MANIFOLD COMPOSITIONS: FORMAL CONTROL, INTUITION, AND THE CASE FOR COMPREHENSIVE SOFTWARE.

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ABSTRACT

The paper defines the concept of manifold compositions and establishes that a comprehensive type of software based on solid formalism is required for such a project. Practical issues related to the use of randomness are discussed and tools used to compose three such manifold compositions are detailed. Arguments against the “black box” approach and formalism are reviewed and rebutted while insisting on the need for a flexible formal framework that does not neglect the role of intuition. Manifold compositions promote an experimental attitude and challenge tendencies toward commercialization of music.

1. PROLEGOMENA: WHAT.

A manifold composition consists of all actual and potential variants of a work that contains elements of indeterminacy and is composed with the assistance of a computer using the same code and data set every time [15]. All members of the manifold share the same basic structure, pitch and rhythmic materials and have similar textures but different seeds for the random number generator trigger variations in the output. These variations can range from a slight re-arrangement of notes in the score or of the computer-generated sounds in time to radical alterations of textures and even of the formal architecture of the piece. This is an idiomatic way of using computers to mass-produce unique versions of an archetype or, more formally, to generate members of an equivalence class of compositions.

Discussing aleatory works by Berio, Boulez, Pousseur, and Stockhausen, Umberto Eco writes: “ They are to be seen as the actualization of a series of consequences whose premises are firmly rooted in the original data provided by the author” [4]. There have been a number of early attempts to generate multiple variants of the same work with the assistance of a computer: the *ST* series by Xenakis, Hiller’s *Algorithms*. Koenig’s *Ubung für Klavier*, and Larry Austin’s P*hotoforms: Fractals for Computer Band*. None of these works though satisfies the main criteria of a manifold composition which is that both the same data and the same code be used every time.

In producing manifold compositions, the integrity of the process requires a comprehensive set of instructions or a "black box" which reads in the data and outputs the finished product without outside interference. Modifying the results or intervening while the computations are performed would amount to the alteration of the data or of the logic embedded in the software. In this context, post-production work becomes not only incongruent but, in fact, unnecessary, a feature particularly relevant in the case of a unified and seamless approach to composition and sound synthesis such as that of *DISSCO* [7].

Obviously this type of approach requires a lot of work and delicate fine tuning. It success depends in a great degree on detailed pre-compositional planning and on a reliable formalism. These are sometimes controversial notions and will be discussed later (3.1); suffice now to say that the more rigorous, complex and flexible they are, the more successful the outcome. It should also be emphasized that strict logic and planning which overlook the specifics of the musical materials and intuition are counterproductive.

2. PRACTICAL ISSUES: HOW.

2.1. Indeterminacy.

To a large extent, the act of composing is one of decision making, of choosing from a range of possible outcomes according to certain criteria [12]. Some or all such choices may depend on chance, and randomness plays a crucial role in the production of manifold compositions. It may be used at multiple levels, from shaping an envelope, which may control the amplitude of a partial, the rate of vibrato, etc., to choosing pitches, determining the density of a texture, or to deciding in which order modules of form are going to succeed each other.

The role of chance, where and when it is applied as well as within what limits it is allowed to operate is at the latitude of the composer. The phrase "controlled randomness" aptly describes a situation in which the details are both governed by chance and restricted within a well defined realm of possibilities.

A play between stable, fixed elements and random occurrences could be effective in organizing the musical material. It will become apparent only when comparing two or more variants of the manifold but then it will illuminate differences while establishing, at the same time, connections through the static, unchanging components.

2.2. Examples.

A look at three manifolds illustrates some of the points mentioned above.

2.2.1. ***A.N.L.-folds****.*

A.N.L.-folds is a 2:30 min. work for computer-generated sounds. Three of the eight sections of this manifold composition remain basically the same in all versions: the beginning chord, its retrograde at the end, and the *Argonne chime*, a little jingle, in the middle. They are the pillars that anchor the other sections. The fifth section, a grainy sound mass type of texture, preserves its character every time but individual attacks and pitches are always different. The remaining sections, 2-3 and 6-7, emphasize, respectively, tremolo/vibrato and transients of frequency or amplitude. The density of the 2-3 group is lower than the density of the 6-7 group. They can switch places as far as their content goes but the density remains attached to the section number. The overall density of the piece may also vary between 200 and over 500 sounds.

Even in the case of the fixed sections (1, 4, and 8), the minute details of the make up of each sound are bound to fluctuate with every rendering due to the indeterminacy present at all levels of composition and sound synthesis. In spite of such differences, the outcomes are easily recognized as the "same" piece because of the permanence of the unchanging sections.

C	m	m	**C**	*G*	m	m	
H	o	o	**H**	*R*	o	o	**C**
O	b	b	**I**	*A*	b	b	**H**
R	i	i	**M**	*I*	i	i	**O**
D	l	l	**E**	*N*	l	l	**R**
	e	e		*Y*	e	e	**D**
1	2	3	4	5	6	7	8

Table.1 ***A.N.L.-folds*** formal structure

Over 100 members of the ***A.N.L.-folds*** were generated using *Manifold*, a computer-assisted composition program, and *DIASS*, an additive synthesis program running on the IBM-SP of the Argonne National Laboratory. Five "samples" are available on CD [16].

2.2.2. ***Daria*** *and* ***decaf****.*

Daria and its sister ***decaf*** were composed with *DISSCO*, a software system for composition and sound synthesis, presented in detail at the 2005 ICMC [7], and form together a second example of manifold compositions. Both have 21 sections arranged in two distinct sequences, one for ***Daria***:

$E_0 C_0 B_0$ $\mathbf{A_0 C_1}$ $D_0 E_1 D_1 A_1 C_2 E_2 C_3 A_2 F_0 E_3 D_2$ $\mathbf{C_4 A_3}$ $B_1 C_5 E_4$

and another one for ***decaf:***

$B_0 C_0 E_0$ $\mathbf{C_1 A_0}$ $D_0 E_1 D_1 A_1 C_2 E_2 C_3 A_2 F_0 E_3 D_2$ $\mathbf{A_3 C_4}$ $E_4 C_5 B_1$

section	symmetries										
1-3	E_0	C_0	D_0								
4-5				A_0	C_1						
6-7	D_0	E_0									
8-14			D_1	A_1	C_2	E_2	C_3	A_2	F_0		
15-16										E_3	D_2
17-18							C_4	A_3			
19-20									B_1	C_5	E_4

Table.2 Symmetries in ***Daria***

There are obvious symmetries inside both arrays. The eleven central sections are identical while sections 1-3 and the respective retrogrades 19-21 are rotated around the C axis while the pairs 4-5 and their 17-18 counterparts could also be retrograded. (The contents of sections identified by the same letter are interchangeable but a section's duration may not change).

The central group common to both arrangements includes its own symmetry around E_2: A_1 C_2 E_2 C_3 A_2 and the last seven sections (15-21) are a retrograde of the first seven (1-7) - which makes F_0 and D_1 the odd elements of this piece.

section	symmetries										
1-3	B_0	C_0	E_0								
4-5				C_1	A_0						
6-7	D_0	E_1									
8-14			D_1	A_1	C_2	E_2	C_3	A_2	F_0		
15-16										E_3	D_2
17-18							A_3	C_4			
19-21									E_4	C_5	B_1

Table.3 Symmetries in ***decaf***

At the same time, the E segments contain themselves internal symmetries in contrast with the Ds, which are rather chaotic. The C segments are build exclusively around five pitch classes, Do, lA, Re, mI, fA or d, e, c, a, f which appear in assorted degrees of alteration and distortion.

As in the previous case, there is a play here between stability (the core group of sections, the symmetries, the five pitches, the matching character of the same letter segments and their respective durations) and the changing aspect of the music (different order of modules, the perpetually new placement of sounds in time). Indeterminate within specific limits are also the loudness as well as the amount and rate of vibrato, tremolo and transients, reverberation, and placement in space.

Along the lines of the same dichotomy, the density of certain components is fixed, while other component's density fluctuates within a given range. Patterns are reproduced exactly in some cases or with assorted degrees of accuracy in other. Similarly, the creation of new objects/sounds is done through one of three methods: Continuum, Discrete, and Sweep. The first method distributes attacks randomly during a certain time interval, Discrete establishes ahead of time moments when events may occur, and Sweep, the third, arranges them in strict temporal order at predestined possible locations.

The sounds have permanent attributes (e.g. a well defined spectrum), but are modified as they change frequency and loudness, as they are modulated in numerous ways, distributed around the performance space and reverberated . They are viewed as personages who interact with each other as well as with their environment, individuals changing garb and facial expression according to the company but having a constant internal constitution. ***Daria*** and ***decaf*** are available on a CENTAUR CD, CRC2834.

2. Work in progress.

A work in progress for violin and computer-generated sounds, is also being composed with *DISSCO* and introduces two more features that contribute to the manifold composition construct.

The duration of the entire piece is allowed to fluctuate randomly between 8 and 13 minutes with the lengths of its sections expressed in percentages of the total duration. The rather substantial difference between the lower and the upper limit create obvious problems in choosing and organizing the materials. Conversely, the distinction between members of the manifold is enhanced this way and the concept becomes easier to perceive.

The second feature involves the participation of a live performer who is offered multiple alternatives either between modules of form or within them insuring that the performer's contribution will not be the same in all renditions. The piece becomes then the result of a triple collaboration between the composer who conceives the work and writes some predetermined segments, the performer making personal choices, and the computer responsible of the random divergences from the abstract model. Ultimately, they all play a role in the dialectics of stability and renewal.

The diversity of options and situations exemplified by these three manifold compositions, can only be achieved with the assistance of comprehensive software such as *DISSCO*.

2.3. Tools.

A review of tools used in the above examples, some straightforward and others more sophisticated follows.

2.3.1. Probability distributions.

Probability distributions are among the mechanisms frequently utilized as selection procedures. Equiprobable distributions over a set of values or within a range defined by the composer are the most common ways of creating chaotic textures with maximum entropy. If the behavior is time dependent, either envelopes are used or a more subtle solution given by the expression:

$$\exp(a + b * (x - 0.5)^2 * (x - z)^2) \quad (1)$$

where a, b are constants, x is the element whose probability is sought, and z expresses a local preference. This expression, borrowed from MP1, an older program [12], performs a comparison between an average situation and an ideal one. It usually specifies a distribution between already selected min and max values.

Another probability-related procedure, a set of functions whose sum is 1 for any given *x* value is helpful when a number of variables are considered simultaneously. Inspired by Xenakis' diagram of densities for his ST/10-1, 080262 [18], it could control the way a sound is distributed on a multi speaker playback array. Moreover, families of similar but distinct functions can be created by choosing *x* and *y* points within a given area and are suitable when assigning amplitude envelopes to the partials of a sound. Not used in these particular manifolds are the more familiar, standard distributions.

2.3.2. Deterministic procedures.

Quasi-deterministic procedures, which contribute to the stable aspects of the manifold, also include a gamut of methods from simply reading sequences of values from a file to more involved tools such as sieves. A more in-depth discussion of sieves may be found in *Formalized Music* [18] or in Christopher Ariza's article [1]; here only aspects related to the manifold examples presented above will be mentioned.

In DISSCO, sieves have the form of two link lists or two arrays, the first one holding the elements of the sieve, the second one their weights. The first list is built through set operations applied to residual classes modulo *m* (e.g. 3_2, 17_6, etc.) or by simply reading predetermined values from a file. The second list is established either by reading in preset weights or through two slightly more involved methods, periodic and hierarchical. The periodic method assigns weights by cycling through a set of given values.

sieve	0	2	4	6	8	10	12	14	16	18	20	22
weight	5	1	3	2	3	1	5	1	3	2	3	1

Table 4. Periodic sieve

Here the sequence 5,1,3,2,3,1 is repeated, starting with the 12_0 sieve elements.

The hierarchic method assigns to each residual class a particular weight and uses the sum of the weights

sieve	0	2	3	4	6	8	9	10	12	14
weight	6	3	2	3	5	3	2	3	6	3

Table 5. Hierarchic sieve

when the sieve element is common to more than one residual class. In this case, 2_0 residual class was assigned a weight of 3, 3_0 residual class was assigned a weight of 2, and 12_0 residual class a weight of 1. Eventually, the link list of weights is dumped into an array, which is then normalized.

The first example could be used to define the internal structure of a 3/4 meter (with 12_0 as the bar line), which emphasizes the beats (0, 4, 8) and the down beat in particular while the second example could be used to create a single beat (12_0) which allows both sextuplet (0, 2, 4, 6, 8, 10) and sixteenth (0, 3, 6, 9) subdivisions giving preference to the sextuplet and to the beat itself.

When applied to start times, such a sieve creates a template containing moments when events *may* occur. It is indispensable to define such possible attacks when using traditional notation for acoustic instruments. It is also necessary if a sense of orderly organization of time is desired when dealing with synthesized sounds.

Start time templates contribute to the makeup of matrices that are used by the Discrete method, already mentioned in connection with ***Daria*** and ***decaf***. Three elements go into the composition of a matrix: the weights of the sieve/template, which are attached to attack points (columns); weights assigned to event types (rows); and envelopes representing the probability of *individual* event types (one per row) at a given moment, independently of the attack point weights. The resulting matrix serves to choose a specific type at a particular attack point. This rather complicated but crucial procedure, was described before in more detail [6].

Sieves and matrices mix discrete values, precisely defined, with probabilities thus bringing together again the stable and the changing aspects of the composition.

2.3.3. Patterns.

Patterns deal in a more sophisticated way with the same dialectic. First, a series of intervals is drawn on to create a sequence. It may be used as such or it may be distorted by randomly choosing one member of an equivalence class for each element of the pattern, by scrambling their order, or both. For instance, given the sequence of intervals:

+2, -1, +3 -5

if we define the first value of the pattern to be 48, set the condition that no member of the pattern may be lower than 38 or higher then 63, and choose a modulo 12 for the congruence relation, the available alternatives are:

		62		61				59
48	+2	50	-1	49	+3	52	-5	47
		38				40		

Table 6. Pattern building

One value from each column is selected randomly and, for example, both sequences 48, 62, 61, 52, 59 and 48, 38, 61, 52, 47 are possible. The order of the elements within the sequence may be preserved: 49, 59, 40, 50, 61 or changed: 48, 47, 62, 49, 40, etc.

Applied to pitch, the last option creates an aggregate whose components are differently ordered every time they occur but belong to predefined pitch classes. This corresponds to a "reservoir of pitches" similar to a chord in one of Boulez's domains. A dodecaphonic tone-row may be obtained by reading the pattern elements only in the original order and a straight "motive" by restricting the range as well.

2.3.4. Formal design.

Formal designs, which preserve the integrity of process and are consistent with the "black box" or comprehensive approach, may be imagined; here are two examples.

The first one assumes the existence of a field with characteristic areas set apart through specific parametric values, which represent potential regions of the piece. Several paths run through this landscape and are traveled by the performers. These trajectories together with the topography of the place form the pre-compositional material, an archetype or a template for the piece.

The scenery is enhanced by the presence of a stationary observer. The observer's vision sweeps this field but covers only a limited angle and a turn of the head reveals only a portion of it, an actual slice of the piece. At the same time, new perspectives of the region surveyed are discovered when the observer's own location in the field changes. This in turn modifies the counterpoint between trajectories as well as their projections on the background field. The piece becomes a corollary of the observer's location and curiosity, a relativist vision of the world. This idea was explored in ***Maiden Voyages***, for trumpet, prepared piano, tape, and three slide projectors and it is described in an CMJ article [13].

The second example is based on the presence of an ostinato of non-retrogradable rhythms or palindromes arranged along a virtual time line. The same succession of attack points (rhythm) is obtained by moving forward or backward from the palindromes' origin. Coupled with the fact that the ostinati are identical, these symmetries allow the music to jump back and forth between the beginnings and endings of rhythmic sequences without corrupting the process.

Short ostinati, which are easily recognizable, do not create an interesting situation but stretched over larger chunks of time, they become intriguing. Going one step farther, such a template may be understood only as a potentiality which means that not all attacks will be activated every time. Depending on the local density, fewer or more of these prospective attacks will be selected through some random mechanism hiding the austerity of the symmetrical background.

The result, a form whose modules may be interchanged and reversed, could be a metaphor for memory associations justified by intersections of thoughts. In ***Cuniculi***, for five tubas, the virtual time line is stressed by a steady increase in entropy, i.e. in the complexity and disorder of the music and the procedure is used to suggest burrowing through time [14].

3. AESTHETICS: WHY.

From formal control to the comprehensive or "black box" approach, to the role of intuition (or the apparent lack thereof), a number of issues embraced here are raising some eye brows. Any discussion should start by considering the main objections.

3.1. Criticism.

We are told that formalisms are rigid and sterile, limit the imagination, do not leave room for intuition, and that even composers like Xenakis were at their best when trespassing the boundaries of their systems. Dictionaries define formalism as "strict adherence to prescribed or external form" or as "marked attention to arrangement, style, or artistic means (...) usually with corresponding ***de***-emphasis of content" [9] or, when applied to music, as "the tendency to elevate the formal aspects above the expressive value in music, as in Neo-classical music" [17]. Integral serialism and other structuralist trends in music have been criticized for their formalism along with Xenakis, Bach, Machaut and Ars Nova while the epithet attached to a composer's music could lead to disgrace under stalinist regimes. In less threatening milieus, an artist is usually accused of hiding behind formal concerns and not letting his subjectivity surface for fear of revealing the inner self.

3.1.1. Rebuttal.

A brief rebuttal will have to start by noticing that all music is based on some sort of formal system explicit or implicit as in the case of a common language. Also, formal concerns are not the exclusive prerogative of neo-trends classical or not. In other words, they do not necessarily implicate only pastiche-driven attempts, which copy an old form and pour in it an out-of-place substance.

Tonality itself is a complex and coherent system with formal rules, which have evolved over time, some of them anchored in acoustic realities. It is a highly hierarchical system that encompasses not only the pitch domain but also rhythm and meter as well as the formal design of a piece. Deterministic, causal relationships govern its elements in accord with the eighteenth century Enlightenment way of thinking.

Trying to break away from tonality, an established but exhausted formalism, Bartok and Debussy rely both on approaches based on the use of proportions such as the golden mean [5] or on the Lucas and Fibonacci series [8]. Even Schoenberg's "free" atonal writing is systematic and close to the set theory of later years although much less scrupulous than his tone-row system. At the extreme end of the spectrum, John Cage, started with a methodical way of writing music, the "square root" technique, and ended up in the realm of chance. However, when scrutinizing the process that leads to the writing of his chance pieces it is easy to detect a structuralist-type mentality in the way he organizes in a very disciplined manner the materials.

It follows that the dictionary definition is loaded with preconceived ideas which focus on a small subset of what "formal" might mean in music, biased in favor of a nineteenth century aesthetics (emotionalism) and fearful of the abstract. It also follows that formalisms come in many shades, some stricter than others, that they all have in common some sort of a systematic scheme, and, most importantly, that bad compositions are not necessarily the fault of this way of thinking.

As for the "adherence to (...) external form" leading to the "***de***-emphasis of content" one has only to read the famous "Schoenberg Is Dead" article by the 1951 integral serialist Pierre Boulez [3].

3.2. Necessary formalism.

Most philosophers place music last in their taxonomy of the arts and fault it with not being able to represent concrete objects or feelings but Arthur Schopenhauer reverses the order for the exact same reason: alone among arts it is non-representational. According to Schopenhauer, music "is as *immediate* an objectification and copy of the whole *will*" (the noumenal) "as the world itself is" [11].

John Cage's statement about trying to "imitate nature in its mode of operation" looks at the same issue from the perspective of a creator of music. Then, if the most noble goal of art is to tell us something about the world, it seems reasonable to construct this metaphor, this parallel reality that is music, with the help of the most successful tool available to us in the investigation of the world of phenomena, the formalism of mathematics. Tonality and the use of the golden section (both based on ratios) achieve this with somewhat modest means, Xenakis with more sophisticated ones.

It is also interesting to observe that, for example, Boulez accomplished his move from the rather stiff ***Structures*** to the much more fluent ***Le marteau*** not by abandoning a formal approach but by adding more rules and more complexity to his music. A key ingredient, complexity, is one of the terms of Birkhoff's famous aesthetic measure formula [2] while the Information Theory [10], employed by Hiller, Brün, Xenakis, and many others, seems to provide good guidance in how to pace the amount of it in a piece.

If it is true that not every formal approach is appropriate in any given situation, it is equally true that some kind of formalism of a reasonable complexity is required in order to produce a work emulating the intricacy of nature and its modus operandi

3.3. Manifolds - what can they do for you

The traditional goal of composers is to fabricate a finite, well defined aesthetic object. At the same time, process music either shows the changes such an object endures as we listen (as in some minimalist works), or it presents an object that is the consequence of applying a systematic procedure (as in ***Nomos Alpha*** by Xenakis). In both instances the process itself, defined by an algorithm, becomes the focus of attention.

A manifold composition is a process that generates an arbitrary number of self-contained objects and sets in motion a course of action that has a life of its own. It also addresses the rather dubious complaint about electro-acoustic music, mainly that such works are museum pieces, frozen in time, without the life performers bring to a otherwise petrified written score. By stipulating that any given variant may be presented only once and that for any further performances alternative variants should be generated, the manifolds remove the danger of stagnation. The addition of live performers answers the other part of the objection.

3.3.1. Comprehensive software.

A code that can generate scores of distinct realizations without external interference is essential for such a project. It is inconceivable that someone would attempt to manage the production of hundreds of manifold members by hand, tweaking details for every one of them until they are just “right”. If the software delivers substandard output, the answer is not for the human composer to “correct” the output, but to improve the software until it becomes flexible, and responsive enough for the task. The “black box” has to be reliable and robust enough to perform equally well in all situations, not only in some particular cases.

The computer then becomes a composer’s collaborator for a few reasons [14]. As it was shown before, computers are better than humans at supplying unbiased random selections. Because the output has to be accepted as is, the composer is forced to examine more carefully the reasons behind each decision, with increasing awareness, and constantly questioning available options - an invitation to introspection. And, finally, the computer provides the means to experiment.

A formal approach especially when combined with the use of comprehensive software, is an invitation to go beyond the already tried ways of thinking about composition and music in general since it may lead to unexpected results, which reveal aspects not anticipated but logical and rewarding. The comprehensive software serves to test the fact that these are stable features and not accidental happenings. Honesty demands that, even when such outcomes are surprising, they be accepted as long as they are congruent with the logic of the process. Which does not mean that *any* thoughtless experiment is valid, that the “gone fishing” paradigm is justified when the scope of the enterprise is poorly defined. An elegant mathematical expression does not guarantee interesting music - it has to make sense in a musical context.

A question still remains: what is the role of personal taste, of subjective judgment? Does the search for abstract, for non-referential, lead inevitably to an impersonal and dull kind of music?

3.3.2. Intuition and subjectivity.

One could also ask: is it possible to write love poems and use grammatically correct sentences at the same time? The answer to the last question is no more obvious than the answer to the preceding one. The main difference is that a love poem, in order to be understood, has to be written in a common language while a piece of music does not (see Schopenhauer).

Actually, there is more room for intuition and subjective choice then it appears at the first glance. John Cage once said that the first thing he decides about a new piece is its duration, a personal judgment of which many other ones depend within his formal system. Xenakis takes the time to explain in his book why a certain formula (a personal choice) is appropriate to a specific task. These are subjective and sometimes intuitive decisions, which already put a stamp on the piece. Moreover, the composer is the one who selects the system, the formalism itself.

Down the line, what materials are employed: instruments and sound sources, pitch collections and tuning (if any), number and type of parameters, patterns (or lack thereof), etc., are all the result of decisions in which the intuition is included. The difference between a successful piece and a mediocre one depends on such personal choices and how system and materials are manipulated: Xenakis’ music is dramatic and engaging while the same techniques produce tedious works in other hands.

Also, often overlooked is the fact that *en route* adjustments are crucial and that the initial plan needs to be constantly tested against reality. What seems a good scheme in the beginning might prove contrived later on and require further fine-tuning. Similarly, if the final output is not only surprising but also disappointing, the code, the data, or both should be modified.

All the above fall under what is generally understood by craftsmanship which in the case of manifold compositions also include sound design and programming. A DISSCO component, LASS, (Library for Additive Sound Synthesis) offers detailed control over every aspect of sound synthesis and extends the composition process to the way sounds are constructed [7]. Skillful software design which increases the performance of the computer and extends the number of opportunities available to the user complements musical dexterity.

Finally, there is an inherent and not always explicit personal world view embedded in all these options, from the choice of the system, to that of the materials, to the sounds’ makeup, and even to the choice of the programming language

4. Conclusion: implications.

Composers are tempted for good reasons to utilize commercially available software, which in many instances is remarkably powerful. It avoids re-inventing the wheel and it is guaranteed to work. It might also lure the user into adopting the options it provides in stead of pursuing personal ones.

A project such as the one described here takes the much less popular path of building from scratch a system that is responsive to the author's idiosyncrasies even as it tries to be as general as possible. In doing so, the role of the composer is changed from being the only person in charge of the venture to a team member. DISSCO, the comprehensive software without which manifold compositions would not exist, is the result of a long collaboration between a composer and a mathematician, Hans G. Kaper, with input from a number of computer science students, members of the Advanced Computer Music seminar at the University of Illinois.

Realizations of a virtual prototype, members of a manifold could be as different as pieces written by distinct composers but based on the same formal scheme, or as similar as performances of the same piece by separate artists. To underscore this feature as well as the ephemeral quality of any musical rendition, it is required that a variant be performed in public only once. Subsequent performances should include new members of the manifold composition generated for those specific occasions. The only exception consists of a small number of "samples" recorded on CD but not intended for public presentation.

The intent behind such restrictions is to prevent the music from acquiring the status of a well defined, frozen object and from becoming a commodity.

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