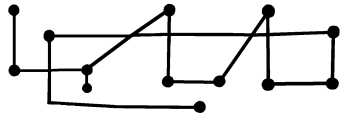
MODULAR MUSIC



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> For me, every attempt to bring a work to a close after a certain time becomes more and more forced and ridiculous. I am looking for ways of renouncing the composition of single works and—if possible—of working only forwards, and of working so "openly" that everything can now be included in the task in hand, at once transforming and being transformed by it; and the questing of others for autonomous works just seems to me so much clamor and vapor.
>
> —Karlheinz Stockhausen[1]

WITH THIS STATEMENT, Stockhausen articulates the impulse to create a modular composition. That a piece could be flexible and subject to constant change between performances was beginning to become relatively well-established as an idea; with the possible exception of some periods of Cage's work,[2] the notion that such an approach could form a complete compositional method was not. Even though works might be internally flexible, generally they had limits and were deemed complete (in terms of their composition) following the composition of all component parts and the structural format which bound

them. What if this was not the case though, and a piece became continuously extensible so as to form a complete compositional method encompassing all of a composer's work? This paper attempts to set out principles for the design of such a method, drawing on modular product platform theory, and implementations of modularity to different degrees within object art, literature, and music. After discussing the needs which drive the development of such an approach, key concepts and techniques of modularity and system design are presented with examples drawn from these fields, supported by an extended examination of my own modular project *#[unassigned]*. The paper concludes with a consideration of the implications of working in a modular way.

Why Modularity?

As a starting point, it is worth establishing a definition of modularity. According to the Oxford English Dictionary, a module is:

> **module** n. **1** a standardized part or independent unit used in construction, esp. of furniture, a building, or an electronic system.[3]

A compositional, or indeed any, method involving use of modules therefore would require a number of standardized units and a procedure for fitting them together. This forms the basic concept of such a way of working, whatever the context. There also clearly needs to be a motivational force to adopt such an approach, presenting a perceived advantage over other methods. In Anna Ericsson and Gunnar Erixon's *Controlling Design Variants: Modular Product Platforms*, reasons for industry's adoption of modular product architecture are summarized, demonstrating their benefits:

> The development of modular product designs results in many positive effects on the product range level. A properly used modularization has the following advantages:
>
> - higher flexibility—product changes, due to market or new technology, can be made more easily since they will only influence limited parts of the product;
> - reduction of product development lead time—parallel development activities are possible once the interfaces between modules have been defined;
> - parallel development of the product and production system—product development plans can be translated into production plans for each module;

- reduction of production lead time—parallel manufacturing of modules instead of manufacturing an entire product in a single sequence;
- less capital tied up in production—work-in-progress is reduced due to shortened lead times, less stock maintenance of ready-made products;
- reduced material and purchase costs—the reduction of part numbers means less to purchase and less to administrate, and higher volumes per part number;
- improved quality—modules tested before final assembly have shorter feedback links, allowing easier adjustments;
- easier service and upgrading—standardized interfaces make adding or replacing a module easy; and
- easier administration—quoting, planning, and designing customized products can be done more efficiently.[4]

Most of these reasons relate to increasing productivity, reducing costs, and simplifying administration: essentially working in a more efficient manner without a reduction in the quality of the result. They also highlight the more creative benefits such an approach provides: greater flexibility, improved quality, and independent development of a product and production system. For example, reuse of modules in new contexts allows more of the material's potential to be explored through new configurations rather than limiting it with a fixed relation to other material. This is both a creatively valid position and an efficient use of composing time. Without wishing to imply a utilitarian approach to music or make a direct comparison with the economically driven needs of manufacturing, these practical and creative reasons could be seen to have a place in modular musical composition, and be sufficient reason to justify adopting this approach. First, though, it is important to examine precedents both in music and other contexts to determine principles on which to base such a system.

Modular Structures in Manufacturing and Object Art

Product Architecture and Modular Theory

Modularity is, of course, well established in many forms of product design and manufacture. Anything for which a production line is used will almost inevitably feature some modular components which are then assembled to produce an object or variable range of objects. We are also familiar with modular products where we as consumers have control over

the final structure, with the manufacturer simply providing the components and the means to connect them: examples might include IKEA's modular furniture ranges, Portakabin's modular buildings, and Lego.

Ericsson and Erixon go on to present design criteria for modular product architecture in a suitably context-free manner as to be adaptable to modular music. Initially, they suggest a definition of product modularity as

> having two characteristics: 1) similarity between the physical and functional architecture of the design, and 2) minimization of the degree of interaction between physical components. Hence, the modular product platform definition of *modularization* is "decomposition of a product into building blocks (modules) with specific interfaces, driven by company-specific strategies."[5]

Here they isolate one of the most important concepts in any modular structure: the interface. In any physical system, there needs to be a standardized way of joining modules in order that a variety of products can be constructed with minimal alteration of the basic modules. For example, Lego bricks have a common spacing of knobs and recesses: if these were different for each brick, they could not clip together. This needs to be considered at the planning stage of a modular product, before the products themselves are built. In order to contextualize this as part of the product development process, Ericsson and Erixon construct a hierarchy of different structural levels which should be considered when planning a modular product and production line:

> Product architecture can be treated on three levels: the product range level [the modular system], product level [items constructed from modules], and component level [the modules]. Measures to reduce complexity affect the product range, product, and component levels exponentially. . . . There is, therefore, a great potential for improvement if the right decisions are made at the higher levels.[6]

This emphasizes the need to make the correct decisions on the product range level (particularly with regards to the interface design), as mistakes here multiply to cause significant problems at lower levels.

They go on to outline other key structural concepts in modular product design. Of particular relevance here are the subassembly and carryover, both of which will be shown to have direct relevance to modular music:

> A *subassembly* is often the result of the assembly planning activity. Subassemblies are created because the product design does not permit entire assembly in one flow. The need for many subassemblies may be one of the first indicators of poor product design. A *module*, however, is chosen for specific, corporate strategic reasons and the interfaces should take the ability to be assembled into account. It is often beneficial to subassemble the modules off-line of the final assembly line. Consequently, a subassembly is not necessarily a module, but a module is often a subassembly.
>
> A *carryover* is a part or a subsystem of a product that most likely will not be exposed to any design changes during the life of the product platform. The part, therefore, can be carried over from an earlier product generation to a later one.[7]

So a modular system consists of a conceptual rationale for its employment, a pool of modules, and an interface with which to join them. All of these are inter-dependent. Within this product range architecture however, whether this be in manufacturing or art context, there are two distinct categories of modular structures: open and closed.

CLOSED MODULARITY

Closed modular structures have a limited number of possible formations. When dealing with physical objects, there are two principal criteria which indicate that a structure is closed. Firstly, there needs to be a limiting interface which restricts the ways in which modules can be joined within the rules of the system (as defined by the requirements of the product). So to take the example of a flat-pack furniture kit, although each component module is physically separate and independently manufactured, each has a particular place in the assembled product. The interface fixes each module's position in relation to the others, so while it might be possible to substitute equivalently shaped modules (for example, in a different color), most modules have a unique position which cannot be changed and although it might occasionally be physically possible to attach a shelf perpendicularly to a cabinet, the eventual use prevents this. The interface is therefore defined both by its physical connectivity options and the practical constraints of its eventual use.

The other criterion which indicates a structure is closed is that of having a limited number of modules. When combined with a limiting interface, a finite number of modules allows the creation of a finite

number of objects (however large this number might be). Importantly, for a modular structure to be closed, both conditions must be satisfied. Having a limiting interface but an unlimited number of modules,[8] or a limited number of modules which can be connected in an unlimited number of ways, clearly results in an unlimited and therefore open modular system. For a closed modular structure to exist, it must have both a limiting interface and a limited number of modules.

In a manufacturing context, one of the case studies Ericsson and Erixon discuss is the Swedish winch manufacturing company Sepson. This is a clear example of closed modularity:

> The modularization project generated a new concept for winches, consisting of six modules. Three of the modules were variant modules and the rest were common units.[9] With the new modular design, a typical winch uses seven modules (including two gear-box modules). Through various combinations of the six modules, 28 variants of winches can be created.[10]

There were therefore a limited number of possible modules that could be used, and a limiting interface through which they could be connected. Crucially here the interface makes the product non-extensible, and therefore closed.

A further example can be seen in object artist Carl Andre's work from the 1960s, which utilized readily obtainable building materials to produce modular structures in a variety of arrangements. His *Equivalents I-VIII* (1966) used 120 firebricks in various arrangements to test our understanding of equivalency. All the bricks are the same, and are tessellated in an identical way in each configuration: bricks placed end-to-end to form rows, which are then placed next to each other to form larger structures. This method creates a closed modular system because each construction features a limited number of modules (120) and there is a fixed interface (the bricks could not be spread randomly around the room under these conditions, for example). Although the number of permutations available is very high, it is not infinite as there are closing conditions built into the method. It should also be mentioned that in this case the interface method is driven by artistic and not functional needs: other artistic applications of the same materials with a different interface could also be found, something which is less likely in a manufacturing context.

OPEN MODULARITY

Open modular structures have an unlimited number of possible formations. As with closed structures, the nature of the interface and the number of modules has a direct bearing on defining a structure as open. Here, either of these two conditions needs to be unlimited. If there is no fixed interface, any method of combination is theoretically possible, immediately creating a theoretically infinite number of structures. For example, if the Carl Andre piece were to remove the particular tessellation method as an interface, it would clearly allow any placement of 120 bricks to become valid within the work's remit. Also, if there is no limit to the number of modules that can be used, then the structure becomes continuously extensible, allowing progressively larger structures with a correspondingly larger number of permutations. Again, with Andre's work, if each configuration was not limited to 120 bricks, the structure could theoretically consist of any combination (allowed by the interface) of all possible bricks at any given moment.

Returning to self-assembly furniture, many of IKEA's storage ranges are modular in an open way as they are also extensible. For example the IVAR shelving range consists of eight side units of differing heights and depths, six shelves of differing widths and depths, and a range of cabinets.[11] These can be used to shelve out a wide variety of spaces as a result of the flexible interface between modules and the possibility of adding to the configuration at a later date if a new use is required.[12] While the interface is limited (although quite flexible), the system allows users to continually expand their configuration as required making this an open product. In contrast to other ranges (e.g. IKEA's BILLY range), customers buy the modules themselves as opposed to kits with pre-selected combinations designed to build a particular object.[13]

Within object art, Dan Flavin's work provides an example of an open modular system. Flavin's "proposals" are constructed out of arrangements of neon lights, but whereas in much of Andre's work each unit is identical and tessellated, with Flavin there are often differences between each module (e.g., color, size, orientation) and, more importantly, no common interface. *"Monument" for V. Tatlin* (1966–9) is perhaps closest to Andre's use of modules as the close, ordered arrangement suggests an interface and focus on the relationship of the modules to each other and the overall structure. We see it as an object, which could exist in any space. Other configurations go beyond this however. Although it clearly uses the same materials, *greens crossing greens (to Piet Mondrian who lacked green), 1966* cuts across the space positioning the lights in more than one plane and separating them

physically. So while with Andre there is a use of a single basic module which is repeated and tessellated, with Flavin these modules are varied, do not have a standardized way of relating to each other between constructions, and leak out from the object itself into the space in a more tangible way. This is a clear example of *open* modularity, as the absence of a common interface leads to an infinite number of permutations of even a limited set of modules.

So with closed modularity, there are a limited number of structures that can be made as a result of having a limited number of modules *and* a limiting interface between them. With open modularity on the other hand there are an unlimited number of possible structures due either to the lack of a limiting interface between modules, *or* the number of modules theoretically available.

Modular Structures in Temporal Arts

While many of the concepts developed in modular product platform theory are transferable to modular structures in art, they do not take into account the temporal nature of music, relating as they do to physical structures. Although there is in one sense a physical placement of objects when dealing with notation and the manipulation of score fragments, sound files, or equivalent units, the experience of music takes place in time. As a result, any interface for a piece of modular music (or literature, film, dance, etc.) must regulate the degree of linearity created by resultant sequences of modules. As with object-based modularity, temporal modularity also requires both modules and an interface, but there is perhaps also a greater need for a map of the modular network given the lack of a physical trace: when constructing a physical object it is self-evident, whereas a temporal object is not immediately clear and must be experienced in sequence to become intelligible. In some cases, as will be seen, such notation is relatively straightforward, but as systems grow, mapping an increasingly complex set of links becomes very difficult indeed.

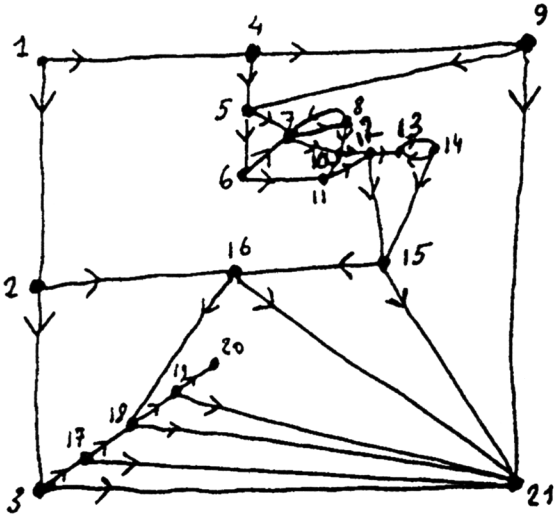
With temporal modularity there are also two principal interface methods: linear and simultaneous. Modules might be placed so as to follow each other or to occur at the same time, and combinations of these two methods of placement have the potential to create a rich network of inter-relations. With each, depending on the context, there will be local criteria which define the nature of the connection, but generally a rule system is in operation to determine allowable configurations within the aims of the system. Temporal modularity can also exist in open and closed forms.

CLOSED MODULARITY

Closed temporal modular structures require both a limited number of modules and an interface which has an end condition in order to produce a limited number of formations. Many such examples exist in literature and the work of the Oulipo[14] writers in particular. Perhaps the two best known examples are by Raymond Queneau. His *Cent Mille Milliards de Poèmes* (*One Hundred Thousand Billion Poems*, 1961)[15] was originally published as a set of ten sonnets with each line printed on separate strips of paper that could be recombined to produce 10^{14} different poems. Although there are a colossal number of potential poems which result from this method,[16] it is nevertheless closed as a structure. There are only ten lines which can act as the end of the poem and there are no feedback loops within the system. Upon reading the final line of a given version therefore, the poem is complete within the rules of the system. Importantly, while the rhyming structure is consistent regardless of the choice of lines made, the links between each line are nonsensical. Any line might follow any other within the structure without fear of reducing the semantic content: indeed, the poem relies on the serendipity of connections made through this approach.

The other Queneau work of note in this respect is his *Un Conte á Votre Façon* (*A Story as You Like It*, 1967).[17] This brief example defines a genre much developed subsequently, that of multiple-choice narratives, familiar through many adventure stories where readers are able to choose their own route through a narrative. In Queneau's *Story*, the narrative centers on three peas/beanpoles/bushes and their dreams. It consists of 21 short events (modules), each followed by two choices for the reader as to the next event. Upon moving to the next event, there are again two more choices and so on until the final event (20 or 21) which concludes the story, as shown in Queneau's graphical representation of the structure in Example 1.[18]

This is a multiply-*directed* narrative which has one start point and two end points, rendering it closed. This is also true of most of the more ambitious examples of this genre, notably the series of books created by Steve Jackson and Ian Livingstone.[19] In Livingstone's *Deathtrap Dungeon* (1984),[20] the reader works through a series of 400 events in an effort to guide their avatar through a maze populated by hostile creatures and puzzles. Each paragraph is more substantial than with Queneau, and has between one and six exit routes, creating a relatively complex series of narratives. There are also more frequent termination points which, with the exception of the final successful outcome, result

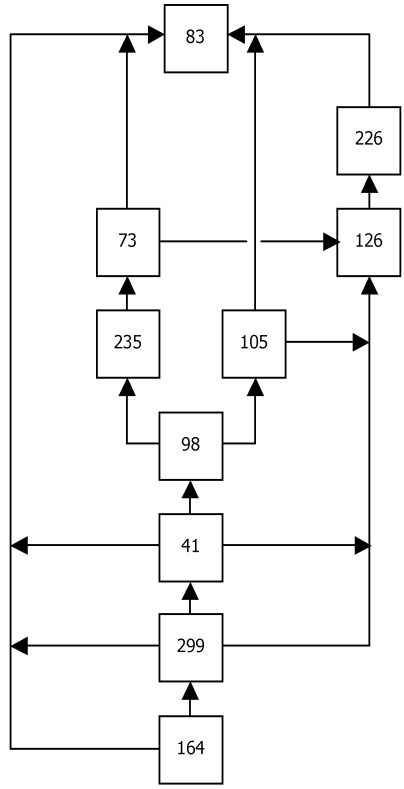


EXAMPLE 1: GRAPH OF RAYMOND QUENEAU'S *UN CONTE Á VOTRE FAÇON* (*A STORY AS YOU LIKE IT*, 1967)

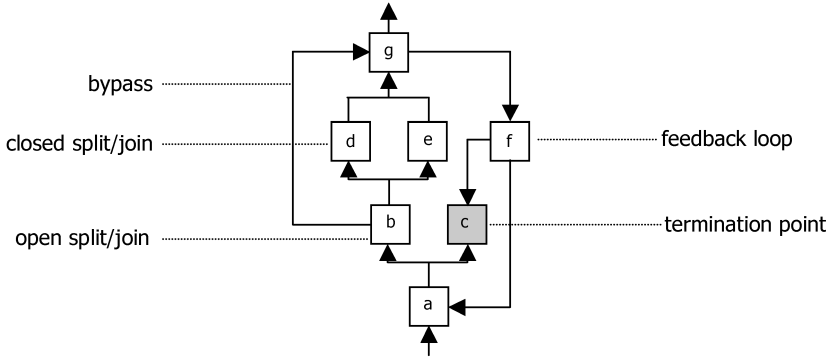
in failure of the task at hand. Livingstone develops a range of common structural devices to organize the events in his narrative. Principally these consist of variations on a branching structure where one event opens up the possibility of two, and so on. In order to limit the complexity though, branches regularly converge to produce separate episodes within the narrative. For example, regardless of decisions made by the reader, a route through the first 64 events always ends up at event 37. In Example 2 a smaller episode can be seen.

Here, the entire episode will take readers from event 164 to event 83, regardless of the decisions they make (although crucial information may only be learned depending on the events visited). There are however nine possible ways to move between these two points. Although this is not a particularly efficient example as there are fewer paths than nodes, when taken over the entire story, the number of routes increases exponentially. In such structures, a number of common formations appear:

Example 3 clearly shows the function of split/join points. There is an open split at (a): this decision point does not have an inevitable outcome as the path may end at (c) (a termination point), or go to (b) where it may continue to a further split at (d)/(e) or bypass them to conclude at (g). The split/join at (b) is closed however, as regardless of the decision made, the path converges at (g). There is also a feedback loop via (f)



EXAMPLE 2: DIAGRAM SHOWING THE STRUCTURE OF AN EPISODE IN IAN LIVINGSTONE'S *DEATHTRAP DUNGEON*

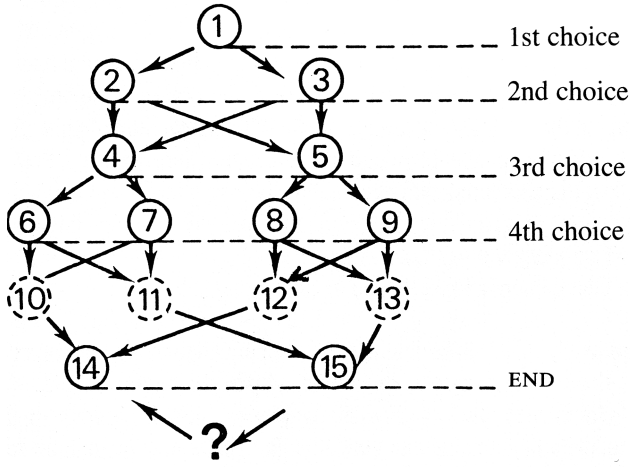


EXAMPLE 3: COMMON FORMATIONS IN PRINTED MULTIVARIANT NARRATIVES

which allows a further tracing through the network, with the possibility of being terminated at (c). The vast majority of *Deathtrap Dungeon* consists of these formations with varying degrees of complexity. The network of sieves and funnels guides the reader along an inevitable path to one of the termination points (there are 29 in total).

Without such a structure, controlling a multivariant narrative would be virtually impossible: writing out all of the possible paths as separate texts is pointlessly impractical. Within this structure though, the authors still need to manipulate the text so that whichever route is taken, the flow of text from event to event still makes sense. Some events are relatively neutral in their meaning (e.g., a choice of going west or east, leading to a new location which needs no introduction), while others, where interaction with other characters or objects takes place, are more loaded (e.g., attempting to elicit responses from another character and following these up without redundant duplication of information). This clearly demonstrates the inter-dependency of the interface and the design of the individual modules, as with object-based modularity.

The efficiency of this approach can be seen in another Oulipian example, Paul Fournel and Jean-Pierre Énard's multiple-choice theatre described in "The Theatre Tree: A Combinatory Play."[21] Here too a split/join network is used. Their aim was to produce a play with four decision points at which the audience could intervene (see Example 4), but realized that an endlessly branching structure would be practically



EXAMPLE 4: DIAGRAM FROM PAUL FOURNEL AND JEAN-PIERRE ÉNARD'S "THE THEATRE TREE: A COMBINATORY PLAY"

impossible for actors to realise. By joining the narrative later in the play it became manageable. Fournel says:

> the audience will be asked to choose four times, which means there will be five scenes in the play. Given that our "tree" contains fifteen scenes (four of which do not lead to choices), sixteen different plays of five scenes each may be engendered. In order to produce these sixteen plays in traditional fashion, one would have to write eighty scenes (16 × 5). We have thus economized sixty-seven scenes.[22]

Closed modular structures also appear in music. A widely used strategy is the use of mobile forms, developed initially by Earle Brown in the 1950s from the work of Alexander Calder. In the preface to his *Folio* (1952–4), Brown states that a mobile score is

> subject to physical manipulation of its components, resulting in an unknown number of different, integral, and "valid" realisations.[23]

This creates a clear link to the notion of modularity, and suggests a route to its possible application in music. In practice however for the pieces in this collection, manipulation refers to the orientation of a page (*December 1952*), the placement of clefs against staves (*November 1952 "Synergy"*), the synchronisation of parts (*mm87* and *mm135 March 1953*), and the application of tempo (*October 1952*). This is not (necessarily) a modular approach, although it shares a similar concern with creating multiple outcomes from a limited set of materials and instructions.

A closer link can be found in Karlheinz Stockhausen's *Klavierstück XI* (1956). Here an array of 19 groups (modules) are spaced on the page with no definitive ordering or implication of sequence. To play the piece, the performer selects a group at random ("the first that catches his eye")[24] and chooses the tempo,[25] dynamic and type of attack. On completion of a group, another is selected and the tempo, dynamic and attack instructions at the end of the previous group should be applied. If a group is arrived at for a second time there are some alternative interpretation instructions (mostly octave transpositions), and when a third occurrence takes place, this is the end of the piece.

Visually, the piece can clearly be seen to be constructed from modules that can be combined according to a defined method via an interface. The fact that most modules end with either a sustained sound or a pause also highlights the structure of the piece aurally, with its use of self-contained moments, perhaps emphasizing the modular nature of the music (some groups end with the word *binden* (join) however, which

might lead to a more continuous performance). Stockhausen also specifies that the piece "should if possible be performed twice or more in the course of a programme."[26] Clearly the variable nature of the piece is something that carries a proportion of its meaning and that it is important, as with Andre's *Equivalents I–VIII*, that we experience more than one version in order to understand this. *Klavierstück XI* is apparently an example of a closed modular piece: the number of modules is fixed, and there is a terminating condition in the interface (finish after the third repeat of a group).

Perhaps the best example of a modular work from this period though is Earle Brown's *25 Pages* (1953). In contrast to *Folio*, Brown combines physical manipulation of the score with a modular structure. He explains the method of preparing the score in the introduction:

> The 25 Pages may be played in any sequence; each page may be performed either side up; events within each two line system may be read as either treble or bass clef; the total time duration of the piece is between 8 mins. 20 sec. and 25 mins., based on 5 sec. and 15 sec. per 2 line system as probable but not compulsory time extremities. A time structure in terms of seconds per 2 line system may be preset by the performer, obtained from the composer or be arrived at spontaneously during the performance. The indicated note durations are precise relative to each other and to the eventual time value assigned to each line system. . . . It will be seen that the basic "mobile" elements of the piece; page sequence and inversion, clef disposition and time; admit of a considerable number of different presentations of this material. All of these possibilities are valid within the total concept of the work provided that once a selection from the range of possibilities has been made, it be executed with devotion and accuracy in regards to the time durations, attacks and intensities. The variable factors are to be dealt with to any degree of simplicity or complexity interesting the performer. The piece may be played by any number of pianos up to 25.[27]

So here there are twenty five modules (or fifty if you include both inversions, of which a maximum of twenty five can be performed in any one version). They can be combined in a clearly stated manner (an interface) and he suggests the notion of validity in relation to this approach, implying that ways of using this material outside of the interface are not possible. Brown accepts all possible realizations if the instructions are followed with intent as being legitimate instances of the piece: this too is vital for any modular construction where the end-user

has the responsibility of constructing the finished item (whether it be a self-assembly shelving system or a piece of music).

25 Pages is also seemingly an example of a closed modular piece: Brown did not write any further pages, and the interface is clearly defined. There is however a problem, and one that is peculiar to any situation where there is an element of interpretation of the finished structure before its perception. While theoretically there are a limited number of permutations of the pages, orientations, and deployments of clefs, there are not a limited number of versions. Brown's suggestion that interpreters arrive at a duration for each system (and therefore the piece) that does not have a "compulsory time extremity" effectively creates an infinite number of versions. A particular arrangement of the physical material might be interpreted in an infinite number of ways, with each system lasting any fixed duration. Brown's modularity here is physically defined by two elements: page sequence and orientation (how the notation is ordered). This is then modified or customized by an interpretative layer: duration and clef disposition (what the notation means). So while the score can be considered a modular construction, the sounding result potentially deletes any trace of this in our experience of the music: it is a conceptual modularity.

Brown recognized this difference in his prefatory note to *Folio* in relation to mobility and graphic scores, stating

> a *conceptually* "mobile" approach to basically fixed graphical elements; subject to an infinite number of performance realizations through the involvement of the performer's immediate responses to the intentionally ambiguous graphic stimuli relative to the conditions of performance involvement.[28]

So only our knowledge of the score and concept behind the piece reveals this aspect of its construction. This is clearly a different situation from both Andre's and Flavin's work where however much the viewing context mediates our experience, we still see the modules and are aware of the method of construction: indeed, this is one of the principal conveyers of meaning in the work.[29]

OPEN MODULARITY

Open temporal modular structures require only the absence of an interface which has an end condition in order to produce an unlimited number of formations. If this is the case, whether there is a finite

number of modules or not is irrelevant. In order for this to happen, the interface might allow repetitions and loops, layering of modules, or multiple end points. In his "For a Potential Analysis of Combinatory Literature," Claude Berge (another Oulipo member) discusses the use of circuits in such systems. In relation to Queneau's *Cent Mille Milliards de Poèmes* he observes that "it should be noted that the reader advances in a graph *without circuits*; that is, he can never encounter the same verse twice in a reading."[30] Essentially, the reader cannot double back and repeat a previously read line. There are however examples of multivariant narratives in which such loops form a central structural role, and produce open forms as a result.

Since the advent of hypertext, many authors have contributed to the development of hypertext fiction, a branch of literature which develops the multivariant narratives of Queneau's *Story* and Jackson and Livingstone's adventure books (not to mention work by Julio Cortázar, Marc Saporta, B.S. Johnson, and implications of the work of Jorge Luis Borges) in computer realizations. While a book is perhaps designed to project linear narratives as a result of its bound format and the progressive turning of numbered pages, blocks of on-screen text can be more easily linked without a need for such linearity. Authors have used the loosening of narrative constraints provided by the medium to produce work which deals with networks rather than trajectories.

In his "Patterns of Hypertext,"[31] author and theorist Mark Bernstein suggests a method for this by presenting a range of structural devices used by authors to control readers' progression through a story. Many of these are familiar from earlier printed examples such as those outlined above. He observes the split/join, the sieve (tree), and the cycle (loop) and in addition defines, amongst others: the contour, in which cycles interface with each other to produce larger cycles; the tangle, where a number of exit links do not give the reader a clear idea as to their direction, creating narrative confusion; and the neighborhood, where individual episodes display associative tendencies and create stable inter-related areas of a text (obliquely referencing Erixon's and Ericcson's subassemblies). The expansion of the cycle/loop in particular is central to open modular forms. Theoretically, endless retracings through a network may occur within a single reading. In a good example of such work, these repetitions create new relationships with the narrative as previously assimilated information is reframed in the light of new developments.[32] This feedback clearly increases the number of readings, potentially to the point where termination is a choice of the reader, rather than being enforced by the author.

Marie-Laure Ryan also discusses the properties of digital texts which create open forms in her paper "Multivariant Narratives."[33] In the course of defining three aspects of such narratives, variable discourse, variable point of view and variable plot, she discusses Stewart Moulthrop's *Victory Garden* (1991), an early and now classic form of the genre, saying:

> The presence of circuits—the formal trademark of a network—means that there may be many different ways to get to the same node. The system designer can control the reader's itinerary on the local level (where to go from a given node) but not on the global level. This feature discourages what I call a "narrative" interpretation of the sequence viewed by the reader: an interpretation that narrowly associates the order of appearance of lexia with a chronological and causal chain of events in the reference world.[34]

And later that it

> does not tell a different story for every reader, or with every reading session, it rather tells a story in many different ways, varying discourse instead of plot. Approaching the text like a jigsaw puzzle, the reader rearranges lexia mentally, so that a fragment encountered at T1 in the reading sequence may be assigned time slot T22 in the reader's final reconstruction of the plot.[35]

This then suggests that while the events of a particular story might be limited, the navigation structure allows for an unlimited number of readings due to the presence of circuits in the text, and that this may in fact not tell different stories, but the same one in a variety of ways.

This is equally true of Matthias Spahlinger's *128 erfüllte Augenblicke* (*128 fulfilled instants*, 1975) for voice, clarinet, and cello. It isolates three parameters (number of pitches, duration, and a pitch-noise continuum), each of which has four defined discrete possible states. Spahlinger uses these possibilities to create a three-dimensional grid with sixty-four vertices. Further to this, he also specifies one of two possible changes of state: the tendency to increase or to decrease. This results in 128 separate combinations of these parameters, for each of which one instant (module) was composed. These are mostly very short, ranging from 2 to 37.5 seconds in duration, and a single long instant (*.311*>) lasting about 4′20″. Each instant has a unique number derived from its position on the grid and its tendency to increase or decrease.

In performance, the players decide on the sequence of instants to be played. Spahlinger's preliminary remark clearly outlines the piece's open nature, as he states "the performers are free to choose the order in which they play the instants, as well as the number of times they play them or repeat them."[36] So again the presence of circuits allows an infinite number of realizations of the piece as instants can be repeated: there is no time-limiting condition or possible exhaustion of the material in these terms. The result is an open modular form. Spahlinger also recognizes the fact that formally the piece has no fixed structure. Although he provides a diagram representing the relationship of the modules to each other, this gives no indication of the myriad of possible structures that might be presented. This emphasizes the fragmentary (and modular) nature of the music, which Spahlinger summarizes by saying,

> The fact that the musical development of this three-dimensional form cannot be depicted, separates the instants, as if they wish to exclude each other mutually, but also opens them up for each other at the same time—in a sad freedom.[37]

By creating very precisely notated modules, Spahlinger's approach is made noticeably different from that of both Brown and Stockhausen. While the ordering of each module is variable, the performance of each is essentially fixed. There is no composed transformation layer where the material is modified, leading to a situation whereby modules are generally identifiable. It is possible to recognize each module given sufficient exposure, something which is much harder to do in *25 Pages* or *Klavierstück XI* where the notated material is altered by the methods stated. This emphasizes the fact that the modular nature of the music might be audible and carry meaning,[38] even if the listener has no prior knowledge of the ideas behind the piece.

In this piece however, as with all the modular structures examined so far, the question of differences in meaning if we perceive the work on its own (as a single realization, and without knowledge of the concept) or as one of many hearings (or the possibility of multiple hearings) remains. Spahlinger addresses the effect this might have on the listener, saying,

> The fact that the listener knows where he is without knowing where he is formally and temporally (that all, in sum, could occur differently), might contribute to making all the hierarchies . . . which develop between the text and context [appear] as simply temporary.[39]

So he is suggesting that one outcome of such an approach is to challenge the conventional relationship between the work and its context by disorienting the listener through the subversion of any received sense of linearity in music they might have.

One final example demonstrates a different approach to modularity. While with the examples from Brown, Stockhausen, and Spahlinger modularity is apparent in the sequential (re)arrangement of material, with much of John Cage's work simultaneity is also a component of the modular interface. In Cage's work, the possibility of combining sections of individual instrumental parts with themselves, with other instrumental parts in the same piece, or with nominally separate pieces is apparent. On the level of combining complete pieces, there is a selection of indeterminate music from 1957–70 which may be performed simultaneously. In the preface to his *Song Books* (1970) Cage states this clearly:

> The solos may be sung with or without other indeterminate music, e.g. *Rozart Mix* and *Concert for Orchestra*.[40]

These pieces include *Concert for Piano and Orchestra* (1957–8), all of its constituent sub-pieces (*Solo for Violin*, *Solo for Bassoon*, etc.), *Solo for Voice 1* (1958), *Fontana Mix* (1958), *Aria* (1958), *Variations I* (1958), *Solo for Voice 2* (1960), *Variations II* (1961), and *Song Books* (1970). The actual method for combining pieces is not precisely specified, but it is implied by the instructions for creating a performance of *Concert for Piano and Orchestra*:

> The whole is to be taken as a body of material presentable at any point between minimum (nothing played) and maximum (everything played), both horizontally and vertically: A program made within a determined length of time (to be altered by a conductor when there is one) may involve any reading, i.e., any sequence of parts or parts thereof.[41]

and for *Solo for Violin*:

> Given a total performance time-length, the player may make a program that will fill it.[42]

So the interface for these pieces is simply an agreed time-length, which might change in certain situations,[43] and the relatively open instructions for the creation of each part. It is therefore very open, in line with

Cage's well-documented views on simultaneity of experience.[44] These pieces demonstrate a higher-level structural modularity, and one where the notion of distinct pieces might be subsumed into the view of a composer's work as a whole and the implication that all music is part of the modularly structured experiences of our daily lives.

His clearest modular piece though is the later *Music for* (1984–7), which consists of seventeen separate parts for voice and instruments and no score. In the subtitle, Cage denotes that there is "no fixed relation"[45] between parts, and in the performance directions that

> Played in its entirety the work will last 30 minutes. If desired, performances of shorter lengths may be given, each player independently of the others choosing an uninterrupted sequence of pieces and interludes[46] the length of which is approximately that of the agreed upon time.[47]

As with his earlier indeterminate work, a common performance duration provides the interface, but within this there is a higher degree of control of material. Each piece must begin within a specified time window lasting either 15, 30, 45, or 60 seconds, and finish within a later window of the same duration. Each interlude starts and ends at a precise time point. So although there is almost no precisely controlled synchronization of material, within more general terms the kinds of material which might be heard together are to some extent predictable. This is true only for complete performances using all the parts and lasting the maximum duration however: if parts are missing, or if in a shorter performance players do not choose to play uninterrupted sequences of pieces and interludes which correspond to each other in relation to the time structure, then it becomes impossible to predict the result and the piece becomes more open.

This piece, in contrast to sequential modular constructions where modules follow each other and are not superimposed, opens up many more possible arrangements. The fact that modules may be combined both sequentially and simultaneously adds a contrapuntal element to the interface. In Cage's work in particular this raises the possibility of unplanned coincidences and their resonant meaning outside of music, in accordance with his general philosophy.

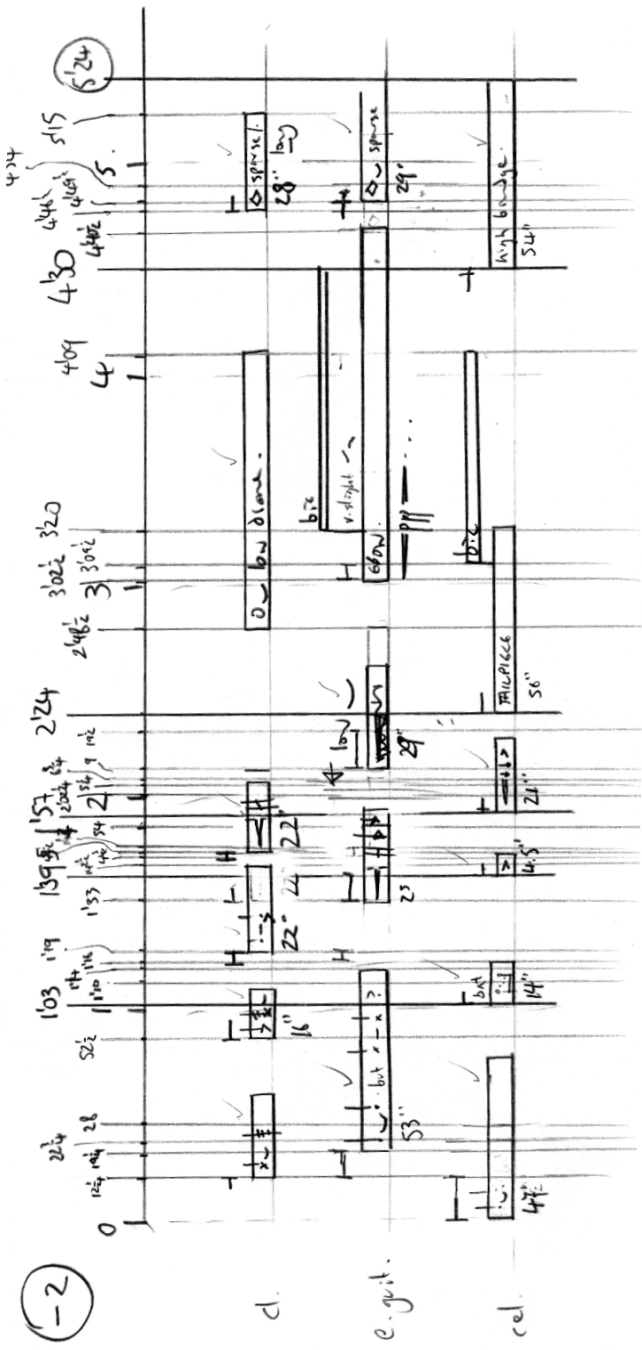
These examples of modular approaches to structure in manufacturing and object art, as well as literature and music, suggest some of the possibilities such strategies might offer with regards to flexibility and recontextualization of material. The generative nature of these constructions, where a very large number of potential realizations might

be spawned by a single system, gives them an additional structural level and with it an additional layer of meaning. Most of these examples are to some extent, however, limited in their scope as although they may be open and subject to an unlimited number of permutations, they are not necessarily extensible. Upon completion of the system, no new modules are added and they become locked. The possibility, then, of adopting an entirely modular approach where the design of a system is not only open but can also be extended indefinitely is a natural continuation of this work.

Developing a Modular Music System

In order to further examine the practicalities of developing a modular music system, my project *#[unassigned]* is offered as a case study. I have been working exclusively on *#[unassigned]* since July 2000. From the outset, my intention was to create a piece that could be for any instrumentation or sound producing media, and last for any duration: an open modular composition. I wanted to be able to reuse existing material in future versions of the piece, and to be able to add new material. I also wanted a structure that could deal with precise and approximate synchronization of parts. My intention was to make individual versions that would be performed only once, made for specific performances (being therefore performer-, event-, and site-specific). Each version of the piece would provide a new perspective on the material, and listeners hearing more than one version might make connections between them. My aim was to develop a modular working method rather than a singular modularized composition. This approach developed from a period of writing only very short pieces (under c. 15 seconds) which later began to be joined together using time structures, and with Lacan's notion of "rings of a necklace that is a ring in another necklace made of rings"[48] very much in my mind.

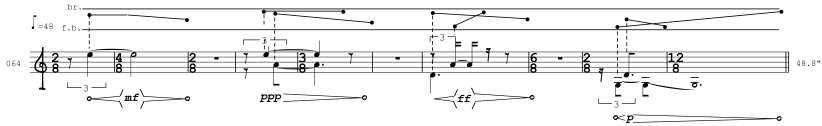
#[unassigned] originally consisted of a developing pool of material for solo instruments or sound sources and a simple interface for combining them in different ways. In the early versions of *#[unassigned]*, the process of composition initially involved creating a time structure which provided a number of points to which modules could be attached. To begin with these structures were derived from a matrix approach based on Christian Wolff's paper *On Form*.[49] The asymmetrical nature of these structures tended to create short sections with a high density of time points, and longer sections that are relatively sparse (see Example 5). Later versions were developed more intuitively as this system had largely



EXAMPLE 5: TIME STRUCTURE FOR #030501-2

been internalized. This interface is of course extremely flexible and extensible as almost any juxtaposition of modules becomes possibly leading to a wide variety of possible configurations in finished versions. The meta-scores produced through this process only exist as a compositional sketch and have no status as a performance scores. From these instrumental parts are produced: as players use stopwatches to co-ordinate their parts and because there is no need for a conductor, a full score is unnecessary.[50]

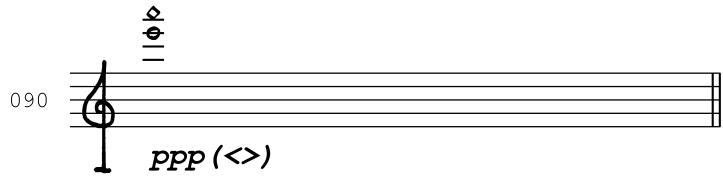
The next stage was to attach modules to particular time points (rounded to the nearest second for ease of performance)[51] using one of two methods. For metered modules—that is, those that are through-composed and normally barred with a tempo indication and specified duration—a window time-bracket is specified. One of the limits of the bracket is a time point, with the other being chosen in order to control the possible overlap of material with other events (normally creating an entry window of c. 5–10 seconds). Through-composed modules tended to be more gestural, with carefully placed material separated by bars of silence (see Example 6).



EXAMPLE 6: THROUGH-COMPOSED MODULE FOR VIOLIN FROM #[*UNASSIGNED*]

The other method for working with time points relates to more continuous sounds (e.g., drones or repeated actions with variable durations) or single events. Here a start and end point is specified, where each is one of the structure's time points. These modules generally consist of one action, which normally results in a sustained sound, often for a longer duration than with through-composed sounds. These might be static sounds with no internal change, or more unstable sounds where specified inconsistencies in playing techniques cause the sound to fragment, suggesting a rich micro-structure (see Example 7).

Although I have occasionally made modules with multiple instrumental parts, the vast majority are for solo instruments as working at this structural level allows the creation of a greater variety of configurations as it avoids what are essentially subassemblies (which reduce flexibility). They varied in length from five seconds to scalable drones which in some versions lasted for about four minutes. Most



EXAMPLE 7: ACTION MODULE FOR VIOLIN FROM *#[UNASSIGNED]*

tended to last between twenty seconds and a minute though. Most of these modules' sound resources have been developed through a process of experimentation with instruments and working with performers. They share a number of characteristics, and to an extent define the soundworld of *#[unassigned]* in general. Principally these are:

- extremes of dynamic, normally approaching silence,
- extremely slow or small ranges of movement (e.g., bow speed, air flow, finger speed),
- extreme registers,
- uncontrollable physical movements (e.g., very rapid single finger tremolos),
- unpredictable responses from instruments, sometimes through alteration or preparation (e.g., coffee stirrer between the strings on a violin),
- very long or short durations of sounds, and
- use of lo-fi electronic transformations (e.g., dictaphones, guitar effects pedals).

These characteristics provide many ways of finding points of contact between sounds as described. For example, adopting similar ranges of movement with the slow drawing of a heavily pressed cello bow and the gradual scraping of a credit card along a bass piano string both result in a series of uneven clicks. This allows textures to be developed, altered gradually, or contrasted with different types of material.

From the outset I decided the title of each version would use a numerical system based on the date of the performance. This has a number of practical advantages: it gives a unique reference for each piece; it is memorable as it is linked to an event; it is flexible and does not control compositional decisions (i.e., structure, or which modules could be used); and it is not programmatically related to the music. I decided to call the piece (at the product range level) *#[unassigned]* as this meta-title had a variable space into which version-specific titles could be inserted. For each version, the [unassigned] portion of the title

is replaced by the assigned performance date in the format *ddmmyy*, so for a piece performed on 18 July 2000, the title would be #180700.[52] This gave me enough scope to develop multiple versions of the piece without tying myself in knots, a problem that was apparent with some of the earlier attempts.

This approach was central to all versions of *#[unassigned]* created between July 2000 and June 2005. It was both a flexible and efficient way of working which crucially did not compromise any of the pieces I wanted to write. For each new version, having settled on a duration and instrumentation, I developed a time structure and placed existing modules, as well as newly composed ones, onto it like a collage. I was, however, gradually becoming aware of the need to develop the system to make it possible for people other than me to make versions of *#[unassigned]*. I began thinking about ways to develop a system to allow others (performers or listeners) to assemble versions of *#[unassigned]* from kits of supplied materials while retaining the essence of the versions I had already made and leaving room for expansion.

Initially I needed to develop the existing *#[unassigned]* system to make it more rigorously organized but without losing its flexibility: Many of the decisions were intuitive, which may cause problems for a more autonomous piece. The main issues with the existing system in this respect were the lack of consistency between module durations and the largely intuitive time structures I had created. The first stage therefore was to adopt a standardized module format to allow for a simpler interface. For clarity I settled on making one minute modules which had the same form as the earlier versions (through-composed and action/drones). The through-composed modules contained bars of silence which allowed the spacing of gestures internally, in much the same way as the earlier time structures spaced denser modules externally. The action modules were scalable in units of one minute.

The interface consisted of placing these one minute modules next to each other (or separated by one-minute silent modules to space material) in each instrumental part. While this limits some of the possible placements of modules given the longer basic duration, the clarity of the interface and simplification of construction in relation to the needs of the new system outweighed this. Additionally, modules were composed with the new structure in mind (hence the spacing of material in each minute), and the start of each player's minute is not synchronized to enable different overlays. In an ensemble performance, one player elects to start by starting their stopwatch. The remaining players then start at a point of their choice within 0–30″ of the starting player's cue. Note that "start" means a player starting their stopwatch:

initially there may be no sound dependent on the module selected. Stopwatches are therefore not synchronized between players. This replicated the flexibility of the time brackets in earlier versions of *#[unassigned]* and also ensured that modules overlapped slightly rather than all starting at the same time.

These two aspects of the new system were straightforward to develop, and many of the earlier modules were taken as carryovers. Using the system to create my own versions proved an easy transition, and there was very little difference in the products of the two approaches (many of the new one-minute standardized modules were adapted from earlier modules). The main problem was how to replicate my compositional decision-making so that others could create authentic new versions of *#[unassigned]* from kits by applying a simple process or algorithm to the system.

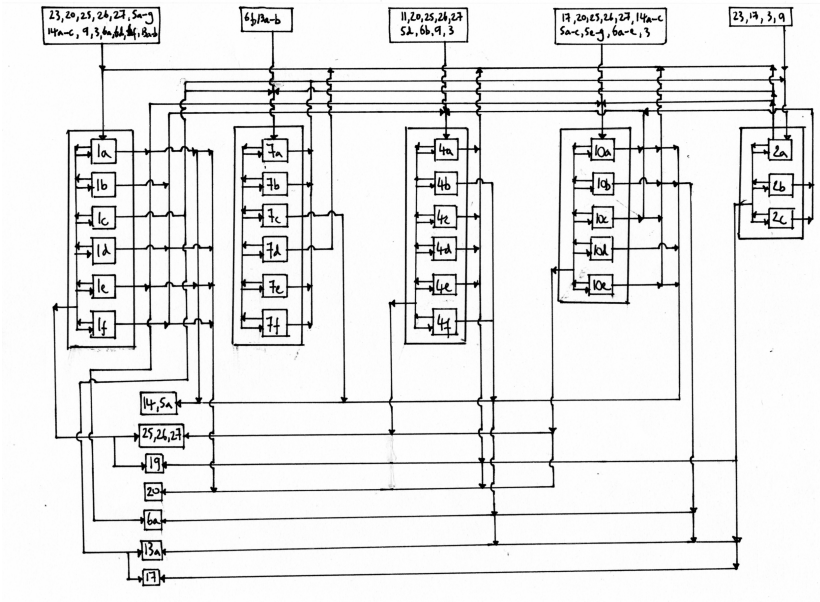
The solution I initially arrived at was a development of the approaches discussed above drawn from multi-variant narrative fiction. The example of Queneau's *Un Conte á Votre Façon* and the work of Jackson and Livingstone provided a clear model for creating a directed network of modules through which a route could be traced by following a number of multiple-choice options, assuring a range of continuities within the boundaries I deemed acceptable (i.e., there were modules I would not generally place next to each other which could be excluded as choices). For each instrumental part, I numbered the modules giving them a unique reference.[53] The inter-connections were then mapped using a network diagram, as shown in Example 8.

It became apparent very quickly that as the system developed, this representation of the network would become increasingly unwieldy. Connections between modules became very complex and difficult to notate. I decided therefore to use a lookup table which, while not being as visually interesting and self-evident, was more practical to implement by users and to expand as the project developed. This can be seen clearly in the (abbreviated) example from the clarinet part (see Example 9).

The user chooses a starting module and looks it up in the left column. It may be followed by any of the modules in the right column, and this process is repeated until the part is complete. The order of modules in each part can be freely chosen within the constraints outlined in the module order table. For example, a player might choose the following order for an eleven-minute performance:

003d–003a–003c–008–007–001–silence–silence-007–009–003a

Note that is not possible to move directly from 003c to 007—the network makes some restrictions on continuities within the music. These



EXAMPLE 8: NETWORK DIAGRAM FOR #*[UNASSIGNED]*

current	May be followed by:
silence	any module
001	006a–e, 007a–d, 008, 010, 011, 014, silence
002a–f	002a–f, 003a–e, 004a–d, 005a–f, 009, 012, 013, silence
003a–e	002a–f, 003a–e, 004a–d, 005a–f, 008, 009, 011, 012, 013, silence
004a–d	002a–f, 003a–e, 004a–d, 005a–f, 009, 012, 013, silence
005a–f	002a–f, 003a–e, 004a–d, 005a–f, 008, 009, 011, silence
006a–e	001, 006a–e, 007a–d, 008, 010, 011, 014, silence
007a–d	001, 006a–e, 007a–d, 009, 010, 012, 013, silence
008	001, 003a–e, 005a–f, 006a–e, 007a–d, silence
009	002a–f, 003a–e, 004a–d, 005a–f, silence
010	001, 002a–f, 004a–d, 006a–e, 007a–d, silence

EXAMPLE 9: LOOKUP TABLE FOR MODULE SEQUENCING FOR #*[UNASSIGNED]*

were compositional decisions built in to the system, with timbral and gestural similarity as the principal criteria for sequentiality. It can also be seen that module 007 is repeated, as is module 003a from the grouped page 003a–f. Two contiguous blocks of silence are also used. This allowed all of the formations proposed in theoretical writing on multi-variant narratives to be utilized: It is potentially full of loops, split/joins, tangles and contours providing a rich array of possible routes through the material. It also creates restrictions, forcing users to find ways of moving from one module to another and creating neighborhoods within the piece defined by material types (e.g., tremolos, glissandi, etc.).

While this method governed sequential chains of modules, it did not replicate decisions which affected the simultaneous placement of modules to create textures. Most earlier versions of *#[unassigned]* used regions where one material type was prevalent in order to create links across a texture. This too needed to be built into the new interface rule system: it needed an equivalent process to determine what could be heard *with* what, as well as what could be heard *after* what. This created a practical problem. Having two potentially restrictive systems in operation could cause dead ends where it became impossible to find continually permissible combinations and sequences of modules. It would also result in an unnecessarily complex method for creating pieces: I did not want to resort to requiring a computerized module-selection program. My initial solution therefore was not to restrict simultaneities between instruments on the basis that the sequential links were sufficiently strong to create linear points of contact.

After trialing this system for a year in a few versions, it also became evident however that the one-minute module was a rather coarse unit. Although the staggered stopwatches and asymmetric placement of material within each minute created some flexibility, it was impossible to have a very wide-ranging combination of sounds. It was also, more importantly, a relatively inefficient notation for performers. Given that the material is relatively sparse it required them to count continuously for the duration of the piece, whereas in previous versions while not playing they simply needed to wait until the next cue point. As a result, I looked at the system again and returned to using the original varied module lengths (and adapted the module pool once more) and a series of predefined time structures with the construction defined by a simple algorithm.

The time structures are different for each instrument and use simple processes to space entries at a density of one entry per instrument per clock minute (see Example 10a). The cue points act as a start times for metered modules and start or end times for action modules.

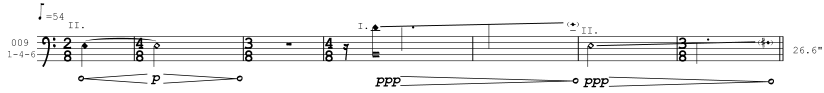
(a)	(b)	(c)
0′37	0′37	0′37
1′27	1′27	
2′17		2′17
3′07	3′07	3′07
4′57	4′57	
5′47		5′47
6′37	6′37	
7′27	7′27	7′27
8′17		8′17 etc.
9′07 etc.	9′07 etc.	

EXAMPLE 10: TIME POINT EXAMPLES FOR INSTRUMENTAL PARTS IN #*[UNASSIGNED]*

Additionally, selected time points can be omitted according to a simple pattern. For example, every third time point could be omitted, or alternately every second then every third, or other similar regular processes (see Example 10b and c). This allows for thinner densities of sound, for example in large ensemble pieces or as a way of making more spacious solo pieces.

In order to solve the problem of acceptable simultaneities and sequences, descriptors of a range of material archetypes were assigned to each module. For example [1] refers to high sounds, [4] to sustained sounds, and [6] to sliding sounds. So a module for cello featuring a slow glissando harmonic might be marked [1–4–6] (see Example 11).

Each minute of the piece is then marked with one of these descriptors, effectively fixing one aspect of the sound for modules starting in that minute. So for example if [1] was specified, all modules that are cued in that minute (and they might extend past its boundary) will be high in pitch relative to the instruments' ranges. They may naturally have other disparate characteristics (e.g., noise based, unstable,



EXAMPLE 11: CELLO MODULE FROM #*[UNASSIGNED]* SHOWING MATERIAL DESCRIPTORS

pulsed, etc.), but will have at least one point of contact: fulfilling the condition of sound-matching that has been a fundamental feature of my own versions of *#[unassigned]*. This also ensures that sequentially there are links, as modules overlap or are separated by silence, forming subassemblies of similar material. In constructing a version then, the following stages are followed:

1) Select a different timepoint chart for each instrument.

2) Assign a material-type descriptor to each minute of the piece.

3) Assign a module to each timepoint for each instrument such that it is characterized by the relevant descriptor for that minute.

This is a relatively straightforward means of construction for a version of *#[unassigned]*, employing generally short metered modules (lasting between c. 10–50 seconds) and scalable action modules, placed in a time structure which controls the density and positioning of events, as well as global sonic characteristics for separate phases of the version. At the time of writing I am still assessing this system, but feel it is sufficiently robust to allow the construction of autonomous versions of *#[unassigned]* which have limited independence and extensibility within a carefully bounded rule system. Open modular compositions are by definition works-in-progress.

Implications of Using a Modular Method

Working in a modular way raises a number of questions as to the nature of the compositional process, the role of the author, and the status of the piece itself: there is a fundamental change in method associated with adopting this approach. In his definitive text *The Open Work*, Umberto Eco addresses many of these questions, acting mostly as an advocate for works which display such tendencies. A common criticism of any open work is that it is somehow unfinished. By lacking a definitive form, there is an implication of indecision on behalf of the author. Eco neatly summarizes this argument, stating,

> In primitive terms we can say that [open works] are quite literally "unfinished": the author seems to hand them on to the performer more or less like the components of a construction kit. He seems to be unconcerned about the manner of their eventual deployment. This is a loose and paradoxical interpretation of the phenomenon, but the most immediately striking aspect of these musical forms can

> lead to this kind of uncertainty, although the very fact of our uncertainty is itself a positive feature: it invites us to consider *why* the contemporary artist feels the need to work in this kind of direction, to try to work out what historical evolution of aesthetic sensibility led up to it and which factors in modern culture reinforced it. We are then in a position to surmise how these experiences should be viewed in the spectrum of a theoretical aesthetics.[54]

Some of these reasons have already been discussed, but are best perhaps articulated by Cage's comment that "Sometimes compatibility hides itself. Probably, we are ultimately compatible with everything, but we make it impossible for things to reach us, or they just don't cross our paths, or some such thing."[55] By loosening relationships between a work's elements the possibility of unforeseen yet interesting and valid combinations of material might occur, albeit often within carefully defined boundaries. It is this that is the principal reason for artists working in this way, or as Eco puts it "[these new musical works] reject the definitive, concluded message and multiply the formal possibilities of the distribution of their elements."[56]

Eco also points to developments in science and the way such thinking filtered through to artists' practice as important driving forces in the development of open forms:

> The notion of "field" is provided by physics and implies a revised vision of the classic relationship between cause and effect as a rigid, one-dimensional system: now a complex interplay of motive forces is envisaged, a configuration of possible events, a complete dynamism of structure.[57]

Crucially this begins to justify the open form work as something which can display completeness while remaining variable in its configuration, and that linearity is not a prerequisite for a cohesive structure. The field analogy also counters the claim of arbitrariness:

> The *possibilities* which the work's openness make available always work within a given *field of relations*. As in the Einsteinian universe, in the "work in movement" we may well deny there is a single prescribed point of view. But this does not mean complete chaos in its internal relations. What it does imply is an organizing rule which governs these relations. Therefore, to sum up, we can say that the "work in movement" is the possibility of numerous different personal interventions, but it is not an amorphous invitation to

> indiscriminate participation. The invitation offers the performer the chance of an oriented insertion into something which always remains the world intended by the author.[58]

A well-conceived open work therefore is not simply an unorganized collection of components that an author could not be bothered to arrange into a finished object, but a network of carefully considered possibilities. Eco goes on to draw an analogy with a dictionary, stating that its openness does not qualify it as a work, even though it can clearly be used to construct all manner of texts. He asserts that it is the structural interface which renders something a work, saying,

> The "openness" and dynamism of an artistic work consist in factors which make it susceptible to a whole range of integrations. They provide it with organic complements which they graft into the structural vitality which the work already possesses, even if it is incomplete. This structural vitality is still seen as a positive property of the work, even though it admits all kinds of different conclusions and solutions for it.[59]

The move towards working in an entirely modular way also has many repercussions with regards to the compositional methodology and the identity of the resultant music. Conventionally composers produce pieces, which are discrete manifestations of their ideas at a given point in time. These ideas are continuous however (and separate from the pieces themselves) and often bleed across boundaries between pieces, but are necessarily constrained within individual works. With a modular approach, these boundaries still exist at the product (or version) level, but there is an additional segmentation of ideas and material at a modular level. The composition of a module is a bounded activity as there is a sense of completeness about it as an independent unit (a different situation to unbounded material in a non-modular piece). The potential for dislocation is clearly apparent then if modules used in the same version have been composed over a long period of time. The original purpose or idea behind a module will in all probability have changed somewhat during this time, disrupting the linear development of compositional thought over such a period. This destabilizes a sense of linear development in a composer's work.[60]

In the long term, a modular approach has some similarities with a non-modular one in relation to a composer's overall work and development though. A back catalogue of separate compositions might be seen as a modular combination of a composer's ideas. Over an

extended period, a non-modular composer will have a series of ideas that have been used in pieces, and their overall approach might develop over the period. A modular composer, in addition to this, will have a stock of material that can be recombined to produce new versions of the piece, and this will also develop gradually over this period. So an entirely modular approach to composition is partly a way of objectifying a composer's ongoing development, which is essentially operating at the project range level. This development includes changes in areas of technique, style, and aesthetic concerns, for example.

There is a sense that the boundaries we make between any artistic objects are artificial or at least arbitrary. This distinction between concepts, aims, and an aesthetic on one hand, and discrete objects through which these might be experienced on the other suggests that they operate in different ways. There is a general feeling we get about a composer's work that is separate from, but largely created or informed by, the work itself. The work is perhaps a convenient way for ideas to be articulated, but it is largely driven by external factors (e.g., the need to communicate ideas in a temporal domain, or through practical opportunities such as performances). With a modular approach, perhaps paradoxically, the equivalencies between the change in a modular work and the composer's development erode these distinctions. There is a closer link between ideas and their realization.

The potential for the arrested development of a composer's ideas is of course a problem in any extended project however, whether it is modular or not. The aforementioned dilemma of trying to relate early ideas to newer ones over the course of a long working period might lead a composer to discount new ideas at least temporarily as they have no possible relation with the work at hand: they become redundant. This is an issue that Dan Flavin has commented on in relation to his work. He embraces this situation however, saying,

> All my diagrams (for the proposals), even the oldest, seem applicable again and continually. It is as though my system synonomizes its past, present and future states without incurring a loss of relevance. It is curious to feel self-denied of a progressing development, if only for a few years.[61]

and also,

> [My work] lacked the look of history. I have no stylistic or structural development of any significance within my proposal—only shifts in partative emphasis—modifying and addable without intrinsic change.[62]

Even with a relatively open modular interface, it is easy to see how this situation might arise. Changes of emphasis could replace development of ideas, with the potential for the composer, or artist, to find themselves in a dead end. Terry Riley presents a playful solution to this problem in relation to his work:

> The way I work is to develop certain patterns. I practice these for a long time, just in their straight form, like an exercise. And after a long time those patterns start ingraining themselves in my consciousness and develop into new patterns. And so after a while, the old patterns almost become forgotten, and sometimes the difference in the pieces is the evolution of the patterns—how they develop into a new shape. So that, for instance, I'm still playing a piece today that I was playing in 1966, but the original pattern has disappeared. It's convoluted into an entirely different shape, so, even though I consider it the piece that I was playing in 1966, it's different. . . . The continual on-going differences of form is one of my main loves. I think it's fantastic. Certain moments can create a whole different viewpoint of those patterns.[63]

Both Riley and Flavin hint at the main problems of a modular piece, and indeed any open form piece that might sound different from one performance to the next: what is the piece, how might it develop a sense of identity, and what is it which defines this? Essentially the meta-piece is the piece, including both the realized versions and the modules. An individual version or module is not the piece however, simply a component of it. This situation has created a number of practical problems where writing separate pieces might not. Composers produce pieces and have a list of works. What happens if they produce a single piece, which is always different? For different people, there are different answers to these questions however. There is a certain convenience to having a set of pieces, and many institutions are geared to this assumption. For example, to register works for the Performing Rights Society a composer needs to submit separate returns for each version as their data is based on title, instrumentation and duration as the principal calculators of revenue. So from the PRS's perspective, the meta-piece may not exist: for them, the individual versions are pieces. For listeners there is always the implication, as demonstrated with modular work in other arts, that they are missing something or only experiencing part of the piece. While each version may exist as a workable structure in its own right, as with Andre's *Equivalent VIII* or a single permutation of Raymond Queneau's *One Hudred-Trillion Poems*, there are many more implied possibilities. Umberto Eco clarifies this by stating,

> [In open works] there is a tendency to see every execution of the work of art as divorced from its ultimate definition. Every performance *explains* the composition, but does not *exhaust* it. Every performance makes the work an actuality, but is itself only complementary to all possible other performances of the work. In short, we can say that every performance offers us a complete and satisfying version of the work, but at the same time makes it incomplete for us, because it cannot simultaneously give us all the other artistic solutions which the work may admit.[64]

For a single version, this might suggest an extra level of meaning for anyone who engages with the concept, but it equally well may not. Each version should therefore be musically self-sufficient and avoid the requirement to have experienced other versions. So for some listeners the sole version they have heard is the piece, for others the knowledge of the project transforms their view, while for a smaller group of listeners, hearing more than one version allows them to contextualize this knowledge through experience: they can make actual comparisons between versions. For listeners, there is a range of possibilities as to what the piece might be. This is a very similar situation for performers, although it is likely that those in the category of having played more than one version might begin to make more active comparisons between versions and their reuse of material.

The main problem with the music's identity though is that the piece does not sound the same each time. We generally know particular pieces because we recognize distinctive pitch patterns, rhythms, timbres or other combinations of elements. Where these might not recur in subsequent hearings, what is there to link the experiences as instances of nominally the same piece? At this point, knowledge of the concept or recognition of common modules between versions are the only ways this can be achieved (that is, being told, or finding out for oneself).

Adopting a Modular Approach

Having begun by considering reasons for adopting a modular approach drawn from a manufacturing context, it is important to assess how these might be advantageous in practice in a musical realization. Many of the specified advantages of adopting a modular approach presented by Ericsson and Erixon in *Controlling Design Variants: Modular Product Platforms* are transferable and can be seen in a musical context:

- *Higher flexibility*:
  The ability to respond efficiently to individual performance situations is one of the great advantages of a modular approach. Constructing versions for unusual ensembles can be achieved more speedily than if the piece was entirely new: potentially all the material might be ready for assembly and not need developing from scratch. There is also nothing lost when creating versions for specific occasions where there might only be one performance, as all modules are returned to the pool for future consideration.

- *Reduction of product development lead time*:
  Given a successful musical architecture, developments in the type of piece that it will produce can be adapted relatively simply, without the need to re-evaluate practice. Creating new types of version (e.g., an installation) can be done independently of working on other versions or the modules themselves.

- *Parallel development of the product and production system*:
  This is part of an ongoing re-evaluation of the music's architecture, where the composition of new modules might suggest adaptations at the *product range level*, and vice versa. It is important to realize the need to constantly review the way modules might fit together, and how particular performance contexts might require the system to change or develop (e.g., the difference between recordings, performances and installations). Fixing either the types of modules employed, or their possible means of interrelation can lead to an inflexible working method.

- *Reduction of production lead time*:
  The ongoing development of a large pool of material that can be combined in an infinite number of ways makes it simple to produce unique constructions in a relatively short space of time. Building a ten-minute piece from existing blocks of material that have a predefined method of interrelation is in most cases more time-efficient than starting from scratch for each new piece (although this is not precluded of course). The option to make a new construction from entirely new material is always available, as long as it is consistent with the music's architecture at the product range level (otherwise it ceases to be part of the project). Creating new modules can happen independently of the construction of complete pieces, and in successful cases, such modules will appear in a wide variety of realizations.

- *Improved quality / easier service and upgrading*:
  Reuse of existing modules provides opportunities to test them in practice. For example, a non-standard playing technique might cause similar problems for players which after a few uses suggest a particular strategy for rehearsal, aiding future performances. Conversely, some modules might not be practicable and need reworking for future performances, which can happen without the piece itself being lost.

Clearly a modular approach to music has its benefits if applied appropriately. If well designed, such a system can be used to create a wide range of pieces and be no less restricting than any other method. While it will never have the total flexibility of (theoretically) starting from scratch with each new composition, the systematization of some aspects of a compositional technique can create an environment which ensures certain consistencies through extended use. The possibility of renouncing the composition of individual works in favor of developing a single generative meta-composition may be seen to impose too many constraints on a composer's working practice, but ultimately it is a creatively restrictive decision like any other.

Notes

1. Quoted in Karl Heinrich Wörner, *Stockhausen: Life and Works*, translated by Bill Hopkins (Berkeley, Calif.: University of California Press, 1973), 110–1.
2. For example, the compositions linked to the *Concert for Piano and Orchestra* (1958), or the *10,000 Things* (1953–6).
3. *Concise Oxford English Dictionary*, 9th edition, s.v. "module."
4. Anna Ericsson and Gunnar Erixon, *Controlling Design Variants: Modular Product Platforms* (Michigan: ASME, 1999), 17–8.
5. Ibid., 19.
6. Ibid., 17.
7. Ibid., 19–20.
8. Although it is practically impossible for an infinite number of modules to exist, the important point is that the structure is extensible.
9. *Common unit* is a term used by the authors to describe a module which is present in all resultant products.
10. Ericsson and Erixon, 88–90.
11. See http://www.ikea.com.
12. I have used IVAR as a storage system in five different locations over the past few years and in each case it has been readily adaptable to the space.
13. Although with BILLY each shelving configuration is more or less fixed upon construction, they can be combined as larger units to produce new structures. This range is therefore an example of Ericsson and Erixon's *subassembly* concept.
14. Oulipo (*Ouvroir de Littérature Potentielle* or Workshop for Potential Literature) was founded in 1960 by Raymond Queneau and François Le Lionnais and consisted of writers, mathematicians, and academics. Their activities focused on researching the "possibilities of incorporating mathematical structures in literary works," and "writing which was subjected to severely restrictive methods." See Harry Mathews and Alastair Brotchie (editors), *Oulipo Compendium*, second edition (London: Atlas Press, 2005), 37–44 and 205.

15. Paris: Gallimard, 1982.
16. If each of the possible permutations of the poem were read end-to-end lasting a minute each, it would take over 190 million years to complete!
17. In *Nouvelle Observateur* 140 (July), 28–9.
18. Claude Berge, "For a Potential Analysis of Combinatory Literature," in *Oulipo: A Primer of Potential Literature*, second edition, edited by Warren F. Motte Jr. (Normal: Dalkey Archive Press, 1998), 121.
19. *Fighting Fantasy* (New York: Puffin Books, 1982–95).
20. London: Puffin Books, 1984.
21. Paul Fournel and Jean-Pierre Énard, "The Theatre Tree: A Combinatory Play," in *Oulipo: A Primer of Potential Literature*, second edition, edited by Warren F. Motte Jr. (Normal: Dalkey Archive Press, 1998), 159–62.
22. Ibid., 160.
23. Earle Brown, *Folio* (New York: Associated Music Publishers, 1961), Prefatory Note.
24. Karlheinz Stockhausen, *Klavierstück XI* (Wien: Universal Edition, 1957), Performing Directions.
25. The performer decides on six different tempi from very slow to very fast which should then be related to the six tempo markings in the score as they occur.
26. Ibid.
27. Earle Brown, *25 Pages* (Toronto: Universal Edition, 1975).
28. Earle Brown, *Folio*, prefatory note.
29. Links might be made with Steve Reich's "Music as Gradual Process" in which he states "I am interested in perceptible processes. I want to be able to hear the process happening throughout the sounding music. . . . What I'm interested in is a compositional process and a sounding music that are one and the same thing." Steve Reich, "Music as a Gradual Process," in *Writings on Music 1965–2000*, edited by Paul Hillier (Oxford: Oxford University Press, 2002), 34–6.

30. Claude Berge, "For a Potential Analysis of Combinatory Literature," in *Oulipo: A Primer of Potential Literature*, second edition, edited by Warren F. Motte Jr. (Normal: Dalkey Archive Press, 1998), 118.

31. Mark Bernstein, "Patterns of Hypertext," in P*roceedings of Hypertext '98*, edited by Frank Shipman, Elli Mylonas, and Kaj Groenback (New York: Association for Computer Machinery, 1998), 21–9. Also available at http://www.eastgate.com/patterns/Print.html.

32. An experience which may be familiar when rereading a book or seeing a film for a second time where previously unnoticed incidents assume greater significance based on knowledge of their eventual outcome.

33. In *A Companion to Digital Humainities*, edited by Susan Schreibman, Ray Siemens, and John Unsworth (Malden, Mass.: Blackwell Publishing, 2004). 415–30.

34. Ibid., 420.

35. Ibid., 420

36. Mathias Spahlinger, *128 erfüllte Augenblicke: systemat. geordnet, variabel zu spielen*. (Wiesbaden: Breitkopf & Härtel, 1984), preliminary remark.

37. Ibid.

38. Again, a clear link can be made here with Reich's views on the audibility of compositional process.

39. Peter Niklas Wilson, "What a Composer Can Never Compose: Notes on Mathias Spahlinger's Chamber Music," translated by John Tyler Tuttle, liner notes for Ensemble Recherche, *Música Impura* (Accords compact disk 206222, 1998), 18.

40. John Cage, *Song Books: Volume I* (New York: Peters Edition, 1970), general directions.

41. John Cage, *Concert for Piano and Orchestra* (New York: Henmar Press, 1960), piano performance instructions.

42. John Cage, *Solo for Violin* (New York: Henmar Press, 1960), performance instructions.

43. The conductor in the *Concert for Piano and Orchestra* uses his arms to represent the hands of a clock. He controls the speed of musical

time by varying their speed of rotation, thereby altering the players' predefined clock timings.

44. For example, "I would assume that relations would exist between sounds as they would exist between people and that these relationships are more complex than any I would be able to prescribe. So by simply dropping that responsibility of making relationships I don't lose the relationship. I keep the situation in what you might call a natural complexity that can be observed in one way or another." John Cage quoted in Michael Nyman, *Experimental Music* (Cambridge: Cambridge University Press, 1999), 29.

45. "Parts for voice and instruments without score (no fixed relation), title to be completed by adding to 'Music for'—the number of players performing." John Cage, *Music for* (New York: Henmar Press, 1984), title page.

46. A *piece* is written on two systems and consists of either a held note or a more gestural passage in proportional notation. An *interlude* lasts 5, 10, or 15 seconds, and consists of single notes or chords to be played in free rhythm but with the specified articulation.

47. Ibid., performance instructions.

48. Jacques Lacan, "The agency of the letter in the unconscious or reason since Freud," in *Écrits: A Selection*, translated by Alan Sheridan (London: Tavistock Publications, 1977), 153.

49. Christian Wolff, *Cues: Writings & Conversations*, edited by Gisela Gronemeyer and Reinhard Oehlschlägel (Köln: MusikTexte, 1998), 38–50.

50. In practice, only one group of performers has asked for a score to help prepare a performance. Although I am present at almost all of the performances, the use of timings and lack of precise synchronization make many of the reasons for a score redundant.

51. Time brackets using fractions of a second seemed unnecessarily precise, given the lack of synchronization between players' stopwatches and the use of approximate entries.

52. If more than one performance takes place on the same day, a suffix is added, so the two versions performed on 3 May 2001 were #030501-1 and #030501-2.

53. The reference uses the name of the instrument followed by a three digit code and a letter (a–f) to signify a variant (e.g., clarinet002e).

54. Umberto Eco, *The Open Work*, translated by Anna Cuncogni (Cambridge, Mass.: Harvard University Press, 1989), 4.

55. Richard Kostelanetz, *Conversing with Cage* (New York: Limelight Editions, 1988), 218.

56. Eco, 3.

57. Ibid., 14.

58. Ibid., 19.

59. Ibid., 20.

60. This situation is also found in longer non-modular composition where a composer's ideas might change over the course of completing the piece. It also occurs when revising a piece, where a composer might need to rediscover thought processes from an earlier point in their development. Anybody who has attempted this will be aware of the dilemma of trying to recreate earlier ideas (authentic composition?) or apply subsequent knowledge and experience in any revisions.

61. Quoted in David Batchelor, *Minimalism* (Cambridge: Cambridge University Press, 1997), 54–5.

62. Ibid., 54.

63. Robert Ashley, *Music with Roots in the Aether* (Köln: MusikTexte, 2000), 192–3.

64. Eco, 15.