Notating electronics

Carl Faia, Brunel University, London

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What interests me most in electronic music so far is the notation, the score.
Igor Stravinsky[1]

Introduction: Solutions in search of a problem

One early morning in January of 1985, I drove down from Santa Barbara to Los Angeles to hear a concert with the Los Angeles Philharmonic. After the preconcert talk with Toru Takemitsu and Nicolas Slonimsky, I detoured to the bathroom before heading into the hall to find my seat. Somewhere between washing my hands and exiting the toilets, I was accosted by a well-dressed gentleman of a certain age, fluffy grey beard, plaid sports coat (elbow patches) and a rather gentle but persistent demeanour. He wanted to know if I was a musician. I said I was studying composition, and his eyes began to twinkle. He opened the manilla envelope he had been carrying and proceeded to explain to me the new notation system he had created. There were many papers with diagrams and what seemed to be variations on the notation system we typically think of when we talk about music notation from the western civilisation. Yet it was slightly, somehow, different. As this was LA and being accosted by strangers for all sorts of things is a common activity, I extrapolated myself with a promise to contact him when I had more time. This never happened, but I did bring the news of a new notation system to my professor, thinking that I may have chanced upon the next great advancement in music. «Quack», was my teacher's considered reply.

I had walked head on into the unruly garden of music notation that has been cultivated for centuries. Music notation contains so many contradictory historical developments, as well as political, religious and self-serving campaigns that it resembles more

[1] Igor Stravinsky and Robert Craft, *Conversations with Igor Stravinsky*, (New York: Doubleday Garden City, 1959), 112.

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a free-for-all bazaar rather than a highly codified system of symbolic representation for music. There is a reason why we need books like Gardner Read's, *Musical Notation: a Manual of Modern Practice*, in which the author, citing too many examples of the 'notational nightmare' kind, proposes a book to be used as a «tool to make effective and accurate notation more accessible»[2].

As a young composer, I made good use of Read's book and sought out other guides. There are many books available to provide «some insight into the present meaning of a goodly number of terms» and help «see more clearly why certain terms have the meaning which at present attaches to them»[3]. Kurt Stone's work on modern notation covers a wide range of styles and techniques and includes pedagogical methods, historical information and acts as a handbook for practitioners. *Music Notation in the Twentieth Century: A Practical Guidebook* responded to the current problems and solutions being proposed to remedy the limitations of notation by examining «the new inventions for clarity and efficiency in practical use, select the devices that appeared most universally satisfactory, eliminate duplications, and codify the results in a practical guidebook»[4]. Moreover, Stone would propose and direct the *Index of New Musical Notation*, in turn leading to an international conference organised in 1974 to codify and agree upon new notion practises. Arguably less dramatic than the Council of Trent and its influence on plainchant[5], it would be a precursor to other such activities including the *Music Notation Modernization Association*[6], focused on all aspects of music notation and engraving, and the more recent *International Conference on Technologies for Music Notation and Representation* (TENOR)[7] held every year since 2015.

Yet, with such a rich history and all the available sources and resources, arguably little has changed, really, from the moment the music staff came into use in the 9th century[8]. John Haines does a wonderful job in researching the source of the staff (relieving Guido d'Arezzo of that claim to fame in the process).

> Who can blame music historians for frequently claiming that Guido of Arezzo invented the musical staff? Given the medieval period's unmanageable length, it must often be reduced to as streamlined a shape as possible, with some select significant heroes along the way to push ahead the plot of musical progress: Gregory invented chant; the

[2] Gardner Read, *Music Notation: A Manual of Modern Practice* (New York: Crescendo, 1979), v.

[3] Karl Wilson Gehrkens, *Music Notation and Terminology* (New York: The A. S. Barnes Company, 1914), iii.

[4] Kurt Stone, *Music Notation in the Twentieth Century*, A Practical Guidebook, (W. W. Norton & Company Incorporated, 1980), xiii.

[5] Kenneth Levy et al., *Plainchant*, vol. 1, Plainchant (Oxford University Press, n.d.), §10.

[6] The Music Notation Project, <http://musicnotation.org/home/about-faq-contact-info/> (03/19).

[7] TENOR - International Conference on Technologies for Music Notation and Representation, <http://tenor-conference.org/> (03/19).

[8] Raymond Erickson, *Musica Enchiriadis, Scolica Enchiriadis*, vol. 1, Musica Enchiriadis, Scolica Enchiriadis (Oxford University Press, n.d.).

> troubadours, vernacular song; Leoninus and Perotinus, polyphony; Franco of Cologne, measured notation. And Guido invented the staff[9].

There are many revered and essential writings on music throughout recorded history. Through all these treatises and counter treatises, from the pedagogical Guido d'Arezzo, *Micrologus* (c. 1026), to the modernist Nicola Vicentino, *L'antica musica ridotta alla moderna prattica* (1555), to veneered theorist Gioseffo Zarlino, *Le istitutioni harmoniche* (1558), and the rebuttal of Vincenzo Galilei, *Dialogo di Vincentio Galilei ... della musica antica, et della moderna* (1591), as well as the mathematic certainty of Marin Mersenne, *Harmonie universelle* (1636-1637), we see the development of musical thought growing through speculative theory, scientific experimentation, and performance practice.

A gross generalisation follows: all these ancient texts bow in the direction of the Greeks and Boethius (c. 477-524 AD) and the philosopher's *De institutione musica*, yet they all use the same musical staff, more or less, with the same way of notating pitch, more or less, and rhythm, more or less. There is generally much quibbling about harmony, the classification of genera, tetrachords and tunings, the representation of commas, the correct use of modes, and methods for pedagogy, with assorted detours into new notation practises. The approach to change, in spite of the polemics, is incremental and subject to being quickly forgotten if not practical.

It is important to recall this background because the notation of electronic music, I believe, fits into this evolutionary lineage. Regardless of the many varied developments around the fundamental elements of music, the flexibility of the music staff to bend to any (ab)use is a strong recommendation to the continued use of it for notating electronics. There is a mass of writing from composer Nicolas Slonimsky defining and describing the craft of music. He warns us, with a paper presented in 1938, of using personal systems and the obligatory process of adding to the canon:

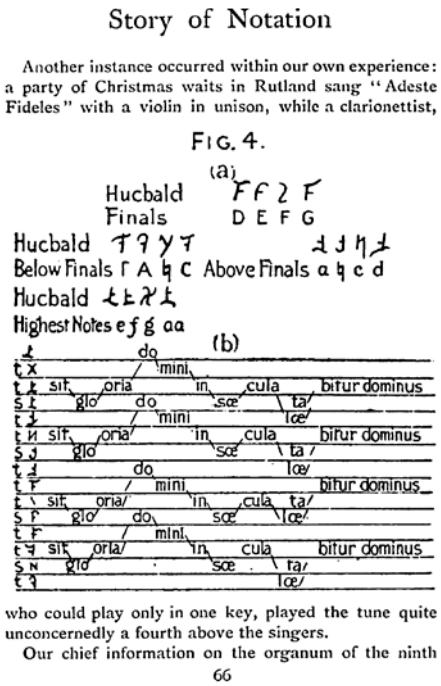
> The establishment of a new usage is very often signalized by the impossibility of accounting for it except by an exceedingly artificial method. When this happens, it is well to draw a working hypothesis from repeated occurrences in the past, and then apply it to new ones[10].

There are many histories of music notation available today, and it is useful, in this context, to have a look back at these from time to time for inspiration and caution. In the 1903 work, *The Story of Notation*, C. F. ABDY Williams provides deep background and starts out the book with an «outline of the history of the representation of musical sound in writing» from the Greeks through to the birth of harmony. In Chapter V, we learn of the origins for the staff with graphic examples showing a family resemblance to the one we use today. Figure 1[11] is the staff as it was being used in the 9th century,

[9] John Haines, 'The Origins of the Musical Staff', *The Musical Quarterly* 91, no. 3–4 (2009): 327-78, 327.

[10] Nicolas Slonimsky, 'The Plurality of Melodic and Harmonic Systems', *Papers Read by Members of the American Musicological Society at the Annual Meeting*, 1938, 16-24, 16.

[11] Charles Francis Abdy Williams, *The Story of Notation* (London: The Walter Scott Publishing Co., Ltd., 1903), 66.



Story of Notation

Another instance occurred within our own experience: a party of Christmas waits in Rutland sang "Adeste Fideles" with a violin in unison, while a clarionettist,

FIG. 4.

(a)

Hucbald F F 2 F
Finals D E F G
Hucbald T 9 Y T J J 4 J
Below Finals Γ A 4 C Above Finals a 4 c d
Hucbald L E 2 L
Highest Notes e f g aa

(b)

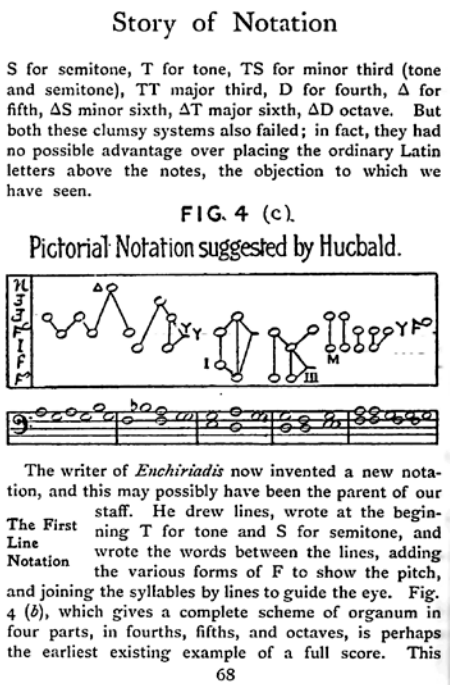
do
mini
sit oria in cula bitur dominus
glo do sœ ta
mini lœ
sit oria in cula bitur dominus
glo sœ ta
do lœ
mini bitur dominus
sit oria in cula ta
glo do sœ lœ
mini
sit oria in cula bitur dominus
glo sœ ta
lœ

who could play only in one key, played the tune quite unconcernedly a fourth above the singers.

Our chief information on the organum of the ninth

66

Figure 1. Page 66 from *The Story of Notation.*



Story of Notation

S for semitone, T for tone, TS for minor third (tone and semitone), TT major third, D for fourth, Δ for fifth, ΔS minor sixth, ΔT major sixth, ΔD octave. But both these clumsy systems also failed; in fact, they had no possible advantage over placing the ordinary Latin letters above the notes, the objection to which we have seen.

FIG. 4 (c).

Pictorial Notation suggested by Hucbald.

The First Line Notation

The writer of *Enchiriadis* now invented a new notation, and this may possibly have been the parent of our staff. He drew lines, wrote at the beginning T for tone and S for semitone, and wrote the words between the lines, adding the various forms of F to show the pitch, and joining the syllables by lines to guide the eye. Fig. 4 (*b*), which gives a complete scheme of organum in four parts, in fourths, fifths, and octaves, is perhaps the earliest existing example of a full score. This

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Figure 2. Page 68 from *The Story of Notation.*

and Figure 2[12], from the same period, shows a notation technique probably not unfamiliar with composers using graphic notation today. The book is worth a read if only for the breezy way the author places, and displaces, some of the more iconic movements in music history and his frank portrayal of national clichés and a breakdown of some of the more ephemeral developments of notation. Of particular interest for this article, however, is the discussion in Chapter XII: «The Attempt to Invent New Forms of Notation, and to Reform the Old» of which a short excerpt follows.

> If the shelves of the various libraries of Europe were searched, it would probably be found that for some centuries a new notation has appeared about every three or four years, each of which is called by its author 'The' new notation, for he fondly thinks that it will become universal. A notation is like a language; it does not suddenly appear, as the result of the efforts of some mighty genius. It is the result of the united efforts of generations of musicians endeavouring to express their melodies in such a way as to make them understood by their fellow-musicians… Any improvements in a universally accepted notation come very slowly, not as result of one man's inspiration, but by a consensus of opinion that such and such a detail requires to be, and can be, improved[13].

[12] Ivi, 68.

[13] Ivi, 196-197.

One final note for this very brief introduction: the importance of the copyist's influence and the process of editing and publishing to musical notation should not be underestimated. The work of the copyist monk is of such intricate beauty that it might be forgotten that the marks on the page embody what is, for the most part, the most disembodied of arts: invisible waves in the air. Beyond the philosophical and scientific implications of this, there is a truly practical aspect that depends on the talent and craft of the copyist, the monk in the monastery or, in modern times, the engraver at Fabers, as well as the technology employed for the job at hand. As mentioned above, John Haines describes a very practical reason for the development of the staff, while other writers provide background to our inherited symbols. In *Histroire d'une ligne de musique* (1914), the Abbot N. Joachim presents ten colour plates with pedagogical and historical descriptions for a class taught at the seminary in Tournai, France. Beautiful reproductions on their own, the graphics on Plate 6 in Figure 3[14] shows a table of common symbols and their transformations through usage over time from the 10th through the 16th centuries: an early example of what might be the grand staff, the origins of the note names used in *solfège*, and two examples to practise the correct usage of the B natural and B flat in a melody. Of the table of symbols at the top of the plate, the Abbot reminds us that the only way to understand the common signs in use today is to trace their transformation in the hands of the copyists over the centuries[15].

I became musically literate following the same methods dating back to the 10th century. Learning FACE (spaces in the treble clef) and «Every Good Boy Does Fine» (lines on the treble clef … it was another epoch) would be familiar to Guido and his students as a method to memorise the elements musical representation. As a composer, I would seek out experimental works and more radical approaches to notation. Yet, as far away as a composer might appear to stray from the staff, radical approaches by very different composers' works such as Cornelius Cardew's *Treatise* (1963-1967) and Krzysztof Penderecki's *Threnody to the Victims of Hiroshima* (1960) tend to revert to the mean, and we see, in the score itself, more than the remnants of the good old traditional music staff. It's a good, sturdy system.

Create, play, learn…

In conversation with Morton Feldman, John Cage explains why he translated Feldman's graphic score, *Ixion* (1958), into readable music for the players to perform Merce Cunningham's ballet, *Summerspace* (1958):

> It was written on graph and used numbers and that was the piece, of course, and that was the way to read it, but with the exigencies of rehearsals… I translated it into

[14] Joachim, Abbé N., *Histoire d'une Ligne de Musique, Ou Aperçu Historique Sur l'evolution de La Notation Musicale En Occident* (Tournai, France: Self Published, 1914), plate VI.

[15] Joachim, Abbé N., *Histoire d'une Ligne de Musique, Ou Aperçu Historique Sur l'evolution de La Notation Musicale En Occident* (Tournai, France: Self Published, 1914), 13.

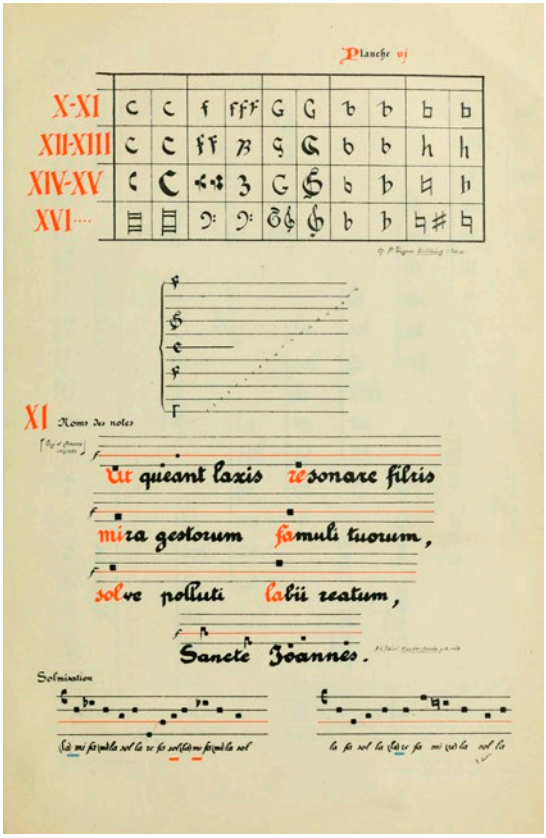



Figure 3. Plate VI from *Histoire d'une Ligne de Musique.*

> something conventional with quarter notes … which was not what the piece was, but which permitted the musicians to quickly play it, where the numbers meant they would have had to devote themselves, in a way they actually didn't have the time or inclination to do[16].

Cage goes on to describe other instances of this need to translate graphic scores, and there is a fascinating discussion between the two on the use of notation, new notation, the meaning of notation and the frustration with notation. This points out the very different problems we run into as creators, performers and teachers. Feldman, at that time, was using graph paper and various systems for composing. Even if Cage defends the graphic score and the composer's wish to coerce the performer to interpret the score *in situ*, he also accepts the practical reality of the situation: musicians read music, not graphs. My experience has been that musicians, when asked to interpret a graphic

[16] Morton Feldman and John Cage, *John Cage and Morton Feldman In Conversation, Radio Happening V of V Recorded at WBAI, New York City, 1966 - 1967* (WBAI, 1967), 30:00, <http://archive.org/details/CageFeldman5> (03/19).

score, will either write out their interpretation (if they are classically trained) or play 'as written' in the graphic score (if they are improvisers). Neither response is necessarily ideal. Writing everything out might detract from the intended poetic ambiguity of the score, while pure improvisation may favour more the superficial solution.

Music being music, it does not require a score to exist, of course. Feldman avoids traditional notation (as does Cage, for that matter, in a number of his own works), yet requires it for musicians to perform his music… and returns to more traditional notation in his later works. One might see traditional notation as a constraint and composers avoid it for the sake of freedom. For the creative process, this might work, but is less useful for the practicalities of performance. We need a score to pass our music on to others, for pedagogy, as well as to create. We need the score for notating electronics for the same reasons: creating, performing, and learning.

The addition of another source of sound in a score should be notated in the same way that any instrument is notated. While the sound of the electronics might appear radically different than the sound of a traditional instrument, I would argue that it is not as radically strange as the difference between an orchestral score and the resultant sound. There is little that we can assume from a full orchestral score that will provide direct relationships to the sound we hear. Training, experience, and journeyman like apprenticeship in the bowls of the orchestra provide the necessary tools to 'hearing' an orchestral score. Understanding notated electronic music, being made of the same material, requires the same kind of process to 'hear' what is being represented in notation.

The staff and traditional notation provide everything we need to capture the quintessential elements of music: pitch on the vertical, time on the horizontal, and anything else in the margins. While live electronics have a particular need for notation in relation to performers – they need to play from a score – there is, or there was, another good reason for notating electronic music that existed only on tape: claiming copyright. An example of traditional notation used for tape music can be found in the article *Notes on 'A Piece for Tape Recorder'* by Vladimir Ussachevsky[17]. He describes the reason for notating the tape work as having little do with the actual composition process because «the Copyright Office in Washington does not grant a copyright on a work as a musical composition unless it is written or printed in ordinary musical notation», and so he spent forty hours doing just that. The article then goes on to provide insight into his reasoning of the notation.

Figure 4[18] is taken from the article and shows a page of the score as submitted to Washington. A more or less traditionally notated work with four staff systems. Of special interest are the lack of bar lines while precise time is given in seconds, the use of the relative dynamic notation (mezzo piano) alongside precise decibel indications (20 dB), and the simple approach for notating the various sounds in the piece (M; h-s; R above the staff is a metallic hard struck sound with reverberation)[19]. I find this

[17] Vladimir Ussachevsky, 'Notes on "A Piece for Tape Recorder"', *The Musical Quarterly* 46, no. 2, Special Issue: Problems of Modern Music (1960): 202-9, <https://doi.org/10/cgrz87> (03/19).

[18] Vladimir Ussachevsky, *Piece for Tape Recorder* (Self Published, 1956), 4.

[19] Vladimir Ussachevsky, 'Notes on "A Piece for Tape Recorder"', *The Musical Quarterly* 46, no. 2, Special Issue: Problems of Modern Music (1960): 202-9, <https://doi.org/10/cgrz87> (03/19).

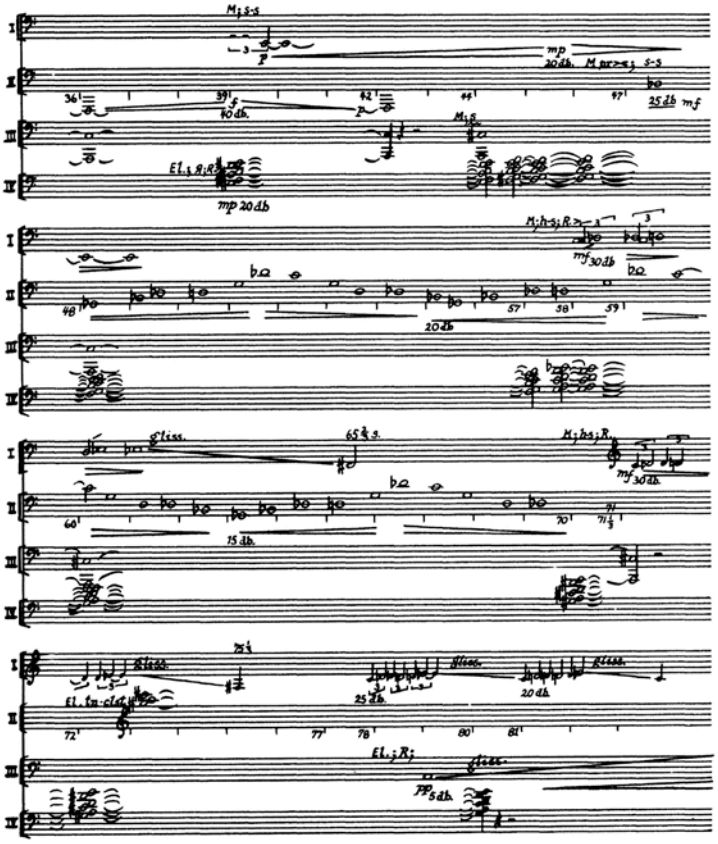



Figure 4. A page from Vladimir Ussachevsky's *Piece for Tape Recorder* (1956).

a brilliant solution to the problem of notating electronics (live or sampled). Because of the clarity and precision as well as a certain ambiguity inherent in any music notation, I could propose this to an ensemble to be performed live or as an exercise for music students to realise versions according to individual interpretations.

Karlheinz Stockhausen's work for melodic instrument and feedback (tape loops, or delays) *Solo* Nr. 19 (1968), might be seen as a hybrid of graphic and traditional notation, and another possible model for composers in their own approaches to creating and notating their music. My experience with this work dates from a collaboration with Benny Sluchin at IRCAM culminating in versions of the work for trombone and oboe[20]. I later collaborated with Serge Bertocchi on a version for saxophone[21]. I also

[20] Benny Sluchin, 'A Computer-Assisted Version of Stockhausen's Solo for a Melody Instrument with Feedback', *Computer Music Journal* 24, no. 2 (2000), <https://doi.org/10.1162/014892600559308> (03/19).

[21] Karlheinz Stockhausen, *Solo*, performed by Serge Bertocchi, *Expériences De Vol # 8*, (France: In-Possible Records, 2010), CD.

have realised a version for ondes Martenot for Nadia Ratsimandresy[22]. Much has been written about *Solo* and I would refer anyone interested to read the articles cited above and to peruse the score itself. The work is part of a series of pieces using a complex and extremely personal approach to the composing process. The score of *Solo* contains 12 unbound sheets, six are with traditionally notated staves and six are graphic representations of the formal schemes to be followed in constructing the music to be played. The performer, or arranger, is required to make their own versions following the detailed directions of the composer and according to their instrument's possibilities and their individual artistic interpretation. There may have been the idea that the performer should be able to realise the work in real time during the performance, selecting the various sections from the traditionally notated sheets according to the formal scheme being performed. As far as I know, this never happened. There are several pages of instructions on how to interpret the various signs in the formal schemes as well as detailed information on the technical aspects of the electronics.

I have worked on Version III of this score in three versions with three different collaborations and all three are quite different. The difference, I believe, comes for the loosely tight instructions of the composer and the choices he allows for the realisation of the work. As free as the process might seem, the work is highly organised. The composer has divided the process of creating, learning and playing into overlapping procedures: choosing a form, learning the construction method (allowing for internalisation of the work through active participation), applying the composers process with the performer's intuition and expertise, into a realisation of the final playable form.

In spite of the experimental nature of the music and the advanced technology used, the performer will play, in the end, from a traditionally notated score. The same score will be used in practice and performance. While this process is a valuable exercise in craft in the pursuit of artistic creation, the work has another important characteristic that is perfectly controlled and inalterable: duration. As the work is based on feedback loops on a specially designed tape machine, the durations are calculated according to the length and speed of the tape recording. Of all the parameters of music that may be interpreted by the performer/creator, overall time, in this particular case, is neither flexible nor interpreted. Indeed, overall durations of each formal scheme are of extreme precision: 10' 39,8" for Version I or 15' 25,9" for Version III, for example. While this strict constraint makes for various complications in the realisation of the work, the final form resembles any other traditionally notated score. Formal Scheme III and a realisation of the B section for Ondes Martenot can be seen in Figure 5 and Figure 6.

Having pages of performance notes in a contemporary music score is nothing extraordinary and usually this is there to define extended instrumental techniques or non-standard notations. In the case of *Solo*, the performance notes are augmented by elaborate directions as to the interpretation and realisation of the symbols the composer has created for the process. The act of choosing, interpreting the symbols and

[22] Carl Faia and Nadia Ratsimandresy, 'Kinectic Waves at Art Zoyd Studios', in *Actes Des Journées d'Informatique Musicale* (Mons, Belgique: JIM, 2012), 233-236.

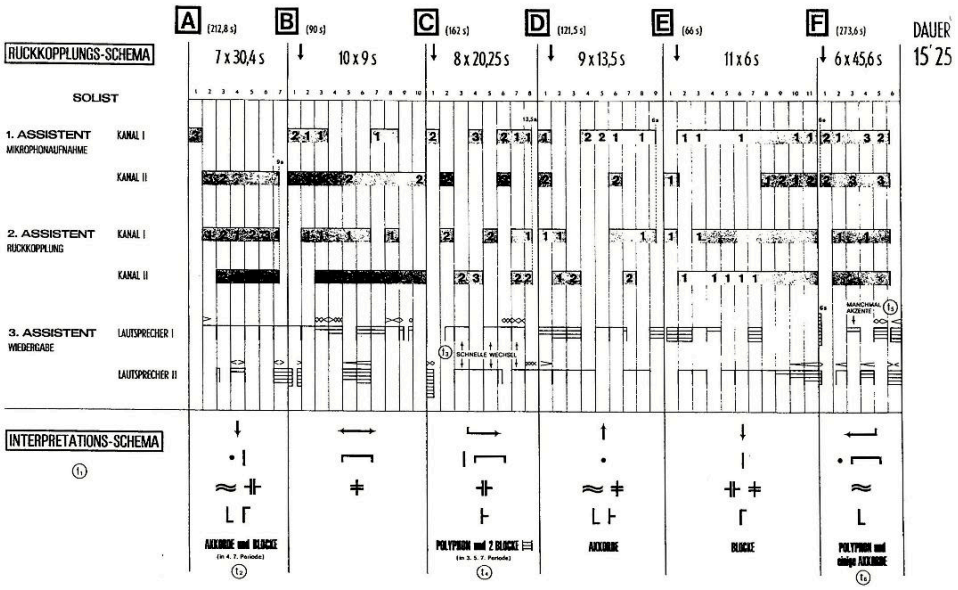


Figure 5. Schematic for Form Scheme III in Stockhausen's *Solo, für Melodie-Instrument mit Rückkopplung*.

constructing the final playable version arguably places the performer into the natural and traditional role of collaborative partner.

Allowing the performer this responsibility is a key element in practical notation that should not be minimised. Baroque performances of period compositions might sound radically different to the period scores in which they have been notated. Often times more complicated in our ears than on paper, the performer takes the written score and provides all the bits not written out – think of the two chord cadence in the Adagio of Bach's *Brandenburg Concerto No. 3* as an extreme example. Performance practice is an important aspect of any musician's education. There is a common practice to be codified in today's notation, but this requires a certain level of performer involvement. Leaving everything to chance or writing everything out undermines the role of the interpreter. Stockhausen's approach here provides a possible path forward in creating a rich environment for collaborative creation. The score of any realised version of *Solo* belies a complexity absent from the notation, notably due to the layers of music from the feedback loops, but also through his use of ambiguous and relative terms for denoting effects and playing techniques. Music that is performed, heard, but not completely overly written out in the score or completely devoid of traditional indications. To oversimplify, we don't need new notation unless the performer needs new notation. Composers need to tell the performer what they want, performers can tell them how to symbolise it if needed, or, if that fails to work, to use text descriptions.

Finally, the score notes of *Solo* provide invaluable information on the technology used for the feedback loops, including pictures of the tape machine and flowcharts for the audio treatments. Important for the operators and assistants and performers for

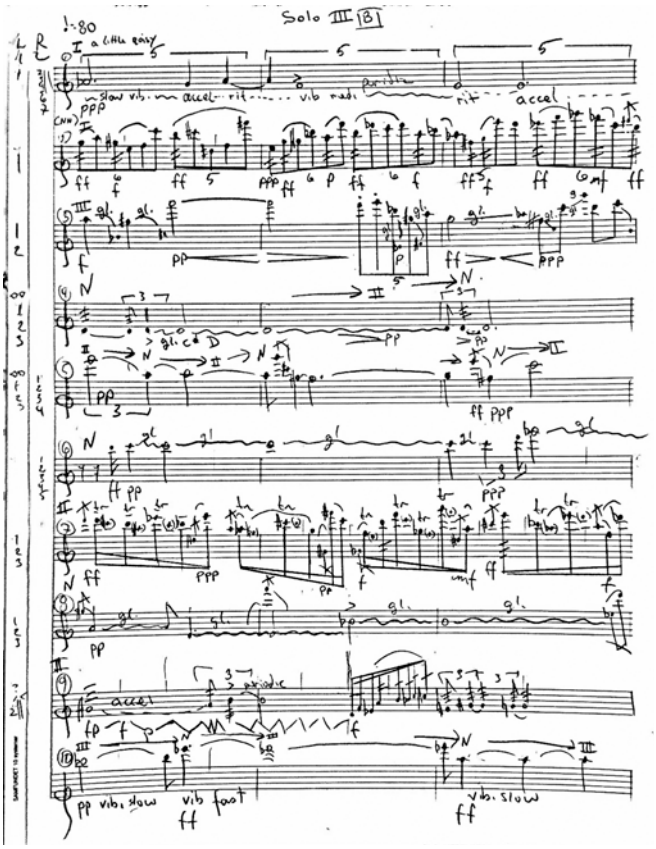



Figure 6. Realisaton for ondes Martenot of section B of Form Scheme III in Stockhausen's *Solo, für Melodie-Instrument mit Rückkopplung.*

the first performances, but crucial for the longevity of any pieces using technology. The feedback loops were recorded on a specially designed tape machine that no longer exists. Bringing a viable version of the work to the computer became possible once technical limitations (namely, RAM or the delay times) were available. Transposing electronics to a new technology, however, is not just dependent on the gear. The most important aspect of any translation/porting is the detailed information of the processing employed. The information provided in the score of *Solo* is a model that any composer using technology should study for documenting electronics (c.f. Figure 7). And while Stockhausen's work is exemplary in every aspect of the notation practice as required for future performances, there are other less obsessive examples available as models. The equally relevant precise notations and instructions, although of a lesser complexity, may be found in the score of Luigi Nono's *A Pierre. Dell'Azzurro Silenzio, Inquietum* (1985)[23].

[23] Marc Battier, Carl Harrison Faia, and Olivier Pasquet, *A Pierre. Dell'Azzurro Silenzio, Inquietum* [de] Luigi Nono, Cahier d'exploitation, Ircam, Centre Georges Pompidou, 2000.

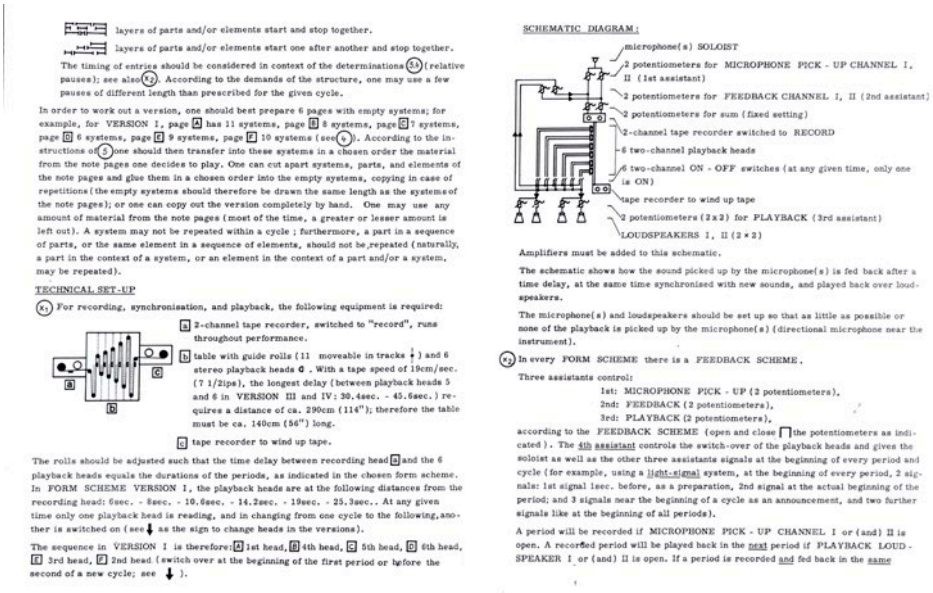


Figure 7. Detailed technical setup instructions form the score of *Solo.*

The patch (or the process) as score

Working with James Dillon on the creation of *La coupure* (2000)[24], composer, computer music designer and performer created a close working collaboration. The creative process consisted of recording the performer playing his personal percussion instruments, analysing the samples, developing algorithms for various processes of synchronisation, studio production to develop some of the more complex sounds, and making a concert Max patch designed to allow for real-time improvisation on the part of the performer, the computer music designer (me) and continuous modifications by the composer. I saw very little of the score from the composer as I developed the patch. Discussions on the various orders of the sections (or modules as they were called) performed by the percussionist, Steven Schick, would focus variably on the technological hurdles, the *mise en scene*, the desired sound effect, and the overall narrative arch of the work. This creative back and forth continued from the production period, into the rehearsals and carried on through to the final performances. The variables for the final performance would include many cues for audio triggered at the computer, video playback and live video matrixing controlled by a complex timing algorithm, onstage event sensors triggered by the performer at fixed and improvised times, and a performance part for the computer music designer consisting of spatialisation control, effects faders improvisations, and patch control during the performance. I go into more detail about the process of constructing the patch in my thesis[25], but the Ariadne's

[24] James Dillon, *Nine Rivers: 5. La Coupure (1989-2000)* (London: Peters Edition, Ltd., 2000).

[25] Carl Faia, 'Collaborative Computer Music Composition and the Emergence of the Computer

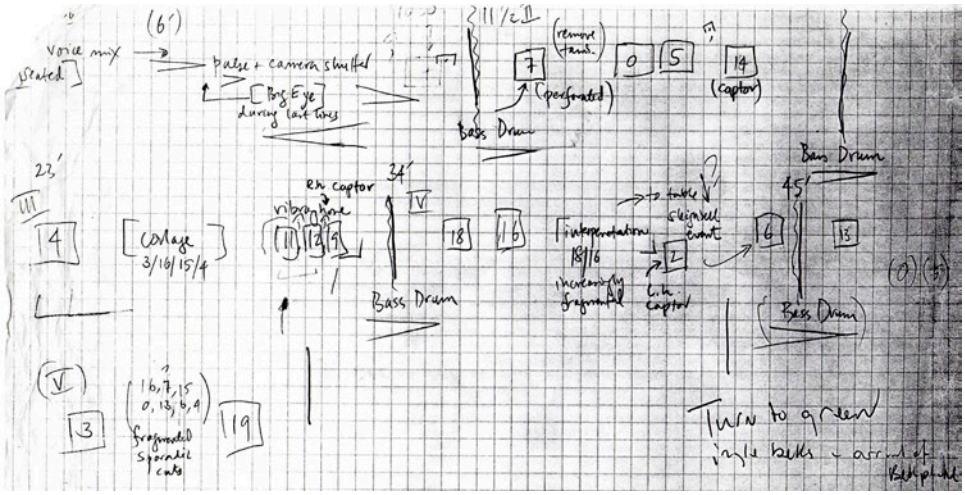


Figure 8. Sketch of the formal strucure of James Dillon's *La coupure* (2000).

thread for the performance became the list of cues within the patch and the experience gained in rehearsals more than the traditionally notated modules created for the performer. Figure 8 from the production period shows how the modules (numbered squares) were not performed in order and could be (and would be) changed around, while structural elements (the Bass Drum) were used to delineate the overall formal structure. The 'score' in this case consisted of the traditionally notated modules for the performer, as well as the processing within the patch and the unwritten performance practice learned for the piece. Figure 9 Shows a version of the patch with some of the cues and the clock source (bottom) visible during rehearsals and performance. The interdependent and flexible nature of this kind of score works well during the creation and first performances. It fails, however, when different performers and computer music designers wish to perform these pieces. Without the oral confirmations of all those involved in the creation, the continued performance of this work risks obsolescence, or requires a modified, and possibly contrary, approach to the work by future practitioners based on the existing patch, recordings and limited score.

Documentation, or archiving, as Laura Zattra recently reminded us[26], is an important aspect of the creative process for a better understanding of the work but also the longevity of the music. This archival process should also be part of the score, especially in the context of notating electronics. I have collaborated with many composers over the years, all idiosyncratic in method and creation. I understand the importance of oral history and tradition as pieces I have worked on and premiered are now being performed by others. I sometimes receive phone calls or emails asking about the signifi-

Music Designer' (Thesis, Brunel University London, 2014).

[26] Laura Zattra, "Is Originality Undetected Plagiarism?", in *Electroacoustic Music: Is It Still a Form of Experimental Music?* (EMS18 Conference – Electroacoustic Music Studies Network), Villa Finaly, Florence, 2018, oral presentation.

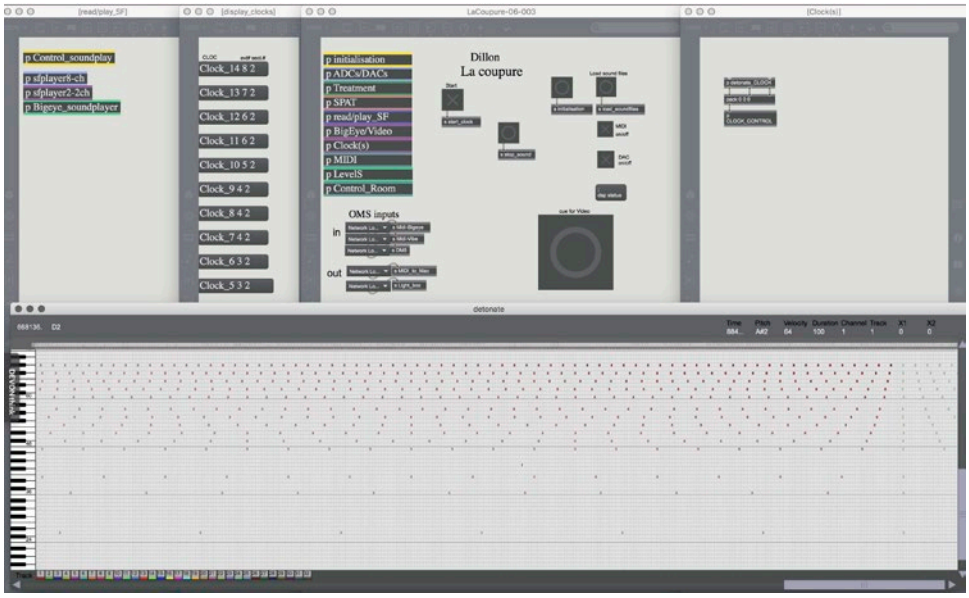


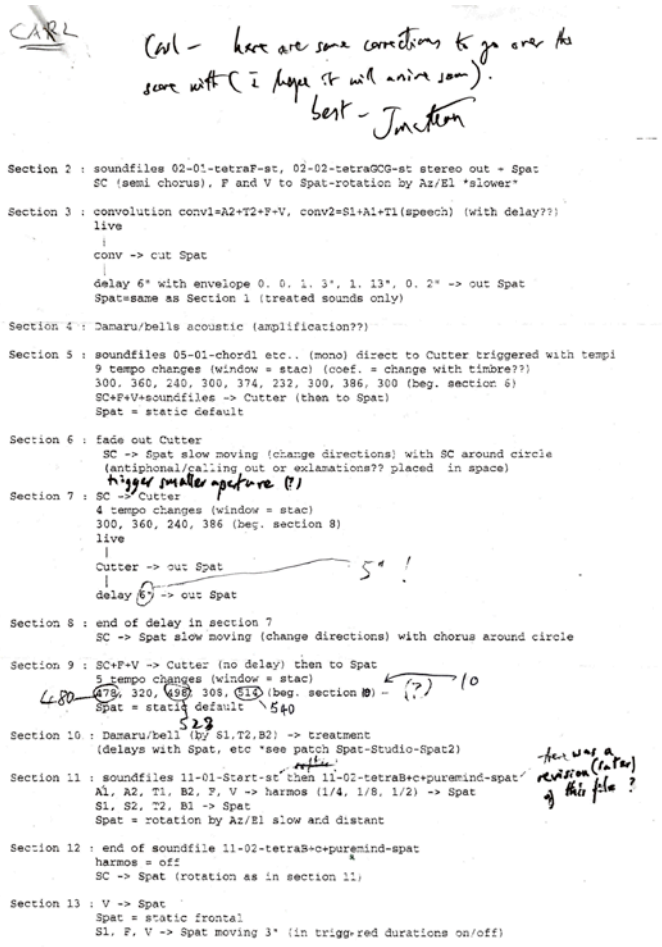
Figure 9. Max patch in development showing the "clock system" programmed for process synchronisation in *La coupure*.

cance of a certain sign in a score is supposed to mean, or if they could have a missing sound file, or where to locate a subpatch, or instructions lost by the publisher, or if I could rearrange a patch for a different performance configuration. Without clear notation, including descriptions and commentaries, the piece might never be performed after the premiere. If that work's electronics are not correctly notated, the piece will not be played and may also be forgotten. Without this information available, *Solo* would have been lost instead of being revived nearly 30 years after its premiere.

The Harvey Example

A final practical example of notating electronics, with Jonathan Harvey, might provide a base from which to consolidate some common practices. I collaborated with Harvey on *The Summer Cloud's Awakening* (2001), for mixed choir, flute, cello and electronics, and *Two Interludes for an Opera* (2004), for large ensemble and electronics. We worked out a form of notating the electronics based on the processes within the Max patch and transposed this to the final score. There are many examples which might be of interest here, but I'll focus only on the most relevant.

As with the collaboration with Dillon as described above, the production process led to a concert Max patch with unique forms of processing. In the Dillon, little of this was actually notated in the traditional score. The process of passing from one section to the next and the adjustments and manipulations required by the computer music designer existed in the form of experience and practice with few notes in the


CARL

Carl – here are some corrections to go over the score with (I hope it will arrive soon).
best – Jonathon

Section 2 : soundfiles 02-01-tetraF-st, 02-02-tetraGCG-st stereo out + Spat
SC (semi chorus), F and V to Spat-rotation by Az/El *slower*

Section 3 : convolution conv1=A2+T2+F+V, conv2=S1+A1+T1(speech) (with delay??)
live
|
conv -> cut Spat
|
delay 6" with envelope 0. 0. 1. 3", 1. 13", 0. 2" -> out Spat
Spat=same as Section 1 (treated sounds only)

Section 4 : Damaru/bells acoustic (amplification??)

Section 5 : soundfiles 05-01-chord1 etc.. (mono) direct to Cutter triggered with tempi
9 tempo changes (window = stac) (coef. = change with timbre??)
300, 360, 240, 300, 374, 232, 300, 386, 300 (beg. section 6)
SC+F+V+soundfiles -> Cutter (then to Spat)
Spat = static default

Section 6 : fade out Cutter
SC -> Spat slow moving (change directions) with SC around circle
(antiphonal/calling out or exlamations?? placed in space)
trigger smaller aperture (?)
Section 7 : SC -> Cutter
4 tempo changes (window = stac)
300, 360, 240, 386 (beg. section 8)
live
|
Cutter -> out Spat
|
delay (6") -> out Spat
5" !

Section 8 : end of delay in section 7
SC -> Spat slow moving (change directions) with chorus around circle

Section 9 : SC+F+V -> Cutter (no delay) then to Spat
5 tempo changes (window = stac)
480 478, 320, 498, 308, 514 (beg. section 10) – (?) 10
Spat = static default 540
528

Section 10 : Damaru/bell (by S1,T2,B2) -> treatment
(delays with Spat, etc *see patch Spat-Studio-Spat2)

Section 11 : soundfiles 11-01-Start-st after then 11-02-tetraB+c+puremind-spat
A1, A2, T1, B2, F, V -> harmos (1/4, 1/8, 1/2) -> Spat
S1, S2, T2, B1 -> Spat
Spat = rotation by Az/El slow and distant
there was a revision (Carl?) of this file ?

Section 12 : end of soundfile 11-02-tetraB+c+puremind-spat
harmos = off
SC -> Spat (rotation as in section 11)

Section 13 : V -> Spat
Spat = static frontal
S1, F, V -> Spat moving 3" (in trigg-red durations on/off)

Figure 10. Text document with audio effects, treatments, and routings for *The Summer Clouds Awakening* (2001).

patch. The Harvey collaborations had similar working processes, but produced notation practises stemming from the concert Max patch with representations of the audio treatments and spatialisations.

We named the treatments used in each work: *cutter* designated an implementation of granular synthesis designed for a rhythmic effect, *conv* (short for convolution) for an implementation of vocoding, *Harmos* for harmonisation clusters, and *Spat* for the spatialisation. Each effect has several settings in the patch. The patch has a matrix allowing for complex audio routing. Finally, to trigger the various treatments and sound files, a performer triggers the patch with a MIDI keyboard from the stage. We needed notation that would be flexible and easy to use, clear and precise for rehearsals, pertinent for the keyboardist, and, as a bonus, easy for the conductor to understand if necessary. Once we had decided on the treatments to be used in the work, I created a text document containing the exact processes in abbreviated form (cfr. Figure 10).

This became useful for the composer to readjust, to correct, to change, but also to understand each process. Once a simple protocol is set up, then the process should coherent. For example, sound files are referred to by specific names prefaced by the number of the section and order: "02-01-terraF-st", is the first sound file in the second section, named "terraF" (pertaining to the provenance and fundamental of the sound) and is in stereo (other sound files are in mono or 8 channels). Abbreviations F and V refer to flute and violoncello respectively.

Referring to section 10 and 11 in Figure 10, the text descriptions as sent to the composer were then copied and pasted in the score (Figures 11 and 12). In Section 10, soprano 1, tenor 2 and bass 2 are playing Damru/bells into their microphones. The audio is then sent through to a series of delays and spatialised with a specially programmed treatment outside the normal Spat routing, but clearly noted in the score. In section 11, sound files are triggered, voices are being routed through the matrix to the clustered transpositions (harmos) which are then routed to the Spat treatment in a setting of slow simultaneous rotation by azimuth (horizontal) and elevation (vertical). The keyboard part is performed by the player on stage. Each note is a trigger of some kind (sound file, start of the process, end of the process, program change). The numbers pencilled in above each note refers to the cue within the patch and allows for easy following (and control) of the process by the person behind the computer during rehearsals and performances. The importance of this information became evident in the practice of performing the piece and we decided it should be incorporated into the score.

The score of *Two Interludes for an Opera* is similar in many aspects to the earlier work, except that the cue numbers are now noted along with the keyboard notes being played for triggers. There are a series of treatments, with similar naming, and a specially designed spatialisation with two independent Spats and a large array of presets for each. There is an audio matrix with all 21 instruments as inputs allowing for any combination of routing imaginable. The score contains information on instruments to be treated, parameters or presets to be used and spatialisations as with the earlier work. The composer has written in the exact routing and parameter configurations this time (instead of the copy/paste of the text file as before) and there is more detail on the page concerning interpretations of the electronics (Figure 13). The keyboard has been placed in the centre for the score, a more traditional although debatable move, and MIDI note numbers have been pencilled above the keyboard triggers in my score.

Of special note is the addition of controlled spatialisation we developed and added to the existing protocol. There are a series of spatial movements designed with precise rhythmic characters for the treating the audio sources: short complex, ritardando/accelerando, strong character obtrusive, slow/fast moving contrasted, etc. (As this was a preparatory work for an opera, there are thematic aspects of characters being explored throughout.) These rhythmic figures (cfr. Figure 14), labelled Rythm 1 through Rhythm 6, were coded into the patch. They could then be notated in the score with a number and a tempo designation (cfr. Figure 15).

In the examples shown in figures 13, 14 and 15, all the information we need to perform the electronics of the work is included in the score. It is important to have the

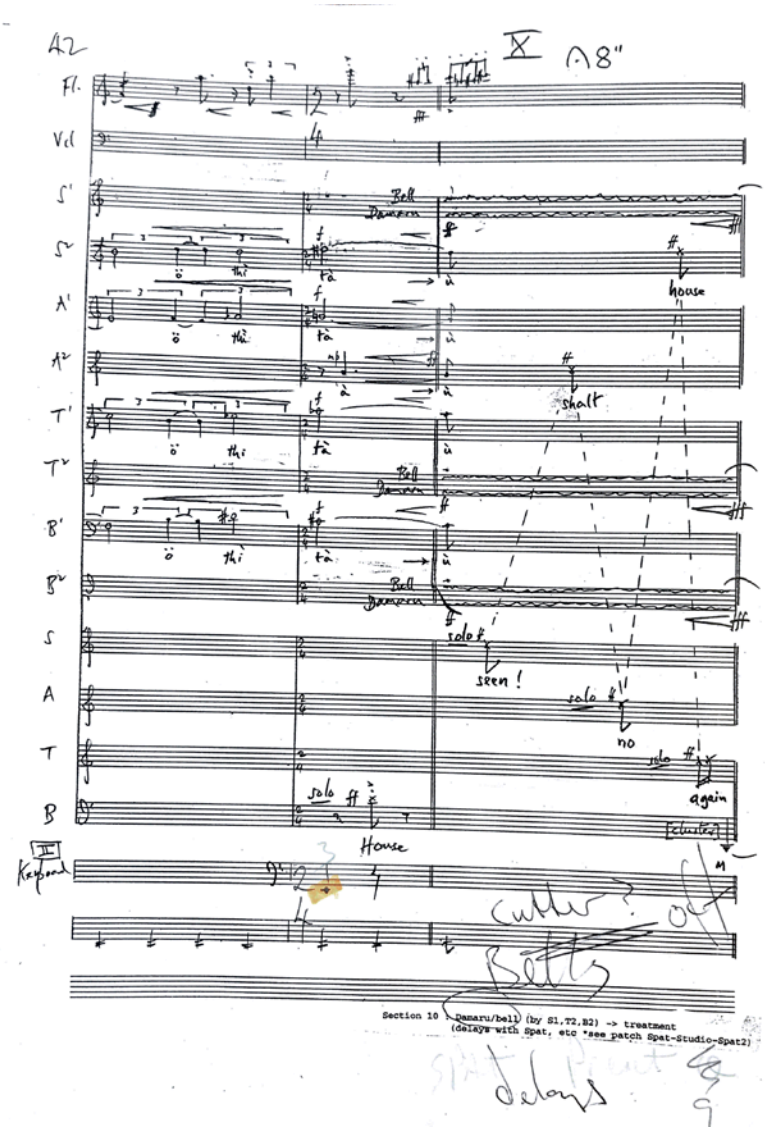



Figure 11. Page 42 from *The Summer Clouds Awakening*.

Max patch and the score in hand to understand everything, but there is no mystery as to what is required or guesswork as to what the notation is representing. As beneficial as it might be to have the original creators on hand when a complex composition is performed, a correctly notated and presented score should be enough for the performance and the transmission of the piece in the future. The notation of the electronics in the scores provide information on the treatments, the attacks times, the durations, the dynamics and, when possible, pitch information. In addition to the information on the process and notation of the technology, there is an effort to provide interpre-

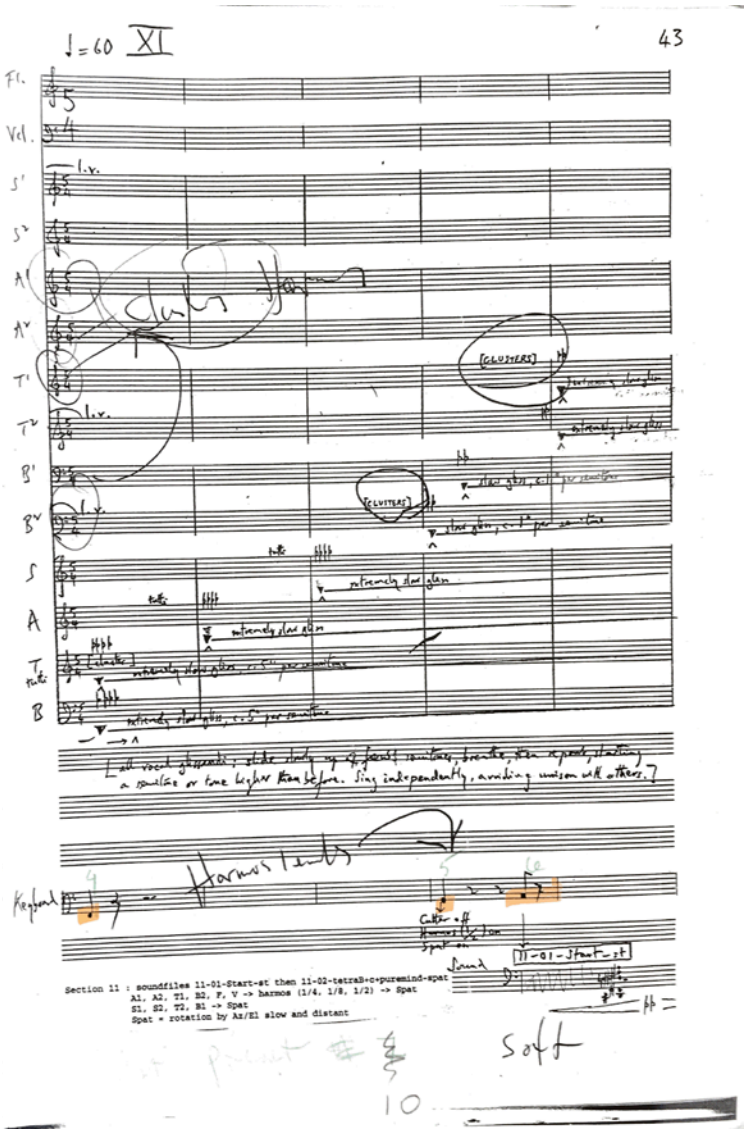


Figure 12. Page 43 from *The Summer Clouds Awakening*.

tative notation for the computer performer including description of gestures, fader control indications, and relative dynamics for competing electronic effects. Not only does the score provide enough information to perform the work without the original collaborators, but there is enough documentation or archival information to allow for an eventual translation to newer technology when the time comes.

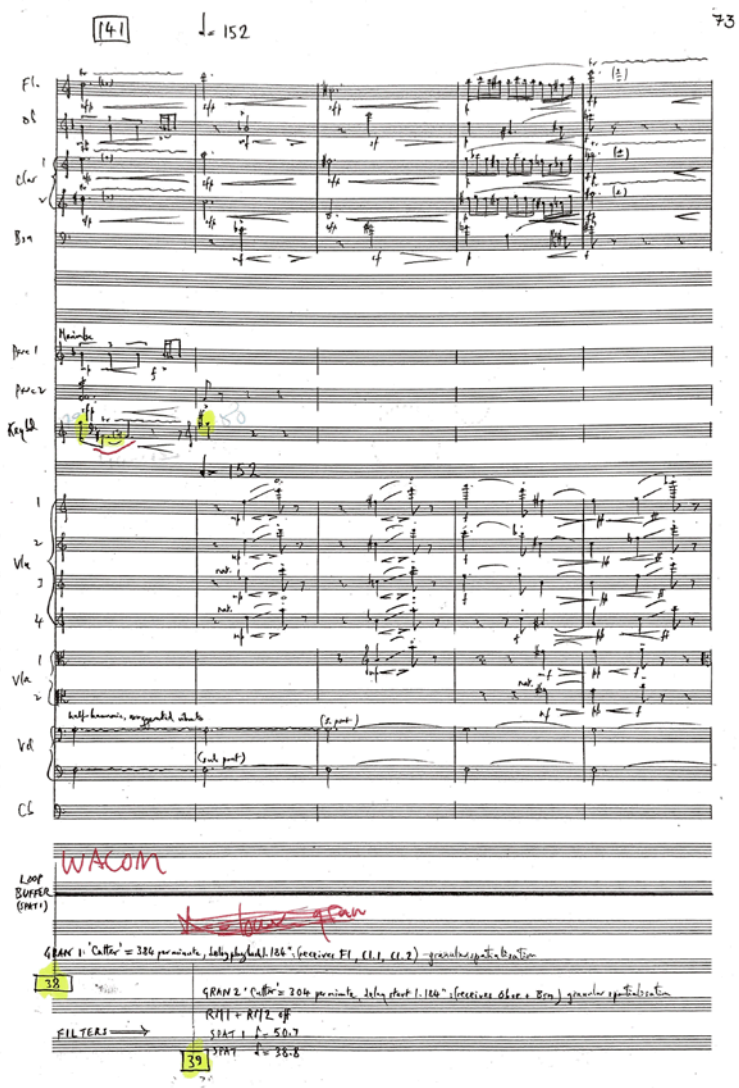



Figure 13. Page 73 of *Two Interludes for an Opera* showing detailed electronics notation.

Accepting WYSI(not)WYG

The score is not the music, so the visual does not need to directly correlate to the sound we hear. While some analysis systems allow for clearly marking musical elements and are useful for analysis, the same system should be avoided for the score. A sonogram approach, like that used in Pierre Couprie's EAnalysis, is extremely helpful

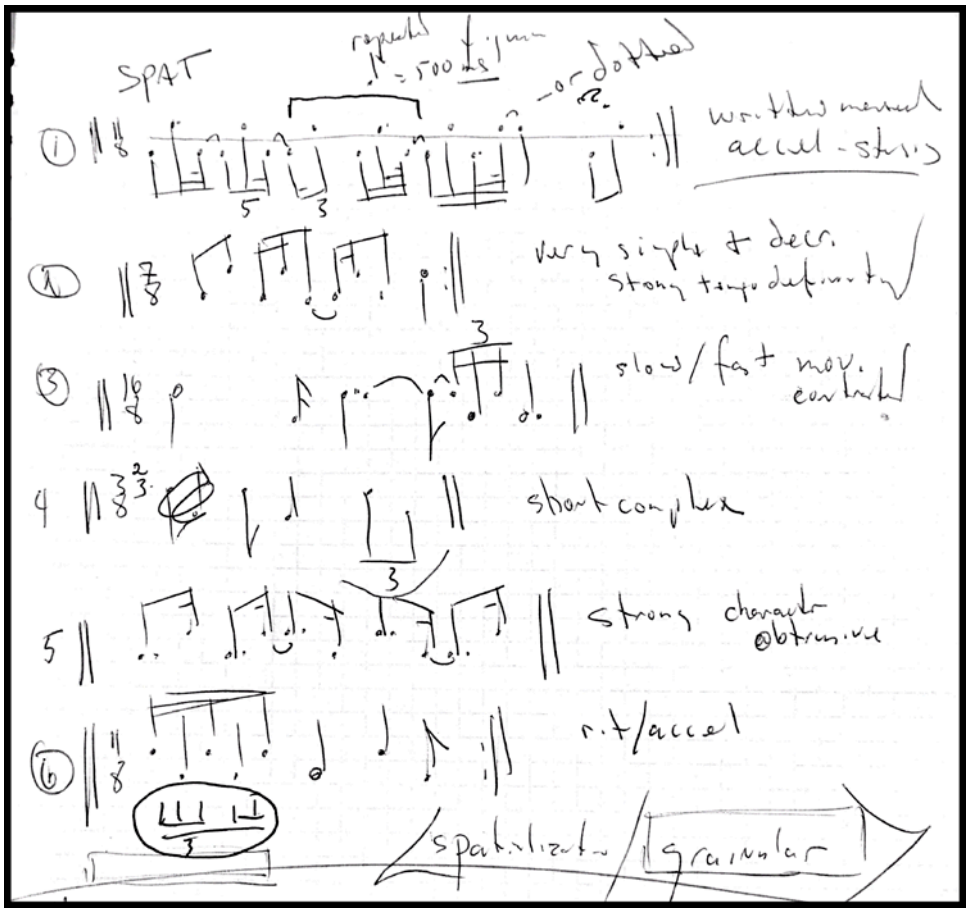


Figure 14. Notes for the rhythmic spatialisations as developed for *Two Iterludes for an Opera*.

in deconstructing a recording[27]. Having the ability to analyse sonic parameters in great detail is beguiling. The beauty of this proposition, using the visuals seen on screen in attractive colours and shapes in scores, is also its weakness as a compositional system. The beauty and justness of the representation is similar to the problem Cage had with Feldman's graphic score. At some point a musician needs to learn and perform the score. In traditional notation, even a glissando in a treble clef staff from the top line F to the bottom line E over any distance will be open to organic interpretation in its execution. A coloured graphic that might represent a glissando, however, needs to be firstly translated to the analogous line, or notes, before it can then be interpreted. An unnecessary step for the performer and a good reason to avoid using nontraditional graphics.

WYSIWG is an acronym for 'what you see is what you get'. The text in a word processor is WYSIWYG if it is printed out the same way it looks on screen as you

[27] Pierre Couprie, *EAnalysis*, version 1 (Paris: Pierre Couprie Software, 2018), <http://logiciels.pierrecouprie.fr/> (03/19).

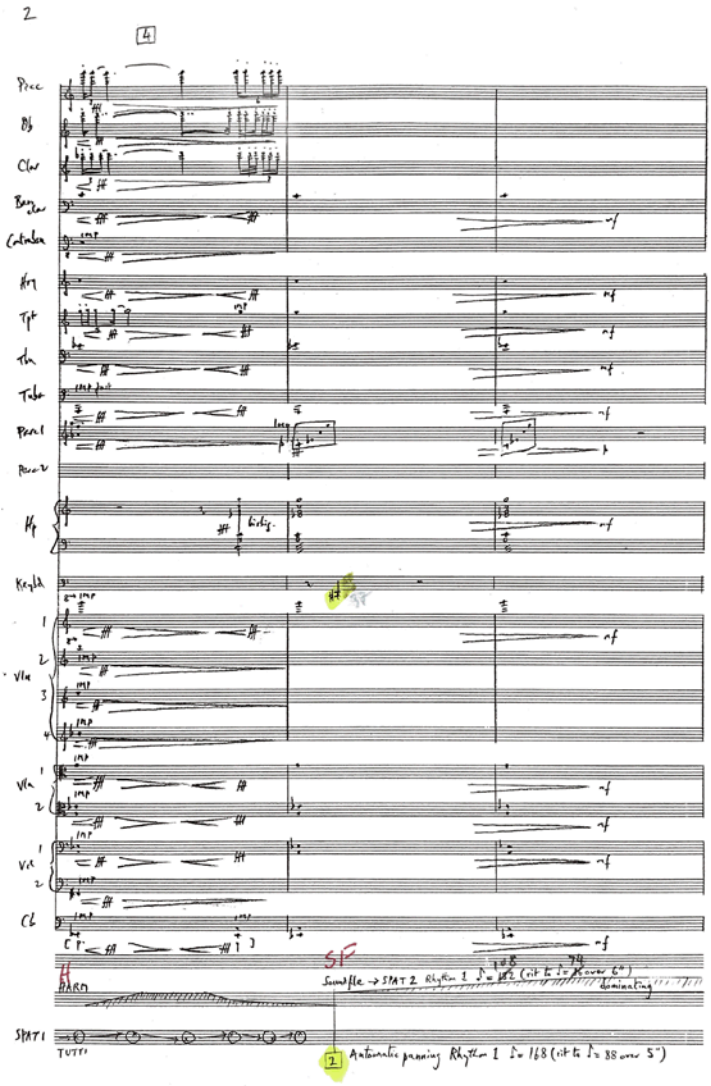



Figure 15. Routing and rythmic spat notation in *Two Interludes for an Opera.*

write or preview the document. As we have seen, music is not WYSIWYG. A note on the staff will have a different meaning depending on the instrument, the player, the musical context, the air, and so on. As musicians, we are trained to understand this and to develop our internal ear, to endlessly practise eye/ear/finger (or voice) dexterity, to see invisible connections within a score, to hear timbre when we see a black dot on a staff. When a composer short circuits this process, performing practice needs to be recalibrated and rethought. Is that helpful? Is it necessary? Do we really need that new notation?

Compared to the abundance of treatises on music and its notation over the last 15 centuries, notating electronics is a practice in its infancy. I would like to build upon this rich and varied tradition instead of introducing anything new, unless «such and such a detail requires to be, and can be, improved». There are a certain number of common practices I believe are important and relatively straightforward concerning the craft of notating electronics. These practices come from practical engagement with performance and creation. Born out of necessity in places that specialise in electronic music creation, I believe we do need to codify and publish and teach both the notation and the practice of documenting the electronics as much as, if not more than, the traditional elements of the repertoire.

A few propositions for better practice in notating electronics

A simple graphic system based on five horizontal lines and four spaces, learning music notation, however, is deceptively difficult skill to acquire. It is an expert system that requires a period of training to learn and an even longer period to master. As this is a system that works, however, we can add to the repertoire by codifying common practice and the simplest of symbols.

There has always been and there will always be a need to explain and define possible interpretations of the symbols we use in notating music. The common practice period might be seen as a moment when everyone agreed, more or less, on the many parameters of music, including its notation. While utopian to imagine a common practice period for electronic music notation, having an agreed upon code for notating electronics is a worthy endeavour and one that could be developed over time in regular meetings between practitioners, publishers, and musicologists. A possible forthcoming project.

In the meantime, I have noted below a few basic tenants for approaching the notation of electronics. You might also be interested in a more recent, and highly regarded, guidebook for notation by Elaine Gould, *Behind Bars: The Definitive Guide to Music Notation*[28].

1. Keep it simple and direct. Use a minimum of directions for any addition to a score: 'M; h-s; R' being abbreviations for a 'Metallic, hard-struck, reverberated' sound is easy enough to remember and should be taken as a model.
2. Allow the performer into the process of interpretation, too much information destroys that process. There is always something the performer will bring to the composition. How much or how little depends on how you notate the score.
3. Keep in mind that the score is the best place to add documentation on the technology, machines, equipment and processing of the electronics. In the event that the technology you used for the creation becomes obsolete, by providing this invaluable information, hopefully your music won't.

[28] Elaine Gould, *Behind Bars: The Definitive Guide to Music Notation:* (Faber & Faber, 2011).

4. Providing as much information as possible about the technology and the process used to create and/or perform the work is extremely important for understanding and transmitting the work. Time should be allotted for this aspect of any creation (adding time after the premiere for this is highly advisable).
5. If using a Max patch (or similar), comment the processes, clearly label the important structural elements of the patch (DSP, control, cue systems) and provide a glossary for all abbreviations. The score should contain the same information and abbreviations.
6. Text descriptions are good, but don't depend on words alone to explain the notation. There should be an organic base to the notation. If a notation exists in the tradition form that approaches the effect, start with that (i.e. notating a transposition might be similar to the notation of a string harmonic with added detail in cents if necessary).
7. All the above could be combined into a protocol peculiar to each work that is simple to implement and understand and folds neatly into a written score, as well into a Max patch or other creative electronic music environment.