

# Digital Autonomy In Electroacoustic Music Performance: Re-Forging Stockhausen

Robert Esler

University of California, San Diego  
resler@ucsd.edu

## Abstract

*The author proposes a digitally autonomous role in the performance of electroacoustic music. In Stockhausen's work, "Solo for Melody Instrument and Feedback Loop" he provides a framework in which to build a piece. Written in 1966 the piece originally used analog technology but provides the caveat for 'electroacoustic means' when creating the prescribed timbre and noise manipulations of the acoustic instrument. In addition the score calls for three or four assistants to control various aspects of the feedback loops. In this version the author has created an entirely computer controlled realization, replacing the assistants and creating all noises and timbres digitally. The author argues that technology has equal leverage with the written score when interpreting electroacoustic music.*

## 1 Digital Autonomy

The idea of digital autonomy stems from the growing need and practice of re-realizations for technologically ephemeral electroacoustic works. Performers, composers and computer musicians have accepted, for the most part, the miniaturization of older analog, and obsolete digital hardware into software modules and patches. Stockhausen himself admits the contrary, expressing a desire for an authentic performance practice for electroacoustic music by using 'period instruments'; hardware from the 50's and 60's. (Stockhausen, 1963-1977) There is something very compelling and admirable about that position, however, in practice it is more than extremely difficult for a performer to comply.

Digital autonomy assumes a contemporary interpretation in re-forging works of such criteria. There is an idealized stance towards the elimination of extra personnel and unnecessary hardware. The performer acquires complete control over the re-realization of the electroacoustic work. This emphasizes a more focused assimilation of the digital and acoustic environments, and includes the digital realization as an absolute part of the performer's interpretation.

Performer's are often bystanders when confronted with musical situations of this kind. An engineer creates the digital re-realization, and the performer executes the score. The two collaborate, but because of this removal,

neither can understand the intimacy of each part nor appreciate the musical subtleties of either interface. This removal is the polemic for digital autonomy, and reveals the indolence by performers to substantiate an active role in their interpretations of electroacoustic music.

Karlheinz Stockhausen's *Solo for Melody Instrument and Feedback Loop* (Stockhausen, 1966) is an exploration of this autonomous role. The instrument chosen for this work is a vibraphone with the subtitle 'computer-processed' to reinforce the necessary intervention of the computer to facilitate technical limitations inherent in the notational portion of Stockhausen's piece. This includes glissandi, timbre and noise alterations. There are three basic aspects to the work: 1) The notation played by the performer. 2) The feedback loops controlled by three assistants during the piece as per the score. The first assistant opens and closes the input to the microphones. The second opens and closes the input to the feedback. The third monitors the stereo image and/or cues the other two when sections start and end (this may also be shared with a fourth assistant). 3) The assimilation of three timbral and three noise modifications to the acoustic instrument. These aspects have all been combined into one application controlled by the performer. The assistants are replaced digitally, with the performer themselves pre-recording their actions. The three timbres and noises are chosen and digitally created by the performer, as is the notational material from a notational bank. The composer provides the structure for the work as a whole.

## 1.2 Reasons for Digital Autonomy

1) Practical – Computerized assistants eliminate the dependence on other people's schedules, opinions, and time constraints. It also increases reliability and assimilation of both environments. Utilizing digital timbre and noise modulations reduces the amount of transition time between subsequent changes.

2) Aesthetic – *Solo* is not a solo, but a quartet. Thus, the performer is relying on three other people to contribute to their own personal interpretation. Stockhausen mentions the assistants are to make decisions during the course of the piece as to where they place the 'perforations' made by the opening and closing of the

input lines. However, such impromptu interaction is not feasible. In reality the assistants learn the performer's part and coordinate their actions accordingly, an action that can also be pre-recorded by the performer/interpreter.

3) Theoretical – The electroacoustic element is as much of the interpretive material as the written score. Why would the performer relinquish control over this aspect? Do titles like “Piece for Flute and Electronics” imply a solo-duo? What are the implications of using technology to replace human interaction in musical works? These questions helped inspire the decision to reduce the process of *Solo* to an autonomous computer controlled environment.

## 2 Stockhausen's Rules

Stockhausen's *Solo for a Melody Instrument with Feedback Loop*, written in 1966, has an open instrumentation and relatively free interpretation process. The piece has six independent pages of music that can be arranged in any order. Each page is associated with a schematic area that dictates the interpretive processes.

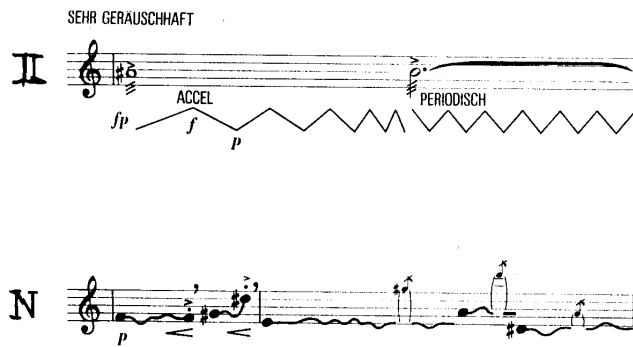


Figure 1 - score sample

Stockhausen asks for four timbral distinctions (labeled N, I-III), where N is the natural quality of the instrument. Three additional timbral changes must be made to the instrument, which can include, but not limited to, muting, changing instruments, extended techniques, and using electro-acoustic devices. From this, three viably different timbres can be used and function within the stratification of the feedback processes. In addition to the three timbres there are three levels of noise (somewhat noisy, noisy, very noisy) that are applied to any timbre as notated in the score.

The instrument must also accommodate three octaves of material (C4-C7), which can be transposed according to the range of the instrument, and have the ability to execute glissandi, vibrato, tremoli, a wide range of dynamics and long sustained notes. The vibraphone provides all of these qualities with the assistance of computer processing. With the inevitable change in instrumentation from a vibraphone to a computer-

processed vibraphone, there was growing precedent in technological absolutism.

Interpretation of the music is controlled by a *Formschema*, with up to six different versions chosen by the performer. The *Formschema* has two parts, a feedback score that gives instructions of when and where (which speakers) feedback should occur, and an interpretation schematic which explains how the music should be interpreted and which part of the score should be a part of that interpretation. Together these parts interact based on a timeline divided into six sections (cycles) labeled A through F. Each section is sub-divided into six or more sections (periods) that are designated a time interval in seconds.

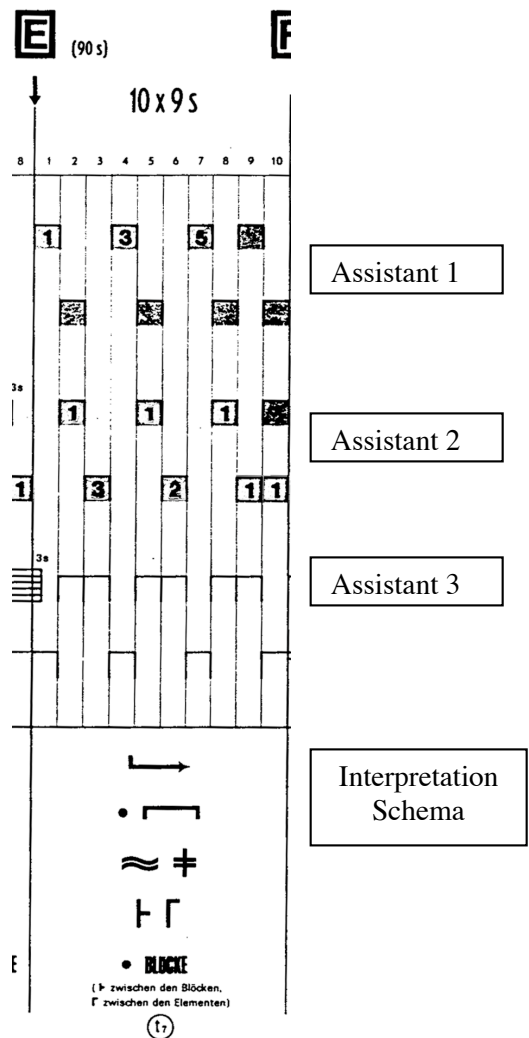


Figure 2 – Formschema sample

The feedback score has three lines for ‘players’ or assistants that aid the feedback and playback processes. A fourth assistant signals everyone, including the performer, when a particular section or sub-section has

passed, as well as monitors the playback heads of the tape machine during performance.

The boxed numbers are the number of times the assistant opens, closes and re-opens the microphone input line, and which channel to record. If there are no numbers present, the entire period is recorded without interruption. If the period is blank, then nothing is recorded. These recordings are then later controlled and played back by the third assistant who opens the appropriate channel(s) when boxes, or lines, are indicated. The second assistant records the output of the tape (feedback loop) using the same strategy as the first assistant.

The six pages of music sustain instructions from the interpretation schema. These are categorized into five different levels and notated through five specific symbol sets. The first set of symbols, represented by arrows, indicate how to interpret the selection of material from the score.

When Stockhausen uses *interpret*, he means to withdraw material from the particular page based on the second set of symbols. These symbols direct the performer to choose from the page either complete systems, parts of systems or elements of systems. Then, this material is compared based on a third set of symbols to play systems, parts or elements that are either the same, different or contrary from one another. Each selected system, part or element is separated by a pause of short, medium or long duration

Finally, the fifth set of symbols explains the interaction of either systems, parts or elements with the feedback:

- 1) POLYPHON: entries should fall between entries of playback.
- 2) AKKORDE: entries should be synchronous with playback.
- 3) BLÖCKE: entries should be superimposed to create layers separated by pauses.

### 3 Process of Design

All the timbre and noise modulations were based around the harmonic qualities of the vibraphone and programmed in Pd (Pure Data). The vibraphone does not have an intrinsically complex timbre, and is considerably one of the more 'pure' sounding instruments given its sinusoidal harmonic structure. The timbres for this version of *Solo* were designed to add complexity to the composite sound with the first modulation being the simplest and the third being the most complex.

No attempts were made to *prepare* or alter the vibraphone physically, this deemed too cumbersome within the context of the piece and did not seem to fit within the conception of the idea of the digital autonomy; instead all processing was performed digitally. However, as part of the design process it was important to not lose

the identity of the vibraphone entirely within the combined timbre. Each alteration had to attain a composite that was aesthetically interesting, while retaining this relationship to the vibraphone. One additional effect that had to be included in this realization are glissandi. Since the vibraphone is not capable of executing glissandi the computer had to simulate this task. The effect had to be controlled by the performer using a modulation wheel on a MIDI keyboard.

#### 3.1 The three timbre distinctions

I. Ring Modulation - modulating frequency is 3.3 times the input signal. This provides an effective color of high and low bands of enharmonic partials.

II. Vocoder A - uses a clarinet sample as the timbre stamp. This sample is a chorus of clarinets, not just one, to avoid the presence of a pedal note when using this effect. When processing the vibraphone, this vocoder illuminates a blend of even and odd partials in conjunction with the vibraphone, blurring the identity of the instrument slightly in distinction from the ring modulator.

III. Vocoder B - uses a gong as the timbre stamp. The gong saturates the timbral spectrum and emits the most complex composite.

#### 3.2 The noise gradations

*Noisy (geräuschaft)* - filtered white noise multiplied with the signal. This was chosen to create a simulation of a loud noise floor. The effect is meant to be subtle but not transparent.

*Somewhat Noisy (etwas Geräuschaft)* - a series of sawtooth waves multiplied with the signal. The intention was to create a buzz that is more focused than the white noise, as though the vibraphone was 'prepared' in some fashion.

*Very Noisy (sehr Geräuschaft)* - incomplete vocoder. Essentially, this noise modulator inaccurately resynthesizes the signal through a calculated error. What results are thick bands of enharmonic partials that buttress the harmonics of the vibraphone.

This collection of noise and timbres worked very well in combination with the vibraphone. In addition, they are well suited to create diverse textures when layered in the feedback loop but still retain an identity. Aesthetically, using a computer to create the timbre/noise modifications was more desirable as there was more control in their design when compared to the limitations of acoustic modification to a vibraphone. This also became an exercise in sound design for the performer, allowing a great deal of freedom and creativity when producing real-time DSP modules

The assistants were all automated via a master timer that executes their actions through a text file (q-list). It is designed to accept an on/off message for each fader

controlling the feedback loop. Part of the interpretation process is to program the assistants' *Formschema* to work within the framework of the constructed score. Since the performer will presumably not perform the piece exactly the same each time, there is an eventual amount of variability between performances. This subscribes to Stockhausen's instructions for spontaneity in the assistants' actions provided that many of the periods are too short for any human to produce a more cogent result.

The feedback loop was designed to simulate the original configuration from 1966 which was one very long tape with six different tape heads (one for each section). Each head was placed at corresponding distances to account for the time of each period. The digital version of this process uses six variable delay lines. If a preceding period is longer than the subsequent period, only a portion of that period will feedback, not the entire period.

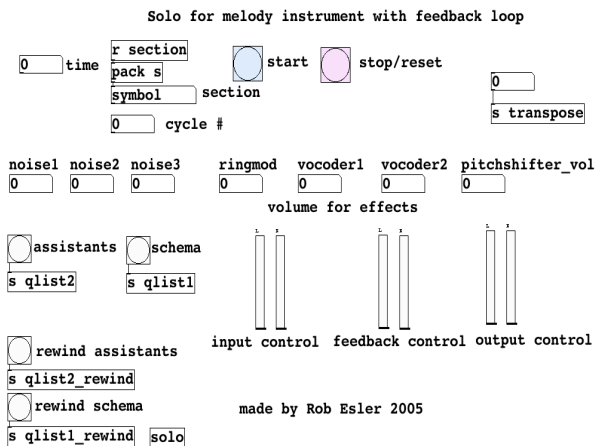


Figure 3 - Pd interface for *Solo*, displays the assistants, timbres, noises, and glissandi all controlled by a MIDI keyboard controller.

## 4 Remaining thoughts

It is apparent the idea of autonomy in this realization is vetted through a performative interpretation. The progression of technology over the past forty years has changed the venue of electroacoustic performance. Computers have provided performers with an interface they can control signal processes in tandem with their acoustic instruments. This is why the re-forging process of antiquated works can be an exercise in interpretation for a performer. They can evaluate the importance of the technology within the composition and its role in performance. Such vital steps bring electroacoustic music to life. From there, a performer can posit a meaningful interpretation of a work that includes technology as an equal constituent.

There have been several other digital realizations of this piece that have sustained the original partitioning of assistants and performer. One example is the Sluchin version, for trombone and computer, that programmed all the tasks into one application, run by a single assistant. (Sluchin, 2000) This approach reduces the interpretation to two people and allows for a duality between the technology and the performer. The system Stockhausen has created provides for multiple representations. Stockhausen's own recordings show the versatility of this system through his versions for synthesizer and for flutes, neither of which are produced live. (Stockhausen, 1995) Perhaps, this was a means for Stockhausen to avoid the difficulties of older technology, and maintaining the textural, interactive, and timbral sensibilities of his work. In any event, these examples show precedence of digital control for the assistants and feedback circuits.

In the context to this realization of *Solo*, complete control was a necessary part of the interpretation. The instrument is a computer-processed vibraphone, there are no acoustic modifications to the instrument. As opposed to other versions for flute, trombone or cello that use mutes, instrument changes, or extended techniques to execute their prescribed timbre and noise modulations, this version does not utilize these devices. Thus, human assistants seemed as foreign components to this system.

It was discovered that 'Digital Autonomy' is not a pejorative concept in relation to the performance of electroacoustic music. The composer is still the creator, however, the performer becomes the director in charge of communicating the musical elements of the work, whether they are for an acoustic instrument or combined with a computer. The performer assumes a responsibility to uphold the laws set forth in the world the composer has created.

*Solo* can be performed in a variety of ways and still resonate the same musical values it spoke in 1966. Digital autonomy is intrinsic to the communication and interpretation of these values not just in *Solo* but electroacoustic music as a whole. The performer is the interpreter and controls all aspects of assimilating media, of any kind, into their performance. At this point everything is just music.

## References

- Sluchin, Benny. "A computer-assisted version of Stockhausen's *Solo* for a Melody Instrument with Feedback ." *Computer Music Journal*. No.24, (2000) 39-46.
- Stockhausen, Karlheinz. *Solo für ein Melodie-Instrument mit Rückköpplung*. Vienna: Universal Edition, 1969.
- Stockhausen, Karlheinz. *Solo*. (Dietmar Weisner, flute.) 45 Stockhausen. 1995.
- Stockhausen, Karlheinz. *Texte zur Musik*. Köln : M.D. Schauberg, 1963-1977.