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Problem-Solving Strategies in Music Composition: A Case Study

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The composition of a piece of contemporary music for solo piano, 16-piece chamber orchestra, and 6-channel, computer-processed sound was tracked and documented from its initial conception to its concert premier. Notebooks, sketches, diagrams, recorded interviews, and the final score were used to address the solving of three compositional problems raised within the context of the piece. The first problem concerned the need to compose the five themes for the piece (23–100 s in duration) for both solo piano and chamber orchestra. Issues of performance constraints associated with the two media and on translation from a restricted to a more open timbral palette played an important role. The second problem involved composing the two major parts of the piece with similar temporal structures but vastly different ways of traversing the same thematic musical materials. Spatial, graphical representations and self-imposed graphic organization of the score were important factors in resolving this issue. The third problem involved conceiving of the computer component to accompany either of the two major parts, because the piece could be played with them in either order. The solution involved organizing the computer component into discrete parts that had fairly continuous textures and finalizing this component before the final composing of the instrumental components. Issues concerning the aspects of compositional problem-solving that are available for study, the types of representations used in problem solving, and the generalizability of such results to other pieces by the same composer or other composers are discussed.

EXCEEDINGLY little work in music psychology has examined the creative process in music, particularly as concerns written composition. The problem is to delve into the mind of a composer in the process of composing. This goal relies of course on being able to glean what is going on in the

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composer's mind on the basis of explicitly external manifestations (talking, writing, drawing, sketching). Given that such manifestations are clearly an imperfect reflection of all that happens as a composer goes about his or her creative activity, we might nonetheless ask what they can tell us about the representations used and the problem-solving processes that operate in the creation of music.

One of the few attempts at delving into such processes was presented by Sloboda (1985), who delineated three approaches to gaining psychological insight into written music composition: examination of written manuscripts (sketches and notebooks), examination of what composers say about their compositional process, and observation during a session of composition. Time and geographical constraints, as well as an unwillingness to potentially perturb the creative process, led to a use of the first two approaches in the present study. Most of the emphasis in this article will be placed on what the composer said about what he was doing, although reference to diagrams, notebooks, and sketches will also be made.

The current study[1] took on the task of tracking the composition of a specific piece of music, *The Angel of Death* for piano solo, 16-piece chamber orchestra, and computer-processed sound (Reynolds, 2001), as it was composed during a 4-year period, from the initial formal conceptions in late 1997 to its Parisian premier performance in June 2001 and its Californian premier in April 2002. The composer, Roger Reynolds, is a world-renowned creator of contemporary music who teaches music composition at the University of California at San Diego. His work has been commissioned and played in North America, Europe, and Asia and has been recognized with a Pulitzer Prize. His methodical way of approaching the task of composing has been thoroughly documented (Reynolds, 2002b), and it seemed that an initial approach to following the compositional process would benefit from someone who is verbally articulate and who systematically archives his sketches, musical developments, and musings. Further, a relationship of mutual trust has evolved over a period of over 15 years between myself and the composer, which allowed a certain delving into the depths of his compositional thought that might not otherwise have been possible.

1. To situate the context, the tracking of the composition of the piece was part of a larger project with a team of cognitive psychologists and music analysts. This project will be the subject of a future special issue of *Music Perception* and of an electronic book on CD-ROM to be produced by IRCAM in 2004. The aims of the larger project included testing people's perception of the thematic materials of the piece in terms of relations of musical similarity, as well as their ability to recognize thematic materials under various kinds of compositional and electroacoustic transformations. It culminated in *in situ* experiments conducted at the world premier concert in Paris and the North American premiere in La Jolla, CA, during which listeners evaluated in real time their reactions to structural or emotional aspects of the piece.

It should be recognized at the outset that the creative process is differently instantiated in different people. Any case study of the creative process will have a certain specificity to it, particularly as concerns contemporary music composition in which there is little conventional agreement about musical syntax and form. The attempt here will thus be to glean certain specifics related to the individual composer and the particular piece being composed, with an eye to which aspects may eventually be generalized through further study of other composers.

The Piece

Roger Reynolds' compositional process evolved over many years to entail extensive planning of every aspect of a musical work. He links this approach to the fact that his father was an architect, and also that he completed a degree in engineering physics before embarking on advanced musical training. He considers all aspects of the use of imagination, sketching, drawing, description, and association to be as much a part of "composition" per se as is the commitment to noting down actual successions of pitches, rhythms, and instruments in the final score. The method of working with diagrammatic formal design (laying out an entire work's structure in detail before actually beginning to determine its moment-to-moment details) is a hallmark of Reynolds' compositional method. He first conceived a plan of *The Angel of Death* in two main parts, traversing the same musical materials from strongly contrasted perspectives (Reynolds, 2002a). These two parts in their final form are shown schematically in Figure 1, similarly to the way he had originally designed them. The basic musical material is concentrated in five thematic elements (ranging from 23.5 s to 99.5 s in duration) that are distributed over a 17-minute duration. The themes are joined by formal elements called Transitions (related to traditional bridge and transitional passages) and Combinations (comparable to traditional developmental passages). The two parts each cover the same structural chronology (in outline, Theme 1 ' Theme 5), but from markedly differing perspectives: one with clearly demarcated sections ("S"), the other evolving organically ("D" for domain). The solo pianist and chamber orchestra each present some of the materials in a given part, so that the design has a layered aspect. As can be seen in Figure 1, however, their assignments reverse from one part to the other (e.g., Theme 1 appears in the piano in S and in the orchestra in D).

The thematic elements are characterized by evocative titles, the naming having arisen in response to a request by a psychologist colleague to characterize the themes verbally (Theme 1*: Equilibrium in Extremis*, Theme 2: *Contradictory Assertion*, Theme 3: *Tremulous Uncertainty*, Theme 4: *Jagged*

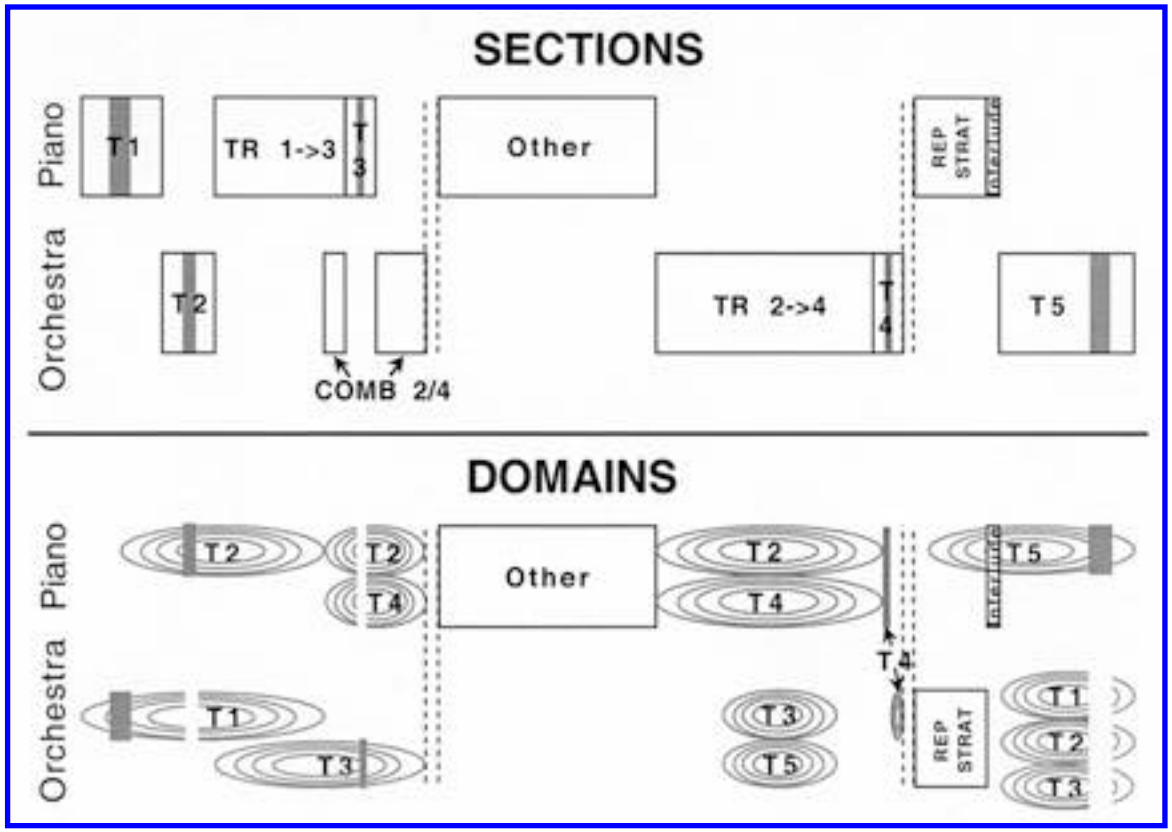

Fig. 1. Schematic representation of the temporal organization of piano and ensemble strata for the two parts of *The Angel of Death*. There is a strong correspondence in temporal structure between the two parts (although COMB3/5 and COMB1/2/3 regions in the piano stratum of the Sectional part, present in the original plan, were abandoned in the final composition), but the material in one instrumental stratum in one part appears in the other stratum in the other part. Squares indicate clearly delimited sections. Ovals indicate a more diffuse expanse of time within which materials derived from the thematic sections are deployed. The gray rectangles correspond to the "core elements" of each thematic material. T1 = Theme 1, TR1'3 = region of transition from a predominance of Theme 1 materials to a predominance of Theme 3 materials. COMB2/4 = region in which materials from Themes 2 and 4 are combined. Other = a special, nonthematic region for piano solo. RepStrat = region of repetitive, stratified rhythmic patterns, unrelated to the thematic materials but drawn from the same pitch resources. Interlude = a brief, quiet piano interlude that is a kind of premonition of the piano Epilog at the end of the piece (see Figure 2).

Rips, and Theme 5: *Interior Line*). Each has a number of subsections, and these are planned in advance in rather detailed fashion. Their inner proportions, pitch resources, textural character, formal shaping, rhythmic vocabulary, and instrumentation are all established in categorical ways. Thus, once actual musical sketching begins, there can be a free play of intuition within the boundary conditions, the local conventionality, that has already been established. It is crucial that these thematic elements be strongly and distinctly characterized if the structure of the work is to be heard. Each theme has a central subsection considered as the core element (gray boxes in Figure 1), which occurs at the same moment in both parts and in nearly identical form with only a change in instrumentation. It must also be mentioned that there are two "jokers" of sorts that appear in very similar form in the two parts. One is a very extended section, centrally located, and identified as "Other." This passage is a concatenation of cyclical ostinati that are purposely out of phase, so that the overall impression is one of constant change, but without direction: always the same, always different, never "going anywhere." It is a unique event and participates not at all in the remainder of the work. The other one is a series of more directional, rhythmic ostinati organized in repetitive strata (labeled "RepStrat" in Figure 1). A piano interlude, rhetorically similar to the core element of Theme 5, occurs just before this theme in both parts and serves as a kind of premonition of the Epilog, also played by the piano (Figure 2).

There is a computer-processed component made up of 10 larger "images" (on average considerably longer than the themes, ranging from 51 s to 161 s). These comprise various transformations by way of digital signal processing techniques including time extension and compression, transposition, editorial algorithms, and filtering. The computer materials are also spatialized over a six-channel diffusion system. Some images, such as the initial one, which links the first instrumental part to the second, are wholly derived from a single theme. Others draw on several. But all five themes, previously recorded in both 16-instrument ensemble and solo piano versions, are used at some point in the computer layer. They are presented in transformations qualitatively and procedurally different from those that occur in the purely instrumental portions of the work.

The two parts may be performed in either order (S-D, or D-S). However, just before the close of the first one played, computer sound enters (Figure 2), linking the two instrumental parts, modulating and commenting upon the second instrumental part, then summing up in a solo coda-like section that commences after the second part ends. As the computer coda concludes, the solo pianist has a brief Epilog. The result, in the mind of the composer, is a complex, but modularly assembled structure that can be disassembled and examined in a variety of ways.

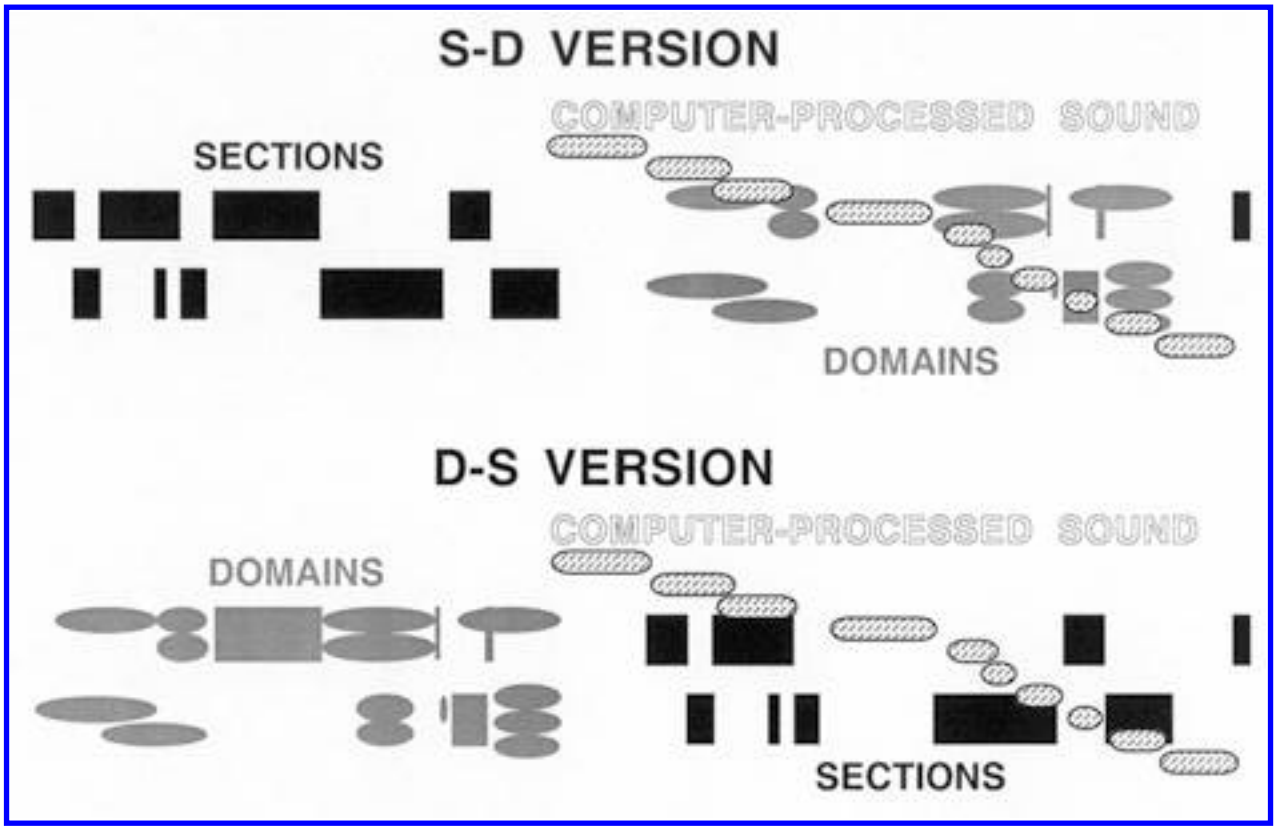

Fig. 2. Schematic representation of the global structure of the two versions of *The Angel of Death*. The computer part always begins near the end of the first part, whether it is S or D and develops into a computer solo bridging the two parts. A final recapitulation played by the computer part followed by a piano *Epilog* always occurs at the end. The *Other* section is performed live by the piano in the first part, whether it be S or D, and is played by its computer-processed counterpart in the second part. See Figure 1 for details concerning the different regions.

For the analysis that will follow, it is crucial to understand the order in which things occurred during the compositional process. First, the formal plan (similar to the diagrams in Figures 1 and 2) was designed and refined in late 1997 and early 1998. Then the initial textural and verbal characterization of the thematic materials, independently of instrumentation, was made in mid-1998. The orchestral versions of the thematic materials were composed in late 1998 and early 1999 and they were recorded in March 1999. The piano versions were subsequently finalized in the latter part of 1999 and were recorded in May 2000. The computer part was realized in several stages during several visits to the Institut de Recherche et Coordination Acoustique/Musique (IRCAM) in Paris in September 2000, December 2000, and March 2001. The Sectional part of the instrumental score was starting to be sketched out in late 2000 and was finalized shortly after the March 2001 trip to Paris. The Domain part of the score was written in the Spring of 2001, and the piece was premiered in June of that year in Paris.

Problems to Be Solved

Several compositional problems must be solved given the formal structure of the piece as just described. Three of them have been selected that address issues from the level of musical themes, to that of large-scale form, to how form and content mutually determine each other.

The first problem is that the same thematic materials need to be composed for two different instrumentations (piano, chamber orchestra), because they appear in one part of the piece in one instrumentation and then switch to the other instrumentation in the other part. How did the composer approach the problem of conceiving of the basic thematic materials from which most of the other parts of the piece are derived, for instrumentations that have vastly different possibilities and constraints? And what does this approach indicate about the way he represents the nascent musical elements and about how he uses these representations to resolve the problem?

The second problem concerns the parallel temporal structure used to organize the two parts (S and D), which have very different characters. What representations did the composer use to conceive of the structural parallelism and to inhabit the forms in different ways with the same basic musical materials? How were the different natures of the two parts developed within this similar framework?

The third problem is posed by conceiving of the piece as having two versions depending on the order of presentation of S and D parts, but always having the electroacoustic part (which symbolizes the angel of death) occur only in conjunction with the second part. How did the composer

conceive of the temporal structure, thematic derivation, and texture of the computer part so that it would work with either S or D? Further, how did he conceive of the S and D parts so that they could both stand on their own in a purely instrumental manifestation (first part) or operate in collaboration with the computer part (second part)?

Method

Because this study is observational rather than experimental in nature, it is important to describe what information is used to infer what was happening in the mind of the composer as he solved the selected compositional problems. Roger Reynolds already had a systematic approach to composing. He generally has one or more notebooks for each piece in which elements as varied as metaphors, inspirational readings, graphic sketches of thematic textures, architectonic formal designs, verbal descriptions of musical elements, series of numbers and proportions used, and so on, are noted and dated. In addition, he preserves graph paper, on which mathematical relations are visualized that will determine series of duration proportions, as well as sheets of music paper on which are developed pitch resources and preliminary musical sketches. For the purposes of this project, therefore, he was required merely to augment slightly an activity that was already part of his habitual compositional practice.

In addition to this wealth of written material, nearly 20 hours of interviews were recorded, with other participants of the larger project also participating from time to time. These interviews were all transcribed verbatim. The majority of the analyses that will be performed in this paper are based on the recorded interviews, with occasional reference to the notebooks, sketches, and final score. So the primary data are Reynolds' verbalizations about what he is doing in relation to the piece. The summary of what was gleaned from these sources, as well as from the many hours of collaboration within the framework of the larger project, is presented in the main body of the text, which is interspersed with edited quotes from the interviews in order to let the composer speak for himself. In addition to selecting from the often wide-ranging interviews the parts that are relevant to a specific concern, the editing involved making a spoken utterance suitable for print: removing hesitations, false starts, and redundancies. It should be noted however that we are not using a real-time technique involving "speaking-out-loud" while solving the problem, but after-the-fact reflection and recounting. The delicate nature of artistic creation and the solitude it requires precluded the former approach.

The composer felt it important for me to point out that what follows may seem extremely complex in the recounting. All artistic projects involve

complex trains of thought in parallel on many different levels and on many different issues concerning the object of creation. These thought processes are not usually made obvious or explicit, but occur in subterranean fashion during the process of creation. The selected dimensions of this process being documented here are only a part of what was going on and are congruent with the scientific endeavor that accompanied the artistic project. They require the composer to objectify things that he is doing, something he would never do unless asked. Such explications are not a normal part of the creative process.

Two Instrumentations of Thematic Materials

As shown in Figure 1, materials in a given region that are assigned to the piano in one of the S or D parts, move to the orchestra in the other part, and vice versa. This double instantiation in the instrumental part of the piece necessitated composing the thematic materials for both instrumentations. They also served as source materials for the Transition and Combination regions. In addition, the two versions were recorded early in the composition process, and the recordings were used as source materials for the electroacoustic part. The axial relationship between the two instrumentations of the materials was one among several dualities that inhabited the piece (persistence vs. disruption, S vs. D parts, instrumental vs. electroacoustic parts, two versions of the piece, etc.).

The initial characterization of the five themes was done without explicit reference to their instrumentation. One of the first stages was finding verbal labels and designing graphically represented textures (which the composer refers to as "texture maps") for the themes that distinguished them and defining the musical texture being sought (Figure 3).

> I often feel when I'm looking for a title for a piece, that the characterization tells me something about the degree to which the situation is formed in my mind. So I start out with some kind of a textural ideal, and then in order to intensify that, and to turn from an abstraction into an experience that matters, that one can invest something in, I have to decide what sort of dramaturgical or functional distinctions would be useful. So . . . I decided on these terms as ways of ensuring that I really had understood what it is that they could do, and that those things were then appropriate to the places in the form to which I had decided to assign these textures. . . . I said explicitly to Harvey [Sollburger, the conductor for the recording of the ensemble version of the themes] when he got the score that I trusted he would pay attention to that in shaping his musical ideas. [N]ot only rhythms, harmonies, and so on are important, but textural and emotional differentiation as well: the titles are suggestive. (1 March 1999, La Jolla)

> For some time, I've also been using thematic elements . . . which are composed at the beginning, then become the source of materials that are created or extrapolated from them in other parts of the piece. [It thus] becomes more and more important to design [them] so that they will have a high level of uniqueness, so that their generally extrapolated genetic material will still have some flavor of an original character. [So] in addition to the other characteristics including pitch resource and rhythmic or proportional character, which would be a general controlling feature from the point of view of time or rhythm, I also think normally about each theme, or each subsection, as having some kind of a primary textural character—it might be linear, or chordal, or figurative in some way. (28 May 2000, Paris)

Reynolds (who is a pianist) felt that he started with the piano as an unconscious focal point, using the body image of piano playing to impose boundary conditions on the conception of the thematic textures such as the one shown in Figure 3.

> I've never thought about this before, but when I started, I was designing what were essentially two-handed textures. I didn't think a lot about that, but it was the case. (2 March 1999, La Jolla)

> What would be the point of my starting out in this situation and writing out textures, which I knew a piano couldn't play? Since at the beginning I knew that one of the conditions of this was that there needed to be a piano and an instrumental version of the themes, I thought from the beginning that I would accept, as a condition of the music itself, piano-like conditions, piano-like constraints. So in terms of chord spacing, in terms of register, speed, densities, and so on, everything was really created from the beginning with the idea of [not having] more than 10 or 11 notes in a chord, and the notes would be spaced in such a way that they could be played by the hands. And so, from the very beginning, the graphic design [see Fig. 3], the textural provocation as I was calling it, before starting to compose, was also done thinking about pianistic technique. Even though I'm not really a performing pianist, I'm very, very comfortable with the piano, and I know how the hands move on the piano, so it's not really a big issue for me to think of textures in a pianistic way to begin with. (28 May 2000, Paris)

He nonetheless also recognized that already present in his mind was the fact that the materials would have to be adapted to the orchestra, producing a double set of constraints on their formulation: their "instrumental plausibility" was always in the background when doing the initial texture maps.

The compositional problem to be solved was how to compose thematic materials that were as similar as possible for two instrumentations with very different possibilities and constraints. So what are the constraints and

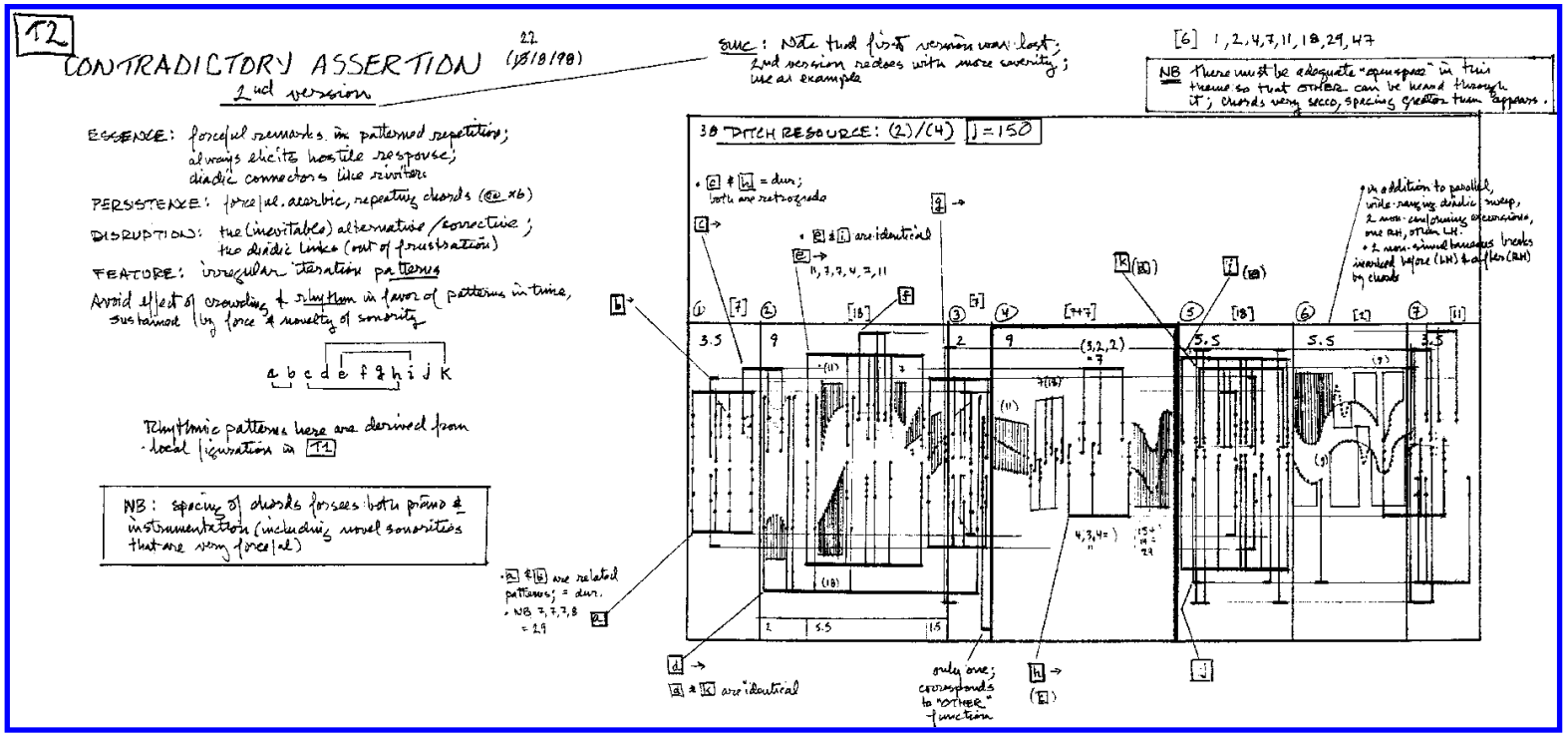

Fig. 3. Texture map for Theme 2 (*Contradictory Assertion*). This graphic, verbal, and numerical characterization of the theme was created very early in the compositional process. ©1998 by Roger Reynolds. Used with the permission of the composer.

possibilities that arise for each instrumentation and how were they solved? In the composer's own words:

> What I did was to start creating materials that were I think constrained by three fields of concern. One is the registral limitation of hands: how wide can a hand reach, and how quickly can it move? The second thing is the idea of the coordination of a gesture by a single mind, and at the same time, having it open to re-creation by a large ensemble. And thirdly, the issue of doing it economically. Normally, I would write in certain kinds of subdivisions, and with certain kinds of notational complexity, which give a certain texture of fluency and complexity to the music. But if I did that here, it would invite imprecision. So it was important to use more rapid tempos, and more straightforward beat subdivisions, as a way of ensuring not necessarily that it was going to be done easily, but that everybody would be very clear about exactly where they were supposed to be at every moment. (2 March 1999, La Jolla)

The actual composition and final shaping of the themes was done for the orchestra, and the final piano score was "translated" from the orchestra version with relatively few departures from an exact transcription. Consider now the following fields of concern in composing the two versions: registral limitations of the pianist's hand, gestural cohesiveness and economy of writing for the orchestra, and the issues raised by the timbral difference between the two versions.

REGISTRAL LIMITATIONS OF THE PIANIST

Theme 2 (*Contradictory Assertion*) is a good example of how the registral limitation of a pianist's performance was dealt with. The original texture map for this theme is shown in Figure 3. The theme is characterized by sudden alternations in dynamics and between vertical sonorities and rapid runs, with frequent jumps in register.

In writing the ensemble version, Reynolds allowed himself to push the limits of what was pianistically feasible.

> When I got into writing, actually composing, I think the sketch was actually more pianistic at the beginning than it was instrumental or ensemble writing. In other words, the initial concepts, even though I created the score and the more specific versions of the themes for the ensemble first, were piano-friendly to begin with. Now, I made all the final shaping decisions in the context of the instrumental ensemble, not in the context of the piano. And so from time to time, as with Theme 2, when there were very rapid registral jumps, I would realize as I was writing something for the ensemble that this really wouldn't be playable for the pianist, and I just let it happen. But I would say that by and large I set for myself a standard that was quite rigorous. My aim is to

> have, let's say, 99% of the notes that are played by the ensemble playable by the pianist, and in the same register. This was an important aspect, because I did this textural planning before beginning to compose. So I would not have created a situation in which there were groups of notes at the top, bottom, and middle of the entire range. I would have realized at the beginning that this would just definitely not be possible. (28 May 2000, Paris)

In subsequently doing the piano version, adaptations had to be made. Reynolds' approach to these changes demonstrates the crucial role that performance strategy plays in the composition itself.

> In dealing with the *Contradictory Assertion* theme, which I decided would be a complex interlocking of iterated sonorities, chords, it was equally obvious that the pianist could not at very rapid tempos reliably jump back and forth all over the keyboard and hit multipitched chords with complete reliability and precision. . . . It just became very clear that you can't have two hands in the middle of the keyboard, and then .08 seconds later, have those same two hands at the wide edges of the keyboard, and then .09 seconds later, back in the middle. It can't be done. So in those cases, what I did was to hedge the representation of the chord in a way that allowed it to be played. So for example, if there's a skip necessary from the mid-register to the outer register, I might expect that the left hand does more, and therefore that the player's attention is more directed to the left hand, and the right hand does maybe a single note, which is not the top note of the figure, but the bottom note. Therefore the right hand can almost automatically jump, and the left hand is attended to more, because it has a more complex goal. (2 March 1999, La Jolla)

GESTURAL COHESIVENESS

A pianist can organize and execute complex, even polyphonic, musical gestures with great facility, because there is one mind controlling a single body. Composing such pianistically feasible gestures for the orchestra poses problems, because many independent agents must be synchronized and coordinated simultaneously and sequentially.

> In characterizing the materials, I realized that I would not normally have written the ideas, the musical ideas, in the way that I did. I would normally have written at a slower tempo, with longer beats, and with more irregular subdivisions of the beats, and more use of grace-note figures that allow latitude. But I realized that that was not going to work at all in the context of 16 people coming together in a similar mode of unanimity. So this just had to be abandoned. (2 March 1999, La Jolla)

This expansion of the pianistically conceived material to a chamber orchestra posed practical problems that were addressed with a different notational style, and even influenced Reynolds' approach to notation.

> I thought: I want to write this music in such a way that nobody is going to have a serious question about what he or she is supposed to do. And that meant notating in a deliberately constrained, or pragmatic way, and constantly asking myself questions like, "what would be the most straightforward way to write this?" And that probably resulted, for example, in using more rapid tempos than I would usually use. . . . And I would say that that worked out extremely well in the sense that the ensemble grappled with the musical content of these passages very rapidly, and that has, just incidentally, caused me to really rethink the way I do everything. And at this point I'm trying very hard in a way that I haven't before, which I realize with some chagrin, to write everything in a way that's immediately playable. (28 May 2000, Paris)

This issue was particularly apparent in Theme 4 (*Jagged Rips*). The score of the opening measures of this theme is shown in Figure 4 in its orchestral version.

> One of the themes that created the biggest difficulties was *Jagged Rips*. This has to do with questions of hand-positioning, and the speed with which you can move laterally and accurately. But at the same time, I had also to be thinking about how similar things would be managed in an instrumental ensemble, where no instrument has the compass that equals the piano's. So one of the ideas that came right away was that these *Jagged Rips* aren't, in fact, just rips, they're *jagged* rips, and what that means is that there is directional instability. So if you're essentially going from bottom to top, from low to high, then you don't just continuously monotonically rise, you rise and then there's a brief downward turn, and then rise again, downward, rise.... Why? Well, partly because it's more interesting, and partly because it gives rise to the possibility for logically solving these issues of register. So I did not start out by thinking at every moment in the *Jagged Rips* theme, what instrument will play this? . . . But in the back [of my mind], there were always these two other factors: can [the score] be quickly and clearly understood and realized, not only for the pianist, but for the players and the conductor? And can this be regenerated by a large number of people working together? It didn't turn out to be quite as problematic as I had thought. (2 March 1999, La Jolla)

This gestural unity was sought simultaneously with another compositional goal, to which we will return in more depth later: the timbral elaboration of the material in the orchestra. In the case of *Jagged Rips*, the timbral variation was imposed in part by the registral span of the gestures, covering a range of pitches that no single orchestral instrument could cover.

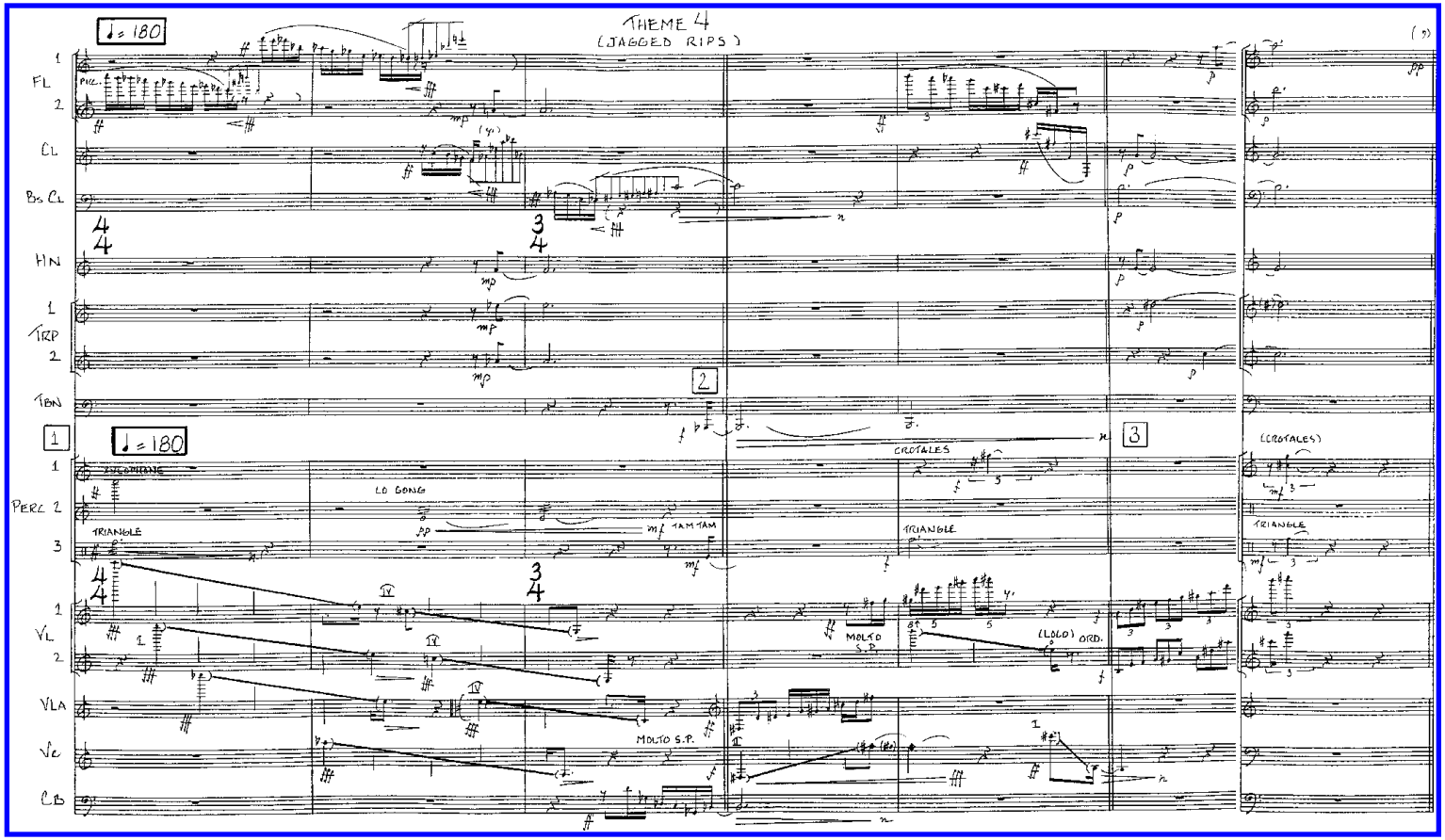

Fig. 4. The opening seven measures of the orchestral version of Theme 4. The piano version of this theme is an exact transcription of the 16th-note and grace-note passage from piccolo to flute to clarinet to bass clarinet to contrabass to viola to violin and flute to clarinet and then to two violins. It does not include the pedal tones in woodwinds, brass and percussion, nor the glissandi in the strings.

RR: The ensemble has far more timbric resource [than the piano], so you want to avail yourself of that. . . . I wanted to have a great deal of timbric flux, so anytime there's a line in the piano part, that line, of course, is monotonic in terms of timbre, but in the instrumental version, a line that takes, say, four bars is likely to be presented by as many as four to six different instruments, and that means that they have to be very carefully coordinated, and that they tend to come in in hairpin-like ways: they start quietly, swell such that they come to dominate the line, and then fade out, such that the interest, the spot-light timbrically is passed on to another instrument. . . . So then you've got this issue that arises, that's very tough for musicians to deal with, which is to be precisely together, and precisely in tune. . . . If you have rapid iterations, even though players are playing at a fixed tempo, if they're not playing together, and they have to contribute their own short block of iterative activity to a general line, it turns out not to be as easy as you might suppose. For example, if you had a passage in sixteenth-note subdivisions, so one player played four, and then the successive player played four, and then another one four, and so on, the chances that it would come out sounding: "DA-ta-ta-ta-ta-ta-ta-ta" are very, very small. So what you do is to have an overlap of one or two notes, on one or both sides. You have to think carefully about whether the player comes in on the beat, or off the beat, and what that will tend to do in relationship to dynamic level, and so on.

SMc: So ideally with the overlapping, the sense that you're trying to get, if they play very precisely, is a kind of fusion of the instruments, so it'll move from timbre A through A+B, to B and so on.

RR: Yes, and when you start that way, you realize that if a player is going "DA-ta-ta-ta," it's different than if he's going "DA-ta-ta-ta-TA." So the arrival on a new beat stabilizes the speed of the preceding subdivisions in a way that may be slightly thrown off if there's not an arrival.

SMc: A closure.

RR: Yes, right. So then you get into this issue of, well, are we going to have a sense of plodding to the music because a lot of beats are being iterated by multiple instruments, so you have to take that into consideration. . . . There's another kind of strategy that I realize came up a lot here which [has to do with] gestural cohesiveness. In *Jagged Rips*, there are a lot of glissandos, played often *sul ponticello* that tend to have the purpose of creating a gestural clarity in a situation which supports what otherwise might be fragmentary passage work. So, those are things that come to mind right away as features, metric and beat subdivision issues, registral and dynamic shadings such as to make the participation of a particular instrument ideal, smooth, that it would fit well; gestural reinforcement. . . (2 March 1999, La Jolla)

This timbral elaboration of the opening descent in *Jagged Rips* is conceived such that each descending gesture that terminates with an asynchronous rip is assigned to a given instrument, passing from piccolo to flute to clarinet to bass clarinet to contrabass. The gestural reinforcement referred to is provided by glissandi in the strings moving from violin to viola to cello, joining the last descent of the melody line in the contrabass.

TIMBRE AND INSTRUMENTATION

A major issue that arises with differences between piano and orchestra obviously concerns timbre. In orchestrating a thematic material that was originally conceived fairly independently of its instrumental instantiation, the composer had to make certain decisions about how to shape and organize things when the material was deployed across strings, woodwinds, brass, and percussion. Assigning different parts to different instruments could bring into relief certain aspects or structures that might not show up in the piano version. Orchestration is an area of the musical enterprise that has generally escaped theoretical treatment in the music theory and analysis community. Furthermore, composers usually describe decisions concerning instrumentation, and Reynolds is no exception, as completely intuitive, although it is clearly a case of informed intuition. It would appear that "knowledge" about timbre and instrumentation is more procedural than declarative, involving, as Reynolds says, "a lot of pragmatic factors: which instruments can play in which registers, how loud or quiet the material was, how it was articulated" (28 May 2000, Paris). That being said, several issues were addressed explicitly in the interviews concerning timbre and instrumentation.

> Another issue was, of course, timbre. There are obviously fairly serious limitations on what the piano can do articulatively in comparison to the 16-instrument group. I have, for example, tam-tams, gongs, cymbals, and things for which there's no parallel in the piano. So, partly in consideration of that, I didn't give a very extensive role to unpitched percussion. . . . I did think about the quality of timbre of chords, and any kind of harmonic entity. I had to, of course, think about the agility of different instruments, because the piano can do things that it's very much less practical for woodwind or string instruments to do. Brass instruments are more limited, they can do some things, like sforzando chords and so on, that are very parallel to what the piano does. But I guess with regard to timbre, I was thinking in several ways. I was not thinking sectionally, that is, I wasn't thinking, the woodwinds against the brass, against the strings, normally. And I was more thinking in terms of color and registral balance, and [composing the ensemble version] went ahead pretty much without consideration of the piano version. So then when I got to the piano version, I had to figure out what

> I would do to emulate the way it had been written in the ensemble version. Part of that had to do with dynamics. Part of it had to do with pedaling, whether it's secco or resonant, with the pedal down. Part of it had to do with articulation, staccato, tenuto, and so on. But [many of the ensemble effects] really can't be recreated and I think that the [streaming] of thematic material that is possible with the ensemble version is very striking and there's nothing one can do about it. The trade-off, which becomes clear when you listen to the two versions, is pretty interesting. It is between coloristic distinctiveness and rhythmic perfection. The degree to which the solo pianist can shape speed and always nail simultaneity in chords is not matched easily by the ensemble. But of course, the ensemble's ability to differentiate between a clarinet, a flute, a trumpet, and so on, can't be matched by the piano. (28 May 2000, Paris)

One area of instrumentation just mentioned that is particularly interesting is its potential effect on stream organization. Sudden changes between instruments can induce segmentation of the melodic line into fragments (Deliège, 1987) or reorganization into two or more streams with notes having similar timbres being grouped into a given stream (Bey & McAdams, 2003; Iverson, 1995). The thematic material might be heard in the piano version as extremely homogeneous, with a relatively clear stream organization, but if the material starts bouncing around between instruments, fragmentation may or may not result, depending on the sequential timbral relations. Reynolds was asked whether he had a sense of how this would play out in the thematic materials for *The Angel of Death*.

> The instrumentation design normally is very faithful to the contour and grouping design of the phrases as composed. It's not only that the phrases are constrained by the textural sketch in relation to each subsection, they're also constrained in terms of the numbers of notes there can be in them, because there are these normative ideas, that there will tend to be 7 or 11 or some standard set of numbers of elements in any flourish. What that means is that there's an easy basis on which to delineate or subdivide anything which is very long. I probably in fact would have used that strategy for taking apart something which seemed impractical to do: let's say, a line began in a register comfortable for the clarinet, and then rose to one that required the flute or piccolo. Now, on the other hand, I tended from the beginning to always have at the back of my mind the idea of what instrument was going to be playing. Not definitively, that is. If you look at the sketch that became the basis for the original ensemble version, I think you would not see many indications of instrument. But I think that I was thinking that way: the flute can play this, or this will probably be clarinet, or this will be trumpet. There's a kind of plausibility criterion that is constantly flowing in the background. (28 May 2000, Paris)

A good example of the approach to this problem is the opening of Theme 5 (originally called Flamboyant Line), a monodic line in the piano which acquires a great deal of timbral motion with the orchestra. The score for orchestra is shown in Figure 5. Two techniques are used to guarantee the linearity in the orchestral version: adjacent instrumental combinations have close timbral relations and the partial overlapping of notes ensures smooth transitions.

In making the two versions, there were a number of timbral and instrumental issues that came to the fore. Reynolds tried to emulate the effects between the two versions: pedaling in the piano and the weight of low pitches in the piano or of low unpitched percussion in the orchestra. Such attempts were approximations and left differences, albeit interesting ones, between the two versions.

> There are differences between the ensemble version and the piano version. For example, one of the differences that you get, and which everybody who transcribes music back and forth from keyboard to ensemble, or ensemble to keyboard knows, is that the facilitations of the pedal on the piano are very, very great. So when you write for instruments, everything is naked in a way; there's no given sustain, unless you actually write in sustaining instruments. Now in the fifth theme, this became a part of the design of the counterpoint. I decided very early in working on the fifth theme that I wasn't going to be happy with the idea of a one-pitch-at-a-time line that went on for two minutes and forty seconds. It just wouldn't have been really satisfying, even if it had been a very flamboyant line, more flamboyant than it is. So I decided at the beginning that the line would begin, first of all, to leave traces of itself, so that as you moved up and down in contour, a particular pitch would be held, while the next pitch in the overall melodic design was sounded. So you began to get not exactly a counterpoint, but a kind of sluggishness or referentiality of the line within itself. That was one stage. Then there would be another stage where a contour design instead of being conceived as a single wide-ranging line, would rather be conceived as two simultaneous lines that interlocked a little. (28 May 2000, Paris)

This "pedaling" or lingering harmony was of course easy to realize in the orchestra because independent players could hold the lingering notes. Examples of lingering notes are clear in Figure 5: the B♭ in the flute, the D in the vibraphone, the high A in the violin, the C in the vibraphone, and the high E♭ in the flute. However, adapting this technique to the piano required consideration of performance constraints, "thinking about whether the pianist's hand could actually hold a particular pitch while reaching another." (28 May 2000, Paris)

Other aspects related to timbre and articulation quality were more difficult to reconcile and were left as large differences.

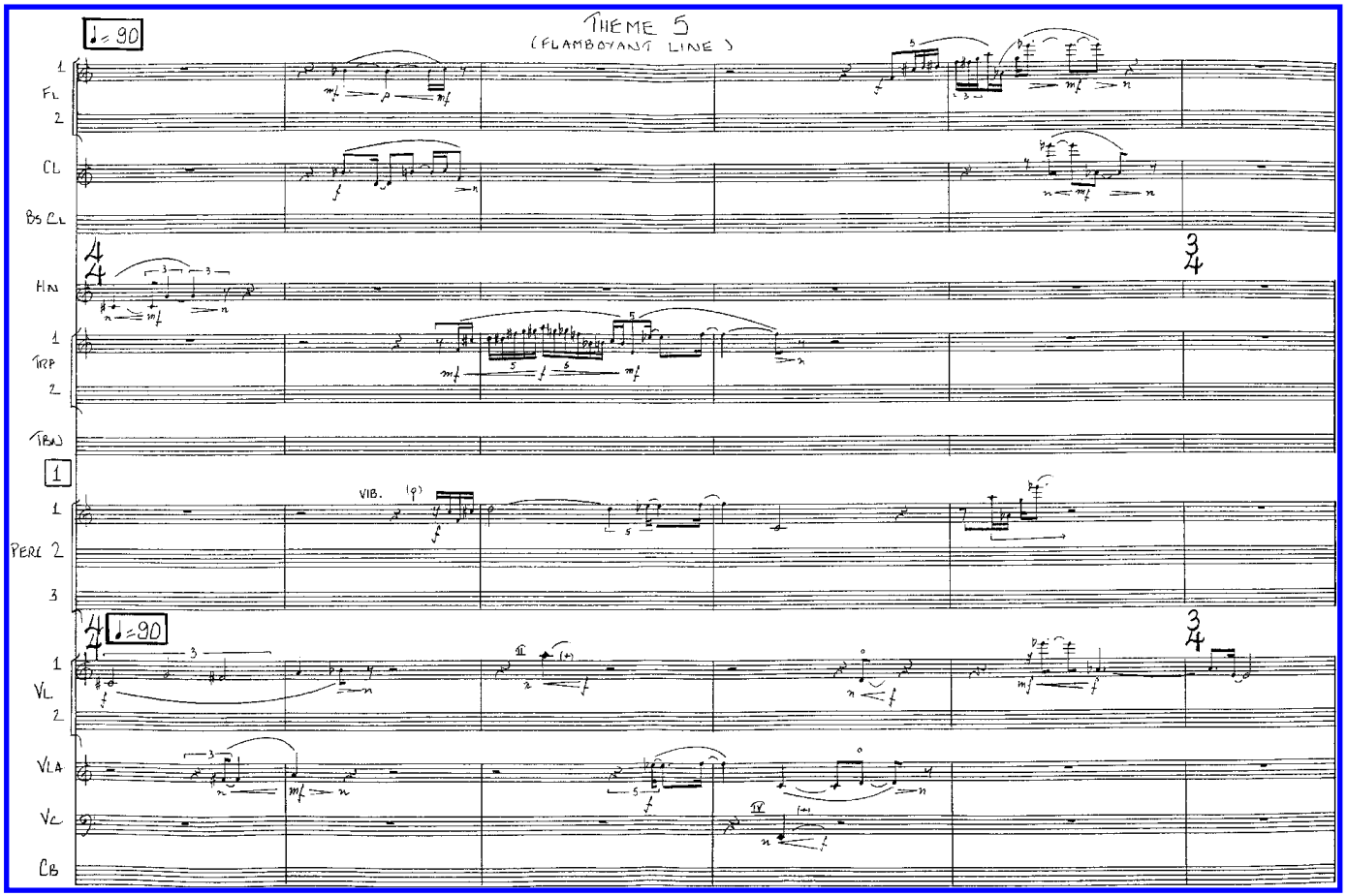

Fig. 5. The opening six measures of the orchestral version of Theme 5. The piano version of this theme is a nearly exact transcription. ©1999 by Roger Reynolds. Used with the permission of the composer.

> The first theme's subsection 7 has spiccato sixteenth notes in it. When you hear the violins playing a spiccato sound off the string, it is fundamentally different from what the piano does in terms of specificity. I would say, in that situation, that the identity both of the three against four rhythm, and the identity of the pitch counterpoint is replaced or displaced by a different quality of sound, which is less pitch-oriented, lighter, less specific. It's a very strange thing, and in some of those sections, I have this feeling when I hear the two versions now that the ensemble version is somehow losing some of the objective content of the music, because that content of pitch and time is being *so* modulated by the effects of the instrumental timbre, which also includes, I think, the issue of instrumental, of tonal volume. And that whole idea of the *size* of a sound: it's one thing to hear a clarinet, or a horn playing, it's something quite different to hear a spiccato violin in the mid-register, upper register. There's hardly anything there. It can't be simulated just by playing very softly. That was one of the thoughts that I had when Jean-Marie [Cottet] was recording the piano sections. I thought of taking sections like subsection 7 of the first theme, and putting it up an octave in the piano, to make it have more of this barely-there or evanescent quality. But on the one hand, there was no planned structural agenda, and on the other hand, there's a series of factors that play into everything: how is this instrument going to sound in that register? (28 May 2000, Paris)

Of course, timbral differences could be used to structure the thematic materials differently, to bring to the fore associations of events across time on the basis of timbral constancy. This technique was used in the second theme, by creating associations between certain harmonic entities and certain instrumental voicings of the harmony.

> Some things were proposed by categorical rigidity, as for example the fact that a particular chord in Theme 2 always had the same instrumentation. Whenever it came back, it took the same timbral resource, and it also frequently sounded all the pitches, but not always. I allowed some flexibility there too. So let's say there was a seven-note chord, which repeated seven times, in several of the seven, there might actually have been only four notes sounded. . . . Those that were sounded represented the chord, but the chord might not have been completely fulfilled, and of course that then gives me more flexibility when I write the piano version. (28 May 2000, Paris)

Some differences between pianistic and orchestral possibilities were resolved in almost a metaphorical way. The problem of the lowest notes of the piano and of unpitched percussion and instrumental doublings in the orchestra were dealt with in terms of the notion of "weight."

> There was one very strong issue, which is the low end. The piano is much more assertive and articulate in the lowest register than the ensemble can be. This would have been an argument for a contrabassoon, for example, or for a contrabass clarinet, or something, which I thought about and decided not to do. So there *are* places where I've used octave doublings. This is another issue, in fact. I realized that the piano has the capacity to address certain kinds of sonorities with perfect tuning because octaves are not a problem in the piano, just as unisons aren't. Octaves *are* a problem with an ensemble, and so in the low register, that means sometimes that the contrabass, the cello, the trombone, the horn, and the bass clarinet, actually play higher than they do in the piano version. The piano version uses the lowest A and the highest C, and the instrumental version can't use those lowest pitches. So I had to compensate for that, and I partially compensated by octaves, partially compensated by greater weight, that is, putting more instruments on the low pitch, and partly I compensated by the use of tamtam, and low and high gong, to add weight that, of course, the piano can't add. And then in some of the themes, I did use ornamental figurations that play with multioctave sonorities. And I thought that would tie the sound of the piano slightly more than normally to the sound of the ensemble, because we don't use sonorous octaves very much in contemporary piano writing. (2 March 1999, La Jolla)

INTERIM DISCUSSION

We have seen that the composer possesses acquired knowledge, much of it explicit, of the performance constraints in piano and orchestral instruments: what they can and can't do, individually and collectively; what the ranges of their timbral and articulative qualities are. This knowledge allowed him to accommodate the coordination of what were initially conceived as pianistic gestures to an orchestral realization. They also led him to adapt his writing style to allow for the complex chaining of instruments in wide-ranging gestures that surpassed the range of individual orchestral instruments. This adaptation involved the use of tempos that were faster than he would normally employ, simpler beat subdivisions that allowed overlapping relays between instruments that were tied to metric structure, and gestural reinforcement to lend a timbral continuity to certain passages. The conception of the pianistic textures clearly drew upon the composer's intimate knowledge of the ergonomics of the piano, which took the form of a body image of piano playing, the constraints on what could be realized by two hands and ten fingers. Finally, it is also apparent that the composer has another realm of knowledge, this one much less conscious and relatable through verbalization, concerning the timbre of the different instruments in different registers, as well as the judicious use of timbral effects of

instrumental combinations and sequencings. This knowledge was brought to bear when imaging perceptual effects of orchestration in terms of fusion of sounds from different instruments and the composite timbres that emerged, as well as the segregation of sounds into streams or the segmentation of melodic lines on the basis of timbral discontinuities. It would seem that there is a whole realm related to orchestration involving procedural knowledge for which most composers have difficulty expressing what they know and how it is they employ what they know when making orchestration decisions.

Section and Domain Parts of the Work

Reynolds conceived of the work in two main parts. He considered the parts as constituting the same landscape of opportunity traversed in contrasted ways. The Sectional part (S) presents materials so as to maximize a listener's awareness of the identity of the sections and the moments at which structural landmarks are articulated. In the Domain part (D), the material elements are meant to be understood as sources of influence radiating out from the thematic core elements rather than clearly bounded sections. As such, the D part is more continuous and organic in nature with boundaries that are less sharp. These two ideals are represented graphically in Figure 1 by boxes and ovals, respectively.

The technique used for the composition of the parts of the piece involved a detailed temporal plan of the sectional and subsectional organization of each part, such that the major landmarks occurred at identically timed places in both. Several such landmarks existed. They include (1) the core elements of each of the five themes (gray boxes in Figure 1), which occur in either the piano (T1, T3, T5) or orchestra (T2, T4) in S and in the complementary instrumentation in D, but are otherwise identical, (2) the very brief piano interlude ("Interlude" in Figure 1) that serves as a kind of premonition of the "Epilog" played by the pianist at the end of the whole piece and occurs identically in both parts, (3) a section called "Other," which is played live by the pianist in the first part (whether it be S or D) and occurs in a computer-processed version in the second part, and (4) a section of repetitive, stratified ostinato patterns ("Rep Strat" in Figure 1) that occurs in nearly identical form in piano in S and in the orchestra in D. Around these landmarks one finds the full themes and the clearly marked sections of transition between thematic materials or combinations of the materials (of two or three themes) in S. The S part was composed first, followed by the D part, allowing the composer to emulate the musical character of the regions around the landmarks, all the while allowing these materials to take on a more complex and temporally extended form.

Part of the formal plan (in its final manifestation) up through the section COMB 2/4 is reproduced in Figure 6, with the S structure in two strata (piano, ensemble) in the upper half, and the two strata of the D structure in the lower half. Note the presentation of the full themes in the upper half and the precise temporal alignment of the core element of each theme between both parts, but with a change in instrumentation.

"RepStrat" was not in the original formal plan in 1998. It was introduced after it became clear that a Combination region, with materials from Themes 1, 2, and 3 starting just after the second silence and continuing through the presentation of Theme 5, would disturb this theme, particularly once the computer part was added. This combination was abandoned in S, reduced in temporal extent in D, and replaced at the beginning of the planned region by "RepStrat" and the piano "Interlude" in both parts. The "Interlude" came about as a result of Reynolds' desire to end the piece with the live piano in a final "Epilog." It had implications for the S/D structural relations.

In contrast to these commonalities between S and D, the compositional approach to the combination and transition regions was very different in each.

> What is clear is that when I was working on S, I decided that the transition sections were going to involve new material, which is to say textures that didn't exist literally in any of the themes, and also harmonic structures that didn't exist there. . . . But even this newness of course was always indebted to or derived from [the themes]. But I'm making this distinction because when I got to D, everything that happens there is literally out of the themes. So in a way, the domain section is purer than the sectional structure. To go back to sectional, it seemed to me that it was important that the transitions have the character of what I think of as transitions in—let's say—Beethoven. You can see that the detailed plan of transition 1 to 3 [Figure 7] almost gets like the descriptions of the themes. There's a detailed textural and sort of narrative commentary about what's going to happen here. (12 June 2001, Paris)

Figure 7 shows this plan for the region of transition from Theme 1 to Theme 3 (TR1→3). Note that the various regional subsections are derived from thematic subsections (T1.4 is subsection 4 of Theme 1). Reynolds considered TR1→3 as formally important in S, because it was to be the first nonthematic region.

> The main things that required thinking in terms of long arches were the transitions, and the first transition is crucial because it has to establish what the music is going to be like outside its thematic areas, because the beginning of the piece is literally just two contrasted themes [1 and 2]. So I decided in S that there would be strategies developed that would

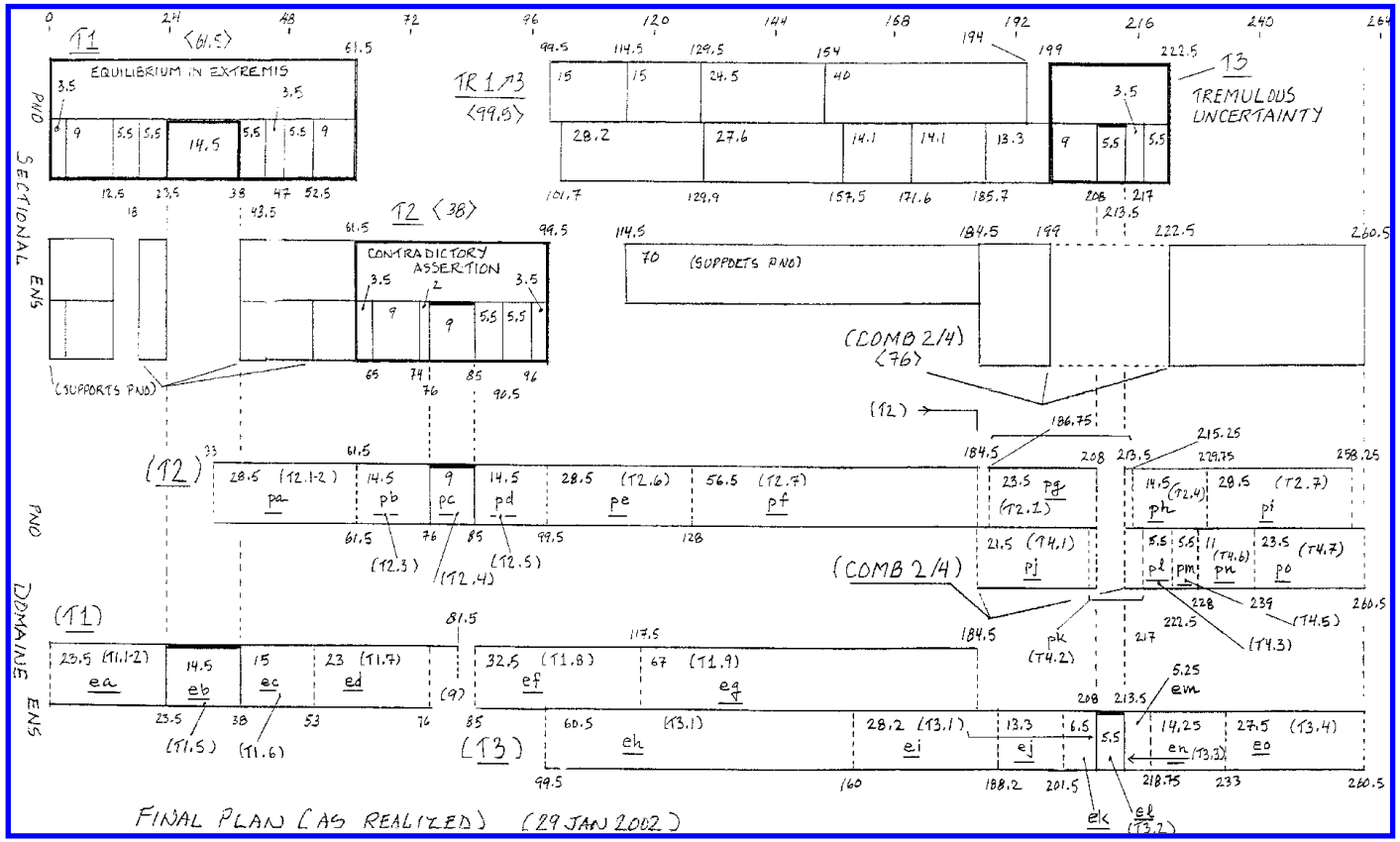

Fig. 6. First part of the formal plan of *The Angel of Death*. The upper two strata represent piano (PNO) and orchestra (ENS) for the Sectional (S) part. The lower two strata represent piano and orchestra for the Domain (D) part. Vertical dotted lines connecting the S and D parts show temporal alignment between them. The boxes represent sections and their theoretical durations are shown in seconds. In the D part, the notation (T1.5) indicates that the material in that region is derived from subsection 5 of Theme 1.

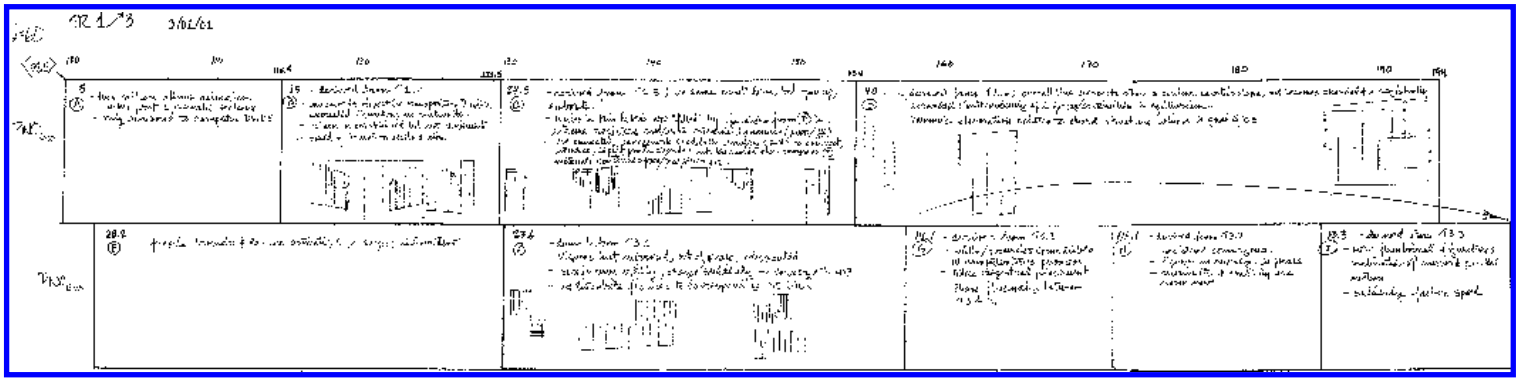

Fig. 7. Texture map for the region of transition between Theme 1 and Theme 3, which occurs just after Theme 2 in the S part (see Fig. 1). ©2001 by Roger Reynolds. Used with the permission of the composer.

> allow that transition to create some kind of a long trajectory, and that it really would move from the domain of Theme 1 to Theme 3, and would kind of merge right into Theme 3. The strategy in Theme 1, in the sectional half of the piece, involved a lot of ostinatic chordal interplays. So there was an agenda, and there were materials created, as I said, indebted to but not identical with the thematic elements. (12 June 2001, Paris)

In D, the approach was different and can be gleaned from Figure 6 where the subsections are explicitly derived from subsections of the themes (e.g., T1.1-2, T1.5, T1.6, T1.7, T1.8, T1.9 in the ensemble stratum).

> When I got to the Domain part, I realized that one of the possible ways of treating the situation, when I looked at the array of overlapping layered boxes, was not to create any more material, but to allow the entire content of that 12 or 13 minutes [sic] to be made up of the themes themselves in different distributions or realizations. So what I did was to go through and name all the boxes, like *pa* (piano A), or *pb*, *pc*, *pd*, etc., and *ea*, *eb*, *ec*, etc., for the ensemble ones [see Fig. 6], and then I looked at the original themes and decided which [subsections were appropriate to use in each of the "boxes"]. (12 June 2001, Paris)

> I think the crucial thing in working on D was figuring out how to use what I called in the notebook the wings that spread out from either side of the core element. And I guess it wasn't clear to me at the beginning . . . that the way I was going to resolve that problem or that task was to take the individual segments of the original themes as mines or quarries out of which I would take the essence of the wings. So, in a certain sense, you could argue that the themes that were presented in S are in fact still present in D, but they're diluted by a temporal extension, which is not based on trying to mimic the proportionality of the original theme. . . . I used the elements of the original themes in relationship to their efficacy, given the musical situation that I was trying to deal with. So [for Theme 1] you've got [subsections] 1 and 2, and then 5, 6, 7, 8, 9 are there. . . . I always respected the chronological seriality. That is, things that occur in the theme before the core occur before the core in D, and things that occur after, occur after and there's never a shuffling. (14 April 2002, La Jolla)

Another strategy by which S and D parts were composed with parallel temporal structures actually arose out of time pressure. The S part was composed first after the majority of the computer images had been finished. As Reynolds began to compose the D part, time grew short as the deadline for the concert approached.

> What I decided, when I actually started working on D, partially as a matter of expedience under enormous time pressure, but also partially

> because of the context of the piece, the experimental aspect of it, was that I would go through and actually lay out 40 pages to have precisely the same metrical and tempo relationships as in S. I've never done anything like this before, and I guess what I decided was that this would work well as a kind of further influencing matrix. For example, because of the layered proportional structure in D, there was not any reason, sometimes, for a tempo change that was brought about in the S version by the fact that there were thematic boundary conditions that needed to be respected. So I thought, maybe this doesn't make sense, but I decided to do it anyway. I think actually it was a very good thing to do, and that it did have interesting influences that worked very much in favor of the project of D. But on the other hand, it was also frequently true that I had to alter my ideas about what I wanted to put in a particular bar because graphically, in the S version, it had been, let's say, empty, so it was very small. And now in the D version, I might have wanted to use a lot of beat subdivisions, but there wasn't any space to do it, so I couldn't do it. And sometimes, I did other figurative things like tremolandi, or trills, or something. But often, I just allowed that to be another challenge, and went with it.
>
> So I guess there's the value, on the one hand, of the economy of not having to make a decision, having the decisions already made for you, and that's of course something that you know I'm a great believer in, to have some hierarchical plan that causes you to make decisions about things such that when you're actually composing, you don't have to think about all the factors that are influencing the situation, because some of them have already been globally realized. And so the way I decided to work on D enlarged that tendency to some degree. . . . So what this means is that a lot of the material that is explicitly present in S is only, in a way, shadowy . . . only implied in D. . . . So anyway, D turns out to be a kind of augmented jigsaw puzzle where the problem was how to manifest these materials that I had determined on a rational basis, would be represented in each of the boxes? How to actually get in there and realize that, so that at every stage, I knew what the metrical and tempo structure was, I knew what the layout of the sections was, so I knew when things were going to change, and I knew what materials from the themes, either pianistic or ensemble, I would be drawing from, and then the problem, the task came just down to mediating all these factors. And I must say it was really enjoyable, and not problematic, except that of course it took a lot of time. (12 June 2001, Paris)

INTERIM DISCUSSION

One of the main strategies used for solving the problem of creating a similar temporal structure inhabited in different ways by the same thematic materials involved a spatial, architectonic conception of the global

form and detailed planning within this representation. Time was mapped as a dimension, as in a written score, and the two instrumental factions were conceived as strata. Spatial reasoning was used in superimposing the S and D parts in the formal plan in order align certain aspects temporally. Musical landmarks were used to create pillars of commonality that provided for moments of similarity; but also served for the imagination of different processes of variation and transformation by which the thematic subsections could be deployed in a way that was informed by the ideal of the larger-scale textures and atmospheres that each part was to convey. This kind of formal plan, quite prevalent in Reynolds' compositional method, serves as one kind of self-imposed boundary condition around which more local decisions are made at the moment of composing the score. Another kind of boundary condition imposed, this one arising partly out of time constraints linked to the impending performance, involved the imposition of a spatial, metric, and tempo frame in the score of D, which was constrained to have the same page layout as that of S. Such pragmatic decisions obviously had an impact on the final result, but the flexibility of operation of the composer simply integrated them into the process.

Conception of the Electroacoustic Component to Go with Either Part

Given that the temporal nature of the two parts is so different and that the piece can be played as S-D or D-S, the computer component had to be conceived to go with whatever part comes second. Here Reynolds opted for a strategy in which much of the computer component was finalized before the final instrumental composing took place, having in the meantime made many decisions concerning the layout and textures that would be sought in the instrumental score. He decided to design a loose temporal relation between textures of the computer-processed sound and the instrumental component. The final ten computer sections would be synchronized at their onsets with specific points in the score, but would evolve temporally as appropriately directed textures that would not hinder more precise rhythmic and melodic figuration in the instrumental component, but would support its formal shape. These computer sections were listened to many times during their development and referred to again as the actual composition began to be finalized in the score. So in fact, this problem of the relation between the computer component and the instrumental component was intricately interwoven with the task of composing the sectional and domain parts. Certain aspects of the original formal plan for the piece were omitted or modified (particularly in S) as it became clear that certain of the computer sections were quite strong in character, requiring a simplifying or thinning out of the instrumental score.

Early in the design of the formal plan of the piece (Figure 1), the computer component was imagined as overlaying the second part of the piece, whatever the order: S-D or D-S.

> The computer overlay will use materials extracted from the themes, but it has no particular geometry or form right now, it's just an idea. My notion is that [it] comes in shortly after the first half ends, whichever half it is, and then influences the space between, and then influences whichever [half] is second, by combination. This is sort of to the side, but I'm thinking, at least for the moment, about calling the piece something like *The Angel of Death* or *Dark Angel* or something like that. So the metaphor here that's sneaking into my head is that somehow this material is going to come, is going to be above and outside the realm of the music, and is going to somehow cast a shadow. It's going to go below, it's going to like [. . . emits a growly grumble . . .] and I don't at this point exactly know what that means. But these halves, which are objectively fairly parallel from a formal point of view except for their means of articulation, will be rendered different by the influence of this overlay. (17 April 1998, La Jolla)

The influence would, of course, depend on the relation between the computer component and the concomitant instrumental component, particularly on how they integrate musically. This concern raised the issue of the order in which things were to be created. The following reflection occurred when the themes were first being recorded in their orchestral version.

> I got to thinking first of all about [the computer component] and working on the themes, and decided that it just wasn't going to be possible to foresee this with the themes alone. The themes just didn't give enough information, even though the fifth theme is dominant in the latter part of the piece. It is co-existent with forms of the other themes [COMB 1/2/3], so I decided that it was something that I was simply going to have to be able to invent when I got there. But this is going to be a major issue of the completion of the piece, . . . because I can't write the end of the piece without the [computer component], and I can't write the [computer component] without the end of the piece. They're absolutely integral, and they have to be created at the same time, in terms of design. For this reason, the coming of the Angel of Death, coming down over that material, has to integrate with it. (2 March 1999, La Jolla)

These concerns for integration and the problem of synchronization between instrumental and computer components later led Reynolds to a sectional conception of the computer component aligned with the formal structure of the instrumental component (Figure 8).

> It has become clear to me that the integration of the computer part—which is going to be quite extensive, and quite, I think, forceful—with

> the ensemble and piano, is definitely a nontrivial issue. So I've been trying to figure out how to approach that. The thing that I don't want to get into, which I never have gotten into, with rare exceptions, is some kind of click-track or score-reading by the computer, so that we're working on a moment-to-moment precision or coordination [between the two parts]. It's something that I don't believe in, basically. In spite of the duration of the [computer component], my desire, at this point anyway, is for the [computer component] to be a consistent presence, not to come in and out episodically, but to have a continuity. It might be possible to make it up as a kind of collection, to organize it as a stream of episodes, or fragments, that could have decisive endings or beginnings, which could be cued to precisely coordinate with what was happening in the piano and instruments. From performance to performance, there might a shift in the way they aligned, but the overall thing could be contained by design within the allotted time. So this was a very nice sort of breakthrough idea, which allows both flexibility and control at the same time. (20 September 2000, Paris)

Reynolds decided that the pace in the computer component should be deliberately slower than that of the subsections of the themes. They are thus, on the one hand, larger in scale on average than the theme subsections and tend to have less variability to them. On the other hand, they are shorter in duration than the larger-scale and continuous sections of the instrumental writing (Transition and Combination regions, "Other," "RepStrat"). The conception of the computer component as made up of discrete parts solved a technical problem, but there remained the issue of integrating the musical materials on several levels, which led to some general considerations concerning integration.

> So the first thing is to have a metaphor of a behavior, which fits in either the category of Domain/persistence, or Section/disruption. The second thing is to find out what technical processes would be necessary to make this metaphor occur, and, not of course incidentally, do we actually have the capacity to do these things? . . . Then the third thing is: do I have actual material, which is suitable to undergo these transformations? And then the fourth thing is: how long does it need, and where will it fit? So I have to now figure out where each of the things that I'm thinking about is going to be found in the piece, and that they will all basically have [an] overall characteristic of descending. Anyway, it's a matter of folding all these criteria into a pragmatic fit. Now, as soon as I see this unfolding, I begin to get nervous, because I realize that the density of information in the computer part, and in the ensemble and piano parts can't be self-obliterating. You don't want things interfering with each other. So how do you have two or three strands of sound going on simultaneously—the computer, the pianist, and the ensemble—and not interfering with each other? That's not going to be straightforward, but of course, I have the advantage of not having actually written much of the music that exists here other than the themes,

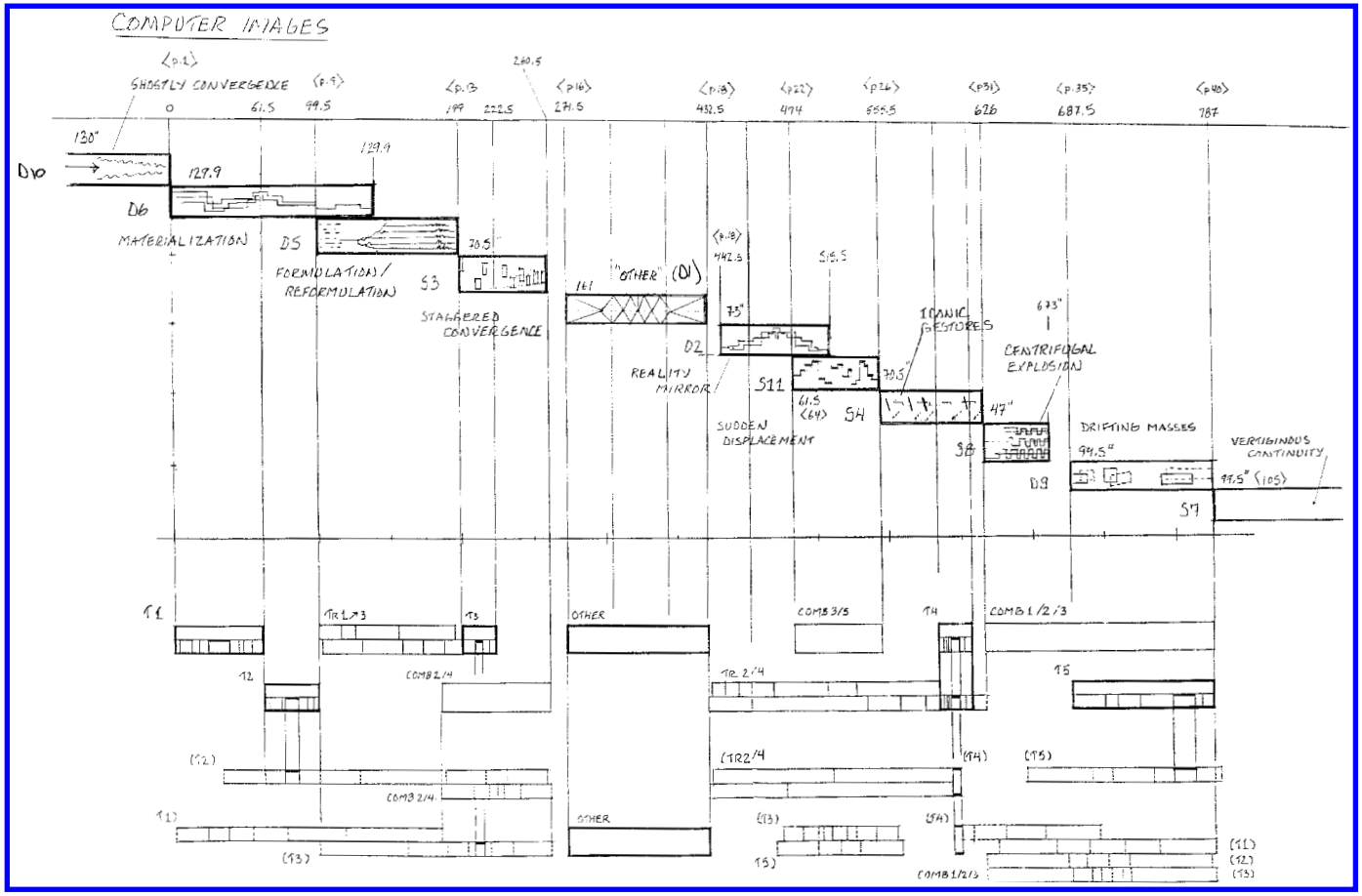

Fig. 8. Formal diagram illustrating the temporal alignment of the computer images (upper part) with the S and D parts (lower part as in Figure 6), as well as the projected textures of each image. Note that S3 was eventually removed. The notation <p.1> indicates that the computer image is synchronized to the instrumental component on page 1 of the score. Note that the S and D parts have identical page numberings.

> and I can probably arrange to keep the computer out of the way of the themes without a lot of difficulties, simply because the themes don't have that much duration. In terms of the whole, they don't occupy that much of the time. (20 September 2000, Paris)

The crucial problem posed is that the instrumental materials must be viable both on their own and in conjunction with the computer component. This concern led to decisions concerning the order in which things had to be created at a moment when the computer materials were being finalized in their general content and form.

> I have to think of instrumental materials, which can be both free-standing and collaborative with the [computer component], depending on whether they come in a first- or second-half presentation. And it's not totally clear how that's going to happen. It is obvious that the first thing I will have to do is to compose the sectional version, because even though I don't want to think of the domain version as being subordinate or derived, the fact of the matter is that there's a more constrained or structured sort of decision making that has to go on. So it seems to me that I have to start with [S], and then I'll play off that, in extrapolating it into the other half. But I guess the thing that is most preoccupying me at this point is that space is being left open for other components in the creation of some of these 11 computer sections, more than it is in others. Some of these sections seem to me almost not to brook any interference, and I don't know what I'm going to do about that. (8 December 2000, Paris)

Once the majority of the computer materials were in place (excepting their spatialization with a six-loudspeaker array), Reynolds began composition of the S part. This part was not yet completed when he returned to IRCAM to finalize the computer sections, including their spatialization. It had become clear in the interim period that some adjustments were necessary to both the computer and instrumental components.

> It's possible at this point that some sections of the planned computer part might actually not get used at all, which would allow the instrumental stuff to come through more. There is a real issue about the computer matching, and not overwhelming, the instrumental writing. And the [computer] parts that occur during thematic sections take cognizance of that and they stay out of the way. What I have to do, of course—this is a real trick, and I'm not confident at this point yet that I've solved that—is to write in such a way that the instrumental writing in and of itself, is interesting and sufficient, but at the same time, that it can take the addition of other factors, without becoming absurdly problematized, crowded, or whatever. And of course, some of this can be handled by level adjustments in rehearsals. . . . Pieces like *Archipelago* and *Transfigured Wind*, to a degree even *Personae*, have very

> robust computer parts, and it works with the instrumental writing. The problem is, in those pieces of course, it's planned from the beginning, that there will be a section which has a featured computer part, and therefore the instrumental sections will be written with that in mind, and they don't have to be all by themselves at other times. So it is possible that I will still have to get into making some kind of adjustments, even in rehearsals, and drop passages out. You know, it's really a difficult problem, I think certainly the most difficult thing that I've tried conceptually perhaps ever, because you have to leave room for something, that is both needed, but not necessary. (23 March 2001, Paris)

In addition to dropping 1 of the original 11 computer sections (S3) to avoid overwhelming the delicate Theme 3 in the piano, the combination regions 3/5 and 1/2/3 were finally dropped from the S part. However, their analogs were retained in the D part, where the thematic materials were more sparse and interpenetrating anyway (see Figure 1). It is important to note that Reynolds had stereo versions of the computer sections to refer to while composing the scores for S and D parts.

After the premier concert in Paris, Reynolds reflected on the place that the relation between the computer and instrumental materials occupied as he was composing the score.

> Although I started out being concerned about the issue of whether the computer sections would mix appropriately with the newly composed things, . . . I really didn't pay any attention to it [while actually composing]. I think the reason is that by that time it had become clear to me intuitively that the materials were all so familially similar, or deeply connected, that I was going to be able to accept whatever happened. Also, I suppose there wasn't really time to laboriously check all of it. And, in fact, when I thought back to other pieces, like *Transfigured Wind*, or *Archipelago*, or *Personae*, in which there have been extensive computer sections, it has always been the case that there is a deep sort of familial rootedness of all the materials. The original solos or thematic elements were composed with a certain basic set of dimensional commitments in time, in pitch, in texture, and so on, and the computer parts arose literally out of them, and the other materials in the piece that were not thematic or computer also arose out of them. This means that there's always this kind of shared quality, which always seems to be productive of good things. (12 June 2001, Paris)

This "familial connectedness" is, of course, a direct result of the source materials for the computer component being taken from recordings of the thematic subsections. The following reflection on the computer section D2 (*Reality Mirror*), demonstrates the thematic and sonorous indebtedness of the computer component to the original thematic materials that are presented explicitly or in derived form in the instrumental component.

> Little by little, I started exploring possible sources for the identity of these segments of the computer part, and that partly comes about from just listening to the [recorded thematic] materials, partly comes about from things that I have already done in other pieces, and then of course it comes about from listening to what it is that [Frédéric Voisin and I are] beginning to do in the [computer] processing of the materials. So we're poking around in what seemed like promising areas of transformation, and some of those are very provocative. So I started thinking of things like, for example, having the complementary piano and ensemble versions of a particular passage, let's say a passage that begins low then rises. Then it would be possible to play let's say the piano version stretched forwards, and then, as it was reaching its apex at the end, you bring in the ensemble part reversed, so that you have a kind of reality mirror. And to refine that a little more, you might begin with the piano actually sounding as it did in real-time, that is at the appropriate pitch, and speed, and so on, and then start dynamically stretching it, so that you move into this more unreal and cloudy realm. And then the ensemble comes in, and goes back towards reality, but doesn't actually get there. So, on the one hand, I'm interested in the idea that it doesn't get there metaphorically, but on the other hand, it doesn't get there in fact because it doesn't sound good. So all these things are balances you know between different imperatives. (20 September 2000, Paris)

The time stretching of the recorded sources was performed with a computer algorithm called a phase vocoder, which allows one to speed up or slow down the rate at which material is traversed without changing the frequency content and thus the pitches and harmonies perceived. Reynolds felt that this technique was particularly well suited to the problem of the coexistence of the computer component with each of two different instrumental versions with different temporal characters.

> One of the very reasons for being very interested in the phase-vocoder [type of transformation], is that it allows you to stretch in time pitch or harmonic movement that would be quite rapid in real time, but becomes more manageable and placid when it's stretched. Considerable stretches have the great advantage of not only producing interesting variations on, or transformations of, the more-normal-paced music, but they also have the advantage of slowing down harmony and therefore making the accommodation [to the instrumental component] easier. (20 September 2000, Paris)

INTERIM DISCUSSION

The main issues to be addressed with this problem were the coordination and integration of the computer component with the instrumental component in its two versions, as well as conceiving of the instrumental versions to be both self-sufficient and collaborative with the computer component.

The problem of global coordination was resolved by conceiving of the computer component as discrete images the beginnings of which were aligned with specific points in the instrumental score. Then each computer image was designed to have a certain textural continuity and shape that did not require moment-to-moment synchronization with the instrumental component, which was more structurally delineated in S and more organic, but still clearly structured temporally in D. Again, a graphic map, in which the computer component's structure was superimposed on that already designed for the S and D parts of the instrumental component, was used as a conceptual aid.

The problem of the integration of the computer and instrumental components was resolved in part by the fact that they shared common resource materials: the subsections of the basic thematic materials were used in their piano and orchestral versions as starting points for the development of the Transition and Combination regions. This provided, in the composer's conception, a familial connectedness between the components that were to occur simultaneously. Furthermore, the computer images were composed first and used as a gauge against which the composition of the S and D parts could then be composed in that order. From the interviews it appears that a clear imagined sense of the interaction of materials and textures, and of what kinds of density/complexity were being sought, were the ground upon which the moment-to-moment compositional decisions were made. This approach allowed a parallel imagining to occur that sought to optimize the mutual constraints imposed by the computer, Section and Domain parts. The parallelism of imagination involved conceiving the instrumental part as being composed both on its own and in interaction with the computer component, which already existed. This inner listening that must necessarily play an essential role in music composition is another realm that is difficult to access in the compositional process on a real-time basis without interfering with the process itself.

General Discussion

A question that Roger Reynolds raises about his own problem solving in the creative process concerns what the way he works means in terms of providing a window into the creative mind. While such an issue is far too vast, and the elements that we have to go on too sparse, to address this question in detail, a number of features of his personal approach are worthy of consideration. Reynolds is both a highly imaginative and extremely methodical composer. His method has evolved over several decades of work and he feels that this method has given him a way to proceed in the creation of new esthetic forms within a universe that is his own, although

there are certainly aspects that are common to the work of other contemporary composers. The method involves an ability to break a problem down into components that can be addressed individually and knowing where to set limits on what he is trying to achieve in reasonable fashion. He voluntarily seeks to push much, but obviously not all, of what is generally happening at an intuitive unconscious level toward a rational conscious state in order to be dealt with explicitly. There are many levels of objectivation in his method that may well be specific to his way of working.

The notion of self-imposed boundary conditions emerges often in his writing and speaking of his own creative process. Boundary conditions in "art music" were previously dictated by common practice conventions, and still are in much popular, folk, and jazz music. In contemporary music, they have to be set individually by the composer in order to create something that is graspable for the listener, within what Reynolds has called a "tradition of the moment." The boundary conditions used by Reynolds involve many aspects, only some of which have been explicitly addressed in this papers: early decisions about the formal structure of the piece, the nature of the resource materials (e.g. pitch series organized hierarchically, sets of numbers used for densities and groupings, sets of duration proportions), relations among different sections of a piece in terms of the materials from which they are derived, and so on. Many of these constraints solve certain problems globally, leaving intuition free reign at other levels. But they are never imposed in a fixed and inflexible manner: as the needs of the music dictate in the final composing, changes are made, and his esthetic sense is the final arbiter.

This method proceeds from large-scale planning, to the specific resources to be used, to the creation of thematic materials and then to the use of those materials to create the designed form. For Reynolds (personal communication, 2 November 2003), there is a commitment to a particular position here: large entities must arise out of the elaboration of small entities. He feels that in traditional music, large forms are the concatenation of smaller forms, a conception that is opposite to that of sculpture, for example. An example of a composer who approaches this problem differently is Iannis Xenakis, who often starts with a great abundance and then limits what is actually selected for the final score, as the sculptor chisels away the parts of stone that do not correspond to the form being imagined.

Reynolds compositional problem-solving involves many kinds of conceptual aids: graphic representations of formal design and texture, verbal descriptions of materials and atmospheres or attitudes that he seeks to create, and the more traditional musical sketches at various levels of abstraction or partial representation of the musical elements that are being created. Some of these may be quite specific to Reynolds, although composers such as Darius Milhaud have been known to use graphical representations

as aids in the conception of musical works, and many composers, such as Ludwig van Beethoven, were known to make extensively reworked sketches before proceeding to the final composition. At any rate, what emerges from this particular work, and more musicological studies of music composition such as those reviewed by Sloboda (1985), suggests that there is a kind of metaphorical level at which musical elements are represented. This metaphorical level allows many different kinds of representations outside the realm of symbolic musical notation to be used in the conception of musical elements, often simultaneously as in the case of Reynolds.

Of course, as in any psychological study, one must wonder to what extent these "results" generalize to other pieces by the same composer, to other composers of contemporary music, and to composers of other musics. What is probably most common among composers and other music creators is an ability to imagine, to hear internally, to image auditorally, the musical materials being worked with. But there are certainly many different strategies for resolving compositional problems. From having spent a couple of decades in the presence of many different composers, it seems that there are enormous variations in personal style and strategy. The problem for the psychology of music will be not only to find methods for probing into these processes, but to find the creators that are willing to reveal, to the extent that such is possible, what they are doing when they compose.[2]

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2. Portions of this work were presented at the 7th International Conference on Music Perception and Cognition (McAdams & Reynolds, 2002). The research was funded in part by a grant from the Cognitique program of the French Ministry of Research. All of the edited interviews have been checked by the composer. I would like to express my deepest gratitude to Roger Reynolds for allowing me to accompany him on this magical voyage and for sharing unreservedly his innermost thoughts on the music he was making. Such opportunities are rare and beautiful.

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