

The Next Music - MAPPS

Using Technology to Extend Virtuosity for a 21st Century Music

Keith A. McMillen keith@beamfoundation.org

2011 will be remembered as the year 21st century music started. History marks the inception of a new art form if it provides significant innovation and delivers long-term impact.

The integration of technology with traditional musical instruments has been long sought. This document describes the tools, techniques and motivations that are providing a fresh creative landscape for demanding composers and respected performers. We are seeing results from what is growing to be an accepted system for a revolutionary new musical style.

Time for a change

Where does Western concert music go next? Let's look back at some specific musical events that shaped previous centuries with originality and impact:

- 1912 - **Stravinsky** premiers *Rite of Spring*
- 1823 - **Beethoven** writes 9th Symphony - *Ode to Joy*
- 1722 - **Bach** composes *Well Tempered Clavier*
- 1607 - **Monteverdi** invents modern opera - *L'Orfeo*

We see that these World-changing compositions occurred within the first decades of their centuries. Each of these compositions was unique in its use of increasingly sophisticated musical elements and reflected the times in which it was created. We are ready and waiting for what this century will produce to mark our contribution to Western musical evolution.

What is needed to create a New Music?

Music is an abstract art that relies on technology or instruments to bring it into existence. Since the 1600's these instruments were of a sufficient refinement that a non-vocal, purely instrumental music with its own rules and syntax, could engage listeners and flourish.

Any next music will require an integration of today's technology built on the tradition, rules and virtuosity of previous musical periods. Western music aggregates past accomplishments and builds on them.

Any new music must survive over time, be playable by others and satisfy some fresh needs and means of expression.

The desire to create a new music must be prevalent and encouraged by the environment. The feasibility and practicality of taking this next step requires a coherent effort that can envision the demands of the musical endpoint while delivering the tested components required to make such a music workable. I believe the vision is finally clear and the necessary elements are now available to launch a new musical style. One that combines what is unique from our era, builds on the past and advances the elements of composition, structure and interaction to a significant and inspiring new level.

Technology Changes Art

Art is subject to the talents of its creator and the facility of the available tools. The Baroque period (1600 - 1750) witnessed a sweeping revolution in the quality and usability of musical instruments. This era saw the rise of rationalism and the embrace of science and its resultant advances in technology. The refinement of gamba into violin along with the rise of the harpsichord and church organ determined what music would be created. The characteristics of these new instruments shaped the way composers related to their compositions and encouraged new musical conventions.

Think of the fugue and its interplay of entwined melodies. Each of the voices of a fugue has similar weight and importance. The harpsichord and organ were the first instruments to afford comfortable access to all notes and, inherently, had no dynamics. Therefore every note from these instruments, by design, had similar loudness and importance. Before this time notes got louder when you played them harder. The new instruments needed to exist before composers could possibly perceive these characteristics. The technology allowed, if not created, the art of counterpoint.

- 1600's: New Instruments = Baroque
- 1750's: Pianos = Equal Temperament
- 1820's: Stable instruments = Symphonic Orchestra
- 1890's: Banjo & Saxophone = Jazz
- 1950's: Electric Guitar = Rock and Roll
- 1960's: Computers & Synthesizers = ?

While pianos matured in the Classical era (due to improvements in keyboard escapements and metallurgy), explorations in tuning created equal temperament. Equal temperament (an even spacing of frequencies between all of the notes)

allowed composers to move to any of the 12 major and 12 minor keys at any time without concern for uneven dissonance. Modulation among keys lifted music out of the modal restrictions present since Pythagoras.

Further technical refinements in the brass and woodwinds allowed large numbers of these instruments to be played together in tune and have full chromaticism (ability to play all 12 notes). This advance, along with the prior standardization of violin technology (1620 - 1748), gave us the Symphony Orchestra, which has remained unchanged since the mid 1800s. The Symphony Orchestra has been the big gun of Western concert music for 200 years.

Other advances in instruments gave us the Saxophone, banjo and electric guitar. While these new instruments triggered the creation of Jazz and Rock and Roll, the doors to the Symphony hall remained closed to any new additions. Compositional growth for Western Concert music came from other inventions within the syntax and elements governing the arrangement of tones and variations in the timbres of these concert instruments.

The Studio as Instrument

Advances in computers and synthesis have given us a wonderful half-century of experimentation and creativity. Numerous compositions have captured ground that was new territory for the sonic empire. These same advances gave us the perfection of audio recording.

The “studio as instrument” as musical concept arrived shortly after WWII through the work of Schaeffer and Henri. The world was introduced to Music Concrete - the

cementing of everyday sounds in a specific order. While Music Concrete and subsequent studio pieces gave us much to listen to, they left us with nothing to perform. There is no legacy of playable works, no repertoire, no ability to have musicians interpret the score of the composer in a live concert setting.

Many consider the work of George Martin and the Beatles to represent the apex of “studio technique”. This recording high also contributed to the demise of the group, as they could no longer perform their music in concert. The performance of live music is what originally allowed the group to perfect their sound and writing, yet this trade-off of complexity in favor of live performable music contributed to their undoing as a viable musical ensemble.

Since then, numerous composers have submitted to the devil's deal of an increased sonic palette over any performable work. A recording is their legacy. I had the pleasure to meet Gyorgy Ligeti in the early '80s and asked him why he does not compose with computer or electronics (he did create two tape works in '57 and '58) and his quiet response was, “I want my music to be playable after I am dead”. He did not mean the playing of a recording.

Today's compromise is the live performance of an instrumentalist over a recording crafted in the studio. Some musicians also “perform” recorded music, but this is found mostly in improvisational settings with few compositions joining the repertoire.

The Instrument as Studio

With new timbres afforded by new technology, many composers have dipped their toe in the water, but after some attempts withdrew. This includes some of our best composers such as Terry Riley, John Adams and Steve Reich who have explored electronic based music but have retreated to the performable climes of traditional instrumentation. Even Larry Polansky, a pillar of the computer music scene, has transferred his talents to writing for traditional instruments. Composing is just too much work to create a piece that will only be played once.

We are completing work on the last elements that embody the “Instrument as Studio”. This work enables artists to create, score and perform a piece with the same access to the modern sound palette, but for live stage. Again building on the accomplishments of the last 50 years, but advancing the medium to where studio complexity can be achieved in real time in a composition that is playable and durable in much the same way as other instrumental music.

So what makes music “Classic” ?

While the term “Classic” has a specific meaning in the world of music (it is the period that comes between the Baroque and Romantic era (1750 and ~1830)). It is also colloquially applied to all Western art music. No matter, as the general meaning of the word conveys the mark of high standard or quality. So what makes music classic? I propose:

- Survives across space & time
- Inspiring and learnable instrumentation
- Consistent and persistent notation
- Accessible to composers, performers & audiences
- A growing lively repertoire

I live in the San Francisco bay area. If I want to hear a Schubert String Quartet I have two choices this weekend. I do not have to live in Vienna or in the 1800's. Classic music survives both space and time.

Because the Schubert quartet uses instruments available to many people who have become skilled in their art from studying with one of many teachers and is in a standard readable form of notation, it is classic. It is available for people to study and audiences choose to hear it played; it is part of our musical heritage. There are other pieces that can be construed as similar either from the same composer or contemporaries. It is classic.

I am truly pressed to think of a piece of music using computer technology in a significant way that can lay claim to any of the above attributes. Most pieces are written for a select performer and a specific performance and the composer usually needs to be present for the piece to occur. There may be a recording. If the composer himself tries to perform the same piece, even a few years later, he is plagued with compatibility issues, trying to find working hardware or a musician who is capable of reviving the performance.

So why is modern Western concert music in such a bind? First off, most people will probably not acknowledge there is a problem. We keep getting "new music" such as a restaurant makes "new food" when it offers today's meals. Yes, there is performance music being made that has not been heard before. But does it explore new elements of musical structure or deliver a fresh perspective on innovative directions in composition?

Notation and Instruction

Western music grows because of the DNA of notation. The notational system in use today is a thousand years old and comes to us from a single person - Guido of Arezzo. Guido codified (in his *Micrologos*, published in 1026) the use of a staff of horizontal lines with a single symbol representing both pitch and duration. The do-re-mi syllable approach we learned early in life is Guido's doing. Motivated by the need to create more singers of Gregorian chants, Guido was able to teach monks in six days what used to take six months. His system works and is why we have, literally, a millennium of musical history.

The importance of a robust notational system cannot be overemphasized. The ability to gain mastery over an instrument requires a repertoire - pieces that can be practiced and critiqued by comparison to other players, usually a teacher.

Notation is the transport mechanism used by a composer to share his creation with audiences via the performer. It is as important to music as the written word as literature is to society. Without a standardized notational system, a composition would have a small diameter of influence - such as an amusing family story.

Notation has grown and changed with the needs of the composer yet remains playable by anyone who reads music.

Evolution of variables in Western Music

Just as biological organisms evolve to more complex forms, the elements of musical style have grown significantly over the last 2500 years. Starting with Pythagoras' exploration of the ratios of the harmonic series, we have seen an ever-increasing complexity in the elements of music.

Ancient music through the first millennium of the Current Era was based on simple

- Ancient - unison 500BCE
- Plainchant - modal 600CE
- Sacred - polyphony 1000CE
- Baroque - counterpoint 1600CE
- Classical - homophony 1750CE
- Romantic - structural 1830CE
- Modern - atonal 1910CE

melodies and rhythms. These melodies were initially sung in unison advancing to simple modal harmonies in the early dark ages. Church or Sacred music expanded modal music using polyphony to place voice upon voice.

Melodic complexity reached a celebratory zenith during the Baroque period where the mathematical nature of music was fully explored through counterpoint. Following Baroque, the

Classical style took advantage of the freedom of modulation made possible by equal temperament. This style, known as homophony, added tension/release caused by key change and presented itself as a lead melody on top of moving chords.

Romantic music saw the rise of structures beyond the fixed four movement symphony or three section concerto. Arias and Fantasies freed the composer from the expectation of form. Modern music embraced the democratization of the 12 degrees of the scale known as atonal music and abandoned any strictures of form that lingered from previous times.

The last 100 years have seen, rather exhaustively, what permutations can be had from 12 tones and rhythmic variations that sometimes fall below the threshold of human perception. Unusual timbres have been evoked from all parts of instruments using over-blowing, banging on tops and pegs, whisking the bow through the air - anything to make a new noise. I believe composers have been admirably thorough in their resourcefulness in eliciting new sounds from old instruments. But that thoroughness has left little ground for exploration. As Phillip Glass said, "If you are not exploring new technique, you are not creating something original" .

Tick Tock, Flip Flop

I have attempted to outline trends and dependencies of Western art music as well as the limitations of recent applications of technology. However, forward we must go. So what is next and why haven't you heard about it?

Computers are the ultimate compositional tools. Music is not math, but it is based on math. The workings of acoustics, melodic and rhythmic structure, and the ability to literally produce all possible sounds - computers extend the mathematical foundations of music to a logical and flexible new domain. Computers are the best tool man has developed to date for manipulation of the numbers that can represent all we know about music and make it responsive to our expressive intentions in a new and meaningful manner.

Just because this hasn't happened yet does not mean it cannot or will not. The piano took over 150 years to go from "a curiosity that will never replace the harpsichord" to a concert instrument that has become the workhorse of western music. The violin was "a rude instrument most appropriate for dance" until Amati perfected the techniques of violin making. Technology takes some time to knock off the rough edges of a new inventions and endear itself to people in general and artists in particular.

Think of the revolution of the digital camera: a gimmick in the early 1990's - low resolution, power hungry and the size of a brick. Now all we have are digital cameras and mostly in our phones! The last KodaChrome film was developed in December 2010 at Dwayne's Photo in Parsons, Kansas. All it took was twenty years for digital technology to mature to the level where it became the standard.... about the time it takes a freshly made

violin to start “opening up” .

No new Instruments, just new Connections

There will be no new instruments. Believe me. People have tried for a hundred years. Even the saxophone was a shotgun wedding between the woodwinds and brass. The electric guitar is frets on a radio. Possibly the time for instruments, like the giant sequoia, has come and gone. We use the QWERTY keyboard and the inverted number pad even though they are not optimal and better alternatives exist.

- Start with known user skills
- No new instruments
- Extract information from performers
- Enhance, connect and control:
 - a. Score to Instruments
 - b. Instruments to Score
 - c. Instrument to Instrument

We know the instruments we have. No new human input apparatus for creating audio has a repertoire, pedagogy or a population with the virtuosity earned at the end of 10,000 hours of study. We have numerous instruments that are struck, plucked, blown, bowed and fingered while held in a variety of ways. Practice trains the performer's muscles, memory, and soul to create a bond that transcends simple intelligence. The instruments we have

work; let's build on this.

Live “Classical” music is the ordering of sound moderated by performers and their instruments according to a score. Due to the nature of previous instrument technology, this has always been a feed forward system where the score “controls” the musician who “controls” his instrument to make sound.

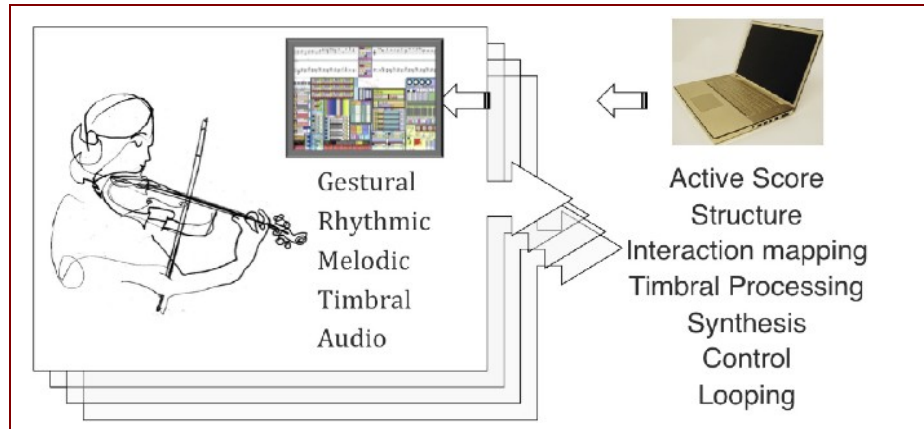


Kronos with K-Bows in hand, with me and Douglas Quin in the middle.

If we were to input the gestures of the performer and the sound from his instrument into a new technology system we could explore new relationships. The score could change the instrument's sound directly. The instrument could affect the score. And, most exciting, the musicians could affect each other.

The Score

What I am promoting is the adoption of a new active notation system (named MAPPS - Musically Accumulating Persistent Performance Score) that embeds all of the audio processing, control mechanisms and sound production into the score itself. Imagine a musical version of a computer document where you can click on a word or embed a movie. This was magic 20 years ago but is now expected of most of the things we read.



The components of such an active score system and the means to extend instruments to communicate with it now exist. I have developed sensor bows for all the stringed instruments as well as an audio acquisition system that can communicate with computers and network performers. These tools are called K-Bow and StringPort and are readily available.



The active score - MAPPS - is the result of 30 years of work focused on uniting instruments and technology for live performance. It has been used for dozens of performances and 100's of rehearsals. There is a repertoire from multiple composers. It is comprehensive in that it contains sufficient tools and options to satisfy most of the timbral and structural needs of today's composers. And it is extensible so new methods and technologies can be integrated without disturbing the previous work.

Portable computers powerful enough to run the program and accept the musician's data are now readily available. A basic working system is in place and illustrates the new possibilities once you network instruments, the score and musicians using 21st century technology.



"I am completely blown away by the K-Bow...One literally has the power to control and manipulate sound at their finger tips with virtually no disruption to the technical act of playing their instrument." - Jeffrey Zeigler, Kronos Quartet

What is next?

This is all fine and good, but in order to be widely accepted it must be proven in a big way. The test of MAPPS' viability is a set of public performances of sufficient scale to attract notice and gain momentum. We are working toward a series of performances by a dozen world class String Quartets playing pieces from a dozen composers who have realized music in MAPPS. All of this work will be moderated by a non-profit organization I started in 2004 - the BEAM Foundation.

BEAM Foundation has provided money, time and energy for the promotion of MAPPS, and this new ideal. My present company, KMI, designs and builds the extensions to stringed instruments needed to interface and network the players. Numerous pieces have been commissioned and BEAM as well as other institutions has funded performances of works using MAPPS.

- 12 string quartets equipped & trained
- 12 composers working in MAPPS
- MAPPS on multiple computer platforms
- WW performance schedule
- Three year timeframe

There are K-Bow sensor bows and StringPort interfaces in use by major universities including SUNY, McGill, Rice, Vienna University of Music and Art, Hanyang University at Korea, Berklee College of Music, and Stanford. MIT opened their 150-year anniversary festivities with a K-Bow cello concert

in March 2011 composed by Todd Machover (of Media Lab fame) where the K-Bow also controlled lights and video. Chris Chafe, dean of music at Stanford, premiered a work with the K-Bow spring 2011 in Beijing.

Talented musicians such as Jeff Zeigler, Jon Rose and Neil Duffalo are performing using these new tools. Composers are using MAPPS technology for pieces and documentation. Kronos will premier a MAPPS / K-Bow piece named "Polar Suite" this November in New York by composer Douglas Quinn. The flexibility and refined integration of the MAPPS system will continue to enable significant new works and performances.



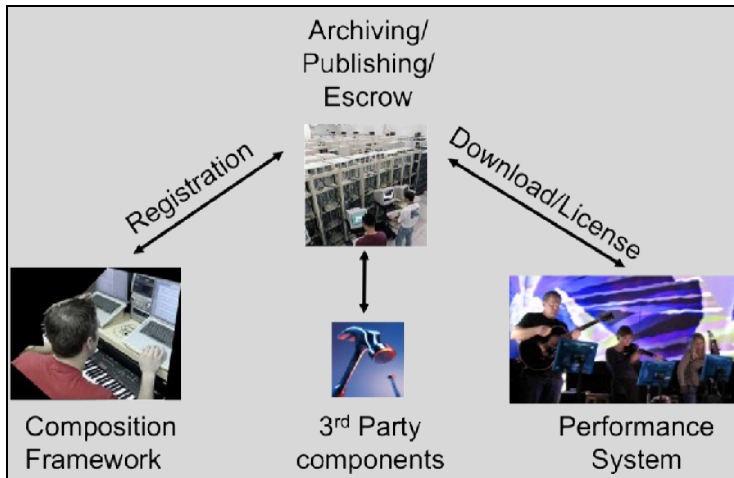
Keith with some of the K-Bows that did not make it

Composer Douglas Quin commented, "The K-bow is an extraordinary and visionary invention in every sense. Keith's passion for strings shines through in the detail and elegance of the bow's design: packing in as much technology and punch as possible without losing sight of the feel of a traditional bow. As a composer the possibilities are endless and I finally have an opportunity to create what I have been conceiving in my mind's ear".

In developing this new work for the Kronos Quartet, David Harrington shared his excitement, "This is an opportunity to essentially relearn our

instruments and to transform how we approach live performance. "Polar Suite," will be a

very different kind of string quartet and an extraordinary sonic adventure--thanks in large part to the K-bow and what is now possible! It feels like a whole new palate of colors in the music world, and I'm right at the very beginning putting the primer on the canvas".



In addition to commissioning pieces and creating performances of this next music, there will be the need for BEAM to organize, educate, archive and distribute the MAPPS active score system. Such an undertaking would not have been possible before digital technology reached the level of maturity it has today. This is a change on par with the adoption of standardized notation 1000 years ago.

In practice, a Composer will download the MAPPS composition framework and realize his score. There exist many tools and methods within MAPPS that make composing and experimenting a rewarding experience after a short learning curve. BEAM will facilitate this with classes, presentations and direct support for composers.

Once a piece is created it will be uploaded and registered at the BEAM archives, where it will be maintained, archived and published. Performers will download the music and with a minimum of extra technology (such as sensor bows and laptop computers) they will be able to perform the work. Over time this infrastructure will become widely supported and compositions will be readily available for easy access and performance.

The next three years demand a ramping of efforts to bring the project to fruition. We welcome your participation to help shape this next generation of music.

What the experts are saying about MAPPS:

"Forty years ago I had a dream where musicians using advanced instruments played together while connected to a central computer which integrated and guided their performance. With the work of Keith McMillen and MAPPS, this dream is now a reality. There is nothing else like this in the world. MAPPS changes everything."

- [Max Mathews](#)

Father of Computer Music

"The MAPPS system is more than very impressive, since it can 'compose' practically anything you can think of, including things you may never have thought to think ..."

- [Alvin Curran](#)

Composer

"MAPPS is at the forefront of music and technology. Unlike many other cutting edge endeavors, they are guided by their sense of art rather than by the tools involved."

- [Will Wright](#)

Creator of [The Sims](#) & [Spore](#)

“I look forward to composing with MAPPS because I know that my pieces will be performable 50 years from now. What Keith and the BEAM Foundation are doing is the single most important undertaking in modern music.”

- **Richard Boulanger**

Composer and Professor, Berklee College of Music

“MAPPS is a modern composer's dream come true, an ensemble for live performance that combines composition and improvisation at a core level.”

- **Paul Dresher**

Composer and Musician

“MAPPS is capable of a wide assortment of aesthetics and sound worlds. Also, the transitions through these changes happen with a smoothness unexpected of real-time digital audio instrumentalists.”

- **Eric Roth**

Composer

“The MAPPS system is a tremendously flexible composer's and performer's toolkit. I look forward to seeing composers find ways to adapt the system to their individual styles and formal obsessions.

Orson Welles once said, that a movie studio was "... the biggest electric train set a boy ever had". I think MAPPS just may be the modern composer's electric train set.”

- **Jay Cloidt**

Composer

Keith McMillen has been working over 30 years to develop the tools and technologies required to create MAPPS. This goal has required him to make dozens of advanced instruments, patented inventions and numerous successful companies in order to advance the technology sufficiently to reach this musical objective. Keith received a degree in acoustics from the University of Illinois in Urbana and began his professional career in 1979, when he founded Zeta Music. The company's revolutionary electronic instrument designs created a new market in the music industry, and the brand Zeta is the "gold standard" for electric and electronic string instruments. He also created the world's first programmable audio mixer, best selling looper and most popular iTunes plug-in. Subsequent roles at Gibson and Harman allowed him to perfect methods of performance networking. Recent ventures succeeded in creating sophisticated signal processing algorithms needed for intelligent audio management and advanced user interface devices.

For more information please go to:

<http://www.keithmcmillen.com/k-bow/overview>

<http://www.beamfoundation.org/index.php>