

Round table

Electronic Controllers in Music Performance and Composition

Presentation

As part of this electronic book, the editors have invited several composers and designers to take part in a *round table*. A set of questions, addressing current trends in the gestural control of music, were written by the editors, Marc Battier, Marcelo Wanderley, and by Joseph Rován.

The questions were sent to all the participants. Each answer was in turn forwarded to all, hence the reference to a *round table*.

The answers are presented in the order they were received. We would like to thank all the participants for their contribution.

Participants

William Buxton

Don Buchla

Chris Chafe

Tod Machover

Max Mathews

Bob Moog

Jean-Claude Risset

Laetitia Sonami

Michel Waisvisz

Questions

1. EVOLUTION

- 1.1. Could you shortly summarize when and why you first became interested in using electronic controllers for performance/composition?
- 1.2. What kind of performance/composition using gestural controllers are you doing today?
- 1.3. In your opinion, would you consider the current state of these gestural controllers satisfactory. If not, what are the shortcomings?

2. PERFORMANCE/COMPOSITION

- 2.1. In your opinion, what makes an electronic controller expressive?
- 2.2. What would it take for a new controller to become a "standard" device so that a repertoire could be developed for it (like the theremin and martenot in the past)?
- 2.3.a Can new electronic controllers replace traditional instruments as viable performance tools? Should they?
Upon William Buxton's suggestion, this question was replaced by:
- 2.3.b Can electronic controllers become as viable performance tools as traditional instruments?
- 2.4. Do you ever use gestural controllers outside of performance situation, for instance, as compositional tools in the studio?
- 2.5. How would you characterize their role in this context?

3. INTERDISCIPLINARY CONNECTIONS

- 3.1. Regarding the development of input devices, what can gestural control gain from specific fields such as HCI, ergonomics, experimental psychology, cognition?
- 3.2. Is there any sense in adapting scientific methodologies from other disciplines like HCI, etc., for developing controllers, or do musical controllers require idiosyncratic approaches?

4. FINAL WORDS

- 4.1. Are there any points that we haven't covered? If so, please address at your leisure.

1. EVOLUTION

1.1. Could you shortly summarize when and why you first became interested in using electronic controllers for performance/composition?

William BUXTON

I began with standard commercially available synthesizers back in around 1969. In late 1969, I met Hugh LeCaine at the National Research Council in Ottawa, who was making all kinds of touch sensitive devices, and other controllers for electronic musical instruments. Then in 1970, also at the NRC, I first saw and used a computer for music composition. This also had some interesting interactive devices. This all led me to understand the power of alternative interactive devices, and the fact that one could be proactive and design them oneself - you didn't have to take only what you could buy.

Laetitia SONAMI

The need for personalized electronic controllers for performance came about when I started using computers in performance in the late 80's. Until then I was using a mixture of home-made analog devices, mixing them with pre-recorded sounds on tape, and live voice. There was an inherent "theater", or gestural "vocabulary" when using these analog devices: turning knobs, moving faders... seemed satisfying enough and provided sufficient control. Then, I started using the computer: what was I to do on stage, so much "power" at hand and yet our hands were tied. So many sounds, yet so little real-time control. In 1991, I collaborated with Paul DeMarinis in a performance for Ars Electronica, entitled *Mechanization takes Command*. We decided to fit a pair of kitchen gloves with hal-fx sensors which could trigger a variety of sounds from slaughter houses (one of the first beneficiary of mechanization, but this is another story....).

Robert MOOG

Building electronic music instruments was a hobby of mine from the time I was 12 years old or so. They were very simple devices, - little more than 'one-note organs'. I didn't have access to keyboard mechanisms, so I made switches and levers out of the junk in my father's home workshop. Back then I could play the piano pretty well, but I didn't know anything about experimental music or electronic music. I experimented with crude control devices for my own amusement.

Chris CHAFE

My story starts with adaptations to cello playing in about the same year as I started programming sound analysis routines (with punch cards). Obviously, the cello work did not involve real-time digital at that point but it marks the beginning of my interest in using electronics to extend the instrument's timbral possibilities. One example is an effect where cello signal was fed into the mouth so that it excited vocal cavity resonances. Something I still do, but entirely in software.

Digital controllers came into the picture when MIDI devices appeared which could be put to use for control of musical lines generated algorithmically and in real time.

Don BUCHLA

In the early 60's I was experimenting with electronic generation of sound, and felt the need to create control structures that facilitated alternative approaches to performance with this new-fangled media. I built a hand shape sensor to control timbre, and subsequently designed specialized touch sensors to locate multiple sounds in 3D space, applied optical ranging to the control of other musical parameters, and constructed some voltage controlled instrumentation that eventually evolved into modular analog systems.

Tod MACHOVER

I'm a cellist, and have always been an avid performer. In high school, I was in a rock band and amplified my cello with headphones and processed it live in various ways. After Juilliard, I arrived at IRCAM in 1978, and started working with Giuseppe di Giugno and the real-time synthesizer development team. We soon developed custom-built keyboards, sliders and buttons to use with the 4C and 4X machines, and this was a revelation for me. Both in the studio and live, I was quickly drawn to the combination of precise software definition of a composition and control environment, with gestural control for expression, interpretation, and variation. After I got to MIT in 1985, I concentrated on building so-called Hyperinstruments, to allow individual performers to control complex sounds and structures. This was motivated by my opera *Valis*, for which I wanted to combine the performance precision of a rock group with an evening's worth of dense music - it ended up being compressed to only two performers, playing enhanced keyboards and percussion.

Jean-Claude RISSET

From the late 50s, following the activity of musique concrète in France and electronic music in Germany, I realized that controllers were important to shape the music. However, at that time, I composed for instruments, and despite my scientific background, I was attracted neither by musique concrète nor by electronic music, despite their huge potential, because I found the control too crude in musique concrète and the sounds too dull in electronic music. I came to Bell Laboratories between 1964 and 1969 to work with Max Mathews and explore the musical resources of computer sound synthesis. The process of direct digital synthesis was at that time far too slow to think about real-time. In the late sixties, it became easier to produce interfaces for smaller computers : real-time became possible in hybrid systems, in which the computer calculated functions for voltage-controlled hardware such as Moog voltage-controlled oscillators or amplifiers. Max Mathews proposed me to work with him on the design of such a hybrid real-time system, but I elected to pursue my exploration of direct synthesis. A real-time system using several gestural controllers (keyboards, switches, knobs, and a 3-D "wand" - a kind of 3-dimensional potentiometer with the possibility of feedback) was designed and implemented by Max and Richard Moore under the name of GROOVE : it was remarkably well thought-out, and it influenced later systems, such as the 1974 Synclavier, the first real-time digital synthesizer by Jon Appleton, Sydney Alonso and Cameron Jones. In the seventies, I was impressed by the approach on physical models and gestural control with feedback implemented by Claude Cadoz, Annie Luciani and Jean-Loup Florens.

While in IRCAM between 1975 and 1979, I was not convinced by the real-time craze - few real-time works of these years have survived. In the eighties, I enjoyed Joel Chadabe's pioneering use of the Theremin linked to the Synclavier to control compositional parameters with gestures. I wrote a piece for the Ensemble d'Instruments Electroniques de l'Itineraire.

I was struck by the experiments on the synthetic performer by Barry Vercoe and Larry Beauregard around 1982. In 1989, I was invited by Vercoe to work at the Media Lab : I used a gestural controller I knew and enjoyed, namely an acoustic piano - a Disklavier with MIDI input and output, with which Scott Van Duyne and I implemented a *Duet for one pianist*.

Michel WAISVISZ

It started at home, together with my brother, I was four years old, playing with my father's short-wave radios, tuning into the telexzooms, the squeaks and squeals and distorted voices from afar.

We used to play warplane flights and space journeys with these instruments, for hours and hours, and fabricated bigger dials to tune in more precisely. Also the antennas were manipulated, metal objects moved near the spools, we blew air from the end of the vacuum cleaner towards the loudspeakers and moved bottles and pipes in front of the speakers in order to create some kind of "flanging".

My father built a Theremin when I was 14. At that time I was listening, to, amongst others, early records of electronic music; also with my brother we explored record players; not only did we discover "scratching" and looping but we also were changing the surface of the record with washing powder, syrup, glue and were carving and filling it with fine metallic grit in order to obtain "granulated" and chopped versions of the original recordings.

I started giving concerts at 16. By that time I played with an old cither that was prepared with all kind of objects. The sounds were picked up with electro-magnetic guitar microphones. I also played bass in a "happening" band by hitting and pulling a heavily amplified knitting needle through a wooden frame.

At 18 composer Dick Raaijmakers let me literally in through the back door of the electronic music studio of the Royal Conservatory in The Hague.

I started making tape music. But instead of playing them back in the normal way I developed a tape performance instrument: "The TapePuller" - two stands with tape heads for two identical tapeloops and the performer sitting in the middle and "rowing" the tapes; and synchronised loudness control with two footpedals.

The studio had an early Moog cabinet synthesiser. I used to hang the connecting wires in tea and other wet objects and experimented controlling the sounds by pouring the tea on wired clothes. I ended up buying this wonderful Putney VCS3 synthesiser (Zinovief design). Here I opened the back and started touching and connecting the wires with my bare hands. This gave subtle control over wild timbres and was the inspiration for what later became the CrackleBoxes. Philosophically it was interesting as a human being to become a variable electronic conductor/resistor, and a reasoning and sensing part of the instrument one plays.

In the early seventies, based on this integrated principle, I started working on the development of Crackle boxes. These were finally built and sold through STEIM in the mid seventies.

Also, in the mid seventies, I created the first "playable exhibitions" with all sort of Crackle objects and created many music theatre performances with these objects.

In 1984, I gave the first concert with what is now known as "The Hands" in The Concertgebouw in Amsterdam.

In 1988, I started working on The Web (the first Electro-mechanical computer for the programmable distribution of simple finger movements into a networked set of generators for complex music control signals) .

Since 1985, I have been developing software instruments, in collaboration with Frank Baldé: the Lick Machine, Sam, LiSa.

At present, I enjoy not modifying The Hands too much, and concentrate as much as possible on the creation of music in various collaborations and solo-projects.

At STEIM we are preparing a big travelling "playable exhibition" with many new instruments. Some of them were presented already at the Touch festival late 1998.

Max MATHEWS

My interest in electronic live performance started in the 1960's when Dick Moore and I created the Groove system. I believe it was the first live performance system which involved computers. I think my main motivation was the pure joy of performing, the joy of hearing a piece of music in real time with my expression, expression as I felt the music at that moment.

Today and for the last decade I have worked on the Radio- Baton. The Baton tracks the motions in two and one half dimensional space of the ends of two batons moved by the performers hands. It uses a capacitive sensing technique.

Although we have made much progress toward expressive sensors, many limitations remain. In particular, fast three dimensional sensing in large spaces with complete freedom for the performer has yet to be achieved

1.2. What kind of performance/composition using gestural controllers are you doing today?

William BUXTON

I am, regrettably, out of the music business today. However, all of what I learned in electronic music instrument design I am now applying to the design of systems for 3D computer animation and design.

Laetitia SONAMI

I am using the lady's glove of my own design. Its latest incarnation was built by Bert Bongers who lives in Den Haag. The lady's glove is an elbow-length glove made to measure. It is made of a fine mesh of black lycra onto which are sewn a variety of sensors: hal-fx, resistive strips, accelerometer, ultra-sounds,

pressure and various switches. It is easy to wear, it feels like a second skin. The slightest motion of the hand is captured, together with the distance between both hands and the left hand and the floor (with ultra sounds receivers fitted on the right wrist and left foot). The signals go to the SensorLab, made by Steim in Amsterdam (which by the way sponsored the latest version of the glove built by Bert), where they are converted to MIDI and sent as MIDI signals to the computer. I use MAX MSP, which maps the incoming MIDI signals to various sound parameters, whether it be triggering samples, controlling the synthesis, filters, etc... This varies according to the compositions. We are now thinking of a new version of the lady's glove which will probably retain most of the sensors, but may use new hardware for acquiring the data.

Robert MOOG

I play a little theremin, but I'm more interested in the design of gestural controllers than I am in playing them.

Chris CHAFE

I perform in concert with algorithmic accompaniment (sometimes referred to as jamming with my equations). Also in my work are standalone soundfile pieces for loudspeaker (aka., tape pieces, sometimes with performers). The cello and other instrumentalists are hooked to controllers that don't interfere with playing technique and which allow tight control over real-time computer-generated parts.

Don BUCHLA

I'm currently using tactile surfaces (Thunder) and spatial sensors (Lightning) as primary control elements for a variety of musics.

Tod MACHOVER

My work has split into two pretty different strains. On the one hand, I am still interested in sophisticated controllers for virtuosic musicians, like the hypercello we designed for Yo-Yo Ma in 1991, or the conducting system for my Bug-Mudra project. I've been trying to increase the sensing sophistication and expressive interpretation of such instruments, and am about to build a new generation of hyperstring instruments - including a cello to play myself - which will integrate, hopefully, better audio analysis and processing than in the last versions. At the same time, I've become increasingly interested in developing gestural controllers for non-professional musicians and children, in order to draw the general public more deeply into music appreciation and creativity. I've tried to concentrate on interfaces which are simple, sensuous, and physically fairly easy to play, but which are also musically rich. I developed a whole series of these controllers for the Brain Opera in 1996 - including things like the Gesture Wall, Melody Easel, Rhythm Tree, and Harmonic Driving - and am currently working on controllers/instruments for kids that we're calling Music Toys. My personal favorites so far are the Sensor Chair, which uses electric field sensing to translate the seated user's motions into sound, and the Singing Tree, which analyzes voice quality to generate a musical aura that matches the "feel" of one's singing. They're both pretty simple, but they feel right to play, and are understandable - more or less - to audiences. The "Toy Symphony" project that I'm working on now is an attempt to bring these diverse strains and interests together: high-end controllers (i.e. a new hyperviolin), Music Toys for kids, and symphony orchestras.

Jean-Claude RISSET

I am still working with the Disklavier, and I envision using Max Mathews radio batons (I have occasionally used the baton to control a Disklavier) and other controllers - not to speak of mixing consoles or the alike.

Michel WAISVISZ

Mainly The Hands and occasionally The Web. These are used for composing and performing a series of compositions, theatrical pieces and dance pieces.

Spin offs and variations of these instruments are being developed for an exhibition of instrumental objects that will travel the years to come and give the audience a possibility to play and perform en discover these new, and some by now "old", approaches. With these instruments I have also started to give workshops for music, theatre and puppeteer professionals and students.

Max MATHEWS

To be expressive, a sensor must measure and communicate two kinds of information. These are triggers and continuous variables. Triggers tell the computer precise moments in time that have musical importance. Continuous variables control many obvious musical factors that must be changed gradually.

The sensor should be able to sense any part of the performers body, but most important are the fingers, arms, and articulators. These body parts provide the fastest and most sensitive channels with which the human brain can communicate with machines in the outside world. Of these channels, articulator communication is the fastest and the least developed.

I believe that traditional instruments and electronic controllers are equal in their sensing sensitivity. I also believe that electronic sounds overcome basic limitations in instrumentals sounds. A violin is beautiful, but it always sounds like a violin. Recently I have worked on a new synthesis technique, Scanned Synthesis, which provides facilities for "massaging" timbre in ways that are new. It was developed to fit both physiological and auditory psychoacoustic abilities and limitations of human beings. Sensors are very important parts of this system.

Musical sensors are obviously a minor use of sensors in the modern world. Almost everything we do from driving a car to telephoning involves sensors. Music is more demanding than most other sensor applications. The techniques we develop for music may be very important for non musical functions

1.3. In your opinion, would you consider the current state of these gestural controllers satisfactory. If not, what are the shortcomings?

William BUXTON

I think that there has been little progress over the past few years. Some of this is due to MIDI and the reliance on commercially available technologies. This is all a double-edged sword. MIDI, etc., makes it easy to hook up new devices. In fact, if you couple MIDI with MAX and the I-Cube, for example, there is a great potential performance space to explore. But on the other hand, we have not made much progress in developing instruments or performance vehicles that demand and can support virtuoso performance. We are still largely making instruments that are on the low end of the scale in their ability to capture the subtle nuances of gesture and skill, and are truly worthy of daily practice, in terms of one's performance skills.

Laetitia SONAMI

I can only talk of mine, I haven't actually tried others but haven't been impressed by any. Now, satisfaction in which aspects? There may be satisfaction in the precision of the controls, but it may not be satisfactory in the gestural, hence theatrical aspect. Or it may be theater and totally irrelevant as a controller, or it may be a great performance tool and yet very restrictive in the conceptual stages of the compositions, and so on. It is a delicate balance, which probably varies with each composer depending on what she/he needs or wants to accomplish. I believe one has to compromise (or "adapt" may be a better word) when using these new instruments, and compromise might be unacceptable for those who wish to achieve "ultimate" control (and this is yet another story..) Now, if you ask me whether the lady's glove is satisfactory, the answer changes every 2 days, whether I am actually using it, or thinking about it ! I let you guess which one is the most satisfactory...

Robert MOOG

No, I don't consider the current state of these gestural controllers satisfactory. The technology is very young and immature. In general, good tactile feedback is missing.

Chris CHAFE

There is plenty of room for improvement in accuracy and feel. The finesse players are accustomed to in playing their natural instruments suggests they enjoy mechanical "gesture amplification". For example, flute embouchure. Very fine physical adjustments have large sonic consequences that can be mastered through practice. A slight roll of the lips or displacement of the tongue can be "loud" in terms of expression. The feel of the instrument also contributes to its control. As we are learning, vibration sense in touch is one mode by which a performer monitors the state of their mechanical musical oscillator. On the cello, that's relayed particularly well to the fingertips on the bow and up where the left hand-fingers stop the string.

Don BUCHLA

I find the current states of the above mentioned controllers satisfactory, but I have the unusual advantage of being able to readily add features or correct shortcomings as the need arises. Both Thunder and Lightning have been around for a decade, so they're now quite stable, design-wise.

Tod MACHOVER

I think that most of the fundamental issues and techniques have been explored and developed in these past years, and that there is a wealth of wonderful work to build on. (This will be seen as a Golden Age of controller design, much as many of the basic electronic music ideas were developed by Stockhausen and others in the 50's). But I bet that the next period will involve lots of tough refinements to bring these controllers the final 10-20% to make them really wonderful. Personally, I think that there is more than enough fantastic sensor and hardware research to build on now, and that the more difficult questions are how to interpret all of this sensor data, and how to map it simply and richly into musical results. I also think that it remains difficult to balance the "comprehensibility" of a new controller with its sophistication or complexity. Things are easy to learn, or for an audience to "read", if mapping between gesture and result is one-to-one, or based on traditional musical paradigms. But part of the interest in new controllers is to extend the range of what is manipulated, whether in the density of sound textures or the complexity of musical structures. It's hard to keep this richness and not lose the audience ("What - if anything - is going on?"), to say nothing of novice performers or kids who have to learn and use the new instruments.

Jean-Claude RISSET

It seems hard for me to separate the controllers from their musical usage. Some are clearly ingenious and well built, but their evaluation is inseparable from their purpose in the musical control. The mapping of musical parameters in terms of the gestural space is critical. Instruments need a lot of practice, but certain shaping gestures require musical sensitivity and muscular suppleness without requiring an overlearned technique.

Michel WAISVISZ

I like to answer this question in a generic way first.

A growing number of researchers/composers/performers work with gestural controllers but to my astonishment I hardly see a consistent development of systematic thought on the interpretation of gesture into music, and the notion of musical feed-back into gesture.

When I lecture about the work we have done at STEIM in this field I'm regularly confronted with responses like: "but that is all very personal".

Fortunately in music a lot is "personal", but "the personal" is not an analytically impenetrable romantic chaos of emotions, feelings and ghosts. One can analyse and create distinct relationships between the character changes of a gesture, and the change of musical content - and context - in a way that ones musical intentions are clearly grasped by listeners. This is of course limited to the context of a certain cultural scene, as is the case with the new music scene anyway. But interestingly enough in recent years I have seen the gestural approach in the independent music scene increasingly reaching across cultural borderlines.

Many of the institutional research efforts however still focus on the recycling of traditional instrumental metaphors and are reluctant to "touch the real thing".

As with most of the new digital media technologies it seems that its creators cannot envision more than a meager recreation of existing concepts, imitation of analogue worlds. New Media, but with old content, in even older contexts.

I do not ignore the fact that the analogue world has a lot to offer, but in our field with the help of new technologies (digital and analogue!) you have the freedom to create any gestural relationship with a vast area of sound. New instrumental objects can be envisioned. One can go beyond the recreation of a sort of clarinet or bongo or baton or a supercharged cello or even joystick.

At present the music instrument industry also shows no guts at all.

I met wonderful researchers from several companies, but they never seem to get their ideas through the filter of the marketing people.

About my own experiences with gestural controllers I can only say that I fight with them most of the time. That's something that almost every instrumentalist will tell. But if you are in the position to be able to design and build your own instruments, and so many interesting technologies pop up almost weekly, you are tempted to change/improve your instrument all the time. This adds another conflict: you never get to master your instrument perfectly even though the instrument gets better (?) all the time.

The only solution that worked for me is to freeze tech development for a period of sometimes nearly two years, and then exclusively compose, perform and explore/exploit its limits.

I suppose that in the years to come the widespread belief in the benefits of unlimited technological progress will slow down. The fact that technology does not really improve our wisdom and does not solve the basic problems that humanity will see itself confronted with will be recognised by many. In pop music, even in the hard core underground of new techno, there is already a longing to return to folk or folk emulation. In the new media culture the quest for new technologies as an inspiration for our living culture will probably lose its present (highly virtual) aura, and people will, as has happened before, crystallize progress into "standards"... whereafter some completely new, or very old, medium will capture our imagination.

2. PERFORMANCE/COMPOSITION

2.1. In your opinion, what makes an electronic controller expressive?

William BUXTON

Its affordances to enable one to articulate subtle nuances of gesture and intent. This is largely tied to the ability to capture and amplify human motor skill potential.

Laetitia SONAMI

From a programming point of view, it would be how tightly coupled with relevant sound parameters, from the performer's point of view, how much pleasure there is in performing with this instrument (pleasure? what a concept!): this may include the idea of "give and take", learning, discovering, mastering the instrument. From the "viewer" point of view, how do the gestures actually relate, not only to the sounds controlled by these gestures, but to the overall composition.

Robert MOOG

For a monophonic or duophonic instrument, one needs a means of varying at least three independent parameters continuously, with rapid, precise tactile feedback that is matched to the incredible response of the hands and breath. For polyphonic devices, percussion controllers, and the like, we need substantial 'total bandwidth' with tactile feedback.

I know that the theremin doesn't provide tactile feedback. The theremin is a special case. It's very expressive, but in a somewhat quirky way.

Chris CHAFE

First, the sound or process that is being controlled needs to provide a sufficiently expressive range of sonic output. Tight coupling to changes in behavior is the key. Of the more interesting parameters in physical models, some are non-monotonic and can be state dependent. Moving a controller to a particular value may not produce the same result a second time. Not a problem in the mechanical world where precision is determined not by exact numerical values but is rather a result of learned behaviors, feedback and tight coupling.

Don BUCHLA

Multi-dimensional degrees of freedom, with resolution and range appropriate to the controlled parameters, and perceptually insignificant lag time. In short, a close, reproducible, expansive coupling of gesture and response.

Tod MACHOVER

I think that any musical instrument has to let you go directly from a musical idea or feeling to sound, without worrying about technique or physical manipulation. In addition, the instrument has to let you achieve the full range of expression - with no time delay or data intermittency - in a specific context. The context is important, since no controller or instrument can be expected to do everything. To make this possible, I usually find that it is necessary to accurately analyze a sufficient but constrained number of features (more than five but less than twenty), and to interpret their interrelationships. I tend to favor controllers that use sensous, resilient materials, such as fabrics, rubber, liquids, putties and gels, rather than the plastics or metals that are often used for computers, cars or sporting equipment. Natural body gesture or vocal production is also wonderful to use, although still tricky to measure and interpret. I also think that mappings have to be defined in such a way as to let the performer think as much as possible about musical and qualitative manipulations, rather than physical interface ones. A great design danger is to indiscriminately add features to measure - either too many features, or insignificant ones - or to treat features and controls as independent and unrelated. The controller has to have an incredible simplicity, even if it is technically very complex.

Jean-Claude RISSET

Again, this seems to me to depend upon the music and what is at stake in the musical performance. Max Mathews has contended that often, in Western music, pitch is the most important and the least expressive musical parameter : in piano works, pitch is specified by the score, and any deviation is considered a wrong note. In the violin, minute pitch deviations are meaningful: if these deviations can be specified by a controller, it may be quite expressive if used with taste.

Michel WAISVISZ

I have a problem to associate a gestural controller in the first place with "more expression". A gestural controller is not just an instrument with more subtle control and therefore more "expressive".

Expression is a notion that historically strongly is related to melody. It is not precisely defined. It is often seen as what the performer adds to the melody, a "personal touch from the heart" to use the romantic description. It's as if it adds an emotional context to melody, sometimes almost as a comment. Some simply say: "It is what makes music musical" - to avoid further discussion!

This century however has seen an immense rise in the notion of "sound". Electro acoustic music has defined itself often as "timbral music", or a "sonic continuum". In jazz and pop it is the "sound" of a musician that counts. "Sample" culture has turned working with "sounds", and the notion of sound as visions, into a highly popular practice.

I think that the main quality of gestural controllers lies in being able to deal with the expression of these new approaches of sound. The gestural controller can be made sufficiently complex in its control diversity, and therefore can optimally deal with expressive timbral control. And with this I mean it can provide the translation of physical intentions of the composer/performer, ranging from utmost fragility to outstanding trance, into a set of related timbral trajectories.

The translation of parameters is often done in a crude one-to-one way. However it is possible to create a network of relationships between a group of control signal generators and distribute a simple finger movement in a complex set of control signals to the music synthesis system. This area is often considered as a technical area. I believe the algorithm for the translation of sensor data into music control data is a major artistic area; the definition of these relationships is part of the composition of a piece. Here is where one defines the expression field for the performer, which is of great influence on how the piece will be perceived.

One of the freedoms in gestural control design is the fact that one can design a controller without being restricted by physical characteristics of the sound synthesis system. Unlike in most of the traditional instruments there is not an unbreakable mechanical relationship between the "keyboard" and the sound producing "mechanism" anymore. Any object filled with sensors can do the job. One is free to implement physical effort at a place in the system where this is not needed at all. Constructing a sequence of changing relationships between the physical object and the musical result can become a composition in itself. The instrument that presents itself toward the performer as a "dynamically mapped keyboard" becomes a character with its own rules, and as a new form of music theatre: ready to be mastered, partnered, domesticated or let free by the performer.

In my work I have always designed instruments that demand a considerable degree of physical effort to be played and at the same time they are able to convey the slightest trembling of the hand. These tremblings are, during a concentrated performance, not just errors, but an integral part of the muscular/mental effort pattern that lays at the base what is perceived as musical expression. Music in a pure conceptual format is only understandable by the ones who know the concepts. Music that contains the physical expression of a performer is recognisable by a larger group through that expressive mediation of the performer.

During inspired performances I have experienced that a mental/physical state can emerge where a fast closed loop establishes itself between the musical intention, the muscular effort and actions, the mechanical response and the sonic feed back and the perception of this whole loop. This happens so fast that one seems to act immediately in sound and not in "terms of sound" and not in terms of "control". Composition/performance melt into a single state of emerging - timbral - expression .

Finally I would like to mention the intriguing addition of "expression" to meta control through the use of gestural controllers.

Meta control is commonly implemented in algorithmical composition, semi-automated conductor systems and other complex control areas such as: theatre lighting or the manipulation of multi-media robots.

To connect gestural controllers to meta control algorithms in music performance is relatively new. To use the composers/performers, traditionally low-level, motoric behaviour to control higher levels of musical organisation (composition, phrasing etc) will wildly expand the notion of expression.

Whether this will lead to the equivalent playing a harpsichord with a shovel or an angel conducting the Crystal Orchestra of the Spheres with the twinkling tip of a fine finger is to be seen.

2.2. What would it take for a new controller to become a "standard" device so that a repertoire could be developed for it (like the theremin and martenot in the past)?

William BUXTON

I would suggest that there are a couple litmus tests. One would be that it is worthy of practice - that the more you invested in learning it, and acquiring skill, the better results you got, and, furthermore, this was ongoing - i.e., the potential of the human gave out before the potential of the instrument. Second, I would argue that such an "instrument" to be worthy of years of practice, must be capable of sustaining a broad range of repertoire.

Laetitia SONAMI

It seems to me that to become a standard device, the controller has to come with a package of sound synthesis software. For instance, one could imagine a palette which would allow the user to map the particular sensor to various dsp. There should be a choice of sound synthesis, so that one would not be limited to a particular "sound". It should be flexible enough that this mapping could be changed during the performance. This mapping should be offered at both the micro level and macro level of the composition. It should be cheap enough so that individual composers could afford it and experiment, and it should not require engineers 24 hr on-line to function!

Robert MOOG

First, it has to feel good. Like pornography, good-feeling controllers are hard to define with words, but you know one when you use it. Second, it has to look good, both for the sake of the musician and the sake of the listener. Third, it has to be matched to the configuration and capabilities of the hands. Fourth, it has to provide tactile feedback, which itself embodies a complex set of relationships.

Chris CHAFE

On the one hand, the obvious things need consideration: multiple copies of the instrument would have to be in circulation and the instrument would have to be practical in the sense that it behaves "like an instrument," e.g., you could simply take it out of its case and play it, reliably. On the other hand, it needs to offer compelling and sophisticated musical sound or control of process. These qualities would attract strong performers and the possibility of works and/or ensemble playing that endure.

Don BUCHLA

Optimal design. Satisfaction of a need with a design that is robust, highly refined, and immune to technological obsolescence. A new controller should offer new modes of interaction, although it may encompass imitative modes as a subset. It should offer simple means to realize trivial musical responses, and yet should be challenging to the point of rewarding years of practice with ever-increasing virtuosity. To encourage repertoire, its future availability must be assured, and it must be affordable and readily accessible to the musical community. The Theremin is an excellent example of a controller that meets all these criteria.

Tod MACHOVER

The glib answer is that our controllers will become "standard" when they are good enough, i.e. optimized to control just the right musical features in just the right ways. In fact, it differs a great deal depending on the kind of controller. Controllers based on existing instruments, or using "natural" human gesture - especially for amateurs - will be the easiest to standardize. Controllers that involve complex, new playing technique (like the Yamaha "Miburi") or really novel approaches to compositional control (like the SalMar Construction) will take a long while to integrate. More basically, there is a major cultural change from instruments that manipulate notes and articulation, to controllers that shape timbres and structures. As far as I can tell, the culture isn't catching on very quickly to this idea, which seems pretty obvious to those of us in the field.

Jean-Claude RISSET

I think it would need both a certain similarity to existing instrumental techniques, so that virtuosos can take advantage of their skills and new possibilities that did not exist in previous instruments. Alternately, a controller that can capture significant gestures could become a standard, provided it could be connected to a musical system that could map it in various ways to musical parameters. But it does not seem that any standard is emerging at that time for a general system: the trend seems to be toward specific individual devices, despite the potential generality of programming. This could change shortly, since general purpose computers are getting very fast, eliminating the need for special-purpose circuitry.

Michel WAISVISZ

I'm cannot relate to the assumption that lies at the base of this question.

Standards are shared illusions with temporary value within confined groups of people in which the persons who hold power have great influence on what is a standard or not.

Standards are not values, but trendy subjectivities that quite often occur at the end of periods of progression.

I do not think that the Theremin or the Martenot can be considered standards. Do we tend to call them so because more than one person performed written melodic scores with them? If yes: many more instruments should apply: a sine wave generator in the first place.

I like the situation in which there are no standard instruments. I encourage musicians to develop their own sets, or their own variations. I like to encourage composers to write for persons and their instruments, instead for instruments exclusively; or better to become performers as well.

It's needed to compose for performance, and not for the "soul" of the score.

I have been amused to hear young composition students mutter about the "unstable and short life cycles" of new gestural controllers. They hadn't yet made a single piece for a present day audience, but were already worried about the hereafter.

I enjoy the fact that our presence in culture is just temporary. To work a whole life in order to be remembered by others is not my cup of tea. "Ars longa, vita brevis" is for carved stone and other slow declining materials, but not for human communication. It helps me tremendously to be biased and short-sighted about this.

2.3.a Can new electronic controllers replace traditional instruments as viable performance tools? Should they?¹

William BUXTON

The question is poorly formed. Yes, the Piano-Forte sort of replaced the harpsichord. But only temporarily. Certainly not since Wanda Landowska. Likewise, cinema did not replace theatre, TV did not replace cinema, and the internet will not replace TV.

1. This question was modified according to suggestions by William Buxton. The reformulated question was sent to all Round Table contributors and can be found at § 2.3b below.

This is not a story of replacement, but rather complimenting. So, perhaps a better question is, will electronic instruments be accepted in the ensemble along side of traditional instruments? Well, the answer is demonstrably "yes." Just look at the electric guitar in big band music, or the Hammond B3 organ in jazz. They have carved a niche, and are just "instruments."

Laetitia SONAMI

I don't think it is a question of replacing. New instruments only replace older ones when they improve their technology, otherwise they offer a new vocabulary, an expansion into new musical territory. On a different subject, traditional instruments have been fitted with newer technology, which allows the performer to expand its performance while relying on her or his acquired skills, and this can be quite successful when the performer has a good understanding of the electronic music vocabulary and is not too naive about its history. On the other hand there is the creation of new controllers which needs to explore new grounds and not emulate old gestures. This is a difficult area to explore, does the controller need a particular "body" so that the gestures are more easily assimilated, or does it become entirely virtual and convince both the user and perceiver of its "physicality"?

Robert MOOG

I'm assuming that the question means: "Can new electronic controllers replace traditional instruments for producing music that was originally conceived with traditional instrument in mind"? The answer to that question is "most likely not". My reason for that answer is that, in traditional instruments, the control interfaces and the tone production means are tightly integrated, and that electronic controllers have to emulate this integration in order to have the musical response of the traditional instruments. If the emulation can be done at all, the cost is generally much higher than the traditional original.

Jean-Claude RISSET

Again the same problem of the demands of instrumental performance : Sloboda and his colleagues have shown that it took thousands of hours of works to anyone to learn to play an instrument at a professional level. A conductor does not need that much technical practice, although he does exert significant musical control. With GROOVE, one can set up types of control resembling that of the conductor : but then the score must be put in advance in the memory of the system, which becomes very different from the situation with a traditional instrument.

Michel WAISVISZ

One just has to study the conflicts Niklaus Harnoncourt encountered when using what he considered "authentic" instruments to realise that the notion of 'traditional instruments' is not a very stable one. Traditional instruments have been recreated all the time and changed according to trends that depict what is "authentic" or "just" at that time. Even the grand piano underwent changes not long ago. The concepts of traditional instruments have always been, and are, dynamic.

Many of the instruments that we now call traditional are known from the culture of the symphony orchestra. The symphony orchestra for a while became a metaphor of a well organised, stable, society. The instruments all had their place and the instrumentalists had specific roles in that organisation.

Society is not that stable anymore and definitely not organised as the symphony orchestra still is.

There are now many new ways, beyond the symphony orchestra, in which a composer/musician can independently develop his/her position in the musical world.

The musician of today, equipped with gestural controllers and sound synthesis instruments, and good amplifiers, can produce the sound impact of a symphony orchestra with the wave of a hand. The musician is now free to change musical roles all the time. An ensemble of musicians can play one instrument together, musicians can re-use each others sounds, and compose/perform networked on stage or in different places in the world at the same time.

Instead of becoming "viable performance tools" in the traditional sense, the new tools do not need to prove themselves in terms of the cultures of the past. They should be judged by their function in our present days new cultures.

2.3.b Can electronic controllers become as viable performance tools as traditional instruments?

Laetitia SONAMI

Definitely, as far as I am concerned, it is like driving a Porsche or staying with a 2cv! (OK, I am kidding, I do not want to upset the virtuosi). The question may be more whether compositions "born" from the use of these controllers are viable? I do not think that one should doubt the necessity for electronic controllers, this is unquestionable as we have now a complex musical language born from digital technology. The unfortunate aspect which I still do not understand, is that we never tried to develop the interface. There is may be an arrogance, an inflation, a selfishness? in thinking that we can create anything we want, but do not have to bother about how we will use it, how we will communicate with it, or how we will share it with others.

Chris CHAFE

Absolutely, and for my part they already have. I often play the Buchla Lightning in conjunction with my bow and it's become integrated to the extent where it's become a part of my instrument. If the question is, will the cello part go away? -- it hasn't yet, for me. But, we're making real gains in human-computer interaction and there's an emerging world there to explore.

Don BUCHLA

(I'm glad you re-phrased this one.)

My answer is most definitely. For many, they are right now. As far as widespread acceptance, it will take time; time to recognize their right to exist, build their population, develop repertoire, and broaden the musical aesthetic. The evident co-dependence of these variables serves to extend this delay.

Tod MACHOVER

It depends on the type of controller. I personally think that the most effective controllers will be the most radical ones, the ones that least try to imitate traditional musical functions but add new possibilities to our music-making. Timbre and structure-shaping seem to me to have the most potential, as do controllers that interconnect a number of performers in a single musical activity or mix and blend widely diverse sonic sources. Traditional instruments cannot shape and manipulate these parameters on the scale possible with new controllers, computers and sound synthesis/processing devices. When these musical potentials are combined with elegant, sensuous interfaces and intuitive, rich mappings, the result will be very seductive. Our standards and reference points for traditional instruments are so highly developed, that it will take a long time for controller extensions to be accepted as sufficiently refined — especially from an acoustic standpoint.

2.4. Do you ever use gestural controllers outside of performance situation, for instance, as compositional tools in the studio?

William BUXTON

Yes, including animation, where MIDI controllers support what might be called "desk top performance animation" or "Desk top motion capture".

Laetitia SONAMI

This is an interesting question, I do not believe that one can compose with a particular controller in mind, and not embed this controller in the compositional process. It would be like writing a vocal piece not knowing about the voice. There is a process which goes back and forth between composing, adapting the compositional ideas to the controller, (if one is technically inclined: adapting the controller to the composition), and allowing the controller to bring in its own vocabulary, its own logic and "demands" to the composition. So this may be frustrating as it may require compromises, but if one is intent on doing live performances, it is part of the territory.

Robert MOOG

I don't. I'm not involved in studio composition.

Chris CHAFE

My studio work involves a great amount of real-time capture from performance of sounds and processes. Gestural controllers figure in both direct and algorithmically-derived music which is then editable.

Don BUCHLA

Not much studio use, personally. I have seen them effectively applied to control of lighting, video, and sound sculpture.

Tod MACHOVER

As mentioned above, I often use gestural controllers to introduce non-professional musicians to creative activity; I think that there is enormous potential in this field. My real dream would be to have a gestural control environment that I could use to develop new pieces in my studio, to improvise and compose with. In fact, that was the biggest reason that I got involved with developing gestural controllers twenty years ago. But the truth is that I haven't yet found or developed a system that felt sufficiently powerful in this regard. The reason is simple: So far, in order to design controllers that "behave" the way I want, I carefully imagine the type of music that they will produce and construct the analysis and mappings that will make this possible. By the time the controller and hyperinstrument exists, I have already designed the type of music it will make, to a large extent. In fact, the experimentation has often taken place in my head. I often find that the more constrained the instrument is, the finer the expressive variations that it can produce. However, there have been several hyperinstruments that I have developed that have allowed me to manipulate and experiment with musical materials in a way that I couldn't possibly have done without them. I think specifically of mixing and processing hundreds of samples simultaneously with the Sensor Chair, or creating complex, evolving timbres and harmonies with the Singing Tree.

Jean-Claude RISSET

Yes, when I get a chance.

Michel WAISVISZ

I use them as:

- Compositional tools; to play and organise, save and reselect and order sound sequences.
- Navigation tools; to find my way in soundlibraries on stage and in the studio.
- Programming tools for editing sounds in MIDI synthesizers and changing the parameters of for example the LiSa software.
- I experimented with them for writing emails while in hotel rooms (using macro's).
- I have used software to mix-up the key relationship with the MIDI commands and to play without knowing what the result will be. This I used in the process of: "Oracling"; just playing, without knowing the exact output beforehand and recording and using the good bits as an inspiration for new pieces.
- At STEIM we also created instruments for disabled people and for a wide variety of therapeutic projects.
- I find specially conceived low-threshold controllers extremely helpful in education: the web, the MIDI conductor are successfully being used to help students through a hands-on approach; intuitively find their way in the world of sounds.

2.5. How would you characterize their role in this context?

William BUXTON

Much of music and animation composition/performance are about changes in time. These are often more easily articulated by demonstration (performance) than by description (notation/composition). The technologies expand our palette. While we don't use every colour in the "palette" for each "stroke of the brush", nevertheless, it is good to have the expanded set of choices, each with its own idiom.

Laetitia SONAMI

Which context are you referring to?

Chris CHAFE

The controllers are used in the same way whether the result is for later editing or is immediate (on stage).

Don BUCHLA

As real time instrumental resources, gestural controllers play a similar role in the studio as on the stage. As control devices for computer based composition programs or other media, they take on new roles.

Jean-Claude RISSET

If I can use a control and vary the performance practice, this becomes a source of material, variations, and possibly of ideas.

This need not always be done in real time. For instance, in the eighties, I have used MIDI keyboards to play a sequence of notes, then these notes are mapped into the non-tempered pitches of a table selected in advance to control MUSIC V synthesis.

Michel WAISVISZ

We were able to develop a more natural "feeling". This creates a more intimate relationship with the instrument. People experienced this as "warm machines".

The controllers that I use also liberate me from the usual chair/desktop setting. It is great to leave the "desktop world" and to be able to walk while you think and work.

Also: being able to change the functionality of a tool gives you a surprising and inspiring way to reflect on your work methods in general. Changing old gestures can be liberating, confusing and forces one to review its habits. Lazy as I can be, this has for a long time proven to be a good strategy to wake up and rethink the strategies of work and life.

3. INTERDISCIPLINARY CONNECTIONS

3.1. Regarding the development of input devices, what can gestural control gain from specific fields such as HCI, ergonomics, experimental psychology, cognition?

William BUXTON

Interesting question, and one where i would give a different answer now than 10 years ago. I have recently been arguing that HCI and ergonomics are "failed sciences". Why? If we look at the design of the Personal Computer, it can be argued that there has been virtually no significant change in the design since the introduction of the Xerox Star in 1982. Now note, that this product (which commercially introduced, widows, icons, GUI, the mouse...) came into being with the benefit of virtually NO HCI or ergonomics literature. Yet, since then, you could pile the accumulated literature over 10 metres high, and yet virtually NONE OF IT has had any impact on design in practice. In a still photograph, a Xerox Star is indistinguishable from a modern PC. The science has failed.

Why? Because it is not a design-based discipline. Virtually all of the people who made contributions to electronic music instrument design were actively involved with musicians, or performers themselves, and they took the approach of a designer, not a scientist. Yes, they benefited by science, but the approach was not scientific. It was far more closely rooted in the practice of industrial design or architecture.

Laetitia SONAMI

Probably a lot, but I am not an expert in any of these fields, so I cannot give any intelligent answers. The main problem I can see, or have seen so far, is one needs to adapt this knowledge with an understanding of the new environment in which it will be used . Experts in these fields are often not the actual users and may not even care or worry about applications in the "real-world" in general. That is why we are still using simple keyboards and mouse after, how many years? Of using computers.

Robert MOOG

The field of ergonomics examines the factors that determine comfort and minimize fatigue. These factors are of prime importance in good controller design.

Chris CHAFE

Controllers for music are often cut from the same engineering "cloth" as general-purpose controllers. Advances in allied fields are especially applicable when they bring the user / performer closer to sophisticated and intuitive control of a task.

Don BUCHLA

Many considerations from the above-mentioned fields (and others) are important to good controller design. But I would not claim that it takes an expert in ergonomics to invoke good ergonomic principles.

Tod MACHOVER

I guess you never know where good ideas will come from. All of the fields mentioned have produced their share of insights that are worth being aware of. But like music composition, instrument and controller design is a creative art and doesn't easily follow prescriptions. The danger with prescriptive sciences is that they tend to define a territory where things are supposed to happen, a kind of normalcy. Good, integrated designs - whether of artworks or of great tools - tend to push past what was assumed to be possible, tend to arrive at startlingly simple syntheses, and just plain to propose solutions for problems that no one may have even considered. One of the most exciting things about the current development of gestural controllers for music is that it is so often driven by creative individuals who have something unique and important to express as artists, and will grapple and bend materials and rules incessantly until that vision is realized. The results may not be so easy to standardize, but this process does lead to unpredicted scientific developments (since no one else would have asked such crazy

and demanding questions), to surprises for the human factors community, and to very exciting controllers that are art works in themselves and often an inspiration for interface designers in other fields.

Jean-Claude RISSET

It can help, in particular to avoid dead ends - but it can be the other way around : in the past, the insight and ingenuity of musical instrument developers has often been an inspiration for the above fields. A good pianist sight-reading accomplishes an ergonomic feat, even though he may never have heard about ergonomics : but ergonomic requirements have been taken in account implicitly in the design of the keyboard, the notation, etc.

Michel WAISVISZ

With some exceptions it has struck me in conversations with specialists from some of the sciences mentioned above that they often merely verbalise a number of aspects of what I already knew "physically". It was understandably the knowledge of the spectator that they conveyed.

In recent years I have had the desire to learn about the inside of performance, to deepen the knowledge of the maker, I wanted to concentrate on the understanding of the multiple forms of consciousness during performance. This is an inside journey. The vision of the spectator on this activity can be analytic - in the wrong way by pulling the performer back too much to the outside appearance of performance. For this purpose the immediate spontaneous response from the spectator is more valid, more connected with the experience the performer just had. Scientists, (for good scientific reasons) very often have lost that ability in their professional role. Friends in the HCI sector however have followed our work with great interest, notwithstanding my relatively negative attitude.

These remarks here are not meant as generic as they may sound; they are to be understood in the context of the work I undertake these years. More into the music, integrating technology in an intuitive preparation of a new series of works.

About ergonomics: ergonomics for musical instruments is a paradox. We need instruments as obstacles, as challenges. Mentally and physically mastering these is one of the main ingredients of musical tension in performance.

No virtuoso violin without a pain in the neck.

I cannot be other than very conservative at this point. I do not get any excitement from a performer numbly toddling a mouse or occasionally pushing a key awkwardly posted in a chair. Neither do I enjoy the by now traditional bunch of DJ's jumping around and at regular intervals just pushing a button or hitting a slider.

I love to see a performer work him/herself up into that decisive set of gestures; like a billiard master after a long sequence of preparations successfully hitting a whole field of conditions with refined, complex but unidirectional effort.

I'm happy to see that in the world of electronic music performance the practice is improving through the growing use, and sophistication, of gestural controllers.

If some institute will foster the development of ergonomics towards "the ergonomics of desirable effort in musical obstacles", I will generously contribute my experiences.

Max MATHEWS

Interdisciplinary research is critical in making progress toward expressive control of live music. The development of new sensors is a challenging problem in physics and good physicists are needed to make significant progress here.

The choice of what parts of the human body to sense is a profound and fascinating psychological and physiological question. Sensing is not a one way communication. We have recently realized the importance of haptics. Active sensors that can exert forces back on the performers have added a whole new dimension to expressive control.

3.2. Is there any sense in adapting scientific methodologies from other disciplines like HCI, etc., for developing controllers, or do musical controllers require idiosyncratic approaches?

William BUXTON

I question this. What has the HCI community contributed to their own world in the past 20 years? Precious little. I know, as one of the key "contributors." Things will move ahead from those who have a balance in their insights and technique in design and technology (and its affordances) on the one hand, and appreciation and understanding of music performance on the other. You need eyes, ears and imagination.

Laetitia SONAMI

I think they require idiosyncratic approaches, but that does not exclude infusing methodologies from other fields. Nothing should be excluded if it proves itself useful. Again, whoever develops controllers, need to understand their application not from a theoretical perspective, but actually from a practical perspective, which means they should use them, and also enjoy them... (again, some pleasure is necessary in all this).

Robert MOOG

I think that musical controllers tend to require specialized development approaches. Not necessarily idiosyncratic, but specialized. You're dealing with the hand-brain system, a complex, sensitive, fast-moving system. You're also dealing with the aesthetics of performance, - how you integrate a given set of gestures into the *motion* of performance.

Chris CHAFE

Musical controllers provide a great testbed for advancing knowledge in these allied disciplines, so it cuts both ways. The study of haptic devices in music is shedding light on how touch is especially apt for time-based control tasks (as opposed to spatial). To probe more deeply such a question requires adopting investigative methods which are appropriately scientific.

Don BUCHLA

These approaches are not mutually exclusive. A new controller may be inspired by an extant musical instrument or technique. It may result from a desire to exploit a particular gestural set, perhaps unavailable to the acoustic domain; or it could be inspired by some sort of sudden brain flash or weird dream. Application of scientific methodologies may be essential toward refining and optimizing the final product, but don't belittle the importance of intuitive and quirky thinking.

Tod MACHOVER

Although, as I mentioned above, there are always good nuggets to be found in any discipline (and you never know which not-so-great idea will jog your imagination in just the right way), one has to be very careful not to appropriate findings from one discipline to another without fairly liberal translation and filtering. Music since World War II has often suffered from applying the latest results from any number of scientific disciplines - in a kind of "science envy" - without much measured scepticism. It happened with number theory, linguistics, morphogenesis, chaos theory, etc., so we have to approach the use of HCI and related findings very carefully. I think that it is at least as useful to study successful interfaces in unusual places - like toy design, fighter plane or automobile design, commercial packaging, telesurgery, videogame interfaces, etc. And many of the questions we face regarding the analysis of natural human behavior are being explored in interesting ways in the perceptual/affective computing and gesture recognition fields, so there is research there worth following. But I think it's important to remember that we musicians deal with some of the most profound and subtle human capabilities - emotion, expression, gesture, communication - all of which are still far from being fully explained in theory. I think that it's quite likely that in following our creative intuitions - through whatever combination of methodologies each of us prefers - and by designing visionary controllers to produce and perform exciting, new music,

we will have uncovered important new principles of ergonomics, identified significant categories of measurement and analysis, established new standards for gesture interpretation and mapping, and in fact led the way - rather than following the pack - to a new understanding of expressive interfaces. And of course we will have raised many new and tough questions, which good work always does.

Jean-Claude RISSET

Both. Probably control gestures can be classified in ways that do not depend upon the field of application : Claude Cadoz has proposed such a classification. On the other hand, consider musical pitch, for instance : octave similarity is strong, which shows clearly that pitch should be treated simply as a linear parameter.

Michel WAISVISZ

The people that I learned most from were: puppeteers and some sports people.

Puppeteers deal with gesture as a life-giving force all the time. Modern puppeteers are able to give life to the simplest objects by finding ways to let the objects work themselves and just interfering with gesture where it is needed. I have always unconsciously treated my sounds as being my puppets, until two years ago at the Institute International de La Marionette at Charleville-Mezierre (Fr) puppeteers made me aware of our mutual interests. Now I know my sounds are my puppets; and I have to share my life with them. I will start collaborating with puppeteers and am looking forward to the results of this collaboration.

Some sports people have given me insight in concentration matters. Especially the effects of concentration and over-concentration (temporary stress) on muscle control. I have loved the old golfer who explained me that in order to make a natural swing (unobstructed by muscular stress) he used to sing while hitting the balls. This led to a distraction and through that: the lowering of unconscious and disturbing muscle activity. This gives such a nice insight in the effects of the vocal side-activities during performance of for instance Glen Gould and Charles Mingus (he used to talk a lot while playing).

I tend to avoid the scientific methodologies in periods where my main activity is composing/performing because of the way they translate in practical advice. Scientific advice has often come in the form of lists of facts and derived rule-like strategies. Preparing oneself for work in the mental/physical performance area demands a method of communication that is geared towards improving musical awareness and building up sonic and interhuman consciousness. The old greek priest running the business at Delphi would have been the right coach. But if he would be still alive he would probably have been bought up, cloned, "scientifically" reprogrammed with and sold to the masses by a company in Redmond.

4. FINAL WORDS

4.1. Are there any points that we haven't covered? If so, please address at your leisure.

William BUXTON

Perhaps we are looking under the wrong stones in all of this. Perhaps at this stage the key question is not about performance, or instruments, but simply, "Where is new music today"?

It is increasingly difficult to hear any music today that could not have been written a decade ago (or two). Much of the progress in technology has been to make it easier to make yesterday's music today, as opposed to tomorrow's music.

But where is the vision of tomorrow's music to come from, or is this even a vision worth searching for?

Perhaps some new ways of thinking about technology and performance will provide the catalyst to some new insights. But for me, for the most part it is all "déjà vu", or should I say, "déjà entendu"?

Therein lies the real challenge for those picking up the gauntlet left by us "old guys". I welcome the chance of being surprised.

Laetitia SONAMI

I think they require idiosyncratic approaches, but that does not exclude infusing methodologies from other fields. Nothing should be excluded if it proves itself useful. Again, whoever develops controllers, need to understand their application not from a theoretical perspective, but actually from a practical perspective, which means they should use them, and also enjoy them... (again, some pleasure is necessary in all this).

Chris CHAFE

The bottom line for me in my current music is synthesis control, especially controlling physical models of the voice and bowed string. I find a need for persistent synthesis voices, turned on once and controlled via complex parameter trajectories. These can be performed either direct in real-time or with trajectories derived from physical models of articulators which are themselves responding to real-time gestures. The gain in expressivity is partly due to instrument models which render quite fine sonic detail including state-dependent behavior. There is also an appreciable win in the range of articulator "messages" that are imparted via the sound. I enjoy the fact that there exists an entire dictionary of bowing terminology and that even strokes of the same kind will carry meaning about the phrasing context. To get that kind of complexity means rethinking schemes by which synthesis and its control are linked. The happy part is that it's actually turning out to be a simpler control design than an endlessly tweaked "NoteOn" paradigm which never (in my work) quite escaped the realm of playing sounds from a library.

Tod MACHOVER

I think its important to remember that a gestural controller needs various elements, working together flawlessly, to be effective. The physical characteristics of the controller, and even its brute measurement and sensing capabilities, are only part of the picture and not necessarily the most significant part. Real breakthroughs will come with innovative ideas about what is truly central and necessary to measure in expressive musical behavior, how we interpret and map that information, and what music we make with it. I'll always vote for musical impulse and vision being the driving factor in such design, and that's what I think we should emphasize going into the next century.

Jean-Claude RISSET

I think that gestural controllers are important and useful for both composition and performance, but they do not necessarily require real-time for either function. Manufacturing of recordings is already an example of "non real-time performance", requiring a lot of editing, mixing. It is conceivable to design

means of performance using the specification of curves and functions, that could be used by physically handicapped people. This is not to lessen the importance of gestural controllers : their use should be tailored to the job and to the user.

Michel WAISVISZ

The more real interactivity is added to the systems that we live with in daily life the more we have to deal with the notions of performance. Every "suser" becomes a performer somewhere, whether it is dealing with coffee machines, installations in museums, setting the clockradio before falling asleep, buying tickets or browsing the internet on a mobile phone in public.

The music community has built up a tremendous amount of knowledge about performance and the relationship composing/performing, especially the transferring of emotion through sensitive instruments. Many of the music research institutes and smaller organisations are increasingly confronted with bad financial support and/or budget cuts. Some have to fear for their existence.

I think this is a tragic paradox and I hope an awareness about the value of this knowledge will come in time.

I like the emergence of a new generation of performers. At STEIM, four out of ten of the new applications for research en development projects come out of this group, somewhere growing between academic/electro acoustic and DJ-culture. With a strategy to be authentic, while maintaining a connection to a certain "scene". Searching without dogmas in the whole gamut of electronic music instruments in order to stick together their own set.

They deal with attitude; conceptualism is over. Their goal is to convey intention and simply use the tool that connects with their attitude and intention. Almost like wearing the right gyms.

So: gone is the systematic analytical approach towards the development of generic instruments. There is historical awareness, but preferably not beyond 40 years back. The instruments can be new, or deadly old. They may even not work properly. They might be merged with another instrument; they can be cheap mass production gadget instruments, etc.

Amongst them is a growing interest in gestural controllers. They want to move in front of the (DJ) table; stand in the light. And add sweat to the performance like some of their dancing audiences do.

And they want to move also to the concert situation; middle size halls in non-art buildings and friends who listen. Becoming international stars for small audiences through mediation via the Internet. Have the appropriate gear, not necessarily the newest, fastest or most expensive gear.

It's as if the music finally starts to count.

Max MATHEWS

I think the questions Battier, Rovin and Wanderley have posed to the round table are excellent. They focus on the really important problems in this field. Also the choice of sensors as the subject of the round-table is right on target.

Sensors for music control have long been neglected. I feel it is the area the greatest advances in electronic music will come in the next decade. It has been a pleasure to participate in the round table.

