Summary of Week 11 Readings

**Fels (2002) – Mapping transparency through metaphor: towards more expressive musical instruments**

1. Introduction – Why is this so difficult? In transparent mappings, I guess. “…transparency provides an indication of the psychophsiological distance…” Metaphor involves literature, is common cross cultures. Examine 4 systems.
2. Transparency, Expressivity and Literature – Player and listener are both responsible. Bimodal with vision.
   1. Transparency of Device Mappings – facilitates expression, (why do we re-summarize DMIs in every paper?), no longer physically bound, who knew!?, opaque mappings are difficult for both the player and the audience (drum sounds on a keyboard), player transparency and audience transparency create a plane, player needs physical intimacy and audience needs understanding.
   2. A framework for expressivity – OT (opaque to player, transparent to audience), TO, OO and TT (the best, I guess, traditional instruments). OO is very nervous system. To move technology out of OO region: simplicity and functionality. Simplicity for audience and functionality for player.
   3. Increasing expressivity using metaphor – Mapping can benefit from metaphor, summary of mapping strategies (one to one, modal, convergent, etc.).
      1. Convergent non-modal mappings – like a piano, many ways to strike the same key.
      2. Convergent modal mappings – synthesizer, like piano, but can change sound sets through selection, more opaque, especially to audience.
      3. One-to-one non modal mappings – direct relationship between control and output. Violin metaphor is used by “BoSSA.” This seems to simply be promoting instrument based DMIs. Guitar blends the two groups with frets (many finger positions to one note).
      4. Metaphor as a design tool – Metamuse uses granular synthesis, like “waterfall.” Metaphor used for DMIs to be discussed, how can its use be expanded?
3. Iamascope: a metaphor for a video controller – Interactive kaleidoscope. Initially difficult for performers to understand the musical mappings, but designers brought in the metaphor of the guitar. Films participants and maps their gestures to sound in a one-to-one fahion.
   1. Vision to music subsystem – Converts intensity differences to MIDI
      1. Image processing – computes average intensity over time.
      2. Music production – Change in screen regions are notes within a chord (autoharp?).
   2. Mapping and expression – it’s like a guitar where the computer is holding down the chords. Problems: hard to time (regions are in space) and cannot select chords. Free hand gestures are always problematic.
4. Sound sculpting: a metaphor for sound design – the metaphor is a small, stretchable object.
   1. Pragmatic based design – small objects are expressively manipulated, do not need tools: claying, carving, chiseling and assembly. Mostly claying.
   2. Sculpting FM synthesis – Difficult to control without tactile feedback, derivative method better. Pitch and duration of notes not mapped. Visual was thought as a learning tool, but manipulation without haptic feedback was more difficult than imagined.
   3. Sound sculpting evaluation – difficult to learn and use. Somewhat opaque.
   4. Sound sculpting: lessons learned – metaphor of sound IN object worked well for panning and reverb. FM synthesis did not map well to this metaphor (“…a more appropriate metaphor may be useful…” well, that’s a lot of help.)
5. Metamuse: a metaphor for granular synthesis – based on metaphor of rainfall, uses granular synthesis. The randomness and computational intensity of granular synthesis can create opacity, can this opacity be conquered with a well-known metaphor.
   1. Design of a particle-driven instrument – props of watering can, support metaphor. Good for height and angle, bad for absolute position.
   2. Implementation – simple physics model in C., Polhemus Fastrak. Virtual droplets play granule when the hit the palette.
   3. Analysis and results – No formal testing, metaphor seems intuitive, breaks down for position, perhaps parameterized samples? Audience expects the metaphor to extend farther than it usually does.
6. Glove-TalkII: a metaphor for speech synthesis – speech controls, metaphor is hand motion (AVT – articulatory model of speech). Continuous mapping, learned with neural networks.
   1. Overview – neural networks: vowel/consonant decision, vowel and consonant. Form hand shape, press foot pedal. Sound for each letter. Easily can move through space (both real and sound).
   2. Mapping and expression – after 100 hours, user can be intelligible. Credit strong metaphor (doesn’t seem strong to me).
   3. Lessons learned – good metaphor, adaptive mapping, transparent mapping. Must introduce new elements slowly.
7. Conclusions and future work – two axis transparency scale. Metaphor cannot compensate for lack of feedback. Metaphor more of a stepping stone.

**Verfaille, Wanderley & Depalle (2006) – Mapping Strategies for Gestural and Adaptive Control of Digital Audio Effects**

1. Introduction – Effects are modifying sounds. Fewer parameters (easier control?). Can also be performed. Artists use, sometimes describe mappings, this is an attempt to scientifically systematize them.
2. Basics about effects control and mapping
   1. Digital audio effects (DAFx) – time-scaling, pitch-shifting and timbre morphing. Sometimes there are models (is it jus a delay, or it is simulating a room?) . Same goal: “…to provide musically meaningful modifications of a sound.”
   2. Control of DAFx – The same parameters can create different effects:
      1. One delay line: frequency modulation
      2. Original sound plus one delay line: echo, comb filter (flanger), chorus (all depending on time an modulation of delay length
      3. Original sound plus several delay lines: multi echo, phasing, reverberation
   3. Types of control – five categories: LFO, gestural, automation, adaptive and algorithmic. Often control type defines effect (LFO in tremolo, adaptive in compression).
   4. Mapping input controls to the effect controls – “Input mapping” : “translates user’s actions into parameter values needed to drive the sound processing algorithms.” What process belongs to the control, and what to the effect, then assign.
   5. Frontier between effect and control –“*we consider as part of the effect the control mapping layer that is specific to the way it sounds, whereas the other control layers belong to the control mapping layer.*” Higher level uses additional layers.
   6. Adaptive and gestural control of DAFx – direct control: extracting the intention through an analysis layer, like score following to a conductor. Two layers, gesture feature extraction, features to control. How should gestures control effects? Some “adaptive” effects rely on auditory features, like compression and auto-tune.
   7. Mapping comparison in DAFx control, DMI control and algorithmic composition – Adaptive effect design: “…the putting of sound information handles as well as gestural handles on digital audio effects, discovering which sound features and gestural controls work well with mappings and sounds into a digital audio effect unit.” How do parameters connect with perceptual dimensions? All kinds of ways, linear, non linear, artistically, scientifically.
3. Mapping sound and gesture features into DAFx controls
   1. Mapping strategies – if you extract features, it becomes higher level and allows the user to escape. High level features (brightness) are computed from low level features (spectral centroid). Redundant features need be considered redundant or else the bog everything down. In principal component analysis (PCA) adaptive features are linear combinations of spectral, transient features.
   2. A multi-layer mapping strategy for gestural and adaptive control of DAFx – Controls (level one), gestural control (level 2). Explicit scheme, sound feature combinations control signal conditioning.
   3. First level mapping between sound features and DAFx controls (adaptive control) – Feature combination (four sublayers), signal conditioning (three)
      1. Explicit mapping for feature combination – first sublayer normalizes gesture. Second changes scale (linear to exponential, logarithmic, etc., for mapping a hand wave {linear} to frequency {exponential}), also adds desired non-linearities, like clipping/low pass filtering. Try to keep it perceptually relevant (duh). Third layer is setting it to control parameter. The fourth is warping for the control parameter.
      2. Control signal conditioning – Layer 1: effect-specific warping, 2: low pass filter and 3: scaling. Must adapt to avoid irregularities from the first main layer.
   4. Second level mapping between gesture features and the first level mapping (gestural control) – Much simpler. 1 to 1 connections (because the extracted gestural features are already perceptually relevant). High level control (because they’ve already processed things so heavily in the first layer).
4. Examples of musical use – six examples. First two adaptive control, rest adaptive and gestural control.
   1. Adaptive robotization – Controlling pitch of a spoken robot. Many sublayers (low pass filter, normalization) are not used. Varies the fundamental frequency (control value). RMS, spectralization are used.
   2. Adaptive granular delay – a set of delay lines with various length and gains.
   3. Adaptive spatialization – MaxMSP patch allows dancer to control parameters of the sound. Dancer’s motion is broken into automatic motion, gesture positioning, motion arc length, transfer function (changing the position of the “interesting portion” of the gesture), source width and trajectory.
   4. Prosody change – prosody: rhythm of speech, gesture controls pitch, time scaling, gain variation,.
   5. Adaptive equalizer – filter envelope changed by gestures and adaptive control.
   6. Adaptive spectral tremolo – tremolo to each frequency bin of the STFT. Can create phasing.
5. Musical implications of our mapping model
   1. A clear separation between sound features and gestures – makes things more transparent, and thus easier to control
   2. Interpolation – helpful for adaptive effects, ability to transition between effects.
   3. The choice of sound features – Explore potential physical similarities between effects and gestures, creating easier and more intuitive mappings.
   4. Perspectives – Implicit mappings? Formal study of the efficacy of mappings? Several effects controlled at once? Visual feedback?
6. Conclusion – Adaptive effects are difficult to control without strategies. Using techniques from sound synthesis, this becomes easier. High level of control with two mapping layers.

**Kvifte (2008) – On the Description of Mapping Structures**

Abstract – How do we describe mappings. We need more concepts. Using examples from traditional instruments, notions of *value* and *set selectors*. *Input control system* where several control actions are seen as a unit, is better suited to describe mappings across different instruments.

1. Introduction – Too much control hinders rather than helps. Fewer, more complex, coupled controls are better. What is the structure of couplings? Most complex mappings are generally found to be the most effective. Traditional instruments rarely have simple, one-to-one mappings. Using the definition of mapping as a link between control and synthesizer. Cross coupling is many to many, coupling is many to one and one to many.
   1. The subjectivity of mappings and couplings – input to output. Coupling is a unitary musical gesture with more control. Looking for a systematic, analytical framework.
2. Structure of common couplings: set and value selectors – Wind pressure in a clarinet affects both loudness and pitch, a one-to-many mapping.
3. Terminology – Discrete and continuous variables are not always separate (e.g. pitch is distinguishable in a singer with vibrato).
4. Wind instruments: an example - Wind pressure in a clarinet affects both loudness and pitch, a one-to-many mapping. In a tin whistle pressure can make pitch jump one discreet octave. By overblowing the musician gains access to a new *set* of pitch values, by a *set selector* (SS). Pitches themselves are values, selected by a *value selector* (VS). If you consider both wind pressure and length of air column, the two inputs are coupled. Each modify the other’s actions.
5. Input systems: grouping and control actions – it is sometimes more convenient to group control actions into *control systems*, or *gestural ensembles*.
6. String instruments: another example – One hand excites, the other shortens. Three variables select: the position of the left hand lengthwise, choice of finger, like on accordions.
7. Multidimensional input – Pitch values are laid out in two dimensions, and are not tied to specific fingers. Sometimes pitch values can be found in several places. They are popular not just because they give several fingering options for one sequence of tones, but because the performer can make many models of these relationships.
8. Independence of parameters – When many inputs are simultaneously tied to many outputs, it is a complex, many to many mapping. To control output parameters independently, you need to add uncoupled controls (like the finger holes, which control length of air column). “…if a parameter in a one-to-many coupling is to be controlled independently of the other parameters in the coupling, the parameter also has to be part of a many-to-one coupling; in other words, the system has to be a complex coupling.”
9. Details of mapping: set structure
10. The structure of input and output variables – Pitch is well ordered, digital; timbre is more unwieldy. Pitch: tin whistle the sets are distinct (overblowing), willow flute has more selection with opening and closing the flute with index finger, trombone pitch is controlled by combination lip control/air pressure and slide position, sets have gaps.
11. A typology of sets – Piano can be one complete chromatic set, or two incomplete gapped sets of white and black keys. Continuous sets contain all relevant values between bounds, gapped do not. Disjunct sets do not overlap (like male falsetto singing).
12. Concluding remarks – Design of mappings is important to construction of new instruments. “It may seem a good idea to use simple or one-to-one mappings, to make an interface easy to understand, and the complexity of some interfaces of traditional acoustic instruments are sometimes seen as a hindrance… however, complex couplings seem to be preferred over simple ones, and the challenge for constructors of new instruments should therefor rather be to make sensible complex interfaces.”

**Momeni & Henry (2006) – Dynamic Independent Mapping Layers for Concurrent Control of Audio and Video Synthesis**

Seeking a manner of control with, “low entry fee with no ceiling on virtuosity.” Need to improve mappings. Concerned with cross mappings of sound and image. This work attempts to describe rich mappings in audio/visual contexts.

Description of a Dynamic, Independent Visual Mapping Layer – the mapping layer changes in time, needs and additional block. Discuss mass spring systems and dynamic interpolation systems (performer moving in a low-dimensional perceptual space).

Perceptual Spaces as Mechanisms for Control – Intuitive way to explore and master high-dimensional parameter spaces. All research look for controlling large number of parameters with only a few input parameters.

Physical Models for sound synthesis – Rich literature, can be used to form mapping techniques between video and audio. Review of synthesis toolkits.

Gestural Control of Physical Models – Review of prior work in gestural control of physical synthesis models.

Concurrent Audio/Video Synthesis – driving concurrent audio/visual from separate and unique data.

Virtual Instruments as Mapping Layers – The importance of mapping cannot be overstated.

Physical Models for Gestural-Control Feedback During Performance – objects that interact in a “natural” and informative way serve as a good interface for mapping experiments. Spinning wheels, and wooden sticks, the more intuitive the better. Visual representation is important feedback.

Mass-Spring System for Real-Time – review of prior work in specifically this paradigm, because there is so much.

Benefits of a Dynamic Visual Mapping Layer – independent layers make it “rich.”

Performing Low-Dimensional to High-Dimensional Mappings – High dimensional expression with low-dimensional control. Dimensionally scale *n* inputs to *m* outputs, where *m* >> *n*. Interpolation space is the weights of all parameter vectors, to make smooth transitions, n to m, as a user moves around the simpler space. 16 masses connected by strings can be controlled (albeit not precisely) with the vertical position of one point.

High-Level Control – 81 masses on springs in a 9x9 grid. Low level control: controlling each mass individually (complete control, deterministic results), one mass is higher level, but unhelpful. Another is to control one mass + resistance, length and damping constants for each spring.

Time-Variable Behavior of Structure – If mapping varies dynamically, it allows for lower dimensional control to explore higher dimensional spaces (with time, of course). The mapping layer itself must be “time aware” for this to happen. When you throw something, a gesture puts energy in, then mapping does the rest (it flies through the air).

Visual Mapping Layers – graphical metaphors are what they’re looking for, like the iTunes visualizer. Makes things easier to understand, because of the intuitive way we can absorb lots of visual information.

An Intrinsic Link Between Generated Audio and Video – Looking for concurrent control of both layers. Either the sound is controlled and the image is synthesized, or vice-versa. Instead lets see audio and video as two parts of the same instrument, same gestures, just different mappings.

Mapping Techniques and Controllability – pay special attention to mass-springs, user inputs control in real time, things (results) make physical sense.

High-Level Physical Descriptors of Mass-Spring Models – Mean and variance of: displacement for equilibrium (each for all masses), lengths of links (potential energy), velocity (related to kinetic energy), and acceleration of the masses).

Considering a Part of the Structure with a View Window – Only going to look at part of the structure, make analysis easier.

Mixtures of Dynamic Mapping Layers:

Interpolation Space for Physical-Modeling Parameters – use a drawing tablet to control the center mass and the location in the interpolation space, buttons to add or remove data within the space. Control intimately! Predictable results, which is good.

Interpolators Used to Mix Predefined States of a Physical Model – allows a performer to get certain places easier, and still work between them.

Physical Model Output for Exploration of an Interpolation Space – instead of moving anywhere throughout the space, restricted by mass springs. Allows for strange and interesting results.

Physical Model as Modulators for the Interpolator’s Inputs and Outputs – allows for low level control of an additive synthesizer with 1000+ oscillators, can control roughness and timbre well.

chdh – a sound and visual, physical modeling synthesizer. Low level control. Two visible masses, a third invisible, user affect rigidity. Can drive synthesis by changing amplitudes of four oscillators.

Implementation – In a MaxMSP patch for flexibility and user base. Pmpd (physical modeling for Pure Data), allows for fast processing of up to 10,000 masses.

Conclusion – dynamic systems of mapping, low to high level, are a good idea.