Facing the Music: Perspectives on Machine-Composed Music

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Leonardo Music Journal, Volume 9, 1999, pp. 79-87 (Article)

Published by The MIT Press

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ABSTRACT

The author describes some of the processes required in creating Experiments in Musical Intelligence, a computer program for the simulation of musical styles. He then outlines many of the problems listeners face when attempting to deal with successful output from such programs. These problems involve redefining terms, debating human- versus computer-creativity and, ultimately, grappling with the meaning of music. This discussion includes an example from the computer-composed opera *Mahler*. The author argues that such music should be considered integral to mainstream human-composed music since it results from a collaboration between humans and the machines they have created.

In 1996, Gary Kasparov and IBM's Deep Blue, a computer chess program, played their first chess match. The computer program, fixed with moves from thousands of games by previous masters for comparison, held its own for a few games but ultimately was confused by unique situations and fell victim to its human opponent. Kasparov writes:

> Even though it is a computer, it had its own psychology. For instance, it played complicated positions much better than simple ones. I tried to remove the image of a machine or some silicon monster sitting somewhere. It was a legitimate opponent, a very strong opponent, and before each game I tried to make an opening or strategy for the game based on my knowledge of this opponent, and I knew that I could learn much better because my opponent would need more time to learn and to come back with really sophisticated counter strategy [1].

The situation changed in 1997 when Deep Blue's developers increased its ability to deal with the unexpected and to invent new strategies. In 1996, the six-game match had gone 4–2 in favor of Kasparov. One year later, the computer program scored a 3.5 to 2.5 win over the human world champion.

While some heralded the news of Deep Blue's victory as a sign that machines had finally superseded humans in yet another domain, I viewed the news as a milestone in *human* achievement. After all, Deep Blue's hardware was created by humans, its software was developed by humans and, most importantly, all of the games on which Deep Blue based its strategies were originally played by humans. While some viewed Deep Blue's victory as machine over mind, I saw it simply as an extraordinary next step in human evolution.

A similar debate exists over machine-created art and music. This debate centers in part on whether or not machines can—or will ever be able to—express themselves in ways that humans can [2]. At issue here is the very nature of creativity and perception [3]. The following points and counterpoints, presented as a somewhat rhapsodic collage, are meant to help elucidate the part of this debate that my project, Experiments in Musical Intelligence, has played.

EXPERIMENTS IN MUSICAL INTELLIGENCE

I began Experiments in Musical Intelligence in 1981 as an attempt to create new music in my personal style. I soon realized, however, that I was too intimate with my own music to define its style in meaningful ways, or at least in ways that could be easily coded into a computer program. I opted therefore to create a program that composed music in the styles of composers whose works I had studied since my early youth—the classical composers of Western Europe. By 1991, Experiments in Musical Intelligence had produced works arguably in the styles of Scarlatti, Bach, Mozart, Beethoven, Schubert, Chopin, Brahms, Rachmaninoff and Stravinsky, among others.

Experiments in Musical Intelligence composes by first analyzing the music in its database and then using the rules it discovers there to create new instances of music in that style. The program also reuses commonalities found in the works in its database that I feel have stylistic importance. I call these commonalities "signatures" (Fig. 1). Further, Experiments in Musical Intelligence applies certain natural language processes and object orientation in its compositional processes, which allows for more extensive output both in terms of work length and stylistic diversity [4].

As illustrated by the sheer volume of articles and interviews about Experiments in Musical Intelligence that have appeared since 1987, the program continues to challenge many previously held assumptions about creativity, inspiration and how and why we listen to music. Such challenges, it seems to me, are healthy and reveal unfounded biases about the manner in which we approach the musical universe around us. When faced with stylistic sound-alikes created by a computer program, many individuals qualify their listening experience to the point where it bears little resemblance to listening at all. For them, this music represents more of a philosophical and even ethical challenge. I submit that much—if not all—of the resultant rhetoric represents a subterfuge, a camouflage engineered to avoid facing the music.

FACING THE MUSIC: REDEFINING TERMS

One of the ways in which listeners refuse to face the music created by the Experiments in Musical Intelligence program involves redefining terminology. This redefining often saves these listeners from having to risk actually evaluating what they hear. In effect, these experiences are disqualified from evaluation, since they do not conform to the listener's redefined terms.

Here is an example of such redefinition. During my attempts to have Experiments in Musical Intelligence's music recorded on compact disc, I encountered an interesting para-

David Cope (teacher), Music Department, University of California, Santa Cruz, CA 95064, U.S.A. E-mail: <howell@cats.ucsc.edu>.

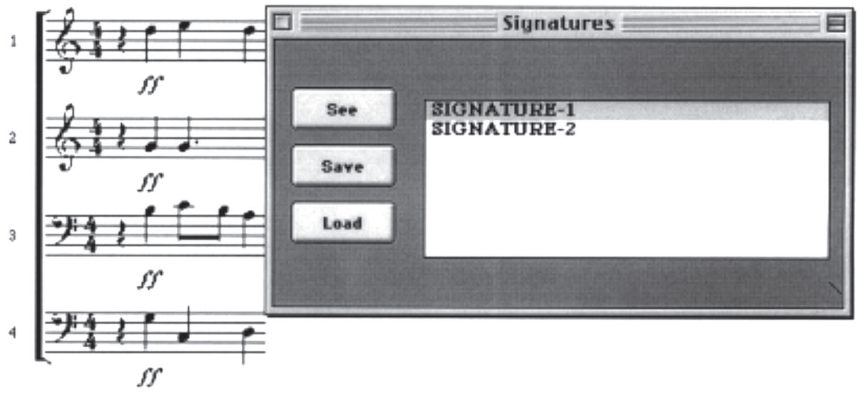

Fig. 1. The Experiments in Musical Intelligence signatures window and an example of a signature discovered in a Bach chorale.

dox. After many rejections, one company respondent insisted that my program's music, though created recently, was not contemporary music but rather classical music because of the classical styles it imitated. I took this comment seriously and attempted to convince classically oriented companies to record the works. I was then repeatedly told, however, that this music was not "classical" because of its date of composition.

I then approached a company specializing in computer music. Counting on this specialization as an edge, I sent the head of the group—a cooperative of professional composers—tapes and liner notes describing my program's compositional processes. I was aware that most computer music composers use computers as synthesizers—in essence, as musical instruments rather than as compositional tools. However, I also assumed that such composers could conceptually grasp the intrinsic aspects of computer composition. I was informed that the group had decided, after extensive discussion among the membership, that my program's music was in fact not computer music at all since the results did not *sound* like computer music. I responded angrily that if one had to narrow the two paradigms to one, surely the only *true* computer music was actual computer composition. They did not agree.

Many listeners and critics further redefine the criteria by which they judge Experiments in Musical Intelligence's output. Such criteria often include stylistic credibility rather than perceived quality. In other words, the music succeeds only if its style matches that of the chosen composer in its database at the time of composition, regardless of whether or not the music itself succeeds as good music. These individuals often listen for quotes or paraphrases that occur occasionally as signatures. Once such patterns occur, these listeners claim that the process produces pastiche rather than original work, even though composers for centuries have quoted themselves and others consciously and deliberately.

Some critics redefine their criteria for listening to Experiments in Musical Intelligence's output by comparing it to other computer creations they have encountered. Still others attempt to discern the compositional processes at work or listen for mistakes. Many other listeners do not know how to listen because they have no guideposts on which to base their experience—Experiments in Musical Intelligence has no life experiences about which listeners can read and relate to with some shared bond. Few listeners, however, attempt to appreciate the music simply for what it is—new music written in known musical styles. This is perhaps due to the fact that by the time they have redefined their terms, they no longer have any reason to listen to the output—their minds and ears have already closed.

FACING THE MUSIC: PERFORMANCE

One of the most flagrant examples of prejudgment of Experiments in Musical Intelligence music occurred in 1989, when a local reviewer "reviewed" a performance of the music two weeks *prior* to the concert. In reference to the announced inclusion of a computer-composed work in the style of C.P.E. Bach, the reviewer argued that too few people were aware of the music of the human version of C.P.E. Bach to be confused with digital imitations. The reviewer admitted to having not heard a single example of output from Experiments in Musical Intelligence, adding that he did not *ever* want to hear such output.

Stephen Smoliar [5] has argued that Experiments in Musical Intelligence's output has been successful *only* because of the performances by living human performers that it has received. In reference to a 1989 performance, Smoliar stated:

> Whether or not it was music when it came out of the computer, it was *certainly* music when it happened at the Santa Cruz Bach Festival . . . The quality of performance often overrides whether what is being performed has come from a struggling genius, a commercial hack, chance decisions, or even a computer program [6].

His thoughts mirror those of many critics. This was one reason I recorded Experiments in Musical Intelligence's first compact disc [7] on a MIDI-controlled Disklavier without any performer interpretation: to demonstrate precisely what the program had composed.

Jason Vantomme responded to this mechanical performance:

> It is quite unfortunate that the examples on *Bach by Design* were not played by live performers . . . it was difficult to judge the success of this work's "genuineness" because of the lack of human expression in the performance [8].

According to these two perspectives, the credit for a successful live performance of Experiments in Musical Intelligence music goes to the performers, while automatic performance results in automatic failure. Either way—from the viewpoint of these critics at least—the program's actual output could never succeed.

FACING THE MUSIC: ANTHROPOCENTRISM

"Ironically the computer program that sometimes produces music as sublime as Mozart's can't tell the difference between a work of genius and a piece of lift music" [9]. Distinguishing between even these two extremes, however, hardly results from the application of quantifiable standards. It seems to me that "telling the difference" is a highly subjective process, the vagaries of which pose as much irony as its absence.

Eleanor Selfridge-Field asks, in reference to Experiments in Musical Intelligence: "Is beauty necessarily linked to human agency? If so, must the agent be the creator, or may the agent be the perceiver? And what of meaning and human agency?" [10] How tragic if we ignored the beauty of a sunset or the grandeur of the stars in a night sky simply because they did not originate with humans.

Douglas Hofstadter, a reluctant champion of Experiments in Musical Intelligence music, remarks that

> the program has no model whatsoever of life experiences, has no sense of itself, has no sense of Chopin, has never heard a note of music, has not a trace in it of where I think music comes from. I'm comparing that with an entire human soul, one forged by the struggles and travails of life . . . and all the experiences that create emotion, turmoil, despair, resignation, everything you want to think of that goes into building a character [11].

While many assume that Experiments in Musical Intelligence's music undermines anthropocentric notions about creativity, the program's music actually *supports* them. For, as with Deep Blue, humans designed and built the computers on which the program runs; a human coded the program which produces the music; humans composed the music that the program uses as a database; and, possibly most importantly, humans listen and evaluate the output. Yet these facts seem lost amid our deep-set fears of being outclassed by machines.

Facing the Music: Signifying?

Many listeners distance themselves from the music of Experiments in Musical Intelligence by questioning the rationale and significance of its existence.

> It is clear that the musical examples that attempt to recreate a known historical style succeed. The question is: What does this signify? Any one piece of music can be "explained" by any number of music theories. Perhaps the main point here is that this music theorist has put his theory to the test, not just on one piece, not just one composer, and not just on one style, and has furthermore used it to compose original works [12].

As flattering as these remarks are, they nonetheless represent another form of distraction from the music itself. Listeners such as this would have us believe that Experiments in Musical Intelligence's significance, if it has any, lies in its ability to conduct tests on compositional and stylistic theory:

> Why have a computer attempt something that we can already do much better by ourselves? The answer is that in doing so we discover more about music as a system of the human intellect [13].

Jim Aiken's numerous critiques of Experiments in Musical Intelligence's music fall into the same category:

> My first rush of enthusiasm for Cope's achievement chilled rapidly into irritated dissatisfaction. What was on the tape was recognizably Mozartean, no question about it. Characteristic turns of phrase were assembled into recognizable harmonic structure, with transposed figures, appropriate bass lines, and cadences in the correct places. The trouble is, it was bad Mozart. Here's this brilliant music scholar and computer programmer, unquestionably a bright, dedicated, and perceptive person, and he has devoted ten years of his life to producing bad imitation Mozart. . . . The question is, is it even theoretically possible for a computer program, no matter how sophisticated, to produce good Mozart? I claim it's not [14].

This last statement strongly suggests that Aiken has joined those who have decided the future quality of the program's output before actually hearing it.

Facing the Music: Soul

John Cage remarks on his perception of the role listeners play in the musical experience:

> Most people think that when they hear a piece of music, they're not doing anything but that something is being done to them. Now this is not true, and we must arrange our music, we must arrange our art, we must arrange everything, I believe, so that people realize that they themselves are doing it, and not that something is being done to them. [15]

I am often told—in the guise of questions about Experiments in Musical Intelligence—about soul in music. But I look at the notes on the page and listen to the music the performers play from those notes and I am struck by a single, clear and resonant thought: the soul I hear, if indeed I hear one, is my own.

Douglas Hofstadter comments that he is very concerned about being "moved" by 20,000 lines of code. He says that this indicates that either (1) music as a whole is not very deep, (2) humans in general are not very deep or (3) computer programs are much deeper than we ever could imagine. Any one of these postulates discourages him.

> Does that mean, worries Hofstadter, that the composer's soul is irrelevant to the music? "If that's the case—and I'm not saying it is—then I've been fooled by music all my life. I've been sucked in by a vast illusion. And that would be a tragedy, because my entire life I've been moved by music. I've always felt I've been coming into contact with the absolute essence of humanity." [16]

I see this as a shamelessly romantic notion for which I share empathy but give little credibility.

Facing the Music: Meaning

I have no idea whether the emotions I hear in certain works exist by virtue of compositional intent; exist because I wish to hear them by means of all I know about the life of the composer and circumstances of composition; or do not exist at all. Certainly, music is an imprecise tool for communication. Not only do its elements have vague meanings, if they have empirical meanings at all, but our aesthetics blur what few meanings they may have.

Interestingly, there *does* exist a music with verifiable meanings. Jean François Sudre, an early nineteenth-century French music teacher, invented what he hoped would become a universal language [17]. He called this language "Solresol." This *langue musicale universelle*—universal musical language—is based on *solfège* syllables from which Sudre created words. The unique aspect of Sudre's language was that it could be played, whistled and sung as well as spoken, each line having an empirical meaning. Solresol became very popular by the middle of the nineteenth century, particularly in France, though the language's popularity had diminished significantly by the turn of this century. Even with all of its flexibility and potential for universality, Solresol ultimately held little interest even for those who had spent the innumerable years necessary to practice and understand it. Given the choice of having a music with prescribed meanings or a music with vague or approximate meanings, humans ultimately opted for the latter. Therefore, music may in fact be powerful *because* it is vague and *because* it means different things to different people.

Even the languages used today, with their more or less concrete meanings, can be vague, particularly in regard to intent. For example, it can be very difficult to ascertain the source of some kinds of expression, even when this expression occurs in a form we expect to provide us with such information. For instance, of the 10 sentences shown in Fig. 2, three are by Shakespeare and seven were created by a computer program I devised to write prose arguably in the style of Shakespeare *or* to compose music [18]. I present the sentences in random order. Those already familiar with the Shakespeare quotes should disqualify themselves from the test.

Of course, the lack of context impairs one's ability to easily factor out the com-

puter-created examples. Therefore, the test is not as simple as it might seem. Statements three, six and seven are, incidentally, by Shakespeare. The remaining sentences were output from my program, which uses relatively simple transition nets—techniques for replicating natural language. This program knows nothing whatsoever about the meanings of the words it uses. These two examples, Solresol and language generation, indicate an appreciable affinity between language and music. These examples also, hopefully, shed a bit more light on the issue of intrinsic meaning in music.

FACING THE MUSIC: WHY?

Audiences, interviewers and especially many composers question my rationale for creating Experiments in Musical Intelligence and pursuing my attempts to proliferate its output. I believe there are many good reasons for this pursuit. First, as my critics cited earlier on in this article point out, the program's analytical and compositional approaches continue to educate about both musical style structure and compositional processes. Pattern matching—one of the program's important processes for discovering style traits—has revealed a world of signatures, earmarks and other patterns that I and many others had previously called "clichés," if we in fact called them anything at all. Studying these patterns over time in a composer's oeuvre often reveals significant stylistic developments that hitherto have been observed tangentially but not explicitly.

Aside from Experiments in Musical Intelligence's educational potential, I believe the program has created some engaging music. Were the program human, this alone would validate its use. This music has merit beyond its origins. Of course, appreciating the music for its inherent beauty requires listeners to set aside any biases they may have about creativity being unique to human endeavor. Good music requires no further justification, regardless of its creator.

Beyond Experiments in Musical Intelligence's educational and aesthetic values, the program has worth as a model for creating applications that feature less autonomous behavior. For example, I invented the program CUE (Composer's Underscoring Environment) [19] based on Experiments in Musical Intelligence's processes. CUE works *with* rather than *for* composers as a kind of compositional sidekick. In effect, composers use the program as they would any standard notation application. However, when a composer's block occurs or whenever curiosity beckons, users can ask CUE for any amount of music—a note, measure, phrase, section or even a movement. CUE then creates the requested music in the user's compositional style (as extant in a previously loaded database) by using the materials of the work-in-progress. I believe that during the next millennium, composers will actively use programs like CUE when composing and that programs like Experiments in Musical Intelligence and CUE will become commonplace rather than the exceptions they are today.

We will continue to use computers as tools for writing, finance, communication, data organization and so on—these tasks remain indispensable. In music, computers will likewise continue to play a significant role both as instruments capable of generating powerful, complex sounds and as notating tools for creating printed scores. However, computer programs can take active as well as passive roles, create as well as compute, challenge as well as just participate in our future. Computer programs such as Experiments in Musical Intelligence can play a significant role in our future world in which much of what we now take for granted as idiocentrically human will be compucentric. Such transference will free humans to seek yet deeper and more significant goals.

Fig. 2. Ten lines of poetry: seven created by a computer program and three created by Shakespeare.

1) When icicles hiss in the bowl,
Bells do mightily toll.

2) If love were young
No means can move thy tongue.

3) Where the bee sucks, there suck I,
In a cowslip's bell I lie.

4) Come our lovely fairy queen,
Never harm and never seen.

5) Bloody waste of shame,
A shallow'd bait of blame.

6) Take, O take those lips away,
That so sweetly were forsworn.

7) If it do come to pass
That any man turn ass.

8) Dull earth with heaven's breath,
Let garlands bring sickly death.

9) Hark, hark! These yellow sands,
The burthen bear in heathen hands.

10) Freeze the holly, love the spring,
Life is jolly, where is thy sting.

FACING THE MUSIC: *MAHLER*

I now pose a challenge directly to you, the reader, by presenting a brief example of Experiments in Musical Intelligence output. The challenge—that of actually facing the music—results from trying to hear the music while being seduced into ignoring it for the epistemology it may represent.

Mahler [20] is a large opera with music composed by Experiments in Musical Intelligence and a libretto created from the letters of Gustav Mahler; his wife, Alma; author Thomas Mann; and composers Anton Bruckner, Arnold Schoenberg, Richard Strauss and Anton von Webern, among others. *Mahler* is the second opera (*Mozart* was the first, *Scriabin* the third) in a series of operas composed on librettos based on the writings of well-known composers. I chose the subjects for these operas based both on my love of the composers' music and on the extraordinary natures of their lives.

Mahler follows the composer's life from his childhood—following "military bands" around—to his death, as chronicled by his wife, Alma. Mahler spent much of his adult life conducting operas, though he never composed one himself. The music, in the style of Mahler, is scored for large symphony orchestra, mixed chorus, children's chorus and soloists.

A few passages found in *Mahler* resemble those found in certain of the composer's works. For example, the opening of the opera is reminiscent of the first movement of Mahler's Fifth Symphony, while the opening of Act Three resembles the third movement of his First Symphony. Comparisons with the original passages, however, prove the Experiments in Musical Intelligence passages to be vague references rather than close paraphrases. I usually reject such imitative output but do not mind it here, simply because Mahler himself seemed so fond of self-referencing.

Appendix A presents an aria sung by the role of Alma from Act One of *Mahler*

in piano reduction. The beginning voice part resembles the accompaniment of Mahler's song "Frülingsmorgen." However, the aria continues in a very different way. A careful comparison of the harmonies of both the Experiments in Musical Intelligence piece and "Frülingsmorgen" would reveal the originality of the computer-composed music and how the program extends and varies the piece's harmonic progressions while maintaining its stylistic integrity.

The second theme of the Experiments in Musical Intelligence aria has many elements in common with Mahler's song "Hans und Grethe," though what are fragments in Mahler's original spin out as full melodies in the computer-generated music. Aside from these similarities, the music of this aria is generally original and conforms to Mahler's style quite effectively.

Setting texts to Experiments in Musical Intelligence's music poses interesting challenges. First, most composers set music to text rather than vice versa due to the requirement that musical meter should, for the most part, match poetic meter. Because my program does not set texts, this process must be reversed. However, via the advantage of using translatable texts from the German, I make several different translations to English and choose the one which best meets the criteria for effective song settings.

What a shame if those with an opportunity to view, hear or perform *Mahler* were to rationalize their way out of any direct experience with this music, for singing and playing the aria should convince readers of its effectiveness regardless of its stylistic conformity. Since most of Mahler's songs are not orchestrated (at least not the versions of them I used in the database), the program's orchestration—based on models from other of Mahler's works (mostly his symphonies)—adds to the uniqueness of this new work.

My composing colleagues often ask me whether or not I miss composing or wonder what I might have composed had I not been coding Experiments in Musical Intelligence for the past 18 years. I respond that I *have* been composing these 18 years and refer them to the more than 6,000 works that would not have existed without Experiments in Musical Intelligence. Their question, of course, begs the deeper question of authorship. Certainly the composers on whose music these imitations were based did not create them. Experiments in Musical Intelligence itself does not compose music without human provocation and, ultimately, follows the dictates of the programmer. Therefore, if only by process of elimination, I am the composer of Experiments in Musical Intelligence's works.

FACING THE MUSIC

In a fairy tale by Hans Christian Andersen called "The Nightingale," a Chinese emperor and his peasants become charmed by the songs of a nightingale. Then, a mechanical nightingale appears that outsings the real bird and gains the favor of the emperor. The real nightingale is banished from the kingdom. Time passes. The emperor lies dying and only the sound of the nightingale can save him. However, the mechanical bird has broken down and no one knows how to repair it. The real nightingale is summoned and happily saves the emperor with its song.

This simple tale lures us into what Anderson sees as a false and alien world of technology. Anderson's tale, however, does not address the issue of how difficult it would have been to revive the living bird had it died or why no one knew how to fix the artificial bird. The tale simply ends with the notion that while technology can be appealing, it will ultimately fail us. This view—that technology represents another world, alien to truth and true beauty—represents a basic trope for the technophobe. This leads us to the idea that

> the alternatives are either a frightened rejection of the Frankensteins we have created or a blind belief in their "superhuman virtues" and a touching faith that they can solve all our human problems [21].

Neither, of course, need be, or actually is, true. Jacob Bronowski writes that

> we are now coming to realize that humans and the machines they create are continuous and that the same conceptual schemes that help explain the workings of the brain also explain the workings of a "thinking machine." Human pride and its attendant refusal or hesitation to acknowledge this continuity form a substratum upon which much of the distrust of technology and an industrialized society has been reared. Ultimately this distrust . . . rests on the refusal by humans to understand and accept their nature—as beings continuous with the tools and machines they construct [22].

We should not condemn computers for what we perceive they can or cannot do, but appreciate what we and our computers can do *together*. Viewed in this way, listeners to Experiments in Musical Intelligence's music should no longer have need to intellectually camouflage their ears but revel in facing the music.

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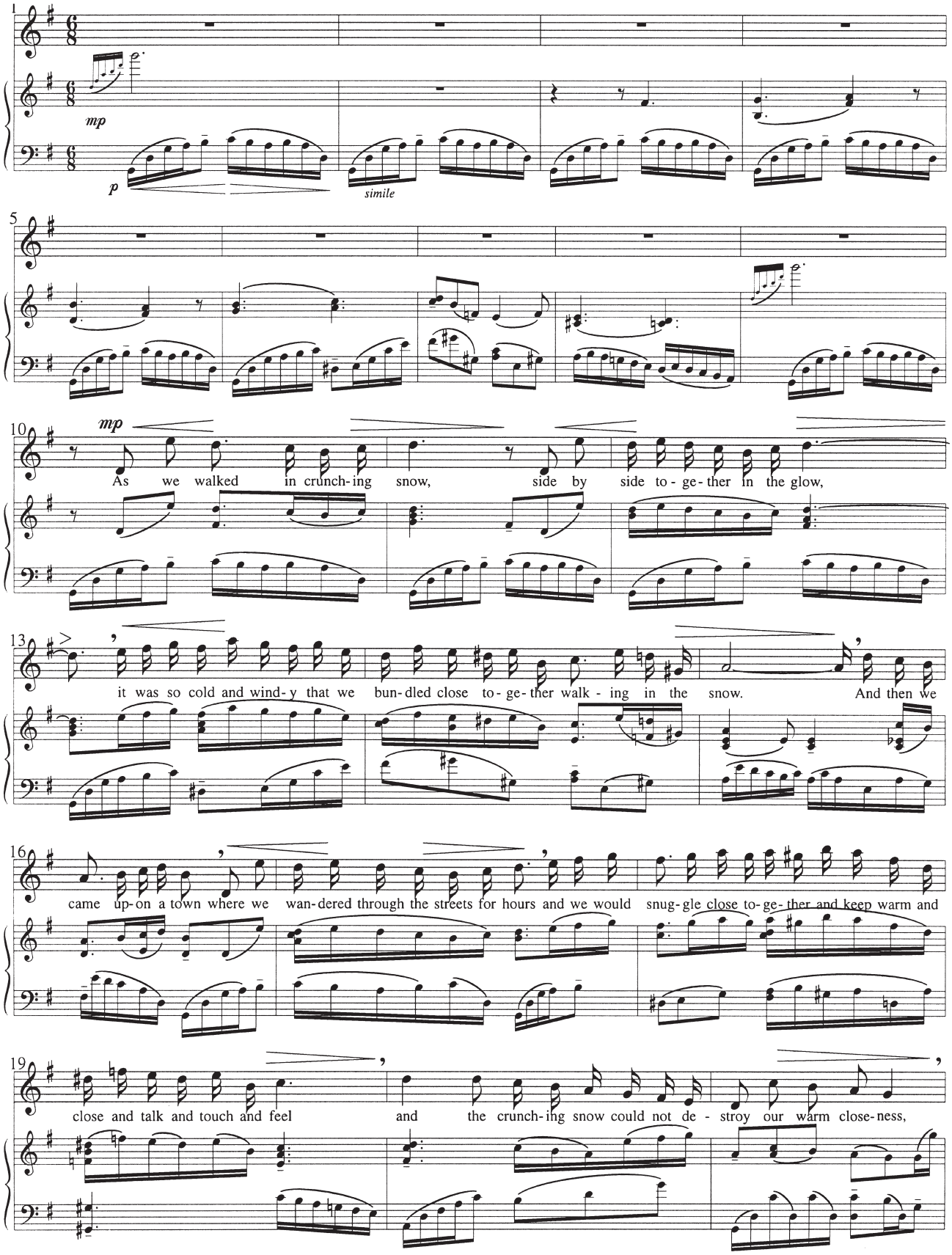
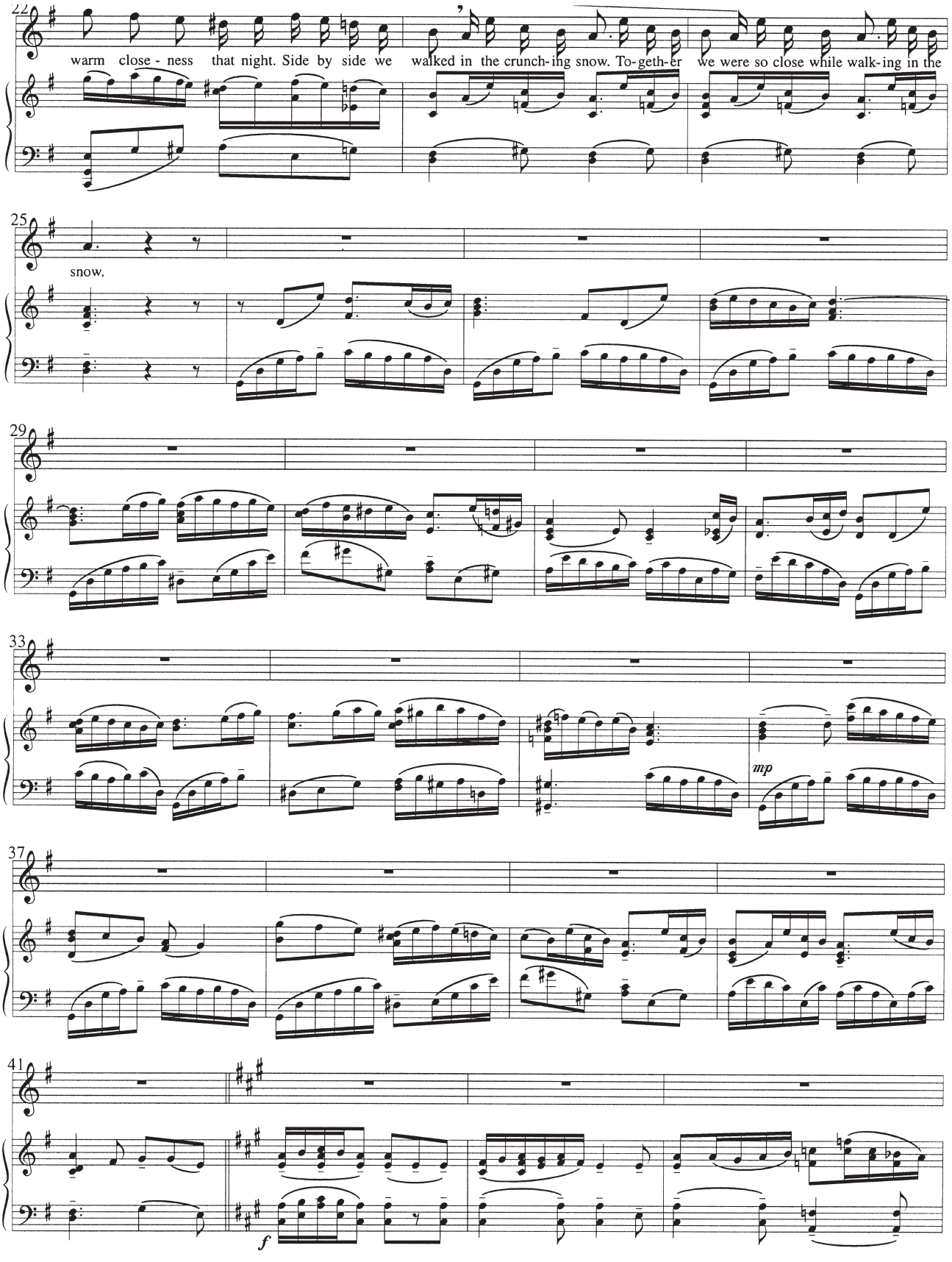
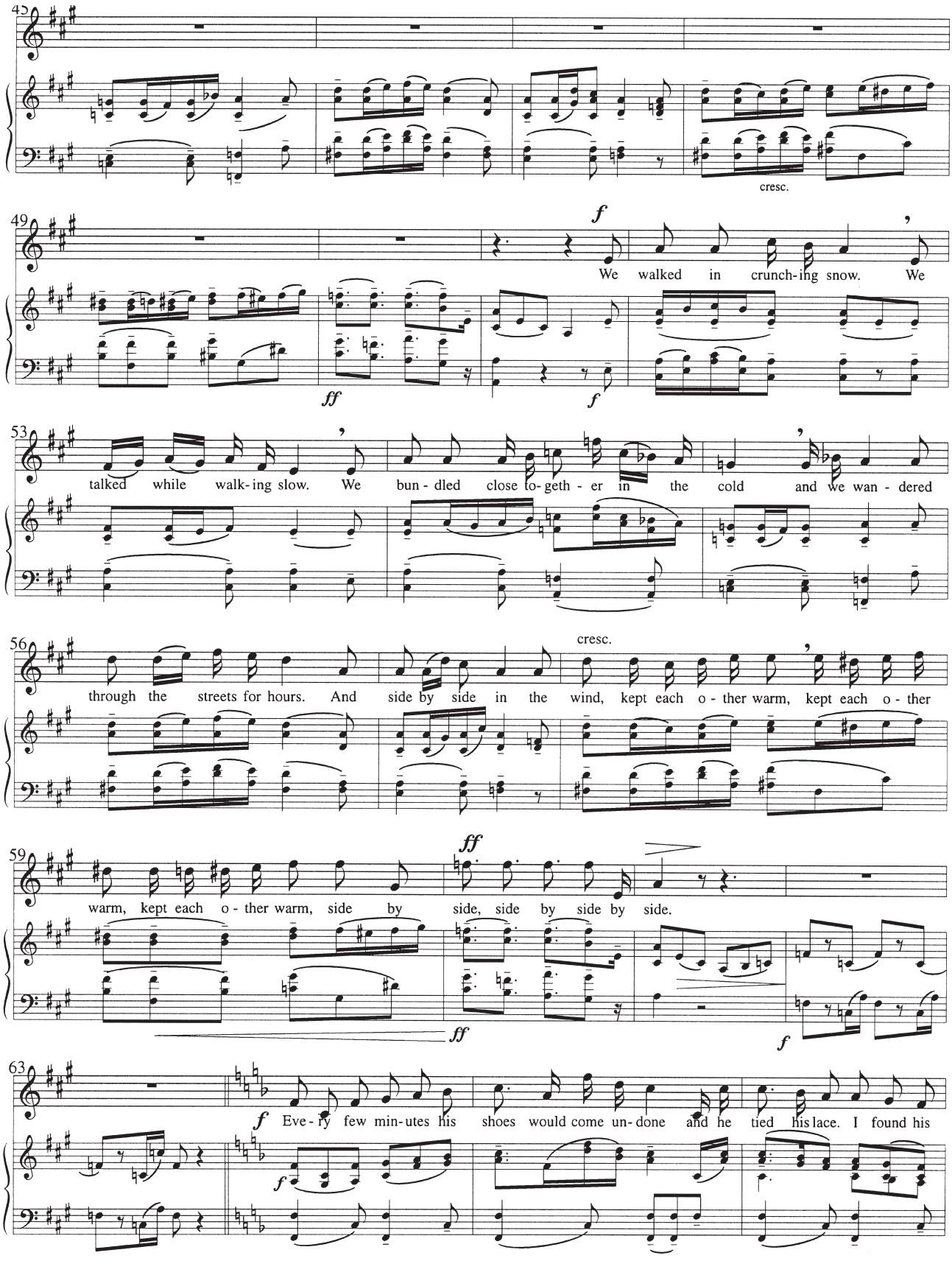
Manuscript received 4 January 1999.

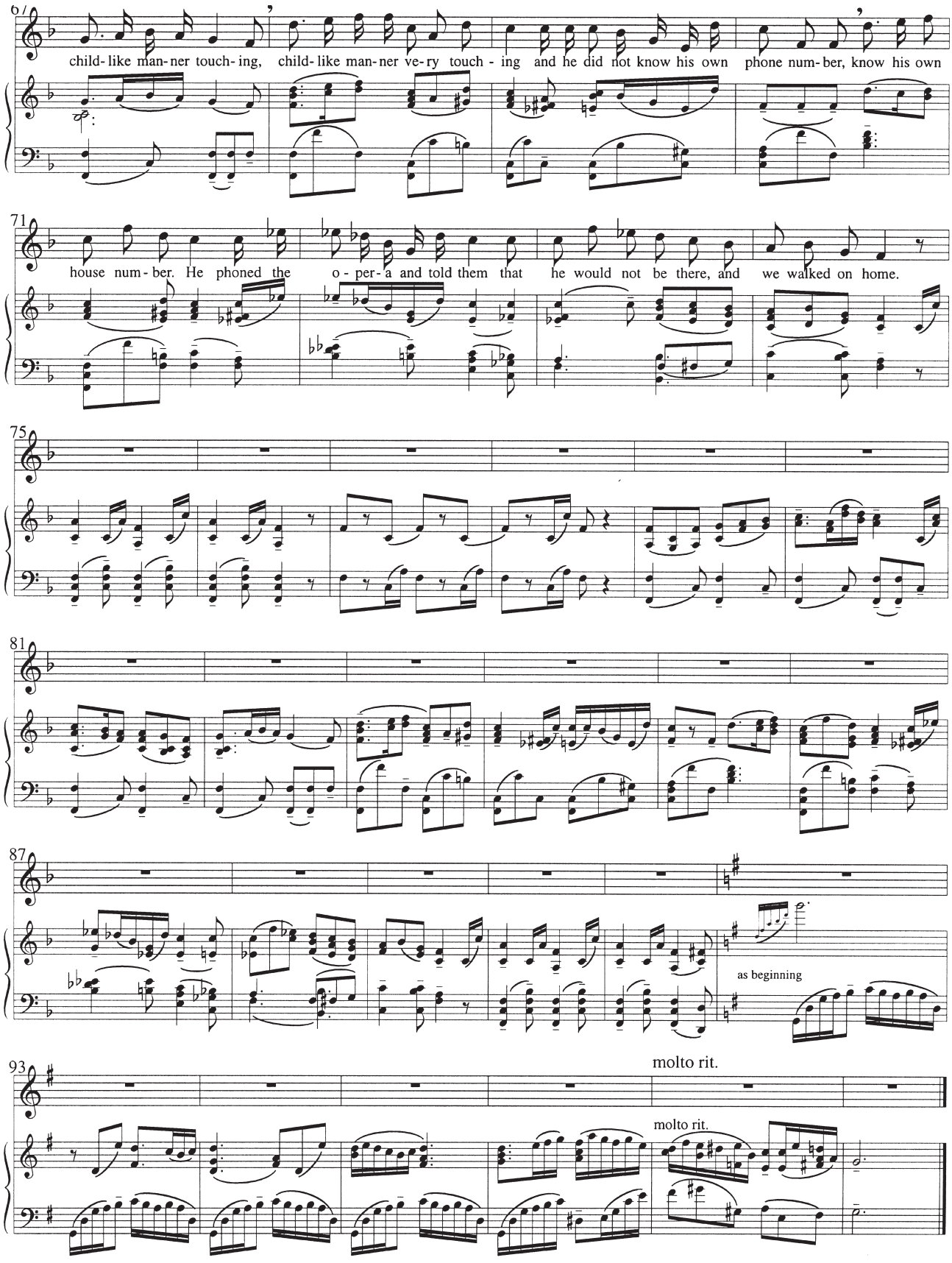
APPENDIX A

The score for an aria sung by the role of Alma Mahler from Act One of the computer-composed opera *Mahler.*




22
warm close - ness that night. Side by side we walked in the crunch-ing snow. To-geth-er we were so close while walk-ing in the
25
snow.
29
33
mp
37
41
f


45
cresc.
49
f
We walked in crunch-ing snow. We
ff
f
53
talked while walk-ing slow. We bun-dled close to-geth-er in the cold and we wan-dered
56
cresc.
through the streets for hours. And side by side in the wind, kept each o-ther warm, kept each o-ther
59
ff
warm, kept each o-ther warm, side by side, side by side by side.
ff
f
63
f
Eve-ry few min-utes his shoes would come un-done and he tied his lace. I found his
f


67
child- like man- ner touch- ing, child- like man- ner ve- ry touch - ing and he did not know his own phone num- ber, know his own
71
house num- ber. He phoned the o - per- a and told them that he would not be there, and we walked on home.
75
81
87
as beginning
93
molto rit.
molto rit.

4