This summary of the research results relates the findings back to the study’s intended goal. I then contextualize these results by comparing them to related research projects, interaction theories and practices. Chapter 7 concludes by discussing some limitations of the study, in both the design and the findings, and proposes directions for future work.
7.1. Re-Affirming the Context Of the Study

The goal of this study was to explore how to design performer-system interaction through leveraging of a performer’s sense of intuition, in the context of improvising with an autonomous generative music system. This study, a case study on performers’ experience working with the Ariel system, addresses the gap that exists between existing interaction models for performance, and commonly held practice-based understanding of performer-performer interaction. The study has approached this goal by implementing mechanisms into the Ariel system for projecting embodied cues indicating the upcoming actions of the system. The modeling choices of these cues were based on information derived from literature in performance pedagogy and cognitive science as well as my personal experience as a performer. To contain the scope of the project, the system focused on breath and attention as a social cue of one’s intention. This choice was based on the literature review and on pilot studies exploring sound and visuals. The model used for leveraging the performer’s intuition was assessed by exploring the affect of leveraging their intuitive sense in their performance experience, using phenomenological interviewing techniques and a grounded-theory based analysis.

The study’s main premise was the notion that breath and attention may act as indicators of a performer’s intention to make an improvisatory decision, and that these indicators, as cues, are sensed and responded to by partners in the act of negotiating actions on stage. The study explored how these indicators could be modeled in a autonomous generative system to provide performers cues to the system’s next action using a mode modeled on performer-performer interaction. During the study, performer-participants discussed and demonstrated in improvisational scenes (as observed during the sessions and in the video data), how this intuition was constructed through a broad awareness of their partners and the environment. A significant part of this awareness was shown to be linked to their perception of their partner’s intention to act.
7.1.1. **The Research Question**

The study was centered on the question:

**Can a simulated breath designed into an autonomous music system leverage a performer’s perception of intention during their interaction with the system?**

Through investigating this core question, the study explores knowledge needed to enhance models for performer-system interaction by:

- Identifying specific characteristics about how the system engages performer’s intuition.
- Comparing the effect of different gesture characteristics on intuitive processing by performers (comparison between pre-cognitive and rational performer responses).
- Identifying and analyzing the effect of offering predictive cues to performer’s experience.
- Negotiation: does the model approach a realistic form of interaction and negotiation?

7.1.2. **Review of Research Protocol Facilitating the Intuitive Experience**

To facilitate the exploration of the research question, the Ariel system was designed to be responsive to the actions of the performers and to the environment, yet also needed to be perceived as autonomous. The mapping between the performer’s actions, the state of the environment and the system’s response has been discussed in Chapter 3. While the mappings provided a base level of responsiveness through interaction between the system and performer, the system’s sonic gestures were largely generated based on its own internal state. The generative process utilized a series of algorithms based on weighted randomness. In this way the upcoming sonic gesture would be perceived as having a direct relationship to the performer’s own gestures. Comments by the performer-participants indicated that they did not perceive their actions to be controlling the system. The performer’s comments described the system as having its own agenda and intention to act, thereby fulfilling the criteria of being perceived as autonomous.
The main focus of the system design was to construct a link between the sound of the simulated breath and the upcoming response of the system, which I refer to as the breathing behaviour that presents the system’s intention to act. The study does not suggest that the mapping between a performer’s action and the system’s response is unimportant in the performer-systems interaction and connection. Comments made by participants during the study confirm this aspect of the performer-system interaction. However, other comments provided by the performer-participants suggest that the performer-system interaction does not need to be limited to a polar action-response paradigm. What this study has explored is how the social cues, common between performers such as breath and attention, can be designed into a computational system to play a part in strengthening the system-performer connection. This use of social cues is shown to be especially important in situations where the system is designed to perform with some level of agency and autonomy.

### 7.1.3 Results

**Findings Concerning Breath**

Chapter 6 described the data collection and analysis process using Phenomenological interviewing techniques and Grounded Theory analysis. Nine statements of findings emerged from the analysis of the collected data (see Table 20). These statements describe the key elements about how the simulated breath affected their experience. In addition, the general model (see Figure 53) of performer’s experience, derived during the analysis process, provides a broad perspective of the performer-participants’ intuitive experiences. This model illustrates how the simulated breath affects the performer’s reflection, offering an additional channel of sensory information from which to construct new knowledge during the improvisation. The new knowledge includes expected information such as when the system may start its next sonic gesture, but also knowledge concerning how performers prioritize their attention in the performance space among the other agents, objects and architecture present. The combination of the study’s 9 findings and compiled General Model provide a new understanding of the performer’s experience that may relate to results from other studies. Through such continued analysis we can move forward in developing more nuanced, embodied and intelligent interaction models for Interactive Performance.
**List of Findings**

1) The simulated breath may be responded to as cue:
   - Of intention
   - Of simple quality

2) The affect of the simulated breath is limited by:
   - The immediate framing of the performer’s perception/attention.
   - The information the performer feels they require in the moment improvising

3) The model used in simulating the breath affects its perception as an embodied cue

4) The volume of breath affects the perception the system being “demanding”

5) The simulated breath facilitates a connection and understanding of the system’s gesture and intention.

6) The simulated breath affords the understanding of non-patterned offerings.

7) The simulated breath adds the perception of presence

8) The simulated breath adds to the perception of the system as an entity

9) Breath affects attention of group
   - When added and taken away

*Table 20. Resulting List of Findings*
Findings Concerning Attention

This study also explored the affect of the Ariel system’s simulated attention on the performer’s intuition of following events. The system was designed with an attention mode specifically for responding to elements in the field of view set by its computer vision algorithm. This focal point for response was located in a small moving window that acted as a point of focus for the system’s attention (see Figure 26, Chapter 5). The visual feedback of this window was not shown to the performers in any way, so that the only indication of the system’s focus of attention to the performer is the response tendencies, the quality of its sonic gestures, of the system’s responses.

When the system was performing in this attention mode the performer-participant’s comments varied, but the overarching tone was of confusion and disengagement. Performer-participants described trying to ‘guess’ if the system was paying attention to
them and then losing interest in the system’s interaction or became distracted by “trying to get it to respond”. Such descriptions suggest that the focused and shifting attention of the system was not understood by the performers. This could be due to the shifting attention model used in the design, or be a result of the performer’s habits of interacting with a interactive computational system. The comments and actions of the performer-participants suggest that this aspect of the interaction and its affect on their intuitive experience requires further research.

7.2. Relating Research Results to Research Questions

The primary findings from the study address the research question by illustrating how the simulated breath is perceived as both a rational cue/signal concerning the system’s imminent gesture as well as an embodied cue. A fuller understanding of how the research question is addressed by the findings is illuminated through considering the guiding themes (see Section 7.1.1) presented as part of the research question. These themes include the: effects of offering predictive cues, characteristics of the simulated
breath instrumental in the performer’s experience, evidence of performer-system negotiations.

The findings from the study bring attention to three primary elements to the effect offering a predictive cue through the system’s simulated breath has on the performer’s experience interacting. First, offering the preparation breath is perceived as bother a rational and embodied cue. The General Model constructed through the study illustrate how these two perceptions affect the performer’s experience differently. The rational perception affects their anticipation of the system initiating a sonic gesture. The rational nature is associated with the construction of a movement vocabulary for the improvisation. In contrast, the embodied perception of the simulated breath, the understanding the intuition of the system intention to act is described as felt and is related in the performer’s comments to engaging with the ‘new’ material, the tendencies of the system. The results suggest that simulated breath of the system has the strongest effect on the perception of the systems generation of new material. In conjunction with the performer’s engagement with the system’s new material, the simulated breath shift of the groups attention to breath and sound. The results show that the simulated breath of the system draws the attention of the group on to sound as a relevant channel for attending to. Finally the simulated breath has the effect of gave the Ariel system more presence. This presence of the system has further effects concerning the performer-system interaction.

The 3 characteristics of the breath became evident as primary elements in the breath’s affect on the performer’s experience. First the timing of the breath, the duration of the inhale and transition to the flute tone, was shown to be successfully in indicating to the performer-participants the rhythmic quality and the duration of the subsequent sonic gesture. Second, the timbre of the inhale as well as the timbre of the flute tone successfully indicated the end of the sonic gesture. Finally the strongest effect was found from the volume of the preparation breath. The volume of the breath was found to shift the perception of the preparation breath from being a sonic gesture of its own, something to be responded to, when it was loud to a preparation of the subsequent sonic gesture when it was soft. Where as the loud breath was perceived as demanding, a command, the soft preparation breath was perceived as a suggestion or request to act.
Finally, the findings from the study also address the question of a possible model facilitating performer-system negotiations. The analyses of the data provided a model illustrating a process of constructing and assessing knowledge in the improvisation. The simulated breath of the system becomes a part of this process, offering a stream of information used in the construction of the new knowledge. The construction of new knowledge affects the performer’s perception of the environment including such qualities as the attention to sound/breath as a channel of information. More importantly, the breath is part of the performer’s prioritizing of agency in the environment (see Chapter 6). With in the environment the performer chooses which elements are likely to provide a reciprocal engagement, feeding their creative energy in the environment. Comments from the performers suggest that the breath encouraged them to include the system as a possibly source for reciprocal engagement but then ‘took back’ the offer when elements such as social expectations were not met. Here there is evidence of a negotiation between the performer and system beginning but more work is required for the negotiation process to be completed.

The results, though encouraging and descriptive of several factors involved in how the use of a simulated breath engages the sense of intuition in the performer, must not be misconstrued as having achieved a performer-system interaction that mirrors the performer-performer interaction as a true negotiation. What is interesting is the dynamic flow of the performer’s perception of the system as an entity fit to negotiate with. The analysis of performer’s comments on this theme resulted in the model of perceiving agency within the environment, presented in Chapter 6. It was found that the presentation of intention initiated a desire in the performers to engage with the system as a partner, especially when the gestures of other partner’s were confined to the same channel of sensation. However, the performer’s desire to interact in this mode came with moral and social expectations such as fair play, sharing, and reliability that the system often did not follow through on. The performers commented on retracting their offer of partnership when such contracts where not fulfilled. And yet the system was not considered a backing track. This discernment of agency in the in the environment is illustrated in the model and a further example of the dynamic and complex nature of the performer’s construction of knowledge during an improvisation.
The Performer Model

The traditional sense-analyse-respond model discussed in Chapter 2 implies a response to a gesture that is understood in a context of meaning, relating the performed gesture to the theme of other gestures performed up to that point. What is unique in the results from this study is that the performer’s comfort and understanding of the system’s gestures seemed to be affected by the presence of the breath. Even more important is that the affect of the breath on the performer’s experience of comfort and understanding was greater when they did not perceive the breath as soft and perceived as a preparation and not as a performer, intentional gesture. This suggests that leveraging the performer’s sense of intuition positively affects the performer’s experience of the performer-system interaction. This is key to what I have referred to as the Performer Model which acknowledges the inclusion of empathetic and embodied interaction qualities found between performers (see Chapter 2).

The Ariel system explored in this study represents a step towards the Performer Model by implementing an embodied cue in the form of a simulated breath and the system’s attention to shapes in space. To place the results from the study in the context of the earlier conversation of interactive systems for performance, it is necessary to discuss how the system incorporates and expands on the sense-analysis-respond paradigm. As part of the interaction, the Ariel system was designed to respond to the actions of the performer’s architectural elements in the space. The performers found the interaction when the system was set to respond to shapes in the space to feel confusing and disconnected. Two conclusions may be drawn from this finding. First that further research is required into the phenomena such as exploring how the performer and system may attention. Second, that the perception of conversation and context remain a significant part of the performer’s experience interacting with the system. The discussion on the performer’s process for constructing knowledge maintains this connection with the model traditional models of interaction by acknowledging the performer’s need for different information in different moments. However, the finding that the performer’s comfort and ability to engage with new complex material generated by the system suggests that intention provides a parallel form of understanding. From this view, the performer-performer model can be seen as an extension of the earlier models. The first connection for the interaction between the performer and system happens on the macro-
gestures (see Figure 55). The performer makes performative gestures and responds to the performative gestures of the system. The study demonstrates the role micro-actions, gestures made in preparation and not intended as performative actions, play in the interaction. The Ariel project implemented the breath as an example of this interaction in terms of the performer’s sensing of the system. Future research will require exploring how the systems sensing and responding to the performer’s micro-gestures may be implemented.

Figure 55. Proposed Levels of Interaction Relating the Performer Model to earlier research in interactive performance
7.3. Contributions of the Study

The main contribution of this study is a better understanding of how performer intuition can be leveraged in performer-system interaction, specifically through the use of breath. The findings illustrate how the simulated preparatory breath contributed to the performer's interaction with the system and the interactions among the ensemble as a whole. Of special interest are two findings, 1) that the simulated preparatory breath facilitates performer's ability to engage with new complex material generated by a system, 2) that the simulated breath encourages the performers to perceive and interact with the system as an entity in the space, affecting their offers and attention in their movements. The first finding contributes to interaction design in stage performance by reconsidering the sense-analyze-respond paradigm. This paradigm is still at work in the interactions taking place in the Ariel study, but they have been expanded to acknowledge the sensing of information not normally connected with the performative, sensed, gesture. The second finding contributes to a broader body of research on embodied communication agents and social cues. This project contributes to this research fundamentally by demonstrating that breath, though usually associated with
speech interaction, can have a significant affect on kinesthetic experience. The study also contributes the understanding that the perception of presence, and at some level agency, is connected to the perception of social cues including breath.

The significance of the study’s findings to the understanding of social cues in general is enhanced by the interdisciplinary aspect of the study. The study focused on actors/dancer interacting with a music system. This is a case study in the intuition of the performers interacting a system where the system is not acting in the performer’s knowledge domain. Still, the knowledge gained through such research in the domain of performance can be applied to other domains (Hoffman, 2006). The structure of the study was chosen to focus the findings on social cues that were not particular to a given performance practice but rather explore the cues between humans engaged in a combined purpose. For this reason, the results described, though most directly addressing interaction in the context of performance, also add to the understanding of social cues in the context of human-system interaction in general. This claim is supported by the connection the results from this study have to other studies concerning social cues in HCI (see section 7.4).

A secondary contribution of this study has been the development of a methodology for researching experience in the context of performance. The developed methodology contributes to performance research, and in particular methods for researching performer experience, by extending the methodology proposed by Claire Petitmengin for cognitive science research in experience in three areas 1) the adaptation of the interview technique, 2) the inclusion of video data, 3) the expansion of analysis process. By addressing concerns in these areas, the developed methodology provides researchers in performance and performer experience a refined and rigorous methodology.

In developing this methodology I have extended Claire Petitmengin’s interviewing technique, ‘Interview of Explicitation’ to create an ‘Interview for Performer Experience’. This new interview technique address three key issues in performance research 1) a notable experience during a performance may happen at any time, 2) the duration of the situation, the performance, may be quite long, 3) the experience of performing often occurs in groups (see section 4.2). This interviewing technique facilitates performers in
reflecting on their experience and becoming more articulate in describing their experience. As such, the study contributes to creating rigorous research in the area of performance and performer experience.

In conjunction with the interview data, I have added the use of video data, both during the performance sessions and the interviews. I have found that performers, when describing their experience at times use gestures and movements that cannot be documented by text. These actions are significant in their description of their experience and often re-contextualize the words they are using. For this reason I have found video to be a valuable addition to the data. I have also used the video data to capture the actions of the performers during the performance session. This data provides a triangulation for the interview data providing contrasting or corroborating information. I have demonstrated how using a third party trained in movement analysis provides validity to the analysis of the video data.

Finally, I demonstrated a method for analyzing the interview data. This method has its roots in both Phenomenological methods and Grounded Theory. The method combines the construction of models, outlined by Claire Petitmengin, with Close Reading and open/ thematic/ axial coding developed in Grounded Theory. By combining these analysis processes, the methodology was able to address contradictions uncovered during the study. This approach to data analysis contributes to performance research by providing an approach that prioritizes the researcher remaining faithful to the performer’s own description of their experience while building a rigorous model of that experience which acknowledges the experience of others.
7.4. The Study in the Context with Research Addressing Perception and Construction of Embodied Knowledge

![Figure 57. Navigational Map for the Study in the Context of Research Addressing Perception]

7.4.1. Relation To Previous Research In Leveraging Social Cues

Beyond the perception of the simulated breath as a cue to the system’s intention, one key affect of the Ariel system’s breath on the performer’s intuitive experience was on their understanding and connection with non-patterned gestures. This finding parallels the work of M.E. Whalen, Hoequist and Sheffert whose work focused on the affects of synthesized breath on the perception of synthesized speech (Whalen et al., 1995). Their findings state that preceding a system’s generated statement with the sound of a breath increased participant’s recall of the statement significantly. Their study also showed that the breath sound enhanced the participant’s recall more effectively then other sounds such as a leaf rustling (Whalen et al., 1995), suggesting that the breath was not solely acting as a sonic warning. Rather, Whalen suggests (1995) that the synthesized voice maybe perceived as more acceptable and natural due to the inclusion of the breath
component. There is also some evidence that the connection to the subsequent sentence, such as the duration of the breath, also had an effect. The results found through working with the Ariel system are consistent with Whalen’s findings. In both studies the connection with new (and complex) material was enhanced by the addition of a simulated breath related to the systems gesture proceeding the system’s sonic gesture. Furthermore, the results from working with the Ariel system expand on Whalen’s study by adding the concept of presence and tempo to Whalen’s explanation, suggesting that the participants in Whalen’s study responding to a presence of the system and a indication of the upcoming quality, rhythm, and duration of the sentence.

The results from working with the Ariel system are also consistent with other research in exploring the modeling of embodied cues as a encouraging direction for enhancing human-system interaction. Foster’s (2007) claim of expressive embodied interfaces enhancing the user’s experience, though quite general, parallels the findings of the work in my study. The performers did find that the simulated breath improved their connection with the system. Their experience of an enhanced connection took the form of knowing when the system is going to play, how long it is likely to play for, feeling the system as more present, and experiencing more comfort in the system. The study’s results are also consistent with results found by Foster (2007) considering the affect of the cue’s ‘appropriateness’ on user’s interactions with “embodied conversational agents”. Foster (2007) and Whalen (1995) emphasize in their writing that the system’s embodied cues and the subsequent response needs to have an appropriate relationship. These findings are paralleled by the findings in this study, including the finding from this study for the need of more research in modeling preparation breaths and other social cues using breath. This study includes evidence that timbre and duration changes in breath are responded to by the performer as social cues, causing the performer to perceive the system as demanding, self-serving, and exaggerated. The affect of these small elements such as timbre and micro-actions are related to Foster’s (2007) suggestion that facial expressions that are not inline with the content of a statement encourage the participants to perceive the system as less trustworthy. The model constructed through this study suggests that an agent not presenting ‘appropriate’ cues, such as breathing too loud will be experienced as being demanding or self-centered, even if the agent is the system. Further more, cues and behaviours perceived to by not
socially appropriate, often caused the system to be perceived as having qualities of both agent and object, reducing the connection. For example, in the study, situations such as the breath not holding through when the system was resting were perceived as someone leaving, and breaths that demanded space to act but did not follow through, initiated comments of being let down and diminished the perception of the system as a partner. Although such comments demonstrate the limitations of embodied cues such as the simulated breath, by demonstrating the empathetic connection being attempted between the performer and the system, these elements illustrate the possible gains that can be made through more research.

7.4.2. **Implications of The Illusion of Togetherness Project**

**7.4.2.1 Parallels**

The dynamic nature of the performer’s situated knowledge is an important element illustrated in the General Model. The model illustrates how their knowledge is continually being tested and constructed (see Figure 53). The process for constructing this knowledge is key in understanding how the simulated breath affects the performer’s experience interacting with a system. Many of the performer’s comments describe their experience as a process of connecting with the system, perceiving its presence and even expecting adherence to social/moral rules. In an earlier project ‘The Illusion of Togetherness’ (Corness et. al., 2010) a model was presented illustrating how audience members make a connection with a performer in performance. The model focuses on the process undertaken by the audience member including their shifts in awareness, understanding and priority of sensation, and in perceiving a connection with a performer in a mediated performance. If we consider that the performer is at the same time watching and engaging with their partner, the performer-performer relationship/interaction is an extension of the performer-audience relationship. The Illusion of Togetherness project was framed as an exploration of “how” the connection is made between the audience and the performer, from the perspective of the audience member. The focus of the work with the Ariel system in the leveraging of embodied knowledge through the design of a simulated breath in the system parallels this work. But, where as the Illusion of Togetherness project described the process audience members apply in making a connection watching a performer, this work with the Ariel
system has described the process applied by performers in connecting with their partner performers or the system. Both models describe a similar dynamic process of constructing and testing knowledge. A comparison between elements of the two processes is discussed in Appendix E.

7.4.3. Combining The Understanding Of Audience And Performer Interactions

Belief in Agency

The model presented in Chapter 6 for assessing and attending to agents in an environment also has parallels in earlier research such as Dix's paper ‘Formalizing Interaction’ (Dix, et.al, 2006). Dix suggests that a participant in an interactive environment observes the response of the system to their actions and the actions of others, in order to construct a ‘belief’ of the responsiveness and agency of the system, such as what actions are significant and what is the range of responses. In examining this model of interaction, a parallel effect was found through my work with the Ariel system. The breath seems to illicit a belief in the performer that they can collaborate, as indicated through the finding statements concerning the increased sense of presence and connection. Without the simulated breath the system was perceived as dead or as background sound, but when the breath was present the system was perceived as a partner. The parallel between the Ariel project and the Illusion project is found in that this belief is tested and re-assessed. Observations of the system’s behaviours and its interaction with others are taken into consideration. When the system does not fulfill the expectations of a full agent, the performer then must construct belief by constructing a new category of agent that is partial.

Assessing Gestures

As the performer assesses the agency of elements in their environment in an attempt to prioritized elements to attend to, they must also assess the gestures. One aspect of the simulated breath illustrated by the groups of performers, was how the simulated breath shifted from being perceived as the system preparing to act or as an action being taken. For some performers it took time to become acquainted with the ‘peculiar’ breathing of the system and even the concept that the system would ‘breath’ at
all. As is presented in the ‘findings of limitations’, how the breath was modeled, including volume, was part of the shifting perception of the simulated breath. This discussion is related to Auslander's discussion on the discrepancy between gestures as performance or gesture is performance (Auslander, 2008). The distinction between as and is performance and how the shift can become part of an interaction in performance is addressed by literature on interaction theatre. Wirth in his book “Interactive Acting” tells the aspiring improvisation actor to pay attention to subtle offers such as facial expressions and body language (Wirth, 1994). He also discusses what he refers to as blind offers, offers made without conscious intent. Wirth’s discussion argues for an awareness of both over and blind offers, often using the terms intended and non-intended actions. Through his discussions, Wirth is suggesting that the distinction between gestures as performance or is performance, in the context of performer-performer interaction is significant in assessing the level of interaction (Wirth, 1994). The results for my work with the Ariel system suggest that performers perceive the simulated breath as a preparation, but that their response to the perception was affected by their belief in the breath as a intended action or unintended action. This suggests that performers assess how to use sensations in the environment based on models from their previous experience.

The shifting perception of the simulated breath can also be linked to interpersonal knowledge or what Bouchard and Wright call ‘semiotics of kinaesthetic knowing’ (Bouchard & Wright, 1997). They present a table of semiotic knowing based on the work of F.M. Alexander that lays out a progression:

- A moment of experience
- Beginning a response/unconscious reaction
- A vague wordless image or feeling
- Preconscious bodily manifestation apparent to others but unconscious
- Beginning to name the experience

The progression is presented from the perspective of the do-er, in the case of this study the performer, but the inclusion of “preconscious manifestations apparent to others but
unconscious explains a possible position of the simulated breath. Considering the suggestion by Bouchard and Wright that micro-gestures are part of the performer-performer interaction, other micro actions modeled into the system might enhance the interaction. The notion of interaction through micro-gestures is under researched. Further research in this area would provide further information on with to base model for conversational embodied agents (Foster, 2007) and other forms of HCI including interactive performance where social cues are identified as part of the interaction.

7.5. Limitations

7.5.1. Model of Breath

This study explored the affect of a simulated breath in a computational autonomous system, Ariel, to leverage the embodied knowledge of a performer. As is implied in the reported results, the experience is strongly affected by the model of the breath. In the Ariel system, the physical model used for the breath was quite coarse.
There is limited information in the literature on how aspects of breath in music such as volume, timing and timbre are empathetically mapped to the upcoming musical phrase. For this reason, the model was designed around personal experience. As more information is compiled on this mapping and techniques for modeling the knowledge are developed, more nuanced exploration will be possible. The model used included aspects of volume, timing and articulation that were found to have an affect on the participant’s experience but needed more refinement. While the mapping between these qualities and the subsequent response effective, comments suggest that more consistency would improve the performer’s trust of the system.

Although the model used could have been more nuanced and consistent, the comments made by the performers suggest that it was sufficient to provide an experience of perceiving the Ariel preparing to breath. The comments show that the simulation provide an experience that facilitate reflection on the affect the Ariel system’s preparation to breath.

### 7.5.2. Research Design

The design of the research was to explore the affect of a simulated breath on the performer’s experience interacting with a generative system. The design required the system to be switched back and forth between offering the preparation breath and not offering the breath. In general this design worked well. The alternating of the research conditions elicited Comments by the performers indicating a change in their experience and an encouraging of their reflection on their interaction process. However, any interaction with a system will remain a representation (Ihde, 1990). I observed that for the performers, the system also remained just ‘the system’. Even though the performers knew (or at times did not know) that the system was changing modes, they were still responding to a computer generating a particular style of music. There is some evidence that the affects attributed to the system, such as bringing awareness to the breath, may have other explanations. For example, the performers may have been perceiving a continuity in the system, distracting them from the shift in the system’s breathing mode, which would blur the affects on their experience. Consideration may also be given to the possibility that as the performers were getting accustom to each other they were not able to get accustom to the system since it’s behaviour kept changing. In this way the design
of the research afforded certain explorations but may have hampered other possible elements of the experience.

7.6. Future Work

Figure 62. Navigational Map for Future Work

7.6.1. Revise Study Design

During this study, a preliminary understanding was developed of how the design of a generative performance system may use models of social embodied cues to leverage the performer's sense of intuition; and how this affects their experience improvising with the system. Continuation of this work may consider more nuanced models of the breath and reliable mapping between the system's preparation and the system's response. A further aspect in this direction would be adding in the ability for the system to sense the intention of the performers and adhere closer to the social rules of fair play expected by the performers. Such changes may reduce some of the confounding factors encountered in this study and provide further nuances to the
understanding of how the breath engaged the intuition and affected the experience. A final extension of this study would be to develop the system’s decision making process to explore the relationship between the social cues and aesthetic considerations.

7.6.2. **Association and Attention**

The findings of this study also suggest that more work in modeling attention and association is warranted for providing an empathetic interaction between performers and generative systems. Performers were not able to use the attention modeled into the Ariel system to anticipate the system’s response. Some performer’s commented on feeling ignored by the system and somewhat disconnected when it was responding to the environment rather than to the movements of the performers. Still, participants did make comments to suggest that there is a element of shared attention working as part of the performer-performer interaction. Performers commented on their use of imagery and association in their connecting to, understanding, and developing on the gestures of partners. For example when working with a live guitarist, the guitarist started dragging their guitar prompting the dancers to drag their bodies across the stage. This decision was discussed a being based on the imagery inspired in them by the sound. Such events suggest that addressing the issue of attention and the influence of imagery would provide new insight to the interactions between performers and help in designing systems to be part of this process. And yet it must also be noted that in the example given, the performers claimed that the image was inspired by the sound of the guitar being dragged, and this claim may be viewed as being supported by research in neural and perception psychology. Yet when the guitar player was placed behind a screen the performers commented on how difficult it was to interact just through sound, and the interactions formerly attributed to being based on sound were not as evident in their improvisations as when visual connections were possible. These finding suggest that consideration of attention and may be a direction for further study. By extending the work to include aspects of association, the project would expand its focus on *intention in action* and address more complex classes of intention.
7.7. Conclusion

This study, on performers’ experience improvising with the Ariel system, addresses the gap that exists between existing interaction models for performance, and commonly held practice-based understanding of performer-performer interaction. In performance practice and cognitive science, intuition is recognized as a key element in interaction, performer-performer or human-human. Yet intuition is seldom considered and is under researched as an element of performer-system interaction. To explore the notion of intuition, the study considered the social interaction between performers finding a parallel with research in Human Computer Interaction on what are termed embodied conversational agents and social cues. The study narrowed its focus to breath as a cue familiar to performers as an indicator of preparation and therefore linked with intuition. An intuition-based interaction model designed around a simulated breath in the system was implemented and tested in a studio environment. The success of this model was evaluated by inviting performers to improvise with the system, in multiple ‘cumulative’ sessions. Data was collected that focuses on the performers experience using an
interview technique designed for recording thick descriptions of participant's intuitive experience. The result provided a understanding of the dynamic nature of the knowledge being used by performers during the interaction in an improvisation. A General model of the simulated breath’s affect on performer’s experience, resulting from the analysis of the collected data, illustrated the assessing and prioritizing of the agency of different elements in the performance environment as assigned by the performer. This model acknowledges a connection with earlier models of interaction used in developing systems for interactive performance, most significantly the underling sense-analyze-respond paradigm of interaction. This study has expanded this fundamental paradigm by suggesting that a simulated preparation breath increased performer’s connection with a interactive performance system, improving their experience of comfort, understanding, their sense of the system’s presence, agency attentiveness and response. These findings are still acknowledged as the performer sensing, analysing and responding to the system and that the fundamental connection was predicated on the system sensing and responding to the performer. Yet, the understanding that the preparation breath has not traditionally been viewed as part of the performed gesture illustrates how this study expanded the sense-analyze-respond paradigm beyond the confines of semiotic interpretation of the performed gesture to include the context of intention and even empathetic understanding. In earlier work, research has shown how interactions between humans contains an element of interpersonal context, and that unintended social indicators are part of human-human interaction in performance and every day life. This study moves towards an understanding of how this level of interaction can be leveraged, in this case through the design of a simulated breath, to enhance the performer-system interaction for interactive performance.
References


In Interaction Challenges for Intelligent Assistants, pp 60-61


Russel, B. (1912), The Philosophy of Bergson, The Monist, Volume 22, Number 3 (July, 1912), pg 321-347.


doi:10.1145/1228716.1228730


Appendices
Appendix A

Link to Transcriptions of Interview Data:

http://breathsprite.wordpress.com/
Appendix B

Link to Transcriptions of Interview Data with Comments Divided into Statement Types:

http://breathsprite.wordpress.com/
Appendix C

Experience Maps of Performer-Participants

Experience map for performer-participant A

Experience map for performer-participant H
Experience map for performer-participant K

Experience map for performer-participant M
Experience map for performer-participant S
Appendix D

Compiled Log on System Development

The design process focused on the models for generating the musical gestures and breathing gestures. The design of these models are describes in the system design section. The process involved adapting models that had been used in earlier works, assessing these through repeated listening noting my own and others interest levels and physical responses, then making changes as necessary in an iterative process.

First system with computer vision incorporated – first prototype for mapping Ariel_Flute_Layered7.

At this stage the following are identified though not all are used

The term “val” is used to mean the mean value of the distribution curve

The tem “mag” means the maximum height of the distribution curve

Control parameters selected include for the generative system

1. Prob of playing
2. Duration of gesture short (val)
3. Duration of gesture short (mag)
4. Duration of gesture long (val)
5. Duration of gesture long (mag)
6. Rhythm low level proportion
7. Rhythm low step number A (val)
8. Rhythm low step number A (mag)
9. Rhythm low step number B (val)
10. Rhythm low step number B (mag)
11. Rhythm foreground proportion
12. Rhythm foreground number A (val)
13. Rhythm foreground number A (mag)
14. Rhythm foreground number B (val)
15. Rhythm foreground number B (mag)
16. Pitch midlevel gesture
17. Pitch midlevel step number (val)
18. Pitch midlevel step number (mag)
19. Pitch foreground gesture
20. Pitch foreground step number A (val)
21. Pitch foreground step number A (mag)
22. Pitch foreground step number B (val)
23. Pitch foreground step number B (mag)

Possible input data

1. Total lines
2. Longest length
3. Shortest length
4. Average length
5. # of lines up
6. # of lines side
7. # of lines diagonal
8. Total circles
9. Largest diameter
10. Smallest diameter
11. Average diameter
12. # of moving points
13. Average amount of motion
14. # of points moving up
15. # of points moving right
16. # of points moving left
17. Largest amount of motion
18. Direction of largest amount of motion
19. X position of largest motion
20. Y position of largest motion
21. Smallest amount of motion
22. Direction of smallest movement
23. X position of smallest movement
24. Y position of smallest movement

The detection of motion was also analyzed for timing providing

1. Sort phrase duration (val)
2. Short phrase duration (mag)
3. Long phrase duration (val)
4. Long phrase duration (mag)
5. Possible step number A
6. Possible step number B
7. Proportion (relationship between long and short gestures)
8. Short period of not moving
9. Long period of not moving

Initial analysis processes

- Averaging over a window
- Change in
- Maximum in a shifting window
- Proportion between parameters (eg short_lines/total_lines)

Testing was done to find the most salient parameters and most affective (strongest connection) and stable input data

Parameters reduced to

- Prob to play
- Test dur A val
- Test dur A mag
- Test dur B val
- Test dur B mag
- Rhythm for A
- Rhythm for B

Data was analyses and the results normalized to provide values from 0 – 127

Tables were used to map the cooked data to appropriate range and response

This way different data streams could be assigned to different parameters quickly. Also the sensitivity of a parameter could be adjusted quickly.
After testing different control parameters for perception and aesthetic in change

Control parameters increased to 7 and initial tests on analysis of input (CV) data started (evident in the development from Ariel_Flute_Layered 6 to Ariel_Flute_Layered 7)

Second version Ariel_Flute_Layered 8.

Third version Ariel_Flute_Layered 9.

<find steps> is put in place to limit the step number in the rhythmic gesture based

Third version Ariel_Flute_Layered 10 (first session with H and C).

(system seemed unresponsive)

The possibility for longer (very long) phrases in put in place by providing a high probability of a next gesture if the phrase length was higher then could be accommodated by the algorithm (?)

Forth version Ariel_Flute_Layered 11

Ariel_Flute_ResearchTool (First session H, C K, G)

Ariel_Flute_ResearchTool2 (final session H, C, K, G)
Appendix E

As part of the process for developing the model illustrating the performer's dynamic in constructing new knowledge in the improvisation, map of the performer’s experience (presented in Chapter 6) were constructed that found 7 key ‘clusters’ of themes evident in the performer's process of interacting with the Ariel system. In ‘The Illusion of Togetherness’ project, a model of the process and audience member undertakes in making a connection with a performer in a mediated performance was presented (Corness et al., 2011). The high-level illustration of this model is shown in Figure 58.

![Image](image.png)

**Figure 58. Model of Audience-Performer Connection from Illusion of Togetherness Project**

A loose correlation is apparent between the elements presented in the map of the performer’s experience and the three components of the audience-performer connection presented in the ‘Illusion of Togetherness’ paper (see Table 21). The figure illustrates how the clusters of topics identified in the experience maps discussed in Chapter 6 relate to the elements of audience awareness in making a connection to a performer. In comparing the two we must recognize that while a performer may be viewed as an audience member for their partner, there is a significant difference in the relationship. The difference stems from the fact that the performer, while viewing the actions of their partner, retains agency in the performance as a whole and even expects to perceive
their influence on their partner’s actions. This difference may be described as the difference between constructing an understanding (performer-audience relationship) and negotiating (performer-performer relationship). Table 17 shows how the three elements presented in the Illusion of Togetherness project can be related to the elements in the presented experience maps, but how the elements in the maps include reciprocal elements. The reciprocal elements are engaged in with an equal sensing and projecting from the performer. For example the *Palette of Gestures* is developed by performers watching their partner and adding their own preferences, the tendencies are both perceived and enacted by the performer. In this way the elements in the maps address the shared agency in performer-performer interaction. It is possible that as mediated performance explores audience agency, this extension to the performer-audience model may become significant.

<table>
<thead>
<tr>
<th>Map of Performer Experience</th>
<th>Illusion of Togetherness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expectations</td>
<td>Contextual awareness</td>
</tr>
<tr>
<td>Palette of gestures (reciprocal)</td>
<td></td>
</tr>
<tr>
<td>Composition (reciprocal)</td>
<td>Interpersonal awareness</td>
</tr>
<tr>
<td>Tendencies (reciprocal)</td>
<td></td>
</tr>
<tr>
<td>Comfort</td>
<td>Physical awareness</td>
</tr>
<tr>
<td>Intentions (reciprocal)</td>
<td></td>
</tr>
<tr>
<td>Sensation</td>
<td></td>
</tr>
</tbody>
</table>

*Table 21. Connections Found Between Performer Experience and Illusion of Togetherness Findings*

### 7.4.2.2 Expanding the model presented by the Illusion of Togetherness project

Where the current project extends the Illusion of Togetherness model is in the exceptions brought on by the shared agency of the performers. For example, the Illusion of Togetherness model focuses on the audience perception of their own safety (see Figure 59).
The study with the Ariel system extends this view of safety by adding the performer's sense of safety for other partners, an extension of social convention. The simulated breath was at times affecting the safety of the performer's perception of safety by letting them know what is going to happen (artistic safety). In this case the performer accepts the breath. At other times the breath suggests the presence of a virtual partner but since the system does not regard the safety of other partners, consider what they need to be safe, the human performer is put in a conflicted position having to choose between engaging/following the virtual or caring for the physical partners. The Illusion of Togetherness study was conducted using one performer and one audience member at a time. The expanded concept of safety, suggested by the work with the Ariel system suggests that even in the performer-audience interaction, consideration for other's safety/comfort may be a factor if there are two or more actors or audience members.

The other major extension to the Illusion model suggested by the reciprocal agency situation in the current project is in the assessment of roles. The framing of the Illusion of Togetherness project assumed the performer as the sole agent with in the environment. In the current project the performer is considering the role and agency of the partners and elements within the environment with much wider possibility. The Illusion of Togetherness model has not addressed the concept of agency in the audience's contextual awareness (see Figure 60) or their interpersonal awareness (see Fig 59). This work with the Ariel system has presented a model of the performer's perception of the environment focusing on the levels of agency. The implications of the
model on the Illusion of Togetherness model is to extend the Illusion model of priority of senses (see Figure 58 above) to include the performer/viewer assessing and prioritizing elements in the environment as possible agents, affecting where they may look for information to understand the performance.

![Illusion of Togetherness Model](image)

**Figure 60. Illusion of Togetherness Model of Audience Contextual Awareness in Performance**

The data in Chapter 6 suggests that prioritization includes the agents ability to present their intention but also on their ability to follow through and consider others. A self-serving or egocentric partner, human or mediated will become ignored or de-prioritized by a performer.