

THE REALTIME-SCORE. A MISSING-LINK IN COMPUTER-MUSIC PERFORMANCE

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ABSTRACT

Between the realms of improvisation and the execution of a paperwritten, fixed score the concept of Realtime-Score opens a kind of "Third Way" of interpretation.

It is based on the idea, that the score for one or more musicians playing on stage is generated in realtime during a performance and projected directly on a computerscreen which is placed before the musicians like a traditional note-stand.

The musicians can interactively influence the evolution of the piece (based on simulations of complex dynamic systems), so that each performance is a unique realisation of a piece.

The text will introduce the concept and discuss linked topics like notation, interaction, interpretation, audience, and the role of the composer in this new concept.

1. INTRODUCTION

In the last decade I wrote a series of pieces where I invited musicians on stage to be interactive partners with the computer. My idea was to create a kind of man-machine-communication within the discourse of playing music.

On the other hand, I was driven by the idea to use nonlinear complex dynamic systems to generate all parameters of a score: by doing so, I found out, that there are possible lots of interesting versions of one piece, which can differ in many aspects, as one and the same dynamic system can evolve - depending on the initial state and on "disturbances" from "outside" during a simulation run - in many different ways.

To make possible lots of different versions starting from one "germ" I shifted the score image away from written paper to the computerscreen by the use of a flexible kind of notation.

Then I brought together both concepts, - interactive signals of the musicians to a computer, and the generation of the score in realtime due to the state of a dynamic system, which is open to interactive signals - and created the concept of the so-called Realtime-Score, a notion I used the first time in 1994 .

2. THE REALTIME-SCORE: THEORY

2.1. Basics

There are several aspects which characterize the concept of the Realtime-Score:

This new type of score for one or more musicians playing on stage is *generated in realtime* by the computer during a performance .

The Realtime-Score is projected directly onto a *computerscreen* which is placed in front of the musicians like a traditional note-stand.

The musicians can *interactively* influence the evolution of the piece (based on simulations of complex dynamic systems) by a set of acoustic or mechanic signs.

Each performance differs from the others: *each performance* creates only *one possible version* of many.

In addition to the Realtime-Score-projection most of my interactive pieces make use of live-electronic sound-transformations, which are also controlled by the system-state inside the computer, and which give a further (acoustic) feedback to the musicians about the inner state of the simulation program.

One of the main-goals of the concept of the Realtime-Score, the creation of a communication-situation between man (musician) and machine (computer), where both "partners" can and must react in a complex, nonlinear way (what makes communication "interesting"), can only be realised, when all these points are given and linked together: the musicians give signals to the computer, the computer reacts nonlinear to the signals and sends out other signals: the change of the parameters of the score and the change of the live-electronic soundtransformation.

2.2. Technical Details

In most of my interactive pieces I have used MaxMSP as programming tool, which offers broad flexibility for doing maths, simulations, sound-transformations and graphics-programming (mostly LCD-based) at once.

As the details of each Realtime-Score are highly personalized, it is - at the moment - not possible, to edit Realtime-Scores as general tools, which may be used by other composers. In the next future it is planned to work out "example"-scores, which can then be used in workshops for musicians and composers e.g.

In performances it is recommended to use two computers, one for the graphic-projection of the Realtime-Score on stage, the other for running the simulation-program and the sound-transformations, at best situated at the mixing-console in the middle of a concert-hall, to avoid long cabeling between audioboard and mixer, and to have best control of the sound-distribution of live-electronics in the hall. Both Computers are connected via MIDI, exchanging control-signals between the machines.

2.3. Different function: Control- and Playing-Score.

The Control-Score has the function, to inform the musicians about the state of the system or about certain inner processes which are important to know to get a "feeling" of how the system "works".

On the other hand the Control-Score can give the musician important information about the interaction itself: e.g. if and when the computer is "listening" to the musician, if the communication with the computer was "successful".

And finally certain playing-parameters can be represented, which may lead the interactive signals of the musician.

In my piece *KOMA* for string-quartet and interactive live-electronics (1995/96), where always one of the four players is the "leader", the Control-Score, to which the "leader" refers, presents certain pitch-borders, which have to be passed through by playing a pitch-glissando: the "leader" makes the decision, which border s/he will pass. Depending on this decision the inner state of the simulation-program in the computer changes and so does the Realtime-Score.

The Playing-Score itself is as obligatory for the musician as a traditional score and has to be read in realtime.

2.4. Example of a Playing-Score: *KOMA*

KOMA for string-quartet, interactive live-electronics and sound/color-projections, my first piece entirely based on screen-projection of a Realtime-Score, has been commissioned in 1993 by IRCAM ("*selection IRCAM*") and was premiered in the Espace de projection by Arditti-quartet and technique IRCAM on February 17, 1996.

In this piece I decided to separate the Control-Score from the Playing-Score to keep things "clear":

The *Playing-Scores* (see Figure 1) for the other musicians (except the "leader") consist of separately notated score-parameters which have to be "read together" by the musicians for playing:

A given *pitch* has to be modified by *microglissandi* shown at the bottom of the screen (these glissando-lines move continuous from right to left, as do the *dynamic indications* above), there are indications of the *type of excitation* of the string (arco punto, pizz., etc.), the *position* of doing so, some *sound-modifications* (e.g. tremolo) and *dynamics* (with changing ranges and shapes). The number underneath the main-pitch indicates the *deviation in Cents* upwards.

The Playing-Score dis- and reappears, whenever the musicians have to *stop* or *start playing*. The result is a very dense "inner" modification of more or less long held main-notes, based on the idea, that "one note" is not just a "point", but a place of a rich, variable "inner life".

So the limitations of the Realtime-Score, which will be reflected later, are coherent with the esthetic intention.

The moving *shapes* of the dynamics, the microglissandi and the change of the *other parameters* including the main-pitch are controlled by the chosen *simulation-model*, which is used on several *micro- and macro-levels* of the whole piece to generate data including routing and variables of the live-electronic programs.

In addition to the Control- and Playing-Score each musician has some "pages" of *prenotated music*, which is *triggered* automatically by the state of the system and projected onto the screen. As a kind of *ironic reference* to this traditional way of playing music this musician is called "soloist" then and gets a special "spot-light" whenever these score-elements appear.

3. THE REALTIME-SCORE: AESTHETICS

3.1. Notation

3.1.1. Readability

The Realtime-Score has to be *readable in realtime*, that means: with a minimum of preparation time during performance.

Thus the different parts of the score have to be *reduced* to a number of elements, which can be learned and "trained" in advance, and which can be seized with "one glance" immediately during a performance.

On the other hand the used signs have to be *precisely enough* to avoid that the musicians shift into "improvisation".

Also the *portions* of the score projected on screen should not be too long: according to my experience it is better to think of small *time-frames*, containing informations about senseful minimum-units of the music to be played, reaching from 3 to 7 seconds.

3.1.2. Time-related Actions

It is an important feature of the Realtime-Score, that all changes which occur *in course of time*, can be *put*

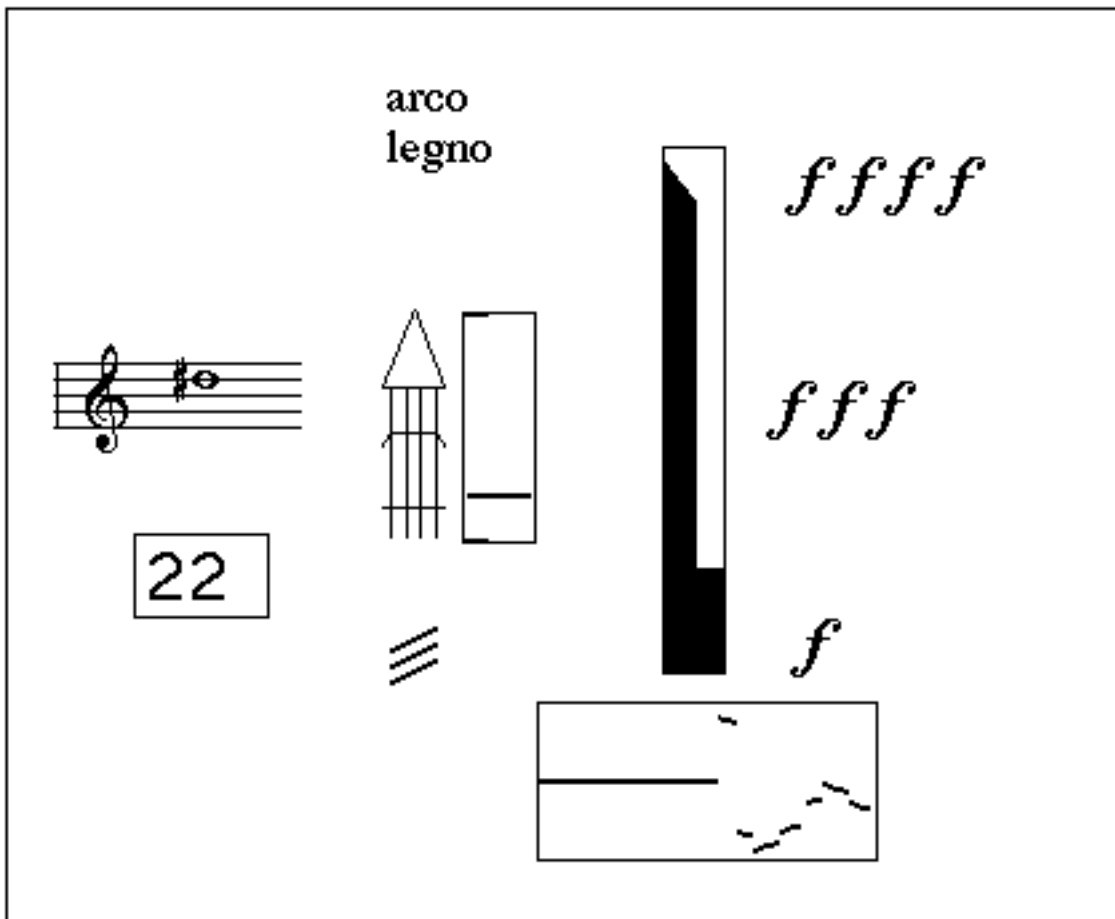


Figure 1. Gerhard E. Winkler: *KOMA*, Example of Playing-Score-part of the Realtime-Score

directly into the score-image (e.g. the "movie-like" scrolling of dynamics and microglissandi in *KOMA*).

In some works I have even shortened the time of changes to a speed, where it becomes nearly impossible to follow all changes: the musicians have been instructed, that the arising "stress" - or even "frustration" - is part of the piece itself. This gives the execution of the Realtime-Score a kind of "theatrical" taste, which can also be extended into other directions. Reaction-time, rhythm, and phrasing can get a new evidence.

3.1.3. Symbolic and Graphic Elements

In general a mixtures of *symbolic* (e.g. a "main-pitch") and *graphic elements* (e.g. Glissando-lines) has turned out to be the clearest way of Realtime-notation. It depends on the idea of the piece and the aesthetics of the composer, which elements these will be.

In ensemble-pieces it is also important to make clear, if one projected part has to be played *independently*, or *in synchronisation* with the other player: in this - and other - case(s) a short *text-projection* (e.g. "solo" or "tutti") can make things clear.

3.1.4. Functional differentiation

As mentioned before, the functional differentiation between "control"- and "playing"-aspect has to be reflected:

Which *control-functions* are important for the musician to know (e.g.: information that the computer is "ready" to "listen" to a certain signal; a direct feedback to interactive aspects of playing or more abstract informations about the state of the simulation-program);

Which *aspects of playing* have to be notated up to which extend of precision? (The range goes from *full realtime-notation*, - using all the "in-time"-possibilities of the computer-screen -, to *partly fixed and prenotated elements*, - e.g. rhythmic patterns, which can be prepared in advance -, up to *fully notated score-fragments*: in this case the "appearance", the moment, when which of the score-fragments is projected, may depend on interactive processes).

Partly prenotated scores which are completed by realtime-instructions I have formerly called "*Score-Files*", to make clear the difference to fully written score-parts on one side, and the "pure" Realtime-Score on the

other side. The mixture of all these elements may give a performance a very flexible and vivid character.

3.2. Interpretation

3.2.1. Interpretation and the New Medium

Musicians, who have already played Realtime-Scores, have compared it with "reading a newspaper" or "looking TV": in both cases the *expectation to "what comes next"*, - which "News" will come on the "next page" -, is clearly named as a part of the interpretation.

The difference to the "book" as the traditional medium of the "score" is quite remarkable, and maybe the reason, why certain musicians refuse to play a Realtime-Score:

Before and after the moment of performance the piece, - in the historical sense -, *does not "exist"*, there is nothing (except the computer-programs and documentation-materials), where you can *refer to*, even nothing, where a jury can control, how many mistakes you have made ...

On the other hand it is a very important role of interpretation of a Realtime-Score, to bring "sense" into this succession of unexpectable moments, not just to "play something". This is also a challenge for the composer, to create situations, where the - even unexpectable - succession gets sense and can be "forseen" in a certain way.

3.2.2. Rehearsing

As a consequence for the musicians follows, that the process of rehearsing shifts from "studying notes" to *get to know*, "how the system works", which *reactions* from the computer will come according to which interactive signal in which context.

The *live-electronic-sound-programs*, which I use in most of my interactive pieces, play a very important role as an *acoustic feedback*.

In any case I have the hope, that when more and more musicians have computers at home, it will be easier to make experiences with the Realtime-Systems, - at least in an acoustical reduced version, using headphones or just plugging the computer into the home-amplifier -.

3.3. Interactive Signals

3.3.1. Indication of Signals

If the played music is not detected the whole time and analyzed by the computer, it is necessary for the musician, to "step out" of normal playing and to give the computer an interactive sign:

The *indication*, that the *function of "playing music"* changes, has to be *given in a clear way* (e.g. a hit on the space-bar of a keyboard, or a gestural indication), and so do the *interactive signals*: this can be lots of different signals, e.g. the use of *sensors* (as I have done in my Opera "*Heptameron*"), special *sound-types* - the idea to

use an instrument not "only" for making music, but also for transporting information encoded for the computer -, or even the *reaction-time* itself between the appearance of playing indication and the - acoustic - start of playing, or the measured length of playing (as I did in my piece "*Hybrid VII*", where the further reactions of the computer depend on how fast the "answer" comes, also including "delayed" answers by will of the player).

3.3.2. Different "Ears"

One of the problems which have to be made clear for musicians, is that the computer is "listening" to sound in different ways than our ears do.

So acoustic signs, - with exception of pitch-recognition, which is quite reliable nowadays -, do not necessarily work "perfect" from the viewpoint of musicians. This difference has to be made clear to them, and - again - it's a characteristic of communication, that it does not always "work" perfectly.

3.4. Selforganisation

3.4.1. Links between Realtime-Score and Musical Selforganisation

Several experiences I made by using *complex dynamic systems* in the compositional process inspired me to the creation of Realtime-Scores one decade ago:

At first there was the experience, that dynamic systems tend to partly *very different evolutions*, even when the starting conditions are quite similar. So after having written the score for my first fully computer-generated piece "*emergent*" (a commission for Salzburg Festival 1993) I came to the critical question: why shall I select *only one version* of so many possible ?, why not make the score *flexible* for the changes and differences between several simulation-runs of the dynamic system ?, why not create a *new notation*, which need not to be fixed on paper, but is directly projected on computer-screens for the musicians ?;

Secondly the necessity for dynamic systems to be "*open*" to the "*world around*" to keep them away from moving into an (aesthetically not so interesting) *equilibrium-state*: this brought me to the idea to use *interactive signals* of the *musicians* to "disturbe" the system or to change certain control-parameters of it.

3.4.2. Nonlinear Behaviour

As a side-effect the use of dynamic systems, - e.g. their influence onto the live-electronic sound-programs -, brings the *live-electronic* away from "linear" use: when I press button A, I can be sure, that action B starts.

The new treatment of live-electronics, controlled by dynamic systems and an interactive environment gets nearer to a real communication-process, where we try to find out, why X behaves in such a way, and how we can motivate X to behave in this or another way. In the context of interpretation of a Realtime-Scores this leads again back to the necessity for the musicians to get to

know, "how the system works", i.e. how it behaves in a special context or in another one.

3.4.3. A Nucleus of Relations

The dynamic systems have the role of a "nucleus" of relations, which is selected by the composer according to the formal idea of a piece, and which is then embedded in the larger context of score-generation and live-electronic-sound-control as a basis or a "set of potentialities".

As the use of such dynamic systems is deeply linked with the aesthetic ideas of a piece, it seems - at least for me - inevitable for a composer to be well experienced in programming and to have knowledge about the mathematics, logistics and possible "behaviours" of dynamic systems.

3.5. Audience

3.5.1. A Repertoire of Signs

For the audience it is very important to *understand* the interactivity of the musicians based on a clear and recognizable "repertoire" of signs.

Otherwise the difference between a traditionally written score and the Realtime-environment will be blurred and ambiguous.

Very helpful for understanding were *projections* of the Realtime-Score image on *video-screens* behind the musicians, so that the changes of the score and the interactive processes were made visible for the audience.

3.5.2. Polyversionality

On the other hand, the problem arises, that there need at least *two version* of one piece to be played to get an experience of the *differences* and thus of the idea behind the Realtime-Score.

Solutions have been found by integrating several versions in one performance (as in my Opera *Heptameron*, where most of the 7 "stories" start at least two times from a "reset"-point and develop into different directions - but also here the difference between *two entire performances* were reasonable, and people who saw two or even three performances of "Heptameron" told about the "meta"-experience they got by doing so).

3.5.3. New Performance Situations

The Realtime-Score seems to change not only the notion of "work", "score", "interpretation" and "composer", but also that of the performance-situation itself:

A mixture of "installation" (where one can enter, move around and go out at will) and "concert-situation" (with fixed start- and endtime, focused sitting and listening) seems to be the best environment for the presentation of this type of music.

3.6. The Composer and his/her "work"

Paper-written *scores*, fixed and "frozen" in a state unchanged since nearly 1000 years, and musicians who spend lots of time to study these scores to prepare for performances, which in respect to the same piece vary in small amounts of so-called "interpretational freedom":

The idea of the score as a "book" one can refer to "in eternity" is still very popular in the community of composers. It has clear evidence that this resistance of the concept of score is motivated by the wish of composers to control the result of their work as a kind of expression of an individual, non-interchangeable personality - a rather reasonable and successful concept: composers *are* (or at least should be) long trained, extremely gifted and experienced specialists in their work. A look back to long years of (western) music history shows that this is a high value, which should not easily get lost.

But the respect for this value should not keep us from searching for *new possibilities of control*, which do not give up the *responsibility* of the composer in general, but which maybe give new definitions of *what* is controlled and thus - maybe - change the image of composing itself.

The *role of the composer* as "author" rests unchanged, also in the new context, but it shifts from the "builder", the "architect" to the *creator of a set of "potentialities"*, comparable to a gardener, who plants "nuclei" or germs, and watches them grow, depending on influences from the environment, in this or that way. All versions are welcome.

4. CONCLUSION

I would be very happy, if this text could be a starting-point for discussions on the new topic of the Realtime-Score, but still more glad, if other composers would be inspired by this concept and pick up some of the ideas.

As each solution of the problem "Realtime-Score" has to be very personally I am also interested to get to know such pieces or even get informations from or about composers who have already worked in that direction.

5. LIST OF MY WORKS USING REALTIME-SCORES

Les chambres séparées, for saxophone, piano, percussion, light-control and interactive live-electronics (i.l.e.), 1994/95 (produced in ZKM, Center for Art and Media-Technologie, Karlsruhe)

KOMA, for string-quartet, light-control and i.l.e., 1995/96 (commissioned and produced at IRCAM, Paris)

entrop, for female voice, English-horn, pre- and rerecorded sounds and i.l.e., 1994-98 (produced at Experimentalstudio der Heinrich-Strobel-Stiftung des

SWR, Freiburg, premiere at Darmstädter Ferienkurse für Neue Musik 1998)

Hybrid I (SuperPoses), for baritonsaxophon and i.l.e., 1991 (new version in preparation)

Hybrid II (NetWorks), for viola and i.l.e., 1996/2001

Hybrid III (Clumps), for Doublebass and i.l.e., 1996/2001

Hybrid IV (Zoomed::Fringes) for flute(s) and i.l.e., 2000/01 (commissioned by Vienna Konzerthaus)

Hybrid V (MorphoPhrenics) for female voice, interactive video-projections and i.l.e., 2000 (commission by ORF, Austrian Radio, for "musikprotokoll", Graz 2000, new version in preparation)

Hybrid VI (Excursions), for percussion, interactive video-projection and i.l.e., 2001 (commission by Festival Wien modern 2001)

Hybrid VII (FractuReflex), for accordion and i.l.e., 2004 (commission for "Musica Viva", Munich, BR)

Heptameron, interactive Opera, for 3 Voices, 3 Instruments, 7 Sensors on stage, Videos (Lawrence Wallen), and i.l.e., 1998/2002 (commissioned and produced by Munich Opera-Biennale, in coproduction with ZKM, Center for Arts and Mediatechnologie, Karlsruhe. A CD of this production with documentation-material is available at collegno, 2004)

Twins, for Arabian Oud, E-Violine and i.l.e., 2001/02 (the ensemble-version *Twins 'n' Towers* was produced at Salzburg-Festival 2003)

Terra Incognita, a concert-installation for ensemble (ensemble recherche), female voice, Video-projection (Lawrence Wallen), Audience and i.l.e., 2003/04, (commissioned and produced by SWR for Donaueschinger Musiktage 2004).

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