"Sxratch" for Metasaxophone

Matthew Burtner
University of Virginia
Interactive Media Research Group
VCCM Computer Music Center
Charlottesville, VA 22903 USA
cmb4f@virginia.edu

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Abstract
Sxratch (2006) is a musical composition and interactive performance work created for the Metasaxophone, an augmented instrument invented and built by the author in 1999. The Metasaxophone is one of the earliest augmented instruments still in regular use today. The piece uses the instrument interface to control interactive computer sound software and robots.

Keywords
Music, Performance, New Interface, Saxophone, Augmented Instrument, Musical Expression, Artificial Intelligence, Computer Sound, Musical Robots

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design, Performance

Introduction
Sxratch is a composition for solo Metasaxophone exploring the physical interaction possibilities of this unique instrument. In *Sxratch,* the saxophone is struck, thrown, shaken, turned, and blown. The body of the instrument becomes a physically active part of the sonic result as the metasax sensors track parameters such as velocity, angle, acceleration and force. Intelligent samplers and chaotic systems create a bounded performance space in which decisions are made outside the human performer's control. The

saxophone performer is continually forced to improvise with the interface because the system asserts chaotic behavior by making higher-level music decisions and by unpredictably remapping the sensor interface. While the performer continually inputs expressive movement and sound, the system either uses it or does not.

Additionally, with each played note or dramatic movement of the sax, the program remaps the sensor functions such that the performer cannot readily predict the effect of playing gestures. This keeps the performer reacting with gesture and sound in the moment. This feature (or intentional bug) also works against everything musicians learn about mastering an instrument through rehearsal. *Sxratch* forces the performer to develop improvisational methods for new interfaces.

The performance features the sounds of 1) the electro-acoustic saxophone, 2) the *Sxratch* interactive sound synthesis software, and 3) an ensemble of robots also controlled in real time by the Metasax.

The Metasaxophone

The Metasaxophone, designed and implemented by this author, debuted in 1999 at the Center for Computer Research in Music and Acoustics (CCRMA) of Stanford University. The Metasaxophone System involves a series of electroacoustic and digital modifications of an acoustic saxophone. The saxophone is augmented with an onboard computer microprocessor and an array of sensors that convert performance data into MIDI control messages. Additionally, a unique microphone system allows for detailed control of the amplified sound. While maintaining full acoustic functionality it is also a versatile MIDI controller and an electric instrument.

The Metasaxophone puts interactive signal processing under direct expressive control of the saxophone performer. Through the combination of gestural and audio performance control, employing both discrete and continuous multilayered mapping strategies.

Sensor Interface

While the traditional saxophone allows for continuous control over embouchure changes and changing air pressures, the fingers of the performer have very little direct continuous control over the instrumental sound. For all practical purposes, a saxophone key is either open or closed. Half keying is an extended technique of some promise, and excecuting rapid trills can give the impression of a continuously changing sound, but these both involve substantial changes in the air column that can disrupt other key work in progress.

The Metasaxophone adds a new level of key control that does not disrupt normal playing but can be used to substantially modify the sound. By giving the keys pressure sensitivity or ‘aftertouch’, a feature common on MIDI keyboard controllers, the Metasax provides the performer with direct tactile control over the electronic signal processing. The computer interface occupies the unused key-pressure expressive zone. The saxophone keys, which normally execute only binary *on* and *off* changes to the air column, are converted to continuous control levers.

figure 1. The Metasaxophone sensor interface

The microprocessor on the bell of the instrument, gathers performance data from six pressure sensors on the front keys, two pressure sensors off the keys, five triggers positioned at different points on the horn, and a sensor for measuring the movement of the instrumental body itself. Force Sensing Resistors (FSRs) are located on the front B, A, G, F, E and D keys, and beside each of the thumb rests. Three triggers are located on the bell of the instrument and two are positioned on the back, below each of the thumb rests. An accelerometer IC chip on the bell measures the relative movement of the saxophone on a two-dimensional axis – left/right and up/ down tilt.

The data from these sensors are collected via a serial cable into a microprocessor fixed to the bell of the instrument. Analogue pressure data from the performer is converted to a digital representation and trim potentiometers are used to calibrate the input sensitivity of each sensor. In this way the sensors can be "tuned" for each finger.

Electro-acoustic Interface

Although it performs perfectly well as a normal acoustic instrument, it was assumed that the Metasax's primary use would be for electroacoustic music. For this reason, the instrument was also augmented with a unique amplification system. In addition to sending MIDI information, the Metasaxophone sends audio signals through small microphones located inside and around the bell. The microphone system was created uniquely for the Metasaxophone and consists of small condenser microphones fitted to the ends of bendable tubing and encased with the microphone wires inside heat-shrink tubing.

The Metasax microphone system attaches to the back of the Metasaxophone circuit box on the top of the bell, and each microphone can be placed independently at the desired location outside or inside the instrument. The performer can modify the sound of the instrument simply by placing the three microphones in a variety of configurations and adjusting the gain between them. Microphones can be placed inside the instrument without touching the inner walls. The microphone circuit is made to handle extremely high sound pressure levels without distortion. Figure 2 shows the Metasax microphones around the bell.

figure 2. The Metasaxophone microphone system

Each microphone has a separate output allowing the signals to be routed to separate devices for processing or to multiple channels on a mixer.

When playing the Metasax, a performer controls the acoustic saxophone sound, the electric sound and the digital control changes simultaneously. The acoustic saxophone interface is in fact inseparable from either the electric audio signal or the MIDI control changes because any change of fingering affects both the data sent and the resonating air column. The Metasax is thus a highly idiosyncratic but unified controller.

Sxratch Sound Synthesis Software

Sxratch plays with the multifaceted and complex nature of the Metasax interface by introducing chaos and unpredictability into the interface. The sound synthesis software deliberately makes it impossible for the performer to predict how control changes will affect the sounding result. It works against every aspect of planned performance practice in this way.

The performer improvises with the Sxratch software by playing audio, pressing keys and moving the saxophone body. The software tracks all these data sets and randomly remaps the control parameters with every note played or every abrupt movement. At times the software samples the incoming audio stream but at other times it ignores it. At times it accesses stored saxophone samples from disc and at times it does nothing. The performer never knows how it is going to behave. Additionally, a variety of audio sampling and slicing affects are implemented. The keys set the sample length, playback speed, volume, read speed, granulation rate and modulation. Any of these effects may be either set as an initial value or controlled continuously by one of the saxophone keys. The performer never knows which key will control which parameter, or the range of the mapping. The mapping is constantly shuffled.

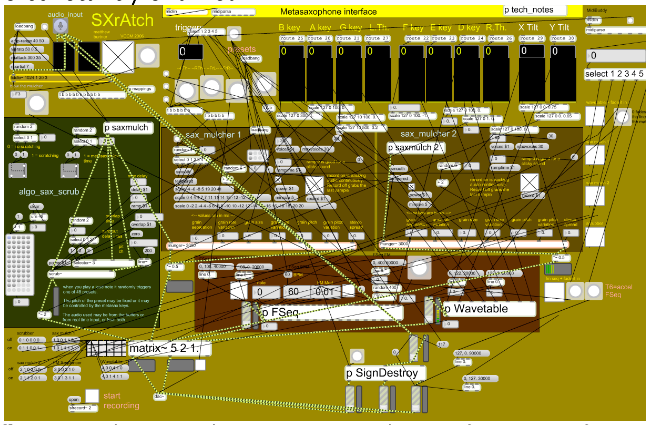

figure 3. The *Sxratch* interactive Max/MSP software interface

If the performer finds a nice sounding result it is only a short time before some event will reset the system and leave the performer searching for a new sound. The system thus constantly enforces improvisation and spontaneity. It does this in an abrupt and harsh manner that gives the composition its character.

Expanding Instrumental Physical Gesture through Software-Sensor Interaction

When creating the piece, the composer imagined that these chaotic aspects create be an enormous disadvantage for the player who could never really learn the instrument. The piece should be frustrating and awkward. But surprisingly it was very interesting and delightful to perform *Sxratch*.

Performing the piece was freeing and irresponsible, turning virtuosity back onto the instrumental system and allowing the performer to enjoy the behavior and discover new modes of working with the instrument. The performer spends less time thinking about what to do and more time listening. It relieved much anxiety from the performance.

Figure 4 shows several video stills from a performance in Paris, France in 2006. The movements here were generated by the sounding result of the system, not by a plan of action. Notice how in frame four the saxophone is almost vertical. And notice in frame 5, 6, and 7 how the left hand position is reversed, the saxophone being held like an upright keyboard. And in the last frame, the saxophone is upside down, being shaken like a bag of flour.

In another series of stills (figure 5) the performer grips the bell to shake the instrument, uses the right hand like hand percussion, drumming the instrument, and in the final frame brings the knee up to steady the saxophone while playing freely with the other two hands. These two video still sequences reveal an expanded range of physical gesture created through the interaction between the *Sxratch* software and the Metasax sensor interaction.

Since its premiere in 2006 at the University of Wisconsin, Milwaukee, *Sxratch* has been performed 15 times in a variety of concert settings. It has been featured in concerts at l'Opa Bastille in Paris, the Stone in New York, the Music Gallery in Toronto, the University of Montreal, Karnatic Lab in Amsterdam, the PASIC Festival in Austin, Club MUSE in Richmond, the EMF Festval in New York and at a number of other venues. The piece was presented at the Paris Selmer Artist Showroom as part of a demonstration of Metasax Systems for the Selmer Saxophone Corporation. *Sxratch* also defined a unique NIME-Punk aesthetic promoted by the ensemble Metasax&DRUMthings in its live performances since 2006.

figure 4. *Sxratch* video still performance sequence

figure 5. *Sxratch* video still performance sequence

Sxratch Robotic Interactions

In 2008, at a performance at the Logos Foundation in Ghent, Belgium, the author collaborated with the M&M Robot Orchestra and performed *Sxratch* with the addition of an ensemble of unique robots. The Metasax MIDI signal was split off from the saxophone and mapped to control different robots on different channels. The performance was so successful that this version of the piece is being recreated for the CHI performance in Atlanta in 2010. For this performance the author will collaborate with EMMI Robotics. The performance will employ an ensemble of robots created by Troy Rogers, Steven Kemper and Scott Barton.

Citations

[1] Metasaxophone Systems website. http://www.metasax.com

[2] Expressive Machines Musical Instruments website. *http://www.expressivemachines.org/*