



Charting the Score in a Multimedia Context: the Case of Paradigmatic Analysis

Nicolas Donin and Jonathan Goldman



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ABSTRACT: Interested in what a contemporary practice of paradigmatic analysis might look like, the authors describe their research project aimed at studying past practices as well as conceiving of future possibilities in the form of a software tool. This article provides working, interactive samples of a prototype of this tool, which can be accessed by clicking on the applications contained in the article. By examining the “situatedness” of the analyst, the paradigmatic approach is seen not only as a precursor of the automatizing ambitions of late 20th-century music theory and musicology, but also as a structuralist reinvention of a tradition of listening that began with the analytical practices which emerged in Wagnerian Europe at the end of the 19th century.

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| I. On the Relevance of Paradigmatic Analysis Today | IV. General Concepts of Interface—Analytical Illustrations |
| II. On the Situatedness of Analysis | V. Possible Outputs of Score Charter |
| III. A Situated and Historically-Informed Design Process | VI. Conclusions |
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I. On the Relevance of Paradigmatic Analysis Today

[1] What could a contemporary practice of paradigmatic analysis look like? Although certainly not practiced in the way or to the extent that Nicolas Ruwet and Jean-Jacques Nattiez may have predicted 40 years ago, linguistics-inspired analysis has surely not been definitively relegated to the dustbin of the history of music theory, its past proponents dismissed as fashion victims of short-lived French intellectual trends. But where can we still find those famous charts, inspired by Claude Lévi-Strauss’s analyses of myths, anticipated by the ethnomusicologist Gilbert Rouget, proposed by Ruwet and systematized by Nattiez, which map out synchronic similarities by placing fragments of scores into columns?⁽¹⁾ Interest in this mode of analysis probably attained a zenith around 1982, the year that the journal *Music Analysis*, then edited by Jonathan Dunsby, devoted one of its very first issues to an English translation of Jean-Jacques Nattiez’s ninety-seven page analysis of Edgard Varèse’s *Density 21.5* (1982). Twenty-five years later, recent literature seems to suggest that two distinct groups of researchers remain interested in paradigmatic methods: ethnomusicologists and computer music researchers. On the one hand,

ethnomusicologists, particularly those of a more “structuralist” than “culturalist” bent, such as the members of Simha Arom’s team at LACITO in France,⁽²⁾ do indeed practice paradigmatic analysis (henceforth PA). However, since these researchers study music of oral tradition, they must necessarily modify PA to a score-less context. As such, they go beyond the bounds of Nattiez’s original project, since he was dealing principally with notated score-based music. On the other hand, computer music specialists, interested in melodic contour detection with a view towards information retrieval or musical similarity measures,⁽³⁾ and only secondarily in semiotics, sometimes give a ritual nod to the pioneering work of Ruwet et al, while rarely inscribing their work within a semiotic or analytic program.⁽⁴⁾ There remains a significant dearth of paradigmatic approaches among the mainstream of music analysts and theorists today, who were, after all, the target group of Nattiez’s work.⁽⁵⁾ What accounts for this scarcity? In order to attempt an answer, it is worthwhile to examine some of the principles underpinning PA, its methodological assumptions, and the ways it was approached by its original practitioners.

[2] Recall that Paradigmatic Analysis is a tabular representation of a musical work that arranges in columns those elements of a score which are considered identical with respect to some condition. In a PA, the music can be followed chronologically by reading from left to right and top to bottom as in an ordinary score, with the understanding that verticalities correspond to recurrences of similar elements. Already in the 1960s, pioneers of paradigmatic analysis had their sights set on algorithm-like rules able to be processed in principle by a computing machine that could generate semiotic analyses. It is striking, however, that none of them pursued this goal with any great fervor, even though their careers extended (and continue to extend) well into the age of the personal computer. And yet this automatization seems compatible with Nattiez’s goal of using paradigmatic analysis to constitute groups of works that share stylistic traits revealed through PA:

The principle of seriation [*mise en série*] is, as a matter of fact, the basis of the technique of automatic documentation which consists, for example in the field of archeology, in making an inventory, without any a priori criteria of relevance, the descriptive traits of monuments, and on the basis of this neutral inventory, to find, with the goal of stylistic characterization or something else, the traits common to several monuments (cf. Gardin 1974).⁽⁶⁾

On the other hand, this automatization seems incompatible with the goal of most music analyses, which seek to account for the singularity of the musical work and/or the comprehension of the analyst, and which even in the most formalized or generative forms of analysis, always involve on-the-fly micro-decisions, formulated during the heuristic process, which result from the inevitable resistance of the material to abstract theoretical rules.

[3] It remains that students of musical semiotics have often been left with the impression that the criteria of automatizability are crucial to the project of PA. The problematic nature of the assumption of “automatizability” in *principle* to paradigmatic operations may be in fact what led to this technological impasse, which could account for the unjustifiable neglect into which this analytical practice has fallen today. Nattiez needed to give more emphasis to this assumption (the claim that PA offers fully explicit rules of segmentation that could be performed by a hypothetical computer poring over strings of note-symbols) than Ruwet did, in order to be able to make PA the centerpiece of his “tripartite” theory of the musical sign (with its poietic, neutral and esthetic levels): he deems PA the very embodiment of “analysis of the neutral level,” the central (and most problematic) stage in the analytical schema that he borrows from Jean Molino.⁽⁷⁾ As he writes, “We then use Ruwet’s initial proposal [i.e., PA] in a framework (tripartition and stylistic analysis) which was never and is still not that of its author” (1975b, 239). Once PA is assigned the role of “analysis of the neutral level,” its objectivity and autonomy from the musical decisions of the analyst become crucial to Nattiez’s semiotic project. It is this problematic “neutrality” that has disturbed many of PA’s critics, such as Jonathan Bernard who, in the pages of *Music Analysis*, calls into question the supposed neutrality of the author of a PA, and in particular, Nattiez’s famous study of *Density*. Bernard worries that the discovery procedures involved in PA are only “superficially appearing to conduct their business in uninterpreted fashion” and are actually concealing their original motivation:

Despite [Nattiez’s] protestations to the contrary, then, he is really on the same footing as every other analyst. His work has been difficult to evaluate, however, because rather than admitting that the “inclinations” of his descriptive tools represent certain fundamental assumptions—assumptions which ought to be open to question, just as are other analysts’ assumptions—he has pretended to begin with properties of musical structure so universal that they have the status of unchallengeable axioms (1986, 209).

It is perhaps possible to accept Bernard’s objection while at the same time embracing a paradigmatic perspective: to do this, we must accept that paradigmatic analysis is the activity of a *situated* analyst who uses historically and geographically determined musical understanding and culture to make analytical decisions at every stage of the process—decisions that are

laden with innumerable assumptions (some or all of which could possibly be made fully explicit).⁽⁸⁾ Furthermore, paradigmatic analysis need not restrict itself to the so-called neutral level, but is itself a symbolic form that can be studied in terms of its modes of production (poiesis) and perception (esthesis). This presupposes an understanding of the situated character of analytic knowledge.

II. On the Situatedness of Analysis

[4] Of course, what allowed Jonathan Bernard to indict Nattiez's analysis so thoroughly was the fact that Nattiez is intellectually honest enough to make explicit so many of the analytical decisions that go into his analysis of *Density*. Thus, the situated character of the analytical act becomes visible right from the start, even if this was not of course Nattiez's stated intention. In several particularly revealing places, Nattiez refuses to decide between two alternative interpretations of a single passage, one of which gives pride of place to pitch, the other to rhythm. An analytical chart usually obscures the fact that it is the result of a choice on the part of the analyst, other interpretive options having been rejected at an earlier stage of the activity of recomposition involved in its fabrication. In contrast, Nattiez lays bare this very ambivalence. This bifurcation leads Nattiez to invent categories that support his analysis and give it its distinctiveness. In his analysis, he assigns lower-case letters ([2a], [4b], etc.) to alternative paths through the chart, as shown in **Example 1**.

[5] As Nattiez notes, the opening of the piece "can be seen, in fact, in two different ways (A and B), showing straight away that the neutral level is not restricted to *one* manner of presentation, but on the contrary displays the diverse configurations possible, though without professing to unite them all . . . The paradigmatic axis regroups units that are equivalent from a given point of view: this does not mean that they are homogeneous" (Nattiez, 1975*a* in Eng. trans., 1982, 248). Alternative A represents an alignment of elements according to rhythmic similarities, while the B column aligns elements according to pitch identities. This bifurcation brings out the distinction in a PA (or in any musical analysis) between *process* and *product*. Rather than being asked to accept a definitively constituted chart, Nattiez, by presenting an alternative, reminds us that the finished chart is the product of a process, one that moves back and forth between the work and the preliminary results of analysis. With this bifurcation, Nattiez brings the analyst on-stage as it were, revealing his own "compositional process" by presenting, in raw form, material that resists tabulation into the paradigmatic chart. It might even be said that PA, far from revealing automatizable rules of segmentation, is effective in revealing *to the analyst* the methodological assumptions that went into the analysis: what categories or concepts were used. When Nicholas Cook, for example, finds Nattiez's list of characteristic features (which are used to determine the paradigmatic headings) "curiously quirky" (Cook 1987, 172)—that is, that there is no universal feature list, but only particular ones made up for each individual piece under analysis—his objection may not be fatal for the enterprise of PA. The reason why Nattiez has a heterogeneous list of such categories as "M1=one semitone down and two up," "0=substitution of Eb for Eb," and "L=to-and-fro motion," is that the analysis has allowed him to reveal the cognitive categories that have been guiding his analysis from the start. The PA makes explicit categories of musical comprehension rather than applying objective neutral criteria of segmentation. These categories were clearly useful for Nattiez's own way of "listening" to the work, and one of the purposes of his analysis is surely to invite the reader to listen to the piece in the same way. In this view, any musical analysis—and PA in particular—is a "signed" listening—a way for listeners (whether experts or amateurs) to qualify and describe what they hear, in however informal a manner and however far removed from the "official" interpretations of the work.⁽⁹⁾ Looking at Nattiez's *Density* analysis, one is then struck by the fact that the *situated* character of the analysis is revealing and interesting, rather than being an element of undesirable subjectivity that needs to be excised from a truly scientific analytical project.

[6] We have seen how Nattiez's analysis of *Density* allows us to become aware of the role of the analyst himself, and the way he *performs* the musical culture to which he belongs: not only writing texts, but also listening to the recording, photocopying the score, cutting out portions of it, arranging them onto a larger paper with balls of tape, etc. These seemingly anodyne material operations turn out to be crucial to understanding this situated analytical activity. Once the analyst is brought onto the stage of the analysis it is not long before the role of the listener/reader of an analysis also becomes thematized. We could then speak of an *esthetic* level of paradigmatic analysis: the activity of the chart-reading listener. From this viewpoint, music analysis becomes a refined tool for listeners to be able to formulate their relationship with the work: inspired by reading an analysis, listeners are invited to borrow the author's conceptual categories and forms of musical comprehension the next time they listen to the work.

[7] A particularly eloquent example of this situatedness, from outside the realm of PA, is Arnold Schoenberg's famous autoanalysis of the relationship between the two themes of his *Kammersymphonie*, op. 9 (**Example 2**). On lines a) and b) appear two nearly literal transcriptions of the two themes. On lines c) and f) Schoenberg re-writes these themes and lays the

foundation of his analysis by variously assigning large or small noteheads or by spacing the notes with a view to bringing out a significant vertical relationship. Finally, in the two intermediary lines, d) and e), he makes explicit the relationship of inversion that he sees as holding between the two themes. Because Schoenberg is both the author of this analysis and of the work analyzed, it is obvious that the extreme subjectivity of his interpretation does not render it worthless or uninteresting. This subjectivity is, however, self-evident. After all, as has often been asked, by what criteria did Schoenberg choose certain notes as being important (the ones connected with lines), and relegate others to the status of auxiliary tones? (cf. Preface to Schoenberg 1995, 36–39) To find the answer to this question is to learn something about the way Schoenberg had come to *bear* his own work some 30 years after having composed it. The composer was clearly expressing through his analysis an *idée fixe* that had once occurred to him, never to be forgotten. At the same time, he found a way of expressing an analytical interpretation in tabular form in such a way as to (successfully?) prescribe *our* listening. In other words, the situated character of the analysis yields precious information. In fact, had Schoenberg formalized his observation even further—for example by extracting a rule and then looking for similar relationships in other pieces—he would not have diminished the fundamentally subjective interpretation to which he submits his work, but he would certainly have made it more accessible to the analytical community at large. This property of communicability that an analysis can possess will be revisited later on.

III. A Situated and Historically-Informed Design Process

[8] Similarly, in dealing with PA today, we cannot but be aware of the situated character of our own analytical stances: our laptops extend our cognitive capacities and become the environment upon which our intellectual activity is inscribed, and at the same time our musicological *Weltanschauung* is informed by a certain critical distance from the structuralist drive for mathematization that was part of a general tendency in the humanities and social sciences towards quantitative analyses of the formal logic underlying the arts, language and all human experiences (epitomized in the efforts of the members of Claude Lévi-Strauss's *Laboratoire d'anthropologie sociale* founded in 1960 at the *Collège de France*; on the history of quantitative analysis in the humanities and social sciences, cf. Dosse 1997). Our own research springs from these starting points: to see if it is possible to create a software environment for PA that allows analysts to perform all their usual activities within its confines, while at the same time taking advantage of the specific possibilities of the computer.

[9] The project presented here was undertaken by the APM (Analysis of Musical Practices)⁽¹⁰⁾ research group at IRCAM in Paris. This research group carries out research in the humanities into different musical practices, particularly those that lie at the heart of IRCAM's activities: composition, contemporary music performance, attentive listening, and music analysis. In this context, music theory is seen as both a central body of methods with which musical phenomena can be approached, and as a musical practice *per se* (a way to express one's musicianship) that can itself become an object of empirical study. One of APM's focuses is the way musical and audiovisual technologies can be used in the comprehension of musical facts being studied by music analysis. To this end, APM has laid out a historical as well as a technological program. On the one hand, it studies the techniques of close listening as they were promoted at the end of the 19th century in various types of listening guides, as well as their posterity in the work of professional analysts of the 20th century; on the other hand, the team works to develop hypermedia tools for music analysis that allow for the inclusion of time-coded annotations into the analytical presentations, which replace the traditional musical examples that one places in a text. This ties in with other projects at this institution. For example, a software package called Music Lab 2, which was a collaboration with the French Ministry of Education,⁽¹¹⁾ included Music Lab Annotation, a tool for synchronizing musical sound and image and allowing a scanned score to be annotated in many ways, in order to produce any of the following: a music analysis, a listening guide, or a “signed listening” (see paragraph 4). The particular focus of the APM team explains why the Score Charter project introduced in the following pages is the result of an unusual admixture of historical and technological research.

[10] APM's “Mise en tableau/écoute segmentée” (“Charting the Score/Segmented Listening”) project, which gave rise to the prototype of the Score Charter tool discussed (and exploited in the application examples) in this paper, was a collaboration between musicologists Nicolas Donin and Jonathan Goldman and software developers Thomas Bottini and Samuel Goldszmidt.⁽¹²⁾ The conception and development of this project, whose most tangible result is the score-charting computer tool for music analysis that is currently in a functional—although far from final—form, took place in 2005–2006, and then again in 2008. This team has followed a model of “collaborative design,” in which designers (programmers) and users work in the same space and interact with each other. This model of team cooperation involves specialists in very different domains who work together at all stages of the tool's development; the two musicologists have a need that they wish the tool to address, without having particular programming skills, while the two developers try to understand how best to respond to this need and to explain the different design options at their disposal to the musicologists without recommending any pre-conceived software solutions. This working model can thus stimulate unconventional responses to the needs of

researchers, however counter-intuitive these approaches might seem from the point of view of computer programming.

[11] The initial idea to develop a software tool capable of performing and presenting auditory paradigmatic analyses is then part of a larger research project concerned with the history of analytical gestures. We became particularly interested in the basic preliminary operations of musical chart-making that would need to be recreated by the software tool: cutting up the score into fragments, transcription/rewriting, joining fragments taken from different lines, the need to alter the chart along the way or even to destroy it. Other functionalities of the tool that were decided upon during the design process were:

- The ability to display temporal data related to fragments that had been divorced from their contexts through the act of segmentation.
- The possibility of assigning descriptive labels (semanticization) to the different fragments.
- The need to be able to set aside some elements for short or longer time periods, because they do not fit into the analytical viewpoint adopted at that precise moment.

It was decided early on that it would be useful to “sonorize” a paradigmatic chart: to synchronize the score with a corresponding recording, in order to be able to hear the fragments and to categorize them on the basis not only of the visual appearance of the score, but also of its incarnation as sound (which is of course absolutely essential when dealing with music for prepared instruments or live electronics, in which score reading alone misses critical musical information). We began by using the synchronization software already designed for Music Lab Annotation, which allows the user to define the placement of the systems, to place markers at junctures in the score, and by tapping, to associate these markers to corresponding places in the sound file. The segmentation is effected by hand, the analyst choosing the placement of the markers before the tool produces the chart. It is important to note that the Score Charter produces charts according to a segmentation that the analyst chooses in the first stages of analysis, and does not attempt to automatically segment a score. A newer version of the Score Charter is being fitted with an internal function for synchronizing score to sound, without recourse to MLA.

[12] A few words about the technical specifications of the tool. The Score Charter tool is developed in Flash ActionScript 2.0. It reads xml files produced during the synchronization procedure in MLA, and also produces xml files, which contain the instructions for producing the PAs from the synchronized score. The Flash programming environment was chosen because it allows for both offline and online tools to be developed, and is convenient for manipulating multimedia data—images, sound files etc. Moreover, the widely-used Flash player—with which most computers are equipped—recommends it as a means for web publication of tool-based music analyses. The Score Charter reads images in jpg format and sound in mp3 format of any bitrate. The xml files are exceedingly small (less than 100Kb), and can be conveniently sent as email attachments. They contain pointers towards the score images and the sound file. These lightweight files make the transmission of these analyses convenient, so that any potential reader who possesses the images of the score and the sound file can access the PA once the xml file is received as an email attachment.⁽¹³⁾ The structure of the tool can be represented as illustrated in **Figure 1**.

[13] While the production of paradigmatic analyses was the primary goal, we also wished the tool to be versatile enough to be able to display other forms of charts that involve fragments of scores, such as the D’Indy tabulation of the Haydn variations shown in **Example 3** or a Leitmotive table. Most importantly, we wanted to design a tool in which the reader of the analysis could interact with the chart, and even alter it. This interaction, which tends to blur the line between the *author* and the *reader* of the chart and puts readers and analysts on potentially equal footing, is only possible in the context of multimedia computer software. After all, a result in the form of a synoptic chart does not automatically give the reader all the information necessary for the reconstruction of the chart from the corpus being studied. In order to be able to submit an analytical conclusion to critical discussion, it is necessary to have access to all of the elements that gave rise to it, which in turn makes it possible to offer bifurcations or alterations to the process, which yield other resulting charts. This can be done effectively through some level of interaction with the chart: comparing by ear the different segments grouped together in the same row or column; modifying the appearance of the chart on the page by changing the order of the lines and the columns or simply the norms of presentation; lastly, it might be desirable to modify the segmentation that gave rise to the fragments which are the input of the chart, and then to re-order the chart as a function of these decisions, which are retrospectively called into question.

[14] The first thing that became apparent is that PA is a special case of a more general practice of charting scores. A genealogical relationship ties Ruwet’s invention to the Wagnerian tradition of processing musical texts. Indeed, Ruwet was inspired by Lévi-Strauss’s structural analyses of myths, which were themselves inspired by the vertical simultaneities of

musical scores. Lévi-Strauss, whose childhood worship of the “God Wagner” (Lévi-Strauss, 1964, p. 23) would have doubtless led him to become acquainted with the *Leitmotive* tables found in the opera guides of the French Wagnerian tradition, such as Albert Lavignac’s famous *Voyage artistique à Bayreuth* (1897), would therefore have been familiar with the experience of recomposing musical information from a score to a chart.⁽¹⁴⁾ In the field of French musical pedagogy, the workhorse of musical institutions throughout the French-speaking world for nearly half a century was the work of another Wagnerian: Vincent d’Indy’s *Cours de composition musicale* (1909). This composition manual abounds in tabular representations of analyses that often take a form reminiscent (to us) of certain modern analytical gestures, especially when d’Indy compares a theme with its variations in a movement from a Haydn piano sonata (Hob XVI/49), and deduces an underlying Gestalt (which he names the “*schème mélodique*”; see Example 3). D’Indy’s juxtaposition of the variations—similar to some Schenkerian analyses, such as Schenker’s reduction of Brahms’s Handel Variations (Schenker 2005, 81–83)—yields an output that in this case is a kind of primordial melodic contour, which, by being placed along the top of the chart, guides and induces a certain reading of the individual variations. The presence of this “*schème mélodique*” makes visually explicit what d’Indy’s analysis later expresses in prose about the variation set: the simple fact that something fundamental is common to all of them. D’Indy’s innovation was to inscribe this common schema along the top of the table. Similarly, in PA, the alignment of elements into columns implies a supplementary concept: that which is common to all of the elements in the column. In the case of PA, this may not be expressed as a transcendental melodic schema, but either as an exemplary element, which amounts to what Nattiez calls a “paradigmatic heading” (*tête de paradigme*), or as a tight web of qualitative relationships—what Nattiez sometimes terms a “paradigmatic theme.”⁽¹⁵⁾

[15] In light of this brief contextualization, PA can not only be seen as a precursor of the automatizing ambitions of late 20th-century music information retrieval or computational musicology (cf. notes 3 and 4), but also as a structuralist reinvention of a tradition of listening that begins with the analytical practices which emerged among Wagnerian Europe at the end of the 19th century, notably with the production of *Leitmotive* tables.⁽¹⁶⁾ (As a result, our project cannot but concern listening subjects, and subjective and psychological time, rather than the study of musical data divorced from listeners.) The intuition that structuralist musicology could be inscribed within a tradition of analytical techniques employed in earlier theoretical writings was noted by Célestin Deliège in 1974, in the years that Nattiez was writing the first book-length overview of musical semiotics, his *Fondements*:

Nineteenth-century treatises (D’Indy, Riemann) already bear the first traces of having sought a segmentation inspired by a concern for logic. In these works, it is already the principle of well-labeled equivalencies which guided these authors . . . In Schönberg, this taxonomy becomes even more precise on account of his having founded his theory on the tradition of Viennese classicism, and therefore, on the principle of variation of a basic cell (Deliège 1974, 32).

In the context of this tradition of chart making, Ruwet’s innovation seems to reside chiefly in a kind of open-endedness of the size and shape of the chart: since new rows and columns are created based on criteria of similitude, the dimensions of the chart only become fixed at the *end* of the analysis (cf. his famous analysis of the *Geisslerlied* shown in **Example 4**), rather than at the beginning; in D’Indy’s more conventional table, the size and form of the grid is predetermined during an analytical stage (i.e. a culturally-informed segmentation of the phrases to be compared) that logically precedes the fabrication of the chart.

[16] Over and above the historical genealogy of PA, what all of these charts have in common is the fact that they are produced by the same material means: retranscription, cutting into fragments, juxtaposition of different musical segments, and so on. It is these tasks that we were interested in emulating as on-screen operations. The tool’s representation of D’Indy’s variation table will make this clear (see **Example 5**). This simple chart for comparison of elements illustrates an important feature of the tool: superimposed segments that might not seem similar from a visual point of view (to a student, for example), can be easily *heard* to be similar. Of course, in a screenshot, used here instead of the application because of a problem in obtaining permissions for the recording used (that of Vladimir Horowitz), the fragments cannot be listened to. In the remaining examples in this article, the main features of the tool will be usable, and the reader will have the possibility of listening to different fragments as well as to entire rows and columns of elements.

IV. General Concepts of Interface—Analytical Illustrations

[17] In [12] the technical specifications of the tool were discussed. In the following paragraphs, we discuss the reasoning behind each of the elements of the tool. It is worth repeating that this tool is meant to aid the analyst in the elaboration and

presentation of his analytical processes, and not to compute analyses automatically in place of the user.

[18] *Synchronization*: The Music Lab Annotation (MLA) software contains a manual synchronization function. In the first version of the Score Charter, image files of the score (comprised of one or several pages) are made to correspond with an audio file using MLA. In the most recent version of the tool, this synchronization apparatus is integrated into the tool itself. In either case, score is synchronized to sound through tapping: with a rectangular tool, the systems of the score are described. By posting vertical markers within these systems while listening to the audio file, a correspondence is set up between vertical posts assigned along the sonogram of the audio file. Spatial coordinates in the score and temporal ones in the sound file are thus associated and encoded into an xml file. Since these vertical posts become the “seams” along which the cutting of the score can take place, it is important to place as many as possible. After the tapping, the synchronization can be corrected by a displacement of the markers in the audio file. It is worth noting that although the tapping process is ostensibly neutral and pre-analytic in character, it is clear that it appeals to the musicality (and therefore situatedness) of the analyst. That is, crucial musical decisions are made during this step, since segmentation in the Score Charter can only take place along markers set up during this process. It is necessary therefore to adopt one of two attitudes: *either* to listen for important formal junctures in the sound file, and then to lay down the markers in the corresponding places on the score, *or* to look for important junctures in the score, and to lay down markers at these places, in order to synchronize them to the sound file. In both cases, this step presupposes musical decisions on the level of listening as well as score-reading. At the same time, the process of laying down markers requires multiple listenings to fragments, and may provoke some unexpected analytical intuitions.

[19] *Segmentation/PA Generation*: With the score synchronized to the sound, the score can be segmented into fragments, while the corresponding sound remains associated with this fragment. Clicking on a fragment plays the corresponding excerpt. We are then in a position to assign to each of these fragments a label (preceded by an asterisk in the analysis of the *Geisslerlied* below) that designates the paradigmatic category to which this fragment belongs. Once every fragment is labeled, the software has in principle all of the user’s input it needs to automatically produce a paradigmatic analysis. This is in fact what happens when the user follows the steps below for producing an “APO” (“*analyse paradigmatique orthodoxe*”). Since the fragments preserve their timing information, the rules the computer follows to create the PA are simple, and go something like this: take the first chronological element, create a column for it; take the next element, and either create a new column (if it has a different label than its predecessor), or create a new row and place it in the first column (if it has the same label as its predecessor); continue in the same manner until there are no remaining fragments outside of the table.

Instructions for Application Use

1. Click on the example to launch the application. Once the new window opens, click anywhere in the window to ensure that it is active, and then use the ‘Page Up’ and ‘Page Down’ keys on the keyboard to resize.
2. Click on the “File Open” button on the top right of the screen (the icon showing an open folder). The labeled segments will appear. Click on segments to hear them. This should resemble the screenshot shown here. This is not the PA; it is a view of the work space cluttered up with labeled fragments. To construct the PA:
3. Click on the APO button. An empty 3x3 grid appears.
4. Click on the “APO I” button on the top edge of the 3X3 grid. An empty 2X2 grid appears.
5. Click on the “APO II” button on the top edge of the 2X2 grid. The PA will appear.
6. To isolate the PA, click on the X-shaped icon located on the top edge of the PA.
7. To see the place in the score from which the fragment was taken, press 'C' (context) with the cursor placed on the element.

NOTE: Score images and sound file may require a few moments to load.

If it fails to load, close the application and reopen

Once the fragment has been excised from the score and placed either into the workspace or directly into a chart, the place in the score from which it was removed turns grey. Since in a classic paradigmatic analysis, each fragment is used only once, the grey shading indicates visually which fragments have been used. Exhausting all the fragments in the score corresponds to the score being entirely shaded grey. However, nothing prevents a user from using the same fragment more than once, since this could conceivably correspond to a legitimate form of analytical practice.⁽¹⁷⁾

[20] *Geisslerlied revisited*: A comparison of the tool’s representation of Ruwet’s PA of the *Geisslerlied* (synchronized with MIDI sound since no recording exists of this apparently apocryphal example) with Ruwet’s original representation (**Application 1**

vs. Example 4) shows a revealing difference. The order of the columns is inverted: Ruwet placed columns **a** and **b** at the edges of the page, leaving space for what would become his elements **c** and **d** in the middle. The Score Charter produces columns in their order of appearance, placing a and b into adjacent columns, with c and d columns on the right. Ruwet's ordering is not justified by the generative rules that he lays out in the article, which, had they been followed to the letter, would have produced a chart that resembled the Score Charter version. Ruwet's decision clearly stems from a desire to have the larger former units **A**, **B**, **A'** etc. each occupy two lines. Also, his layout seems to be the result of his considering the **b** element as having a conclusive function in the phrase. However, his system is ostensibly designed to dispense with "fuzzy" form-functional terms like "concluding function" or "phrase". Ironically, in the first PA in history, Ruwet reveals his own situatedness and betrays his (non-automatizable) non-neutrality. Hence, the tool's rendering of the *Geisslerlied* PA can be used to understand two different directions that our research could have taken: the first direction would have consisted in providing highly constraining rules that dictate how to produce PAs in our tool—a direction that could even conceivably lead to a tool for automatically producing such analyses.⁽¹⁸⁾ The problem here is that, as we have just seen, even Ruwet leaves a residue of his own situatedness in an analysis as simple and as rigorous as his *Geisslerlied* example. As a result, no tool that generates charts through Ruwet's explicit rules of construction could produce an analysis of the *Geisslerlied* with exactly the same visual layout as his own, a fact that Ruwet may not have considered a cause for concern, since he concludes his 1966 article by provocatively declaring that "it is impossible to represent the structure of a musical piece by a single schema" (Ruwet 1966, in 1987, 134). In the second direction (the one we favored), the rules of PA are relaxed in such a way as to allow analysts to produce new versions of paradigmatic charts that would not have been possible from within Ruwet's system; in particular, ones that employ redundancies, variants, elements not included in the chart, etc. The following paragraph shows an example of a less orthodox form of PA undertaken with the tool.

[21] In *Mémoriale* (. . . *explosante-fixe*. . . *Originel*) (1985), Pierre Boulez adopts a form of thematic writing in which each phrase is given an identifiable contour, nuance, timbre: in a word, a characteristic "physiognomy."⁽¹⁹⁾ In fact, in a lecture devoted to an analysis of *Mémoriale*, held at McGill University in Montreal in 1991,⁽²⁰⁾ Boulez shows that in that piece, aside from the music from rehearsal number 24 up through but not including rehearsal 25, which is generated from an independent system (a rhythmic canon), there are no more than four of these fairly easily recognizable thematic units. This invited a simple paradigmatic approach in which the chart has only four columns, one for each thematic unit. This makes the chart less than orthodox since two entities belonging to the same column can differ wildly in terms of their number of notes, their central or polar note pitch, duration, etc., just as long as they share the same expression marking, phrasing, dynamic marking and playing style. Briefly, here are examples of each of the four themes, labeled A, B, C, and D.

For simplicity, only the flute solo part was used in the paradigmatic analysis. This was justified in terms of the conception of the piece, since *Mémoriale* began as a solo flute piece, and the flute part was completed in its entirety before Boulez went about composing the other parts (2 horns, 3 violins, 2 violas, and a cello). It is reasonable then to assume that the form of the piece is discernable from the flute part alone. Moreover, rehearsal numbers 22 through 24 (the rhythmic canon) are also excluded from the PA. Here is what the PA of the first page of *Mémoriale* looks like:

Instructions for Application Use

1. Click on the example to launch the application. Once the new window opens, click anywhere in the window to ensure that it is active, and then use the 'Page Up' and 'Page Down' keys on the keyboard to adjust size.
2. Click on the "File Open" button on the top right of the screen. The PA will appear. To play individual segments, click on them. To play entire rows or columns, click on the play buttons along the left and top edges of the chart
3. To isolate the PA, click on the X-shaped icon located along its top edge.

NOTE: Score images and sound file may require a few moments to load.

If it fails to load, close the application and reopen

[22] *Analytical difficulties and modifications of interface that they entailed*: It is interesting to look a bit closer at some of the challenges encountered over the course of this analysis, in order to highlight the way that the tool can be used. In the case of one element, its brevity made it difficult to classify, since it could be thought to possess aspects of A, B or even D (see **Example 10**). The possibility of listening to the fragment and comparing it aurally with elements in different columns can help in deciding where it ought to be placed. Alternatively, the tool has a function for the duplication of elements (button on top right of screen), which allows the user to place the same element in two different columns. Another difficulty arose when looking at the measures that follow **Example 11**. If we accept that the above example has the character of a B element, what

is less obvious is deciding whether this example comprises a single segment or three distinct ones. Using the tool, the entire excerpt can be cut out as a single segment, and if necessary, deleted, and the same passage can then be divided into three separate segments which are then laid out on separate rows of the PA. At any rate, the tabulation of the work into these four loose-knit paradigmatic categories was the starting point for the discovery of serial techniques at work in the ordering of the notes, particularly of the long held note with which each of them ends, and as such, the PA was the first step towards an analysis of the type that Nattiez would characterize as *external poietic*: following the PA, hypotheses were advanced about the way the work was produced by the composer. The example of *Mémoriale* brings out the need for another simple but crucial aspect of the interface: we needed a work (or play) space in which different fragments could be physically juxtaposed as well as labeled according to categories that were meaningful to us. This gave rise to two other important features of the interface: the intermediary (work) space and the labeling system (semanticization).

[23] *Workspace*: In this fairly indeterminate area, different labels can be freely assigned to the fragments and then compared visually and aurally with other fragments. In the case of *Mémoriale*, only four semantic labels were necessary, but the labeling process did take place in this space, which was needed in order to test whether the categories proposed by the composer were in fact relevant to the analyst's conceptualization of the piece. The need for this space was not recognized initially (after all, the presence of a workspace is never thematized by writers on PA), but grew out of the collaborative design project: it was another outgrowth of a reflection on the *process* of analysis. This space proves useful as it allows the user to group similar fragments together spatially in an informal manner, as a prelude to formally grouping them in the PA.

[24] *Semanticization*: As for the paradigmatic labels (those which are associated with elements and have names like ***a**, ***B**, etc.), they are neutral in character, and thus are generally not meaningful in themselves to the analyst. They are sufficient as a way of encoding elements involved in the production of a PA (such as the **a**, **b**, **c** and **d** of the *Geisslerlied* and the **A**, **B**, **C**, **D** of *Mémoriale*). The reality, however, is that more often than not these neutral labels become associated with a web of meanings. Either the paradigms are given neutral labels at the beginning (**a**, **b**, **c**, etc.) and then over the course of the analysis acquire a musical content in the analyst's mind, or the labels given to the paradigms at the beginning are thoroughly non-neutral ("jagged melody," "unisons," "head motive," etc.) and are only replaced with neutral symbols at a later stage of the analysis, and then presented in this manner. In either case, the neutral symbols become associated with meanings: designations (location in the score) and/or connotations (heuristic qualitative markers such as "to-and-fro motion," "ascending," "espressivo," etc.). We wanted to be able to label fragments with a multiplicity of terms that would allow the analyst to classify them and be reminded of their provenances. In so doing, we are trying to rehabilitate the least dogmatic and most semantically rich approach to PA possible, one that Nattiez explicitly embraces at one point through his notion of "paradigmatic theme" discussed above ([14] and n. 15) and developed in the following passage:

The important thing to keep in mind when classifying the phenomena, is to supply what Molino calls a "block," that is a group of elements paradigmatically associated which possess a "family resemblance," but for which the criteria of association are not necessarily identical from the first to the last element in the paradigm. (1975b, 264)

It is in the workspace that the analyst identifies these family resemblances, by proliferating potentially relevant labels during this stage. Through a process of refinement and reduction, the number of paradigmatic themes is eventually reduced to a manageable number that can be accommodated into a chart (see **Example 12**). Of course, nobody is campaigning for the publication of "honest" analyses that include the un-retouched mess of the workspaces in which they were created. Nevertheless, the presentation of finalized, definitive versions of analytical charts never fails to conceal crucial information for the reader trying to reconstitute the process of analysis. We could imagine a kind of compromise in which some elements of the workspace remain in the (online) published analysis; in particular, those elements that get segmented but then do not find a home in the final chart could be left to linger in the workspace, in the name of full disclosure, and as an admission that not *everything* fits comfortably into the analytical viewpoint adopted.

V. Possible Outputs of Score Charter

[25] Often, we chart the work in order to become acquainted with it, without any idea of what the charting process will yield. At other times, a chart can be a presentation method for a deduction made a previous stage. In the third and most stimulating case, the chart-making activity provides the conditions for a new deduction to be made. D'Indy's preceding table, with its discovery of the "*schème mélodique*," would fall into either the second or the third of these categories. The question is impossible to answer precisely because of the static and definitive form of analyses on paper. Other non-orthodox variants

of classic PA can be imagined that are particularly apt at discovering and presenting aspects of large-scale form.

[26] The Score Charter is used in the following example to bring out how the form of a work can be deduced from an abstract and unheard model in Pierre Boulez's *Anthèmes 1* for solo violin (1992). The starting point of this analysis was the seemingly trivial observation that a melodic profile consisting of an appoggiatura, followed by a long note often played as a trill, and concluding with several short notes was typical in Boulez's music in general, and in *Anthèmes* in particular (in which it functions, perhaps, as a sort of macroscopic version of the attack-resonance-decay profile of any sound) (Goldman 2001). The idea was to represent the work as the progressive revelation of the constituent parts of an underlying theme that conforms more or less to the three-staged model of the Boulezian phrase. Eight different cells belonging to this virtual theme were discerned, and the entire 8-minute piece (with the exception of a pizzicato section and the concluding section) could be interpreted as the enunciation of a theme that exists only in virtual form, and never with a full complement of its eight elements, which were labeled **a1**, **a2**, . . . **a8** (see **Example 13**). Placed together (although it never appears in the piece in this form), these elements form a virtual phrase that more or less follows the tripartite structure outlined above (See **Example 14**; *attack*: sul pont. tremolo and rising "jeté" phrase; *resonance*: trill with legato phrase underneath; *decay*: irregular 16th notes followed by half-hair, half-wood 32nd notes).

[27] The Score Charter can be used to isolate and group together different instantiations of its outputs by assigning one column for each element of the virtual theme, a1 to a8. This virtual theme can then be listened to, even if it never appears in unabbreviated form in *Anthèmes*. The tool is then used to represent the deployment of a virtual theme that never appears as such in the work. In the following example, only the first of Anthème's six sections is displayed. In this section, only 3 of the 8 elements of the virtual theme are employed:

Instructions for Application Use

1. Click on the example to launch the application. Once the new window opens, click anywhere in the window to ensure that it is active, and then use the "Page Up" and "Page Down" keys on the keyboard to resize.
2. Click on the "File Open" button on the top right of the screen (the icon showing an open folder). The chart will appear. To play individual segments, click on them. To play entire rows or columns, click on the play buttons along the left and top edges of the chart
3. To isolate the chart, click on the X-shaped icon located along its top edge.

NOTE: Score images and sound file may require a few moments to load.

If it fails to load, close the application and reopen

The different instances of the theme can be verified through listening; each fragment's membership in one or another of the columns can be questioned by the author of the PA as well as by the reader. This example also shows how this type of unconventional PA can be used to succinctly describe large-scale form. ⁽²¹⁾

[28] As our last example showed, the frequent use of the tool over the course of its development leads to new unanticipated issues. Problems with the current version of the tool as well as possible future extensions are enumerated here. They have been logged and are in the process of being integrated into a new version of the tool developed by Thomas Bottini as part of a larger software project at the Université de Technologie de Compiègne (UTC). ⁽²²⁾

- *Synchronization*: in the present version of the tool, once the synchronization is completed, it cannot be altered at a later stage of the analysis. This is a problem with respect to our processual point of view. Synchronization being a step that is laden with analytical presuppositions, a tool like the Score Charter should allow for some of these presuppositions to be called into question over the course of the analysis. In a new version of the tool currently being developed by Thomas Bottini, the user will be able to modify the placement of the markers at any stage of the analysis, since the synchronization will be integrated into the tool (rather than being imported from MLA).
- *Alignment, visual fine-tuning of spacing*: in most PAs, it is necessary to respace the notes so that specific pitches or melodic contours can be aligned. The tool at present is not precise enough to be able to stretch stems in order to achieve the kind of alignment that can be achieved on paper. ⁽²³⁾ The new version of the Score Charter should be able to manipulate the visual spacing of the fragments by non-proportionally-constrained stretching and contracting.
- *Creation of rules*: it would be desirable for a later version of the tool to be able to define rules for chart production. One could imagine having a catalogue of rules in which fragments are classified by their duration, by the semantic label they have, etc., and in which new rules are to be defined by concatenating these. These rules then become the means for

automatically producing different kinds of charts. The user could then conceivably visually compare the type of chart that a given rule yields, obtaining the visual result of adopting one set of rules versus another.

- *Encoding*: a future version of the tool might use a score image enriched by some kind of musical encoding of some or all of its content into standard forms such as MIDI or HUMDRUM, which then allows for more elaborate musical spacing along the lines of music editors like Finale or Sibelius.

VI. Conclusions

[29] Both the preliminary considerations outlined at the beginning of this article, as well as the practical business of designing a tool like the Score Charter, compel us to reconsider the status of the chart in music analysis in general. One of the most salient criticisms of graphic presentations of analytical data appears in an article by Kofi Agawu (1989) on the practice and the epistemological status of Schenkerian graphs and analytical charts in general. For him, the abundance of charts and graphs in an analysis is sometimes used as a smokescreen to hide the lack of specific conclusions or the inability to synthesize observed facts, causing them to publish elaborate but problematic analytical works-in-progress. Agawu concludes that

the extensive printing of graphs in our journals may well be a sign that all is not right. Are not many of the graphs we use pre-analytical (representing the genesis of the analyst's efforts) rather than analytical (presenting the actual conclusions arising from the analysis)? Except in the case of didactic works, such printing of long samples of hierarchic notation with no specific conclusions arising out of the effort seems to me to blur the dividing line between tautological demonstrations and exhaustive ones (Agawu 1989, 295).

It may well be that the malaise that Agawu observes is a feature of the paper medium for music analysis, rather than a problem with excessively data-rich analytical charts in general. Agawu would like scholarly articles in scientific journals to provide compact charts that are resyntheses of the data culled over the course of the analysis, placed in a manner considerably removed from the analytical process through which the results were derived. Once we are dealing with analyses that begin life as multimedia objects, this constraint can be relaxed. The dynamic character of multimedia representations of tabular information can conveniently encapsulate in compact form different stages of the analysis without the abuse of charts that Agawu deplores. Following this approach, not only are the results accessible, but also the steps and the operations that *led* to those results, a form of methodological transparency that adds to the scientific credentials of music analysis by inviting refutation at each step. If we wish to better integrate into the writing of analysis the fact that the results presented are first and foremost the culmination of a listening practice, then we must find ways to connect *technologies of publication* to the *analytical apparatus* itself. This is done in such a way that readers can assimilate the analysis by redoing it themselves, allowing them also to extend, to modify or to contradict the analysis proposed. Agawu's criticism of publishing snapshots of pre-analytical tabulation is rooted in it being a wasteful or futile activity in the paper medium, particularly when no particular conclusions are drawn from them. One could imagine that Agawu might be less critical of a non-paper multimedia context in which access to the conclusion implies that the user must pass through some decisive stages, either the real stages of the analysis, or (preferably?) their reduction into a logical progression: a fictional narrative constructed for didactic reasons.

[30] In the realm of multimedia projects focusing on musical works, two approaches that implement specifically process-based presentations have been explored: one which allows the reader to engage with the processes through which the composer produced the work, and the other with the processes through which the analyst produced the analysis. An example of a project of the first kind, which allows the reader to engage with the composer's creative processes, is a DVD-Rom produced by the APM team on the work *Voix(r)ex* by French composer Philippe Leroux.⁽²⁴⁾ The Score Charter, on the other hand, takes the opposite tack, in that it allows the reader to follow the *analyst's* paths to the work rather than the composer's. There are examples of projects having aspects of both of these approaches. One in particular is of special interest to us since it uses paradigmatic methods: Michael Clarke's analysis of Jonathan Harvey's *Mortuos Plango Vivos Voco*, which appeared in a book chapter in a volume devoted to the analysis of electroacoustic music. On the accompanying CD-ROM, the reader is both invited to perform some of the compositional operations that Harvey used (but in the context of an analog studio) to construct the piece, and to follow a paradigmatic presentation of it (cf. Clarke 2006), using the software package Clarke helped to develop, Sybil (cf. Clarke 2005).⁽²⁵⁾ Of course, Clarke's analysis does not use PA as part of its discovery strategy, since the material is already segmented according to sketches that the composer made available to him; the PA serves the purposes of presentation only. However, Clarke's work deserves recognition for being the first example of an auditory PA ever published, and makes a major step towards countering a serious criticism often leveled at PA.

[31] Nicholas Cook, in his *Guide to Musical Analysis*, lumped "semiotic analysis" in the category "Formal Approaches to

Analysis” along with set theory (Cook 1987, chapter 4). He defined “formal analysis” as “any kind of analysis that involves coding music into symbols and deducing the musical structure from the pattern these symbols make” (1987, 116), and expressed his doubts about the usefulness of PA for musical understanding:

The problem is this: how much of what matters about music is retained in the translation from sound-experiences to abstract categories such as “ascending conjunct line”? Can we say anything important about the experience of a given line simply by classifying it as the opposite of lines which are descending or disjunct? Aren’t we in danger of making precise statements about musical scores which have only the vaguest connection with the music we experience? (Cook 1987, 181)

This criticism is not wholly unjustified, and it may indeed hold of the two analyses that he studied. His criticism, according to which PA is cut off from lived musical “experience” and its results difficult to generalize, were valid at the time, and may very well account for the fact that few music analysts seemed to take a serious interest in this practice. In 1987, of course, it would have appeared farfetched that were PA, that most algorithmic and “machine-like” of methods, transposed onto the computer, it could integrate listening experiences through its auditory component. And yet a tool like the Score Charter could possibly be used to integrate the listening subject into the analysis, and to make visible the distinctive listening experience of the analyst. This would be the furthest thing from the “formal approaches to analysis” that Cook had in mind. Such an approach could lead PA away from the formalist, notation-centric (to use Philip Tagg’s terminology [1987, 284]) model to one that incorporates critical listening into its apparatus.

[32] As for the personal, situated character of analyses, Bruno Nettl, in the 1983 edition of *The Study of Ethnomusicology*, raised a concern that deals not with the analytical “yield” of PA, but with its role within a community of analysts. In semiotic-inspired analyses such as those of Nattiez and Charles Boile’s, in vogue in ethnomusicology at the time, Nettl notes that

the methods become more and more complex; in a sense they give more information but are harder to read, lend themselves less easily to comparison, and are more difficult to apply by someone who did not originate them. Despite the universalist intention, they turn out to be culture-specific, or at best scholar-specific. (Nettl 2005, 95)

Nettl’s criticism is the sociocultural counterpart of Agawu’s technical criticism, and needs to be taken seriously: certainly, an analysis can be specific to a particular researcher (a particular listener), but, as has been emphasized already, PA can be a method of transmitting this unique way of hearing to an open-minded other. Nettl was correct to note that PAs are complex and difficult to read, but couldn’t this be a result of the fact that their practitioners over-emphasized the need to make every step explicit? After all, the goal of PA is the same as that of a mathematical proof: to convince the reader. As such, a PA, just like a mathematical proof, should only contain as much information—and no more—as is needed to convince the reader of the point of view of its creator. As in mathematics, it is understood that a fully-explicit argument is possible in theory, but inconvenient and unnecessary in practice. Once PA is implemented as a method for transmitting musical experiences, it could transcend the solipsism that Nettl rightly observed in some PAs. With a software PA, a reader who wants to retrace all of the steps of the analysis can do so, as was noted with respect to Agawu’s argument above. Moreover, if it is true that the present musicological era has gone “beyond structural listening,” then there is more than one correct way of listening to music (or indeed, if it has gone postmodern, then there is *no* correct way). A multimedia environment in which different analyses can all be opened in the same interface favors comparison and evaluation: both multiple interpretations of a single work and navigation through a corpus of several works. Although the Score Charter is conceived primarily as a method for studying individual works, and not as a response to Nattiez’s early hopes (invoked above) to use PA in the service of style analysis of large repertoires on the model of archeology, it would be desirable to extend a multimedia tool to encompass analyses of groups of works (the works of a single composer, of a single period, etc.).

[33] A final word is in order about automation. From the point of view of computer science, this tool is strikingly lacking in innovation, since it contains no new algorithms. If there is anything innovative in it at all it is the idea of having theorists and musicologists conceive and design their own tools specially adapted to their needs, rather than being forced to make pre-existing *musical* tools (Finale, MaxMSP) perform *musicological* tasks for which they were not designed, or oblige musicologists to learn from scratch non-musical programming environments in order to perform tasks specific to music analysis. The Score Charter, conversely, is designed with very well-identified music-analytic goals in mind (making charts of scores), with the hope that the tool could then be applied to perform other (analytic) tasks for which it was not specifically conceived. Nevertheless, far from being opposed to computer-assisted analysis, certain stages of the analytical process could doubtless benefit from automation, such as the synchronization process, or the outputs of performance information analysis.

In later versions, the Score Charter could be given connectivity with other tools that take charge of some of the automatizable stages of the analysis. However, the creators of our tool are interested in some of the necessarily unautomatizable stages in the analytical process: those which appeal to analytical decision-making based on one's specific musical culture (such as the rules for chart-forming described above) and which could benefit from the versatility provided by a digital interface. The collaborative design project would have to be extended to find out, in conjunction with the software developers, just *which* automatizable aspects of the analytical process would be feasible. Here again, such a study would necessarily have two facets: a technological project as well as a genealogical investigation of a crucial practice in music theory since its inception.

Nicolas Donin
IRCAM
1, pl. Igor-Stravinsky
Paris 75004
France
nicolas.donin@ircam.fr

Jonathan Goldman
University of Victoria
School of Music
PO Box 1700 STN CSC
Victoria, BC V8W 2Y2
Canada
goldmanj@uvic.ca

Works Cited

- Adiloglu, Kamil, Thomas Noll and Klaus Obermayer. 2006. "A Paradigmatic Approach to Extract the Melodic Structure of a Musical Piece." *Journal of New Music Research* 35/3: 221–236.
- Agawu, Kofi. 1989. "Schenkerian Notation in Concept and Practice." *Music Analysis* 8/3: 275–301.
- Allard, Michel et al. 1963. *Analyse conceptuelle du Coran sur cartes perforées*. Paris-The Hague: Mouton.
- Ayre, Craig. 1994. "Debussy's Significant Connections: Metaphor and Metonymy in Analytical Method." In *Theory, Analysis, and Meaning in Music*, ed. Anthony Pople, 127–151. Cambridge: Cambridge University Press.
- Bencini, David, Michele Ignelzi and Lelio Camilleri. 1992. "Paradigmatic Analysis through the Computer." In *Secondo Convegno Europeo di Analisi Musicale*, ed. Rossana Dalmonte and Mario Baroni, 609–612. Trent: Università degli Studi (Dipartimento di Storia della Civiltà).
- Bernard, Jonathan. 1986. "On 'Density 21.5': A Response to Nattiez." *Music Analysis* 5, 2/3: 207–231.
- Blasius, Leslie. 1996. *Schenker's Argument and the Claims of Music Theory*. Cambridge: Cambridge University Press.
- Campos, Rémy and Nicolas Donin (eds.). 2009. *L'analyse musicale, une pratique et son histoire*. Geneva: Conservatoire de Genève/Droz.
- Chemillier, Marc. 2009. "L'analyse paradigmatique. À propos de l'œuvre de Gilbert Rouget." In Rémy Campos and Nicolas Donin (eds.), *op. cit.*, 85–106.
- Clarke, Michael. 2005. "An Interactive Aural Approach to the Analysis Of Computer Music." In *Proceedings of the 2005 International Computer Music Conference (ICMC) Escola superior de Musica de Catalunya, Barcelona, Spain, 4–10, 2005*, ed. Andres Lewin-Richter and Xavier Serra, 85–92. San Francisco: ICMA.
- . 2006. "Jonathan Harvey's *Mortuos Plango, Vivos Voco* : An Interactive Aural Analysis." In *Analytical Methods of Electroacoustic Music*, ed. Mary Simoni, 111–143. London: Taylor and Francis.

- Cook, Nicholas. 1987. *A Guide to Musical Analysis*. London: Dent.
- Deliège, Célestin. 1965. "La musicologie devant le structuralisme." *L'Arc* 26: 45–52.
- . 1974. "Les techniques du rétrospéctivisme." *International Review of the Aesthetics and Sociology of Music* 5/1: 27–41.
- D'Indy, Vincent. 1909. *Cours de composition musicale*, vol. II. Paris: Durand.
- Donin, Nicolas. 2004. "Towards Organised Listening: Some Aspects of the 'Signed Listening' Project, Ircam." *Organised Sound* 9/1: 99–108.
- . 2005. "Samson François jouant *Noctuelles*: notes de lecture." *DEMeter*.
- Donin, Nicolas and Frédéric Keck. 2006. "Lévi-Strauss et « la musique ». Dissonances dans le structuralisme." *Revue d'Histoire des Sciences Humaines* 14: 101–136.
- Dosse, François. 1997. *History of Structuralism*, 2 vol. Trans. Deborah Glassman. Minneapolis: University of Minnesota Press.
- Goldman, Jonathan. 2001. *Understanding Pierre Boulez: Notes on Anthèmes*. "Creating a labyrinth out of another labyrinth." M.A. diss. Université de Montréal.
- . 2006. "Exploding/Fixed: Form as Opposition in the Writings and Later Works of Pierre Boulez." Ph.D. dissertation. Université de Montréal.
- . 2009. "Charting *Memoriale*: Paradigmatic Analysis and Harmonic schemata from Boulez's '...explosante-fixe. . .?'" *Music Analysis* 27.
- Hutchins, Edwin. 1995. *Cognition in the Wild*. Cambridge: MIT Press.
- Ignelzi, Michele and Paolo Rosato. 1998. "Signification in music: between structure and process. A new role for paradigmatic analysis." *Contemporary Music Review* 17/1: 39–55.
- ISMIR 2005 Conference Proceedings: 6th International Conference on Music Information Retrieval, London, UK, 11–15 September 2005*, ed. Joshua D. Reiss and Geraint A. Wiggins. London: University of London, 2005.
- ISMIR 2006 Conference Proceedings: 7th International Conference on Music Information Retrieval : Fairmont Empress Hotel, Victoria, BC, Canada, 8–12 October, 2006*, ed. Roger Dannenberg, Kjell Lemstrom and Adam Tindale. Victoria, University of Victoria, 2006.
- ISMIR 2007 Conference Proceedings: 8th International Conference on Music Information Retrieval, September 23rd–27th 2007, Vienna, Austria*, ed. Simon Dixon, David Bainbridge, and Rainer Typke. Vienna: Österreichische Computer Gesellschaft, 2007.
- Koozin, Timothy. 1999. "On Metaphor, Technology, and Schenkerian Analysis." *Music Theory Online* 5.3.
- Lartillot, Olivier. 2002. "Musical Analysis by Computer Following Cognitive Model of Induction of Analogies." *Proceedings of the International Computer Music Conference, Göteborg, September 16–21, 2002*: 20–27.
- Lavignac, Albert. 1897. *Le voyage artistique à Bayreuth*. Paris: Delagrave.
- Léotar, Frédéric. 2003. *Les mélodies buchées touvas et ouzébèques : aspects compositionnels et dimension culturelle*. Ph.D. dissertation. Université de Montréal.
- Lévi-Strauss, Claude. 1963. "The Structural Study of Myth (1955)." In *Structural Anthropology*, trans. Claire Jacobson and Brooke G. Schoepf, 206–231. New York: Basic Books.
- Littlefield, Richard and David Neumeier. 1992. "Rewriting Schenker: Narrative-History-Ideology." *Music Theory Spectrum* 14/1: 38–65.
- Marchand, Guy. 2003. *Bach, ou, La passion selon Jean-Sébastien : de Luther au nombre d'or*. Paris: L'Harmattan.
- Monelle, Raymond. 1992. *Linguistics and Semiotics in Music*. Chur: Harwood.

- Nattiez, Jean-Jacques. 1971. "Situation de la sémiologie musicale." *Musique en jeu* 5: 3–17.
- . 1973. "Trois modèles linguistiques pour l'analyse musicale." *Musique en jeu* 10: 3–11.
- . 1975b. *Fondements d'une sémiologie de la musique*. Paris: UGE.
- . 1982. "Densité 21.5 de Varèse : essai d'analyse sémiologique." Montreal: Faculté de musique de l'Université de Montréal, 1975a. Eng. trans.: "Varèse's *Density 21.5*: a Study in Semiological Analysis." *Music Analysis* 1/2: 243–340.
- . 1998. "A Comparison of Analyses from the Semiological Point of View (the Theme of Mozart's Symphony in G minor, K550)." *Contemporary Music Review* 17/1: 1–38.
- Nettl, Bruno. 2005. *The Study of Ethnomusicology: Twenty-Nine Issues and Concepts*. Urbana: University of Illinois Press, 1983; rev. and exp. ed.
- Puig, Vincent et al. 2005. "Musique Lab 2: A Three Level Approach for Music Education at School." In *Proceedings of the 2005 International Computer Music Conference (ICMC) Escola superior de Musica de Catalunya, Barcelona, Spain, 4–10, 2005*, ed. Andres Lewin-Richter and Xavier Serra, 419–422. San Francisco: ICMA.
- Rouget, Gilbert. 1961. "Un chromatisme africain." *L'Homme* 1/3: 33–46.
- Roy, Stéphane. 2003. *L'analyse des musiques électroacoustiques : modèles et propositions*. Paris: L'Harmattan.
- Ruwet, Nicolas. 1987. "Méthodes d'analyse en musicologie." *Revue belge de Musicologie* 20 (1966): 65–90. Reprinted in *Langage, musique, poésie*, 100–133. Paris: Éditions du Seuil, 1972. Eng. trans.: "Methods of Analysis in Musicology." Mark Everist (trans.) *Music Analysis* 6, 1/2 (1987): 11–36.
- Sampaio, Luiz Paulo de Oliveira. 1999. *Reflets dans le miroir : essai d'analyse sémiologique tripartite des Variations, opus 27 de Webern*. Ph.D dissertation. Université de Montréal.
- Schenker, Heinrich. 2005. *Der Tonwille. Pamphlets in Witness of the Immutable Laws of Music : Offered to a New Generation of Youth*, 2 vols, ed. William Drabkin, trans. Ian Bent, William Drabkin et al. Oxford: Oxford University Press.
- Schoenberg, Arnold. 1975. "Composition with Twelve Tones (1)." 1941. In *Style and Idea*, 214–244. London, Faber and Faber.
- . 1995. *The Musical Idea and the Logic, Technique, and Art of its Presentation*, ed. Patricia Carpenter and Severine Neff. New York: Columbia University Press.
- Suchman, Lucy A. 2007. *Plans and Situated Actions: the Problem of Human-Machine Communication*. Cambridge-New York: Cambridge University Press, 1987. 2nd ed., *Human-Machine Reconfigurations: Plans and Situated Actions*. Cambridge-New York: Cambridge University Press.
- Szendy, Peter. 2007. *Écoute : une histoire de nos oreilles*. Paris : Éditions de Minuit, 2001. Eng. trans.: *Listen: a History of Our Ears*, trans. Charlotte Mandell. New York: Fordham University Press.
- Tagg, Phillip. 1987. "Musicology and the semiotics of popular music." *Semiotica* 66, 1/3: 279–298.
- Théberge, Paul. 2008. "Exploring the creative process: hypermedia tools for understanding contemporary composition." *Circuit, musiques contemporaines* 18/2: 77–85.

Footnotes

1. Cf. Lévi-Strauss, 1955 in 1963; Rouget 1961; Ruwet 1987; Nattiez 1975b. Incidentally, according to Igelzi and Rosato (1998, 39), paradigmatic analysis had an important precursor in the work of Italian composer Firmino Sifonia in the early 1960s, who had no knowledge of Ruwet's work.

[Return to text](#)

2. [Laboratoire de langues et civilisations à tradition orale](#), associated jointly with the Centre national de la recherche scientifique (CNRS) and the Universities of Paris 3 and 4.

[Return to text](#)

3. Such as the work presented in sessions of recent ISMIR (International Conference on Music Information Retrieval) meetings with names like “Self-Similarity and Structure,” “Classification,” “Motivic and Melodic Analysis and Retrieval,” etc. Cf. Proceedings of ISMIR 2005, 2006 and 2007.

[Return to text](#)

4. Among several significant exceptions to this rule, we could cite Olivier Lartillot (2002), who lays out a program for a software tool which detects motivic similarities in raw musical material, and a study by Adiloglu et al. (2006) which uses topological concepts to develop an automated, mathematical approach to the paradigmatic analysis of the melodic content of a piece of music.

[Return to text](#)

5. Exceptions to this can be found in the work of many of Nattiez’s graduate students: Sampaio (1999), Léotar (2003), Roy (2003), Goldman (2001, 2006).

[Return to text](#)

6. Nattiez 1975b, 359. All translations in this paper are our own, unless a published English version exists, and is cited in the bibliography. Nattiez cites Gardin’s work in using computers to analyze the Koran (Allard et al. 1963).

[Return to text](#)

7. In any case, Nattiez’s opinion on the possibility of automation was not stable during the years that he theorized musical semiotics in general, and PA in particular. In 1971, he seemed favorable to a project which automatizes analysis of large repertoires. According to him, “since we need to tally all the recurrences of stylistic traits and to establish the rules of their combination, essential formal models will be supplied by information theory, computer science, statistics and mathematics” (Nattiez 1971, 15). However, rather than delving into the details of a computational musical stylistic analysis, he lamely writes that “the development of computational studies in the humanities, in musicology in particular is so widespread today in America, that this research area must be dealt with in a journal issue entirely devoted to it” (Nattiez 1971, 18). Needless to say, this issue was never published, and already in 1973, Nattiez deploys cautionary arguments against automation which he continues to embrace to this day: “It would be false to think that an explicit procedure has an algorithmic character: a machine, programmed according to these directives, could not produce the analysis in our stead: first of all, because our attitude with respect to the text is never totally neutral; acculturated as we are to tonal works, we have intuitions about their code. Secondly, because our procedure does not make an inventory of *all* the effective operations. It does however allow the musicologist to verify his own procedures and to be supported by a consistent methodology in order to criticize them and to improve other analyses” (Nattiez 1973, 7). The same ambivalence can be observed in Ruwet’s seminal 1966 article “Méthodes d’analyse en musicologie,” in which he seems to initially posit the possibility of automation—albeit only in principle—when he speaks of a “machine for identifying elementary identities” (which, admittedly, he places within quotation marks). However, he ends the article on a less futuristic note, by pronouncing the seeming impossibility of the automated production of definitive analyses: “The consequence of all this is, as has been seen, that it is impossible to represent the structure of a piece of music by a single arrangement” (Ruwet 1987 in Eng. trans., 32).

[Return to text](#)

8. This ties in with the notion of situated cognition, a key concept in recent research in cognitive anthropology. Cf. for example Lucy A. Suchman’s classic *Plans and Situated Actions: The Problem of Human-Machine Communication* (2007) and Edwin Hutchins’ *Cognition in the Wild* (1995). These two works were instrumental in defining the hybrid of historical and empirical research which characterizes the agenda of the APM team, and resulted notably in the papers collected in Campos and Donin 2009. The notion of situated analysis employed in this paper is explored in greater depth there.

[Return to text](#)

9. Sometimes, a signed listening can be as informal as the way in which a reader might annotate a copy of a novel by jotting down notes in the margins. The term derives from the fact that it is a distinctively personal way of listening to the piece which could be figuratively thought to be “signed” just as a painting or a critical reading of a poem is signed by its author. For more information, cf. Donin 2004. A fine example of multimedia performance analysis designed by the APM team is available [here](#).

[Return to text](#)

10. Cf. APM's [webpage](#).

[Return to text](#)

11. Cf. Music Lab 2's [webpage](#). Cf. [Puig et al. 2005](#).

[Return to text](#)

12. Donin and Goldszmidt are permanent members of the APM team, who are engaged in a number of long-term projects as can be seen at the above link. Bottini is a doctoral candidate who began work on the tool as a research intern at IRCAM in 2005. Goldman (a musicologist at the University of Victoria) was a guest researcher in the APM team in the Fall of 2005 and again in the summer of 2008 thanks to a grant from the City of Paris's Guest Researchers Office. Other articles on the tool dealing with aspects of the collaborative design and the problems of integrating computer software development into musicological practice will involve the other two members of the team.

[Return to text](#)

13. In the next version of the tool, ActionScript 3.0 will be able to read scores in pdf format.

[Return to text](#)

14. On the relationship between Wagnerian Leitmotive tables and Lévi-Strauss's analyses of myths, cf. [Donin and Keck 2006](#), 131–134.

[Return to text](#)

15. “We could propose the term “*paradigmatic theme*” for the totality of criteria in the name of which elements are associated along the same axis of equivalence. It should be noted that these criteria are not necessarily supplied only by the first element in the paradigm, which we term the “*paradigmatic heading*” (*tête du paradigme*)” (1975b, 264).

[Return to text](#)

16. Just as a critique of Schenker needed to be buttressed by the writing of a history of Schenker and Schenkerian analysis which places it within a specific musical and cultural context (e.g., [Littlefield and Neumeyer 1992](#) and [Blasius 1996](#)), so paradigmatic analysis could benefit from a historiographical perspective. The first steps towards a historiography of music analytical practices (with a specific section on the genealogy of paradigmatic analysis) can be found in various chapters of [Campos and Donin 2009](#).

[Return to text](#)

17. Jean-Jacques Nattiez often rewrites the same fragment more than once when a single fragment could be considered to belong to more than one paradigm. In this case, he encloses the re-written fragments in parentheses.

[Return to text](#)

18. Cf. [Chemillier 2009](#).

[Return to text](#)

19. This presentation will only touch on those aspects of the analysis which relate to PA analysis with the Score Charter. For a thorough analysis of *Mémoriale*, cf. [Goldman \(2009\)](#).

[Return to text](#)

20. A cassette recording of this lecture was consulted at the Pierre Boulez Archive at the Université de Montréal's Faculty of Music.

[Return to text](#)

21. One might encounter material constraints when using the tool for a longer work with denser orchestration, even with a large monitor. This limitation is equally true of any attempt to publish a PA in a book or journal, however.

[Return to text](#)

22. POLIESC: *Pratiques Ordinaires, Lectures Intensives et Écritures Structurées de Contenus numériques multimédia*.

[Return to text](#)

23. After viewing a demonstration of the Score Charter in 2006 at McGill University, Jean-Jacques Nattiez noted that superimposed elements in the tool's PAs could not be sufficiently aligned.

[Return to text](#)

24. The DVD “De *Voi(rex)* à *Apocalypsis*, fragments d’une genèse: exploration multimédia du travail de composition de Philippe Leroux,” Nicolas Donin, Samuel Goldszmidt, and Jacques Theureau, which appeared as a supplement to *L’inouï—Revue de l’IRCAM 2* (2006). This DVD-ROM allows the user to perform some of the electroacoustic operations which gave rise to the piece (for voice, instruments and electronics). Cf. review of DVD in [Théberge 2008](#), in which another IRCAM multimedia project dealing with contemporary music composition is discussed, a CD-ROM on Roger Reynolds’ *Angel of Death*, produced by Stephen McAdams and Marc Battier (Paris: IRCAM-Centre Pompidou, 2005).

[Return to text](#)

25. Cf. Sybil’s [website](#).

[Return to text](#)

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Prepared by Brent Yorgason, Managing Editor and Mitch Ohriner, Cara Stroud, and Tahirih Motazedian, Editorial Assistants