Composing for the (dis)Embodied Ensemble: Notational Systems in *(dis)Appearances*

Matthew Burtner
University of Virginia, McIntire Department of Music
Virginia Center for Computer Music (VCCM)
Charlottesville, Virginia, USA 22903
mburtner@virginia.edu

ABSTRACT
This paper explores compositional and notational approaches for working with controllers. The notational systems devised for the composition *(dis)Appearances* are discussed in depth in an attempt to formulate a new approach to composition using ensembles that navigates a performative space between reality and virtuality.

Keywords
Composition, notation systems, virtual reality, controllers, physical modeling, string, violin.

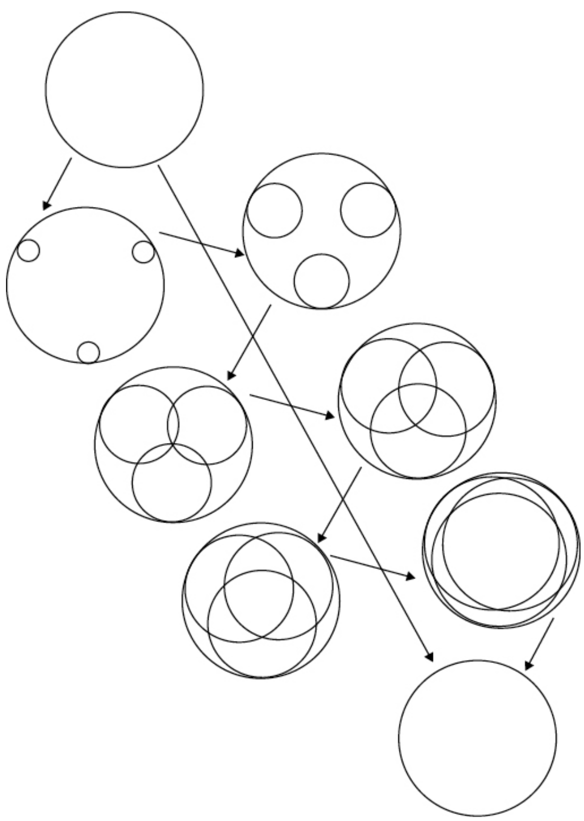

Figure 1: Musical form of *(dis)Appearances* showing the generation, emergence and disappearance of the independent instrumental elements.

1. BACKGROUND

1.1 Notations for NIME Y1.9K to Y2K

New interfaces for musical expression (NIME) and new approaches to sound synthesis provide composers opportunities to draw from an ever richer orchestra of expressive instruments and tools (Cook 2002, Paradiso, Hunt 1999, Wanderley 2001). In recent years, the renewed interest in the area of musical controllers reflects the origins of electronic music in the early 20th Century when pioneers such as Cahill, Theremin, Trautwein, Martenot and Hammond carved out the beginning of electronic music as a performance-based field (Roads 1996, Holmes 2002). But these brave-new-century interfaces left little trace in the way of compositions or even notational systems. Recordings or scores of original music for these instruments would be valuable because it would point to key aspects of how artists perceived the expressivity of the new instruments.

In today's brave-new-century there is a strong tradition of electronic and experimental music composition, embracing a wide range of styles and forms. However, we see little research into designing systems to describe repeatable sequences of control change, ie. notation. Composers are often performers of their own inventions, or a demonstration-improvisation is created for a new instrument showing the facilities of the controller more than exploring any real musical depth the instrument may possess.

A work such as Stockhausen's *Mikrophonie I* from 1965, for a large tam tam, microphones and mixer remains a part of the performed classical music canon precisely because the score describes a sequence of control changes over time and therefore it *can* be performed (Burns 2001). The notational system was invented by Stockhausen, and if it did not exist, our understanding of the piece and certainly of the rich expressive potential of the extended tam-tam would be impoverished. (Figure 2) .

While a tam tam is not a NIME per-se, Stockhausen's extended exploration of the instrument combined with the unique network interaction between the ensemble provides a good metaphor for the type of relationship we see between instrument, synthesis, performance and composition in the field of computer music. Additionally, the approach to the interface is itself an excellent example of how recombining control parameters in performance and composition can redefine and augment traditional interfaces.

Figure 2: Original performance of Mikrophonie 1, 1965 in Cologne. Photo by Klaus Barisch

1.2 Formative Work

1.2.1 Noisegate 67 and the Metasaxophone

This paper stems from a more general interest in investigating notational systems for new musical interfaces. Frequent performances with the Metasaxophone (Burtner 2002) and a desire to create repeatable sonic states with that controller inspired the development of a notation for *Noisegate 67* (1999). The notation system for that piece has been discussed in detail previously and presented to the NIME community (Burtner 2002).

1.2.2 MinMax and the Scanned Synthesis System

Working with Max Mathews on his Radio Baton Scanned Synthesis system led to another notational approach for controllers for the composition *MinMax* (2000). In this notation, the performer is given detailed information about aspects of the system such as time in seconds, display feedback from the Scanned Synthesis window display on the computer monitor (visual feedback cues), movement of the two batons across the baton antenna surface, movement in the Z plane, other controller aspects of the Radio Baton such as the potentiometer settings, sounding pitches (audio feedback), and programming instructions for setting up the synthesis algorithms such as timbre, pitch system settings, hammer position and hammer force, hammer spacing, string tension and mass centering.

These notational constructs are totally idiosyncratic to the Max Mathews Scanned Synthesis System. But a performer given that system can recreate *MinMax* from the score. The score was made because Mathews was traveling to ICMC 2000 in Berlin to present scanned synthesis with Bill Verplank (Mathews, Verplank, Shaw 2001). As part of the demo Max had requested a short piece that he then could play as a first example of compositional uses of the synthesis technique. The score was made so that Mathews could present the piece without the presence of the composer. Figure 3 shows a page from the score of *MinMax*.

1.2.3 S-Trance-S and S-Morphe-S: Morphological Instruments

The potential for morphological instruments arises when control and synthesis instrument parameters become separated (Chadabe 2002). In a project with Stefania Serafin, the acoustics and artistic possibilities of this disassociation has been explored (Burtner and Serafin 2000, 2001). The compositional outcome of this research project is expressed musically in the compositions *S-Trance-S* (2001) for a bowed string tenor saxopohone, and *S-Morphe-S* (2002) for a soprano saxophone singing bowl.

In *S-Trance-S*, the Metasaxophone was used as a controller for bowed string physical models. By controlling the string from within the gestural space of a wind instrument, new expressive potentialities of the model are opened. The disembodied nature of physical models becomes a means of recombining it with other interfaces, creating extended techniques for physical models that would not be possible for the real instrument. This piece has been discussed in detail in a previous article (Burtner and Serafin 2002).

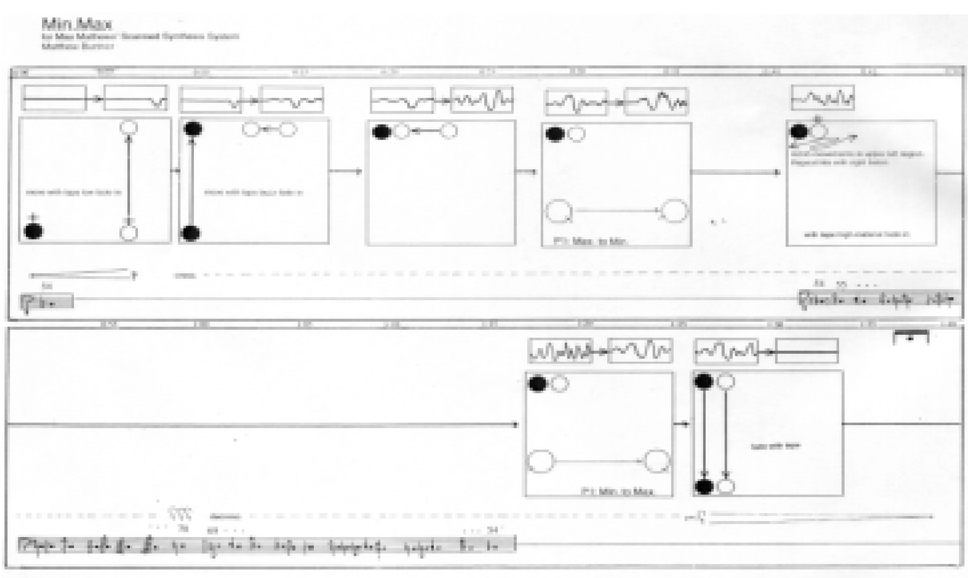

Figure 3: Score of *MinMax* for Max Mathews' Scanned Synthesis System

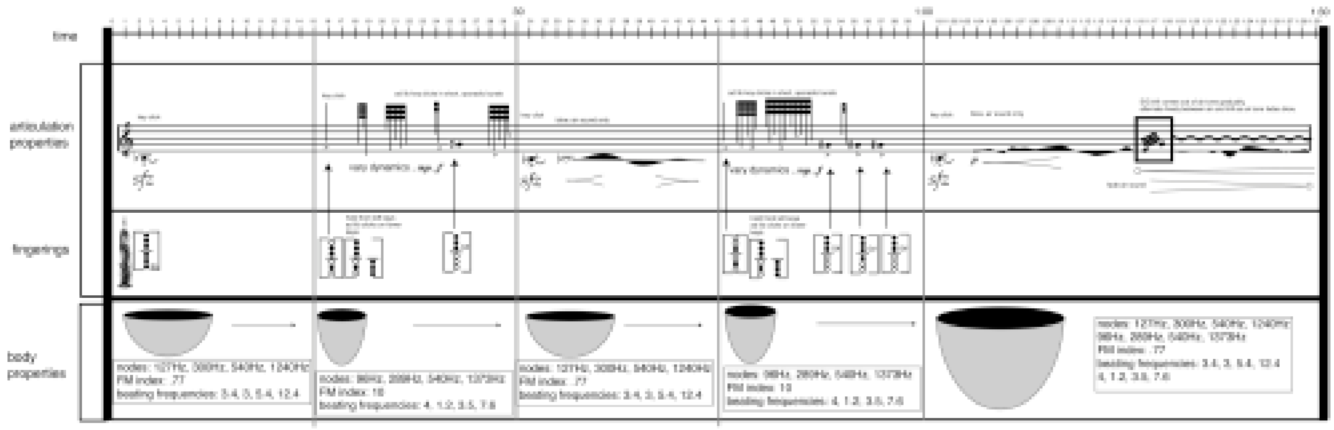

Figure 4: *S-Morphe-S* soprano saxophone performance interface

In *S-Morphe-S*, a real soprano saxophone is reembodied within a virtual bowl by sending the saxophone through a physically modeled bowl as an impulse to the model. The result is a hybrid instrument with the articulatory characteristics of a soprano saxophone but the body of a singing bowl. The saxophone uses varied articulations such as key clicks, breath, trills and sustained tones. The shape and material properties of the bowl are varied in real time creating a continuously transforming body. Figure 4 shows a page from the performance score of *S-Morphe-S*.

The working paradigm of these pieces investigates virtual reality by placing a performed physical instrument outside the realm of physical reality. In live performance this is compelling because the audience perceives something that should be impossible happening in real time.

The titles of these compositions reflect the philosophy behind them. *S-Trance-S* refers to the series of dream or hallucinations represented by the different morphological forms generated as the energy of the controller is transfused into the medium of sound. These hybrid forms then act as the extensions of their archetypes, exploring states of metamorphoses. The title *S-Morphe-S* comes from the Greek word for *form*, and in Greek mythology Morpheus was the god of sleep, of disembodied forms. The english word commonly used for a transformation between two objects is morph, a shortening of metamorphosis, derived from the Greek. The title of this piece is meant to evoke all of these meanings -- dreamed images, transformative bodies, and disembodied forms.

It occurred that this process of transformative reality based on the combination of embodied and disembodied instruments could be explored further and that interesting performative states between reality and virtual reality could be navigated musically.

1.2.4 Somata/Asomata and a Concentration on the String

In recent years the string has been a focus of much development. The violin controller technology (Nichols 2001, Young 2002, Trueman and Cook 1999) and the research on physical models for strings (Serafin and Smith) are both at a sophisticated state and continue to grow. This allows for interesting compositional opportunities for combining synthesized strings and string controllers in different ways.

Somata/Asomata (2002) for electric string quartet and computer string quartet explores this approach to the hybrid string ensemble. In this work the computer is used to separate the sounding instrument from the instrumental controller. In this way, physical properties are remapped in different ways

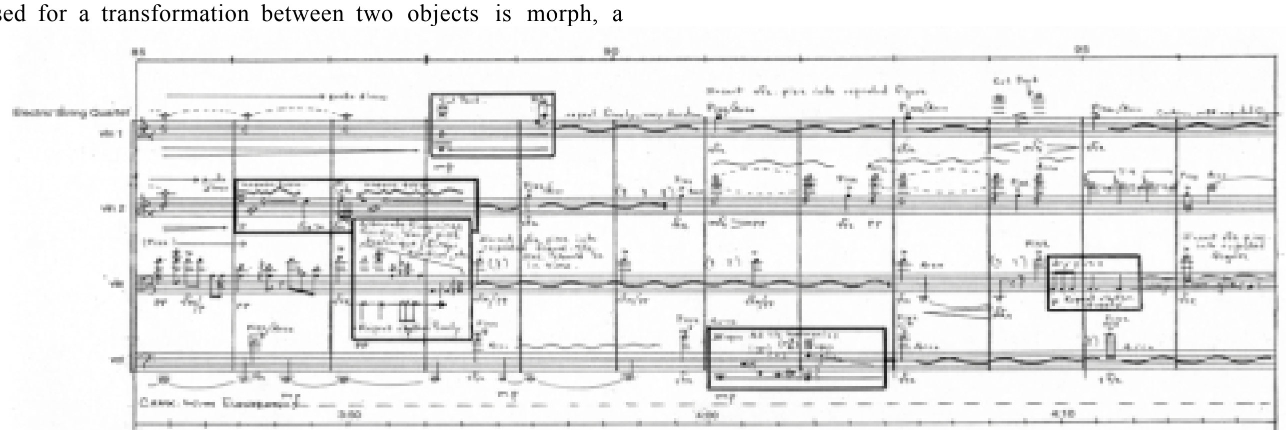

Figure 5: Measures 85-97 of *Somata/Asomata* for electric string quartet and computer quartet

to create a hybrid set of virtual instruments having selective properties of entirely different instruments. Notions of body and control are then explored through the recombinatory properties of these elements.

The concept of instrumental reality is explored through the cross-fertilization of acoustic and electroacoustic instruments in the four "digital prints" of the string quartet presented in the electronics. The violin prints are computer-generated physical model strings, controlled with extended, non-string controllers. The viola print is a computer processed acoustic string sample, predominated by convolved, granulated and phase shifted pizzicato sounds. The cello print is an unprocessed recorded string, the sound made using extended techniques such as bowing on the bridge, overbowing, and multiphonics.

2. *(DIS)APPEARANCES*: A (DIS)EMBODIED TRIO

(dis)Appearances (2003), a musical composition for a trio of amplified acoustic violin, electric violin, and computer violin/multicontroller, explores the nature of disembodiment and physical acoustic reality through the use of computer controllers and physical modeling synthesis. The piece is scored for a string trio in which the ensemble is not defined by register (as with a traditional string trio) but by states of embodiment/disembodiment.

2.1 Overview of the Instrumentation

An acoustic violin controlled with a real bow substantiates a basis in resonating real-world acoustics. An electric violin controlled with a bow outfitted with sensors that also acts as a real time controller for audio processing of the electric signal, mediates between the physical body as resonating space and the nonphysical computer-generated reality. The electric violin presents the physical presence of a controlled violin that is in fact an electric instrument using human-computer interface technology. Finally, the physical model violin, controlled by a multicontroller interface, presents a completely virtual, modeled, then extended violin. This trio mediates a space between embodiment and disembodiment as illustrated in the example below.

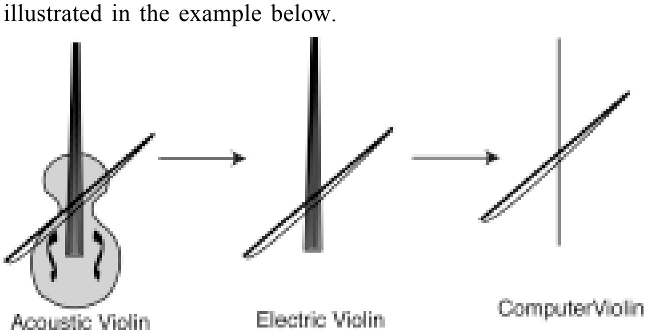

Figure 6: Instrumentation disembodiment in *(dis)Appearances*

The musical form of *(dis)Appearances*, illustrated in the graphic in Figure 1, is derived from a musical idea based on the idea of appearance and disappearance.

Figure 7 illustrates the technical configuration of the piece. Each instrument's sound comes from a separate speaker located near the performer. In *(dis)Appearances* the electric violin bow is used to control signal processing of a hard-body electric violin instrument, creating a complexly variable electric instrument. The computer violin instrument, a physically modeled and extended violin controlled by a modular multi-controller system with a Peavey PC1600x multi-slider controller at its core.

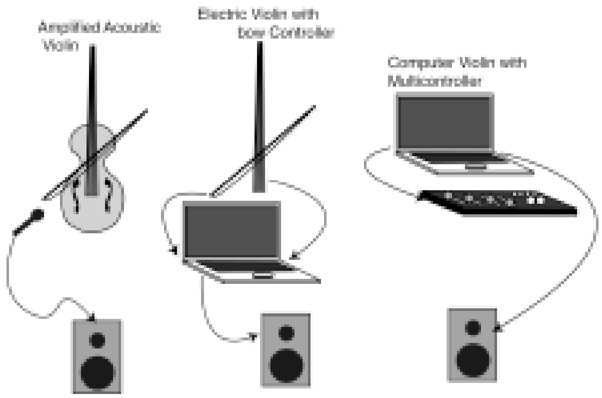

Figure 7:Controller configuration in *(dis)Appearances*

2.2 Formal Overview

The form is a transformation of identity, simultaneously in and out of reality as illustrated in Figure 1. Each instrument develops a characteristic identity that both grows and disappears simultaneously. The identities interrelate, replacing and feeding off of one another. The acoustic violin anchors the form of the piece which is divided into 25 expanding pulses. The pulses are articulated by a novel technique of the performner holding the violin to her/his face and blowing across the *F* holes of the instrument. The electric violin identity is formed of natural harmonics, processed and pushed towards breath or noise. The computer violin/multicontroller identity is a machine-like glissando and buzzing that becomes increasingly unstable and multilayered, vanishing out of the range of hearing.

As the formal graph in Figure 1 illustrates, the three elements grow and overlap until the overlapping is complete and they have eventually occupied the same musical space.

3. NOTATION

The following sections present aspects of the notation for each of the three instruments. The notational approaches are in some manner quite different reflecting the degree of difference between the controllers.

3.1 The Acoustic Violin

The movements across the violin strings are notated in the score using the graphic notation shown in Figure 8. The representation shows the four strings, the bridge, the fingerboard, and the pegs.

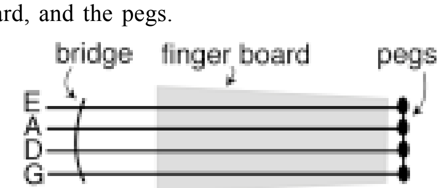

Figure 8: graphic representations of the bowed violin

The performer can orient the bowing action according to instructions such as shown in Figure 9. The left side of the figure shows the manner in which a normal down-bow would be scored. The right gesture shows a bowing action starting on the G string near the bridge and moving vertically across the strings to the A string while moving horizontally from the bowing area to a position near the top of the finger board. The curve of the line reveals a simultaneous gradual slowing of this movement.

Figure 9: left: normal down bow, right: altered bowing motion

Bowing types described in the score include up bow/down bow, bow pressure changes, and bow speed changes from stopped bowing to very fast bow speed. The notation of bowing in this manner was influenced by working with the physical model violin in which every paramater of the physically-based instrument needs to be accounted for and carefully structured in a controller mapping.

Pitch and dynamics are notated in a traditional fashion on their own staff.

In addition to being bowed, the acoustic violin is blown by the performer. Inspired by the ability to apply different types of impulses to physical models such as blowing the physical model string or bowl, the acoustic violin is also articulated here by blowing. The blown acoustic violin is a key aspect of the piece because the form is generated from 25 blown breaths, each one augmented by X (+1, 2, 3…25).

The blowing is accomplished by holding the violin to the mouth sideways and blowing across one of the "F" holes. The violin can be both blown and bowed simultaneously if held correctly. The performer blows across the hole with an "f", "h", or "sh" sound to fit with the timbre of the bowing. Blowing pressure is shown graphically on its own staff.

Figure 10 shows a single system of the acoustic violin score. In the example, a down bow motion moves from the G string gradually across the strings to the E string while simultaneously moving up the finger board horizontally. The bowing movement is slow, and becomes slower. The pressure increases for the first part then decreases to very light pressure. The left hand does not touch the strings. The dynamics of the gesture crescendo and decrescendo. Simultaneously the performer blows across the F hole.

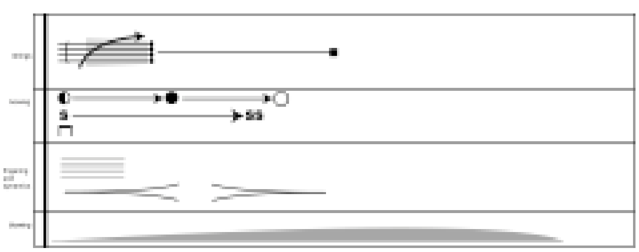

Figure 10: Acoustic violin score example

3.2 The Electric Violin

The hard body electric violin part is made entirely of harmonic nodes on the open strings. The score has four systems: density, articulations, fingering/dynamics/rhythmic figuration, and signal processing instructions.

The density staff shows the approximate density of the articulated harmonics. The vertical axis shows pitch bandwidth (high or low nodes). Vertical size indicates dynamics and horizontal size indicates duration. The performer follows the overall movement of harmonic grains but can be very free with the actual interpretation.

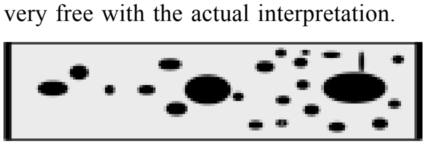

Figure 11: Density staff

The types of articulations the performer can use are given in the articulation staff. The performer freely alternates between articulations appearing in the staff over the given duration. The types of articulation described are tenuto, accent, detached tenuto, stacatto and jete.

The available types of articulation are combined together in a box over a particular duration. Global variables such as bow pressure and vibrato are added as modifiers of the articulation type. Figure 18 shows an example of alternating articulation types with increasing bow pressure over a defined time.

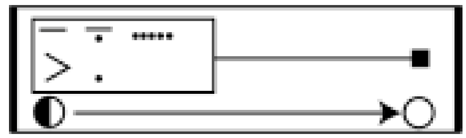

Figure 12: Articulation staff

Harmonic node fingerings are notated on a traditional pitch staff. The performer can play any of the notated harmonics in any order or the type of motion is described. Dynamics are also notated in a traditional manner, below the pitch staff.

The signal processing control staff gives instructions to the performer about tpes of signal processing applied to the amplified signal.

3.3 The Computer Violin/Multicontroller

The exbow computer violin is played with the modular multicontroller. In composing the piece, a PC1600X slider box was used. This controller offers enough continuous control parameters to dynamically alter the numerious physical model violin parameters.

The exbow interface (Figure 13) is programmed in Max/MSP. The score provides a single staff for all parameters of control with each control variable being assigned a number.

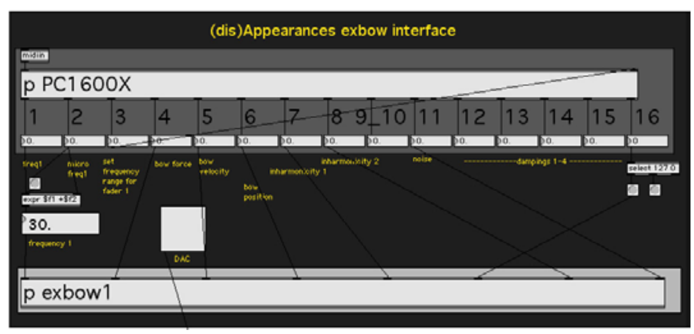

Figure 13: Exbow performance interface

In the PC1600X configuration, each number represents a slider from left to right. The top of the staff represents the slider-at-top position, and the bottom represents slider-at-bottom. The control parameters of the Exbow are:

1) Frequency: This determines the total frequency range of the model, set by slider 3, Frequency Range. The frequency range defaults to 5000Hz.

2) Micro-Frequency: This is a 15 Hz plus or minus deviation from the frequency. The performer can bend the pitch using this slider.

3) Frequency Range: The range of slider 1 is set between 5000 and 15 Hz. All the way up is 5000Hz.

4) Bow Force: Extreme force is at the top and no bow force is the bottom.

5) Bow Position: sul ponticello is the top and sul tasto is the bottom

6-7) Inharmonicity 1 and 2: Inharmonicity is increased by moving the sliders up.

8) Noise: Noise is introduced by moving the slider up.

The computer violin notation shows a control parameter only when it is being set or changed. In Figure 14 the initial position settings for sliders 1, 2, 3, 4 and 5 are given. Slider 5 is moving at the beginning of the measure, and slider 6 starts moving down halfway through that motion. The performer resolves the need for specific sliders to be controlled with the left or right hand.

Because of the potential for overwhelming the performer with performance data, it is important to understand that positioning of the sliders is approximate. The performer will need to use her/his ear to tune the specific setting to a desireable sound that fits into the context of the sounding music.

The detached nature of the multislider control interface was appealing when working with the extended physical model string because specific parameters could be isolated and set against very slow moving parameters. For example, the slightest change of bow pressure can become a compositional parameter because of the ability to isolate the micro-timbral effects of this otherwise dynamic property.

The change of parameters notated in the computer violin part would be impossible to play on an acoustic violin. Parameter configurations that would not make a sound on an acoustic string create interesting virtual acoustic states on the modeled string. For example, by maintaining all parameters in a steady state and only changing bow force, very interesting sounds can be obtained. On a real string it is very hard to isolate bow force from bow speed because any increase in pressure coincides with a change in bow velocity which the performer imediately tries to compensate for. Combining this type of parameter isolation with the possibility of dynamically changing the inharmonic properties of the string generates entirely new possibilities for composing music for strings.

The Graphic overview and Dynamics Staff provides an approximation of the overall changing sound.

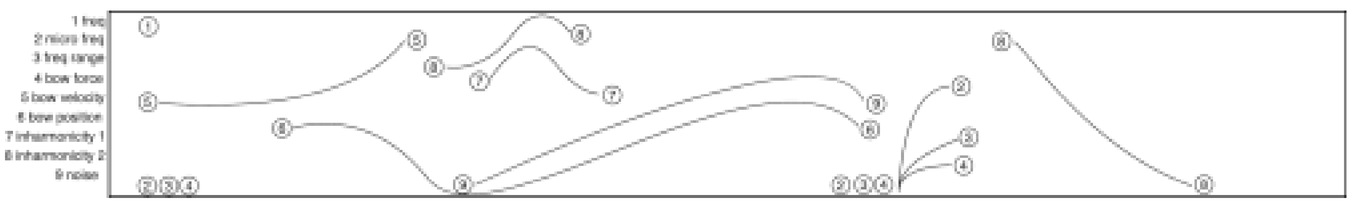

Figure 14: Computer violin score example

4. THE SCORE

Figure 15 shows a page from the score of *(dis)Appearances*. The notational elements described above have been combined into a single system, now forming an orchestrated musical ensemble.

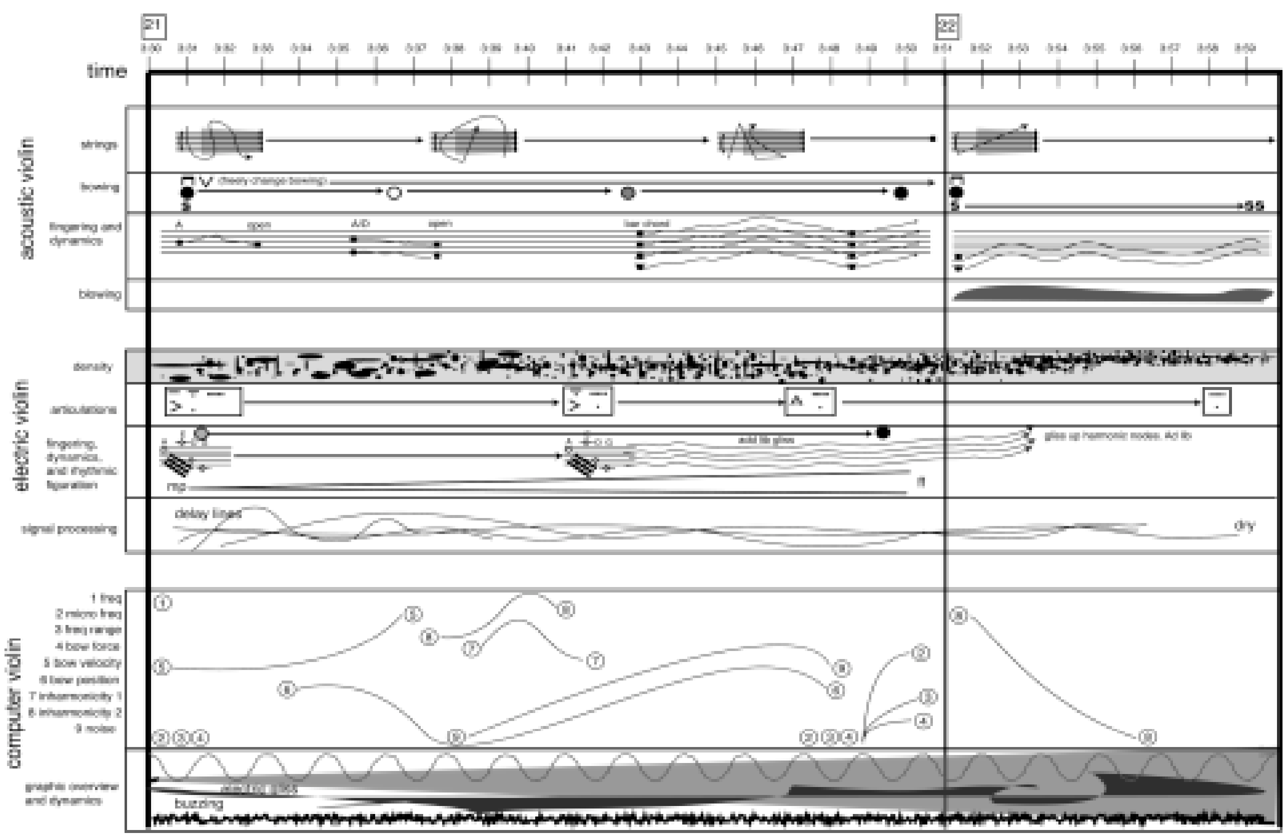

Figure 15: Score Excerpt from *(dis)Appearance*

5. REFERENCES

[1] Burtner, M. "The Metasaxophone: Concept, Implementation, and Mapping Strategies for a New Computer Music Controller." Organized Sound, vol. 7, n.2. 2002.

[2] Burtner, M. "Noisegate 67 for Metasaxophone": Proceedings of NIME 2002, Dublin, Ireland. 2002.

[3] Burtner, M., and Serafin, S.. The Exbow Metasax: Compositional Applications of Physical Models Using

[4] Instrument Controller Substitution. *Journal of New Music Research*, vol. 31, June 2002

[5] Burtner, M., and Serafin, S.. Extended Techniques for Physical Models Using Instrument Controller Substitution. Proc. ICMA, Perugia, Italy, 2000.

[6] Burtner, M., and Serafin, S. Real time Extended Physical Models for the Performer and Composer. Proc. ICMC, Havana, Cuba, 2001.

[7] Burns, C. 2001. "Realizing Lucier and Stockhausen: Case studies in the performance practice of electroacoustic music." Proceedings, International Computer Music Conference 2001, pp. 40-43. San Francisco: International Computer Music Association.

[8] Chadabe, J. "The Limitations of Mapping as a Structural Descriptive in Electronic Instruments. Proceedings of NIME 2002. Dublin, Ireland. 2002.

[9] Cook, P. Principles for Designing Computer Music Controllers. Proc. of NIME-01, Seattle, USA, 2001.

[10] Hunt, A. 1999. "Radical User Interfaces for Real-time Musical Control." D. Phil Thesis, University of York, UK.

[11] Nichols, C. "The vBow: A Haptic Musical Controller Human-Computer Interface", Proceedings of the International Computer Music Conference, Berlin. 2000

[12] Serafin, Stefania, J.O. Smith III, and J. Woodhouse. "An investigation of the impact of torsion waves and friction characteristics on the playability of virtual bowed strings," in IEEE Workshop on Signal Processing to Audio and Acoustics, New Paltz, NY, New York, Oct. 1999, IEEE Press.

[13] Orio, N., Schnell, N., Wanderley, M. Input Devices for Musical Expression: Borrowing Tools from HCI. Proc of the NIME-01, Seattle, USA, 2001.

[14] Paradiso, J. New ways to play: Electronic Music interfaces. IEEE Spectrum 34, 1997.

[15] Mathews, M., Verplank, B., and Shaw, R. Scanned Synthesis, A New Synthesis Technique. Proc. ICMC, Berlin, Germany, 2000.

[16] Roads, C. *The Computer Music Tutorial*. 1996, MIT Press, Cambridge, MA, 1996.

[17] Holmes, T. *Electronic and Experimental Music: Pioneers in Technology and Composition*. 2002, Routledge, New York, 2nd Edition. 2002.

[18] Trueman, D. and P.R. Cook. "Bossa: The Deconstruced Violin Reconstructed." In Proeedings of the ICMC, Beijing. 1999.

[19] Wanderley, M. 2001. "Performer-Instrument Interaction: Applications to Gestural Control of Music." PhD Thesis. Paris, France: University Pierre et Marie Curie - Paris VI.

[20] Young, D. "The Hyperbow Controller" Procedings of NIME 2002, Dublin, Ireland. 2002.