

A MULTI-DIMENSIONAL ENTROPY MODEL OF JAZZ IMPROVISATION FOR
MUSIC INFORMATION RETRIEVAL

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Jazz improvisation provides a case context for examining information in music; entropy provides a means for representing music for retrieval. Entropy measures are shown to distinguish between different improvisations on the same theme, thus demonstrating their potential for representing jazz information for analysis and retrieval. The calculated entropy measures are calibrated against human representation by means of a case study of an advanced jazz improvisation course, in which synonyms for “entropy” are frequently used by the instructor. The data sets are examined for insights in music information retrieval, music information behavior, and music representation.

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SITUATION

Music information is a poorly understood phenomenon. This has resulted in problems for information science; for example, Downie (2004) reflecting on the current state of music information retrieval (MIR):

The grand intellectual challenge facing past, present, and future MIR (Music Information Retrieval) research is the *acquisition of a fundamental understanding of music information itself.*

Pachet *et al* (2004) echoes Downie when commenting on inadequacies related to Electronic Music Distribution (EMD):

Unfortunately, *music listening is a (badly) understood phenomenon today*, and studies in the field...are only just starting.

Music is also a topic of research in disciplines related to information science; for example, organization and decision sciences. In particular, management theorists have turned to a study of jazz improvisation:

Managing shares with jazz improvisation such features as simultaneous reflection and action, simultaneous rule creation and rule following, patterns of mutually expected responses akin to musicians moving through a melody together, action informed by melodies in the form of codes, continuous mixing of the expected with the novel, and the feature of a heavy reliance on intuitive grasp and imagination. (Mangham & Pye as cited in Weick, 1998, p. 549)

And research studies such as Mendonca's *Improvisation in Emergency Response Organizations: A Cognitive Approach* (2001), and Wachtendorf's *Improvising 9/11*:

Organizational Improvisation Following the World Trade Center Disaster (2004) have explored improvisation at the organizational level following the World Trade Center Disaster.

Music Information Retrieval

Given that music information and jazz improvisation are emerging topics of research, what do they have to do with Music Information Retrieval (MIR)? Music Information Retrieval is a blanket term for a diverse range of sub-topics (see Appendix A) including: computational methods of classification, clustering, and modeling, formal methods and databases, web software, human-computer interaction and interfaces, music perception, cognition and emotion, music analysis and knowledge representation, music archives and libraries, intellectual property rights, sociology and economy of music, and philosophical and ethical issues related to music. Music Information Retrieval is of interest to music performers, composers, educators, critics, historians, archivist and librarians, recording industry representatives as well as music consumers.

As Melucci and Orio (2004) point out, there are essentially two forms of music information retrieval (see Figure 1.1):

- Data-based
- Content-based

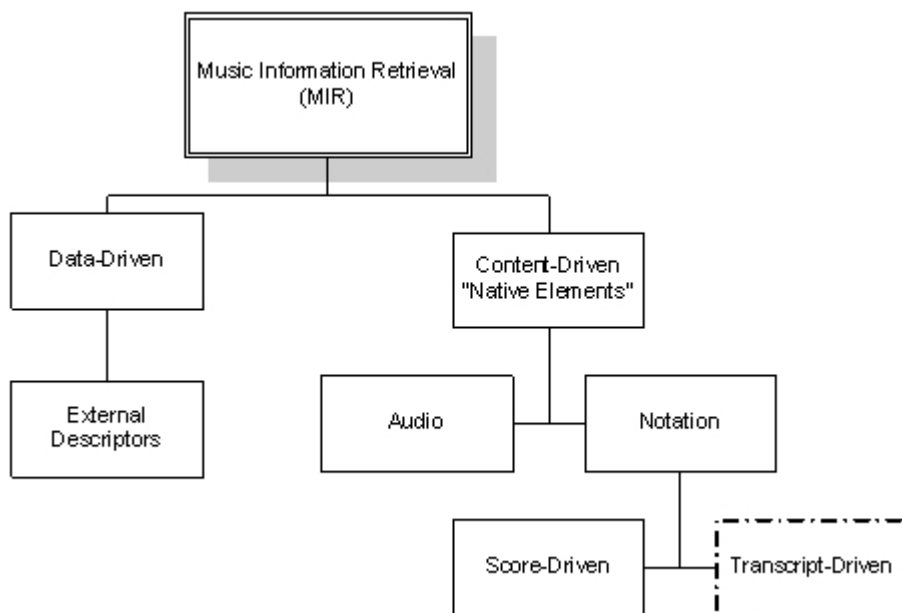


Figure 1.1: MIR Chart

Data driven forms of music classification depend on external alphanumeric musical descriptors such as performer(s) or composer(s) name, title, genre, instrumentation, etc. The problem is the descriptors are not *native elements* (O'Connor, 2004) in the music and require a pre-existing knowledge-base from which to perform music information retrieval; i.e., exact values for pre-defined fields. This severely limits the usability of such systems for users who do not have this knowledge. On the other hand, content-based approaches attempt to extract semantic musical information inherent in the music itself. This may be facilitated by humming a few bars (melodic fragments), playing chords on an instrument (harmonic structures), or tapping rhythms. There are two main approaches to extracting semantic content from music:

Symbolic (notation)

Examples include:

- Music scores
- Lead-sheets

- Transcripts
- Tablature
- Chord charts

Audio (waveforms)

Examples include:

- .mp3 (Fraunhofer IIS)
- .wav (Microsoft & IBM)
- .wma (Microsoft)
- .acc & .aiff (Apple)
- .rm (Real Media)
- .midi (Musical Instrument Digital Interface)

The problem with waveform based music information retrieval is that the technology has not yet developed to the point that it can consistently extract accurate and useful semantic information (such as melody, harmony, and rhythm) from the waveform (Haus, Longari, and Pollastri, 2004). One of the reasons for this is the inherent harmonic content in musical notes introduces ambiguity into automated tonal identification processes. For example, the waveform of a single A note at 220 Hz includes harmonics at double (440 Hz), triple (660 Hz), and quadruple (880 Hz) frequencies. Thus, notation offers the only alternative for functional content-based music information retrieval at this time.

While music notation offers a working solution to content-based music information retrieval, it is not without its limitations. Most music performance contains some degree of improvisation; this is a problem (Haus, Longari, and Pollastri, 2004); thus, the need for an exploration of information inherent in improvisational music, and the notational format

necessary for its retrieval. Improvised music serves as the main challenge to a content-based music information retrieval (composed music is inherently in a workable format to be used for retrieval purposes).

Libraries across the world (both public and private) are in the process of either converting or supplementing their collections with digital content. And library music collections in particular are undergoing a digital metamorphosis (for example, see Farivar, 2005) with the advent of peer-to-peer applications, portable multi-media devices such as the iPod, and digital music software and formats listed above such as MP3, WMA, AAC, and RM. The conversion of existing hardcopy collections (phonograph, 8-track, cassette, CD) to digital formats only increases the need for useful content-based music information retrieval systems that facilitate exponentially growing digital music collections. These music information retrieval systems potentially support a wide range of users: music performers, music educators, music historians, musicologists, composers, and music listeners.

Although the following research has potential consequences (and practical applications) for content-based MIR approaches, the results may ultimately contribute to a fundamental understanding of music information, and provide new tools for computational music analysis. Comparing human and calculated perceptions of information in jazz improvisation may contribute to an understanding of music information behavior as well.

Music Information Behavior

One might ask why music is an appropriate topic of research. The following responses address the question, but are no means exhaustive:

- It is, by definition, a fundamental problem for Music Information Retrieval (MIR)
- This necessitates studying music making behavior to inform music seeking behavior.

- We live in a Multi-Mediated world in which music is ubiquitous. Just as with images and text, music information can't be ignored without doing a disservice to our profession and our beneficiaries

This study will address Music Information Behavior (MIB): specifically, the music making and improvisation behaviors that culminate in music performance. While music performance is not exclusive to MIB research, it is recognized as fundamental; where better to start with a study of MIB than from the perspective of musicians themselves? And as Kearns (2001, 2003) demonstrates, perceptions can be calibrated to calculated measurements. Thus, perceptions are more than simply expert, anecdotal evidence. Noting that, MIB is not restricted to musical perception. A listing of potential examples of Music Information Behavior includes:

- Music information seeking, scanning, transfer, processing of analog and digital radio, television, and film
- Music seeking, transfer, and use of digital audio on the Web (file-sharing, peer-to-peer applications, electronic music distribution, intellectual property issues)
- Music information seeking process and use of Music Information Retrieval Systems
- The classification, representation, indexing, abstracting, and archiving behavior in the context of music information
- Music performance, improvisation, and composition

Jazz Improvisation

Additionally, one might ask why jazz improvisation is an appropriate topic of research. Improvisation is the foundation of the performance of jazz music (Berliner, 1994). If a content-based solution can be conceptualized for jazz improvisation, this would have potential for

solving MIR issues related to other genres of music. The form of musical notation that offers the possibility of a solution is the transcript.

Transcriptions are the representation of improvisation in the form of symbolic information. Sources for pre-existing transcripts currently exist (for examples see aebersold.com, penders.com) and manual and automated transcriptions of improvisations not currently notated are a workable possibility.

Along with the improvisation problem in MIR, a classification problem exists as well: how is music to be accurately represented? Does entropy provide a solution? Can jazz improvisation be modeled in terms of quantities of melodic, harmonic, and rhythmic information (entropy)? If so, entropy measures in transcriptions may provide a useful representation schema for MIR (as well as new tools for musical analysis). The following research may provide a conceptual foundation for just such an MIR architecture. A transcript-driven content-based music information retrieval approach (as outlined above) would include the following benefits:

- Music represented according to native elements: melody, harmony, and rhythm
- Music represented according to quantities of information measurable in the music
- Music represented from the perspective of the musicians themselves
- Musical entropy representation provides avenues to explore new connections and relationships in music suitable for musical analysis
- It would require no pre-existing knowledge base from which to perform music information retrieval; i.e., exact values for pre-defined fields
- It is applicable for the whole range of potential users: passive music listeners, amateur musicians, professional musicians, music educators, musicologists, and composers

To sum up the reasons for studying jazz improvisation in the context of music information retrieval:

- The genre is primarily improvisational
- Improvisation is a fundamental problem for MIR (Haus, Longari, and Pollastri, 2004)
- Any research that addresses the improvisation problem, by necessity addresses MIR problems in general
- There may be a connection between entropy and improvisation, thus generating new knowledge in both areas
- Music information is a problem
- The following research may contribute to solving this problem
- In addition, the research may generate new knowledge about music information, music information behavior, and jazz improvisation as a particularly relevant genre of music in which to study such things

Research Questions

1. Does a multi-dimensional entropy model of jazz improvisation provide a useful mechanism of representation for music information retrieval (MIR)? One method of evaluating an instrument's representational ability is to determine if it can distinguish between similar documents. We can refine Research Question One: does an entropy-based approach distinguish, in a predictable manner, between variations on the same jazz theme?
2. Does a case study of a jazz improvisation instructional program inform the construction and potential use of such an entropy model? Do concepts that might be described as "entropy" enter into jazz improvisation? We can refine Question Two: do the words of the instructor in the improvisation class have a significant number of synonyms for "entropy?"

CONTEXT

An exploration of music information must address an initial problem: the multiple definitions (and connotations) of the term “information.” The following section proposes that the natural language usage(s) of the term information pre-exists the research, and a study of music information by necessity must acknowledge and make use of these multiple definitions (A natural language approach influenced by the phenomenologist Ludwig Wittgenstein 1953, 2002).

Information as Thing

An exploration of "information" runs into immediate difficulties since information has to do with becoming informed, with the reduction of ignorance and of uncertainty; it is (thus) ironic that the term "information" is itself ambiguous and used in different ways...Faced with the variety of meanings of "information," we can, at least, take a pragmatic approach. We can survey the landscape and seek to identify groupings of uses of the term "information." The definitions may not be fully satisfactory, the boundaries between these uses may be indistinct, and such an approach could not satisfy anyone determined to establish the one correct meaning of "information." But if the principal uses can be identified, sorted, and characterized, then some progress might be made. (Buckland, 1991)

Buckland, applying a natural language approach influenced by Ludwig Wittgenstein, outlines a topology of information based on common usage of the term. He distinguishes three primary forms of information: *information-as-thing*, *information-as-knowledge*, and *information-as-process*. The Oxford English Dictionary (OED) is cited when defining each:

Information-as-process: When someone is informed, what they know is changed. In this sense "information" is "The act of informing...; communication of the knowledge or `news' of some fact or occurrence; the action of telling or fact of being told of something." (*OED*, 1989, vol. 7, p. 944)

Information-as-knowledge: "Information" is also used to denote that which is perceived in "information-as-process": the "knowledge communicated concerning some particular fact, subject, or event; that of which one is apprised or told; intelligence, news." (*OED*, 1989, vol. 7, p. 944)

Information-as-thing: The term "information" is also used attributively for objects, such as data and documents, that are referred to as "information" because they are regarded as being informative, as "having the quality of imparting knowledge or communicating information; instructive." (*OED*, 1989, vol. 7, p. 946)

Specific examples of these definitions are apparent: information-as-thing can be a book, CD, or DVD; information-as-knowledge the content of the book, CD or DVD; and information-as-process the act of informing (through the communication of the content of the book, CD, DVD by reading, listening, viewing). Buckland goes on to identify information with data, documents, objects, and events; while such definitions are useful in the most general sense, the extreme breadth and depth of what is here considered as "information" raises more questions than it answers: what are the primary forms of information and what makes them distinct?

To facilitate a more detailed understanding of specific forms of information, and to better delineate the topic of research, an elaboration of Buckland's topology is proposed: *information-*

as-text, *information-as-image*, and our focus: *information-as-music*. While not exhaustive of what can be considered information as such, these three forms of information and their inter-relationship can be represented in order to clarify the research agenda. In addition, the phrase *information phenomena* is used as a blanket term to signify any object, concept, or event that is potentially informational.

Making such distinctions, questions quickly arise: what is the relationship between information-as-text, information-as-image, and information-as-music? How can each of these be thought of in terms of Buckland’s topology? What are the unique qualities and characteristics that make these distinctions both necessary and desirable? The following information framework (Table 2.1) has been built on Buckland’s topology in order to better address such questions:

Table 2.1: Information Framework

Information Phenomena			
Information Form	Object	Concept	Event
	Information-as-Thing	Information-as-Knowledge	Information-as-Process
Information-as-Text	Textual documents	Textual content	Textual action
Information-as-Image	Image documents	Image content	Image action
Information-as-Music	Music documents	Music content	Music action

The boundaries of information in the framework are fuzzy and inter-relational: for example, a score can be thought of as text, a recording as a document, and a music video as an image. But ultimately, information-as-music delineates both a unique subject (music) and event

(musical activity). Information-as-process includes actions such as coding and decoding; communication (for example reading, speaking, listening, performing); representing, whether that be in the form of writing, recording, transcribing, filming, etc.; as well as information seeking behavior. While there may be significant overlap between the various information classifications, information-as-music does signify information that specifically addresses the unique phenomenon of music (and its representations). A closer look at the forms of information may help clarify this distinction.

Information-as-text may be what first comes to mind when thinking about information (as Buckland himself tends to emphasize), and includes what are traditionally thought of as “documents.” Information-as-text does not exclude representations of music, for example music recordings and scores, but it is more accurately represented as a specific type of information-as-thing according to the framework.

There are many parallels between information-as-music and information-as-image, including the problem of representation. O’Connor (2004, p. 107) raises questions about images that apply equally well to music:

Pictures are not words and words are not native elements of photographs. However, people routinely describe pictures with words. How are we to conceptualize the process in a useful way?

O’Connor (2004, p. 113) goes on to suggest:

Word texts can be described with elements directly from the document (words) and in a manner similar to daily speech acts...Likewise, word texts have clearly segmented elements and groups of elements within rule bound structures. We can, for example, say that a particular word is a noun and because of its place relative to other words, that

the noun is the subject of a sentence. At one level, then, we can determine topical characteristics of a text with some ease and surety by finding such nouns in significant numbers in a text.

The problem of representing word text is not the same as image and music: unlike word text, alphanumeric representations are not always native elements in image and music. While the problem of music representation is not an explicit topic of the research, the issue only emphasizes the need for a fundamental understanding of music information so that it can be adequately represented.

And while information “things” such as transcriptions (musical documents) may facilitate the research and information “knowledge” (the content inherent in information “things”) may provide much needed material for analysis (in the form of melody, harmony, and rhythm), it is information-as-process in the form of an improvisational musical performance that will be modeled. While music recordings and scores may facilitate the research agenda, it is music as performance (from the perspective of the musicians themselves) that is the focus of the research. Thus, the research emphasizes *information-as-process*; additionally, the information process of a musical performance occurs in a unique space and time referred to as *information space/time*. And so, a musical performance has both a spatial and temporal aspect that is suitable for analysis.

While acknowledging the usefulness of Buckland’s information topology, a more “concrete” and measurable definition of information is necessary in order to facilitate the research agenda; Shannon’s Information Theory provides just that.

Information Theory

American electrical engineer Claude Shannon (along with his colleague Warren Weaver) identified several fundamental elements present in any communication system in his *A Mathematical Theory of Communication* (1947, 1950, 1998). Shannon describes information theory as the study of how messages in a system are transmitted and received; information theory also studies how unwanted noise in a system can interfere with communication.

Shannon's Information Theory quantifies entropy both in the selection of the message to be transmitted and in the transmission of the message itself. Shannon's formula provides a way to characterize this uncertainty (randomness, complexity, unpredictability, surprise) precisely.

The amount of information in a message is measured by using units called bits, short for binary digits (two states). This provides a way to find the minimum number of bits required to send a given message (signal); it also determines the maximum rate, in bits per second, at which a given communication channel can transmit reliable information. Hayes (1991) provides a heuristic justification of this measure by comparing it to a "table look up" process: "the amount of information provided by the signal is exactly the measure of the number of binary decisions that need to be made in that Table look-up process (assuming a structure for the Table that reflects the appropriate encoding of the signal).

Thermodynamics

Thermodynamics had a profound influence on Shannon's information theory, but the relationship is not entirely clear. The intent here is not so much to clarify that relationship (a topic of continuing debate among information theorists) as to acknowledge it. Weaver addresses the influence of the second law of thermodynamics on Shannon's information theory and states

that it is the entropy of the underlying stochastic process in the information source that determines the rate of information generation:

The quantity which uniquely meets the natural requirements that one sets up for "information" turns out to be exactly that which is known in thermodynamics as entropy. (p. 103)

Thermodynamics is the branch of physics which is concerned with the storage, transformation and dissipation of energy (including the flow of heat from which the term is derived). The first law of thermodynamics (conservation law) states that energy can neither be created nor destroyed. This law provides the basis for all quantitative accounts of energy, regardless of its form, and makes energy the most important concept in physics. The second law of thermodynamics (entropy law, or Carnot's principle) states that in all systemic processes a quantity of energy involved irreversibly loses its ability to do work and is degraded in quality. The latter is called thermodynamic entropy whose extreme form is dispersed heat which manifests in a uniform temperature distribution. Another statement of this second law is that in any systemic process entropy never decreases. The third law of thermodynamics (the asymptotic law) states that all processes slow down as they operate closer to the thermodynamic equilibrium, thus making it difficult to reach that equilibrium in practice. This law suggests that the powerful and fast changes which are typical of technology and characteristic of living forms of organization are bound to occur only at levels far removed from thermodynamic equilibrium. It is the second law in particular that is related to Shannon's Information Theory.

Shannon defines the amount of information as the negative of the logarithm of a sum of probabilities. Thus, the amount of information according to Shannon is *equal to entropy*.

Shannon also cautions that "information" at this level should not be equated with the semantic content of a message, only to the probability of the message (or unit information):

If one is confronted with a very elementary situation where he has to choose one of two alternative messages, then it is arbitrarily said that the information, associated with this situation, is unity. Note that it is misleading (although often convenient) to say that one or the other message conveys unit information. The concept of information applies not to the individual messages (as the concept of meaning would), but rather to the situation as a whole, the unit information indicating that in this situation one has a freedom of choice, in selecting a message, which it is convenient to regard as a standard or unit amount.

(p. 100)

Shannon emphasizes that information theory is primarily a theoretical study. However, it has had a profound impact on the design of practical data communication and storage systems, such as telephone and computer networks. The theory can be applied to both the transmission and the storage of messages, because storage is fundamentally transmission in time.

Another important foundation of information theory is Norbert Wiener's *Cybernetics or Control and Communication in the Animal and the Machine* (1948). No less than Shannon himself grants that his information theory owes a great debt to Wiener for much of its basic philosophy. Wiener's cybernetic philosophy integrates the concepts *amount of information*, *entropy*, *feedback*, and *background noise* derived from findings regarding the role of bioelectric signals in biological systems, including the human being. According to Wiener, the human brain and nervous system coordinate information to determine which actions will be performed; control mechanisms for self-correction in machines serve a similar purpose. During World War II, Wiener worked on guided missile technology, and studied how sophisticated electronics used

the feedback principle, as when a missile changes its flight in response to its current position and direction. This principle, known as *feedback*, is the fundamental concept of automation. Wiener also noticed that the feedback principle is a key feature of life forms from the simplest plants to the most complex animals, which change their actions in response to their environment.

According to Wiener, in any system where a transformation occurs, control is maintained in response to inputs and outputs. The inputs are the result of the environment's influence on the system, and the outputs are the influence of the system on the environment. Input and output are separated by a duration of time, such as before and after, or past and present.

Wiener considers feedback as primarily a self-regulating system of controlled entropy:

It is my thesis that the physical functioning of the living individual and the operation of some of the newer communication machines are precisely parallel in their analogous attempts to control entropy through feedback.

In a feedback loop (Figure 2.1), information about the result of a transformation or an action is sent back to the input of the system in the form of input data.

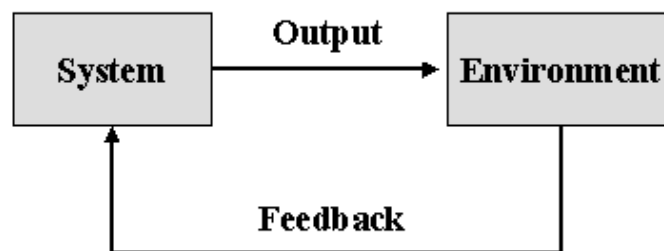


Figure 2.1: Cybernetic Feedback Loop

If these new data facilitate and accelerate the transformation in the same direction as the preceding results, they are *positive feedback* - their effects are cumulative. If the new data produce a result in the opposite direction to previous results, they are *negative feedback* - their effects stabilize the system. In the first case there is exponential growth or decline; in the second there is maintenance of the equilibrium.

Positive feedback leads to divergent behavior: indefinite expansion or explosion (toward infinity) or total blocking of activities (toward zero). In either case a positive feedback loop can lead only to the destruction of the system, through explosion or through the blocking of all its functions: there is a snowball effect. Examples include: chain reactions, population explosion, industrial expansion, capital invested at compound interest, inflation, and proliferation of cancer cells. Or, events come to a standstill: typical examples are bankruptcy and economic depression. The destructive behavior of positive loops is controlled by negative loops. According to Wiener, this control is essential for a system to maintain itself in the course of time.

Whereas positive feedback amplifies change in the environment, negative feedback counteracts change in the environment. Negative feedback is characterized by purposive or goal-seeking behavior. In a negative loop every variation triggers a correction. There is tight control; the system oscillates around an ideal equilibrium that it never attains. A thermostat and a water tank equipped with a float are simple examples of regulation by negative feedback. Purposive behavior (action directed toward a goal) in humans or in machines requires control mechanisms that maintain order by counteracting the natural tendency toward disorganization, or entropy. As with Shannon, entropy is the key concept that characterizes information for Wiener:

The notion of the amount of information attaches itself very naturally to a classical notion in statistical mechanics: that of entropy. Just as the amount of information in a

system is a measure of its degree of organization, so the entropy of a system is a measure of its degree of disorganization. (p. 18)

And also like Shannon, Wiener defines information in terms of probability:

One of the simplest, most unitary forms of information is the recording of choice between two equally probable simple alternatives, one or the other is bound to happen - a choice, for example, between heads and tails in the tossing of a coin. We shall call a single choice of this sort a decision. If we then ask for the amount of information in the perfectly precise measurement of a quantity known to lie between A and B, which may with uniform a priori probability lie anywhere in this range, we shall see that if we put $A = 0$ and $B = 1$, and represent the quantity in the binary scale (0 or 1), then the number of choices made and the consequent amount of information is infinite.

But unlike Shannon, Wiener describes the amount of information as the *negative* of entropy:

The quantity that we here define as *amount of information* is the negative of the quantity usually defined as entropy in similar situations.

The concept of negative entropy did not originate with Wiener; the quantum physicist Erwin Schrödinger made reference to negative entropy (as a principle counter to the second law of thermodynamics) in *What is Life?* (1944):

It is by avoiding the rapid decay into the inert state of 'equilibrium' that an organism appears so enigmatic....What an organism feeds upon is *negative entropy*.

And later, the information theorist Leon Brillouin referred to negative entropy as *negentropy*, in *Information Theory and Science* (1956).

Thus, there is a fundamental contrast between Shannon and Wiener: whereas Wiener defines information as negative entropy, i.e. as a "structured piece of the world," Shannon's information is equivalent to (positive) entropy. This makes Shannon's "information" the opposite of Wiener's "information"; while both Shannon's and Wiener's theories are utilized in the following research, Shannon's positive entropy is the focus. Shannon's positive entropy will simply be referred to as *entropy* (or *information-as-entropy* where appropriate) and Wiener's negative entropy will be referred to as *negentropy* (or *information-as-negentropy*).

Shannon also equates entropy with freedom of choice; Weaver, explaining Shannon's theory:

Information is a measure of one's freedom of choice in selecting a message. The greater this freedom of choice, the greater the information, the greater is the uncertainty that the message actually selected is some particular one. Greater freedom of choice, greater uncertainty, greater information go hand in hand.

Building on Shannon, Watt (1979, p. 59) emphasizes complexity in summarizing entropy:

Information theory statistics are called entropies and they measure the degree of *randomness* or *unpredictability* in a set of elements. These elements can be letters, numbers, words, [television] program production elements, or any other well-defined unit of measurement. The higher the information theory entropy, the less predictable is the appearance of any unit, and the more *complex* is the message.

Shannon's Information Theory defines information as a quantitative measure of entropy (or randomness, unpredictability, complexity) in a system; the quantity of information conveyed by a particular message is inversely proportional to the predictability of that message; when a message is entirely certain (that is, its probability is 1), then the quantity of information

conveyed is zero. When a message is totally improbable (that is, its probability is 0), then to receive such a message would be to receive an infinite quantity of information.

If the probability of a given outcome is denoted by p (Figure 2.2), then Shannon defines the information content (H) of that message, measured in bits, to be equal to the base 2 logarithm (\log_2) of the reciprocal of p . The relation between information content and probability can be represented by the equation:

$$H = -\sum_{i=1}^k p_i * \log_2(p_i)$$

Figure 2.2: Shannon's Entropy Formula

Shannon also identified several fundamental elements present in any communication system (Figure 2.3). In his communications model, a message originates at a source; the message is sent by a transmitter along a channel to a receiver; and then the message finally arrives at a destination:

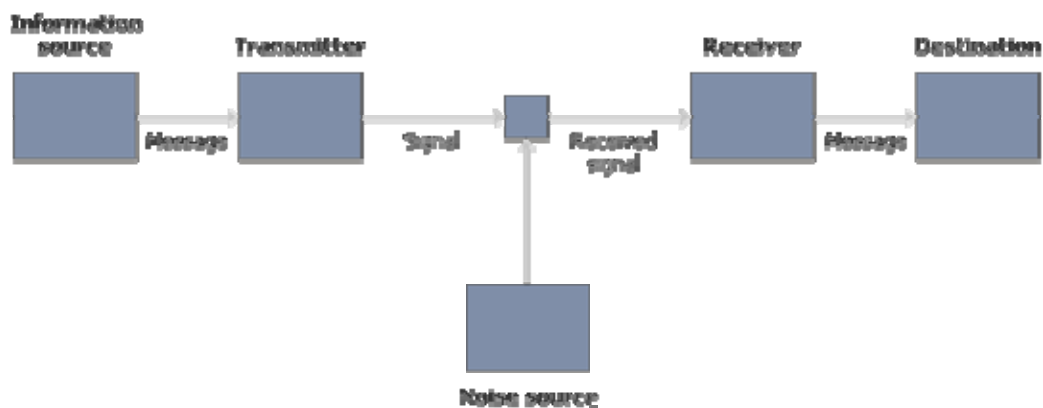


Figure 2.3: Shannon's Communications Model

The information source produces (or selects) the message or the sequence of messages to be transmitted to the destination:

- The transmitter converts the message into a signal suitable for transmission over the channel.
- The channel is the medium that is used to transmit the signal.
- The receiver is a device that reconstructs (either exactly or approximately) the message from the received signal.
- The destination is the person (or thing) for which the message is intended.

Several essential terms are components of Shannon's communications model:

Entropy: The entropy of a source is the average information content from all the possible messages, and the information content from most sources is likely to vary from message to message. Information content can vary because some messages may have a better chance of being sent than others. Messages that are unlikely convey the most information, while messages that are highly probable convey less information.

Channel capacity: Sometimes known as the Shannon limit, channel capacity is a measure of the ultimate speed or rate at which a channel can transmit information reliably. The capacity of a particular system can be approached but never exceeded. Channel capacity is measured in bits per second for a transmission channel and in bits per centimeter (or per square centimeter) for storage channels. Information theory states that if the transmitter is properly designed, information can be transmitted perfectly reliably at any speed up to the channel's capacity. However, if capacity is exceeded, then inevitably the message will be received at the destination with errors.

Data compression: Information theory provides a method for determining exactly how many bits are required to specify a given message to a given precision. This method is called the theory of data compression or, more technically, rate distortion theory.

Also, if there are a number of possible messages, then each one can be expected to occur a certain fraction of the time. This fraction is called the *probability of the message*.

While *channel capacity* and *data compression* are useful to conceptualize the flow of information, and suggest fascinating future research, *entropy* will serve as the main concept to be explored in the context of jazz improvisation. Given that, the next question may be: what does information theory have to do with jazz improvisation and music information? The answer is that an entropy model of jazz improvisation, including a model of the changes in entropy and the communication of changes in entropy in jazz improvisation may contribute to a fundamental understanding of music information.

Weaver asserts communication is comprised of all of the procedures by which one mind may affect another, and his introduction to Claude Shannon's *The Mathematical Theory of Communication* (1947, 1950, 1998) cites examples that include "not only written and oral communication, but also music, the pictorial arts, the theatre, the ballet, and in fact all human behavior." And applications of Shannon's theories have been successful in the modeling of video (moving image documents) as found in Watt (1979), O'Connor (1991), Kearns (2001, 2003). Because music resembles video in being a set of time-varying signals, such research suggests that information theory can be applied to music as well.

Applying Shannon's communications model to the performance of music, we find:

- Information source - musician (more exactly, the mind of the musician)
- Message - music

- Transmitter - instrument
- Receiver - amplifier
- Destination - the audience

Other valid applications might include the instrument as transmitter, air as channel, receiver as ear, and destination as brain. Either way, this is Shannon's communications model applied at its most basic. Considering an ensemble, in which information is flowing between multiple musicians, not only amongst themselves, but between the musicians and audience as well, all while improvising in real time obviously complicates things.

Information in Music

Examples of information commonly found in music are necessary. Such information includes the fundamental building blocks of music: melody, harmony, and rhythm (Feldstein, 1985):

- *Melody*: single pitches sounded one after another
- *Harmony*: The result produced when pitches are sounded simultaneously, such as chords
- *Rhythm*: The organization of beats or pulses in time; rhythm includes both:
 - *Beat* – the pulses in music
 - *Tempo* – the speed of a composition

Melody, harmony, and rhythm are fundamental primitives of musical information that can be quantified as entropy. In the following research, musical entropy will be measured in the multiple dimensions of melody, harmony, and rhythm.

It should be kept in mind that melody, harmony, and rhythm combine in ways that include mathematical concepts such as:

- *Counting* – this is fundamental to playing music. One must count beats per measure and count how long to hold notes.
- *Patterns* - Music is full of patterns: patterns of notes, chords, and key changes. Musicians learn to recognize these quickly. Patterns, and being able to invert them (known as counterpoint), help musicians form harmonies.
- *Ratios & proportions/equivalent fractions* - Reading music requires an understanding of ratios and proportions. For instance, a whole note needs to be played for twice as long as a half note, four times as long as a quarter note, and so forth. In addition, since the amount of time allotted to one beat in a given time signature is a mathematical constant, the durations of all the notes in that piece are all relative to one another and are played on the basis of that constant. Finally, different frameworks of time with which musicians work are based on an understanding of fractions and multiples; for example, understanding the rhythmic differences between 1/4 and 4/4 time signatures.
- *Sequences* - Music and mathematics are also related through sequences, particularly intervals. A mathematical interval corresponds to the difference between two numbers, and a musical interval corresponds to the ratio of the frequencies of the tones.

Jazz Improvisation

The 20th century classical composer Arnold Schoenberg once wrote, “Composing is a slowed down improvisation; often one cannot write fast enough to keep up with the stream of ideas” (Nachmanovitch, p. 6). Leonardo da Vinci was known as one of the great pioneers of improvisation on the renaissance instrument viola de braccio (p. 7). Both Bach and Mozart were renowned as “very free, agile, imaginative improvisers.” Even, Beethoven, when he first came to

Vienna, became known as an astounding improviser, and only later as a composer. The report of a musician-witness:

I fancy that to these improvisations of Beethoven's I owe my most vivid musical impressions. I maintain that unless one has heard him improvise well and quite at ease, one can but imperfectly appreciate the vast scope of his genius...His tempestuous inspiration poured forth such lovely melodies and harmonies unsought, because, mastered by musical emotion, he gave no thought to the search after effects that might have occurred to him with pen in hand.

While improvisation occurs in many forms of music, jazz may be the genre that has most contributed to the art of improvisation. We may ask, what exactly is jazz?

The geographical and historical roots of jazz can be traced to New Orleans in the early 1920s and features improvisations on blues, ragtime, Tin Pan Alley, and Broadway show tunes. It is characterized by a strong, prominent meter; improvisation; and dotted or syncopated patterns (Berliner, 1994). It eventually evolved into numerous contemporary styles and sub-genres of jazz, each of which is unique and distinct; for example, jazz styles found on amazon.com include: *Acid Jazz, Avant Garde & Free Jazz, Bebop, Brazilian Jazz, Cool Jazz, Jazz Fusion, Latin Jazz, Post Bebop, New Orleans Jazz, Smooth Jazz, Soul Jazz, Swing Jazz, Traditional Jazz, and Vocal Jazz.*

While multiple stylistic varieties of jazz do indeed exist, what they all have in common is improvisation (Mendonca and Wallace, 2004). Music performance and the improvisational skills of the performer play a critical role in all styles of jazz. According to Berliner (1994), improvisation in jazz is said to involve:

Reworking precomposed material and design in relation to unanticipated ideas conceived, shaped, and transformed under the special conditions of performance, thereby adding unique features to every creation.

Although improvising has been compared to “real-time composing” (Kernfeld, 1988), it should be noted that the two differ in significant ways (Nettl, 1974). Composition refers to “the discontinuous process of creation and iteration (usually through notation) of musical ideas” (Sarath, 1996), whereas improvisation is a continuous and serial process. Composing involves distributing musical elements (such as notes) over a score that is to be played serially: the composer may add to, delete or edit any part of the composition at any time before its performance. Performance of a composition involves interpreting and articulating a written or memorized score, whereas performance of an improvisation involves conceiving, articulating and remembering an unwritten, evolving score (Berliner, 1994). While a misplaced note in a composition can be erased and rewritten; a misplayed note in improvisation cannot. Errors in improvisation therefore “must be accepted as part of the irrevocable chain of acoustical events, and contextually justified after the fact by reinforcement or development” (Pressing, 1984). As Pressing (1984) characterizes it, “If erasing, painting over, or non-realtime editing exist, improvisation does not.” The production of new ideas is fundamental to improvisation, since it is not enough for improvisers to produce music that has already been composed: they must produce something that, at least to them, introduces novelty.

As outlined above, improvisation is fundamental to a jazz performance; keeping the improvisational process in mind, a multi-dimensional entropy model of information in jazz improvisation will be constructed utilizing data collected from a case study of a UNT jazz improvisation course.

Jazzing with Entropy

By understanding a single fundamental premise, Shannon’s original entropy equation can be applied to many forms of communication (Kearns, 2001). As Moles states, “information is a measurable quantity which characterizes the process of communication” (1966, p. 196). For example, Watt (1974, 1979) calculated useful entropy measures for moving image documents by using five entropy formula based on modifications to Shannon’s statistical model of data transmission (Kearns introduced additional entropy measures in her research on perception in children’s videos). Taking the same approach as Watt and Kearns, entropy measures for music can be calculated by using four entropy attributes inherent in jazz: melodic entropy (HME, where H is entropy), harmonic entropy (HHE), rhythmic entropy (HRE), and composite musical entropy (HCME). The formulae and verbal definitions are presented below:

- Melodic entropy (HME) – the degree of complexity in the appearance of melodic variety in a music transcription or score (Figure 2.4):

$$H = - \sum_{i=1}^k \frac{m \text{ vari}}{m \text{ tot}} * \log_2 \frac{m \text{ vari}}{m \text{ tot}},$$

Figure 2.4: Melodic Entropy Formula (HME)

Where *mvari* is the number of times the *i*th melodic variation appears, *mtot* is the total number of melody notes and *k* is the total possible melodic variations (between 0 and infinity). Thus *k* accounts for all possible applications of the formulas, they are not only applicable to Western classical tempered tunings, but also scalable to Eastern, microtonal and equal tempered tuning as well.

- Harmonic entropy (HHE) – the degree of complexity in the appearance of harmonic variety in a music transcription or score (Figure 2.5):

$$H = - \sum_{i=1}^k \frac{h \text{ vari } i}{h \text{ tot}} * \log_2 \frac{h \text{ vari } i}{h \text{ tot}},$$

Figure 2.5: Harmonic Entropy Formula (HHE)

Where *hvari* is the number of times the *i*th harmonic variation appears, *htot* is the total number of harmonic chords and *k* is the total number of harmonic variations.

- Rhythmic entropy (HRE) – the degree of complexity in the appearance of rhythmic variety (as measured in the beat duration of melodic notes) in a musical transcription or score (Figure 2.6):

$$H = - \sum_{i=1}^k \frac{r \text{ vari } i}{r \text{ tot}} * \log_2 \frac{r \text{ vari } i}{r \text{ tot}},$$

Figure 2.6: Rhythmic Entropy Formula (HRE)

Where *rvari* is the number of times the *i*th rhythmic variation appears, *rtot* is the total number of rhythms (or number of beats) and *k* is the total number of rhythmic variations.

In addition, a composite musical entropy (HCME) can be calculated from the arithmetic mean of HME, HHE, and HRE.

Proof of Concept: Gershwin's Summertime

An example of musical entropy calculations will be demonstrated using the jazz standard (and classical composition) *Summertime* (Figure 2.7; for full score see Appendix B):

SUMMERTIME



Play 10 Choruses

By DuBose Hayward & George Gershwin

Figure 2.7: Lead Sheet for Gershwin's *Summertime* (printed with permission from Alfred Publishing Co, Inc.)

Summertime (lyrics by Doug Hayward, music by George Gershwin) consists of a 16 bar melody and chord structure in the key of D minor and in 4/4 time (4 notes per bar, quarter note per beat). Analysis of the melody (Table 2.2), harmony (Table 2.3), and rhythm (Table 2.4) yields the following data:

Table 2.2: Melodic Data

Pitch Variations	Pitch Repetitions
A	9
G	7
F	11
D	5
A octave below	4
E	1
C	2

Total pitch variations = 7	Total pitches = 39
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Table 2.3: Harmonic Data

Harmonic Variations	Harmonic Repetitions
D-	3
D7+9	1
G-	2
E half dim.	3
A7+9	3
C7	1
Fmaj7	1
Tot. harmonic var. = 7	Total harmonies = 14

Table 2.4: Rhythmic Data

Rhythmic Variations	Rhythmic Repetitions
Eighth	5
Whole and eighth	1
Dotted eighth	6
Sixteenth	6
Quarter	8
Half	3
Half and quarter	1
Dotted quarter and half	1
Whole and half	1
Eighth and dotted half	1
Eighth and a quarter	1
Dotted quarter	1
Tot. rhythmic var. = 12	Total rhythms = 41

Applying the musical entropy formulas to the data set above results in the following calculations (Table 2.5):

$$\text{HME: } 7/9 \times 7/9(\log 2) = 0.010$$

$$\text{HHE: } 7/14 \times 7/14(\log 2) = 0.075$$

$$\text{HRE: } 12/41 \times 12/41(\log 2) = 0.037$$

$$\text{HCME: } (0.010 \times 0.075 \times 0.026) / 3 = 0.037$$

Table 2.5: Calculated Musical Entropy for *Summertime*

HME	0.010
HHE	0.075
HRE	0.026
HCME	0.037

The calculations indicate that the harmonic complexity is the highest, followed by the rhythm, and the melody. The composite musical entropy (HCME) rate gives us a baseline entropy rate for the thematic material contained in the original score of Gershwin's *Summertime*. This baseline thematic material would then be subject to variations, substitutions, or abandoned altogether in a jazz improvisational performance. The baseline entropy rate allows for a comparative analysis of changes in entropy in jazz improvisations. Measuring levels of entropy in lead-sheets and transcriptions of jazz improvisations will be explored as the research proceeds.

METHOD

This research takes a grounded theory approach (Glaser and Strauss, 1967) to a mixed methods (Creswell, 2003) exploration of information in jazz improvisation. The "case context" of a UNT jazz improvisation course (in the form of unobtrusive field observation) will be examined and juxtaposed against the entropy measures (Yin, 1989).

The case study combines a qualitative analysis of a jazz improvisation instructional program at the University of North Texas (Appendix C), along with quantitative analysis of jazz lead-sheets and transcriptions collected from students participating in the course.

The two part case study will include:

1. **Qualitative Analysis:** First, a 'case against case' analysis (Yin, 1984) of Berliner's classic study *Thinking in Jazz* (1994) will be utilized in placing the case study within the broader field of jazz improvisation research. Second, an analysis of an advanced UNT jazz improvisation course will be performed, utilizing field notes collected from non-obtrusive observation of the course for a full semester.
2. **Quantitative Analysis:** Multi-dimensional entropy equations will be applied and entropy rates will be calculated in several jazz lead-sheets and transcriptions in order to explore information in jazz improvisation.

A grounded theory approach will be undertaken in the exploration of information in jazz improvisation. An overview of the grounded theory approach applied in this research follows.

Grounded Theory

A grounded theory approach will serve as an initial organizational framework for the research agenda (a method informed by Glaser & Strauss, 1967). In using grounded theory methodology the assumption is that the theory is concealed in the data and only needs to be

discovered. As such, grounded theory begins with the research situation; in this case a UNT jazz improvisation instructional program (for course syllabus see Appendix C) which included verbal instruction, music analyses, music listening and performances of musical examples (both recorded and live), individual and collective rehearsals, and class performances. Course activities were divided between music analysis, verbal instruction, music listening, performance examples (with and without accompaniment), and individual and ensemble performances.

Within this situation, the task is to understand what is happening in the situation, and the activities of the participants. This is accomplished in part through data collection and analysis. Data can be collected in a variety of ways: observation, conversations, interviews, literature reviews. The data collection process includes *note-taking* of key issues. The data selected is often referred to as the *data sample* or *data set*.

Constant comparison of data is performed during all phases of the data collection and analysis process. It is when performing the data comparison that theories tend to emerge. Once the theories have begun to emerge, then the data is compared to the theories.

The results of this comparison are written down and *coded*. When coding, the task is to identify *categories* (roughly equivalent to themes or variables) and their *properties* (in effect their sub-categories). During the coding, certain theoretical propositions may emerge. These may be about links between categories, or about a core category: a category which appears central to the study. As the categories and properties emerge, connections are made with the core category. These connections are written down in what is called the *memoing* stage.

As the data collection and coding proceeds the codes and the memos accumulate. At this stage, the data sample may be augmented through *theoretical sampling*: purposive sampling which increases the diversity of the data sample. Once data in a core category and its

linked categories *saturate*; data is no longer added to them or their properties. This indicates that it is time to move to *sorting*. Memos are then grouped and sequenced in an order that will support the emerging theory.

In short, data collection, note-taking, coding and memoing occur during all phases of the research. Sorting occurs when all categories are saturated; writing occurs after sorting. It is emphasized that theory is *emergent* and discovered in the data in a grounded theory approach; in many cases, methods can be emergent too; thus, *the flexibility of the grounded theory approach allows for methodological deviations when the data requires it.*

What most differentiates grounded theory from other research methods is that it is explicitly *emergent*. It does not test a hypothesis; it sets out to find what theory accounts for the research situation as it is. In this respect it is like action research: the aim is to understand the research situation. The aim, as Glaser in particular states it, is to discover the theory implicit in the data.

This distinction between "emergence and forcing," as Glaser frames it, is fundamental to understanding the methodology; research based on "hypothesis-testing" is a more static or forced style of research than the emergence of theory in Glaser's approach. In addition, *the place of literature is quite different in grounded theory, as well as the way in which both methodology and theory develop gradually over time (rather than all up front) as data and interpretations accumulate.*

Judgments about the rigor of research are often based on narrowly defined criteria which make sense only for the methodology for which they were developed. Given this, grounded theory has its own sources of rigor grounded in response to the situation in which the research is done. In addition, there is a continuing search throughout the research process for evidence

which confirms and/or disconfirms the emerging theory. Thus, the method is driven by the data in such a way that the final shape of the theory is likely to provide a good fit to the situation.

Glaser suggests two main criteria for judging the adequacy of the emerging theory: 1) that it fits the situation, and 2) that it works. The criterion for a good grounded theory is that it helps in the understanding of a specific situation or experience.

In the data selection stage of the research, data relevant to the research agenda is selected, reviewed, and organized. Notes consisting of relevant observations found when reviewing the data are important in all phases of grounded theory research. In many ways, the notes facilitate the following coding of the data. When working through the data, awareness of theoretical implications is critical. Notes are preferably written down immediately so that there is a continual comparison of the theoretical ideas with the data.

A category is a theme or variable which makes sense of the data or situation under study. It is interpreted in the light of the situation being studied, and the emerging theory. After a time one or more categories often emerge with high frequency in the data or situation under observation, and these are often connected to other emergent categories; this is often referred to as the core category or categories. In a grounded theory approach, it is not recommended to choose a core category too early in the data collection. However, when it is clear that one category is mentioned with high frequency and is well connected to other categories, it is then time to adopt this as the core category (If more than one core category emerges, Glaser recommends focusing on one at a time in order to make the process more manageable).

When a core category has been identified, coding of any sentences which do not relate to the category ceases. In most instances, coding rapidly becomes more efficient as the study

progresses. Coding then begins for the core category, other connected categories, and properties of both.

It is important to record any identified connections between categories in memos. The memoing process is continuous, and is added to the sample as necessary until saturation is achieved. In the process of collecting and interpreting data about a particular category, a point of diminishing returns will eventually be reached. Additional data will add little to what is already known about a category, its properties, and its relationship to the core category; once this occurs, it is time to stop coding for that category and move on. The initial sample is likely to be defined by the particular research situation. If there are many components associated with the situation, starting with a diverse a sample as possible is recommended.

As categories emerge from the data, additions to the sample are sought in such a way that will further increase diversity in useful ways. The purpose is to strengthen the emerging theory by defining the properties of the categories, and how those mediate the relationship of category to category. Both Glaser and Strauss refer to this as *theoretical sampling*. The sample is emergent, as is the theory and the method generally.

Memoing continues in parallel with data collection, note-taking and coding. In effect, *a memo is a personal note about a category or property*, and particularly about relationships between categories. As mentioned above, eventually the core category, and the categories related to it, will have saturated. Once this happens a large number of memos will most likely have been accumulated. The memos will hopefully capture the variant aspects of the theory which has emerged from the data.

In short, in using grounded theory methodology the assumption is that the theory is concealed in the data and only needs to be discovered. Coding makes visible some of its components. Memoing add the relationships which link the categories to each other. The next stage in the research is to structure the research report to communicate the theory to others; this is the purpose of sorting.

Sorting begins by grouping the memos by the similar categories (or properties the categories address). The groups are then arranged according to the relationship between the categories. The layout should capture in two-dimensional space the structure of the eventual report or thesis. The memos are then organized in a sequence which will allow the structure to be described; this provides the basis for write up, which follows.

Once coding, memoing, and sorting has been completed, the writing is less work than it might otherwise be. In essence, the sort structure is the report structure. At this point, it is often simply a matter of preparing a first draft by organizing the notes and memos in sequence and integrating them into a coherent argument.

There are two important points to be made about the role of literature in a grounded theory research: the first is that, in an emergent study, it is not know at the beginning which literature will later turn out to be relevant. This has implications both for the place of reading in the research process and for the accompanying report. The second is that the literature is not given a position of privilege when compared to the data: *it is treated as data, with the same status as other data.*

In most cases, the first place in which a research project begins is with the examination of the relevant literature. In an emergent study data collection can begin as soon as the research situation has been chosen; literature can also be accessed any time it becomes relevant. Glaser

emphasizes the importance of prior background reading in order to provide a model to help make sense of the data. He recommends reading widely while avoiding the literature most closely related to the specific topic of research. His concern is that specific reading may otherwise constrain later coding and memoing.

Additionally, it is important to take special pains to be responsive to the data, to seek disconfirming evidence assiduously, and to defend by careful argument the decision to do so. It also makes sense to access relevant literature *as it becomes relevant* at any stage of the research. It is also important to locate the study within the relevant fields of literature. A wider sample can also be reached by refining the findings in the light of literature from slightly different but related fields. In short, a progressive accessing and reading of relevant literature should be a part of the data collection process.

Comparison of the literature to the emerging theory is a dynamic process, for instance the literature review may overlap with note-taking, coding and memoing. Whether or not this is precisely done, the important issue is how to make use of literature that supports or conflicts with the emerging theory. The literature should extend the theory so that it makes sense of both the situation being studied and the data from the literature.

A contribution to knowledge in most cases follows from a grounded theory research approach. There is also a good chance it will be an addition to the relevant literature because most research builds on what has gone before. The key factor is to be responsive to the research situation as it is. In rare cases an already existing theory may be uncovered. Even if that occurs, a contribution to knowledge has been made, and a valuable one: the theory has been cross-validated, using a very different methodology, than the theory previously offered.

An outline of field observation (as will be utilized in this case study) follows.

Field Observation

The essence of a field observation study is in observing the participant(s) action. Observation of the behavior of people as they live and work in their natural environments can occur along a continuum. The range of observation can extend from non-participatory (as performed in this research), or include the observer as a participant with limited participation or interaction with participants, or designate the participant as an observer with extensive participation and interaction, or constitute full immersion in the culture or setting. Selecting the observational stance depends on the research focus. In situations where the behavior that is observed must occur in public settings and observations pose no threat or consequence to the observed or the observer (as this study will be), an unobtrusive observation is appropriate. Full participation, at the other extreme, is commonly reserved for traditional ethnographic approaches where the researcher fully immerses in the research setting and becomes a member of the community under study as fully as possible. For the purposes of this research, the focus is on non-participatory observation.

For Lincoln and Guba,

...the selection of observational situations is guided by principles similar to those guiding selection of inquiry sites and interview respondents – purposive sampling intended to maximize the scope of the information obtained. (p.274)

Scheduling the observation will vary, depending on the situation, and may occur in different forms and at different points in the research study. This may unfold in a natural sequence that suits the situation. Flexibility is always the key, but it is appropriate to consider staging the techniques in advance to allow for the schedule commitments of the participants. The value of

observation lies in the opportunity to see the participants in their natural setting and gain a deeper perspective beyond the participant's viewpoint of how and when their behavior occurs.

According to Agar (1996): "Participant observation makes it possible for surprises to happen, for the unexpected to occur; These problems in understanding are called *rich points*" (p.31). And it is these *rich points* that provide the researcher with words or actions that can signal the identification of a key concept, action or construct that may support or connect the research to an existing or new hypothesis. For, as Wolcott (1995) believes, fieldwork proceeds "not simply through observation but in recognizing when something of significance – of *potential* significance – has been observed" (p.162). Observing and experiencing these opportunities is only one aspect of field research. Recording the data is essential to capturing the situations for analysis.

To achieve a higher level of interaction and provide the opportunity for greater exploration of the research question(s) and the generation of hypotheses based on informants' insights, combinations of individual interviews, group interviews and focus groups are utilized (as will be performed in the second part of the research agenda). Interviews may be structured or unstructured, exploratory or focused. The design of the interview depends on who is being interviewed and why. Often, in the initial stages of a field study, it is useful to conduct exploratory interviews with key informants and/or participants to develop contextual information and an understanding of the field setting. Exploratory interviews may be structured, with specific questions develop ahead of the interview, or unstructured, with a few open-ended questions intended to provoke the identification of areas that the researcher may not have considered.

According to Lincoln and Guba (1985):

In the structured interview the questions are in the hands of the interviewer and the response rests with the interviewee; in the unstructured interview *both* questions and answers are provided by the respondent (“Tell me the questions I ought to be asking and then answer them for me”). (p.269)

As an exploratory or focused technique, interviews can be positioned within the design plan to elicit information that contributes to the research in a field setting. The interviews can involve one participant or a group of participants. It may be useful, for example, to conduct a focused group interview with a group of supervisors to determine how they respond as a group to certain predetermined situations; or, to informally conduct a group interview with the same group of supervisors to discuss whom they turn to for definitive information in a human resource investigation that emerges unexpectedly. Taking advantage of informal opportunities or scheduling new opportunities is part of the evolving nature of field observation research studies.

While these techniques and instruments generate important data from the participants’ perspective, data recording can occur in a number of ways. Surveys and questionnaires can be delivered and recorded on a computer. Cameras, voice recorders, and audiovisual recorders can be used to capture what is seen and heard in a situation with the consent of the participants. While there are decided advantages to collecting a complete record of any situation, there are also disadvantages to the use of devices for data collection. Besides the possibility that the device may suffer interruption or failure, participants may object to these methods despite agreeing to their use, or be intimidated by them. However, the advantage of securing a record of the data is primary to the needs of analysis and interpretation that follow the collection of data.

Reliance on one data recording method is as limiting as using only one technique or instrument in a field research study. Utilizing a variety of methods is recommended by Lincoln

and Guba. Where possible, and with participant consent, recording an interview is beneficial. Having a full record of the interview allows the researcher to transcribe the responses verbatim and retain the record for later analysis. It also frees the researcher to explore issues within the interview without worrying about trying to record the responses verbatim. While a participant may be willing to have an interview recorded, it may be more challenging to arrange for permission to record an observational situation. Videotaping and audiotaping observational situations present logistical and wider consensual issues. Observational situations are more likely to require the observational and recording talents of the researcher. Regardless of the mechanical devices used to record data, the researcher has a responsibility to accurately document observations.

The researcher can describe their observations by recording them in field notes, which then “constitute a scientific record of the experience for future reference” (Schensul, Schensul, & LeCompte, 1999, p.114). These are distinguished from what DeWalt and DeWalt (2002) identify as “head notes” (p.154), the tacit knowledge that is hard to put into words, and that may or should have been recorded in a diary or personal journal. Field notes are used in every situation by the researcher and according to Spradley (1980) can consist of several varieties: condensed accounts, expanded accounts, fieldwork journals, and analysis and interpretation journals.

Condensed accounts are notes that are taken during the actual field observations and represent a condensed version of what actually occurred. These often include phrases, single words, and unconnected sentences that are used as triggers for a recollection of the observation when the researcher has the opportunity to complete a fuller record. LeCompte and Schensul (1999) describe this action when a research “jots down a mnemonic word or phrase to help in remembering what he or she wants to investigate” (p.13) as occurring during a pause in the

conversation or a break in the activities. This suggests that the process of recording is challenged by more than one dimension: knowing what to record, and finding an opportunity to make the notation. Managing the task of seeing everything that is occurring, recognizing what is significant, and recording the activity and behavior is daunting and requires a focused endeavor. It is recommended that a condensed account is made during every period of the fieldwork or immediately afterward so behaviors and events are not lost. The expanded account fills in the details of the condensed account and recalls things that were not recorded during the field observation. Completing the expanded account as soon as possible is recommended for maximum recollection.

The fieldwork journal is a diary that records the researcher's experience. This journal provides the opportunity for the researcher to identify ideas, fears, mistakes, breakthroughs and problems that occur during the research study. The journal represents the personal side of the researcher's experience and constitutes an introspective record that enables the researcher to explore their biases and feelings and the influence these have on the research. It also provides a record of personal growth through the experience. A record of preliminary generalizations and insights is provided by the analysis and interpretation journal. The initial stages of data analysis are conducted in this journal

Whatever method is used to record observations in field notes, it is important to devise a system to organize, maintain and secure the notes. Using a computer to capture or transcribe field notes relieves the stress of hand recording and is time efficient. Providing adequate backup and security for the system is critical. Another option is dictating field notes for later transcription. This can be time efficient as well, particularly if the researcher can arrange for someone else to transcribe the notes.

Regardless of the methods used to create field notes, according to Schensul, Schensul and LeCompte (p.119), they should incorporate some important features: exact quotes are included, pseudonyms or unique identities are used throughout to ensure anonymity and confidentiality, the observation notes describe the activities in the sequence in which they happened, the notes include relevant history related to incidents or individuals to situate the event, the researcher differentiates their own summary from the direct quotes of speakers, and the date, place, time, and name of the researcher are recorded. Maintaining a consistent standard for the record of field notes facilitates their use in analyzing the data.

To sum up, the research proposed will consist of a case study of a UNT jazz improvisation instructional program resulting in a process taxonomy, information flow chart, and multi-dimensional entropy calculations of jazz lead-sheets and transcriptions. The resulting model of information in jazz improvisation will then be explored in the context of music information retrieval.

CASE STUDY

Introduction

The following mixed methods (Creswell, 2003) “edge” case combines a qualitative analysis of a jazz improvisation instructional program at the University of North Texas, along with quantitative analysis of jazz lead sheets and transcriptions of improvisations collected from students participating in the course. First, a "case against case" comparison (Yin, 1989) of Berliner’s classic *Thinking in Jazz* (1984) will serve as a departure point. Second, a qualitative analysis of a UNT jazz improvisation course (see Appendix C) will be performed, utilizing field notes collected from non-obtrusive field observation over the period of a semester (see Appendix J). An Information Behavior Taxonomy (IBT) and an Information Flow Diagram (IFD) will be constructed from the collected data. Following that, multi-dimensional entropy rates will be calculated in several jazz lead-sheet and transcriptions collected in the course (Appendix D - I). Finally, the combined data set will serve as a model to be explored in the context of music information retrieval.

Berliner’s *Thinking in Jazz*

A classic in jazz ethnography, Berliner’s *Thinking in Jazz* (1994) is a systematic case study of jazz improvisation considered by many to be a foundational resource on improvisation in jazz (Library Journal, 1994). Paul F. Berliner, professor of ethnomusicology at Northwestern University, author of the critically acclaimed *The Soul of Mbirá* (1993), as well as the recipient of an ASCAP-Deems Taylor award for outstanding writing in music, started his jazz studies in the seventies. *Thinking in Jazz* is a fifteen year effort, in which Berlin systematically covers fundamental aspects of improvisation as art form, science, and way of life. Berliner’s case study

includes a broad range of research topics (from inspiration and arrangements to evaluation and audience interaction), music texts (from the 1920s to the present), artist interviews, and disc-, video-, and bibliographies.

Case Description

The primary goal of *Thinking in Jazz* is to reveal how musicians, both individually and collectively, learn to improvise. Chronicling leading musicians from their first encounters with jazz to the development of a unique improvisatory voice, Berliner documents the lifetime of preparation that lies behind the acquired skill of jazz improvisation.

The result of more than fifteen years of immersion in the jazz world, *Thinking in Jazz* combines participant observation with detailed musicological analysis, the author's experience as a jazz trumpeter, interpretations of published material by scholars and performers, as well as original data from interviews with over fifty professional musicians: bassists George Duvivier and Rufus Reid; drummers Max Roach, Ronald Shannon Jackson, and Akira Tana; guitarist Emily Remler; pianists Tommy Flanagan and Barry Harris; saxophonists Lou Donaldson, Lee Konitz, and James Moody; trombonist Curtis Fuller; trumpeters Doc Cheatham, Art Farmer, Wynton Marsalis, and Red Rodney; vocalists Carmen Lundy and Veal Williams; and others. Together, the interviews provide insight into the production of jazz by legendary artists such as Betty Carter, Miles Davis, Dizzy Gillespie, Coleman Hawkins, and Charlie Parker.

Thinking in Jazz utilizes musical examples from the 1920s to the present, including original transcriptions (keyed to commercial recordings) of collective improvisations by Miles Davis's and John Coltrane's groups. These transcriptions provide additional insight into the structure and creativity of jazz improvisation and represent an experiential resource for jazz musicians as well as students and educators.

Berliner explores the alternative ways - aural, visual, kinetic, verbal, emotional, theoretical, associative - in which these performers conceptualize their music and describes the subtle communicative interplay of soloist and ensemble in collective improvisation. Berliner's skillful integration of data concerning musical development, as well as the rigorous practice and thinking artists devote to jazz outside of performance, and the complexities of "spontaneous composition" facilitates a construction of jazz improvisation as a language, an aesthetic, and a tradition. Although Berliner does not attempt to construct a model, his systematic exploration of the jazz tradition continues to fascinate and enlighten musicians, musicologists, and jazz fans alike.

Berliner himself states in the opening notes that this work began as far as the late seventies, and many noted jazz musicians were involved in the conception and contributed to the final product - sharing personal stories, historical notes and specially revising the music examples that constitute a large part of this book. Trying to capture a concept such as improvisation in written form, as well as trying to organize it in a system that would be helpful to understand and cultivate the protocol represents a significant challenge to the research, and many would say that Paul Berliner's approach was successful. Acknowledging that, criticisms do suggest that Berliner has a tendency to favor sound over form, and sometimes dismisses contributions made by non-jazz musicians to the history of improvised music (despite the author's previous work with traditional African music), but what he achieved in *Thinking in Jazz* is generally considered to be authoritative research on the art of jazz improvisation (Kernfield, 1988, 2003).

Case against Case Comparison

It is useful to compare Berliner's systematic fifteen year case study of jazz improvisation with the following "edge" case. This case study was envisioned as a specific and supplemental (and complementary) addition to Berliner's foundational research. This case study specifically explores *information* in jazz improvisation from multiple dimensions: qualitatively, from that of the students, and instructor of jazz improvisation (through field observation), as well as quantitatively through the use of multi-dimensional entropy equations applied to jazz lead-sheets and transcriptions of improvisations collected from a UNT jazz improvisation course. The combined data contributes to an Information behavior taxonomy (IBT) outlining the specific usages of information in the context of the jazz improvisation course, and an Information Flow Diagram (IFD) detailing the flows of information in a jazz improvisation performance, and calculated entropy rates in multiple dimensions (HME, HHE, HRE, HCME) for jazz lead-sheets and transcriptions collected from students in the jazz improvisation course (Appendix D - I). In conclusion, the combined data set serves as a model to be explored in the context of music information retrieval.

Qualitative Analysis

The following qualitative analysis incorporates field notes (Appendix J) collected from non-obtrusive observation of a semester long UNT jazz improvisation instructional program taught by Stefan Karlsson in the spring 2005 semester (see Appendix C for course syllabus). The case study of the UNT MUJS 3370.001 Advanced Jazz improvisation course employed a grounded theory approach (defined in the Method section above) in the construction of the following Information Behavior Taxonomy (IBT) outlining information behaviors in the context

of the jazz improvisation course, as well as the Information Flow Diagram (IFD) mapping the flow of information in a jazz improvisation performance.

Course Description

The following case study of the UNT MUJS 3370.001 Advanced Jazz Improvisation course taught by Professor Stefan Karlsson of the UNT Jazz Studies program was conducted in the spring semester of 2005. Field notes were collected over the course of the semester (January through May) while auditing course sessions (held twice weekly, Monday and Wednesday, one and a half hours each). The instructor's primary instrument is piano, the 13 students in attendance included 4 saxophonists, 3 trumpeters, 3 guitarists, 2 bass players, and 1 drummer.

Course activities (as outlined in the syllabus, Appendix C) included verbal instruction, music analyses, music listening and performances of musical examples (both recorded and live), individual and collective rehearsals, and class performances. Six tunes served as musical material from which to learn specific aspects of jazz improvisation, as well as to contribute to the repertoire of the students. The various instrumentalists were divided into three ensembles and performed the tunes in class approximately every two weeks (see syllabus calendar). Course activities were divided between music analysis, verbal instruction, music listening, performance examples (with and without accompaniment), and individual and ensemble performances.

Information Behavior Taxonomy (IBT)

The following taxonomy (developed from field notes utilizing the three-tiered grounded theory approach of coding, memoing, and sorting) classifies and summarizes the various music information behaviors (MIB) that were observed in the jazz improvisation course. Field notes (Appendix J) are in "raw" form, as fleetingly captured during classroom observation. The notes

naturally took on a shorthand sketch and rough outline format. While the field notes are not in a narrative form, they are provided as a reference. They are by no means exhaustive, but serve as a mnemonic “trigger” of the lived experience.

The taxonomy is a summarization of the most frequent (and most important) music information behaviors observed in the classroom setting (see field notes Appendix J) over the course of the semester. The elements of the taxonomy emerged from the notes. Admittedly there were inherent limitations in the note taking in the observation of the jazz improvisation course setting – particularly since an important term might only have been used once by the instructor, but with such timing and emphasis as to demonstrate it was very important. Stating that, the observations yielded results confirming the assumption that improvisation overtly makes use of entropy as observed in the course setting: ADD TABLE WITH QUOTES FROM FIELD NOTES

Speech Acts: information expressed in speech was primarily in the form of *information-as-knowledge*, and included verbal instruction; *information-as-entropy* was also frequently referred to in the phrases: SURPRISE, UNCERTAINTY, RISK, NOVELTY, COMPLEXITY, NO “WRONG” NOTES; entropy was also referred to metaphorically with COOKING, MIXING SPICES, CONTOUR, I.E., DEGREES OF INFORMATION; exchanging *information-as-knowledge* in question and answer sessions, as well as statements defining song structure, instrumentation, and improvisational form (including sequence of musicians are to take when improvising).

Music Listening: information utilized in listening emphasized *information-as-thing* (CDs) and *information-as-process* (the act of listening to information “things,” as well as listening to live performance of music examples from both students and instructor).

Music Analysis: *information-as-knowledge* (music theory, suggestions of music vocabulary to use over particular harmonic sequences, rules of thumb) expressed using *information-as-thing* (musical documents: notation, lead-sheets, transcriptions), writing music examples on chalk board.

Performance: *information-as-process* (performance) utilizing *information-as-entropy* (improvisation), individual and ensemble rehearsals, and individual and ensemble performance evaluations.

As the taxonomy suggests, music information behavior is fundamental to jazz listening, instruction, performance, and improvisation. A further exploration of the taxonomy will later be undertaken in the context of music information retrieval.

Information Flow Diagram (IFD)

The following Information Flow Diagram attempts to map the flow of information between musicians (and themselves) in the context of a jazz improvisational performance. The diagram integrates components from Shannon's information theory and Wiener's cybernetics. Additionally, the diagram is highly influenced by a similar relationship that Augst and O'Connor (1999) explored between information theory and moving image documents. The diagram attempts to map the multi-layered, poly-directional, spatial and temporal *flow of information* between musicians in their jazz improvisation performances. The diagram integrates several modules, and utilizes concepts such as *feedback loop*; *information flow*; *information channel*; and *information space/time*.

An information flow in jazz improvisation reasonably starts with the most fundamental component: the individual musician. The solitary musician can be characterized as having a *feedback loop* (Figure 5.1) with himself (and in which the flow of information could be further

analyzed in terms of Shannon’s communications channel: source, transmitter, noise, receiver, and destination); the musician can be conceptualized as monitoring and adjusting his musical entropy rate in real-time (regardless of the instrument played). This “feedback loop” can be easily adapted from Norbert Wiener’s cybernetic theory outlined above. And as Wiener (1950) emphasizes, feedback is primarily a mechanism to control entropy (Weiner’s *negentropy*):

Purposive behavior (action directed toward a goal) in humans or in machines requires control mechanisms that maintain order by counteracting the natural tendency toward disorganization, or entropy.

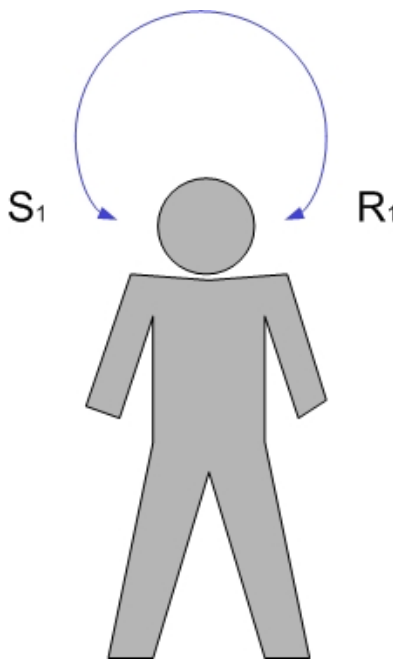


Figure 5.1: Solo Module

In the words of the flutist Jim Denley (in Bailey, 1991):

For the improviser the physicality of producing sound (the hardware) is not a separate activity to the thoughts and ideas in music (software). In the act of creation there is *a constant loop* between the hierarchy of factors involved in the

process. My lungs, lips, fingers, voice box and their working together with the potentials of sound are dialoguing with other levels which I might call mind and perception.

Building on the concepts above, it is possible to conceptualize the individual musician in a communications feedback loop in which controlled rates of entropy (and negentropy) are maintained in a relative state of equilibrium.

The feedback loop concept can be applied to a complete improvisational group as well (a sextet in the example in Figure 5.2); mapping the individual feedback channels as well as the communications channels between each member results in the following group matrix (Table 5.1).

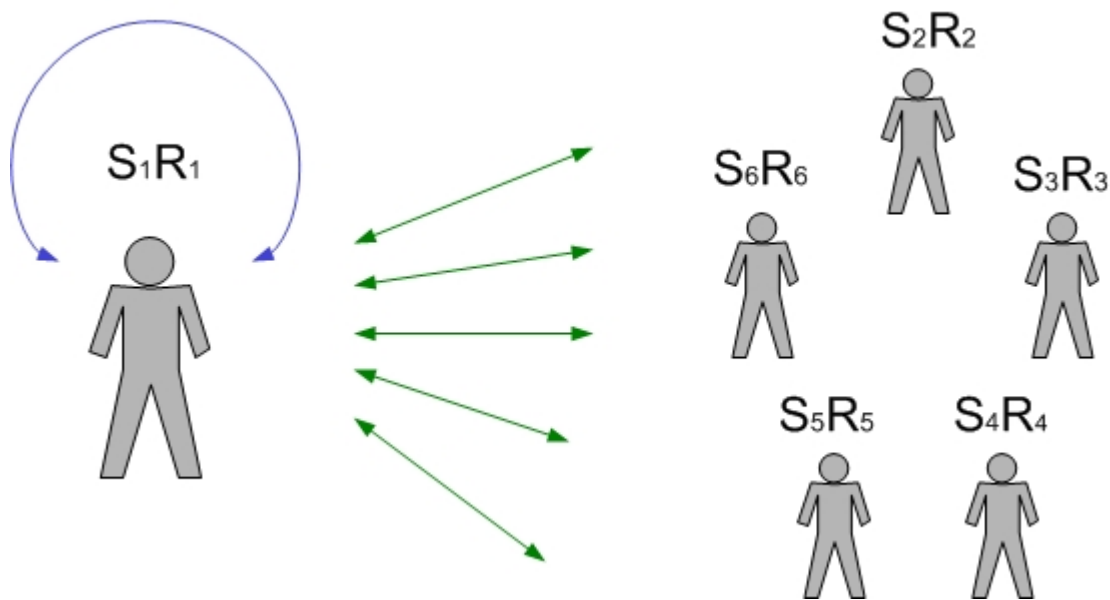


Figure 5.2: Group Module
(S = sender, R = receiver)

Table 5.1: Group Matrix

	S1	S2	S3	S4	S5	S6
R1	•	•	•	•	•	•
R2	•	•	•	•	•	•
R3	•	•	•	•	•	•
R4	•	•	•	•	•	•
R5	•	•	•	•	•	•
R6	•	•	•	•	•	•

The individual “nodes” within the channel mappings can be color coded to indicate the potential for mapping rates of information flow as well (as in Table 5.1). While these colors do not indicate any particular relationship or set of relationships, they are only intended to indicate the possibility of mapping numerous and possibly highly varied sets of relationships.

Feedback loops, and information channels can be extended to the improvisational group, and to the audience as well (in Figure 5.3); mapping the individual feedback channels as well as the information channels between each musician and the audience results in the following composite matrix (Table 5.2). The individual “nodes” within the channel mappings can be color coded to indicate the potential for mapping rates of information flow at this level as well.

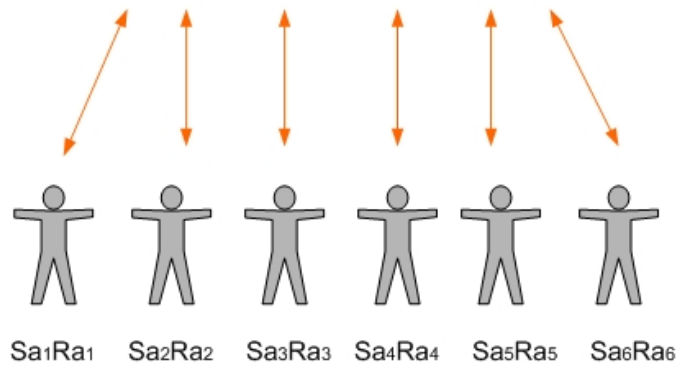
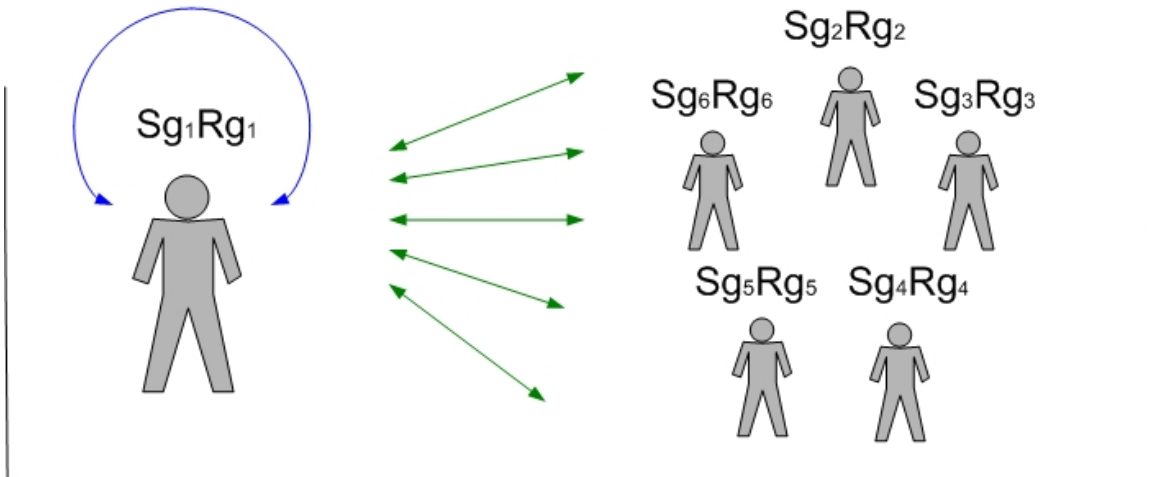


Figure 5.3: Composite Module

(S = sender, R = receiver, g = group, a = audience)

Table 5.2: Composite Matrix

	Sg1	Sg2	Sg3	Sg4	Sg5	Sg6	Sa1	Sa2	Sa3	Sa4	Sa5	Sa6
Rg1	•	•	•	•	•	•	•	•	•	•	•	•
Rg2	•	•	•	•	•	•	•	•	•	•	•	•
Rg3	•	•	•	•	•	•	•	•	•	•	•	•
Rg4	•	•	•	•	•	•	•	•	•	•	•	•
Rg5	•	•	•	•	•	•	•	•	•	•	•	•
Rg6	•	•	•	•	•	•	•	•	•	•	•	•
Ra1	•	•	•	•	•	•	•	•	•	•	•	•
Ra2	•	•	•	•	•	•	•	•	•	•	•	•
Ra3	•	•	•	•	•	•	•	•	•	•	•	•
Ra4	•	•	•	•	•	•	•	•	•	•	•	•
Ra5	•	•	•	•	•	•	•	•	•	•	•	•
Ra6	•	•	•	•	•	•	•	•	•	•	•	•

The composite matrix can be conceptualized as a “snapshot” of individual, group, and audience information flows at any one point in time during a performance. Again, the colors are merely to suggest possible variations in the rate of information flow and do not indicate any particular form or set of relationships.

Mapping a vector space model (Figure 5.4) to individual matrices at regular intervals in time allows us to conceptualize the dynamic information flow processes as they occur within the space and time of a jazz improvisational performance.

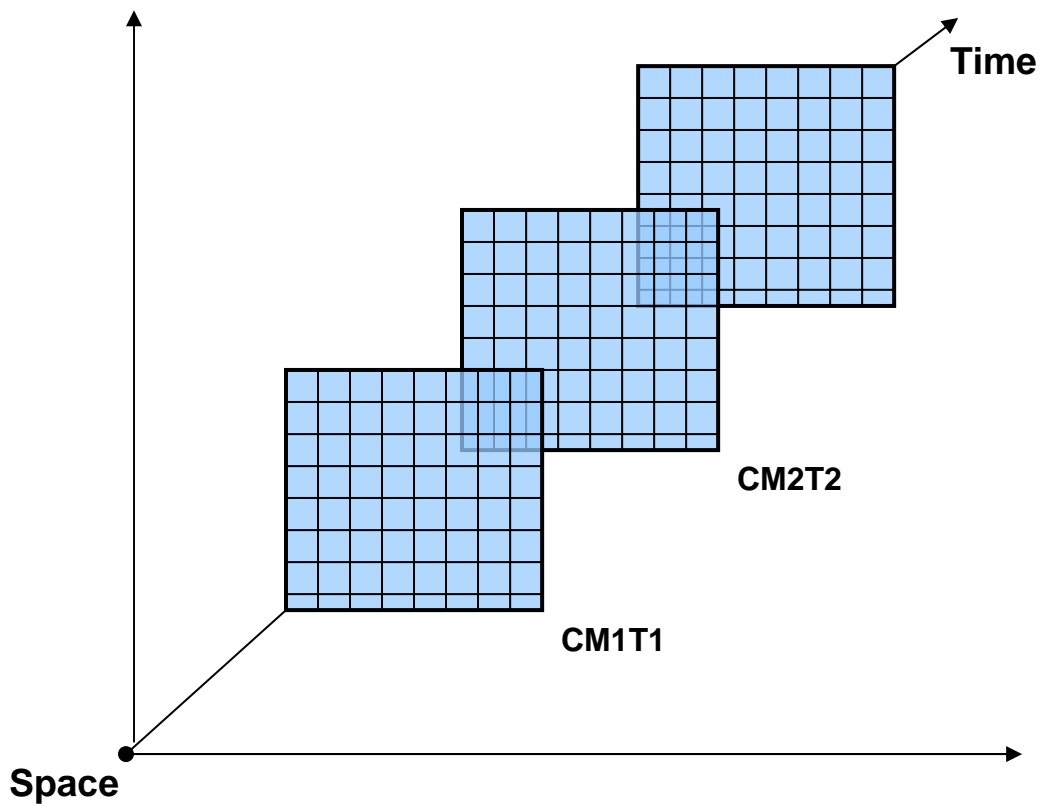


Figure 5.4: Vector-Space Model

(CM = composite matrix, T = time)

The various modules and matrices above are conceptualized as integrated components of a model of information flows resulting in changes in entropy in jazz improvisation. This diagram will be later explored in the context of music information retrieval. The next step is to calculate entropy rates in jazz lead-sheets and transcriptions of improvisations collected from the course.

Quantitative Analysis

The following entropy calculations are applied to select jazz lead-sheets and transcriptions of improvisations (Appendix D - I) collected during the case study of a UNT jazz

improvisation instructional course. The transcriptions feature melodic instruments (instruments which sound single pitches in succession, such as trumpet and saxophone) therefore the harmonic data remains equivalent for the lead-sheet and transcriptions in the case of harmonic entropy (HHE). Harmonic instruments (instruments capable of sounding multiple pitches simultaneously, such as piano or guitar) and rhythmic instruments (drums, percussion) which sound rhythmic and poly-rhythmic data only (with or without a discernable pitch) introduce additional complexities and will be explored in future research. Also, lyrics are not addressed in the following research, although it should be kept in mind that the resulting analysis of melodic instruments could apply equally as well to vocal melodies.

Several heuristics were utilized in the data collection process and following music analysis: data is listed chronologically, roughly in the order in which it appears in the lead-sheets and transcriptions; in the melodic data, octave displacements are indicated chronologically as well: for example, subsequent notes are indicated as above or below the initial octave where appropriate. And tied notes (sustained notes) are listed as notated, with the various multiplications of rhythms that make up each tie indicated individually as well. In addition, entropy will be referred to as complexity (following Watt's lead), and quantities (or degrees) of information. These terms are judged the most accurate and most intuitive characterizations of the abstract concept of entropy in the context of jazz improvisation.

U.M.M.G. (Upper Manhattan Medical Group)

2. UMMG
 (UPPER MANHATTAN MEDICAL GROUP)
 Music by Billy Strayhorn

PLAY 2 CHORUSES (♩ = 208)

SOLOS

BRIDGE

LATIN

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Figure 5.5: *U.M.M.G.* (printed with permission from Music Sales Corporation)

U.M.M.G. (composed by Billy Strayhorn) is a mid-tempo bebop tune (suggested beats per minute = 208) in AABA form, and consists of an 8 bar melody and chord structure that is repeated twice, followed by an 8 bar bridge, concluding with an 8 bar restatement of the initial melody and a 4 bar turnaround (for full score see Appendix D). The tune is in the key of D flat major, and is in 4/4 time (4 notes per bar, quarter note per beat). Analysis of the melody (Table 5.3), harmony (Table 5.4), and rhythm (Table 5.5) yields the following data:

U.M.M.G. (Upper Manhattan Medical Group)

2. UMMG
PLAY 2 CHORUSES (UPPER MANHATTAN MEDICAL GROUP)
(♩ = 208) Music by Billy Strayhorn

1. D^bA 3- D^b- G^b7^b9 2. D^bA 3- Ab-

D^b7 G⁰ C7^b9 FA Ab⁰

D^b7^b9 G^b- 1 Ab7 F⁰ B^b7^b9 Eb-

Ab7 D⁰7/C D^bA D⁰7/C D^bA

SOLOS C^b Ab

F⁰ B^b7^b9 Eb- Ab7 D⁰7 D^bA D^bA D^b- G^b7^b9 2. D^bA

BRIDGE

Ab- D^b7 G⁰ C7^b9 FA Ab⁰ D^b7^b9 G^b- Ab7

F⁰ B^b7^b9 Eb- Ab7 D⁰7/C D^bA D⁰7/C D^bA

LATIN

D⁰7/C D^bA D^bA

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Gb7b9	1
Ab-	1
Db7	1
G half dim	1
C7b9	1
Fmaj7	1
Ab half dim.	1
Db7b9	1
Gb-	1
Db dim.7/C	2
Tot. harmonic var. = 17	Total chords = 33

Table 5.5: Rhythmic Data

Rhythmic Variations	Rhythmic Repetitions
Dotted half	10
eighth	12
Eighth + dotted quarter	6
Dotted quarter + quarter	3
Eighth + half	5
Dotted quarter	5
Eighth + quarter	4
quarter	12
Quarter note triplet	6
Half note	3
Eighth + quarter + half	1
Eighth + whole note	3
Tot. rhythmic var. = 12	Total rhythms = 69

Applying the musical entropy formulas to the data set above results in the following calculations (Table 5.6):

$$\text{HME: } 18/62 \times 18/62(\log 2) = 0.0254$$

$$\text{HHE: } 17/33 \times 17/33(\log 2) = 0.0799$$

$$\text{HRE: } 12/69 \times 12/69(\log 2) = 0.0091$$

$$\text{HCME: } (0.0254 + 0.0799 + 0.0091) / 3 = 0.0381$$

Table 5.6: Calculated Musical Entropy for *U.M.M.G.*

HME	0.0254
HHE	0.0799
HRE	0.0091
HCME	0.0381

The calculations indicate that the harmonic complexity is the highest, followed by the melody, and then the rhythm. The composite musical entropy (HCME) rate gives us a baseline entropy rate for the thematic material contained in the original score of Billy Strayhorn's *U.M.M.G.* This baseline thematic material would then be subject to variations, substitutions, or abandoned altogether in a jazz improvisational performance. The baseline entropy rate allows for a comparative analysis of entropy in jazz improvisation. Measuring levels of entropy in a transcription of Wynton Marsalis' trumpet improvisation in his recorded version of *U.M.M.G.* follows.

Wynton Marsalis' Improvisation on U.M.M.G.

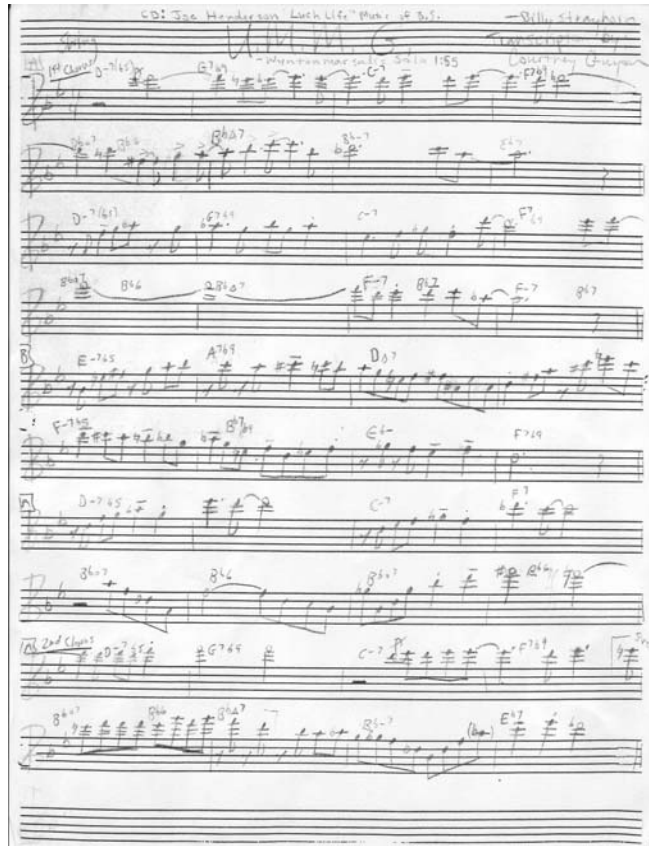


Figure 5.6: Wynton Marsalis' Improvisation on *U.M.M.G.* (transcription collected and printed with permission from Professor Stefan Karlsson, UNT)

This transcription (see Appendix G for full transcription) features 2 choruses (64 bars) of Wynton Marsalis' trumpet improvisations on the mid-tempo bebop tune *U.M.M.G.* (from Joe Henderson's *Lush Life: The Music of Billy Strayhorn* CD). As stated above the tune (composed by Billy Strayhorn) is in AABA form, and consists of an 8 bar melody and chord structure that is repeated twice, followed by an 8 bar bridge, concluding with an 8 bar restatement of the initial melody and a 4 bar turnaround. The tune is in the key of D flat major, and is in 4/4 time (4 notes per bar, quarter note per beat). The improvisation has been transposed to the key of Bb in order to accommodate an Eb instrument (alto saxophone). While the trumpet is not a harmonic instrument (not capable of multiple simultaneous pitches), it is primarily a melodic instrument,

and the rhythmic content of the melodic material is also suitable for analysis. Analysis of Joe Henderson's improvisation at the level of melody (Table 5.7) and rhythm (Table 5.8) yields the following data (since there is no harmonic variation, the harmonic data is restated from Table 5.4):

Table 5.7: Melodic Data

Pitch Variations	Pitch Repetitions
Eb	19
F	16
E	5
D	25
Db	5
F#	5
G	21
A	14
Bb	13
C	8
A octave below	3
F octave below	28
Ab	13
Eb octave below	3
Gb	9
F# octave above	3
Bb octave below	7
E octave below	9
C#	9
B	3
D octave below	16
Db octave below	4
C octave below	3

G octave above	3
C# octave below	5
B octave below	1
Total pitch var. = 30	Total pitches = 250

Table 5.8: Rhythmic Data

Rhythmic Variations	Rhythmic Repetitions
Eighth + half + quarter	1
Eighth	163
Eighth + dotted quarter	5
Quarter	33
Half + quarter	2
Eighth + eighth	2
Dotted half	1
Eighth + dotted half	5
Eighth + whole + whole + eighth	1
Eighth + half	3
Dotted quarter	3
Half + eighth	1
Half + quarter	1
Half	9
Eighth + quarter	1
Eighth + dotted half + quarter	1
Dotted half + quarter	1
Tot. rhythmic var. = 17	Total rhythms = 233

Applying the musical entropy formulas to the data set above results in the following calculations (Table 5.9):

$$\text{HME: } 30/250 \times 30/250(\log 2) = 0.0043$$

$$\text{HHE: } 17/33 \times 17/33(\log 2) = 0.0799$$

$$\text{HRE: } 17/233 \times 17/233(\log 2) = 0.0016$$

$$\text{HCME: } (0.0043 + 0.0799 + 0.0016) / 3 = 0.0334$$

Table 5.9: Calculated Musical Entropy for *U.M.M.G.* Improvisation

HME	0.0043
HHE	0.0799
HRE	0.0016
HCME	0.0334

Since no new harmonic information was introduced in the improvisation, the calculations indicate that the harmonic complexity is equivalent, while the melody, and then the rhythm decrease. The composite musical entropy (HCME) rate gives us a baseline entropy rate for the melodic and harmonic information contained in Wynton Marsalis' improvisation on *U.M.M.G.* This baseline thematic material as analyzed in *U.M.M.G.* was subject to variations, substitutions, and in some cases abandoned altogether in Wynton's jazz improvisation. Surprisingly, the entropy rate calculated in the transcription of Wynton Marsalis' trumpet improvisation in his recorded version of *U.M.M.G.* decreases from the baseline entropy rate of the thematic material (as found in the lead-sheet) which serves as its foundation. Percentage of changes in entropy between two or more measures can be calculated by dividing the entropy rates and subtracting the result from 100: while the melodic entropy rate decreases 83.1% (the melodic complexity decreases by 83.1%), the rhythmic entropy decreases by 82.4%. Although the composite entropy rate decreased by only 12.3% (when factoring the equivalent harmonic entropy), the calculations suggest the probability that the improvisation may be more predictable than the baseline thematic

material contained in the lead-sheet. In addition, when entropy decreases in one dimension, it may decrease proportionally in another. More analysis is needed to confirm such probabilities.

Lush Life

197
Lush Life Billy Strayhorn
(As played by John Coltrane)

Freely [A] D^b6 C⁹ D^bMA⁷ C⁹

I used to vis- it all the ver- y gay pla - ces. Those come what
may pla - ces where one re - lax - es on the ax - is of the wheel of life to get the
feel of life from jazz and cock-tails. The girls I knew had sad and sul-ten
gray fa - ces. With dis - tin - gue tra - ces that used to be there, you could see where they'd been
washed a - way by too man - y thru the day, twelve o' - clock tales. Then

(Faster) [B] F^{Mi} F^{Mi}6 F^{Mi} F^{Mi}7 F^{Mi} G^{Mi}7(9) C⁷

you came a - long with your si - ren song to tempt me to mad - ness, I
thought for a while that your polg - nant smile was tinged with the sad - ness
of a great love for me. Ah! yes, I was
wrong. a - gain I was wrong.

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Figure 5.7: *Lush Life* Lead Sheet (printed with permission from Cherry Lane Music Publishing Company)

Lush Life (composed by Billy Strayhorn, and made famous by Duke Ellington) is a ballad (approximately 58 bpm) in ABCD form and consists of a 14 bar verse section followed by a 14 bar bridge, then a 12 bar verse section followed by a 14 bar bridge, 54 bars total (See Appendix E for full score). The tune is in the key of Db major and is in 4/4 time (4 notes per bar, quarter note per beat). Analysis of the lead-sheet melody (Table 5.10), harmony (Table 5.11), and rhythm (Table 5.13) yields the following data:

Table 5.10: Melodic Data

Pitch Variations	Pitch Repetitions
Ab	21
Db	15
Eb	33
F	40
Gb	8
Ab octave above	9
A	13
B	20
Bb	15
E	12
C	18
D	6
C octave above	9
D octave above	2
Gb	8
F#	7
G#	7
A octave above	1
Fb	1
Bb octave above	2
Total pitch variations = 20	Total pitch repetitions = 257

Table 5.11: Harmonic Data

Harmonic Variations	Harmonic Repetitions
Db6	4
Cb9	5
Dbmaj7	14
Eb-7	3

F-7	7
F#-7	3
Ab-7	2
D13#11	14
D9#11	2
Db-6/9	2
D13#11	3
G-7b5	2
C7	2
F-6	2
F-	6
Ab13	3
B9b5	1
Bb9	1
A9b5	1
Eb-7add11	1
B13	4
Emaj7	1
Db9	1
C13	1
Fmaj7	1
A13	1
Eb7#9#5	1
Abmaj7	2
E-7	1
A7	1
Dmaj7	1
D-7	1
G7	1
Cmaj7	1

C7#11#9	1
F-7add11	1
Bb7	2
F#-9	2
A9#5	1
Ab7#9	1
A7#9	1
Bb7#9	1
B7#9	1
C7#9	1
Gb13	1
Total harmonic variations = 45	Total harmonic repetitions = 109

Table 5.12: Rhythmic Data

Rhythmic Variations	Rhythmic Repetitions
eighth	111
Quarter triplet	42
Quarter triplet + eighth	5
Quarter + eighth	2
Dotted quarter	18
half	2
quarter	39
Quarter + half	1
Eighth + whole	1
whole	1
Whole + half	1
Eighth triplet	6
Dotted half	3
Eighth + dotted quarter	2
Tot rhythmic variations =	Total repetitions =

14	234
----	-----

Applying the musical entropy formulas to the data set above results in the following calculations (Table 5.13):

$$\text{HME: } 20/257 \times 20/257(\log 2) = 0.0018$$

$$\text{HHE: } 45/109 \times 45/109(\log 2) = 0.0513$$

$$\text{HRE: } 14/234 \times 14/234(\log 2) = 0.0011$$

$$\text{HCME: } (0.0018 + 0.0513 + 0.0011) / 3 = 0.0181$$

Table 5.13: Calculated Musical Entropy for *Lush Life*

HME	.0018
HHE	.0513
HRE	.0011
HCME	.0181

The calculations indicate that like *U.M.M.G.*, the harmonic complexity is the highest, followed by the melody, and then the rhythm. The composite musical entropy (HCME) rate gives us a baseline entropy rate for the thematic material contained in the original score of Billy Strayhorn's *Lush Life*. This baseline thematic material would then be subject to variations, substitutions, or abandoned altogether in a jazz improvisational performance. The baseline entropy rate allows for a comparative analysis of changes in entropy in jazz improvisation. Measuring levels of entropy in a transcription of a jazz improvisation will be explored in the following analysis of the saxophonist John Coltrane's classic solo from his classic *Lush Life* recording.

John Coltrane's Improvisation on *Lush Life*

The image shows a page of musical notation titled "LUSH LIFE - COLTRANE SOLO". The notation is for a saxophone solo, starting with the instruction "SAXOPH IN Bb". The score consists of ten staves of music. The first staff begins with a treble clef, a key signature of two flats (Bb major), and a 4/4 time signature. The music is written in a single melodic line, featuring a variety of rhythmic patterns and intervals. The notation includes many beamed eighth and sixteenth notes, as well as some triplet markings. The score ends with a double bar line on the tenth staff. In the top right corner of the page, there is a small number "15" and the text "STEATHOEN/COLTRANE".

Figure 5.8: John Coltrane's Improvisation on *Lush Life* (transcription collected and printed with permission from Professor Stefan Karlsson, UNT)

The transcription (Appendix H) of John Coltrane's improvisation on the tune *Lush Life* (featured on the John Coltrane *Lush Life* CD) consists of the first 20 bars on the C section (2nd verse of the tuner). As stated above, the tune is a ballad (suggested 58 bpm) in the key of Db major and is in 4/4 time (4 notes per bar, quarter note per beat). (The improvisation has been transposed for an alto saxophone, which is a Bb trumpet. Thus it has been notated at concert pitch). Like Wynton Marsalis' improvisation on *U.M.M.G.*, Coltrane's improvisation is primarily

melodic, and thus the harmonic entropy is equivalent to the lead-sheet. Analysis of the transcription of Coltrane's melody (Table 5.14) and rhythm (Table 5.15) yields the following data:

Table 5.14: Melodic Data

Pitch Variations	Pitch Repetitions
Bb	30
Db	6
D	10
C	9
B	13
F#	13
Cb	1
F	14
C#	8
A	6
Ab	5
Db octave below	1
C octave below	8
Bb octave below	9
Ab octave below	1
C# octave below	13
E	3
B octave below	9
G	2
G octave below	12
Eb	6
D#	1
E octave above	1
D# octave below	5

D octave below	4
G#	2
A#	1
Eb octave above	1
Total pitch variations = 28	Total pitch repetitions = 194

Table 5.15: Rhythmic Data

Rhythmic Variations	Rhythmic Repetitions
Eighth note triplet	20
Quarter	7
Eighth note triplet + eighth not triplet	6
Eighth	6
Sixteenth	55
Sixteenth note triplet	12
Thirty-second	70
Dotted eighth	3
Eighth + sixteenth	1
Sixteenth + eighth + eighth note triplet	1
Eighth + dotted eighth	1
Dotted eighth + dotted eighth	1
Dotted eighth + sixteenth + sixteenth	1
Eighth + quarter	1
Eighth + sixteenth	2
Sixteenth + quarter	1
Sixteenth + thirty-second	1
Eighth note triplet +	1

eighth not triplet + eighth note triplet	
Eighth note triplet + quarter	1
Tot rhythmic variations = 20	Total repetitions = 191

Applying the musical entropy formulas to the data set above results in the following calculations (Table 5.16):

$$\text{HME: } 28/194 \times 28/194(\log_2) = 0.0063$$

$$\text{HHE: } 45/109 \times 45/109(\log_2) = 0.0513$$

$$\text{HRE: } 20/191 \times 20/191(\log_2) = 0.0033$$

$$\text{HCME: } (0.0063 + 0.0513 + 0.0033) / 3 = 0.0302$$

Table 5.16: Calculated Musical Entropy for *Lush Life* Improvisation

HME	.0063
HHE	.0513
HRE	.0033
HCME	.0302

Because no harmonic variations were introduced in the improvisation, the calculations indicate that the harmonic complexity is equivalent with the *Lush Life* lead-sheet, while the melodic and harmonic entropy increases moderately. The composite musical entropy (HCME) rate gives us an entropy rate for the thematic material contained in John Coltrane's improvisation on Billy Strayhorn's *Lush Life*. The baseline thematic material analyzed in the lead-sheet was subject to variations, substitutions, and occasionally abandoned altogether in Coltrane's jazz improvisational performance. While the melodic entropy rate increases by 71.4% (the melodic

complexity increases by 71.4%), the rhythmic entropy increases by 66.6%. The composite entropy rate increases by 40.1% (when factoring the equivalent harmonic entropy), and the calculations suggest that Coltrane's improvisation is far more complex than the baseline thematic material contained in the lead-sheet (and more complex than Wynton Marsalis' improvisation on *U.M.M.G.* respectively). The levels of entropy as measured in the transcription analysis of the saxophonist John Coltrane's classic solo from his *Lush Life* recording indicates an increasing level of both melodic and rhythmic entropy from the baseline thematic material contained in the lead-sheet. It should be noted that entropy is a quantitative measure, and not a qualitative one; higher or lower degrees of entropy in an improvisation are not necessarily indicative of more improvisational skill and daring, although such conclusions are intuitive (and perhaps accurate). The calculations for Coltrane's improvisation suggest that when entropy increases in one dimension, it may increase proportionally in another. Again, future analysis is needed to validate such a probability.

A Shade of Jade

108

A Shade of Jade

Joe Henderson

$\text{♩} = 264$

fast

A Cmin \flat Cmin \flat Cmin \flat

Cmin \flat F \flat sus4/G D \flat Ma7(\flat 5) D \flat Ma7(\flat 5)

E \flat Ma7(\flat 5) EMa7(\flat 5) DMa7(\flat 5) D \flat Ma7(\flat 5)

D \flat Ma7(\flat 5) D \flat Ma7(\flat 5) 1^{st} D \flat Ma7(\flat 5) 2^{nd} D \flat Ma7(\flat 5)

B G \flat Maj7 G \flat Maj7 F7(\flat 9)

F7(\flat 9) B \flat min B \flat min G \flat 7

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Figure 5.9: *A Shade of Jade* Lead-Sheet (printed with permission from Alfred Publishing Co., Inc.)

A Shade of Jade (composed by saxophonist Joe Henderson) is an up-tempo bebop tune in AABA form and consists of a 12 bar melody and chord structure that is repeated twice (AA), followed by a 16 bar melody and chord structure (B), concluding with a repetition of the 12 bar A section (for full score see Appendix F). The A section is in the key of C minor (Eb major), while the B section shifts to Bb minor (Db major). The tune is in 4/4 time (4 notes per bar, quarter note per beat), and played at a brisk tempo (suggested bpm=264). Analysis of the Lead sheet melody (Table 5.17), harmony (Table 5.18), and rhythm (Table 5.19) yields the following data:

Table 5.17: Melodic Data

Pitch Variations	Pitch Repetitions
D	36
Eb	19
G	19
C	27
F	21
F octave below	12
Bb	7
G octave below	10
A	3
Ab	6
Gb	7
Db	8
Ab octave above	3
Bb octave above	1
Gb octave above	4
Total pitch var. = 15	Total pitch rep. = 183

Table 5.18: Harmonic Data

Harmonic Variations	Harmonic Repetitions
C-6/9	12
Fsus4/G	3
Dbmaj7b5	16
Ebmaj7b5	3
Emaj7b5	3
Dmaj7b5	3
Gbmaj7	3
F7b9	2
Bb-	2
G half diminished 7	1

C7b9	1
Fmaj7	1
D-7	2
F-7/Bb	1
G-7/C	2
Abmaj7	2
D half-diminished 7	1
Ab6/9	1
Abmaj7b5	1
G7b9	1
Tot. harmonic variations = 20	Total harmonic repetitions = 60

Table 5.19: Rhythmic Data

Rhythmic Variations	Rhythmic Repetitions
half	36
quarter	42
Quarter + eighth	18
eighth	26
Dotted quarter	21
Eighth + half + whole	11
Eighth + dotted half + eighth	9
Eighth + whole = dotted half	9
Quarter + whole + half	3
Half + quarter	1
Eighth + dotted quarter	2
Half + quarter	1
Eighth + whole	1
Quarter triplet	3

Whole + quarter	1
Eighth + half + dotted half	1
Eighth triplet	3
Eighth + half + half	1
Tot. rhythmic var. = 18	Total rhythms = 189

Applying the musical entropy formulas to the data set above results in the following calculations (Table 5.20):

$$\text{HME: } 15/183 \times 15/183(\log_2) = 0.0020$$

$$\text{HHE: } 20/60 \times 20/60(\log_2) = 0.0334$$

$$\text{HRE: } 18/189 \times 18/189(\log_2) = 0.0027$$

$$\text{HCME: } (0.0020 + 0.0334 + 0.0027) / 3 = 0.0127$$

Table 5.20: Calculated Musical Entropy for *A Shade of Jade*

HME	.0020
HHE	.0334
HRE	.0027
HCME	.0127

As with *U.M.M.G.* and *Lush Life*, the calculations indicate that the harmonic complexity is the highest, but unlike the others, the rhythm has the next highest entropy, with the melody containing the least entropy. The composite musical entropy (HCME) rate gives us a baseline entropy rate for the thematic material contained in the original score of Joe Henderson's *A Shade of Jade*. This baseline thematic material would then be subject to variations, substitutions, or abandoned altogether in a jazz improvisational performance. The baseline entropy rate allows for

a comparative analysis of changes in entropy in jazz improvisations. Measuring levels of entropy in a transcription of Lee Morgan's jazz improvisation follows.

Lee Morgan's Improvisation on A Shade of Jade

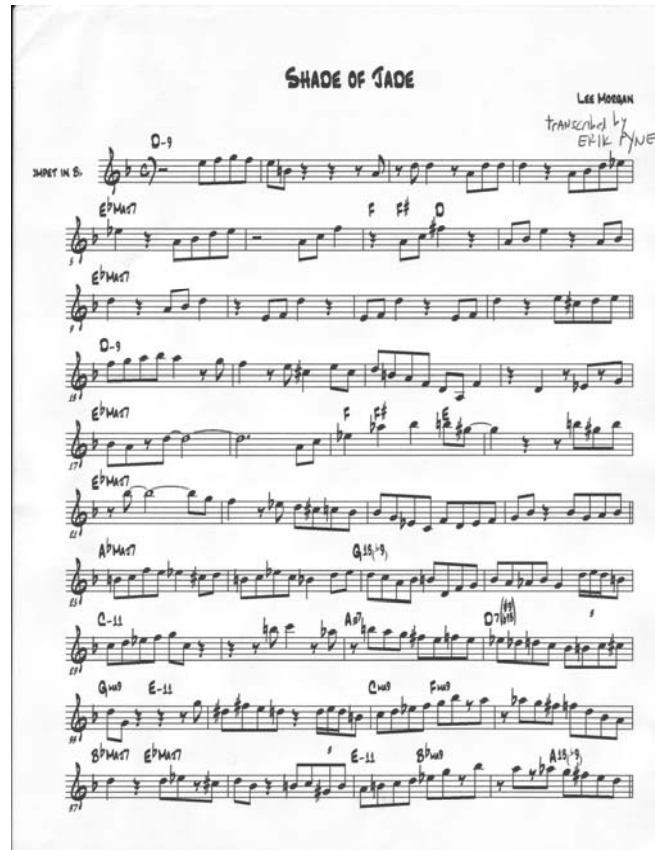


Figure 5.10: Lee Morgan's Improvisation on *A Shade of Jade* (transcription collected and printed with permission from Professor Stefan Karlsson, UNT)

The *A Shade of Jade* improvisation features a full 104 bar performance by the late trumpeter Lee Morgan (see Appendix I for full transcription) as can be found on the saxophonist and composer Joe Henderson's *A Mode for Joe* CD. The A section is in the key of C minor (Eb major), while the B section shifts to Bb minor (Db major). As stated above, the tune is in 4/4 time (4 notes per bar, quarter note per beat), and played at a brisk tempo (suggested bpm=264). The transcription is notated in the key of Bb to accommodate the Bb trumpet transposition.

Analysis of the improvisation melody (Table 5.21), and rhythm (Table 5.22) yields the following data:

Table 5.21: Melodic Data

Pitch Variations	Pitch Repetitions
E	49
F	24
G	24
B	19
A	29
D	54
E _b	37
B _b	36
F [#]	12
E octave below	5
F octave below	20
C [#]	19
A octave above	15
B _b octave above	15
B octave above	6
D octave below	11
A octave below	10
E _b octave below	7
G [#]	5
A _b	9
C	25
C octave below	3
C octave above	2
D _b	3
D [#]	1

F# octave below	1
G octave above	17
G# octave above	1
Gb	1
C# octave below	2
Pitch variation = 30	Pitch reps = 472

Table 5.22: Rhythmic Data

Rhythmic Variations	Rhythmic Repetitions
Eighth	423
Quarter	44
Eighth + half + dotted half	1
Eighth + quarter	2
Eighth + half + eighth	1
Sixteenth	6
Eighth + half + quarter	1
Eighth note triplet	15
Sixteenth note triplet	3
Eighth + dotted quarter	2
Eighth + half	1
Eighth + eighth	1
Dotted quarter	1
Eighth + half + quarter	1
Half + quarter	1
Dotted half + quarter	1
Eighth + quarter + whole	1
Whole	1
Half	1
Tot. rhythmic var. = 19	Total rhythms = 507

Applying the musical entropy formulas to the data set above results in the following calculations (Table 5.23):

$$\text{HME: } 30/472 \times 30/472(\log 2) = 0.0012$$

$$\text{HHE: } 20/60 \times 20/60(\log 2) = 0.0334$$

$$\text{HRE: } 19/507 \times 19/507(\log 2) = 0.0004$$

$$\text{HCME: } (0.0012 + 0.0334 + 0.0004) / 3 = 0.0117$$

Table 5.23: Calculated Musical Entropy for *A Shade of Jade* Improvisation

HME	.0012
HHE	.0334
HRE	.0004
HCME	.0117

The calculations indicate that the harmonic complexity is equivalent, followed by decreasing entropy rates in the rhythm, followed by the melody. The composite musical entropy (HCME) rate gives us a baseline entropy rate for the improvisational material contained in the Lee Morgan's trumpet solo on *A Shade of Jade*. The baseline thematic material (represented in the lead-sheet) was subject to variations, substitutions, and abandoned altogether in Morgan's jazz improvisational performance. The baseline entropy rate of Lee Morgan's trumpet solo allows for a comparative analysis with the lead-sheet at the level of entropy. It is interesting to note that the level of entropy for Morgan's solo was lower in the dimensions of melody and rhythm compared to the lead-sheet. This indicates that the thematic material contained in the improvisation is more predictable than the baseline thematic material contained in the lead-sheet theme. While the melodic entropy rate decreased by 40%, the rhythmic entropy decreased by 85.2%. The composite entropy rate decreased by only 7.9% (when factoring the equivalent

harmonic entropy), and the calculations suggest that Morgan's improvisation stays very close to the baseline thematic entropy contained in the lead-sheet (and is less complex than Wynton Marsalis' improvisation on *U.M.M.G.* and John Coltrane's improvisation on *Lush Life*). Once again, it should be noted that entropy is a quantitative measure, and not a qualitative one; higher or lower degrees of entropy in an improvisation are not necessarily indicative of more improvisational skill and daring. It may be that the more predictable improvisation is the most satisfying one to the listener, but that is a matter of future research. It is important to note that this do not necessarily indicate a qualitative judgment; further research is necessary to assess general patterns in entropy rates for jazz improvisation, as well as response patterns of music listeners. Again, the calculations for Morgan's improvisation suggest that when entropy decreases in one dimension, it may decrease proportionally in another. And again, more analysis is needed to confirm such a probability.

As we can see from these examples, entropy measures enable us to quantify information in a way that suggests a useful mechanism of computational analysis for music and jazz improvisation. Avenues of exploration suggest themselves here; and the analysis above provides a blueprint for doing so.

BEYOND THE PLATEAU

Summary of Case Study and the Resulting Model

The two part case study above included qualitative analysis in the form of a ‘case against case’ analysis (Yin, 1984) in a comparison with Berliner’s classic study *Thinking in Jazz* (1994). Second, an analysis of a UNT jazz improvisation course was performed, utilizing field notes collected from non-obtrusive observation of the course over the period of a semester. The course observation and field notes were then utilized in the formation of an Information Behavior Taxonomy (IBT), which represented the various forms of information and activates associated with those forms of information. In addition, an Information Flow Diagram (IFD) was developed, in which the channels of information flow between musicians during a jazz improvisation were mapped both spatially and temporally. And finally, quantitative analysis was undertaken in the form of multi-dimensional entropy equations that were applied to and entropy rates calculated for several jazz lead-sheets and transcriptions (collected from the jazz improvisation course) in order to explore information in jazz improvisation. As stated above, a grounded theory approach was taken in the case study of the jazz improvisation course, as well as the subsequent development of the IBT, IFD, and entropy analysis (an overview of the grounded theory approach applied in this research was detailed in the methods section).

The combined data set developed from the case study includes the Information Behavior Taxonomy (IBT), Information Flow Diagram (IFD), and multi-dimensional entropy equations (HME, HHE, HRE, HCME). These three components form a model of information in jazz improvisation. As stated throughout the research, the combined data set has been developed with the context of music information retrieval (MIR) in mind. Next, an Information Architecture for

Music Information Retrieval suggested from the model above will be outlined. First, we will review in greater detail each of the three components that form the model of information in jazz improvisation proposed here.

As stated above, the Information Behavior Taxonomy (developed from field notes utilizing the three-tiered grounded theory approach of coding, memoing, and sorting) classifies and summarizes the various music information behaviors (MIB) observed in the jazz improvisation course (as observed in the classroom setting). Again, the following taxonomy is restated here as a reminder of the music information behaviors as experienced in the classroom setting, and the observations yielded results confirming the assumption that improvisation overtly makes use of entropy:

Entropy in the Jazz Improvisation Course

Speech Acts: information expressed in speech was primarily in the form of *information-as-knowledge*, and included verbal instruction; *information-as-entropy* was also frequently referred to in the phrases: SURPRISE, UNCERTAINTY, RISK, NOVELTY, COMPLEXITY, NO “WRONG” NOTES; entropy was also referred to metaphorically with COOKING, MIXING SPICES, CONTOUR, I.E., DEGREES OF INFORMATION; exchanging *information-as-knowledge* in question and answer sessions, as well as statements defining song structure, instrumentation, and improvisational form (including sequence of musicians are to take when improvising).

Music Listening: information utilized in listening emphasized *information-as-thing* (CDs) and *information-as-process* (the act of listening to information “things,” as well as listening to live performance of music examples from both students and instructor).

Music Analysis: *information-as-knowledge* (music theory, suggestions of music vocabulary to use over particular harmonic sequences, rules of thumb) expressed using *information-as-thing* (musical documents: notation, lead-sheets, transcriptions), writing music examples on chalk board.

Performance: *information-as-process* (performance) utilizing *information-as-entropy* (improvisation), individual and ensemble rehearsals, and individual and ensemble performance evaluations.

As the Information Behavior Taxonomy indicates, music information behavior is integral to jazz instruction, listening, analysis and performance; in addition, information is inherent in the music itself, both at the compositional (as represented in lead-sheets) and improvisational levels (as represented in the transcriptions). The utilization of information by the musicians was frequent at all levels outlined above. The musicians were familiar with, and made frequent use of information in jazz instruction and performance, as well as the information inherent in the musical processes and content of jazz improvisation. This suggests that information may be the ideal mechanism of representation for a music information retrieval system based primarily on serving the needs of music listeners, music educators. The form of information that was most frequently utilized, and that was inherent in content of jazz improvisation is *information-as-entropy*. Based on these research findings, entropy emerges as a useful mechanism for music information retrieval, in part because it is inherent in the music, and also because of its familiarity with musicians.

In addition, the Information Flow Diagram mapped this flow of information between the musicians (and themselves) in the context of a jazz improvisational performance. While the diagram integrates components from Shannon's information theory and Wiener's cybernetics, it

is also highly influenced by research that O'Connor (1999) undertook on information theory and video. The diagram maps the multi-layered, poly-directional, spatial and temporal *flow of information* between musicians in their jazz improvisation performances, and integrates concepts such as *feedback loop; information flow; information channel; and information space/time*.

While the IFD is enlightening in its own right, as a model of information flow in jazz improvisation, it also further reinforces the inherent nature of information in jazz performance and improvisation, and further suggests that information provides as ideal mechanism of representation for music information retrieval. Before outlining an information architecture developed from such concepts, it is worthwhile to revisit current problems in MIR.

A representation (and by consequence a classification and indexing) problem exists in MIR: how is music to be accurately represented? Does entropy provide a solution? Can jazz improvisation be modeled in terms of quantities of melodic, harmonic, and rhythmic information (entropy)? Such questions provided the backdrop for the resulting research. The results of this research strongly suggest that entropy measures in transcriptions may provide a useful classification schema for MIR. In addition, the research provides a conceptual foundation for a transcript-driven content-based music information retrieval architecture that would potentially include the following benefits:

- Music represented according to native elements: melody, harmony, and rhythm
- Music represented according to quantities of information (entropy) measurable in the music
- Music represented from the perspective of the musicians themselves
- Musical represented in a way that suggests new connections and relationships in music suitable for music research and analysis

- It requires no pre-existing knowledge base from which to perform music information retrieval; i.e., exact values for pre-defined fields.
- It is applicable for the whole range of potential users: passive music listeners, amateur musicians, professional musicians, music educators, musicologists, and composers

As the calculations of melodic (HME), harmonic (HHE), rhythmic (HRE), and composite musical entropy (CME) for the jazz lead-sheets and transcriptions indicate above, entropy provides an ideal mechanism for music represented according to the quantities of melodic, harmonic, and rhythmic information content (that is inherently contained in the music) that by its very nature does not require external descriptors for its search and retrieval (a key problem in current music information retrieval design). From the start, the case study (and combined data set) has been developed with the context of music information retrieval (MIR) in mind; an Information Architecture for Music Information Retrieval developed from the model of information in jazz improvisation will now be outlined.

Information Architecture for Music Information Retrieval

As the case study and entropy calculations indicate, entropy provides a computational model of music analysis with both syntactical and semantic consequence. The application of entropy equations to jazz improvisation (as well as the method of application) makes possible a quantification of musical information, while making use of musical documents that are readily available, and accessible to musicians from a broad range of levels. The entropy equations provide not only a computational model of music analysis, but a mechanism of representation for music information retrieval as well.

The main reason that music information retrieval lacks an ideal mechanism of representation is that the information architectures for music information retrieval are primarily

data-driven, i.e., utilize external descriptors (Melucci and Orio, 2004). The problem with the external descriptors is they are not *native elements* (O'Connor, 2004) in the music and require a pre-existing knowledge-base from which to perform music information retrieval; i.e., exact values for pre-defined fields. Once again, this severely limits the usability of such systems for users who do not have this knowledge. Thus, a content-based approach that extracts semantic musical information inherent in the music itself is necessary: entropy provides just such a content-based approach.

The following information architecture (Figure 6.1) maps the various hardware and software tools and technologies and functions that would make up an ideal music information retrieval system based on a music represented by entropy (through a music database indexed and classified according to rates of entropy in the multiple dimensions of HME, HHE, HRE, and HCME):

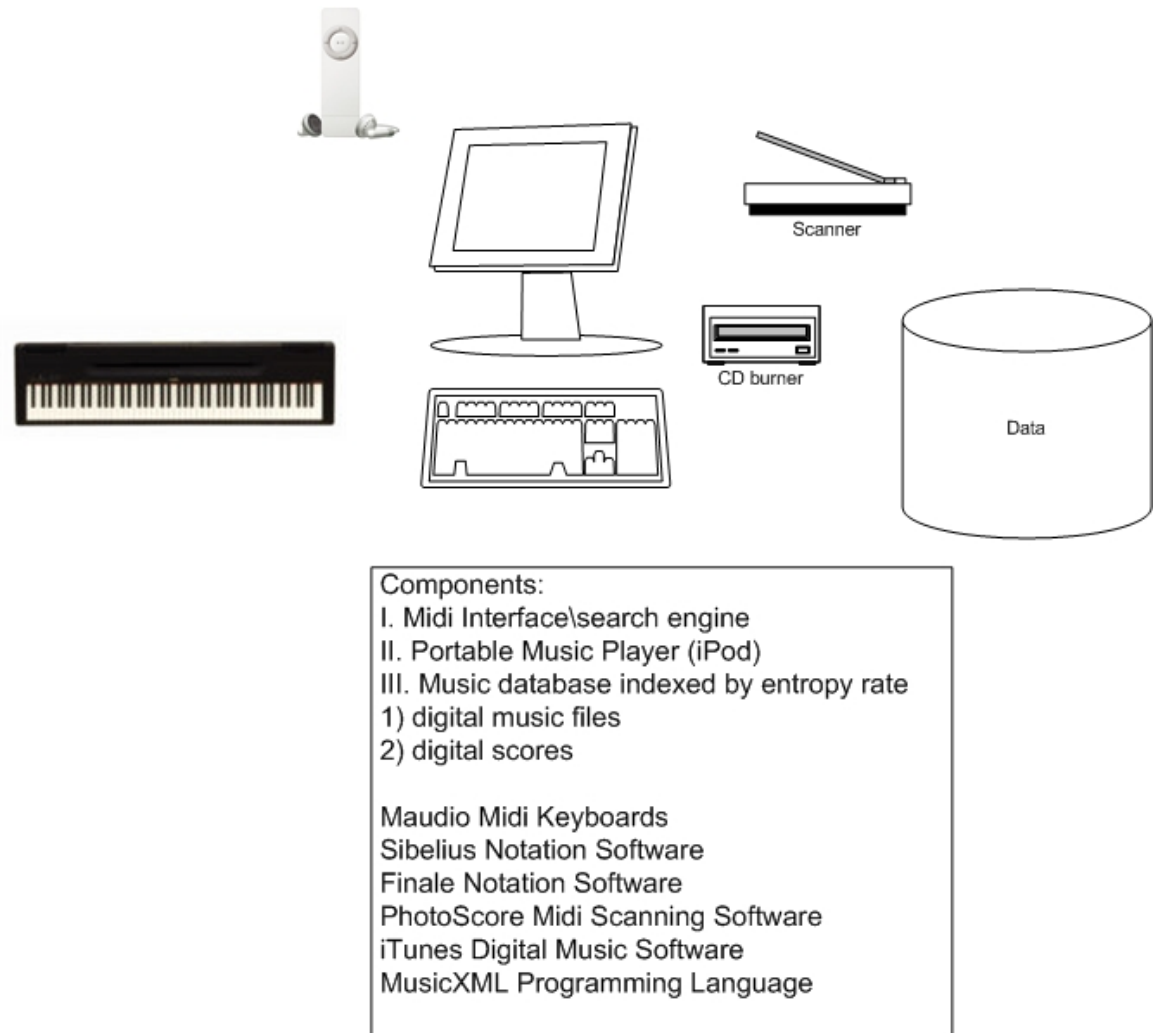


Figure 6.1: Information Architecture for MIR Components

A synopsis of the various components and their interactions will now be outlined. A midi interface (for example, a midi keyboard as in Figure 6.1) would serve as the primary musical interface (which is supplemented with a scanner and midi scanning software to input notated music. This could be supplemented with a traditional text-based search engine as well) for musical input. For example, a musical phrase (a melodic, harmonic, or rhythmic fragment, or complete phrase) could be played into the keyboard and converted to notation using readily available automated midi notation software packages such as Sibelius or Finale (in addition, with

the utilization of pitch-to-midi converters a microphone could be used to capture music information as well).

Once the musical phrase has been converted to notation, melodic, harmonic, rhythmic, and composite entropy rates could be calculated as appropriate (perhaps utilizing a module developed within the notation software itself). The entropy calculation(s) would then be compared to the contents of the database indexed by melodic, harmonic, rhythmic, and composite entropy rates.

Although software designed with the specific information architecture suggested here would be ideal, the index look-up could be automated using a currently available search and retrieval interface, and database software (in other words, the investment in hardware and software to implement the proposed architecture is minimal). The various software components (midi notation software, entropy calculation module, search interface, database) could ideally communicate (more specifically, pass information) utilizing a standardized music programming language such as musicXML. The results of such a search query could then be browsed and retrieved manually in hardcopy formats such as text, phonograph, or CD (using existing indexing systems such as library of congress (LIB)) or retrieved digitally and transferred to a portable multi-media device such as an iPOD.

Suggested Future Research

In addition to the melodic instruments explored here (saxophone and trumpet), harmonic (piano, guitar) and rhythmic instruments should be explored as well. Also, the analogous relationship between vocals and lyrics (and any connections with entropy) should be researched as well. Obviously, computational music analysis using the entropy equations could be expanded to other musical styles, genres, and efforts should be made to automate musical entropy

computations utilizing new software designs and/or modules in currently available software notation packages, as well as new designs. Proof of concept, demonstrations, and “go-live” music information retrieval systems based on the architecture outlined above could be developed, tested, and implemented; and both conceptual and technical aspects of entropy should be explored in relation to MIR design. While the music analysis of entropy rates as performed in this research can measure various degrees of complexity in the multiple dimensions of melody, harmony, and rhythm that have simply not been quantifiable otherwise in the history of music, it should not rule out further developments in the fascinating relationship between music and entropy.

It made sense to suggest in Question One that entropy would likely provide a robust form of music representation, since entropy measures have proved successful with other time varying signal systems – telephone calls, television and film, even Power Point Presentations (Kearns 2005). We did find that entropy measures did, indeed, distinguish between different variations on the same theme. In a sense, the more interesting question was Question Two - whether or not entropy is a “native element” of jazz musicians’ engagement with their music – and the research indicates an unequivocal yes. Such entropy analysis suggests additional questions to be further explored: how far does the improviser “stray” from the initial thematic material contained in the lead sheet? Higher entropy rates in improvisations would logically indicate the introduction of new musical material into the jazz tune being performed. How do various improvisations (between different performers, instrumentation, individual, and collective) of a jazz tune compare with each other as well as against the original composition (as measured in the lead-sheet)? Do certain improvisers maintain a particular set of entropy rates when improvising on a variety of jazz compositions? Do well known jazz improvisations feature a narrow entropy

range, or do they fluctuate widely? Do music listeners favor particular entropy rates in their music?

In addition, semiotics may provide additional avenues to explore the signatory aspects of entropy in jazz improvisation. What do the signs of entropy inherent in music notation, analysis, and performance signify to the listener? How do such signs convey emotion and meaning in music (Meyer, 1958)? Such questions are only the tip of the iceberg and provide years of thought and application in a variety of musical contexts.

Parting Words

As the calculations of melodic (HME), harmonic (HHE), rhythmic (HRE), and composite musical entropy (HCME) for the jazz lead-sheets and transcriptions indicate above, entropy provides a form of computational music analysis. Such music analysis of entropy rates can measure quantities of information in the multiple dimensions of melody, harmony, and rhythm that have simply not been quantifiable otherwise. Additional computational analysis based on such quantifications suggests itself; for example, the measure of information content in the compositions versus improvisations as demonstrated above. In addition, entropy provides a representational mechanism in which to build a content-based music information retrieval system, with music instruments (and microphones) serving a natural and useful interface for musicians of all types and levels, from amateur to professional.

It is hoped that this research will provide inspiration and food for thought on the multiple disciplines and topics that are interlaced within it: the relationship between jazz and entropy and the analysis necessary to explore it further, the flow of information in a jazz performance, the use of information in jazz education, as well as the potential for novel and greatly improved forms of

music information retrieval developed in part from the perspective of perhaps the most enlightening of users, and from which we have the most to learn: the musicians themselves.

APPENDIX A: INTERNATIONAL SYMPOSIUM ON MUSIC INFORMATION RETRIEVAL
(ISMIR) 2004 CALL FOR SUBMISSIONS

ISMIR 2004 solicits original contributions in the following domains and topics, as they apply to music information retrieval (this is a non-exclusive list):

1. Computational methods for classification, clustering, and modeling
 - a. Musical feature extraction (mono- and polyphonic music)
 - b. Similarity and pattern matching
 - c. Retrieval
2. Formal methods and databases
 - a. Applications of automated music identification and recognition, such as score following, automatic accompaniment
 - b. Routing and filtering for music and music queries
 - c. Query languages (expressiveness, complexity)
 - d. Standards (RDF, XML, INDECS, MPEG, Dublin Core, *MARC, Z39.50...) and other metadata or protocols for music information handling and retrieval (CDDDB, ...)
 - e. Multi-agent systems, distributed search
3. Web software for music information retrieval
 - a. Semantic Web and musical digital objects
 - b. Intelligent agents
 - c. Collaborative software
 - d. Webbased search and retrieval
4. Human-computer interaction and interfaces
 - a. Multi-modal interfaces (audio, text, gesture...)
 - b. User interfaces and usability

- c. Mobile applications
 - d. User behaviour
- 5. Music perception, cognition, affect, and emotions
 - a. Music similarity metrics
 - b. Syntactical parameters (pitch, rhythm, timbre, texture,...)
 - c. Semantic parameters (aesthetic, emotional appreciation)
 - d. Musical forms, structures, styles and genres
 - e. Music annotation methodologies
- 6. Music analysis and knowledge representation
 - a. Automatic summarization, citing, excerpting, downgrading, transformation
 - b. Formal models of music, digital scores and representations
 - c. Music indexing and metadata (authoring and generation)
- 7. Music archives, libraries, and digital collections
 - a. Music digital libraries
 - b. Public access to musical archives
 - c. Benchmarks and research databases
- 8. Intellectual property rights and music
 - a. National and international intellectual property right issues
 - b. Digital rights management
 - c. Identification and traceability
- 9. Sociology and Economy of music
 - a. Music industry and use of MIR in the production, distribution, consumption chain
 - b. User profiling

- c. Validation
 - d. User needs and expectations, evaluation of music IR systems, building test collections, experimental design and metrics
 - e. Business models and experience
10. Philosophy and ethics
- a. Developing MIR tools for non-western music
 - b. Dealing with personalized user profiles
 - c. Epistemological and methodological foundations

APPENDIX B: *SUMMERTIME* LEAD-SHEET (PRINTED WITH PERMISSION FROM
ALFRED PUBLISHING CO., INC.)

SUMMERTIME



Play 10 Choruses

By DuBose Hayward & George Gershwin

Chord progression for the first system:
 Treble staff: D- (measures 1-2), (D7+9) (measures 3-4)
 Bass staff: G- (measures 1-2), E ϕ (measures 3-4), A7+9 (measures 5-6)
 Treble staff: D- (measures 7-8), G- (measures 9-10), C7 (measures 11-12)
 Bass staff: F Δ (measures 7-8), E ϕ (measures 9-10), A7+9 (measures 11-12), D- (measures 13-14), E ϕ (measures 15-16), A7+9 (measures 17-18)

SOLO

Chord progression for the solo section:
 Treble staff: D- (measures 1-2), (D7+9) (measures 3-4), G- (measures 5-6), E ϕ (measures 7-8), A7+9 (measures 9-10)
 Bass staff: D- (measures 1-2), G- C7 (measures 3-4), F Δ (measures 5-6), E ϕ A7+9 (measures 7-8), D- (measures 9-10), E ϕ A7+9 (measures 11-12)

REPEAT AND FADE OUT

Chord progression for the repeat section:
 Treble staff: D- (measures 1-2), G7 (measures 3-4)

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APPENDIX C: MUJS 3370 COURSE SYLLABUS

MUJS 3370-Advanced Jazz Improvisation

Instructor: Stefan Karlsson
Office: MU # 351
Phone : [REDACTED]
Email: [REDACTED]
Class Time: T/TH 10:00-10:50am, room # 263
Office Hours: M/W 2pm, and TH 2pm

Prerequisite: Successful completion ("B" or better) of MUJS 3360

Course Objective: This course is designed to prepare students with necessary improvisational skills, ideas and concepts at an advanced level. In addition of being evaluated on improvisational knowledge, students also need to demonstrate accuracy in the knowledge of the melody and chord progression. Each student will be tested on melody and chord progressions thru various skill exams. In addition, two solo transcriptions are also required for evaluation. In preparation for each song, additional hand-outs will be given out by the instructor.

Content/Grading:

• Playing Evaluations	(6)	60%
• Transcriptions	(2)	16%
• Keyboard Skills	(6)	12%
• Chord changes (written)	(6)	12%
• Melodies	(6)	P/F (<u>failure to pass</u>)

all six exams will result in an automatic "C" in the course)

Playing evaluations, transcriptions, written chord changes and melodies will be graded during regular class time (note: written exams on the chord changes to each tune will be given during the class time following "song introduction" class day- see course syllabus.) In order to save valuable class-time, the various keyboard tests will be given during a private contact time

Attendance Policy:

Two unexcused absences are permitted, however beyond the 2nd unexcused absence, each absence will lower your final semester grade by one letter grade. Excused absences should be cleared in advance if possible.

Suggested Listening Materials:

"Mode For Joe" (Joe Henderson, Blue Note Records), "Lush Life" (Joe Henderson, Poly Gram Records), Aebersold Play-A-Long vol.66 (The Music of Billy Strayhorn), "We'll Meet Again" (Bill Evans, Warner Bros. Records Inc.), "Interplay" (Bill Evans, Riverside Records) and "To Know One" (Joey Calderazzo, Blue Note Records). Allmusic.com is also a good choice for providing other choices of recordings.

M/Tu		W/Th
Week 1 ("UMMG")	no class	introducing song #1
Week 2	playing/discussion	playing/ discussion
Week 3	playing/discussion	playing evaluation#1
Week 4	introducing song #2 ("Time Remembered")	playing /discussion
Week 5	playing/discussion	playing evaluation#2
Week 6	introducing song #3 ("Lush Life")	playing/ discussion
Week 7	playing/discussion	playing evaluation #3
Week 8	transcription evaluation #1	transcription #1
Week 9	introducing song #4 ("Tomato Kiss")	playing/discussion
Week 10	playing/discussion	playing/ discussion
Week 11 Saw")	playing evaluation #4	introducing song #5 ("Sea
Week12	playing/discussion	playing/discussion
Week 13 of Jade")	playing evaluation #5	introducing song #6 ("Shade
Week 14	playing/discussion	playing/discussion
Week 15	playing evaluation #6	transcription #2
Week 16	Finals week (FIPE)	

Compliance with Federal Statues: The College of Music complies with, "The American's With Disabilities Act", in making reasonable accommodations for qualified students with disability. If you have an established disability as defied in this act and would like to request accommodations, please see me as soon as possible.

Scholastic Honesty Policy: cheating, in any form, will result in an automatic grade of "F" in the course, the removal of the student from the course, and immediate reporting of the student's actions to the office of the Dean of Students and to the office of the Dean of College of Music.

APPENDIX D: *U.M.M.G.* LEAD-SHEET (PRINTED WITH PERMISSION FROM MUSIC SALES CORPORATION)



2. UMMG

Handwritten signature

PLAY 3 CHORUSES
(♩ = 208)

(UPPER MANHATTAN MEDICAL GROUP)

Music by Billy Strayhorn

FØ Bb7b9 Eb- Ab7 Db7 DbΔ

1. DbΔ *3* Db- Gb7b9 | 2. DbΔ *3* Ab-

Db7 GØ C7b9 FA AbØ

Db7b9 Gb-7 Ab7 FØ Bb7b9 Eb-

Ab7 Db7/C DbΔ Db7/C DbΔ

SOLOS *Cb* *Ab*
FØ Bb7b9 Eb- Ab7 Db7 DbΔ | 1. DbΔ Db- Gb7b9 | 2. DbΔ

cimmin tone

BRIDGE
Ab- Db7 GØ C7b9 FA AbØ Db7b9 Gb- Ab7

FØ Bb7b9 Eb- Ab7 Db7/C DbΔ *Φ* Db7/C DbΔ

LATIN

Φ Db7/C DbΔ *Φ* DbΔ

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APPENDIX E: *LUSH LIFE* LEAD-SHEET (PRINTED WITH PERMISSION FROM CHERRY
LANE MUSIC COMPANY)

Lush Life

Billy Strayhorn
(As played by John Coltrane)

Freely **A** D^b6 C^b9 D^bMA⁷ C^b9

I used to vis-it all the ver-y gay pla-ces, Those come what

D^bMA⁷ C^b9 D^bMA⁷ E^bMI⁷ F^{MI}7 F[#]MI⁷ A^bMI⁷ D13(#11)

may pla-ces where one re-lax-es on the ax-is of the wheel of life to get the

F^{MI}7 D⁹(#11) D^bMI^{6/9} D13(#11) D^b6 C^b9

feel of life from jazz and cock-tails. The girls I knew had sad and sul-len

D^bMA⁷ C^b9 D^bMA⁷ C^b9 D^bMA⁷ E^bMI⁷ F^{MI}7 F[#]MI⁷

gray fa-ces With dis-tin-gue tra-ces that used to be there, you could see where they'd been

1/4 bass

A^bMI⁷ D13(#11) F^{MI}7 D⁹(#11) D^bMI^{6/9} G^{MI}7(b5) C⁷

washed a-wav by too man-y thru the day, twelve o'-clock tales. Then

(Faster) **B** F^{MI} F^{MI}6 F^{MI} F^{MI}7 F^{MI} G^{MI}7(b5) C⁷

you came a-long with your si-ren song to tempt me to mad-ness, I

1/4 bass

F^{MI} F^{MI}6 F^{MI} F^{MI}7 F^{MI}

thought for a while that your poig-nant smile was tinged with the sad-ness

A^b13 **(Slower)** B⁹(b5) B^b9

of a great love for me. Ah! yes, I was

E^bMI⁷ A⁹(b5) E^bMI⁷(add 11) D13(#11)

wrong, a-gain I was wrong.

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(Med. Ballad)

C $\text{♩} = 58$
 Chords: $D^{\flat}MA^7$ $D^{13}(\#11)$ $D^{\flat}MA^7$ $D^{13}(\#11)$ $D^{\flat}6$ $F^{\#}MI^7$ B^{13} $E^{\flat}MA^7$ $D^{13}(\#11)$

Life is lone - ly a - gain and on - ly last year ev - ry - thing seemed so sure. Now

12 bars

Chords: $D^{\flat}MA^7$ $D^{13}(\#11)$ $D^{\flat}MA^7$ $D^{13}(\#11)$ $D^{\flat}6$ $D^{\flat}9$ C^{13} $F^{\flat}MA^7$ A^{13}

life is aw - ful a - gain, a trough - ful of hearts could on - ly be a bore. A

Chords: $A^{\flat}MA^7$ $E^{\flat}7(\#9)$ $A^{\flat}MA^7$ $E^{\flat}MI^7$ A^7 $D^{\flat}MA^7$ $D^{\flat}MI^7$ G^7 $C^{\flat}MA^7$ $A^{\flat}13$

week in Pa - ris will ease the bite of it, All I care is to smile in spite of it.

D Chords: $D^{\flat}MA^7$ $D^{13}(\#11)$ $D^{\flat}MA^7$ $D^{13}(\#11)$ $D^{\flat}6$ $C^7(\#9)$ B^{13} $F^{\flat}MI^7$ $B^{\flat}7$ (add 11)

I'll for - get you, I will, while yet you are still burn - ing in - side my brain. Ro -

12 bars

Chords: $F^{\#}MI^9$ B^{13} $A^9(\#5)$ $A^{\flat}13$ $D^{\flat}MA^7$ $G^{\flat}13$

mance is mush sti - fling those who strive, I'll live a lush life in

Chords: $F^{\flat}MI^7$ $B^{\flat}7$ $F^{\#}MI^9$ B^{13} $A^9(\#5)$ $A^{\flat}13$

some small dive, And there I'll be while I rot with the rest of

Chords: $A^{\flat}7(\#9)$ $A^7(\#9)$ $B^{\flat}7(\#9)$ $B^7(\#9)$ $C^7(\#9)$ $D^{13}(\#11)$ $D^{\flat}MA^7$ $A^{\flat}13$ $D^{\flat}MA^7$ $D^{13}(\#11)$ $D^{\flat}MA^7$ $D^{13}(\#11)$

those whose lives are lone - ly too.

(Double-time Feel) X
 (First solo begins here)
 Solo on CD; after solos, D.S. al Coda

Chords: $A^{\flat}7(\#9)$ $A^7(\#9)$ $B^{\flat}7(\#9)$ $B^7(\#9)$ $C^7(\#9)$ $D^{13}(\#11)$ $D^{\flat}MA^7$

those whose lives are lone - ly too.

(molto rit.)

Solos are in double-time feel swing.

APPENDIX F: A *SHADE OF JADE* LEAD-SHEET (PRINTED WITH PERMISSION FROM
ALFRED PUBLISHING CO., INC.)

A Shade of Jade

Joe Henderson

♩ = 264

fast

A Cmin⁸ Cmin⁸ Cmin⁸

Cmin⁸ F^{sus4}/G D^bMa7(b⁵) D^bMa7(b⁵)

E^bMa7(b⁵) EMa7(b⁵) DMa7(b⁵) D^bMa7(b⁵)

D^bMa7(b⁵) D^bMa7(b⁵) ¹D^bMa7(b⁵) ²D^bMa7(b⁵)

B G^bMaj7 G^bMaj7 F7(b⁹)

F7(b⁹) B^bmin B^bmin G^ø7

A Shade of Jade 109

C7(b9) F#Maj7 Dmin7 Dmin7

Fmin7/Bb Gmin7/C Gmin7/C GbMaj7 AbMaj7

AbMaj7 Dø7 Ab9 AbMaj7(b5) G7(b9)

A Cmin8 Cmin8 Cmin8

Cmin8 F#sus4/G DbMa7(b5) DbMa7(b5)

EbMa7(b5) EbMa7(b5) DMa7(b5) DbMa7(b5)

DbMa7(b5) DbMa7(b5) DbMa7(b5)

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APPENDIX G: *U.M.M.G.* TRANSCRIPTION (PRINTED WITH PERMISSION FROM
PROFESSOR STEFAN KARLSSON, UNT)

String

1st Chorus

Wynton Marsalis Solo = 1:55

2nd Chorus

The musical score consists of ten staves of music. The first staff is marked 'String' and '1st Chorus'. It begins with a treble clef and a key signature of two flats (B-flat major/D minor). The melody is written in a series of eighth and quarter notes. Above the staff, there are several chord notations: D-7(b9), G7(b9), and C-7. A handwritten note above the staff reads 'Wynton Marsalis Solo = 1:55'. The second staff continues the melody with chords Bb7, Bb6, Bb7, Bb7, Bb-7, and Eb7. The third staff has chords D-7(b9), G7(b9), C-7, and F7(b9). The fourth staff has chords Bb7, Bb6, Bb7, F-7, Bb7, F-7, and Eb7. The fifth staff has chords E-7(b9), A7(b9), and D7. The sixth staff has chords F-7(b9), Bb7(b9), Eb-, and F7(b9). The seventh staff has chords D-7(b9), C-7, and F7. The eighth staff has chords Bb7, Bb6, Bb7, Bb6, and F7. The ninth staff is marked '2nd Chorus' and has chords D-7(b9), G7(b9), C-7, and F7(b9). The tenth staff has chords Bb7, Bb6, Bb7, Bb-7, and Eb7. The score ends with a double bar line and a key signature change to one flat (B-flat major/D minor).

JMM 6 p. 2

Musical staff 1: Treble clef, key signature of two flats. Chords: D-7b5, G7b9, C-7, F7b9.

Musical staff 2: Bass clef, key signature of two flats. Chords: Bb7, Bb6, BbΔ7, F-7, Bb7, F-7, Bb7.

Musical staff 3: Bass clef, key signature of two flats. Chords: E-7 b5, A7b9, DΔ7.

Musical staff 4: Bass clef, key signature of two flats. Chords: F-7b5, Bb7b9, Eb-7, F7b9.

Musical staff 5: Treble clef, key signature of two flats. Chords: D-7b5, G7b9, C-7, F7.

Musical staff 6: Bass clef, key signature of two flats. Chords: Bb7, Bb6, Bb7, Bb6.

Empty musical staves for practice or additional notation.

APPENDIX H: *LUSH LIFE* TRANSCRIPTION (PRINTED WITH PERMISSION FROM
PROFESSOR STEFAN KARLSSON, UNT)

LUSH LIFE - COLTRANE SOLO

STRAYHORN/COLTRANE

IMPET IN B:

5 5 5

5 5 5

5 5 5

5 5 5

5 5 5

5 5 5

5 5 5

5 5 5

5 5 5

5 5 5

APPENDIX I: A *SHADE OF JADE* TRANSCRIPTION (PRINTED WITH PERMISSION
FROM PROFESSOR STEFAN KARLSSON, UNT)

SHADE OF JADE

LEE MORGAN

IMPEY IN B:

5 9

13 17

21 25

29 33

37 41

45 49

53 57

61 65

69 73

77 81

Chord annotations: D-9, EbMaj7, F, F#, D, EbMaj7, D-9, EbMaj7, F, F#, EbMaj7, AbMaj7, G13(b9), C-11, A#7, D7(b9), G#9, E-11, C#9, F#9, Bbm9, EbMaj7, E-11, Bbm9, A13(b9).

2 D-9 SHADE OF JADE

E♭MA7 F F# E

E♭MA7

D-9

E♭MA7 F F# E

E♭MA7

D-9

E♭MA7 F F# E

E♭MA7

Handwritten musical score consisting of six staves of music. The notation includes treble clefs, a key signature of one flat (B-flat), and a 4/4 time signature. The music features various rhythmic patterns, including eighth and sixteenth notes, and rests. Chord annotations are written above the staves, including: **A^bMaj7**, **A13(9)**, **C-11**, **A^b7**, **D7(9)**, **G^bMaj7**, **E-11**, **C^bMaj7**, **F^bMaj7**, **B^bMaj9**, **E^bMaj7**, **E-11**, **A13(9)**, **D-9**, **E^bMaj7**, **F**, **F[#]**, **E**, and **E^bMaj7**. The staves are numbered at the beginning: 77, 81, 85, 89, 93, 97, and 101.

APPENDIX J: FIELD NOTES

MUJS 3370 JAZZ IMPROVISATION

1/23 UMMG

Outline syllabus

Chord chart harmony/focus w/melody

Tempo – rubato suggested 80 bpm

-writing out chord changes to UMMG (Joe Henderson)

-memorized from lead sheet handed out week before

-what's unique about the tune?

diminished tag

S. plays examples on piano

Listen to Joe Henderson recording

-asks class questions – what noticed, appreciated?

-sustained notes to bridge

iii VI ii V

-medium up-tempo

-think phrases, not chord changes

-groove

-take chances, no wrong notes

-interact, place notes, interact w/ rhythm section

-time feel, triplets – forward motion

-hard changes

Subing (substituting) things out

-polytonal chordal approach

-Joe in red zone, but resolves

-stretch rubber band, outside/inside

S. plays examples

Wynton - sustained notes, closer to chords, controlled, creating melodies

- using sequences to navigate changes

- Stephen Scott piano last 8 bars?

- iiV ½ step up

| Eb- | Ab7 |

| E- A7 | Eb- Ab7 |

Listen to chords, top note

Plays example.

Ab -/F Bb7#5/F

Polytonality - Joe Henderson approach

Bmaj#5/F Augmented, whole tone

Plays whole tone, augmented example.

Resolve to V, ignore ii

Apply V (ii in parentheses)

- pedal is V

- Bbsus b9

- tune a big sequence

Two bars Bbsus b9, two bars AbsusB9 to Dbdim licks, shows down motion

- introduces interesting compositional ideas

- Wynton, wrong notes the jewels

- plays tune w/ drum & bass
- Instead of scales find motifs, 2,3,4 notes

Lot of talk, getting into concept

So much information

- so much info
- dig into tunes
- getting outside foundation w/polytonality
- make connections on connections
- find pattern & sequence 4ths, 5ths
- good phrasing, structure, space

1/25 UMMG

Performance evaluations

Ensembles: trios, quintets

Workout arrangement, don't over prepare

Realize when enough is enough

1st Group – tune up (2 horns, guitar, bass, drums)

Next Wednesday playing evaluations

- guitar take melody on bridge
- intro 8 bars

Plays

Stop: drums – too fast, don't swing, watch dynamics

Good groove: counts 1,2 1,2 ah ah

Plays head

4 on the floor 3rd chorus

Build tension

Bass – leave more space

Trumpet – take more advantage of melody

play melody w/ rhythm section.

A way to look at improv

What does the melody & rhythm of melody suggest?

Thematic elements

What makes UMMG, UMMG?

- what three spots make the tune
- why did he write the song?
- Has a purpose, have a purpose when you improvise

Counts off tune

Slow down, take more chances

Leave more space, don't exhaust in 1st chorus

- plays tune as trio
- lay back, brew in the pot
- train your ears
- sit down and two choruses of solo, can sit down and write what he's playing
- polytonality
- next Monday have five diminished licks written out to show
- counts tune
- trumpet plays diminished scale

- have scale choices down
- plays some scales over chords
- shed on scale choices, take time, develop off the melody, then throw yourself into tune
- develop melodies over changes
- shape melodies, clarity in lines
- guitar take more chances on backup
more clarity in lines
- Bass breath more

Second Group

Counts tune off, slows it down

Quintet

sax solos, stops – likes staccato ideas

involves rhythm section

knocking on the door

- playing reminds him of Sonny Rollins, Charles Lloyd
- find the jewels
- if Dizzy plays b5/#11 examples
- twist and the land? Its musical theatre
- Character, surprises to make it interesting
- Purpose, love for music, search, have correct tonalities
- Then get out on stage and act
- E natural serves as leading tone

Find something unique in tune and sequence it

Leave idea – it will sound like uncertainty, mistake

Every instrument has idiomatic differences to take advantage of

Trumpet: stops – feels really inside, simple, playing a lot, got stuck in a hole

- Find a purpose, ask how can I make a difference, find a couple spots in tune
- Or we ramble without a purpose
- Slow down, more space
- F to Db ½ E- to A7 sub
- Incorporating accelerated ideas
- Flurries, 16th note runs
- Stop concentrating on changes
- Sit at piano F to Bb, what notes will work, what options
- E note over Eb –
- Create really strong connections
- Changes on tune, seamless

1/31 UMMG

Third combo –

Playing evaluations Wednesday (be in office 9:30 AM)

Comment sheet with grade

Performance will be recorded on videotape

Come to office to checkout

1st Fender Rhodes (1978) Denton, Honda hatchback

Any questions on time?

Plays Db dim. – asks horn player

Horn player reading dim. Licks

Down min. 3rds in parallel motion

Tritone subs – should have some memorized

Individuals in class giving examples

Fun tune, like the tune?

Ask what do you like about tune? – Dim to maj

Likes tritones in melody – likes when its over

Counts off tune

Plays head

Very tight, groove, classical feel

Long lines both sax and trumpet

- guitar: good feel

S. writes (on chalk board) articulation, rhythm, details

- Stops after guitar

Describe articulation?

Sax – off beat, a little timid, play less, more melodic content from melody

- Have changes in mind

- Counts off tune, sax plays solo

Should be able to recognize tune

- plays piano, single note example

- implying changes and melodic ideas

- sequences

- Play over each chord – scales, arpeggiations,

- Then create melodic ideas
- Too busy, slow down, more ups and downs, more surprises
- Same with guitar 30% of time interesting chords, flavor

What do you do when you practice? Do you practice?

Guitar: play over changes

Lost me, can't hear changes. Like I ask you – going to put some sugar in the sale

Know what a Bbma7 tastes like

Know what cilantro tastes like?

All about cooking

Make a point of stressing changes

Transcribe your own sols

Two chords

Come back and do some surgery on it

-Sax: not think of chords

Easy to memorize

Monday in the kitchen, Wednesday something different

Flavors, colors, textures, scale sounds

All about getting the sound

Not about the names – augmented – just a word

Like that flavor

Rhythm play – counts off

Plays piano improvisation. Augmented example

So many ideas

- humor Sonny Rollins trios
- need humor
- Giving pointers for practice, getting into tune, make it fun, find purpose

Begin, play w/ strong rhythm

Stay there, working on idea

- stick to idea
- -stay there, be honest with it
- Dig in, more grease
- Add more certainty

Group One (Group two in section missing member)

- take out certain notes for clarity
- put in articulation, dynamics, surprises
- really careful with first chord
- UMMG most standard tune this semester
- Not easy, key, specific extensions, Duke, B. Strayhorn into hard bop
- Monk, Shorter, Golson: melody falls on altered notes

Counts off tune

- Stops, slow down, guitar first
- Don't lose track of forward motion
- Get rhythm in body
- Counts off: better, don't push too much
- Extensions
- Sequences, purpose

- Sax
- Trumpet
- Back to guitar player 2
- Trumpet
- Bass
- Joins in w/piano comping
- Piano
- Stops tune

Ideas

1) III VI II V hug each chord

2) connect ii and ii with Bb pedal

Sus b9 sound or dominant whole tone sound to diminished

If you start an idea it should be inside where it's outside, sequence ideas from outside source

Work on Db maj sound

F – pedal works over Ab or Db maj.

F – to A natural

Or F augmented over Db

Extended ideas – longer lines (guitar)

Evaluation on Wednesday

Looking for improvement – taken into consideration

2/7 TIME REMEMBERED

Any questions

Sometimes bad day

- find some consistency
- find a safe zone
- try to find consistency , discover self-awareness

Self-assessment

- would we listen to ourselves?
- Would we buy our record?

Listening to tune – Time Remembered (Joey Calderazzo)

Write changes on tunes Wednesday.

Dorian mode throughout composition

All major 7th are lydian

B- to Eb – direct modulations

26 bars 8-8-10

2 bar phrasing

Plays through

Intervals – lots of tritones

½ step circle of 5ths

Sit down play root movement to melody

Plays 1/2, 5, 1/2, 5, 5, 5, then 3rds

Dorian natural 9

What did we hear in the solo?

Straight 8th swing 120 bpm 2 beats per second

Displacement

4ths, pentatonics

Modal

Every bar new dorian sound

Not typical ii V I

No clear relationships like ii VI ii V

Devise – use sequences

Bluesy sounds in a subtle way

Jimmy Cobb – in recording studio – Jack McDuff doing Giant Steps

Started playing blues over it

Maj7ths use as tension/release

- Can we use chromatic tones?
- G- bebop scale

Take all the information

Tell ourselves its going to be difficult, it is

Just notes on a paper, all about melody

Sometimes take a tune

Find a chord scale – arpeggiate scales back and forth

What about scales on chord changes in real-time?

Perhaps as an etude

Take a challenging Coltrane tune

- plays with rhythm section
- work in 3rds, triplets

Class get horns out

Wednesday – one chorus of solo record and transcribe

Write out a chorus without instrument

Class plays scale exercise with rhythm

- Each low to high in scale register
- Next time through play all 9ths of each chord
- Next cycle 9 and 11 watch for #11
- From top, watch rhythm section
- Next cycle chord tones, then 9, 11, 13

Stops: sounds like you're not having fun

Miles, Shorter used 9, 11, 13

Common tones

Why start on 9, why not 11 or 13?

Plays example

Diatonic tones around 9, 11, 13

Also noticed displacing octaves

Drop to lower octave

1, b3, b5, b7, 9, 11, 13 G- over F-7 to F/Bbsus #11, 13

Root 1st and 2nd inversion

B-13 to Cmaj+11 A C F#Fmaj7#11 BDG

Voice leading upper extended triads

See common tones with moving notes

Vol 45 Aebersold

Bring solo in on Wednesday

Play at home

2/9 TIME REMEMBERED

Tune-up

Try not to double note

Study melody notes fall on color tones

On piano – good thing to do: play maj, min, dom, ½ dim triads

Bill (Evans) was doing maj 13, min 9

Walking through chords

Hold sustain pedal, play on it

Group 2

Tune up

Counts off: play melody first

Trumpet

Play Bbmaj7, sounds out of tune gt/bass

Trumpet play B natural

Plays, stop, change rhythm – more space

Augmentation or diminutions – compress, make intervals smaller

Counts off – plays

Stops – go for colors 9, 11, 13

Leave a lot of space

Plays with rhythm section for examples

Stops, if solos were to go – I would really want to take my time (speaking to trumpet)

Octave displacement, intervals

Sequences, dorian scale

Think Miles, counts

Stops – not enough space

Common tones F# cool into 3rd

Find the real jewels, golden notes

Hardest part of being jazz musician – not to play

13 not a good choice

Trumpet plays, apprehensive

Still playing too much

Happened in master class – no space

Work on space and sound of 9, 11, 13

Play to records in – 9, 11, 13, some chromatic and diatonic tones, don't be afraid of melody

Sax – no homework

Call or email if can't make it

Hear some solos

Guitars: nice texture, not too busy

 Just a little more clarity, motion, character, seamless

2nd trumpet – too busy

Work melody in improv –

Where is it?

Find motif – plays piano, like Beethoven

Force motif development

 Listen

Still no excuse – practice as you will perform

Play a lot of casuals, wedding receptions

Learned to play by playing melodies

Conceptualizing

- play selective w/ improv.
- Stops: play w/Miles cool era concept
- Stop: sounds like articulation not varied
- Miles doesn't tongue as much
- Slide into note – soft to loud

Counts, plays, stops

Sax plays

Trumpet plays, stop

- nice motif – plays too much, waste of time, not hearing pentatonic phrases
- sax plays
- guitar

Write changes on Monday

Then combos 15min each

2/14 TIME REMEMBERED

Tune up

Guitar intro – last 10 bars starts with E-b9sus

Tries several passes

More melody

Band plays

- trumpet too far off the melody

- sax gets lost, get ore comforTable with changes, open window and go for it
- motion, accelerated ideas, not need scales, just two notes

More energy and accelerated kinds of concepts, don't hold back

If you're going to step on yourself do it

Don't be afraid, go for it

Counts off, sax plays

Sequence idea and change notes appropriately

- don't change motifs, next one, next one, etc.
- stick with one

trumpet plays

- stop hitting wrong notes
- make it part of music
- don't stop, keep going, making it part of music
- pay it one more time
- go on with it, be strong with it
- circle band, play around melody
- if we have melody, that's our guide

trumpet

sax 2

Stops: if you don't know the melody you really have a problem

We all listen to Wayne Shorter

- he would pick and choose
- little character without melody itself

- his personal voice

Counts off

Plays 9ths – stress test on your ears

Then go to 11s, 13s

Find 9, 11, 13s and melody

If you know 9, 11, 13s you could fool me

- counts off guitar
- trumpet2
- 3 chords nothing, star w bar 4
- Catches up with band, augmentation and diminution
- Compressing to get flavor
- Maybe play 2 bars ahead
- Common tones, tension and release
- Changes, closer to melody
- Develop more rhythm
- Give articulation
- Even legato still w/ rhythm
- Rhythmic intensity
- Volume nothing to do with intensity
- Play real soft and light but with intensity
- Hard to do, play with any volume still good sound

Trumpet 3 again

Stop: stick on melody note, but displace it 1,3

Sax3

Guitar3

Bass stop: can't play melody

Bass solo again – couldn't hear chords

-make sure natural 13, no b6

Get lost in changes, good rhythmic ideas

Wed. 1st. 5 min. write changes

Group 3

Bring video tapes Wednesday to end of 1st song

Sing the melody

-then start to appreciate

Play each chord tone 1, 3, 5, , 11, 13

Then change -3, -7 accordingly

Learn melody

2/16 TIME REMEMBERED cont.

Work with melody

Develop tune

Practice to get away from barriers

What I heard from musicians

Write changes

Group one – performance evaluation (recorded on video)

B-13 vamp 4bars

Head

Sax

Guitar

Trumpet

Restate head

Group 2

End- horns play last 10 bars

Head

Guitar

Trumpet

Sax

Bass

Head (last 10 bars)

Group 3

Chorus on top, drums solo

Then come in with melody

Drums intro 2 chorus

Head

Trumpet

Sax

Guitar

Head

Monday LUSH LIFE solo piece

Everyone will play solo w/rhythm section.

Learn lyrics, working w/piano

Wednesday write changes, have a week.

2/21 LUSH LIFE

11 AM session with Phil Woods

Ok LUSH LIFE

playing evaluation Wednesday next week

Transcription of song – just solo

Whole solo

Mid term – transcription and solo

Ballads – what's important

Slower tempo, more exposed

Sometimes just play the melody – stick on it

If you can make it sound beautiful on head that's important

Listens to Stan Getz

Sound, phrasing, relaxed

Play Stan Get w/ Kenny Barron

Charlie Haden – People Time

After character, strong personalities

- listen to tune
- followed the melody
- maybe set up a chorus
- then a cadenza
- personality

- play a ballad in a jam session
- are you friends with the instrument?
- Phrasing
- Dexter Gordon, Coltrane, McCoy Tyner
- Johnny Hartman with Coltrane

Lyrics important for learning phrasing

Charles McPheerson – won't play without knowing the lyrics

Peaks and valleys in song through lyrics

Listen again: classic, must have, Hartman with Coltrane

Rubato – if we don't know what words mean we can't relate to the tune

Getting to know lyrics

Going into chorus stay on certain notes

Hang on it, phrasing

Strayhorn wrote at 19 in Paris

Coltrane Lush Life album

Listen

Usually 8 bar to Fmaj, no Emaj

Play solos with drum and bass

Guitar – rubato

Nice slow ballad tempo for chorus

Ok to change key? No, stay with Db

Ignore last 2 bars, no double time feel

Last 2 bars out – go from Db maj7 to Ab13 back to top

Stick to melody

Take to coda

Everyone add cadenza too

Cut off band to do cadenza

Add fermata to D13

For guitar, Piano play verse solo or rhythm section

Lead into chorus

Rhythm section to B

Who wants to play changes?

Write changes Wednesday

No drums today, just bass

Trumpet, guitar, bass

Stop: is everything clear to you? Rhythm section don't be afraid to move a little

Don't hold back on B natural dynamic need F in there

Articulation – dynamically the same

Could have a lot more range dynamic

Find characters in words themselves to mix up articulation

Start 2nd 8

Little bluesy thing at “jazz and cocktails”

Think about phrasing, take your time, not too fast

Everyone play the melody Wednesday

2/23 LUSH LIFE cont.

Legal chord charts usually ok

Worth looking at others

Some are train wrecks

1st 2 bars of Round Midnight for example

Get a piece of paper – write changes to LUSH LIFE (from memory)

Can use charts

How do we learn tunes?

Play melody on piano and root movement

Like an artist – don't start with colors, big lines to get the framework

Hear melody w/root movement

Lots of repetition

Like Killer Joe

1st modulation bar 3 b3 in Ab iiV B maj to C to Eb(5) iiV to D

reminiscent of Body and Soul

plays trumpet

Did you check out Phil Woods 2PM yesterday?

What did he say – melody hardest to learn

Take your time

Play like you sing it

Not a trumpet, an extension of your voice

Not playing your instrument, playing yourself

Like a way to get there, out in the open

Take 2 – red light is on

More character

do a little trill to sustained notes?

Play last bit of verse (last 4 bars of B sec.)

No double time

Next week, Monday or Wednesday on tune

Work on character

More interest

Certain textures in tune that make the piece

Monday –assembly line, Wed. another pass

Dig out recordings of other musicians - listen to Getz

What re the greats doing?

Why do we like listening to this tune?

Sax plays

Ballad, blowing with bass, cyclical crescendo

Drums, texturing with mallets

Bass don't be too quick to but the roots

Sounds a little harsh – keyboard amp

Certain spots waiting to take control

Can be more flexible – mini cadenzas, arpeggiate

Go right into chorus

Stop: can play some funky note on turnaround, all these tunes are the same

ISFAHAN, Db in it

Have to get comfortable, one mistake in melody obvious

Don't hear it much (Lush Life), it's hard

Tackle this, one can get through the rest

Same songs history books, certain stories, copyrights

2/28 LUSH LIFE cont.

Tune up

Did you notice Phil Woods piano?

Playing evaluation next Monday

Group straight head – strive for tone

Band come in 2nd half of verse (bridge)

Guitar intro 1st verse

Band come in 2nd verse

Miss a chord, big deal

Relax, practice, focus on tone

Playing beautifully

Started slower than expected – guitar if your going to play a ballad, down to 40 bpm (like Benny Carter)

About self control

Play again at 40 BPM

Relaxed

Tone control, sound, time

That's what its about, no double time

Like Lil' Darlin' – all quarter notes adding triplets

Clap on 5th bar

Class tries it at several tempos

Trusting each other

Guitar: acted a little scared

Trust yourself, keep track of melody

Play again – start on chorus

Ok better drums – keep it even

Add a little more energy to end of tunes

Some little double time lines

Group 2

Sax, Guitar 2

More phrasing on melody

Felt slow

Piano, plays examples

 Some double time

Rhythm section be more affirmative

Bass – add little harmony parts, fifths

Trumpet, start on chorus

Guitar 2, don't sustain over beat

Play D13#11 maybe play some variation

 E triad lydian

Count off time again

Trumpet: sounds awkward , waiting too late to change

There you go

Feels rushed, a challenge

Work on time, subdivision

Rhythm sec. plays by itself

More transparent on down beats

Articulation, phrasing, trust in the feel

Play again

Be prepared on Wednesday, transcription next Wednesday

3/2 LUSH LIFE cont

Soloist with rhythm section (drum, bass, guitar)

Group 1

Trumpet, plays head

Stop rhythm section – wait for soloist

Add cadenza, work on melody

Like the melody , beautiful tone

Get the changes right – why I'm on your case

Group 2

Sax

Rhythm section a whole lot better

Spoiled it on the changes

All the craft on the melody and fold on the changes

Think melodically but hear the changes

Plays example on the piano – chord changes

Get to hear what's coming

Group 3

Guitar solo

Bass/drums on bridge

Still think forward

Work on melody

Look at melody, be really clear on it

Group 4

Trumpet

Start on chorus

Ok, melody really good

Forgot a couple notes

Top of choruses- solo

Take time, work on phrasing

Don't rush to get to next in melody

Group 5

Sax

Top of chorus

Yeah! I thought this was great

Don't ignore long note, sometimes vibrato, sometimes not

Monday – spill over

Wednesday transcriptions

Each group have a tape

Then done with ballads – we can wake up

3/7 LUSH LIFE cont.

Eddie Gomez Tuesday after break

Performance evaluations Monday and Wednesday

Transcriptions Wednesday – play along to CD

Group 1

Sax

No sheet music

Sax states head

Gt/bass backup

Bass w/ bow

Rhythm section in on chorus

Guitar solo

Bass and brushes on bridge

Trumpet solo

Bass solo

6 today, 6 Wednesday

By 5pm Thursday transcript with CD

Sax 2, gt 2, bass 2, Trumpet 2

3/9 LUSH LIFE cont.

Performance evaluations

Trumpet 3 (guitar, bass, drums, rhythm section)

Scared, don't get scared

Guitar 2

Bass 2

Sax (Tenor)

Starts, stops – retunes with guitar

Restarts

Long cadenza

Drums

Bass w/bow

Gt. Changes

Play melodic Figures w/ mallets

Free 11-noon and 1- 2 for lessons, piano, and transcriptions

Transcriptions due week after spring break

12 versions of tunes – listen over, over, over, again

Piano pass, fail, changes too

24 points off if you miss this

Week after spring break only here Monday

Second week after spring break

3/21 TOMATO KISS

New tune – plays through on piano

Going to Chicago tomorrow

Wed. video tape transcription

Write changes on Monday

Tune analysis

Eb-7|B7/Eb

Ab to A, Bb to B, Db common tone

Gb to F or A, Ab, F for ethnic tone

Motivic

Eb-, F-, Ab maj pent. Or B maj pent

Eb harmonic minor

Put both chords in melting pot – not separate

B whole tone, like a total opposite of Eb-

Diatonic phrases, penatonic

A, Ab, F b, E, Eb Bb, A, Gb, F

Can come up with a synthetic scale

What is a symmetric scale?

Chord scale choices

Out of those find melodic ideas

Not just scalar, but angular w/ups and downs, find a motif

Dig in to it, the flavor

F/Gb “One O’Clock” chord

Dmaj7#5 same as F#/D B melodic min.

D, F, F#, A, Bb, Db

C harmonic min. modes

1 min/maj7

2 h/w dim.

3 maj7#5

4 min7#11

5 alt Dom b9b13

6 Ab maj7#11

7 Fully dim.

Let's play the tune – lots of search for colors

Guitars play piano line

Set up vamp- rhythm section

One more time – Vamp

Bass player playing piano chords

Stop: not hearing the changes, really lay it out

Question: last chord in break? Play line into solos

16 bars Eb pedal

Make a difference w/ 2 or 3 notes

If can't do that – don't play scales

Talking about character

Find a motif

Don't play like a wind up toy – get tired after a while

Played with Rich Perry: can hang on one note 4 minutes

Playing a lot of notes easy

Wednesday play transcription with recording

3/23 Transcription Performances

Video, play along w/ CD

Sight read or memorized

Trumpet1 Lush Life Coltrane solo

Sax 1 UMMG, Joe Henderson solo?

Bass 1 Time Remembered Marc Johnson Duets CD

Guitar 1 Jim Hall & Pat Metheny improv #5

Sax 2 UMMG Joe Henderson solo?

Guitar 2 Time Remembered - Pat Metheny? Bill Frissell?

Trumpet 2 Shade of Jade Lee Morgan trumpet solo

Trumpet 3 UMMG

3/28 TOMATO KISS cont.

Write changes to Tomato Kiss

Playing evaluations next Monday

Group 1 trumpet, sax, guitar, bass, drums

One more time, work on timing

No drums, outline harmony

Get involved, rhythm section making groove

What's difficult about this tune?

Find motif, think about melody

Stick with it, don't run arpeggios

Play examples on piano

Have a stronger cadence

Find an idea, go through circle of fifths

Simple idea, Coltrane used that one

Get a lot of mileage

You might be more comfortable w/whole tone scale, do you know it?

Plays again

Stop: need a stronger rhythm

Like a conga player – some surprises

Plays again

Finish an idea on Eb- and work thru circle of 5ths

Play Ab- melodic minor over G7b#5 7th mode super locrian or diminished whole tone

Find a motif, still have melodic awareness

Stop and think about phrasing, space, rhythm

Wouldn't write a tune w/ just scales and arpeggios – get out of that rut

I V cadence (two chord vamps)

About hearing phrase structure

Think 4 bar phrases

Trumpet 2

Trumpet 3: take your time, no rush, a little bit less stop and go, develop augmented idea

Trumpet 4: take idea up circle of 4ths

Plays again

Start at concert A tritone of Eb

If you stated w/that – wow, what's that?

Compositionally waiting for cadence

Plan and tension/release

Incorporate w/ a rhythmic idea

Can start on Db, E, as w/ A

Hearing notes that don't belong to chords – use them

The more outside you can train your ears to handle it the better

That's the tension and release

Sax 2: Ab- to Galt. Section to work on

Descending whole steps

Work on those details

On vamps wk with ideas, get away from chord changes

Motifs, rhythmic intensity

Work on details

Maj7#5, harmonic maj.

Augmented triads

On Wednesday play whole time

Come out to Dan's Silver Leaf, starts at 9PM

3/30 TOMATO KISS cont.

Evaluations Monday

Trumpet 1

Bass intro, several false starts

No drums

Break on 4

Lots of missed notes

Spend time at the keyboard to get the sound

Bb to B or Ab to A

Ab- to G7 alt (Ab melodic minor)

Gbmaj#5 Bb key note

Need to get to details of chord changes

Get to the colors

Wandering

Have you spent time at the keyboard?

Have to spend more time

Sax 1

Trumpet 2 – more melodies

Sax 2

Trumpet 3: don't play once and get out of there

Stay there and develop it

Doesn't have to be so busy

Add stronger rhythmic energy instead

Like diving board

Don't just jump off the board

Get comfortable technically, rhythmically

Ease into solo

Counts time off again

Bass solo: singing to playing (trying too hard)

Guitar

Various ways to approach time

Begging Eb section can dig down

Stick with blues notes

So many different approaches

Have a goal, a cyclical idea

Have a cadence

Not playing scales

Choose two notes on maj7#5

Write two new melodies over solo changes

2 new songs

A scale not a part of the melody

Turn in Monday w/ playing evaluations

4/4 TOMATO KISS cont.

Performance evaluations

Tune up

Group 1 – sax, trumpet, guitar, bass, drums

Head

Sax

Trumpet

Guitar

Bass

Head

Group 2 - trumpet, tenor sax, guitar, bass, drums

Head

Trumpet

Sax

Guitar

Head

Group 3 – sax, trumpet, guitar, bass, drums

Head twice

Sax

Trumpet

Drums

Handout new tune: SEE SAW (Joey Calderazzo, John Ambercrombie – To Know One)

Do as a 4/4 not 6/8

Have piano sheet Wednesday

F-, F and C in bass, G in melody (G,E, Db, Ab)

4/6 SEE SAW

Transcriptions Monday

Last TOMATO KISS eval:

Group 1 - Guitar, bass, drums

Guitar head

Guitar

Bass

Guitar head

- guitar need to woodshed melody, lots of missed notes
- asks drummer first chord, last chord – stumped

analyzes F/F# in Tomato Kiss

then SEE SAW

Db melodic min.

To Ab mixolydian b6

To C super locrian (dim/whole tone)

To F harmonic minor

To Db lydian (Db-7b13, Db nat. minor)

To Ebsusb9 Phrygian to Db Ab E A

Find common tones

Listen to recording

Advance music – Richie Beirach

Play in 4

Can you come up with c dom. Licks

Plays examples

Who would like to come up?

All play melody together

Play beginning of melody

Counts off

Class plays together

Take time soloing

Trumpet 1

Trumpet 2

Sax 1

Stops

Class plays e Phrygian over Emaj7b5/Eb

Eb, Ab, Bb

Eb min pent

B, Bb, E

Next scale Ab very important

Plays again

Sax 1 cont.

Trumpet 3

Guitar 1

Stop

Calderazzo Abmaj7/w E

Augmented triad

Dbmaj7b5

Play keys, examples

Tune Like BLUE 7

Db-7b13 can do A maj pent, A maj triad

Class – play them

Moves into next chord Amaj

Bbhalfdim/A you have a Cmaj triad next 2 bars c super locrian

F harmonic min. over Db7B13

Not a lot of changes

Lost of binding

Write changes Monday

Play all next week

Playing evaluations following Monday

4/11 SEE SAW cont.

Write changes to See Saw, plus two scale choices for each chord

Plays tune on piano

Writes piano voicing on chalkboard

Tune up/play

FIFE coming up – fast tune Shade of Jade – quarter notes 246 or above

Three tunes – slow, medium, fast

Tuesday of finals week 10am

Any three tunes – lead sheets, no music

Ballads – one chorus

Only so much time

Lush Life – just play the melody if you want

Not all blues

Counts off tune

Group one – trumpet, sax

Stops

Pseudo swing – walking swing – don't push too hard

Counts off

Plays head, one more time

Clapping tempo to speed it up

Stop

What's wrong with the melody?

Wrong notes

12/8 feels good, breaks the swing, more steady time

Once again melody

Stop – are you hearing the chords – let me hear the first chord

What are the notes in the very first chord? I don't know

C7alt? or almost like an Emaj7, then you've got an Amaj7 over Db

Plays chords on piano

Trumpet plays chorus, back to top

Trumpet plays another chorus

Stops – play concert Ab and E

Key notes – E resolving to Ab

Ebmaj triad – triadic harmony

Suspended notes

Counts off – one more time

Stops – what can we play over first chord - the c super locrian, fifth bar

Superimposition – Calt, basic suspension, play any crazy stuff and resolve it

Sax plays

Stops- sax – play Phrygian

Sax takes another chorus

Ok – next chord

Stops – what's the sound there – lay Db minor

Counts –one more chorus – super locrian

Plays on piano

Start from top – Db melodic min same as C super locrian

Have to get that E sound in there, Eb

Sax plays another chorus

Guitar takes a chorus – plays piano

Fmin – have to get that sound in there

Trumpet – have the sounds now – have to get more comfortable

Harmonic minor sound F G Ab Bb, they don't really do it, have no clue that's the sound

Have to get some chordal sounds

Plays again – guitar with piano

Sax2 plays

Trumpet2 – Flugal horn plays – stops playing piano, guitar2 comps

Plays piano again, guitar2 takes a chorus

Bass plays

Guitar3 plays

Bass2 plays

Horns play head twice – end

That b6 – play salt and it calls for sugar – going to sound pretty bad

How do we get that sound – Db -7b6 sound? Db, E, G –ok I would go C, Db, E, maybe G

Have half steps, better than thirds, now some character, base on thirds not going to do it

More personality – half steps make a difference

What's different between harmonic vs. melodic minor?

Now work on details, three notes that will give me that

C super locrian –

Don't be afraid to play over Phrygian, like I was doing over Eb, plays examples

E, Eb, A, Ab over Db-b6

Wed, next Monday playing evaluation

4/13 SEE SAW cont.

Writes piano voicings on chalkboard

Plays chords on piano

Analysis

Scales in thirds, you have chords, add major and minor 2nds, invert

Point not to play scales, but motifs

What leading notes do we need to go from chord to chord, A natural

Richie Beirach into traditional harmony, classical music

Group1 plays head – sax, trumpet, rhythm section

Slow it down a bit, counts off again

Head

b. sax

stop, play Emaj over Eb, Bmaj or Eb Phrygian

What about Fmin/maj b13, why specifically maj9? It's in the melody

Db13 prepares the next chord

What scale choice? F harmonic minor

Counts off

Sax

Trumpet

Stop, wait till the chord comes out, don't skate on top of it, what makes that chord?

Not 1,3,5 - Let the music come to you, don't force it

Eb, E

It's not what is important right now, it's about where it goes, next, next, next

Suspended notes on A maj.

What's the flat6? What's the root? C# minor triad

Play one more time, counts off, plays piano chords

What's coming next?

Now resolve it

Guitar

Sax2

Trumpet2

Guitar2

Stops – comment, give us too many ideas, find an idea and stick with it

Plays piano with rhythm section

Stops – comps with fills, C, D, sequences

Guitar2, wanted to go into 4 time

In general, leave room for simplicity, develop strong melodies, to have something to stand,
finding leading tones by regular suspensions, so you can really hear what each note really needs

to do

So these changes in your ears now? Lots of color, but lots of common stuff, almost like two
scales really

Play on this Monday

FIFE Tuesday, 3 tunes, fast tune 246 or above

4/18 PERFORMANCE EVALUATION ON SEE SAW AND

INTRODUCTION TO THE SHADE OF JADE

The uptempo tune 264bpm

Play 4 choruses

2 choruses with rhythm section, 2 without

Acapella

The trick on this tune is to keep the form

Write the changes on Wednesday

Learn changes by Wednesday

Performance evaluations – video taped

Group 1

Sax, trumpet, trumpet vamp at end

Counts off

Stops – recounts

Head

Sax

Trumpet

Guitar

Bass

Head

Group 2

Tune up

Flugal horn, tenor sax

Counts off

Head

Tenor sax

Flugal horn

Guitar

Bass

Head

Group 3

Guitar, trumpet, sax, drums

Counts off

Head

Guitar

Trumpet

Sax

Drums

Write changes on Wednesday – shade of jade

Want to take the tapes?

4/20 SHADE OF JADE

Grades A's and B's, no C's in here, come see me if you have any concerns or questions

Write changes to Shade of Jade

One more playing evaluation

2 transcriptions in course – one from tunes, one of your choice

Group 1

Trumpet, sax, tenor Sax

Look for format

1 chorus w/o rhythm section

accents on bars 7-8 A section

Bass keep playing on solo chorus

Bridge – hits on bar 9

Bar 10 A section, accent on upbeat of 3

Counts off

Head

Stop

Next to last chorus rhythm section drop out

Counts off

Stop – no swing

Play with rhythm of the melody

Head

Stop – don't walk on A section

Head

Stop – adds tenor Sax

Counts off – play s rhythm section A

Stops – got to tighter

S. plays with rhythm section, working with rhythm section to get feel right

Plays through head

Drums – can play Tony Williams stuff here, color outside the lines

Bass – NY 60s feel, put an edge on it, not laid back

Counts off

Head

Sax

Stop – rhythm section add accents

Counts

Head

Sax

Trumpet

Tenor Sax

Guitar

Head

Like a blues with a bridge

Dbmaj7 can play C blues

Lots of chromatic movement

Find chromatic ideas

Don't try to arpeggiate, chords going by too fast

Go for cadences, Dbmaj7b5

Trick is to relax the phrasing

Bridge is more bee-bop

Gb, Ab pentatonic

G7 resolving to Cminor

That's where you're heading – through the thorns and branches – then the sound of music again

Work with 4 bar phrases

A section – 6bars, 2bars, 4bars

1st 8 bars of bridge like a bee-bop tune

Tempo faster than 264, but why not

Rhythm section speeding up, but better than slowing down

Monday – all groups will play tune

4/25 THE SHADE OF JADE Cont.

Whole class plays with S. on piano

Counts off

Head

Stop

One more time

Play melody one more time, slow it down a bit

C minor pentatonic will cover both melodies, or Eb major pentatonic

Trumpet plays examples with S.

Counts off

Head

Trumpet1

Stop

Feel like your missing the boat on the changes, playing random phrases

Add little blues riffs, plays examples on piano

Somehow you have to come up with melodies

On the bridge, Gb into ii V I, harmonic minor scale maybe

Into Fmaj., F to Dminor is dorian

F- over Eb, a sus chord, Bb mixolydian, then C mixolydian

Then Gb to Ab maj., Fmin pent/Ab maj. Pent.

Last two bars Eb to Ab min., 6th mode of C harm. Min

Really not a new key center, stick with C harm. Min

Rhythm section play with piano chords

Takes a chorus

Trumpet1

Stops

Working on bridge: play a Bb mixolydian and C mixolydian now F-pent/Ab maj pent, then C harmonic min.

Last 6 bars bridge: 2 bars Bb mixolydian, 2bars Ab pent. Maj, 2 bars C harmonic min.

Plays examples on piano

Like Herbie Hancock's Maiden Voyage

Can use the third on sus. Chord, a myth that you can't

Much better trumpet1, did you feel more focused?

Can venture out and play more dangerously, to get more variety

Counts off

Trumpet2

Stop – develop with less notes

Counts off

Trumpet2

Stop – if you get too busy, nothing really happens, choose two notes, move chromatically, resolve to c minor

Counts off

Trumpet2

Stops – rhythm sect. slow it down, don't walk through it

Pick up the tempo

Counts off

Trumpet2

Tenor sax

Stops – good you're fine, let's pick it up

Counts off

Going to give you one chorus by yourself

Tenor sax

Guitar

Stops – you're slowing down

Counts

Guitar

Takes a chorus solo (w/drums)

Stops – still slowing down a little bit

Counts off

Trumpet3

Takes a chorus solo (w/drums)

Stops – got a little lost there

Plays examples on piano

What's cool playing with a rhythm section, starting moving harmonies, maybe G whole tone scale

You hit it and move on, stick with it, give rhythm section a chance to communicate

Just listen and see what might happen

Counts off

Plays piano w/ rhythm section

Stops – maybe resolve it on the third bar then listen more closely to harmonic ideas

Wednesday work at real tempo, go around the block then hit it on Monday

5/2 THE SHADE OF JADE PERFORMANCE EVALUATION

Tune up

FIFE coming up – passed out form

One slow, medium, fast

Come in prepared, you should be fine

Final next Tuesday – sign up

Video

Group 1 – sax1, sax2, trumpet, 2 guitars switch off

Bass – cue the breaks, next to last chorus, after break one more full chorus into next solo

Trumpet, alto, alto, red guitar, brown guitar

20 minutes for each group

Head

Trumpet

Sax1

Sax2

Bass

Guitar1

Guitar2

Head

Group 2 – 2 trumpets, tenor sax, guitar

Trumpet, tenor, trumpet, guitar, bass, drums

Head

Trumpet1

Tenor sax

Trumpet2

Guitar

Bass

Drums

Head

Lot of nice improvements with a lot of you

Dig in more with the rhythm section, use the rhythm section, they have a wealth of possibilities, they will really kick you in the butt

When I'm onstage I will take advantage of the rhythm section, the bass player will push you into a new chord

Hope you had fun with these tunes

5/4 SECOND TRANSCRIPTION ANALYSIS (LAST CLASS)

Tune up

Prepare for transcription performance

Trumpet1 - ?

Guitar1 – Pat Metheny/Jim Hall?

Spoke to class about my research, S. suggested I should present at the Jazz Music Educators Conference

Guitar2 – Ed Bickert

Trumpet2 – Double Take, Freddie Hubbard

Sax2 – Lush Life – Coltrane

Sax3 – Kenny Garrett

Bass1 – ?

Trumpet3 – did not perform, no CD

Drums –

Guitar3 – Bill Frissell, played 2 different transcripts

Bass2 – trumpet solo?

Guitar2 – played piano changes to THE SHADE OF JADE

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