A New Approach to the Analysis of Timbre

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A NEW APPROACH TO THE ANALYSIS OF TIMBRE

by

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Abstract
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Megan Lavengood

Advisor: Professor Mark Spicer

Two distinct approaches to timbre analysis exist, each with complementary strengths and limitations. First, music theorists from the 1980s adopt a positivist mindset and look for ways to quantify timbral phenomena, often using spectrograms, while avoiding any cultural dimensions in their work. Second, writings of the past five years focus on the cultural aspects of timbre but make no use of spectrograms. This dissertation builds upon these two approaches by synthesizing them: discussion is grounded in spectrogram analysis, but situated within a broad cultural context, through interactions with listener experience and ethnographic study of music periodicals and other published interviews. The theory is applicable to any genre of music, but 1980s popular music is used as a case study, with a particular focus on the Yamaha DX7 synthesizer, used in much of this music.

Chapter 1 outlines a methodology for timbre analysis and establishes a system of oppositional vocabulary for the analysis of the spectrogram. After providing a history of synthesizers in popular music to contextualize study of the Yamaha DX7 in Chapter 2, in Chapter 3, several hit singles using Yamaha DX7 preset sounds are analyzed in terms of texture and instrumentation, establishing three distinct categories of textural function: core, melody, and novelty sounds. Through the analysis of texture, instrumentation, and timbre, timbral norms are established for each of the three textural functions. Chapter 4 demonstrates
how musical meaning can be created through the dialectic transgression of the norms articulated in Chapter 3. Chapter 5 focuses on the interactions between acoustic and cultural aspects of timbre through the close analysis of one particular DX7 preset, E. PIANO 1, which was often compared to the Fender Rhodes electric piano. A larger argument about the “’80s sound” is made by interweaving arguments from Chapters 3, 4, and 5. The 1980s can be retrospectively seen as a genre, created through a homogenization of timbre facilitated by the Yamaha DX7 presets. This description of the ’80s sound is valuable in its own right, but these studies also aim to show the value of studying timbre in music analysis more broadly.
ACKNOWLEDGEMENTS

I must first thank my supervisory committee for all their support and guidance at various stages throughout my dissertation. My advisor, Mark Spicer, persuaded me early in my Ph.D. to pursue popular music research, and pointed me toward the Yamaha DX7 and its factory preset sounds as the object of my study. Mark has continually stimulated my work and kept me focused on my goals. Jonathan Pieslak sparked my interest in pursuing ethnography as part of timbre analysis. My methodology was refined through abundant and brilliant feedback from Zachary Wallmark. Poundie Burstein has provided me with an outsider’s perspective on my work in popular music and timbre analysis, which has been particularly welcome when writing proposals and abstracts.

I am also grateful to many other colleagues throughout the field. My interest in both timbre and popular music grew from a final paper in a seminar at Florida State University taught by Michael Buchler, who supported my leap into the uncharted territory of timbre analysis. David Blake then gave me feedback that inspired an entire chapter of this dissertation when I presented this seminar paper at a conference. Joseph Straus and William Rothstein have both been wonderful mentors throughout this process, inside and outside of their monthly dissertation group meetings.

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INTRODUCTION

Timbre is what allows our minds to distinguish one human voice from another. In speech, timbre is essential for human communication, perhaps even survival. Likewise, in music, timbre is undoubtedly one of the most immediate aspects of musical experience. Sometimes referred to in this context as “tone color,” timbre is what allows even non-musicians to quickly distinguish genres of music or different musical instruments from one another. Timbre is widely considered a more significant feature in popular music than in art music.\(^1\) Sentiments such as “in popular music, timbre is more important than harmony or form” are common in everyday discourse and published works.\(^2\) Implied in such a statement is the idea that in art music, harmony and form are more significant. Yet, timbre analysis is still lacking in most music theory venues: scholarly journals, conferences, and in the classroom.

Only relatively recently has popular music analysis become truly mainstream. Presently, the training of most music theorists has focused on European Classical repertoire. Conflicts between popular music research and the classical training of its researchers have not yet been fully reconciled. Classical repertoire is primarily stored and disseminated

\(^1\) This is especially true for pre-20th-century art music.

\(^2\) For example, Philip Tagg (2013, 11): “...it soon became clear that the arsenal of structural terms I’d had to acquire in order to obtain a B.A. in music was quite inadequate [for discussing popular songs with band members], not least when it came to issues of rhythmic/motivic bounce and drive (as in grooves and riffs), even more so when denoting the details of timbre so important in so many types of popular music.” Moore (2001, 155) offers a slightly more reserved version of the same point: “[An emphasis on timbre] is welcome, particularly in music where the construction of timbres becomes subject to precise, conscious control via synthesizers...”
through music notation; therefore, the timbres vary significantly depending on who is playing the music, the instrument on which it is played, the space in which the instrument sounds, and (if the music is recorded) the recording technology used. In other words, the timbres of art music are more abstracted. It follows, then, that the role of timbre in Classical music does not seem to play as large a role in our musical experience as other factors, factors visible in notation: harmony, form, thematic development, and so on. Popular music is instead primarily stored and disseminated through recordings, so most individuals will hear essentially the same timbres each time a track is heard, excepting some variance due to environmental factors. For popular song, then, a particular sound—a particular combination of specific timbres—is uniquely essential to the *Urtext.*³ Despite the integral role of timbre in popular music, most scholars of popular music still focus on pitch and form—the analytical domains most familiar from analysis of the notated scores of art music. This discrepancy is the fallout of the problem of the primary text. As many popular music theorists have argued, since popular music is disseminated through recordings, the recording should be considered the text.⁴

The field seems to have reached a consensus on the status of the recording as the primary text in popular music. But in practice, scholars with Classical music training might begin their analysis of a pop song by making a transcription—in traditional Western music notation—of that track. Transcribing music is personally compelling for many theorists, myself included: the process forces us to listen closely and account for every audible feature, to quantify and measure each component; transcription has a clear end point, after which the

³ The boundaries between art, popular, and folk musics are blurry, and many works exist on the borderlines. But method of distribution is one of the most reliable ways to separate music into this tripartite division.⁴ See, for example, Gracyk 1996,21 and Moore 2001.
transcriber has produced a complete and finished product. After the conclusion of the transcription process, one may have noticed any number of new lines or rhythms that were never before noticed, and perhaps never would have been without the high level of close attention that transcription demands. The benefits of transcribing pop music are multifold. Proceeding to then analyze the transcription, however, rather than the recording, unfortunately ignores this issue of the primary text, and in turn, prioritizes traditional domains of music analysis (pitch, form, rhythm) rather than meeting popular music on its own terms. Analyzing a transcription, or even aurally analyzing harmony and form, can feel much more comfortable and familiar to those scholars who have been “classically trained.”

Most music theorists are aware of these biases and are eager to see more analysis of timbre, yet timbre still does not receive much attention due to a second, more practical problem: analysis of timbre is difficult. A listener does not need to have any musical training to tell that the timbres of a trumpet and a violin are different, because timbre is something that humans intuitively understand. Timbre allows us to differentiate the voices of different people without looking at their faces. In music, timbre is just as significant. Timbre can function as an encoding of a music’s genre, identity, and more. But the phenomenon of timbre is an aggregate of spectro-temporal effects changing in time—surprisingly complex when compared to how easily timbres are perceived. Unlike so many other elements of music, however, timbre as a whole cannot be arranged on a continuum of any kind. Leonard B. Meyer

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5 The advantages and disadvantages of transcription are thoroughly weighed among several musicologists in Stanyek 2014.
6 I use transcriptions throughout this dissertation, but not for the purposes of my own analyses; the transcriptions were made after the fact to aid readers.
7 A single component of an instrument’s timbre can sometimes be mapped onto a continuum, as in Scotto 2016, where guitar distortion is mapped in a two-dimensional timbre space.
defines timbre as a “secondary parameter,” unanalyzable through segmentation or hierarchical organization—and both of these steps are central to many methodologies of music theory, especially methodologies addressing “primary parameters” such as pitch and rhythm. Emily Dolan even goes so far as to say that “[timbre] cannot be easily analyzed as a parameter because ultimately timbre is not a parameter at all: it is aesthetic attention itself.” These difficulties have discouraged analysis of timbre. I believe timbre is analyzable, but a theory addressing timbre must be flexible in order to deal with these issues of nonlinearity and aesthetics.

**Defining Timbre**

Timbre—when not simply defined in the negative (*not* pitch, *not* rhythm, *not* dynamics)—is usually defined as the overtones and partials included in a sound, and the relative loudness of those overtones/partials. In other words, timbre is defined through the aggregate of its spectral elements, and how these spectral elements also change in time. But this definition of timbre is overly narrow. Timbre is affected both by “non-timbral” elements of music such as pitch, as well as by the perceiving mind. As Cornelia Fales has discussed, the human mind does not process timbre in the same way as a computer does; that is, timbre is not purely acoustic. Timbre is affected by neural processes that make any number of extramusical or non-acoustic associations, and timbre becomes interwoven with culture, identity, and other sociological and non-acoustic components. Fales terms this phenomenon “perceptualization.” Timbre perception can further be affected by elements of sound usually categorized as

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8 Meyer 1989, 14.
9 Dolan 2013, 89.
10 Fales 2002.
part of another domain, such as dynamics and pitch. For example, an instrument sounding with vibrato is distinct from the same instrument sounding without vibrato; though vibrato is created through pitch and dynamic changes, one can also consider vibrato an important component of the timbre of an instrument. In light of all this, I define timbre as an analytical domain that is shaped by spectral, temporal, and spectrotemporal elements of a sound signal (i.e., frequency, amplitude, and how those change over time) and also by culture and history.

**Review of Existing Work**

Modern interest in timbre analysis began in the mid-1970s, when advances in computing led to the (relatively) widespread availability of spectrograms, which are visual graphs of the spectrum of frequencies present in a sound signal. Robert Cogan’s 1984 book, *New Images of Musical Sound*, introduces his methodology and addresses a wide range of repertoire, from Tibetan Tantric chant to Elliott Carter. Building from linguistic research by Linda Waugh and Roman Jakobson, Cogan combines spectrogram analysis with a theory of oppositions. Cogan selects thirteen oppositions that can define the “sound design” of a given sound signal, and uses these oppositions to focus his analysis of spectrograms.

Cogan’s work has not inspired many theorists to follow in his footsteps today. Spectrogram images are always visually interesting, but Cogan’s verbal descriptions of the spectrograms tend not to yield insight that is not readily apparent in the image itself. For higher-level connections, Cogan sometimes totals the plusses and minuses in a given table, simplifies the results to an integer, then tracks the change in that integer over time, a process he describes as tracing the “energy” of a given piece. This highly quantitative approach

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11 Cogan cites Jakobson and Waugh 1979 and Jakobson 1951 as his primary influences.
to musical timbre fails to pique my musical interest, because Cogan does not integrate the mathematical operations and objectivity with a higher level of interpretive analysis. Analysts are not drawn to Schenkerian theory or Sonata Theory because of their accounting capabilities, categorizing and counting the elements of music; the hermeneutical imperative in each theory—the relation to musical expression—is what resonates with analysts’ experiences as musicians. Because Cogan resists this interpretive impulse, his work does not arouse interest.

In 1986, Wayne Slawson won the Society for Music Theory’s Wallace Berry award for *Sound Color* (1985). In this book, Slawson evenhandedly and insightfully critiques other contemporary theories of timbre, as well as working toward his own. Like Cogan, Slawson makes frequent reference to the work of Jakobson, Waugh, and other structural linguists. He defines four parameters of timbre, which he calls openness, acuteness, laxness, and smallness, all based on vowel sounds; further, he defines a sound-color space, and operations on sound color. Ultimately, however, Slawson himself recognizes that his spaces and operations are not as well-developed as those of, for example, pitch class set theory, and concedes that his goal is more to spur creative uses of timbre than to analyze timbre. Slawson is a composer, and his theory primarily works toward an understanding of timbre that could directly inform his compositional process, similar to the work of other composer-theorists such as Robert Morris.

Both Slawson’s and Cogan’s pioneering works suffer from similar problems, which pervades much music-theoretical work from this time: an excising of almost all reference to a larger culture surrounding the phenomenon of timbre in the music they investigate. This
is evident in Cogan’s and Slawson’s vocabularies. Words such as “warm,” “hollow,” “metallic,” or “clean”—that is, words that musicians use to talk about timbre—are eschewed in favor of more clinical terms such as “laxness,” “spaced,” or “acute,” which are sanitized of any cultural contamination. Cogan avoids even the word “timbre,” as well as “sound color”—instead Cogan frequently employs terms such as “sonic design” or “sonic character.” The use of the term “sonic” is particularly revealing of a scientific, as opposed to a musical, orientation, and this orientation is paired with a matching, more thoroughly Latinate word. The overly-positivist approaches of Cogan and Slawson do not resonate with the analytical concerns of a twenty-first-century music theorist.

The broadening of the field of music theory, and its subtle blending together with the field of musicology, is evident in recent work in timbre analysis. Zachary Wallmark’s dissertation (2014) works toward building a bridge between cultural musicology and the abundance of timbre research in the field of music perception and cognition, as exemplified by the work of Caroline Traube, Carol Krumhansl, Stephen McAdams, Stephen Malloch, and others. The first part of his dissertation deals with embodiment and cognition, while the second part comprises a few musicological case studies. In these case studies, Wallmark engages with published interviews and ethnographies, combining musicological criticism with cognitive approaches, and ultimately argues that timbre perception is “fundamentally social.” Much perception and cognition research is far removed from the questions that musicologists ask about timbre—necessarily so, as the kinds of questions musicologists ask often are not suited to empirical testing and data-gathering. But Wallmark begins to negotiate these differences.

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12 Wallmark 2014, 36.
Kate Heidemann’s 2016 article, “A System for Describing Vocal Timbre in Popular Song,” achieves this balance between cultural and empirical concerns. She organizes and describes the vocal timbres by combining qualities perceived and embodied in the listener with the physiological actions required to make the sound. Heidemann clearly defines her terms and explains her assertions through anatomy, culture, and/or empiricism.

David Blake’s “Timbre as Differentiation in Indie Music” (2012) introduces his approach to timbre analysis in the context of a discussion of timbre and identity, as he contrasts indie music and mainstream music. He offers four Booleans to describe timbres in rock music—full, distorted, homogeneous, and digestible. After determining whether the Booleans are true or false, Blake traces many different timbre types throughout selected tracks by Neutral Milk Hotel and other bands. Blake’s analyses are insightful, and he furthermore provides a robust philosophical underpinning for the perception and experience of musical timbre. Citing the immediacy of timbre perception, Blake does not offer any empirical verification of the existence of the timbral qualities he lists above. This is a common practice among the vast majority of recent music-theoretical research that deals with timbre. Blake’s significant work in timbre studies and identity could be further strengthened by bringing empirical elements into the discussion, without losing any of the musicality of his analysis. Incorporating spectrogram analysis into the decision-making process would demonstrate to other would-be analysts how these properties come into being. Obfuscation of reasoning deters other music theorists from embarking on their own similar timbral investigations.

The cultural fluency of recent timbre studies is indispensable to our understanding of musical timbre, but examining how our perception of timbres compares to the physical

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13 Cf. Blake 2014, Burns 2014, and Heetderks 2014, all of which were part of a special session on timbre in pop/rock music at the 2014 national meeting of the Society for Music Theory.
measurements of sound signals as shown in spectrogram analysis could augment this approach.\textsuperscript{14} The problem with the early work in spectrogram analysis from the 1980s is that it failed to recognize the shortcomings of spectrograms. The main disadvantage of spectrograms is that the human brain does not process a sound signal in the same way as a computer—in fact, the processing can be quite different indeed. Fales articulates this “paradox” specifically with regards to the identification of a sound source, noting that a person might perceive an entirely different sound source than what the spectrogram shows the source to have actually been, but ultimately the real source might not even matter to the listener, as long as nothing ends up contradicting this information.\textsuperscript{15} This gets to the heart of her concept of “perceptualization,” which she defines as “any cognitive operation or feature that contributes to the perceptual outcome of a signal beyond the actual acoustic elements of the signal.”\textsuperscript{16} A listener’s brain is not passively calculating timbres in the same way that a computer does when it produces a spectrogram. The brain takes quite an active role in determining how listeners experience those timbres, and is susceptible to ignoring or creating timbral attributes that may or may not be present.

One could interpret the phenomenon of perceptualization as an indication that spectrograms are irrelevant or even misleading; I argue instead that these differences between what a spectrogram tells us and what the mind perceives open up a new way of engaging

\textsuperscript{14} I prefer spectrograms to perception studies for similar reasons. For timbre analysis to flourish, there must be a methodology to follow, which, while informed by perception research, functions independently from it. Most music theorists cannot create their own perception studies to analyze any piece, and most pieces won’t necessarily have a perception study that helps inform the analysis. With this in mind, I find spectrograms the most useful tie to empiricism or physical phenomena that an analyst can use to analyze timbre.
\textsuperscript{15} Fales 2002, 57–8.
\textsuperscript{16} Ibid., 63.
with spectrograms, and with timbre analysis more broadly. In order for analysts to feel comfortable embarking on a timbral analysis for the first time, a theory of timbre ought to have clearly displayed, easy-to-follow, independently verifiable reasoning. This is what spectrograms can provide: a common starting point for ensuing discourse. Knowing that spectrograms are flawed, analysts can use spectrograms as one type of data that helps create a larger picture. For example, if and when spectrogram data contradict the way a listener verbally describes timbre in a casual conversation (e.g., an interview), rather than throwing the spectrogram out and defaulting to the listener’s perception, one can specify where the differences lie—in a sense, locate some of the perceptualization—and speculate on the origin of these differences. In short: the spectrogram is a flawed tool that can still be salvaged. I show throughout this dissertation that if the analyst is cognizant of the deficiencies and compensates for them in other ways, the spectrogram remains a fruitful source of timbre research.

**Why 1980s popular music?**

I focus throughout my dissertation on popular music of the 1980s. The rise of the synthesizer began a revolution in timbre in popular music, which opened up a wide universe of possible sounds that simply didn’t exist in prior eras. Comparing the timbral domain to other more traditional domains of music analysis, Allan Moore notes, “particularly in music where the construction of timbres becomes subject to precise, conscious control via synthesizers, timbral qualities can no longer be taken for granted.” Timbre analysis becomes particularly significant at this time. The timbral profile of much rock music might be mundane in 1963,

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17 I engage in precisely this line of questioning in Chapter 4.
but this is certainly no longer true by 1983. When synthesizers first became affordable to the
average person (or at least to the average person who was able to save up a little money) in
the early 1980s, suddenly, everyone had access to the kind of timbral palette that had previ-
ously only been available to successful artists who could afford to pay for time in well-ap-
pointed studios. The availability of commercially-viable synthesizers meant that more peo-
ple had access to a diverse palette of sounds, essentially democratizing the kind of timbral
experimentation that earlier groups like the Beatles had made famous.

Outline of Dissertation

In Chapter 1, I establish my methodology, my oppositions, my spectrogram analysis, and my
methods of interpreting this data. My theory of timbre is broadly applicable to any genre or
instrument, but rather than making this explicit with a series of disjointed analyses of con-
trasting styles of music, I have chosen instead to pursue a secondary analytical goal with my
case studies: a preliminary map of the timbral landscape of music of the 1980s. In Chapter 2,
I discuss the technology of the Yamaha DX7 FM digital synthesizer, the instrument that
serves as my primary lens into 1980s popular music, identifying the scope of the DX7’s inno-
vation and influence on popular music, contextualized within synthesizer history. I identify
in Chapter 3 the uses for the various presets of the Yamaha DX7 within the texture of a pop
song, which is essentially an instrumentalational concern, not really a timbral one. In this
chapter, I also show how the textural functions interact with musical form. I situate my in-
strumentational assessment culturally: these norms are established in mainstream 1980s
popular music. In Chapter 4, I then show how these norms are transgressed in non-norma-
tive genres, displaying the narrative potential of a dialogic analysis of timbre. In Chapter 5, I
present my research regarding the cultural and social significance that the DX7 had in the
past and has today, through a detailed analysis of one DX7 preset, E. PIANO 1. This discussion is drawn from magazines from the 1980s, interviews from the 2000s, and other sources. I tie together ideas from throughout Chapters 2–5 and ultimately argue that the DX7 represents and epitomizes “the ’80s sound,” finally arguing that “’80s” can be understood, in a presentist and explicitly ahistorical way, as a genre of music, with the Yamaha DX7 as one of its most important signifiers. My discussion of the sound-world of the 1980s, in turn, demonstrates what music theorists can achieve through the analysis of timbre.
MOST ANALYSIS DONE BY MUSIC THEORISTS involves looking at a notated score of the music. Visual representations of music, like the notated musical score, have clear advantages as analytical objects over the recording alone. For instance, analysts can take in the music at their own pace, rather than needing to keep up with a recording. Furthermore, they can make connections between non-adjacent musical elements more easily than if they were bound to the progression of the music in time. Of course, musical scores also encourage the analysis of certain musical parameters more than others—rhythm, pitch, and text are much more frequently analyzed than timbre, because a score does not represent timbre in any great detail. Fortunately, with the spectrogram, a representation of music that visually illustrates timbre does exist.

My methodology combines spectrogram analysis with cultural analysis and interpretation of a number of different possible functions of timbre: textural function, narrative, and ethnography. I define a number of acoustic timbral attributes to which one may attune when analyzing timbre. These attributes are organized into oppositional pairs of marked and unmarked terms. But identification of these attributes alone does not produce a satisfactory

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1 It should go without saying that both aural and visual analysis is valuable, and that taking in the score at tempo and in time is another important facet of music analysis.
analysis; this simply lays the groundwork for the true goal of timbre analysis, which is interpretation. In the next chapters, I will demonstrate two methods of interpreting the bits of data afforded to an analyst with a spectrogram: through dialogic analysis, and through socio-cultural study—two lenses that do not exclude one another, and indeed often overlap throughout my work.

**Spectrograms**

A spectrogram approximates the sound waves present in a signal with a visual representation that is easy for our brains to process out-of-time. This represents the principle advantage of consulting spectrograms: they visually represent timbre in a way that is akin to how the notated musical score represents other domains of music analysis. Over the past ten years or so, spectrogram technology has become much easier to access than it was for Slawson and Cogan in the 1980s, through free software programs such as Audacity or Sonic Visualizer. This means that anyone with access to a computer may easily view a kind of visual transcription of the timbre of any recorded sound.²

> A spectrogram charts frequency on the y-axis and time on the x-axis, while showing amplitude with changes in color (Example 1.1), thus visualizing the relative weighting of the energy distribution along a given frequency range and providing a visual representation of most of the elements that define a timbre.³ In a layperson’s terms, a spectrogram shows the

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² These software programs vary widely in terms of the control they offer over different parameters, however, which can drastically affect analysis.

³ The spectrograms throughout this dissertation have been created with iZotope RX4 software. Settings for the spectrograms are as follows. The frequency scale is the Mel scale, which reflects listener perception of pitch space (cf. Pedersen 1965). The amplitude range goes from -92.8 dB (low) to 0 dB (high). The software automatically varies the time and frequency resolution of the Fourier transform to achieve what Izotope’s manual calls the “best spectrogram sharpness in every area of the time-frequency plane.” The fast Fourier transform size is set to 2048. The window is set to cos3. The frequency and time overlap are both set to 4x. For more information, see the iZotope RX user’s manual on Spectrogram Settings.
volume of all the frequencies present in a sound signal, and the way those volumes and frequencies change through time. This means that a spectrogram shows not only the fundamental pitch, but also all the overtones that the ear combines into a single tone with a unique timbre.

Example 1.1: A spectrogram.

Another visual representation of timbre is called a spectrum plot (Example 1.2). In a spectrum plot, frequency is charted on the x-axis and amplitude on the y-axis, which makes a spectrum plot more accurate than a spectrogram when showing a single moment of time, and useful for calculating exact differences in amplitude between various partials. Spectrum plots do not show changes in timbre through time, so spectrum plots are most useful for examining a single moment or for averaging a range of time.
Example 1.2: A spectrum plot showing a single moment of time.

**Oppositions**

In light of the overwhelming amount of information displayed together in a spectrogram, a pre-defined methodology, outlining a process for analyzing the many details within a spectrogram, becomes desirable. I value Cogan’s pre-defined vocabulary for the analysis and discussion of musical timbres communicated through his binary oppositions. I also analyze spectrograms through a system of oppositions, borrowing heavily from Cogan’s pioneering research, but I suggest improvements that build upon his work in a number of ways. Most significantly, I repurpose his system of binaries to address the concept of musical markedness, rather than Cogan’s notion of “spectral energy.” I add new oppositions to address holes in Cogan’s theory—for example, I pay special attention to the analysis of onsets or attack points of sounds, something that Cogan fails to do—and omit oppositions that I have not
found to be useful. I avoid overly technical vocabulary and recouch these terms in common language terms that reflect listener experience.

In sum, I have fifteen total oppositions, grouped into three categories: spectral components of the sustain portion of the sound, spectral components of the attack portion of the sound, and pitch components. I created a separate category for pitch components of a sound in order to precisely articulate what comprises the notion of “timbre.” Whether intentionally or unintentionally, Cogan does not make clear the distinction between aspects of timbre and aspects of other musical domains. Changes in loudness and pitch create changes in the timbre of a sound as well, so these oppositions should not be omitted from analysis, but nevertheless, distinction between elements of timbre alone and elements of other domains that also affect timbre is useful. I have therefore grouped these other elements together in their own section to distinguish them from purely timbral elements.

While Cogan’s oppositions nearly all focus on the decay or sustain portions of a sound, the attack of a sound also contributes a great deal to the perception of its timbre. Without a separate attack profile, listeners typically categorize sounds as sounding particularly synthesized or robotic, likely because almost all acoustic instruments have an attack profile that differs from their sustained tone. An attack sound can also vary in many ways—the attack of a piano sound when the hammer strikes the string is not the same as the attack of a harpsichord sound when the plectrum plucks the string, and both of these are nothing like the attack sound of a trumpet note. Studies have shown that the attack of a sound plays

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4 Rather than solely referring to aspects of timbre, Cogan’s oppositions grave / acute, centered / extreme, level / oblique, and perhaps also steady / wavering all primarily concern pitch; the oppositions soft / loud and (in a way) sustained / clipped primarily concern loudness. Understanding that Cogan was not attempting to create a theory of timbre specifically—rather, he was demonstrating the usefulness of spectrograms in the analysis of music more broadly—explains the resultant problems of using Cogan’s oppositions as a model for timbre analysis.
a large role in a listener’s ability to accurately determine the sound’s source. This significant aspect of timbre must not be reduced to something as basic as the presence or absence of a separate attack profile.

At this point, I will summarize each of my oppositions, clarifying my developments from Cogan where appropriate. For the timbral attributes that are spectral components, I provide visual examples in the form of a spectrogram that puts two opposing sound signals side-by-side for comparison. I have annotated all the spectrograms in white. Here and throughout my dissertation, oppositional terminology is given in italics.

Spectral components of the sustain

1. Bright / dark. This is a renaming of one of Cogan’s oppositions, wide / narrow. This opposition measures the distance in octaves (i.e., pitch space rather than Hertz) between the fundamental and the highest sounding partial (Example 1.3, see page 22 below). Given a fundamental frequency of $x$ Hz and a highest partial of $y$ Hz, the analyst can calculate this distance with the equation $\log_2(y) - \log_2(x)$; the resulting number will be the distance in octaves between the two frequencies. Whether this number converts to bright or dark is a contextual decision, left to the analyst; throughout this dissertation, the boundary is often four octaves.

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5 Saldanha and Corso, 1964. Listeners were able to identify the source of a tone with 50% greater accuracy if the attack (onset) of the sound was included in the sample, as opposed to a sample that cuts out the attack and plays only the sustained portion of the sound.

6 Bright / dark may not correspond quite so simply to wide / narrow. Often, tessitura or range can be essentially equated with brightness; for example, when listeners hear a sine wave sweep from a low frequency to a high one, many state that the tone brightens; however, according to my opposition here, the sine wave would maintain a dark tone throughout the sweep, as its range between its lowest and highest partials would be 0 throughout the sweep. This is certainly a wrench thrown into the equation. For the purposes of this dissertation, however, the measurement of the width of the signal works fairly well in estimating brightness, as I will not deal with such outliers. In future work, I intend to reconsider this opposition in particular.

7 Because theoretically partials can extend infinitely, the analyst may determine a cutoff point at a certain amplitude, which ought to be kept consistent across different analyzed signals.
2. *Pure / noisy.* This is another renaming of one of Cogan’s oppositions, *compact / diffuse.* This opposition considers the thickness of the bands of each spectral element. On the spectrogram, sounds that are *pure* have thin strands for their spectral elements; sounds that are *noisy* have thicker bands, or perhaps a strand that is surrounded by a halo of lower-amplitude energy (Example 1.3, see page 22 below). The thicker the band, the noisier the sound. On the extremes, the resonant tone of a struck vibraphone would produce a very *pure* sound, while a snare drum would produce a very *noisy* sound.

3. *Full / hollow.* Here I rename Cogan’s opposition *non-spaced / spaced.* Some instruments, perhaps most famously the clarinet, do not sound all of the overtones when playing (the clarinet does not sound the even-numbered overtones). Any sound that does not sound all the overtones would be an example of a *hollow* sound; a *full* sound uses all overtones. On the spectrogram, a *hollow* sound will appear to have more space between each of its partials (Example 1.4, see page 23 below). Some sound signals may be *hollow* even when all the overtones are sounded, if some of the overtones are considerably louder than others. Typically, the fundamental is the loudest partial in a sound, and the amplitude of subsequent partials decreases in a regular pattern. If instead every other partial is louder than the ones in between, the sound may be *hollow.* In such an instance, one might think of the partials as being imbalanced.\(^8\) Using a spectrum plot rather than a spectrogram may help identify whether or not any partials were skipped.

4. *Rich / sparse.* This opposition is taken from Cogan. This attunes to the number of partials present in a given sonority. A sound with many partials is *rich,* and with few is *sparse* (Example 1.5, see page 23 below). For sounds that do not have discernible partials, a sound

\(^8\) The significance of this parameter has been described by Krimphoff et al., 1994 and Peeters et al., 2011.
that has wider bands is more rich than a sound with narrower bands. Cogan gives the example of a sine wave as the most sparse sound and white noise as the richest sound.\(^9\)

5. Beatless / beating.\(^{10}\) Another opposition from Cogan, this refers to the presence or absence of acoustic beats, also known as sensory dissonance or auditory roughness.\(^{11}\) Beats occur between two frequencies that are only slightly different, in which case interference is created between the two sound waves. The aural result of this interference is regular fluctuations in loudness, and these fluctuations are called “beats.” On the spectrogram, this will appear as a periodic brightening and darkening of the shade used to render the partial (Example 1.6, see page 24 below).

6. Harmonic / inharmonic. This is a new opposition that Cogan does not address. A sound that is harmonic contains only partials in whole-number ratios to the fundamental (in other words, true harmonics).\(^{12}\) A sound that is inharmonic has some partials not in whole-number ratios to the fundamental. Bells and pianos are perhaps the most well-known examples of sounds with inharmonic partials, caused by the stiffness of the vibrating bodies in each. On the spectrogram, inharmonic partials are most easily identified when they appear in particularly tight clusters (Example 1.7, see page 24 below). Using a spectrum plot rather than a spectrogram may help identify inharmonic partials.

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\(^9\) Cogan 1984, 136.

\(^{10}\) This opposition technically deals with time-variant amplitude rather than spectral energy.

\(^{11}\) Helmholtz 1875, 247; Sethares 1998.

\(^{12}\) Harmonic, partial, and overtones have slightly different meanings. Partial is the most general term, for any one of the distinct spectral elements of a sound signal. Etymologically, the term refers to its role as part of the complex timbre of the sound signal, which comprises many such parts. Overtone is essentially the same as a partial, but the term cannot be applied to the fundamental—overtones are, strictly speaking, partials which occur over the fundamental. Harmonic has the most restricted usage: a harmonic is a partial whose frequency is in a whole-number ratio with the fundamental frequency; in other words, it must be a part of the harmonic series.
Spectral components of the attack

The attack portion of the sound, sometimes referred to as the onset of the sound, is the initial rise from zero amplitude to a peak amplitude, prior to either stabilizing at a sustain amplitude or decaying and returning to zero.

1. Percussive / soft. This consideration is the same as pure / noisy (see above) in the spectral components of the sustain, but instead one should consider only the attack or the onset of the sound signal. I have changed the words to reflect a change in orientation to the attack portion of the sound. A noisy or percussive attack has a wide band of sound at the attack point—what Cogan would describe as attack sounds; a soft or pure attack has a thin strand of sound at the attack point—what Cogan would describe as no-attack sounds (Example 1.8, see page 25 below). I prefer percussive / soft because, strictly speaking, the sound likely does have an attack of some kind, even if the attack is very gentle (i.e., soft). Percussive is particularly elegant, as it encapsulates many essential elements of attack perception—i.e., that it refers to an attack, the immediately felt presence of that attack, and the diffuseness of that attack—in a single term. Furthermore, I believe these terms better reflect the terminology used by practicing musicians.

2. Bright / dark. Again, this consideration is the same as bright / dark above, but now applies to the attack portion of the sound rather than the sustain (Example 1.8, see page 25 below).

Pitch components

1. Low / high. This describes the position in pitch space of the sound signal. While this may not be a strictly timbral attribute, the frequency of the fundamental impacts timbre
perception: for example, high sounds may sound bright even when the distance between their fundamentals and highest partials is not particularly wide. Therefore, this pitch attribute is relevant to an analysis of timbre.

3. Steady / wavering. A sound is wavering if there are microfluctuations in the sound, as in vibrato. Otherwise, it is steady. The difference is clear in the spectrogram, where a wavy line corresponds to a wavering sound and a straight line a steady sound (Example 1.8, see page 25 below). Again, this has to do primarily with frequency, i.e., pitch, but vibrato is widely considered by musicians to be an aspect of timbre regardless.

Example 1.3: CLAV 1 (left) and FLUTE 1 (right) exemplifying bright / dark and pure / noisy.¹³

¹³ All sound signals are Yamaha DX7 preset sounds. The name of the preset is given in all caps, here and throughout the dissertation.
Example 1.4: CLAV 1 (left) and CLARINET (right) exemplifying full / hollow.

Example 1.5: CLAV 1 (left) and MARIMBA (right) exemplifying rich / sparse.
Example 1.6: CLAV 1 (left) and E. PIANO 1 (right) exemplifying beatless / beating.

Example 1.7: CLAV 1 (left) and TOY PIANO (right) exemplifying harmonic / inharmonic.
Example 1.8: CLAV 1 (left) and VOICE 1 (right) exemplifying percussive / soft, bright / dark (attack), and steady / wavering.

One can analyze a spectrogram by going through this list of oppositions and determining which of the two terms better suits the sound. As a shorthand, the negative sign (−) can be used for the term on the left of the slash, and the positive sign (+) can signify the term on the right. Occasionally, a signal might exhibit the negative property at some times, and the positive property at other times; in these cases, the analyst can use the mixed label (±) to indicate the presence of both timbral attributes. The null sign (Ø) can likewise be used when the sound exhibits neither property. These designations can then be summarized in an opposition table, with which the analyst can easily compare the results for different sound signals (Example 1.9).

14 Terms are on the left or the right of the slash based on whether or not they are “marked” terms. Markedness is a concept I discuss fully later in this chapter.
- / + OPPOSITION | BASS 1 | MARIMBA
---|---|---
**Spectral components - sustain**

<table>
<thead>
<tr>
<th></th>
<th>BASS 1</th>
<th>MARIMBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>bright / dark</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>pure / noisy</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>full / hollow</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>rich / sparse</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>beatless / beating</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>steady / wavering</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>harmonic / inharmonic</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

**Spectral components - attack**

<table>
<thead>
<tr>
<th></th>
<th>BASS 1</th>
<th>MARIMBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>noisy/pure</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>bright / dark</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

**Pitch components**

<table>
<thead>
<tr>
<th></th>
<th>BASS 1</th>
<th>MARIMBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>low / high</td>
<td>-</td>
<td>Ø</td>
</tr>
<tr>
<td>steady / wavering</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

Example 1.9: An opposition table comparing two sounds.

### Binaries

Reducing anything to a binary opposition may seem overly crude. Many aspects of music occur on a gradual scale, rather than a simple on/off system, and this is true for timbre as well. For example, on most synthesizers, the attack time of a sound can be adjusted by the programmer, between zero (the fastest attack) and some other number (the slowest attack). The two extremes are just two of the theoretically infinite number of possibilities. Yet I am proposing that the speed of attack is analyzable with a simple binary: percussive / soft. Isn’t this clearly an oversimplification?

Part II of Cogan’s 1984 book offers a philosophical defense of the use of binaries as the basis for understanding, drawing on C. S. Peirce and other philosophers. To summarize briefly, much of our understanding of the world comes from contrasting objects with other

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objects. Inherent in such a comparison is a binarism that opposes one object with another. This is one way in which we experience differences. The idea of binarism has influenced philosophers from Plato to Hegel, so Cogan observes.¹⁶

There is further empirical support for the use of binaries in studies of music perception. Stephen McAdams’s 1999 article, “Perspectives on the Contribution of Timbre to Musical Structure,” deals with the perception of musical timbre, and his experiments demonstrate that binaries might be an effective way to categorize timbre in at least some cases. From a study asking participants to rank the similarity between 153 pairs chosen among 18 timbres, McAdams discovered a three-dimensional timbre space onto which the 18 timbres could all be mapped. One of these dimensions is attack time, on a scale from short (4) to long (-3). Listeners seem to have conceived of attack times as basically short or long, with little middle ground. This is visible in McAdams’s Figure 2 (Example 1.10) by the grouping of the sounds into two clusters along the vertical axis. The timbres vary slightly in their placement along this vertical axis, but essentially, there are timbres that are high at around the +2 mark (vibraphone, guitar, harpsichord) and timbres that are low at around the -2 mark (clarinet, trombone, English horn). In other words, there is empirical evidence for the usefulness of a binary approach for at least some aspects of timbre.

¹⁶ Cogan 1984, 125.
Example 1.10: McAdams (1999), Figure 2.

Context dependency

Not everything in McAdams's timbre space can be so neatly divided, but binaries still prove an effective starting point for discussion as long as binaries are contextually, not rigidly, defined. In McAdams's timbre space, spectral centroid and spectral flux, mapped onto the two horizontal axes, do not show such a clear division as attack time.\(^\text{17}\) This doesn't inherently prove any inefficacy in the use of binaries, however, because another crucial aspect of my

\(^{17}\) Spectral centroid correlates strongly to the colloquial term “brightness,” and spectral flux describes how frequently a sound’s timbre changes during the signal.
theory is that all the binaries must be context-dependent. Focusing on the spectral flux dimension, the instruments do not form two neat clusters as in the attack dimension. But if one were analyzing a chamber ensemble piece for guitar, bowed string, and English horn, a binary for spectral flux would be an effective analytical tool (i.e., stringed instruments vs. wind instruments). The difference in spectral flux between these two types of instruments is audible. If the spectral flux binary were positive for values above 0 and negative for values below 0, then guitar and bowed string would be positive and English horn would be negative. Using this same criterion to evaluate the spectral flux of a French horn and English horn would show that both instruments are negative for this opposition, so if one were analyzing a French horn and English horn duet, this opposition could be used to show what these instruments have in common. But if the opposition was redefined so that values above −1.5 were positive and below −1.5 were negative, then French horn would be positive and English horn negative, and the same opposition could be used to discuss their difference. That this difference is one of degree rather than kind is ultimately not relevant to the usefulness of the binary, as the binary captures this essential difference between the two groups. Far from being an oversimplification, binaries are a flexible tool if one is open to contextual definitions.

Markedness

I argue that binary oppositions enjoy renewed relevance and usefulness in my approach because I couple these oppositions with the notion of markedness—"the valuation given to difference," in the words of Robert Hatten.\textsuperscript{18} Markedness was introduced to the field of music

\textsuperscript{18} Hatten 1994, 34.
theory by Hatten, who in turn borrows the concept from structural linguistics. Oppos-
itions—specifically, asymmetrical oppositions—are a prerequisite for the notion of marked-
ness. As a linguistic example, Hatten cites man/woman: woman is marked and man is un-
marked, because the term “man” can be used to describe a generic person of either gender
(“mankind,” “no man’s land”), while “woman” necessarily describes female-gendered peo-
ple. Note, significantly, that markedness does not necessarily correlate to prevalence: men
and women are nearly equally prevalent in the world, yet woman is the marked term. For a
musical example of markedness, a four-bar phrase would be unmarked, whereas a five-bar
phrase would be marked as having special significance.

Cogan’s original oppositions do not invoke the concept of markedness. Cogan design-
nates timbral attributes as positive or negative based on their “energy state”: “The negative
forms are low energy states: low spectral frequency, low intensity, low activity, low internal
contrast. The positive forms are high energy states: high spectral frequency, high intensity,
high activity, high internal contrast.” This concept of spectral energy is representative of
an overall tendency throughout his book to prioritize the spectrogram image, which only
provides truth content about acoustics, over human experience of timbre, which is influ-
enced by more than just acoustics. Essentially, “high energy” states are states that show
more stuff on the spectrogram. But tracking the “energy level” of a piece’s timbre through-
out the composition probably does little to reflect a listener’s experience of that piece. How
does the progression +2, −2, 0, −6 in the “relative balance” of the positive and negative fea-
tures relate to listener experience? In my view, this is the most critical flaw of Cogan’s book,

omitted references:

19 Patrick McCreless (1991, 61) used this term in print before Hatten, but cites a draft of Hatten’s book (1994) for
his use of the concept.
20 These concepts are more thoroughly explained and defended in Hatten 1994, 34–36.
21 Cogan 1984, 6.
and possibly the reason why his method did not become more popular among music theorists. By contrast, repurposing these positive and negative symbols to refer to markedness not only clearly relates to listener experience, but also imbues the analysis with a sense of cultural attention and nuance.

Necessarily, the analyst must determine which sounds are marked and unmarked based on the context for the analysis. Throughout this dissertation, I analyze 1980s popular music, and specifically, the Yamaha DX7 FM digital synthesizer. I determine markedness by comparing a timbre to what I consider the prototypical pop music sound: the clean electric guitar sound. The guitar has been the primary instrument of popular music since at least the 1950s in almost every style of music. I choose an undistorted guitar sound over a distorted sound because any addition of distortion or other effects narrows the generic and expressive range of the guitar considerably. Hatten considers the minor mode to be marked compared to major because in the Classical era, minor keys would express the tragic; major keys, on the other hand, could convey the direct opposite (the comic), but could also convey any other number of meanings, such as pastoral, military, and so on. Guitar distortion does the same kind of work on genres within popular music: the distorted guitar signifies a narrower range of genres—for example, a narrowing from the broadest category of popular music down to only rock music. Certain kinds of distortion might narrow it still further to heavy metal. An undistorted, clean guitar sound, by contrast, has a wider range of signifying possibilities for genre and expression. Consider the electric guitar sounds used, for example, on Michael Jackson’s *Thriller* (1982): a strongly distorted electric guitar is only used on the

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22 I treat clean, rather than distorted, guitars as the most mainstream sound because I am studying pop music more generally, not rock music specifically. If one were to study rock music, perhaps distorted guitars would become the norm.

23 Hatten 1994, 36.
track “Beat It,” which features a guitar solo by hard rock guitarist Eddie Van Halen. Other tracks, such as “P.Y.T.,” “Wanna Be Startin’ Somethin’,” and “Thriller” all use a clean electric guitar sound.24 The most important consideration in determining markedness, however, is context. For my work in this dissertation, I am taking the whole of popular music prior to the 1990s as my context. If one were to analyze a narrower generic range or any other different context, what is marked and what is unmarked would change. For example, within the context of metal, the reverse of my proposition would be true: clean guitar would be marked, and distorted unmarked. I am asserting that the clean electric guitar is a generic signifier for all of recorded popular music prior to 1990.

As my sample for a clean electric guitar, I use a sound signal from Movie Example 5(a) of Ciro Scotto’s 2017 article on guitar distortion.25 I analyzed this sound considering each of the oppositions given above. Whichever oppositional term applied to the electric guitar signal was the term I chose to be the negative, unmarked term. In other words, each of the terms on the left of the slash—*bright, pure, full, rich, beatless, harmonic, percussive, bright (attack), steady*—corresponds to the timbre of the clean electric guitar (Example 1.11).26

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24 As a disclaimer, the guitar sounds may not technically be *completely* clean—sometimes a small amount of amplifier distortion, compression, or overdrive may be used—but to the untrained ear (such as mine), however, the sounds are basically clean, and I find this good enough for the purposes of my cultural analysis. I thank Drew Fleming for lending me his expertise on guitar timbre and being my primary consultant on this issue, and Ciro Scotto for providing me with Michael Jackson’s “Beat It” as an example of this contrast.

25 Scotto 2016. Scotto does not publish what equipment was used to record his Example 5(a), but I confirmed in private correspondence with Scotto that the signal comes from a is an ESP Eclipse with James Hetfield pickups, played through a Mesa Boogie Mark V on Channel 3, playing an A2 (110 Hz).

26 Scotto (180) claims the signal from his Example 5(a), my Example 1.11, “only contains odd harmonics” (180), or to use my terminology, is *hollow*. This is incorrect—as shown in the spectrogram in Example 1.11, the signal from Scotto’s Example 5(a) is in fact *full*. 

Example 1.11: Spectrogram of a “clean” electric guitar sound.

Each time I analyze another sound in terms of these positive or negative attributes, I am comparing the sound to the clean electric guitar as an aural symbol of mainstream popular music; with each positive or negative sign, I am making a statement about the degree to which a given signal conforms to the norms of pop music, as represented by this guitar. This has profound implications in Chapter 3, where I make connections between timbre, markedness, texture, and instrumentation. My new orientation of the opposition toward markedness, then, reflects listener enculturation and experience that was missing from Cogan’s original methodology.

**Interpretation**

Tracking and quantifying timbral attributes through oppositions is an excellent first step in the study of timbre, yet marking positive and negative signs in a table does little to enhance
our understanding of how timbre interacts with other domains of music as they unfold in time. In this sense, the process of defining timbres through oppositions is somewhat like the process of assigning Roman numerals to harmonies in a piece of Classical music. An analyst must do this to begin analyzing harmony or timbre, but the oppositions and Roman numerals on their own are probably not evocative for the reader of the analysis. One must find a way of meaningfully interpreting the raw data of the opposition tables. There are a multitude of possibilities for such interpretation: for example, the definition of a relationship between timbre and formal function, as in the work of Jean-Charles François regarding the music of Edgar Varèse; the relationship between timbre and identity as in the work of Blake and Heidemann; and the relationship between timbre and embodiment as in the work of Heidemann and Wallmark.²⁷

Exactly what form this interpretation takes is ultimately up to the analyst, but the common thread binding together each of these compelling studies is the identification of some kind of function of timbre—be it formal function, social function, or any other kind. In *Style and Music*, Leonard Meyer writes,

> One can list and count traits—say, the frequency of *sforzandi* in Beethoven’s music or the number of deceptive cadences in Wagner’s operas—till the end of time; but if nothing is known about their functions (structural, processive, expressive, and so on), it will be impossible to explain why they are there, how their presence is related to other features observed, or why their frequency changes over time.²⁸

The linguists from whom Cogan borrowed liberally—Saussure, Jakobson, Waugh, and others—always return to the function of phonemes within a larger context of language as a whole whenever they analyze phonemes as sound. In language, an understanding of function is perhaps more explicitly needed—what is the point of studying a language, that is, a

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²⁸ Meyer 1989, 11–12.
tool for communication, if communication is left unaddressed? Music may not be a language, but in its own sense, music is communicative; thus, without notions of function, significa-
tion, or meaning, the bits of data are meaningless.

Throughout the remaining chapters, I connect timbre analysis with textural function, narrative, and ethnography to interpret the acoustic data of spectrograms. I do not intend for these studies to serve as an exhaustive list of all the means by which one might interpret a timbre analysis; these modes of analysis arose as a consequence of my interest in popular music of the 1980s more generally. Their purpose, then, is twofold. Firstly, and most imme-
diately, taken together, I aim to explain something about the '80s sound—both what makes something sound like it was produced in the '80s, and also what judgments are implied along with that assessment. Secondly, the chapters are a case study that present an argument ad-
vocating for a more widespread study of timbre in musical analysis.
CHAPTER 2
THE YAMAHA DX7 IN SYNTHESIZER HISTORY

My focus on the Yamaha DX7 synthesizer throughout this dissertation may seem overly niche or specialized, but in this chapter I establish the magnitude of this synthesizer’s impact on popular music in the 1980s. While the average person is unaware of the synthesizer by name, the DX7 changed popular music as we know it today. To say that the DX7’s arrival was earth-shaking would be no exaggeration: the affordable price, sound palette, and physical feel of the instrument combined to make the DX7 the new must-have instrument in every studio, garage, and university music department in the U.S. and the U.K. My study of contemporaneous music periodicals has led me to construct a narrative that describes how the DX7 impacted the lives of working musicians in the U.S. and the U.K. in the 1980s.

The sonic landscape of popular music included keyboards long before the 1980s. Along with the piano, the standby keyboard instrument in the pop world, keyboardists might often play electric pianos such as the Fender Rhodes, the Hohner Pianet, the Wurlizer electric piano, or the distinctive Hohner Clavinet, or electric organs such as the Hammond B3 or the Vox Continental. A handful of keyboard legends emerge in popular music during the 1950s and ’60s—Little Richard, Stevie Wonder, Ray Manzarek, and Keith Emerson, to name a few—but prior to the 1970s, the role of the keyboardist was, generally speaking, relegated to a rhythm section role, rather than being featured as a solo instrument. In other
words, while guitar heroes like Jimi Hendrix, Eric Clapton, and Keith Richards enraptured audiences with epic guitar solos, keyboardists typically remained out of the spotlight. The amplified and distorted guitar was able to produce loud, sustained sounds, which were simply better suited to virtuosic and crowd-pleasing solos. In those early decades, the keyboard instruments were no match.

The Moog modular analog synthesizer, developed in the early 1960s, was the first synth that rivaled the power of the electric guitar in volume and timbre. The Moog is an analog modular synthesizer, meaning that the sounds were generated from a sound wave oscillator—a physical (analog) device, controlled, in a physical sense, by voltage. To produce different sounds on the Moog, one needed different modules that would further generate or modify sounds. Sounds were created using quarter-inch cables to “patch” modules together (this is the etymology of the term “patch,” which today refers to any sound or preset on a synthesizer). The resulting collection of modules was typically bigger than the keyboard itself. The size alone meant the Moog could not be taken on the road: this early synthesizer, not unlike the early computers, was a massive device that was prohibitively expensive for most musicians.

The invention of the Minimoog resolved the size issue, and made the price more affordable. Introduced in 1970, the Minimoog was capable of producing a similarly powerful analog sound without needing the bulky modules. The Minimoog had limitations, being a monophonic synthesizer; ironically, these limitations actually led to the liberation of the keyboardist from the background. The Minimoog was not functional as a pad (i.e., sustained, harmonic background) or rhythm instrument like older organs and pianos, but it excelled at the indulgent, virtuosic, monophonic solos that had previously been the exclusive purview
of the electric guitar.\textsuperscript{1} The Minimoog firmly established synthesizers as an important musical instrument within pop and rock music.\textsuperscript{2} The synthesizer rapidly became cool, and moreover, became synonymous with futuristic technology—a signification with important implications for aesthetics in 1980s pop music, which frequently used themes of futurism.

**The Arrival of the DX7**

A handful of synthesizers dominated the sound of the 1980s. The Roland Jupiter-8, released in 1981, was one of these. The Jupiter-8 is an analog synthesizer so immensely powerful that it can seem like the teleological goal of all prior analog synthesizer development. The Jupiter-8 is responsible for many iconic ’80s sounds, including Michael Jackson’s “Thriller” (recorded in 1982) and music for the movie *The NeverEnding Story* (1984).

Analog synthesis never really disappeared from the sound of popular music, but most other quintessential ’80s synthesizers introduced the listening public to other, newer methods of sound synthesis, all of which were made possible by digital computing and microprocessors. The Fairlight CMI, first released in 1979, and the E-MU Emulator, first released in 1981, are two of the first keyboards to use digital sampling. Sampling made any sound imaginable available to keyboardists—or at least, to keyboardists who could afford them. Both the Fairlight and the Emulator were prohibitively expensive for the average keyboardist, with list prices in the tens of thousands of dollars at their release (1979 and 1981, respectively). Successful artists like Kate Bush and Duran Duran, who were able to pay for studio time and access to them, used these instruments to bring an entirely new flavor to their music. Even

\textsuperscript{1} Catforis 2011 details this evolution in Chapter 6, “‘Roll Over Guitar Heros, Synthesizers Are Here...’.”

\textsuperscript{2} For a detailed history of the Moog and the Minimoog, see Pinch and Trocco 2004.
While samplers were out of the reach of many musicians, they left a major mark on the music of the 1980s.  

Also new in the 1980s was wavetable synthesis, famously deployed in the PPG Wave synthesizers. The PPG Wave processes analog waveforms through the digital microprocessors to produce new, more dynamic sounds. Both sampling and wavetable synthesis represent a merging of analog and digital technologies: the source of the sound is an analog source—a recorded analog sample in the case of the sampler, and an analog waveform in the case of wavetable synthesis—but the sound is processed and delivered digitally.

The other classic ’80s synths were purely digital, using frequency modulation (FM) synthesis technology first developed by John Chowning at Stanford University in the 1960s. The New England Digital Synclavier, introduced in 1977, was the first commercial instrument to solely use digital FM synthesis. The Yamaha GS-1, released in 1981, was Yamaha’s first FM keyboard—technically not a synthesizer at all, because it consisted entirely of stored sounds from the factory. Digital FM synthesis remained less popular than other formats until one pivotal moment: the unveiling of the Yamaha DX7 at the National Association of Music Merchants show in the summer of 1983.

The Yamaha DX7 was only produced from 1983 to 1986, and in this short period, Yamaha sold approximately 150,000 of them; the DX7 today remains one of the best-selling synthesizers of all time.  

Keyboardists across Europe, North America, and Asia were enamored by the Yamaha DX7, which likely solidifies the role of the DX7 as a quintessentially ’80s synthesizer. See Vail 2002, 130.

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3 By the late 1980s, sampling-based synthesizers had finally become more affordable, at which point they did become quite popular. Later in this chapter I discuss the Korg M1, the most popular sampling-based keyboard.  
4 After 1986, Yamaha produced successors to the DX7, the DX7II and the DX7II FD. There were no further DX7II FDs produced after 1989, which likely solidifies the role of the DX7 as a quintessentially ’80s synthesizer. See Vail 2002, 130.
ored with the DX7, to the point where it was seen as a replacement for antecedent work-
horse synthesizers. Many musicians were smitten with the possibilities, and not only be-
cause they were dazzled by a brand new technology. Two years after the release of the DX7,
when the newness would already have worn off, jazz and R&B keyboardist Patrice Rushen
said, “[The DX7] is such a great instrument, such a versatile instrument. I think we’re still at
the tip of the iceberg of what it’s capable of.”5 Some musicians even insinuated the DX7
would make other synthesizers obsolete. Roy Bittan, a keyboardist for Bruce Springsteen’s
1986 tour, put this into practice when he transferred all the synthesizer sounds that he
could from the older Yamaha CS-80 analog synthesizer to the DX7: “I realized at once that
[the DX7] was going to be very valuable in the future. … [T]he CS-80 is harder to control, and
the sound is not as clean.”6 Similarly, Jimmy Jam (Timmy Harris), a songwriter and producer
for Janet Jackson and other singers, said he never used a real Fender Rhodes anymore after
the DX7 and other synthesizers began providing similar electric piano sounds: “No [I never
use a real Rhodes sound], I just go direct into the board with a Rhodes synth sound. With all
the companies having Rhodes patches, it's easier to use the variations.”7 Film composer Jerry
Goldsmith gushes, “The Yamaha DX7 is amazing; some people feel that if you have a rack of
three or four of them, you don't need anything else.”8 In the eyes of many musicians, the
DX7 was simply more practical than an array of other synthesizers.

5 Quoted in Frederick 1986, 46. As the interview title insinuates, Rushen played piano from a very young age. She was classically trained before she released her jazz albums, which used the DX7 and other synthesizers.
6 Quoted in Doerschuk 1986c, 72.
7 Quoted in Doerschuk 1987b, 85.
8 Quoted in Darter 1985, 24.
Defining Features of the DX7

“The Synth that Changed Everything”—a title bestowed upon the DX7 in a 30th anniversary retrospective in *Keyboard*—enjoyed its immense success for two reasons. First of all, the DX7 made use of several cutting-edge technologies, and secondly, it sold at a relatively affordable price. Perhaps the most truly groundbreaking feature of the DX7 was its envelope generator. The old standard for an envelope generator was a four-step envelope, or attack-decay-sustain-release (ADSR) envelope, that allowed for control of the rate of the attack (but not its level), the rate of decay, the level of the sustain, and the rate of the release (the level of which was always 0). The DX7 introduced the eight-step envelope, which allows the user to define four different levels, as well as the rates of change between each of those levels, totaling eight steps in the definition of the envelope, and opening up the possibility of all sorts of unusual envelopes. Example 2.1 compares the envelopes of a Jupiter-8 with that of a DX7. 2.1a is a representation of the envelope interface on the Jupiter-8. Each of the four sliders corresponds to a “step” in the four-step ADSR envelope. A adjusts the rate of the amplitude’s increase from 0 to peak; D adjusts the rate of the amplitude’s decay from peak down to S; S is a user-specified amplitude; R is the rate of the amplitude’s decay from S down to 0. There are two switches: one for “key follow,” which adjusts the envelope according to the frequency of the sound to mimic an acoustic instrument, and one for “envelope inversion,” which reverses the profile of the ADSR envelope. By contrast, on the DX7, since both levels and rates of change are specified by the user, envelopes no longer needed to conform to these prototypical rules. Example 2.1b illustrates each of the eight steps in the eight-step envelope.

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9 *Keyboard* 2003, 40.
10 “Envelope” is a common term in synthesizer programming, referring to the amplitude profile of a sound. Typically, a sound begins at zero, peaks shortly thereafter during the attack (A), decays slightly (D) and then maintains a somewhat lower volume as the pitch sustains (S), and then releases (R) back down to zero.
While this figure uses a typically shaped envelope for its demonstration, crucially, the envelope can take on absolutely any shape, since all rates and levels are customizable.

![Diagram of envelope settings](image)

Example 2.1: a) A Roland Jupiter-8 envelope generator and b) a Yamaha DX7 illustration of possible envelopes. Images taken from each synthesizer’s owner’s manual.

This flexibility alone would provide plenty of options for most people, but the DX7 goes further: each of the six operators in the tone-generation process may be assigned its own unique amplitude envelope, once again multiplying the number of the DX7’s potential sounds, and allowing for a dynamism in the timbral profiles of these sounds that was never before possible. Some of the DX7’s presets emulated non-musical sounds, a capability made possible in part by these complex envelope options. For example, TAKE OFF seems to simulate an airplane or spaceship engine starting up and then launching the craft—something which does not have an amplitude profile conforming to that of a traditional or inverted four-step ADSR envelope. If desired, this same envelope generator can also be used to control the pitch, through an additional seventh envelope called the pitch EG.
The timbre of a sound on the DX7 can change further depending on how hard and/or how fast the player strikes the key: in other words, the keys are also both pressure- and velocity-sensitive. Jay Chapman, a writer for *Electronics & Music Maker*, states, “It’s my opinion that the velocity/touch-sensitivity feature ... is a major contributory factor in putting the DX7 into a class of its own when compared to the other polyphonic synths available in the same price range.”¹¹ The DX7’s keyboard action was one of the best in the synthesizer market, and this technology was incorporated into the design of the sounds themselves. Another non-musical preset, TRAIN, would clang a train bell when the key was pressed normally, but if the player then presses harder onto the key, the sounds of a train engine chugging gradually crescendo while the bell reverberates. Sounds like TRAIN and TAKE OFF might sound quaint or gimmicky to modern ears, but this was the first time such a sound had ever been synthesized from scratch (rather than sampled).

Other features were not unique to the DX7, but were still on the vanguard of innovation. The DX7 was one of the earliest keyboards to make use of the now-commonplace Musical Instrument Digital Interface (better known as MIDI) technology. The DX7’s MIDI capability was limited—it only transmits on MIDI channel 1—but effective. MIDI sends data to and from the DX7, which means that users could use MIDI to exchange preset sounds, or to hook the DX7 up as a controller for other synthesizers. Coupled with the DX7’s excellent velocity and pressure sensitivity, the DX7 was a popular choice of MIDI controller. More radical was that the DX7 could be hooked up via MIDI to a breath controller, which could better simulate the sound of wind instruments. As with velocity and pressure sensitivity, Yamaha specially

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¹¹ Chapman 1984, 70.
designed several preset sounds (those ending in “BC”) to be used with a breath controller. In 1983, these capabilities were very hard to find in other synthesizers.

FM synthesis is really what lies at the heart of the DX7’s innovative status. FM is a highly versatile method of sound synthesis, capable of producing a wide range of timbres, if one knows how to program with FM. Although a complete discussion of the processes involved in FM synthesis is beyond the scope of this project, a short overview is helpful in understanding what makes the FM synthesis process of the DX7 so revolutionary compared to subtractive synthesis on analog machines. FM synthesis on the DX7 begins with the generation of sine waves from the DX7’s digitally controlled oscillators, called operators. An operator can be either a carrier wave or a modulator wave in the FM sound synthesis process (as in FM radio), and these carriers and modulators can feed into one another through various arrangements, known as algorithms. In an algorithm with only two operators, often one operator would be the carrier and the other the modulator (see Example 2.2). Relating this abstract mathematical concept to musical sound, the frequency of a carrier will determine the pitch of the note played, while the frequency of a modulator will affect the timbre. The DX7 has six operators, each of which might be turned on or off, and the programmer may arrange these operators into one of thirty-two different algorithms, dictating which operators are modulators or carriers and the relationship between them all. Factoring all these variables together, the number of possible sounds is immense. This vast universe is quickly made apparent to the user of a DX7 through the visual map of all 32 algorithms painted directly onto the face of the instrument (see Example 2.3).

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12 See Appendix A for a table listing Yamaha preset sounds.
13 The inventor of FM synthesis has published very complete and succinct explanations of synthesis via frequency modulation from a mathematical perspective, including concepts such as the modulation index, and how one might simulate various kinds of acoustic instruments. See Chowning 1973.
The innovation of FM synthesis was the greatest strength of the DX7, but also, paradoxically, its greatest failure. The DX7 rapidly gained a reputation as being difficult to program, a reputation that endures to this day, due to the relative complexity of FM synthesis. Using an algorithm to modulate carrier sine waves with other sine waves is not as easily understood by a layperson as the subtractive synthesis technologies used by most analog machines. The daunting new FM digital system motivated many artists’ rejections of the DX7. Alan Howarth, for example, said,

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14 Additive and subtractive synthesis both start from the understanding of timbre as made up of the fundamental and the partials above it. Different sounds are created by adjusting the number of partials and their volume.
I’m not a real DX7 fan … I never warmed up to it, and along came the [Sequential Circuits Prophet VS, a hybrid digital-analog synth]. It gave me some pretty neat sounds. The digital waveforms were nice and bright, and they gave me all the [Hohner] Clavinet and [Fender] Rhodes things, and I could still deal with it in an analog fashion, which is what I’m most familiar with.\textsuperscript{15}

This reveals that although Howarth was interested in the sound of digital synthesis, he was reluctant to spend time stumbling on the learning curve of this entirely new system of sound creation.\textsuperscript{16} Midge Ure similarly states, “The DX7 ... I still think is impossible to program! I can't be bothered with it.”\textsuperscript{17}

Further obfuscating the process of programming the DX7 is its unintuitive user interface. On virtually every other synthesizer before the DX7, timbres were created and adjusted by fiddling with a number of knobs. All these knobs were laid out plainly before the programmer’s eyes; one knob controlled one parameter. The programmer could press and hold a key on the synthesizer, simultaneously twist knobs back and forth, and hear the effect of these adjustments on the sound. The process of creating an analog sound was fairly intuitive, and one did not necessarily need to know about acoustics or anything else mathematical in order to create nice sounds.

A DX7 programmer, on the other hand, interacts with the FM synthesis algorithms through a series of membrane buttons and one slider that increases or decreases numbers. What the slider and the buttons do might change depending on what “mode” the programmer is using—which may seem simple enough, but this simple barrier puts a significant conceptual filter between the visible interface and the technology. Even the conceptually

\textsuperscript{15} Quoted in Burger 1986, 16.
\textsuperscript{16} This quote from Howarth also exemplifies the idea that people wanted the DX7 as a replacement for the Hohner Clavinet and the Fender Rhodes.
\textsuperscript{17} Quoted in Gilby 1985, 39. Note however that despite this, Ure does use the DX7 in many of his own tracks, such as “Do They Know It’s Christmas?” by Band Aid, which I analyze in Chapter 4.
A straightforward slider does not provide the programmer with real-time feedback while adjusting the numbers with the slider: before the programmer can hear what they have done, the sound has to be saved, the DX7 switched over from “edit” mode to “play” mode, and only then can the programmer press a key and hear the results. Listening to the sound is Step 10 in the step-by-step guide to creating a sound in the DX7 owner’s manual. There is no way for programmers to experience the effect of their changes to the algorithm in time as they make the changes.

All of this information is only communicated to the DX7 programmer on a tiny, non-backlit LCD screen, capable of displaying only two rows of sixteen characters each. As Ted Greenwald, an editor for Keyboard magazine, summarizes, “Admittedly, the difficulty of DX programming stems as much from the differences between analog and FM synthesis, and between [four-step] and [eight-step] envelopes, but there was clearly a need for a front panel that related, in graphic terms, to the structure of any given patch.” The combination of the more abstract mathematics behind sound generation, the substantial differences between analog and digital technology, and the difficult interface led to a total avoidance of programming the DX7 by the vast majority of keyboardists.

Given the degree of obfuscation in the process of editing a timbre on the DX7, the instrument’s status as a best-selling synthesizer may seem completely surprising, but the DX7 had one crucial redemptive feature: the pre-programmed factory preset sounds. Thirty-two factory presets were saved into the synthesizer’s internal memory. A cartridge reader gives users access to even more sounds, read from either ROM or RAM cartridges.\footnote{\textsuperscript{18} Every new DX7 shipped with two ROM cartridges from Yamaha with sixty-four sounds each, thirty-two of\footnote{\textsuperscript{18} RAM (random-access memory) cartridges could be rewritten, so users could store their own custom sounds on RAM cartridges. ROM (read-only memory) cartridges were not able to be edited.}}
which were the same sounds programmed in the internal memory, yielding a total of 128
different sounds that came with the synthesizer.\footnote{Japan and Europe received Yamaha’s ROMs #1 and #2, while the United States received ROMs #3 and #4. The presets on ROM #1a and #3a were saved in the internal memory of Japanese/European and American synthesizers, respectively. Most of the presets were shared between 1/2 and 3/4, but some sounds appear only on one region’s ROMs. See Appendix A for a complete list of the Yamaha factory presets.}

The DX7 was one of the earliest synthesizers to come equipped with such pre-programmed sounds, referred to as “presets.”\footnote{One precedent for this technology can be found in home organs, such as the Lowrey Berkshire Deluxe, which would have some preset sounds that were not user-programmable.} In older synthesizers, before the advent of computing and digital memory, there were no such thing as presets—presets are created with digital memory, and digital computing was still new in 1983. On synthesizers like the Minimoog, instead of presets, players had to recreate sounds anew each time, by fiddling with knobs and sliders. To keep track of these sounds, people would write them down on charts. To switch sounds back and forth, one had to physically move the knobs back and forth—or one could take after Rick Wakeman, who is said to have bought thirteen Minimoogs and surrounded himself with them at his shows.\footnote{Pinch 2005, 259. I enjoy this story, but some find it doubtful that Wakeman really had thirteen Minimoogs. I was only able to find photo evidence of him simultaneously using four.} When digital memory was available, people used it to save their own pre-programmed sounds, not to use other people’s sounds. Where factory presets were available, for example, on the Jupiter-8, they were frequently saved over with the user’s own sounds, or otherwise not much used. As Paul Théberge notes, the reason older synthesizers did not have presets was not, as one might assume, because the technology did not previously exist, but rather because instrument makers did not believe there was a demand for the feature.\footnote{Théberge 1997, 75–8.} Synthesizers had only ever existed as a specialized and exclusive kind of instrument, and so in the early days of the synthesizer, people that wanted to
play synthesizers were the same people that wanted to learn how to become synthesizer programmers.

Synthesizers became more integral to the sound of popular music throughout the course of the 1980s. Many everyday musicians, such as those playing in garage bands, wanted to buy their first synthesizer, but had no familiarity with the basic concepts of synthesizer programming. By 1983, the availability of presets made the DX7 exceptionally attractive to such keyboardists. Instead of needing to learn about subtractive synthesis, with its oscillators, filters, and waveforms—or worse, needing to learn about FM synthesis!—the salesperson could show buyers that they simply needed to press one of the thirty-two buttons on the face of the DX7 to quickly access any sound. Bass, harpsichord, Rhodes, brass, organ, strings, bells, and more: everything the buyer might need was available with the push of a button, no twiddling of knobs or comprehension of algorithms required. Sounds on the DX7 are literally at the player’s fingertips (Example 2.4).

Example 2.4: The front of a Yamaha DX7. Players access preset sounds with the two rows of sixteen buttons on the right.

Rather than wrestle with the unforgiving programming interface, most casual players of the DX7, and even many experienced session musicians, relied solely on the presets in
the internal memory or cartridges. In October 1986, when the DX7 had been on the scene for three years, producer David Briggs expressed a sentiment shared by many music makers of the 1980s: “I haven’t had the need [to program the DX7 myself.] Most of the factory sounds that I use are great, and I haven’t been able to improve on them. ... Everybody wants the brass, electric piano, and string sounds.” Théberge similarly reports, “By the end of [the 1980s], marketing departments were estimating that as few as 10 percent of users programmed their own sounds.” The DX7 was a large part of a paradigm shift in what a synthesizer was expected to offer.

What clinched the DX7’s place in synthesizer history was not just its offering all these revolutionary features, but that it offered them at a significantly lower price. Other comparably priced synthesizers, such as the analog Korg PolySix, used more derivative technologies, yet the DX7 competed with the PolySix in price while offering cutting-edge technical specifications. Dave Formula, a keyboardist for the bands Magazine and Visage, raved in April 1984 shortly after the release of the DX7, “… [the DX7] gives you so much for the price. You can compare it with things that cost six times as much, and I don’t see that much difference.” The DX7 was priced significantly lower than other revolutionary synthesizers, which played a large factor in the popularity and subsequent influence that the DX7 exerted

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23 Quoted in Armbruster 1986, 46. Briggs was primarily based in Nashville, Tennessee, and worked mostly with country music artists.
24 Théberge 1997, 75. This number is calculated based on the number of Sequential Circuits Prophet-5 synthesizers received at the factory for repair that still had the factory presets saved to he internal memory. However, Théberge notes also that there may be another explanation for the prevalence of factory presets on the Prophet-5s: programmers may have purged their own custom sounds before sending the synthesizers back to the factory to avoid any infringement by the company on the programmer’s intellectual property. Sounds were not copyrightable at this time, so a company could conceivably steal a programmer’s sound and sell it themselves. Théberge notes that a personal informant attested to this.
25 Quoted in diPerna 1984, 40.
over the popular music scene (Example 2.5). Bob Moog, the inventor of the Moog synthesizer, spoke of the revolution in synthesizer pricing, which the DX7 helped to spur, as a “democratization” of the synthesizer.

The first microprocessor-controlled synthesizers were strictly professional instruments, with price tags of $5,000 and up. ... [Today], no matter how much or how little money you have in your pocket, you can almost certainly find a synthesizer that will give you some musical satisfaction.

As a result the number of musicians who own these instruments has increased dramatically. Early last year I went to catch a Korg clinic which was put on by Chuck Leavell at a local music store in Asheville, North Carolina. As his final demo, Chuck played the Korg Poly 800 and blew the audience away. Here was a portable 8-voice keyboard with programmability and MIDI that cost less than a plane trip to the Coast!

The fact that the event took place in North Carolina should not be overlooked. ... Before then, you couldn’t really buy a synthesizer in Asheville. You had to travel three hours to Charlotte, North Carolina’s largest city. But by 1984, the salesman knew his way around keyboard synthesizers, Chuck Leavell demoed to a hundred or so musicians, and suddenly synthesizers were a musical presence in North Carolina. That’s what I mean by “democratization.”

As I discuss in Chapter 3, the availability of the DX7 and other synthesizers meant that more musicians had access to unusual sounds in their music—to borrow Moog’s terminology, it “democratizes” the novelty sound in popular music. As technologies become cheaper and more accessible, the trajectory of popular music’s sound is altered.

<table>
<thead>
<tr>
<th>Synthesizer name (year)</th>
<th>List price (USD)</th>
<th>Adjusted for inflation (2017)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fairlight CMI (1979)</td>
<td>$25,000</td>
<td>$83,100</td>
</tr>
<tr>
<td>New England Digital Synclavier II, 8-voice (1979)</td>
<td>$13,750</td>
<td>$45,700</td>
</tr>
<tr>
<td>Yamaha GS1 (1981)</td>
<td>$11,850</td>
<td>$33,150</td>
</tr>
<tr>
<td>PPG Wave 2.2 (1982)</td>
<td>$8,800</td>
<td>$22,000</td>
</tr>
<tr>
<td>E-MU Emulator II (1984)</td>
<td>$7,995</td>
<td>$18,500</td>
</tr>
<tr>
<td>Roland Jupiter-8 (1981)</td>
<td>$5,295</td>
<td>$14,000</td>
</tr>
<tr>
<td>Yamaha DX7 (1983)</td>
<td>$1,995</td>
<td>$4,800</td>
</tr>
</tbody>
</table>

Example 2.5: List prices in USD of various 1980s synthesizers.

Reception of the DX7 and Other Digital Technology

The DX7 is part of a collection of advances in synthesizer technology that together changed the rules for what it took to be a keyboardist. Digital technology also delivered sequencers.

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26 Moog 1985, 42.
and arpeggiators to the public. These electronic tools made the synthesizer an accessible choice even for untrained keyboardists. A sequencer is a computer that can store and recall patterns entered by the programmer. The programmer does not necessarily have to enter these patterns in real time, which introduces the possibility of programming something that would be quite difficult to perform if played live. An arpeggiator function allows a keyboardist to hold down a chord while the arpeggiator transforms the chord into a random, rapid arpeggio, hence the name for the technology. This of course makes complex and energetic arpeggios far easier to play, even while performing live. Bob Doerschuk, a prolific music journalist and regular writer for *Keyboard* magazine, wrote of The Human League, “Like electronic magicians, they dazzled their audiences by producing lots of music while playing as little as possible. The point of *Dare* [1981] seemed to be that you didn’t even need to know how to play at all to be in a pop band—a point made many times since then.”27 Using these tools, one barely had to know how to play a keyboard to perform rhythmic and driving licks that would previously have been virtuosic.

This paradigm shift, unsurprisingly, motivated some music makers of the time to vocally oppose these technologies.28 Some saw the wild success of the DX7 as yet another example within a larger trend of moving toward simplicity and automation in keyboards and rock music. For their May 1986 issue, *Keyboard* magazine featured Duran Duran’s keyboardist, Nick Rhodes, as their cover story, a move that outraged those *Keyboard* subscribers who thought the magazine should stay focused on virtuosos (in turn focusing on the genres of classical, jazz, and progressive rock). Consider this letter to the editor, which was published in

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27 Doerschuk 1987a, 86. *Dare* is the third studio album by The Human League.
28 This is one of the senses in which new wave music, and eventually mainstream 1980s pop in general, grew out of the D.I.Y. (“do it yourself,” self-sufficient) ethic of the punk scene in the late 1970s.
the following month’s issue: “How I miss the good old pre-DX7 days. I am so sick of reading about these Fairlight freaks and one-finger virtuosos. As a performer, Nick Rhodes is a joke. Why don’t you interview a real keyboard player, like Rick Wakeman?”29 The letter writer is an example of those that view technologies that facilitate performance and composition with suspicion; i.e., people who are concerned with the relationship between synthesizers, sequencers, arpeggiators, and the notion of authenticity (revealed in the letter-writer’s declaration that Wakeman is a “real” keyboard player). This letter-writer seems unaware that Nick Rhodes actually rarely used the DX7, a fact that Rhodes plainly states in the very same interview that the letter-writer complains about.30 The letter-writer’s misattribution of the decline of keyboard-playing society to the rise of the DX7 shows that the DX7 was the poster child for these developments, even when not directly responsible for the declinational performances.

The DX7 does not make the physical aspects of performance any easier; it has no built-in arpeggiators or sequencers to take away the hard work of moving quickly and adeptly around the keyboard. What really made the DX7 a target for criticism from music-makers concerned with “authenticity” was, instead, the factory presets. The presets meant that synthesizer players were no longer required to be experts in synthesizer programming, which lowered the bar of entry for aspiring keyboardists. Perhaps inevitably, reliance on presets was equated with inauthentic and low-quality music by many musicians. Roland Orzabal of Tears for Fears spits, “Stop using the bloody DX7 presets and invent something new of your own … People should stop pissing around with synthesizers and make fucking good

30 Doerschuk 1986b, 76.
Philip Oakey of The Human League, on the other hand, expressed a more complex frustration with his and his bandmates’ continuing use of the DX7 presets as he reflected on the recording process during an interview with Doerschuk.

They get really bland after a while. And when we get into what I call the DX Sound Hunt, it drives me up the wall. Someone in the studio will say, ‘Okay! Let’s have a bell sound.’ Then we start going through the 128 sounds on our DX—we have the Sycologic MX1 expander board—and playing every one, including the whistle, the train, and the bombs. If we find something we like, it has probably turned up on 50 records that have been made over the past few years. But chances are we’ll give up after half an hour and say, “I guess we’d better [rent] a PPG.” Why couldn’t we get our own sound, like we did in the Dare days?

In this interview, Oakey seems to be regretful, or even in denial, of using the DX7 presets, yet DX7 presets saturate The Human League’s album Crash, released in September of 1986 and produced by Jimmy Jam and Terry Lewis, only eight months prior to this comment.

Similarly, singer-songwriter Joe Walsh (formerly a member of the Eagles) publicly expresses a bit of embarrassment about using the presets during an interview with Keyboard magazine—”I very seldom go through presets. I don’t like anybody to see me sliding my finger up and down the presets on the DX7”—yet DX7 presets can be heard on tracks in his 1985 album The Confessor, released a little over a year before that comment. Walsh also uses some DX7 presets, albeit to a lesser extent, on Got Any Gum? (1987), released just over one year after the

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31 Quoted in Rue and Goodyer 1990, 53.
32 Quoted in 1987a, 88–9.
33 Jimmy Jam and Terry Lewis’s aforementioned preference for the DX7 no doubt has something to do with the reliance on DX7 sounds on Crash. I hear BASS 1 and BRASS 1 on “Money”; BRASS 3 on “Jam”; VOICE 1, BASS 1, and KOTO on “Are You Ever Coming Back”; BRASS 1 and BASS 1 on “I Need Your Loving”; BASS 1 and SYN-BRASS 1 on “Party”; E. PIANO 1 and SYNBRASS 1 on “Love on the Run”; BASS 1 on “The Real Thing”; and LOG DRUM on “Love Is All that Matters.” I think “Human” is likely using DX7 bell and plucked sounds, but I can’t identify which.
34 Quoted in “Uses and Abuses of Synthesizers” 1986, 69.
The common attitude toward DX7 presets in the mid-1980s can perhaps be understood like that toward Auto-Tune today: everyone uses it, but no one wants to admit it.

The prevalence of the presets led musicians to believe that the DX7 was an inflexible instrument—the DX7 was sometimes thought of like a cheap Casio meant for performance only, rather than a robust FM digital synthesizer. For example, Joe Zawinul, keyboardist of the fusion band Weather Report, said, “... I don’t think [digital synthesizers are] as flexible as I want them to be. I played the DX7 for a couple of nights in Japan and I really like it. ... I think Yamaha has some really good things, but I can’t deal with all the sounds they’ve got—after a while, they get stale.”

Here, Zawinul seems to think that the “sounds they’ve got,” i.e., the presets, are an essential part of the instrument, rather than something that can be either used or discarded. This evaluation of the DX7 as an inflexible instrument is factually incorrect, since, as described earlier, the number of possible sounds is virtually infinite, when factoring in the variables such as the thirty-two different algorithms and the possibility for different eight-step envelopes for each of the six operators.

But very few practicing musicians were able to successfully program the DX7 and make their own customized sounds. The most famous person to do so is probably Brian Eno. Eno was largely protective of the patches he programmed, like many programmers, since at

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35 To my ears, BASS 1 is used on “I Broke My Leg,” FLUTE 2 on “Bubbles,” and CALIOPE (sic) on “Slow Dancing,” all tracks from The Confessor. GUITAR 4 I think is also used in “The Radio Song,” CLAV 1 in “Up to Me,” and XY-LOPHONE in “Time” on Got Any Gum?. Walsh might also be using CALIOPE in “Memory Lane,” but produced somehow to sound less sharp—this sounds a bit Mellotron-ish to me, actually.

36 Quoted in Armbruster 1984, 55. Zawinul was discussing his preference for the Sequential Circuits Prophet-5 over all types of digital keyboards, both samplers and FM synthesizers.
this time patches were not copyrightable. Eno nevertheless would give small hints about his methods for making the DX7 sound more unique, as in this 1988 interview:

I’ve found ways to de-stabilize the DX7 a little bit to create interactions between it and other instruments that are more interesting ... I don’t have very good voltage supply, for instance. Within the patches, I build in certain elements that don’t repeat. For instance, there’s something wrong with the programming of envelope generator four on the original DX7 and you can use that to create non-repeating patches. If you have that set to a value under 50, you’ll find that the synthesizer behaves unpredictably. Unfortunately they’ve sorted this out on the second generation of DX7s, so I still use the first one, and that’s an important element of quite a few of my patches.

Eno’s ambition and dedication to learning to program the DX7 was not the norm, however. The vast majority of DX7 players indeed seem to have relied on the presets, the Yamaha ROM cartridges, or even additional presets purchased from the cottage industry of DX7 presets for sale that germinated during this time.

A relatively small handful of presets became particularly widespread throughout the pop music of the 1980s. I have not done a rigorous statistical analysis of the prevalence of all the presets, but to me, E. PIANO 1—the DX7 version of the Fender Rhodes electric piano—seems to be the most ubiquitous; E. PIANO 1 is so remarkable a phenomenon that I will devote a large portion of Chapter 5 to discussing this particular preset and its effect on the “’80s sound.” BASS 1 is perhaps the next most common, and certainly at least as iconic as E. PIANO 1. BASS 1 mimics a funky slap bass, and frequently opens a track with an aggressive riff, as in “Danger Zone” by Kenny Loggins (1986). Other common groups of sounds include the DX7 “flute sounds,” such as FLUTE 1, CALIOPE, and VOICE 1; percussive sounds, like MARIMBA, COWBELL, and LOG DRUM; bell sounds, like TUB BELLS (tubular bells) and CELESTA; and plucked sounds, like CLAV 1 and HARPSICH 1.

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37 Théberge 1997, 76.
38 Quoted in Diliberto 1988, 54.
39 “CALIOPE” is spelled as shown in the Yamaha ROM cartridge, rather than correctly (“calliope”). Colloquially, CALIOPE is frequently called a “pan flute” sound, but this should not be confused for the actual preset PAN
After the DX7

As more and more DX7 players repeatedly returned to these presets on hundreds of records throughout the 1980s, the sound of the presets eventually became recognizable. This quickly diminished the appeal of the instrument, and I hypothesize that perhaps the DX7 sounds particularly dated today because of the existence of the factory presets; perhaps an analog instrument that was more easily customizable wouldn’t have had such an easily recognizable sound. The DX7 became less and less popular as a synthesizer toward the end of the 1980s and into the 1990s, until finally the DX7 had a truly bad reputation and was essentially synonymous with cheesiness.\(^4\) The Roland D-50 synthesizer, released in 1987, which blended sampled attack sounds with digitally synthesized sustain portions of tone, was the first blow to the DX7’s previously uncontested dominance. The Korg M1, an inexpensive sample-based synthesizer released in 1988, completely dethroned the DX7, even breaking the record for most units sold by any synthesizer, which had previously belonged to the DX7.

Now that digital audio workstations (DAWs), digital instruments, and virtual studio technology (VST) have made the sounds of vintage synthesizers more accessible to a larger section of the population, digital FM sounds have returned to the music scene. Modern technology also facilitates the cumbersome process of editing an FM sound, so contemporary music producers are more interested in learning about the process of FM synthesis than music makers of the ’80s or ’90s (Example 2.6). Even DX7 preset sounds have had a resurgence in popularity: for example, Bruno Mars’s 2016 album 24K Magic, which reached #2 in the U.S.

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and #3 in the U.K., uses several DX7 presets or sounds that are mimicking DX7 presets. Ultimately, whether or not 24K Magic uses actual DX7 presets or FM synthesis sounds that merely resemble DX7 presets is beside the point: the DX7 sound has made a comeback in recent years, after a slump in popularity in the ’90s and early 2000s.

Example 2.6: A screenshot of Dexed, a DX7 librarian and patch editor plugin for digital audio workstations.

While the average music consumer, or even most music enthusiasts or music theorists, may not be aware of the Yamaha DX7 as a musical phenomenon, every person who listens to 1980s Anglo/American popular music is familiar with the sound of the DX7 synthesizer. As I have shown through this constellation of remarks from music makers of the 1980s, musicians were constantly using and discussing the DX7 in their music.
Many analyses of timbre mistakenly conflate instrumentation with timbre. Instrumentation, orchestration, and timbre are all interrelated concepts, and their differences must be teased out in order to clearly define the scope of my work. Orchestration is the practice of effectively writing for the different instruments of an ensemble. To orchestrate well, one must be attuned to the details of the timbres of the constituent instruments of the ensemble. A study of orchestration would also take into account the fact that a single instrument can produce multiple timbres, depending on the way in which that instrument is played. Some understand instrumentation to be a broader term than orchestration, one which perhaps does not connote as much artistry, or perhaps does not use string (“orchestral”) instruments, but rather focuses on the factual elements of the orchestration process: the range of instruments, the selection of instruments, and so on. In short, orchestration and instrumentation deal with timbre and the use of different timbres, but their primary concern is not timbre itself, but rather the roles of particular timbres within a larger texture.

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This was first brought to my attention by David Blake, in response to my own 2012 presentation at the Music Theory Society of New York State conference on Sufjan Stevens’s “Come On, Feel the Illinoise!”, so I am grateful to him for spurring this self-reflective train of thought. I also find this to be a problem in much of Erickson 1975, for example, as well.
An analysis of timbre must go beyond an analysis of the instrumentation or the orchestration of a track. In a study of orchestration, instruments are basically contrasted with other instruments. A study of timbre instead would deal with components of any instrument’s sound, like the sound’s *hollowness*, and open the possibility of examining the variety of timbres producible by an instrument as well as the timbral elements that two different instruments share, among other things. In other words, a study of timbre should deal with a specific property of an instrument’s sound, such as the *bright/dark* opposition. A timbre analysis can analyze the same properties across all instruments, and yet can also discuss changes of those properties within a single instrument, depending on the techniques used to play it. These kinds of highly specific qualities of sound are a more auxiliary concern in the study of orchestration. A study of timbre will likely involve a study of acoustics to some degree, while orchestration or instrumentation would be concerned with more practical and immediate aspects of sound.

Studies of timbre and orchestration can of course intersect. One component of orchestration studies is the idea of *blend* among instruments. Timbre is a key component in blending: similarity among different timbral profiles facilitates blending, while distinctive timbral profiles will resist blending.\(^2\) This is not merely an issue of orchestration, or which instruments blend together, but also one of timbre. A saxophone may blend well with a violin if it uses a *soft* attack, but the same saxophonist might instead create a very *percussive* attack that would sound quite distinct from the violin. Two violins could even resist blending with one another if one plays *cantabile* and another plays *col legno*. What would define such

an investigation as a timbral study, and not solely an orchestrational one, is the focus on particular timbral attributes that may transcend the properties of a single instrument.

In this chapter, I embark on a study that clarifies how timbre may be related to texture and instrumentation, focusing especially on the role that the notion of blend plays in texture. I use the methodology I established in Chapter 1 to describe the timbre of the various Yamaha DX7 presets used in several different hit singles produced during 1983–1987, at the height of the DX7’s reign over popular music, to ultimately articulate the typical timbral profiles of textural-functional categories that have long been taken for granted in instrumentation studies. Establishing these norms then allows the creation of narrative trajectories and musical meaning through the transgression or reversal of the norms. In addition to providing an account of timbre, texture, and instrumentation in 1980s mainstream popular music, I also demonstrate the versatility of my approach to timbre analysis.

Textural Functions

“What’s Love Got to Do with It” by Tina Turner, which reached #1 in the US in September 1984 and #3 in the UK in June 1984, is one of the earliest recorded singles to use the Yamaha DX7. Given this, perhaps it is not surprising that the track sounds like a demo tape for the Yamaha DX7 presets, using four of them: CALIOPE, FLUTE 1, E. PIANO 1, and HARMONICA.

Example 3.1 is a transcription of the prechorus and chorus of this track, which uses two of of the four presets: FLUTE 1 and E. PIANO 1. To describe the texture of “What’s Love Got to Do with It?”, the instruments can be placed in three categories based on their textural function. First, in its own category is Tina Turner’s voice, which carries the main melody and lyrics. Second, another category includes the drum set, which plays a basic rock beat; the
Example 3.1: Prechorus and chorus of “What’s Love Got to Do with It?”.

bass line, which plays chord roots in slow, predictable rhythms before switching to a more linear bass in the reggae-tinged chorus; the guitar, which plays strictly chordal accompani-
mental figures; one DX7 preset, E. PIANO 1, which, like the guitar, plays chordal accompaniment; and the strings, which thicken this core texture. These are all accompaniment instruments. The third and final category includes just the FLUTE 1 DX7 preset, which is far less predictable than the other instruments, adding syncopated melodic interjections sporadically throughout the introduction.

These three categories describe what I call *textural functions*. Core sounds articulate foundational aspects of pitch and rhythm in a track, novelty sounds intermittently interject decorative motives, and melody sounds are the voice and any instruments replacing the voice. The three textural functions—core, melody, and novelty sounds—are found consistently in most pop and rock music. While I will focus in my analysis on the Yamaha DX7 synthesizer and the many instrumentational and textural roles it can fill, referencing a traditional rock ensemble will help clarify and elaborate on each one of these textural-functional categories.

At least prior to the 1970s, the traditional rock group would probably use guitar, bass guitar, and drum set for their core instruments, which together serve the role of the accompaniment for the melody instrument, the voice. Put another way, texture in rock music is traditionally a simple melody-and-accompaniment. In this sense, timbre and texture had a predictable relationship in rock music for a long time.

That was before rise of the synthesizer. As polyphonic and digital synthesizers exponentially broadened the roles that the synthesizer could fill, groups began to experiment. Artists in the 1980s might drop traditional guitars and drum sets altogether, in favor of the synthesizer, which offers a greater level of control over a much wider palette of timbres. The Yamaha DX7 was often used in just this way—to replace a guitar or piano. Common presets

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3 This broadening of roles is discussed further in Chapter 2.
used in this way are E. PIANO 1 and BASS 1. When DX7 players use these presets, almost invariably, they use the DX7 as a core instrument. Melody instruments are usually the voice, but two DX7 presets used as melody sounds, replacing the voice, are the HARMONICA and BRASS 2 presets.

Instruments in popular songs are not always limited to those melody and accompaniment—i.e., melody and core—functions. Some instruments will play motives that serve a different function: the novelty sound. A well-known example of a novelty sound would be the piccolo trumpet in “Penny Lane” by The Beatles. The piccolo trumpet in that track has a limited role, only sounding intermittently, as one of the track’s “hooks.” Rather than replacing a guitar or voice, novelty sounds are those used sparingly for coloristic effects, and typically featured in intros, outros, and interludes, as FLUTE 1 was in the prechorus of “What’s Love Got to Do with It?”.

These timbral-functional categories arise from a combination of my own intuition and received wisdom about orchestration practices in a variety of genres. Several other orchestration studies provide precedents for such categorization. Bobby Owsinski’s *Mixing Engineer’s Handbook* (2006), a go-to text for college courses on recording, names five “arrangement elements”: the foundation, pad, rhythm, lead, and fills. What Owsinski calls “lead” is my melody category; what he calls “fills” is my “novelty.” I collapse Owsinski’s categories of foundation, pad, and rhythm into my single category of core instruments.

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4 I am grateful to the colleagues who enhanced my discussion with these various connections: Prof. Judith Ofcarcik for the connection to organ registration, Prof. Greg McCandless for the mixing engineering terminology and the Owsinski text, and Prof. William Rothstein for the connection to Agazzari.

5 The distinction between these elements is not always clear—for example, Owsinski notes that sometimes the rhythm may be considered a foundation instrument. Owsinski also states that the maximum number of elements occurring simultaneously should be four: “rarely will five elements simultaneously work.”
Organists may also find these three categories familiar. While I was unable to find an organ treatise that explicitly outlined these three categories, two categories—"solo" and "foundation" or "chorus", which would be analogous to my melody and core sounds, respectively—are implicit in many authors’ discussions of the types of organ pipes (principals, reeds, flutes, strings, etc.). The remaining category, novelty sounds, are sometimes called “toy stops.” Toy stops include things like zimbelstern (a stop that begins a perpetual tinkling of bells), chimes, pauke (timpani), and other such unusual and non-organ-like sounds whose usage would be reserved only for special occasions like Christmas and Easter.

Agostino Agazzari, writing in 1607 about playing in a consort or large ensemble, spoke of instruments that are “like ornaments” versus those that are “like a foundation”; these correspond to my novelty and core, respectively. Ornamental instruments, in Agazzari’s view, serve “no other purpose than to ornament and beautify, and indeed to season the consort.” Agazzari’s use of the word “season” (Italian: condire) has a peculiar resonance with the word “sweeten.” “Sweeteners” is a term in common usage among sound designers in the music industry for the kinds of finishing touches a novelty sound might provide.

The metaphor works well for core sounds as well: if novelty sounds are the seasoning or sweetener, core sounds in a pop tune are like the meat, starches, and vegetables in a meal. Without the core sounds, we have no track, and without the meat, starches, and vegetables, we have no meal, but the seasonings and the novelty sounds are often what make a truly

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6 See, for example, Ritchie and Stauffer (2000, 373–5) and Gleason (1979, 6–8).
7 Ahrens 2006, 571. I was only able to find this name in one print source, so I am not sure how commonplace the term "toy stops" really is, but nevertheless, many organists discuss such stops as a group of novelty stops.
8 Agazzari does not have a category that corresponds to my melody category. I presume this is because he is focusing on instruments which might be reading from a continuo part, and the melody instrument would instead have its own score apart from the continuo.
9 This term is also alluded to in Covach and Flory 2015, 21.
pleasurable experience. Indeed, many of the most remarkable and well-known Yamaha DX7 presets are novelty sounds. These presets, such as TUB Bells, MARIMBA, KOTO, and CALI-OPE (often colloquially referred to as a “pan flute” preset) often mimic orchestral or folk instruments not typically used in popular music.

I do not define core, melodic, and novelty sounds by their timbral properties, but rather by the way the sounds are used in the track—that is, by their instrumentalational role. These categories are descriptions of textural function, rather than an assessment of timbral quality. However, after defining which DX7 presets fill which roles in the context of 1980s pop hits, I establish timbral norms for the categories, norms that are particular to this idiom of 1980s mainstream popular music. As I show by investigating several 1980s tracks, not just any DX7 preset was used for any role. Each DX7 preset consistently serves the same textural function in each song.

All the DX7 presets used for core and melody sounds have something in common: they have unmarked timbral characteristics that allow different instruments to blend into a texture. Novelty sounds, by contrast, have marked timbral features that encourage these instruments to stand out. In other words, I will show that in mainstream pop and rock music in the 1980s, the ideal for the core instruments is to blend with each other; for the melody instruments, to blend with the voice; and for the novelty instruments, not to blend at all. I’ll demonstrate the norms through this Tina Turner example and a summarizing chart of some other representative singles that do the same thing. Then, I discuss how blend, as an ideal, is a sociocultural construct, one not necessarily adopted outside the context of mainstream 1980s popular music.
Returning to “What’s Love Got to Do with It?” and its use of Yamaha DX7 presets, CA-LIOPE is used in the introduction of the track (Example 3.2). CALIOPE acts as a novelty sound and interjects with its syncopated motives—like what novelty sound FLUTE 1 does in the prechorus. HARMONICA first appears in a lengthy solo section during the instrumental break (Example 3.3). Here, HARMONICA functions as a melody instrument. It functions as a replacement for Turner’s voice, providing a little timbral contrast in this solo section. After this instrumental concludes and after the bridge, the HARMONICA returns during the final chorus repetitions of the track, providing improvised descant lines simultaneously with Turner’s vocals, much like a duetting singer would do.

Example 3.2: Introduction of “What’s Love Got to Do with It?”

Example 3.3: Instrumental break of “What’s Love Got to Do with It?”
Examples 3.4, 3.5, 3.6, and 3.7 are spectrograms for the presets used in “What’s Love Got to Do with It?”\footnote{For details about spectrogram settings, see footnote 3 in Chapter 1, page 14.} Sounds are given a positive or negative assignment for each timbral category based on acoustic information from spectrograms. Compare these spectrograms to the opposition table given in Example 3.8. There are two attributes FLUTE 1 and CALIOPE share with each other and not with E. PIANO 1 or HARMONICA: noisy and inharmonic. E. PIANO 1 and HARMONICA are pure and harmonic presets. As discussed previously in Chapter 1, the assignation of positives and negatives correlate to markedness and unmarkedness, respectively. The FLUTE 1 and CALIOPE presets are both novelty sounds, and they both have the marked timbral properties, noisy and inharmonic. E. PIANO 1 is a core sound, and HARMONICA a melody sound, two categories that have deeper roots in pop and rock music, and similarly, E. PIANO 1 and HARMONICA both have the unmarked properties, pure and harmonic. These groupings reinforce each other: timbral attributes align with the textural functions of these presets.
CHAPTER 3  NORMS OF TIMBRE AND INSTRUMENTATION IN 1980S POPULAR MUSIC

Example 3.4: E. PIANO 1 as heard in Example 3.1.

Example 3.5: HARMONICA as heard in Example 3.3.
Example 3.6: FLUTE 1 as heard in Example 3.1.

Example 3.7: CALIOPE as heard in Example 3.2.
Establishing Norms

“What Is Love?” is saturated with the sound of the DX7, featuring four factory presets: BASS 1, BRASS 2, TUB BELLS, and CALIOPE. Example 3.9 is a transcription of the introduction of this track, using three of these presets. The BASS 1 preset is a core instrument; CALIOPE and TUB BELLS are novelty instruments. BRASS 2 is first heard in the second verse of the track (Example 3.10). Here, BRASS 2 is a melody sound. It joins with and bolsters Jones’s voice, work that traditionally would be done by double-tracking the vocals in an older recording. BRASS 2 takes on the role of the voice, and thus is a melody instrument.
Example 3.9: Introduction of “What Is Love?”.

Example 3.10: Verse 2 of “What Is Love?”.
Examples 3.11, 3.12, 3.13, and 3.14 are the spectrogram images for the DX7 presets used in this track. Example 3.15 is the opposition table for these four presets. The two novelty sounds, TUB BELLS and CALIOPE, share a number of timbral features with each other that BASS 1 and BRASS 2 do not have. BASS 1 and BRASS 2 are both harmonic, full, rich and bright sounds, whereas TUB BELLS and CALIOPE all are inharmonic, hollow, sparse, and dark. Again, like in “What’s Love Got to Do with It?”, the properties that BASS 1 and BRASS 2 share (harmonic, full, rich, bright) are all negative designations within the opposition, and the properties CALIOPE and TUB BELLS share are all positive (inharmonic, hollow, sparse, dark). The assignment of positive versus negative to these timbral attributes may seem counterintuitive (in the case of hollow and sparse especially), but recall that I have defined oppositions based not on their spectral energy, but rather so that sounds that are most typical of rock music receive negative designations, and sounds that are atypical in these contexts receive positive designations. This is a cultural consideration rather than a strictly acoustic one. In sum, TUB BELLS and CALIOPE are more marked than BASS 1 and BRASS 2. Once again, the groupings according to textural function and the groupings according to timbre reinforce each other.
Example 3.11: BASS 1 as shown in Example 3.9.

Example 3.12: BRASS 2 as shown in Example 3.10.
Example 3.13: CALIOPE as shown in Example 3.9.

Example 3.14: TUB BELLS as shown in Example 3.9.
Even in 1987, the DX7 was still going strong. Fusion band Level 42 makes extensive use of DX7 presets in their 1987 album *Running in the Family*. The official video for the title track shows synth player Mike Lindup using two DX7s stacked on top of each other to play all the lines in the track (see Example 3.16). This track peaked at #6 in the UK in February 1987, but only made it to #83 in the US in August. The sounds used include CLAV 1, E. PIANO 1, and VIBES, all of which, conveniently for this analysis, are used at once in Verse 2 of “Running in the Family” (Example 3.17).
Example 3.16: Mike Lindup playing two DX7s in a performance.¹¹

Example 3.17: Verse 2 of “Running in the Family.”

Each one of these DX7 sounds has a different textural function. Like BRASS 2 in “What Is Love?”, CLAV 1 bolsters Mark King’s lead vocals in the verses of “Running in the Family,” and so functions as a melody instrument. CLAV 1 is an extremely bright and rich sound, visible in the spectrogram (Example 3.18). E. PIANO is a core sound, functioning as it

¹¹ Roussel 2006.
almost always does as a harmonic pad within the groove, as in the Tina Turner example. Example 3.19 shows the spectrogram for E. PIANO 1. VIBES interjects improvisatory flurries of notes, as a novelty sound typically does. The spectrogram shows that the VIBES preset is hollow, sparse, and dark (Example 3.20). The use of sounds in “Running in the Family,” in short, echoes the usage of similar timbres in “What Is Love?” and “What’s Love Got to Do with It?”.

Example 3.18: CLAV 1 as shown in Example 3.17.
Example 3.19 E PIANO 1 as shown in Example 3.17.

Example 3.20 VIBES as shown in Example 3.17.
Janet Jackson’s “When I Think of You” from her album _Control_ reached #1 in the US in October 1986 and #10 in the UK two months prior. This track uses MARIMBA as a novelty sound, introducing a rhythmic motive above the electric piano (significantly, not a DX7 electric piano) in the verses and postchoruses, and uses BASS 1 as a core sound, to which Jackson draws attention by announcing “Bass!” before a lengthy bass feature (Example 3.21). The form of this single is unconventional for mainstream popular music (Example 3.22). The intro and bridge of this track are both disproportionately long compared to other pop/rock singles, and the music after the bridge is not the typical repetitions of the chorus, but rather a repeat of the postchorus, a breakdown, and an outro, which could be understood together as an extended outro, lasting from 3:03 until 3:55.

Example 3.21: Screenshot from the music video for “When I Think of You.”

Example 3.22: Formal diagram for “When I Think of You.”

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12 JanetJacksonVEVO 2009.
Example 3.23 is a spectrogram for the MARIMBA preset, and Example 3.24 is the opposition table. The preset is *hollow, sparse, wavering, and inharmonic*, several attributes that help the preset to stand out with its rhythmic motive against the busy groove. That the MARIMBA has very little sustain and a quick decay makes it particularly suitable to short, punchy rhythms. The MARIMBA is mostly restricted to this role until the breakdown section, where the MARIMBA takes on the role the electric guitar had earlier in the introduction. Out of context, MARIMBA sounds like a core sound here in the absence of any other harmonic information. But taking a broader view of the breakdown as one section of an extended outro section as suggested before, MARIMBA still comes across as a novelty sound, one that is featured in the breakdown.

Example 3.23: MARIMBA preset in “When I Think of You.”
Instrumentation and Form

Thus far I have mentioned the use of the following ten DX7 presets: BASS 1, E. PIANO 1, TUB BELLS, CALIOPE, FLUTE 1, MARIMBA, VIBES, BRASS 2, HARMONICA, and CLAV 1. In the following discussion, I will also include two presets that I only discuss in Chapter 4: VOICE 1 and COWBELL. Within each track, the DX7 presets were categorized as being either core, melody, or novelty sounds, and the same presets fell into the same categories even across different albums and artists (Example 3.25).

Example 3.25: DX7 presets and their typical textural-functional roles.

<table>
<thead>
<tr>
<th>Core sounds</th>
<th>Melody sounds</th>
<th>Novelty sounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>BASS 1</td>
<td>BRASS 2</td>
<td>TUB BELLS</td>
</tr>
<tr>
<td>E. PIANO 1</td>
<td>HARMONICA</td>
<td>CALIOPE</td>
</tr>
<tr>
<td>VOICE 1</td>
<td>CLAV 1</td>
<td>FLUTE 1</td>
</tr>
<tr>
<td></td>
<td>VOICE 1</td>
<td>MARIMBA</td>
</tr>
<tr>
<td></td>
<td>VIBES</td>
<td>STEEL DRM</td>
</tr>
</tbody>
</table>
Detailing the textural-functional roles of each of these tracks further reveals a parallelism between textural function and formal function. Core sounds are used throughout the track. This is evident in songs already discussed—BASS 1 is used in every section of “When I Think of You” and “What is Love?”, excepting only the breakout choruses, and E. PIANO 1 is used in every section of “Running in the Family” as well—and also in several other songs that use both E. PIANO 1 and BASS 1 throughout, such as Madonna’s “Live to Tell” (#1 US June ’86, #2 UK Apr. ’86) or Gloria Estefan’s “Rhythm Is Gonna Get You” (#1 US Mar ’88, #15 UK Dec. ’88). Melody sounds are featured in verses and choruses, but omitted for intros, interludes, and the like, as BRASS 2 and CLAV 1 both did. Novelty sounds tend to be featured in intros and interludes, though they will also interject in the gaps of a melody line during the verses and choruses, as CALIOPE, FLUTE 1, and VIBES did.

The form of a pop/rock song, then, reflects the different kinds of textural-functional roles. Core sounds ground the texture and unify each of the sections of the song. Melody sounds carry the lyrics and main melody of the texture and are the main focus of the verse and chorus sections. Novelty sounds are non-essential elements that nevertheless demand attention; thus, they must be kept distinct from the melody sounds. Melody sounds govern the verses and choruses, so novelty sounds are relegated to only the non-essential formal sections like intros, transitions, and outros, or otherwise take on a secondary or countermelody role in those essential sections.

Implied in this power struggle between melody and novelty sounds is a commonality between them. Owsinski recognizes this in his Mixing Engineer’s Handbook, writing, “You can
think of a fill [novelty] element as an answer to the lead [melody].”¹³ The melody sound plays the most important motives and, when the melody sound is the voice, carries the lyrics, but both textural-functional categories carry motivic melodic elements.

**Timbre and Instrumentation**

Across all these singles, the timbral qualities tend to group together, so that melody and core sounds share certain timbral features, and novelty sounds share others. In Example 3.26, I have grouped the twelve presets by my categorizations of their textural function, as either core, melodic, or novelty sounds, each separated by double lines.¹⁴ The table reveals at a glance the consistency in what timbral features a core or a melodic sound will have. In general, the core timbres have more negative designations in the opposition table. Because unmarked timbral attributes receive a negative designation and marked attributes a positive designation, the larger number of negatives in the core and melodic categories indicate a more mainstream sound. Note especially that core and melody presets are all bright, pure, and harmonic. These are timbral qualities that help these sounds to blend together into the song’s groove.¹⁵ Most of these presets are also rich, beatless, and full. The presets have a strong sound, even while they blend well. Recall that the reference sound for unmarked timbral qualities is an electric guitar, which is also bright, pure, harmonic, rich, beatless, and full.

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¹³ Owsinski, 12.

¹⁴ CLAV 1 is probably not typically a melody sound, but rather a core sound. Since CLAV 1 was used as a melody sound in these analyses, I have placed it in this category in Example 3.26.

¹⁵ This statement may seem to contradict Sandell 1995, who concludes from his perception studies that tones with “strong high-frequency components possess some advantage for segregation” (240). Sandell also cites several orchestration treatises that recommend “dark” sounds for blending. I argue that these claims are contextually contingent, and the context assumed for blend—especially in orchestration treatises—is classical music. In pop/rock music, the norms for blend would be quite different. There are fewer instruments performing, and the instruments are typically all amplified; it makes sense that brightness would be a desirable feature for all instruments to blend together.
Table 3.26: Opposition table for twelve DX7 presets.

<table>
<thead>
<tr>
<th>Spectral components: core</th>
<th>Spectral components: attack</th>
</tr>
</thead>
<tbody>
<tr>
<td>bright / dark</td>
<td>bright / dark</td>
</tr>
<tr>
<td>pure / noisy</td>
<td>percussive / soft</td>
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<tr>
<td>full / hollow</td>
<td></td>
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<tr>
<td>rich / sparse</td>
<td></td>
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<tr>
<td>beatless / beating</td>
<td></td>
</tr>
<tr>
<td>steady / wavering</td>
<td></td>
</tr>
<tr>
<td>harmonics / inharmonics</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E. PIANO 1</th>
<th>BASS 1</th>
<th>VOICE</th>
<th>BRASS 2</th>
<th>HARMONICA</th>
<th>CLAV 1</th>
<th>TUB BELLS</th>
<th>FLUTE 1</th>
<th>CALLIOPE</th>
<th>VIBES</th>
<th>MARIMBA</th>
<th>COWBELL</th>
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<tbody>
<tr>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
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Example 3.26: Opposition table for twelve DX7 presets.
Novelty sounds are much more diverse and thus difficult to generalize in the same way as the core and melody sounds, but as a rule, novelty sounds are more likely to receive positive designations for their timbral attributes. Novelty sounds are far more often dark, hollow, or inharmonic sounds. These are all marked timbral attributes, carrying greater semiotic weight in terms of musical meaning because of their non-conformity to the norms of the mainstream pop/rock sound. All of these features will draw attention to the novelty timbres, since they are the opposites of the common features of core and melody sounds (*bright, full, harmonic*). Thus, the novelty timbres are better suited to hooks and solos—at least as long as the songwriter/producer wishes to have a more normative sound in the track.\(^\text{16}\)

**Conclusion**

By formalizing the concepts of core, melodic, and novelty sounds, and further establishing timbral norms for each of these categories through the study of certain DX7 presets, I have achieved a precise understanding of the way that timbral attributes combine with one another within and across different instruments. In short, I posit that the typical goal of a core instrument is to blend, and of a melodic instrument is to sound voice-like (i.e., blend with the voice); the goal of a novelty instrument, by contrast, is precisely not to blend. I find that certain acoustic-timbral features, especially *harmonic, pure, and full*, are particularly conducive to allowing a timbre to blend, either with other instruments or with the human voice. Other oppositional features, like *inharmonic* and *hollow*, do not blend as well, and, as such, are particularly well-suited to colorful interjections, sweeteners, or ornaments. That certain DX7 presets retain the same roles consistently across many 1980s singles demonstrates the

\(^{16}\) Non-normative tracks are discussed in Chapter 4.
existence of these timbral norms I have articulated. By establishing timbral norms, I open an opportunity for dialogic analysis, where the transgression of norms generates musical meaning, the subject of the following chapter.
As with any set of norms, there are bound to be exceptions. In Chapter 3, I detailed the timbral norms of each of the textural functional roles; in this chapter, I discuss three songs that subvert these norms in some way. The transgression of timbral norms enables the analyst to locate musical meaning created through the manipulation of timbres. “Do They Know It’s Christmas?” by Band Aid (1984) is a #1 hit single that features DX7 presets prominently. In this track, timbre itself engages the song’s message of worldwide goodwill. To examine transgressions of timbral norms in non-normative genres, I focused on hip hop and on science fiction soundtracks, two venues that frequently made use of the DX7. In “Girls” by the Beastie Boys (1986), and music from an episode of Doctor Who titled “The Two Doctors” (1986), timbre is used to articulate identity. Both of these forms of musical meaning are created through a dialogue with timbral norms.

“Do They Know It’s Christmas?”

In 1984, in the midst of an Ethiopian famine, Bob Geldorf and Midge Ure put together 1980s UK and Irish pop superstars such as Bono, Boy George, Phil Collins, and George Michael, forming the supergroup Band Aid. The group was created to make a one-off single, the proceeds of which would be donated to a charity fund for the famine. Later, Band Aid reformed three subsequent times, so there are four different versions of Band Aid that released four
separate singles. The 1984 single, “Do They Know It’s Christmas?”, a #1 hit in the UK in December of 1984 and #13 in the US at the same time, features two DX7 presets—TUB BELLs and VOICE 1.¹ The use of both presets is complex, blurring the boundaries between core, novelty, and melody sounds: TUB BELLs and VOICE 1, rather than remaining in their typical textural functional roles (novelty and melody, respectively), both take on new textural functions in the course of the track. Far from invalidating the norms I articulated in Chapter 3, I read this blurring as a fulfillment of the message of unity communicated through the lyrics.

Before I provide a brief analysis of this song, I would be remiss not to mention that the lyrics have, rightfully, received a great deal of criticism for being Euro-centric, patronizing, and offensive. To begin, the title lyric itself is problematic. In Ethiopia, Christianity is in fact the dominant religion, having been practiced there since 1 A.D.—though interestingly, because they follow the Julian calendar, Ethiopian Orthodox Christians celebrate Christmas on January 7 instead of December 25, so depending on when you ask the question, the answer to “Do they know it’s Christmastime?” may in fact still be “no,” but only because it would seem a bit early to an Ethiopian Orthodox Christian.

The rest of the lyrics do no better: they portray a delusionally ghastly portrait of the continent of Africa. Lyrics such as “Where the only water flowing is / The bitter sting of tears” and “Where nothing ever grows, / No rain nor rivers flow” seem to ignore the existence of the Blue Nile river and the tropical forests within Ethiopia’s borders, and many other rivers and biomes outside of Ethiopia within Africa. Perhaps the most perplexingly disturbing line is Bono’s statement, “Tonight thank God it’s them instead of you,” for which I find a

¹ In an exchange on Twitter, Midge Ure verified that these were DX7 sounds: “Dx7 features heavily on there. The bells and flutes were the most prominent sounds. Impossible to program!” VOICE 1 is likely the “flute” sound that Ure references here. https://twitter.com/midgeure1/status/656530976844173316.
well-intentioned motivation difficult to imagine. British journalist Bim Adewunmi critiques the entire mindset in a piece for The Guardian, in which she reviews the fourth “Do They Know It’s Christmas?” single, released in 2014:

There exists a paternalistic way of thinking about Africa, likely exacerbated by the original (and the second, and the third) Band Aid singles, in which it must be “saved”, and usually from itself. We say “Africa” in a way that we would never say “Europe,” or “Asia.” It’s easy to forget, for example, that the [Ebola] virus made its way to Nigeria – Africa’s most populous country and, for many, a potential Ebola tinderbox – and was stamped out only by the efforts of a brave team of local healthcare workers. The popular narrative always places those of us in the west in the position of benevolent elders, helping out poor Africans, mouths always needy and yawning, on their constantly blighted continent, and leaves out harder to pin down villains: local corruption, yes, but also global economic policies that do little to pull some countries out of the depths of entrenched poverty.²

As Adewunmi notes, the problematic lyrics had only marginally improved in the most recent Band Aid single, proving that not all the misconceptions can be written off as quaint 1980s insensitivity. British-Ghanaian hip hop artist Fuse ODG was asked to participate in the latest reincarnation, Band Aid 30, but he refused to participate after locating problematic notions throughout the lyrics that he could not support:

I pointed out to [producer Bob Geldof] the lyrics I did not agree with, such as the lines “Where a kiss of love can kill you and there’s death in every tear”, and “There is no peace and joy in west Africa this Christmas.” For the past four years I have gone to Ghana at Christmas for the sole purpose of peace and joy. So for me to sing these lyrics would simply be a lie.

In truth, my objection to the project goes beyond the offensive lyrics. I, like many others, am sick of the whole concept of Africa—a resource-rich continent with unbridled potential—always being seen as diseased, infested and poverty-stricken. In fact, seven out of 10 of the world’s fastest growing economies are in Africa.

… Returning to London at the age of 11, being African was not something to be proud of because of all the negative connotations it conjured up, and it drove me to be almost ashamed of who I was.

… [T]hough shock tactics and negative images may raise money in the short term, the long-term damage will take far longer to heal.³

Having acknowledged the problems in the lyrics, I now return to their relationship with musical form, and in turn instrumentation and timbre. The form of “Do They Know It’s

² Adewunmi 2014.
³ Fuse ODG 2014.
Christmas?” deviates from the typical verse-chorus pop/rock song: it is essentially a two-part form, in roughly equal proportions. The first part conforms to verse-chorus expectations, while the second is a kind of accumulative coda (Example 4.1). In the first part, the lyrics paint a grim picture of contrast between the Western Christmastime and poverty and hunger in Africa, summarized in the title lyric, “Do they know it’s Christmastime at all?”; the second part, in stark contrast, breaks into a communal, exultant chorus, repeating the mantra “Feed the world.” Taken together, the two sections of “Do They Know It’s Christmas?” exemplify a relationship codified by Frank Samarotto as an “expectation-infinity trope.” Songs exhibiting this trope are in two large parts: the first part begins the song by feeling somehow incomplete (for example, with text that refers to desired change and is non-narrative) and the second part ends the song with music that generates an “endless” feeling through repetition.5

![Form chart of “Do They Know It’s Christmas?” (1984).](image)

TUB BELLS is used in nearly every section of “Do They Know It’s Christmas?”, like a core sound would be, but in fact, TUB BELLS is still a novelty timbre, the same as it is in

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4 The term “accumulative” here comes from Spicer (2004), who details the functions of cumulative forms in several examples of pop/rock music.

5 Samarotto 2012. Samarotto cites “Hey Jude” as the exemplar of this trope. Expectancy sections are characterized by text that is non-narrative, refers to change of state, acceptance of an upcoming state, points to future possibility, and makes temporal references; and music that uses rising or otherwise incomplete-sounding gestures, is formally incomplete, is tonally incomplete, uses lighter instrumentation, and features temporal dislocations. Infinity sections feature text that has repeating lyrics, fragmentary lyrics, or no lyrics, that may make explicit what was hinted at in the expectancy section; the music has a repeating chord pattern, uses long tones and melodic stasis, and has a slower pacing.
“What Is Love?” and many other songs using this preset. In many of these sections, such as the intro and verse 1, the role of TUB BELLS is often to simply toll on middle C. The lyric “And the Christmas bells that ring there / Are the clanging chimes of doom” summons the TUB BELLS back into the texture after being absent since the end of Verse 1, at which point TUB BELLS finally plays a full-fledged motive. Semiotically, TUB BELLS, as emphasized by this lyric, signifies Christmastime; the introduction of a melodic motive into the TUB BELLS’s part at this moment further highlights TUB BELLS’s relationship to Christmas. The motive recurs again in the chorus (Example 4.2). This again demonstrates that core sounds are not necessarily the most important sounds in every sense, even while they contain the essential aspects of pitch and rhythm. The distinction is somewhat akin to structural levels in Schenkerian analysis: notes that are more structural are not necessarily our “favorite notes.”

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6 This brief quotation is a reference to a famous (but undocumented) story, in which Arnold Schoenberg protests to Heinrich Schenker that all of his “favorite notes” are only visible in his graph as little black notes.
CHAPTER 4 TIMBRAL DIALOGUES

Chorus (1:34-2:08)

Voice
won't be snow in Af - ri-ca this Christ-mas-time. The great-est gift they'll

PPG Wave

TUB BELLS

Synth Bass (PPG Wave)

Drum Set

Voice
get this year is life Where no-thing e-ver grows, no

PPG Wave

TUB B.

S. Bass

Dr.

PPG Wave

TUB B.

S. Bass

Dr.

PPG Wave

Bridge (2:08-2:22)

Voice
All?

Here's to you, raise a glass for ev-ery-one.

VOICE 1

S. Bass

Dr.
Example 4.2: Transcription of the chorus going into the bridge of “Do They Know It’s Christmas?”

Example 4.3 is the spectrogram of the VOICE 1 preset as featured in the lead-in to the bridge. This sound has an extremely soft attack—the note gradually increases in volume, and overtones are gradually added in as the note is sustained. VOICE 1 is a rich preset with many overtones, but only after the notes have sounded for some time, since overtones are layered in throughout the sustain. Rather than being loudest at the beginning of the note, as is normal for most of the DX7 timbres, peak volume occurs rather far into the sustain—almost half a second in.

Example 4.3: VOICE 1 as shown in Example 4.2.
At the very end of the chorus, immediately before the bridge, VOICE 1 enters with a brand new melody that is abruptly abandoned (Example 4.2, fourth stanza); as the bridge begins, VOICE 1 is instead used as a pad, playing chords to support the vocal melody. VOICE 1, then, as a pad, takes on the role of a core timbre. This kind of “temporal dislocation” is one of Samarotto’s typical features of the “expectation” section of his expectation-infinity trope: the listener now expects the motive to be taken up again and drawn to a conclusion. This switching of textural-functional roles further underscores the feeling of incompleteness when VOICE 1 interrupts its own melody: not only will listeners expect the melody to return, but they might also expect VOICE 1 to return to its role as a melody timbre.

VOICE 1 fulfills this expectation in the infinity section, regaining its melodic role and taking the interrupted motive up again, bringing the motive to completion as a four-measure phrase (Example 4.4). The infinity section is accumulative. Example 4.4 shows the fully assembled texture (in other words, a transcription of the texture at the point where every line has entered), but at the beginning of the infinity section, not all these lines are present. Example 4.5 indicates the entry of each motive into the texture. The core instruments—the bass, drums, and synth strings—are also present from the very beginning of the infinity section. The TUB BELLS enter next. Next come the vocals, entering with only half of the melody shown in Example 4.4—the first and second measures, “Feed the world.” This creates a call-and-response effect between the melody sound (the vocals) and the TUB BELLS, a novelty sound. As I described in Chapter 3, melody and novelty sounds both carry motives, and as such are in roles that are quasi-oppositional. This kind of call-and-response interaction is essentially a textbook demonstration of how novelty sounds operate in dialogue with melody sounds.
Example 4.4: Transcription of the infinity section of “Do They Know It’s Christmas?”

<table>
<thead>
<tr>
<th>Repetition Number</th>
<th>New Addition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>drumset, synth bass, VOICE 1</td>
</tr>
<tr>
<td>2</td>
<td>TUB BELLS</td>
</tr>
<tr>
<td>3</td>
<td>Vocals mm. 1–2 only (“Feed the world”)</td>
</tr>
<tr>
<td>4</td>
<td>n/a</td>
</tr>
<tr>
<td>5</td>
<td>PPG Wave, vocals mm. 3–4 (“Let them know...”)</td>
</tr>
<tr>
<td>6–11</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Example 4.5: Entry of each line of the cumulative texture in the infinity section.

This opposition is reconciled—or in Hegelian terms, the opposing melody and novelty roles are synthesized—once the texture has fully assembled. When the vocals begin singing the full four-bar melody as transcribed in Example 4.4, during the third and fourth measures of this looping music, the vocals and TUB BELLS play the same melody. This signals that TUB BELLS is moving from its novelty sound role and, remarkably, taking on the role of a melody sound. As I discussed in Chapter 3, TUB BELLS is not suitable in the context of mainstream 1980s popular music for a conventional melody sound because of its many marked timbral characteristics, especially inharmonic and spaced.

Just as the fluidity of VOICE 1’s textural function was reflective of the expectation-infinity trope, so too is the use of TUB BELLS as a melody sound. During the infinity section,
everyone in the supergroup joins in a communal, mantra-like chant (quite similar to “Hey Jude”), and even the TUB BELLS are welcome to join the jubilation. The Hegelian synthesis of the two opposed textural functions, melody and novelty, creates this timbral narrative. Under typical pop-rock circumstances, perhaps the sound of TUB BELLS as a melodic instrument would sound too busy and noisy, but it works in the context of a joyous infinity section.

“Girls”

Reversal of norms also creates meaning. In Chapter 3, I posited that blend is an ideal for melody and core sounds, that is, that they blend with one another. But in tracks where a non-normative sound is specifically desirable, blend may no longer be an ideal at all, in which case, any kind of timbre might be used as a core or novelty sound. Consider the use of the DX7 in the song “Girls” by the Beastie Boys, appearing on their album Licensed to Ill in 1986. The short riff given in Example 4.6 is played with the MARIMBA preset and looped throughout the track. According to my theory of timbre and textural function, because the MARIMBA preset has timbral attributes like hollow, inharmonic, and wavering, it would be most suitable to function as a novelty sound, as in “When I Think of You” (Example 4.7). But in “Girls,” this MARIMBA line is essentially a bass line, but registrally displaced. The only other instruments used in “Girls” are Adam Yauch’s vocals and a drumset—no other more typical bass instrument or chordal instrument exists in the track. Aside from the drum set, MARIMBA is the sole core instrument; thus, the timbral profile of the core sounds of “Girls” is quite unusual compared to the other tracks discussed in this chapter: it is primarily hollow, inharmonic, and wavering, rather than full, harmonic, and steady.
Example 4.6: Verse 2 of “Girls.”

Example 4.7: MARIMBA as heard in Example 4.6.

This instrumentation diverges from the norms of pop/rock music. The divergence itself is not unconventional in the context of the genre—after all, the rap genre was built on subversion of the typical sounds and structures of the dominant pop/rock sound. Rap and hip-hop and other such styles are, nevertheless, in dialogue with the mainstream pop/rock music that dominated popular music before the 1980s. Timbre thus can help shape our perceptions of a song and its relationship to other music. Using non-normative sounds as core
sounds results in a track that sounds unusual and marked in the context of popular music more broadly construed.

The timbral markedness of “Girls” corresponds with markedness within its other analytical domains. The principle of markedness assimilation, which Robert Hatten famously applies to Beethoven, notes how salience and expressivity can be generated by combining markedness in multiple domains; for example, phrases with irregular lengths often also combine with tonal instability in Beethoven’s music, thus heightening the salience of these phrases for the listener.7 Similarly, markedness assimilation occurs through several domains of “Girls.” Generically, within the context of the rap genre (already a marked genre within popular music) and even within the context of Licensed to Ill, “Girls” as a track is marked itself. Though Licensed to Ill is a rap album, “Girls” is not actually a “rapped” song—”Girls” is sung instead. The simple playfulness of the melody is also unusual for popular music; the melody reminds me of children’s songs, not other pop tunes. The resemblance of the MARIMBA preset to the timbre of Orff instruments invites the listener to relate the song to elementary school music class. Given the sexual but ultimately immature lyrical content, these suggestions of childhood in the instrumentation and timbre enhance the track’s brazen cheekiness. In short, the core sounds used in “Girls” are atypical, and the markedness assimilation—pairing these unusual timbres with an unusual song—creates an immediately perceptible distinctive sound for the track. If the novelty sounds are the sweeteners, then this track is like candy.

**Doctor Who**

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7 Hatten 1994, 37.
DX7 presets were not limited strictly to popular music; the presets also found a home in science fiction (“sci fi”) TV and movie soundtracks of the 1980s, such as the BBC series Doctor Who. The musical score of an episode from 1985 called “The Two Doctors,” composed by Peter Howell, is particularly saturated with DX7 presets, where they are used both as sound effects and also as incidental music. To briefly summarize details relevant to this analysis, the plot involves two incarnations of the series’ eponymous Time Lord, the Second and Sixth Doctors, and a human companion, Peri, who are sent to fight against the Sontarans, a race of aliens.

Sci fi soundtracks is a non-mainstream genre, like hip hop, and the core and melody sounds in “The Two Doctors” likewise are not normative. The markedness of the sounds chosen generate musical meaning that enhances the tone of the storyline. This episode uses COWBELL as a melodic sound. COWBELL is similar to MARIMBA: like many pitched percussion sounds, this is another sparse, hollow, inharmonic preset (Example 4.8). Thus, this preset is also quite unlike the other melody sounds, which were rich, full, and harmonic. The COWBELL preset is used in scenes set in Spain; since a cowbell is not a traditionally Spanish instrument, I argue this preset is not meant to sound authentic in any way, but instead simply to sound strange. While the scene is set in a Sevillan hacienda, both the prisoners and the guards are aliens. When Peri, the human companion, runs away from an enemy alien, the COWBELL accompanies her flight. Where the use of MARIMBA signifies playfulness and childhood in the context of the Beastie Boys, the use of COWBELL here seems to connote a more general sense of “otherness.” Increased markedness in many domains of this TV episode enhances the themes of alien worlds and wacky camp that characterizes much of Doctor Who’s appeal.
Example 4.8: COWBELL as used in “The Two Doctors.”

Conclusion

I established norms in Chapter 3 in order to open the opportunity for dialogic analysis, where meaning is created wherever norms are transgressed. In “Do They Know It’s Christmas?”, VOICE 1 and TUB BELLS both cross from one timbral-functional category to another, in alignment with the major formal division of this two-part form. Their movement across categories supports through timbre both the formal structure and the lyrical message: VOICE 1 created a sense of expectation by foreshadowing its future status as a melody sound in the expectation section; TUB BELLS, though not typically a suitable melody sound, switched from novelty to melody in the infinity section, as if happily joining in the communal mantra. In “Girls,” the MARIMBA preset is used as a core sound even while its timbral attributes make it more suitable for a novelty sound, which is somewhat similar to the use of
TUB BELLS in “Do They Know It’s Christmas?”. However, in the absence of a similar expectation-infinity narrative trope, the use of MARIMBA as a core sound throughout the track instead creates the ambience of childishness and irony. The use of MARIMBA in “Girls” is more similar to the use of COWBELL in Doctor Who, where the preset is used as a melodic instrument, portraying the “other” of the characters, who are literally aliens.

Much previous work has been devoted to studying the effects of pitch and rhythmic transformations on the narrative trajectory of a piece. My work demonstrates that, especially for 1980s popular music, analysts may create compelling narratives by studying these interactions between timbre, lyrics, instrumentation, genre, identity, and formal functions.
CHAPTER 5

“WHAT MAKES IT SOUND ’80s?”: THE YAMAHA DX7 ELECTRIC PIANO SOUND

Querying a search engine with the term “’80s sound” returns hundreds of forum posts from amateur producers and curious listeners, wondering, “What makes it sound ’80s?” Despite the proliferation of genres as diverse as punk, new wave, heavy metal, hip-hop, synth pop, and more, when the general public talks about “’80s music,” they seem to have something fairly homogeneous in mind. The ’80s sound is multifaceted, but one key unifying factor is the Yamaha DX7 and its factory preset sounds, which directly led to a homogenization of sound across many diverse ’80s genres.

Writing in 2003, the editors of Keyboard magazine make special note of one DX7 sound in particular: “Anyone remember ... the amazing expressiveness of the Rhodes patch that was subsequently so overused that today it makes us cringe?” What the Keyboard editors here call the “Rhodes patch” is more properly known as the electric piano preset on the DX7, E. PIANO 1. The E. PIANO 1 preset is a recurring motif in discussions about the DX7. E. PIANO 1, the sound of which somewhat resembled a Fender Rhodes electric piano, was one

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1 A few examples include “ELI5: What makes 80s music so recognizably “80s” and different from music from other decades?” from Reddit (https://www.reddit.com/r/explainlikeimfive/comments/3upahm/eli5_what_makes_80s_music_so_recognizably_80s_and/), “80s music - what makes it sound 80s?” on The Straight Dope message boards (http://boards.straightdope.com/sdmb/showthread.php?t=606381), and “What’s the theory behind the ’80s sound of a song?” on StackExchange (http://music.stackexchange.com/questions/11429/whats-the-theory-behind-the-80s-sound-of-a-song).

2 Keyboard 2003, 40.
of the most-used presets of the Yamaha DX7; the preset is a paragon of the ’80s sound. Essential timbral aspects of the ’80s sound are encapsulated within the timbre of E. PIANO 1—namely, brightness and clarity, two qualities that were considered particularly emblematic of digitally-synthesized sounds among musicians of the 1980s. Through this brightness and clarity, the timbral qualities of E. PIANO 1 sonically signify the new technology of digital synthesis, as opposed to older electric pianos like the Fender Rhodes. Dozens of signals combine to form what people refer to as the “’80s sound,” and E. PIANO 1 is only one of them, but the pervasiveness of E. PIANO 1 across so much of 1980s music makes this Yamaha DX7 preset particularly well-poised to function as a symbolic representative of the “sound” of popular music in the 1980s as a whole.

Digital Synthesis and the ’80s Sound

E. PIANO 1 was first distributed with DX7s in 1983, and in just two and half years, took over the musical landscape of Billboard’s three main genres, unifying the sound of all those genres. Many DX7 presets quickly became ubiquitous in the music industry, but none more so than E. PIANO 1. E. PIANO 1 was used in many iconic ’80s ballads beginning soon after the DX7’s release, such as “Careless Whisper” by George Michael, “What’s Love Got to Do with It?” by Tina Turner, and “Hard Habit to Break” by Chicago, all three of which were released in 1984.4 Listening to each of the #1 hit singles on the Billboard charts in 1986 reveals how E. PIANO 1 saturated the charts in this year in particular—and not just on the pop charts, but also on the R&B and country charts (Example 5.1). In 1986, E. PIANO 1 is present in 39% of the Billboard Hot 100 #1 hit singles; 40% of the country #1 singles, and a staggering 61% of the

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4 This track was released as George Michael’s in the UK, but in the USA and elsewhere, it was released as a Wham! single.
R&B hit singles. E. PIANO 1 had such staying power that even in late 1989, E. PIANO 1 is used throughout Michael Bolton’s “How Am I Supposed to Live Without You.” The song reached #1 on the Billboard Hot 100 in January of 1990 and #3 in the UK one month later, rather late in the life cycle of the DX7.

Example 5.1: #1 hit singles from the year 1986 on the Billboard a) pop (Hot 100), b) country, and c) R&B charts. Bolded tracks use the E. PIANO 1 preset.
E. PIANO 1 was considered a substitute for—and by some accounts “utterly phased out”—the actual Fender Rhodes.\(^5\) E. PIANO 1, while quite similar to the sound of a Fender Rhodes, is in no way a reproduction of it; telling the two instruments apart is not challenging. But a verbal characterization of the difference between these two sounds is more elusive. Jazz keyboardist Mitchel Forman said the DX7 “doesn’t have the same depth, warmth, or expressiveness” as the Rhodes, a sentiment which reflects that of many keyboardists and producers.\(^6\) But what does Forman mean by these words, particularly “warmth”? DX7 sounds are very often described with words like “bright” and “clear,” and musicians constantly compare the DX7 to older, analog synthesizers. For example, Mark Kelly, keyboardist for the neo-progressive group Marillion, says that “when it comes to warm string sounds, the DX7 just can’t get it.”\(^7\) Analog synthesizers are often described as having a superior sound to the DX7, simply because the analog synthesizers sound “warm.”

If brightness and clarity epitomize the digital sound, then warmth is the essential characteristic of the analog sound. Understanding precisely what this “warm analog sound” is lets the bright, digital, ’80s sound stand out in relief. Many who think analog synthesizers have a warmer sound argue the warmth comes from the sound’s generation with physical vibrations.\(^8\) Physicality is involved in the tone generation of an analog synthesizer: a vibrating column of air generates the sound, just as in an acoustic instrument like a trumpet, only

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\(^5\) Vail 2003, 46.
\(^6\) Quoted in Summers 1986, 20.
\(^7\) Doerschuk and Greenwald 1986, 19.
\(^8\) Examples of such sentiments can be found in Vail 2005 and in a post on Reddit titled “ELI5: Analog Synthesizer vs. Digital Synthesizer” (https://www.reddit.com/r/WeAreTheMusicMakers/comments/3o0103/el5_analog_synthesizer_vs_digital_synthesizer/, accessed February 2, 2016). The same argument is often made in regard to recording technology (Robjohns 2010). People who maintain a vinyl collection insist that the sound from this analog media is warmer and richer than the sound from digital CDs.
the vibrations happen in vacuum tubes instead of brass tubes. The sound created by an analog synthesizer inherently has imprecisions, flaws, and microfluctuations, peculiar to each synthesizer and its auxiliary equipment, and furthermore dependent on the environment. These variations generate a tiny amount of randomness in an analog synthesizer’s tone, which accounts for its perceived warmth. The DX7 was a departure from analog synthesis. Digital synthesizers generate sounds without involving any physical vibrations (prior to the amplification of the sound). A digital synthesizer is basically a computer: the signals are processed through computer chips. Keyboardist and music journalist Craig Anderton, writing in 2003, recalled that in the ’80s, the “bright, digital sound stood in stark contrast to their analog ancestors,” and that “the DX7’s clarity was a fine complement to the warmth of analog tape.”

Ambivalent opinions on clear digital sounds are everywhere. Ian Boddy, a keyboardist, also used the word “bright” in explicit connection to digital sound when describing the DX7: “That instrument gave the music a harder, more ‘digital’ feel and that, combined with the final mixdown to digital master, produced a harsh-sounding record. It’s not unpleasant to listen to, it just has a bright and hard quality.” Notice that Boddy even uses the word “harsh,” which has a clearly negative connotation, while simultaneously insisting this is not necessarily a bad thing.

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9 Examples of such sentiments can be found in Vail 2005 and in a post on Reddit titled “ELI5: Analog Synthesizer vs. Digital Synthesizer” (https://www.reddit.com/r/WeAreTheMusicMakers/comments/3o0103/eli5_analog_synthesizer_vs_digital_synthesizer/, accessed February 2, 2016).

10 Anderton 2003, 114. Anderton also supposes in this article that digital synthesis does not sound good on digital recordings such as .mp3s: “perhaps digital+digital was just too much.”

12 Quoted in Gilby 1986, 40. Boddy is not only a pop musician, but also an electronic music composer, which perhaps accounts for his fascination with all kinds of electronic sound, even “harsh” sounds that might not be broadly appealing.
Some people could find only limited uses for the digital sound. Keyboardist and songwriter Jim Eshleman said, “The DX7 I mostly use for bell-type sounds. It doesn’t really have as thick a sound as the analog oscillator.” Nick Rhodes, keyboardist of Duran Duran, said “[the DX7] has a number of very clear and very good digital sounds. But still, to me, it sounded a little boring. ... [The DX7] is quite a limiting synthesizer. You either like the sound of it or you don’t, and I didn’t particularly.” A BBC documentary series called *The Shape of Things that Hum* aired an episode dedicated to the DX7. The episode begins with producer and musician Stuart Price stating, “The DX7: the greatest instrument ever created by man,” then cuts immediately following to Barry Smith of the electronic group Add N to (X) saying, “It’s the worst synthesizer known to mankind. It’s a disgusting piece of shit.” The DX7 is utterly polarizing. Among the music makers quoted here, there is agreement that analog warmth is desirable and pleasurable to listen to; the clarity of the DX7, however, receives mixed reviews, wherein even the praise seems to enjoy sound qualities that would typically be viewed negatively (synthetic, harsh, etc.).

**Timbral Warmth as a Cultural Phenomenon**

The preference for analog or digital sound may in fact more to do with culture than with observable qualities of timbre, however. Musicologist Elizabeth Newton writes about analogies of warmth and analog in audio fidelity:

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13 Quoted in Doerschuk 1984, 14.
14 Quoted in Doerschuk “Idyls” 1986, 76. Rhodes is not a particularly technically skilled keyboardist, so he relied heavily on the arpeggiator function built into some early ’80s analog synthesizers (such as the Roland Jupiter 8), and on the sampling technology of keyboards like the Fairlight CMI. The DX7 has no arpeggiator or sampler, so perhaps this is actually what makes the DX7 “boring” to Rhodes, rather than its digital sound.
15 “The Yamaha DX7,” *The Shape of Things that Hum*, produced by Jacques Peretti, Channel 4, January 29, 2001. Both Price and Add N to (X) were active in the late 1990s rather than the 1980s; they belong to a younger generation of musicians. In the documentary Price is referred to as Jacques lu Cont, a pseudonym.
Chicago-based coffee roaster Intelligentsia offers an “Analog” espresso blend, comparing their coffee’s “true” taste to the “real” sound of the pre-digital. What enthusiasts love about analog technology—the weight of those buttons, the tug of that tape—would seem to have little to do with the berry notes of a breakfast roast, but the ideal of fidelity is flexible, applicable across the senses.\textsuperscript{16}

Newton evokes touch to explain the appeal of analog as well—the weight of buttons and tugging of tape. As Newton implies, this kind of marketing can be persuasive, even when, from a rational view, the appeal of analog has nothing to do with the actual product being marketed. The value of an analog experience is, at least today, enculturated as a default. The term “warm,” like most words we use to describe timbre, is an analogy—a \textit{tactile} analogy. Timbral warmth is thus inherently related to touch in some way. Consciously or unconsciously, timbres that music makers describe as “warm” may be timbres produced with a certain kind of touch; specifically, warmth, as a pleasurable sensation, may relate to instruments with physical sound production technologies, which feel more pleasurable under our hands to play than synthesizers or other electronic instruments.

The following passage, written by Roland Barthes, connects tactile warmth as a pleasurable sensation to that of natural materials. Barthes argues for the desirability of warm, natural materials, in opposition to inferior artificiality:

A sign which fills one with consternation is the gradual disappearance of wood, in spite of its being an ideal material because of its firmness and its softness, and the natural warmth of its touch. Wood removes, from all the forms which it supports, the wounding quality of angles which are too sharp, the chemical coldness of metal.\textsuperscript{17}

The implicit value of the “natural” is another component of the appeal of analog warmth.\textsuperscript{18}

Barthes explicitly creates an opposition between artifice and nature when he laments a shift

\begin{footnotes}
\item[16] Newton 2015. Newton argues that the appeal of hi-fi recording is mostly emotional rather than empirical.
\item[17] Barthes 1972, 54. In the context of the passage Barthes seems to be talking about plastic, although here he calls it “metal.”
\item[18] Analog synthesizers are not entirely natural, being synthesizers, but since sound is produced physically, it remains considerably \textit{closer} to nature than a digital synthesizer.
\end{footnotes}
in materials of children’s toys, from the wooden toys he prefers to plastic, which he derides as “graceless,” “at once gross and hygienic”: Painting in broad strokes, a preference exists in American culture for things that are more natural. Examples include cosmetics and skincare, marketed through an emphasis on their natural minerals and plant extracts; or the market for organic food, which has given rise to a host of resistances to “artificial ingredients”—non-GMO food, food without artificial colorings, and so on. This aversion to artifice is often predicated upon one key assumption: that the artificial is something that tries and fails to imitate the natural. A “modern” aesthetic in decorating and architecture involves many of the things Barthes laments in the “Toys” essay: metals and glass, sharp angles, chemical coldness. But just as with drum machines, it would be a mistake to assume that the goal of modern architecture and decorating was to imitate nature. Indeed, the creation of a new aesthetic often explicitly rejects the restrictions of the natural materials of older aesthetics. Whether one appreciates or detests wood, plastic, drum machines, the DX7, or the ’80s sound more broadly may have to do with one’s aesthetic allegiance to either artifice or nature, technology or fidelity. Songwriter Holly Knight said, “I like the fact that the DX7 piano sound is a little bit synthetic.” In short, when people explain why they love or hate the ’80s, they actually point to the same sonic and cultural factors. The polarizing forces that divide people’s aesthetic judgments of the ’80s are the basic elements that define the ’80s sound: artifice, digital synthesis, brightness, lack of warmth.

One might be tempted to unthinkingly agree with Barthes that wood is of course the superior material when compared to plastic or metal. Yet, to continue this specific train of

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19 Quoted in Doerschuk 1986a, 16.
thought as a metaphor, children actually seem to prefer plastic toys to wooden toys. The colors are brighter, the shapes more diverse, the textures more varied. In the same way, there exist many contexts in which one prefers artifice over nature. In his book on new wave music, Theo Cateforis describes the relationship between new wave and the modern:

...[New wave artists] claimed not to be modern, but “moderne,” a reference to the style moderne of the 1920s art deco movement. With its extravagant and sleek designs, art deco had wiped away the cold austerity of World War I, a dichotomy that in the [new wave artists’] eyes perfectly paralleled their own celebratory rejection of the uniformly gray fashion and doom-laden songs that had come to define a grim post-punk aesthetic.20

Plastic as a material epitomizes the modern, the futuristic, and the immense possibility therein. The Buggles, most famous for their 1979 hit “Video Killed the Radio Star,” titled their 1980 album *The Age of Plastic*, clearly referencing plastic as a material symbolic of the overarching modern—and specifically artificial—aesthetic (Example 5.2). Such a move is typical of new wave and synth pop artists, bearers of a modern style and agenda.


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20 Cateforis 2011, 48.
But how did audiences respond to this modern image projected by artists? In an essay “What’s Missing: The State of Pop in 1985,” pop music critic Simon Reynolds summarizes popular opinion and provides his own take: “The usual complaint is that [modern pop] is synthetic, fake. … The experiences [pop musicians] present are such a flattened-out approximation of real life, so drained of real life’s singularity, as to be less than real, like a statistician’s case study.” For Reynolds, synth pop’s aesthetic is detestable because it fails to imitate reality accurately—he does not seem to consider the possibility that this sense of artifice is precisely the intention behind the music to create an aesthetic of the modern.

Drum machines, an essential component of the ’80s sound like the DX7, suffered from a divided popular opinion. Drum machines, with their mechanically perfect timing and uniform timbres, sound robotic compared to acoustic drums played by a human (“drum machines have no soul” being their famous indictment). But sociologist Oliver Wang notes that those who hated drum machines for replacing human drummers were typically “missing the point”: “what most of these artists valued was not just a particular pattern but the specific sound of [the drum machine]. … [Musicians] saw it as an instrument for aiding a larger musical vision.” Musicians did not use drum machines to replicate the sound of human drummers, but rather to create this mechanistic, robotic sound, in service of the modern aesthetic of synthpop.

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21 Reynolds 2009. Reynolds refines the critique that the music is fake by insisting that artists “are baring their souls—it’s just that their souls are mediocre.”

22 Wang 2014, 223. Wang argues that as drum machines began to sound more authentic, they ironically became less relevant. Drum machines were not desired for their ability to replace a drummer so much as for their distinct sound.
This trend comes to a head in discussion around the DX7’s electric piano sound. E. PIANO 1 was considered a substitute for the Fender Rhodes. The Rhodes is not an analog synthesizer; it’s an electrically amplified instrument, like the electric guitar. Sound is produced when the player strikes a key, and a hammer strikes a metal tine, which makes a very soft bell-like sound that is then amplified and projected through speakers. I use Mitchel Forman’s assertion that “[the DX7] doesn’t have the same depth, warmth, or expressiveness [as the Rhodes]” as a touchstone for my argument that the 1980s sound was defined through this opposition between “warmth” and “clarity.” What exactly does Forman mean by warmth here? The Rhodes is probably not considered a “warm” sound in other contexts—it’s a metallic sound. How can we define “warmth” in the Rhodes sound, both in the spectrogram and elsewhere?

Warmth—or, more accurately, a lack of warmth—is one of the central components of an ’80s sound. With this in mind, I examine the timbre of E. PIANO 1 and the notion of timbral warmth, in order to demonstrate the relationship between the sound of the ’80s and timbre, reception history, aesthetics, and culture. To attempt a clear definition of what Forman might have meant by “warmth” in relation to the timbre of the DX7 E. PIANO 1 and the Fender Rhodes, I turn to spectrogram analysis using the methodology outlined in Chapter 1. Identifying the visible differences in the spectrograms between the DX7 and the Rhodes clarifies what Forman may have heard and described as “warmth.” Although I proceed from a technical analysis of spectrogram images, I will show that what listeners describe as “warmth” is sensed not only through the observable acoustic phenomena, but also through culturally-contingent metaphors and perception.
Analysis: E. PIANO 1

Examples 5.3 and 5.4 are spectrogram images for the sound of a Fender Rhodes Stage 88 Mark II and a Yamaha DX7 on the E. PIANO 1 preset, respectively; Example 5.5 is a representation in musical notation of what is played in both examples. Of the binaries given in Chapter 1, the most illuminating in this case are harmonic / inharmonic, hollow / full, and bright / dark: in each of these oppositions, the Rhodes and E. PIANO 1 differ, as summarized in Example 5.6.
Example 5.4: Fender Rhodes Stage 88 Mark 2 electric piano.

Example 5.5: Sound signal of 5.3 and 5.4 rendered in music notation.

<table>
<thead>
<tr>
<th>- / + OPPOSITION</th>
<th>E. PIANO 1</th>
<th>Rhodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectral components - sustain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bright / dark</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>pure / noisy</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>full / hollow</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>rich / sparse</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>beatless / beating</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>steady / wavering</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>harmonic / inharmonic</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Spectral components - attack</td>
<td></td>
<td></td>
</tr>
<tr>
<td>percussive / soft</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>bright / dark</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Pitch components</td>
<td></td>
<td></td>
</tr>
<tr>
<td>low / high</td>
<td>Ø</td>
<td>Ø</td>
</tr>
<tr>
<td>steady / wavering</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Example 5.6: Opposition table for E. PIANO 1 and Fender Rhodes.
Bright / dark, which measures the distance between the fundamental frequency and the highest sounding partial, distinguishes these spectrograms and their sounds from one another. The DX7 has 3.9 octaves between its fundamental F4 and its highest partial, approximately an E8. The Rhodes has only 3.09 octaves from F4 to its highest partial, approximately F♯7. The DX7 sound is more differentiated and more complex by having this wider range between its partials, while the Rhodes sound by contrast is more centered and unified. A wide range represents a bright sound, and a narrow range a dark sound. Darkness is often understood also to correlate to warmth—a darker sound is a warmer sound, and a brighter sound is a colder sound. The expanded range between the fundamental and the highest partial of E. PIANO 1 may be another timbral characteristic to which Forman is responding.

The DX7 has a large gap in its partials, omitting partials eight through 12, and finally sounding partials 13 and 15 (partial 14 is also omitted). This gives the sound a hollow timbre, like a clarinet. By contrast, the Fender Rhodes has a full timbre: each of the partials of the harmonic series is present in sequence.

The Rhodes has a different sort of deviation from the harmonic series, however. The Rhodes sound follows the harmonic series for its first six partials, but then it adds an inharmonic partial between each regular harmonic. This inharmonicity is a relic of the physical attack, which creates inharmonic nubs protruding out of the attack of each note. Inharmonicity creates a small amount of roughness and discord in the tone, which may be perceived as warmth, similar to the way microfluctuations in tuning generate the warmth in an analog synthesizer. The pickups on the Rhodes are prone to distorting attacks that are particularly forceful, further drawing attention to the physicality of the tone production. The Rhodes
also makes a sound when the tine is dampened at the end of the note, visible in the spectrogram as thick vertical lines at the end of the two short notes.

In an aural experiment to demonstrate what these two timbral features achieve, one may artificially create two new samples of the Rhodes and E. PIANO 1 which remove these distinguishing features by cutting out all spectral energy above approximately 3000 Hertz, as well as the energy occurring at inharmonic ratios (Example 5.7). Listening to these two samples side-by-side, one would still hear a difference between E. PIANO 1 and the Rhodes, but the difference is less readily perceptible.

However, there are other differences that the opposition table does not capture—namely, the more complex attack and release of the Rhodes compared to the DX7. Warmth is an inherently tactile analogy for describing timbre. I suspect that Forman’s sense of warmth corresponds just as much to the Rhodes’s touch as to any acoustic phenomena. Physical action—a hammer hitting a metal tine—produces sound in the Rhodes, so the act of playing a Rhodes will feel more connected to the resulting sound for the person playing the instrument. The action of the DX7, though quite good, cannot compare to an instrument with physical action. Forman is a keyboardist himself, so his perspective is one of the performer. The corporeal feedback of physical action vs. digital action undoubtedly corresponds to and influences his feelings about the lack of warmth in the DX7 timbre. This means that the Rhodes attack and release sounds therefore contribute to the sense of warmth in multiple dimensions. The physical technology of the Fender Rhodes directly contributes to a sensation of timbral warmth through touch, and furthermore, the physical sound generation with metal tines introduces inharmonicity and a unique release sound. In contrast, the wider timbral range and unmuddled sound of E. PIANO 1, created through clean, precise digital sound
production rather than physical action directly connected to the keyboardist’s hand, eliminates timbral qualities of warmth entirely.

Example 5.7: An edited spectrogram that removes distinguishing features from E. PIANO 1 (left) and Rhodes (right).

**Conclusion**

My close analysis and comparison of E. PIANO 1’s timbre versus that of the Fender Rhodes is a microcosm of a larger issue—how do we define the sound of the ’80s? Or even, how can it be that there exists an ’80s sound? Kevin Holm-Hudson uses the term *sonic historiography* to describe the process of tracing genre development and “the packaging of rock’s history of sound as sound” through intertextual references.²³ Because of the prevalence of DX7 presets such as E. PIANO 1, the DX7 and this preset in particular is rife with possibility for tracing the intertextual references that generate the unified notion of the ’80s sound. Through the constellation of statements I have collected from musicians, I have established that the

Yamaha DX7 is a 1980s cultural symbol, one that represents rapid advancements in computing technology and futurism, which shaped the way popular music was composed in the 1980s. The DX7 is particularly significant because it heralded a revolution in pricing of synthesizers, making this futuristic technology available to many more people. Other important technologies that impacted the ’80s sound include samplers and sequencers, especially drum machines and arpeggiators. Each of these technologies, in their own ways, lowered the bar of entry for enterprising musicians. Arpeggiators aided musicians who may not have been very technically proficient in composing complex, energetic, and compelling pop tunes. The drum machine and the sequencer together obviated the need for a human drummer, so complete tracks could be created with only one person. These developments in music technology democratized a wide sound palette for a large number of musicians. For example, hip hop culture thrived as the price of electronic instruments became less exclusive.

Digital technology more broadly also had an effect on harmony and form in 1980s music. Following a trend begun with disco, musicians used sequencers in the 1980s to craft loop-based chord progressions. These progressions were then often accompanied by loop-based drum beats programmed into a drum machine. Musical form likewise began to evolve alongside the programming-based writing: the rise in less typical, non-essential formal units, such as postchoruses and breakdowns, seems directly tied to the process of cutting and re-inserting lines programmed into a sequencer. Tied up in all of this is the simultaneous rise of hip-hop, and its huge influence on popular music. Hip hop artists were also drawn

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24 Cf. Cateforis (2014, 13): “[The synthesizer is] the musical instrument that came to represent above all new wave’s status as a modern genre.”

25 Wang (2014) raises the important point that drum machines were often desired for their unique sound rather than as a replacement for a human drummer—for example, he notes that Phil Collins, formerly the drummer for the virtuosic progressive rock group Genesis, used drum machines for his solo tracks.

26 See Rivers 2014.
to the new technology of the 1980s, especially drum machines, and used this technology in ingenious ways. The influence of hip hop is evident in the formal structures of '80s singles, particularly in the use of “breakdown” sections, in which various components of a groove are abruptly cut out and then gradually added back in. The use of a breakdown in songs by Janet Jackson may be unsurprising, but even Howard Jones uses a breakdown in “What Is Love?” (1983). From a loop-based construction perspective, a breakdown involves removing the thicker loops and leaving behind only some of the percussion and perhaps the bass line. This is similar to the processual and loop-based composition of accumulative sections such as the infinity section of “Do They Know It’s Christmas?” In turn, the function of harmonic content in popular songs changed in favor of non-teleological chord loops. This loop-based composition style has taken over the popular music of the present day completely.

Digital technology furthermore impacted instrumentation and timbre in 1980s popular music. Marked timbres, such as those in presets like MARIMBA, TUB BELLS, and CALIOPE were readily available to all musicians. As a result, novelty sounds became a much more common feature of popular tunes during the 1980s than they had been in the immediately preceding decades. The popularity of the DX7 presets led to a kind of homogenization of the '80s sound, as evidenced in the extreme prevalence of E. PIANO 1. Such homogeneity enables a listener to perceive a unified sound even across country, R&B, and pop songs.

E. PIANO 1 summarizes sonically the issues that contribute to the broader '80s sound. In terms of acoustics, E. PIANO 1 is distinct from older electric pianos like the Fender Rhodes.

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27 Spicer 2004 discusses this further: “Yet with the rise of synthesizers, sequencers, and (a little later) drum machines in the 1970s and early 1980s, pop-rock composers were able to control the layering process with ever-increasing precision...” (34).
(and other earlier electric pianos like the Wurlitzer and the Hohner Pianet) through the timbral characteristics of hollowness and a wider range of partials, both of which add a new, ’80s sheen to that sound, which might be described colloquially as “bright.” Brightness is a key factor in the perception of a “digital” sound, so brightness indexes trends in music production in the 1980s. The brightness of E. PIANO 1, and the DX7 more generally, sets both of these things apart from synthesizers and electric instruments of the ’60s and ’70s, whose defining timbral characteristic, by comparison, is warmth. The listening public may not today have explicit discussions about analog versus digital sound, yet a shared understanding exists among us that pop music of the ’80s has a sound that distinguishes the decade. Timbrally, the characteristics of brightness and clarity are the signature of a digital sound. I have shown that E. PIANO 1 demonstrates these characteristics strongly. E. PIANO 1’s timbral profile, combined with its pervasiveness, allows E. PIANO 1 to function as a shorthand for the ’80s sound as a whole.

Perhaps in a sense unlike any other decade in recent history, the 1980s have even become a genre of popular music. This understanding of the term “genre” is unabashedly presentist and retrospective, rather than an attempt to represent what musicians in the 1980s themselves may have thought about their musical milieu. Instead, when I say the ’80s have become a genre, I am speaking to the way the ’80s are discussed in the present day. In his 2016 book *Categorizing Music*, David Brackett proposes that a body of music is a genre as long as it can be “cited”—i.e., quoted, parodied, or referenced—out of context. One instantiation of Brackett’s principle are the popular “’80s covers” of contemporary pop songs by artists like Rihanna, Ariana Grande, and Justin Bieber, produced by YouTube user TRONICBOX.

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28 Brackett 2016, 12.
TRONICBOX takes current hit singles (that is, from 2015–7) and arranges them with new instrumentation to evoke an '80s feeling. The choice of timbres is a huge factor in creating these '80s-sounding covers: in the video “80s Remix: Love Yourself - Good Audio,” Justin Bieber’s vocals for his single “Love Yourself” (2015) are underlaid with a DX7-like slap bass sound, and, of course, E. PIANO 1. The purpose of E. PIANO 1 must be specifically to call forth the ’80s as an intertextual reference. That the ’80s has a particular quotable sound, in the same sense as there is a disco sound or a psychedelic rock sound, enables TRONICBOX to make these covers. This is exactly what Brackett means when he asserts that genres are quotable out of context. The ’80s sound, or the ’80s genre, is a constellation of shifting interrelations, between an aesthetic of artificiality, a culture rapidly adapting to swift advances in computing technology, and the technologies themselves, but perhaps the most immediately perceptible component of the ’80s sound is timbre—the brightness and clarity that the timbre of E. PIANO 1 epitomizes.

This history of the DX7 and its role in the ’80s sound is valuable in its own right, but I hope also to have demonstrated the kinds of questions that timbre analysis answers. In my analytical chapters, I have focused on theorizing instrumentation and the creation of a genre or “sound.” Timbre is a crucial and inextricable domain of analysis that must be addressed to answer such questions satisfactorily. Popular music, and especially popular music from the 1980s, is fertile ground for such investigations. Further, I have demonstrated the utility of a marriage between a technical approach grounded in spectrogram analysis and a

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29 They also visually accompany these songs with images of the artist photoshopped to have stereotypical ’80s hair and clothing. Finally, TRONICBOX adds a VHS effect to the photo: as the YouTube user watches the video, tape artifacts flicker across the screen and distort it.
freeform, ad hoc approach based on immersion in the culture and aesthetics of the repertoire. My hope is this theory will inspire other theorists to engage with timbre in other contexts and repertoires.
APPENDIX

Below is a table of the names of Yamaha DX7 preset sounds. These sounds were distributed on cartridges. A DX7 would come with two cartridges. ROM1 and ROM2 were distributed with Japanese and European DX7s, while ROM3 and ROM4 were distributed with American DX7s.

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