One Knob To Rule Them All: Reductionist Interfaces for Expansionist Research

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ABSTRACT

This paper describes an instance of what we call 'curated research', a concerted thinking, making and performance activity between two research teams with a dedicated interest in the creation of experimental musical instruments and the development of new performance practices. Our work builds theoretically upon critical work in philosophy, anthropology and aesthetics, and practically upon previous explorations of strategies for facilitating rapid, collaborative, publicly-oriented making in artistic settings. We explored an orientation to making which promoted the creation of a family of instruments and performance environments that were responses to the self-consciously provocative theme of 'One Knob To Rule Them All'. A variety of design issues were explored including: mapping, physicality, the question of control in interface design, reductionist aesthetics and design strategies, and questions of gender and power in musical culture. We discuss not only the technologies which were made but also reflect on the value of such concerted, provocatively thematised, collective making activities for addressing foundational design issues. As such, our work is intended not just as a technical and practical contribution to NIME but also a reflective provocation into how we conduct research itself in a curated critical manner.

Author Keywords

New interfaces for musical expression (NIME), collaboration, experimental interfaces, music hardware, music performance, research methods, annotated portfolio.

ACM Classification

H.5.5 [Information Interfaces and Presentation] Sound and Music Computing.

1. INTRODUCTION

This paper presents a collaboration between two research groups across two institutions, and a guest from a third, comprising eleven individuals, so as to explore a style of creative activity we call 'curated research'. We describe the devices and software we made together and draw out their implications both as technical contributions to NIME research but also as a test of the value of our research curatorial strategies. We hope that this paper will initiate a new reflection in NIME research on research methods and show how methodology itself can become a creative concern.

The relationship between creative practice and the design of new artefacts, interfaces and technologies has become a common concern in recent years in research fields such as HCI (Human Computer Interaction), Research Through Design and NIME itself. The most provocative work, for us, follows and extends Frayling's [9] view that creative practice can be a means for doing research itself – creative work is not merely the application of techniques or the mobilization of knowledge gained elsewhere (e.g. in 'pure' theoretical art, humanities or scientific exploration). This places creative practice centre stage in the production of knowledge, technologies and new ways of doing.

A number of contributions exist which give programmatic detail to these perspectives. In several papers, for example, Gaver [e.g. 11] and his colleagues present orientations to design to facilitate creative research under rubrics such as 'design for ambiguity', 'ludic design' and 'design for appropriation'. Binder and his colleagues under the collective identity of A. Telier [7] draw on the philosophical contributions of Martin Heidegger and the sociology of science of Latour [e.g. 15] to reformulate research in HCI and allied fields around a concept of 'design things' as a way of emphasising the complex entangling of the social and the material in design. Developing this view, Björgvinsson et al. [2] argue for a shift of perspective from 'projects' with their typical logics of 'analysis', 'design', 'construction' and 'implementation' to *infrastructuring*, where, instead, a bringing together of a collective of socio-material elements is variably, flexibly and "performatively staged" [2, p104]. The authors describe how these perspectives informed a collaboration between a grassroots hip-hop community, a design organisation, the local public transport administrators and their contractors around a proposal for a 'Bluetooth bus'.

Design-oriented research in this style has inspired the sound art work of Shaw and Bowers who, in a number of papers, describe an orientation to creative work they name 'public making'. Shaw and Bowers [5, 21] document a series of projects where they have worked in collaboration with public-facing institutions to create installations and performances in short timescales with little advance preparation. It is notable that Shaw and Bowers carefully and provocatively theme their public making activities. For example, a recent exploration of the soundscapes of the city of Liverpool [21] was named *SoundLines* after the model of 'songlines', the paths Indigenous Australians trace in the landscape following the land's creator-beings, and participants were urged to trace the hidden sonic connections in the city.

Relatedly, Richards [19], particularly as Dirty Electronics, has advocated a participatory approach to creating performances that has involved public making and workshopping [cf. 14]. He cites Cornelius Cardew's idea of performance as a "call to action" and that "the performance begins on the workbench and is extended on to the stage" [17]. Such performance pieces include a week's public residency wiring and 'sounding' the gallery of the ICA (*ICA Solder a Score*) [18] and a 24-hour event, that also included work by

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Frize, Patel and Topley, exploring post-optimal design and performance (*Dirty Electronics Weekender*) [8].

Our work draws together these sources of inspiration. Following A. Telier and Björgvinsson et al., we do not regard ourselves as engaged in a single collaborative project with just one 'object' as its goal, but rather as initiating an 'infrastructural' activity whereby a range of concerns, interests, skills, materials and technologies are brought together, and a variety of 'things' can be proposed and given a preliminary investigation both conceptually and through making. Following Shaw, Bowers and Richards, we curate our activity through, most notably, a carefully chosen and provocative theme, and encourage a lightweight touch in making to engender wide-ranging explorations. We also share the public-orientation of these writers to research and committed from the start to present a concert of our works. In this way, our design work would be, literally, 'performatively staged'.

2. ONE KNOB TO RULE THEM ALL

We decided to theme our creative work under the title of *One Knob To Rule Them All* (henceforth OKTRTA). This was intended as a design provocation to incite reflection over a rich variety of issues in NIME. Compactly within the title are references to interaction hardware (knob), questions of interactive control (rule), and the exploration of mappings (particularly of a one-to-many sort: them all). It presents what could be taken as a brief for design (a single knob interface) and indeed this was undertaken in a number of ways but was not a sole concern. The allusion to *The Lord Of The Rings* aside from its humour might also suggest dilemmas associated with power and control like those suffered by the possessors of the ring in that work. In addition, the title deliberately used a British English slang word for penis (knob) so as to incite thinking about gender and cultural power, a topic which a number of us reflected on and worked in relation to.

In preliminary email discussion between the participants, having agreed on the title, we elaborated a series of sub-themes to guide our explorations. People were encouraged to orient to the sub-themes in thinking about what they might build but considerable flexibility was allowed. These issues included: mapping, physicality, the question of control in interface design, reductionist aesthetics and design strategies, and questions of gender and power in musical culture. It was not expected that work could address all sub-themes. Rather, we were anticipating the emergence of a 'portfolio' of related work with some family resemblance between pieces [3] which we ultimately intended to 'map' (as we do in section 5).

Up to 20 researchers indicated some interest in participation in our activities – not all could commit to its full programme but we encouraged people to drop in as they could. Eleven individuals participated throughout and developed work which they felt was strong enough to perform in concert. We first met for two days in December 2015 at Culture Lab, Newcastle University, during which we each presented our work and our intentions for responding to OKTRTA. The following week we moved to De Montfort University, Leicester and concentrated on making for two full days with a concert in the evening of the second. The performance was a fully fledged part of the institution's music concert programme.

3. OUR MAKINGS

In this section, we give a brief account of the principal pieces which were made during OKTRA. They are very varied. Some involve hardware innovation, some particular approaches to mapping and software, yet others are material assemblages which cross conventional boundaries of technical idiom. We do not have space here to document exactly how each of these works were created. Rather, we concentrate on sketching the relatively complete form (that is, to performance standards) that the work achieved in the time available, illuminating the descriptions with 'artists' statements'.

3.1 Hyperpot

The *Hyperpot* was a design brought to OKTRA by Jim Frize (JF) and was worked with by a number of us. The *Hyperpot* adds capacitive sensing to a standard rotary potentiometer so that the proximity or touch of the hand with respect to the pot can be used as a source of control data alongside pot position. For JF this creates: "The bastard child of a Theremin and a knob". An Arduino Nano clone was used to run capacitive sensing software and pass on pot position value. Using Max/MSP or Pd, we conditioned the data from the pot and performed some basic gesture recognition. We used thresholding to ascertain when the potentiometer was being touched. The capacitive sensing also gave us an indication how much the knob was being gripped. By timing how long the capacitive values remained within certain ranges, we could detect when the knob was being tapped or double tapped. Comparing one positional value to the next allowed us to detect the direction of motion and we were also able to use this to calculate the rate of movement.

Figure 1: A *Hyperpot.*

We built six *Hyperpots* based on JF's initial prototype. Two of these used potentiometers with a plastic shaft. We discovered that they were not sensitive enough and it was difficult to get good capacitive coupling between the fingers and the potentiometer. We also found that aluminium clad knobs are too sensitive. Touching a metal clad knob or the bare metal shaft of the potentiometer creates a large capacitance that takes a long time for the microcontroller to read. A plastic knob that insulates the potentiometer is essential for making a responsive control with a reasonable amount of sensitivity.

3.2 Fractal Knob

John Bowers (JB), in response to JF's design, proposed that, in principle, an audio signal could be entirely shaped by the movement of a single knob if the data from that knob were given a "fractal expansion". To illustrate this, JB made a Pd patch which read data from the *Hyperpot* into two wavetables (one for knob position, one for proximity/touch). Two streams of sound were generated each in the following manner. The data were scanned at a rate determined by momentary position or proximity/touch (a variety of linear and non-linear mappings were explored). This alone would yield a static sound. To add temporal variation, eight sub-divisions of successive amplitude modulation also shaped the sound. In this way, a wave was produced with self-similarity at eight levels of 'zoom'. This created two richly time-varying sounds. To add further performability, the value of the sub-division was also derived from the current data value taken from the *Hyperpot*. This enabled a variety of drones, glitches, pseudo-sequences and crackling effects to be all derived from the single knob.

3.3 One Knob Live Coding (1): Colossus

Developed by John Richards (JR), *Colossus* is a miniature hybrid digital/analogue device designed around a PIC microprocessor that can be programmed and live coded using one knob and one tactile button. An analogue output, DC voltage, from the microprocessor is created through the technique of pulse-width modulation (PWM) and a passive, resistor and capacitor, low-pass filter. By varying the pulse-width a range of control voltages can be produced. These voltages are used to change the gain of a single supply dual operation amp configured in a

feedback network to generate various oscillations and noise-based textures. The aim of *Colossus* was to develop a device that questioned the relationship between coding and sound generation, and to explore performance through tangible and collective coding. Within the context of OKTRA, there was also an attempt to consider how a reductionist approach (imposed limitations) to instrument control/design could shape a particular performance style/creative output.

Coding *Colossus* involves dynamically writing and reading to and from an array. A pot (knob) produces a range of voltage values that are read using an analogue input of the microprocessor. These values can then be stored into an array by pressing a button. The array length – number of steps in the sequence to be looped – is built-up incrementally (1 step, 2 step etc.) until the maximum length of the array (sequence) is reached. At this point the array is cleared and the process begins a new. The maximum length of the array is predetermined/set in the code. Tempo/speed can be fixed in the code or controlled with an additional, second pot (knob).

The one knob, one button interface and coding method of *Colossus* can result in constant shifting loop lengths and patterns. This is further exaggerated by the indeterminate nature of the voltage-controlled feedback circuit. Moving between read and write modes (using the button) gives a musical characteristic where tension exists between periodic, looped rhythmic patterns and freer gestures derived from 'knobbing'. As an instrument, the device is both generative and gestural. In performance, the beginning and length of the sequence can become abstracted, difficult to determine, and learning to play *Colossus* involves responding to short repetitive patterns of both pitched and non-pitched sound materials.

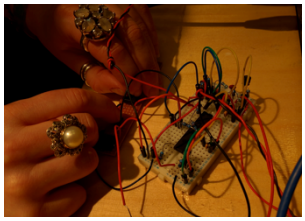

Figure 2: *Colossus.*

During OKTRTA, a performance was developed for a quartet of *Colossuses* (played by JR, Sam Topley, Amit Patel and guest Agnes Cameron) that were synced to one tempo master clock, whilst each performer was able to program their own device. This gave rise to a form of collective live coding where members of the group responded musically to each other's code.

3.4 Live Coding (2): Turing Tape Machine

Developed by JB, the *Turing Tape Machine* (TTM) is a live coding environment based on Alan Turing's concept of an imagined computational machine organised around a tape on which symbols can be read, written or erased by a tape-head depending upon a set of rules appropriate to the state the machine is in (the so-called Turing Machine). JB is developing the concept of the TTM as an unusual way to support the live coding of music by changing on the fly the look-up tables which define the read/write/erase, head-movement and state-change rules. In OKTRA, a TTM implemented in Pd was programmed by writing the look-up tables live using the data from a *Hyperpot*. The values read from the (virtual) tape were converted into voltages via Mutable Instruments' CVpal. These voltages could then be read into *Collosus'* array. In this way, a complex cascade of live coding was created by sharing voltages, all originating from the gestures at a single knob.

3.5 Firmata Generative, Para-Babble and Parallel Activity

A number of our makes involved using values derived from one knob to set parameter values for complex generative processes. In this section, we describe three works developed by Ben Freeth (BF) with this principle.

In *Firmata Generative* values from a *Hyperpot* seed a generative patch in Pd which triggers instruments playing layerings of complex patterns. Comparators examine the potentiometer data for rising and falling edges. This is mapped to effects including delay and reverb to influence the amounts of these applied to the individual instruments.

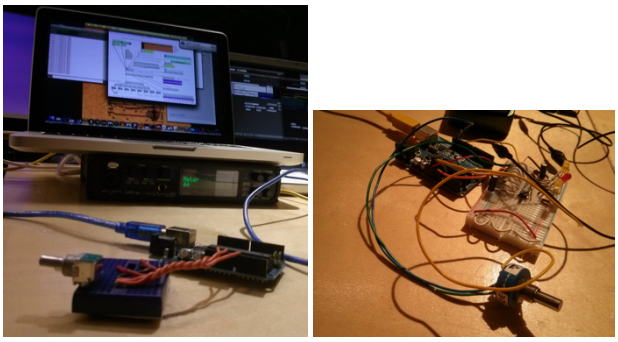

Figure 3: *Firmata Generative* (left) and *Para-Babble* (right)

SpeakJet is an integrated circuit featuring a 5 oscillator synthesizer capable of producing human vocal (allophones) amongst other sounds. The circuit has been used by paranormal researchers concerned with Electronic Voice Phenomena (EVP) to generate scrambled words and sentences as a material upon which, it is hoped, the spirit world can operate to create understandable sentences. In OKTRTA, the SpeakJet chip was controlled by an Arduino microcontroller using a single continuous turn potentiometer mapped to generate streams of user-steered, random allophones. Values passing through a comparator were mapped and inserted into an array controlling the SpeakJet parameters for, e.g., the array of allophones to be played, the speed they are synthesized at, and their inflection. Moving the control also inserted random values into some of the array positions so that each turn of the control produces a unique and constantly varying response from the device. For BF, this "formed a haunted *Para-Babble*. Paradoleic illusions invite speculative and unquantifiable searches for sonic entities with a dubious ontological grounding."

The *Hyperpot* was also deployed by BF in *Parallel Activity* where two 'no input mixer' Max/MSP patches from Lloopp Software, Beauty and Beast, were interacted with in parallel. In all these explorations, as with JB's *Fractal Knob*, a variety of effects could be obtained from a very constrained interface.

3.6 One Nation Under a Knob

One Nation Under A Knob extends prior work by Tim Shaw (TS) and Sébastien Piquemal creating *Fields,* a web based performance system which allows performers to play sound through the audience's smart phones, tablets or laptops [22]. For OKTRKA, a set up was made allowing the performer to manipulate multiple small sound sources with a single knob. Instructions informing the audience how to connect were projected at the start of the performance, and as audience members connected, a subtle sound playing from the devices made it apparent when they were connected. A simple physical modeling synthesizer was made using white noise, a variable filter and a variable delay line. This sound synthesizer was loaded locally on each device but because parameter controls were sent from a centralised server, different latencies occurred between sound sources. Because of the non-linearities in the physical models, differences in latency would tend to lead to divergent interpretations on each phone of exactly the same parameter values. This had the effect of creating complex, slowly shifting textures with detailed variation in response to very minimal performer interaction.

3.7 Ghost Radio

In several of our makes, where the data from one knob was mapped to control some sound synthesis parameter, care was taken over the nature of the mapping function and, sometimes,

several functions were used in parallel to simultaneously create differently organised streams of data. In each of these cases, the mapping functions were built in by design. JB's *Ghost Radio* takes a radical alternative approach to deriving parallel streams of data from a single knob. In this, the knob in question is the tuning dial of an analogue radio (short wave, SSB, AM and FM). The radio signal is transformed using an FFT and split into 8 bins equally separated on a Bark frequency scale (using William Brent's timral-ID library for Pd). The amplitude-followed values from each bin are auto-normalised and scaled in software before being converted into a voltage using a DC-coupled DAC (MOTU Ultralite Mark 3). These voltages are then sent to key locations in a patch on a modular synthesizer.

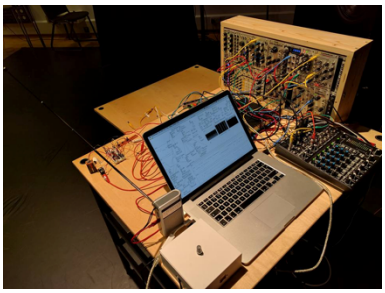

Figure 4: (anticlockwise from left) *Colossus, Ghost Radio, Hyperpot,* , laptop with *Turing Tape Music,* modular.

The patterns of radio reception along the tuner's range provide the mapping functions with the amplitude in 8 spectral bands giving 8 separate streams of control data. This permitted a wide range of behaviours to be experimented with. The 'static' noise between stations yielded 8 randomly and independently moving streams. A static SSB oscillation would create stable (but different) single values. Tuning to music would, naturally, lead to 8 streams which amplitude-follow the source in separate spectral bands. For rhythmic music this would create correlated control streams with a beat-following LFO character. Tuning to stations carrying the spoken voice would create correlated streams with the rhythms of speech. The name *Ghost Radio* is derived from Morton Subotnick's use of what he called 'ghost tracks' – DC voltages recorded to tape which, when played back, gave control voltages (CVs) to his Buchla synthesizer. These tracks were not themselves directly heard. In *Ghost Radio,* an analysis of radio serves the same purpose and, equally, the broadcast itself could be enigmatically withheld.

3.8 ball

A number of our makes problematized the conventional design of a knob, in some cases with a view to raising questions of the nature and value of 'control' in musical interfaces and its occasionally gendered character. For Sam Topley (ST), this led to the creation of *ball,* a knitted interface for interaction with electronic sound with a size (80 cm across) and tactile surface conducive to alternative gestures to "power-knobbing".

Internal sensors (from an embedded, hacked Wii-mote) were used to sonify the movement of the ball. Three-axis accelerometer data were transmitted as Open Sound Control (OSC) messages to Pd via OSCulator where a patch authored by JB read the sensor data into wavetables in a similar fashion to that described in section 3.2. The current values provided a frequency for the three oscillators with the last 256 accelerometer values filling the wavetables. More vigorous and irregular movements tend to create tones with more overtones. Periodic movements tend to produce modulations which can be directly heard and movements in different planes and directions effect the different axes (and hence wavetable oscillators) differently. Using sensor data as wavetable values also has the felicitous byproduct that, if the ball comes to rest, successive values will tend to be the same and the oscillator using such values will output DC (which the patch filters to silence).

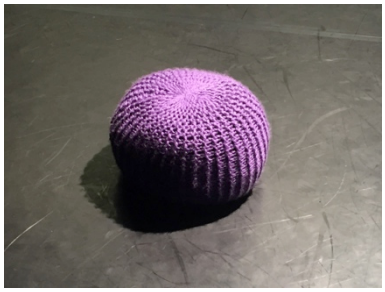

Figure 5: *ball.*

ball was presented as an improvisatory performance piece for small ensemble, with the only directions being for the ball to be rolled between members of the ensemble. The accessible form of the object also encouraged further interaction with the audience who later moved the object around the performance space. Other performance gestures included full body knob turning, careful knob passing and playful games of catch.

3.9 Turntable Assemblage

Neal Spowage (NS): "I wanted my 'one knob' to be large and absurd. I felt it wise to creatively push against the vision I had in my mind of a small and hallowed knob as an object on a plinth, under a spotlight controlling all other knobs with totalitarian supremacy." Accordingly, NS created a performance in which the 'knob' became a significant physical object in the space requiring a whole bodied engagement with it as part of a complex and prone-to-failure assemblage. Altogether the following were assembled into a "Heath Robinson-style" (NS) sculptural apparatus: two vinyl twelve-inch records, a piano key for separating the vinyl, a Technics SL1210 turntable, one AM/FM radio, a selection of Victorian copper gas pipes and light fittings, a selection of boxes to brace the radio against the turntable, and an audio mixer. Of these, the radio and the mixer (which was set to feedback to itself in a no-input style) were the principal sound sources.

In order to strengthen audience interest in the kinetics of his performance and the knob-apparatus-assemblage, NS created a system of elastic pulleys and belts so that the movement of the large sculptural knob assembled around the turntable could be easily seen to be causing the movement on the smaller knobs on the radio and the mixing desk.

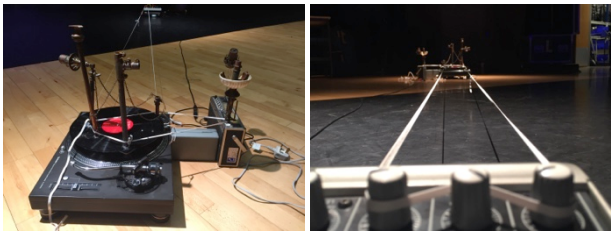

Figure 6: turntable 'knob' (right), no-input mixer (right)

Like ST, NS is problematizing the physical form of the knob and the control often associated with it or thought desirable for musical interfaces. Indeed, he goes to some extremes to create difficulties for himself by, for example, using loose elastic and threading it around the unevenly placed pipes in the loop which controls the radio and insisting on an absurd length for the main control belt which connects to the no-input mixer.

4. OKTRTA PERFORMANCE

It should be apparent that the provocation of *One Knob To Rule Them All* was responded to in a variety of ways by participants. Clearly, some of these responses are related (e.g. the uses to which the *Hyperpot* was put) while others have a character that justifies them standing alone even though they are dealing with a related family of research issues (e.g. *ball* and NS's turntable assemblage). This had clear consequences for creating a live performance programme and so we intended the formation of

ensembles and the ordering of performances to follow how the different sub-thematics had unfolded in our work.

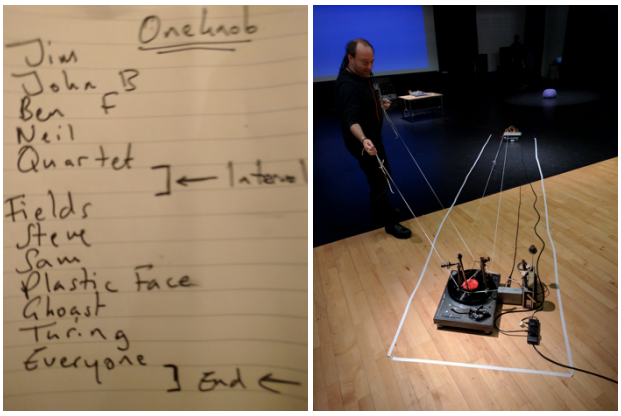

Figure 7: running order (left), NS performing (right)

To enable the public to investigate at close quarters what we had made, we arranged the performance around various 'stations' spread throughout the performance space – each with its own local, one loudspeaker sound system. For example, JF and then joined by JB started the performance improvising with a *Hyperpot* each, with their mixed sound reproduced through a loudspeaker close to where they were standing. To emphasise the thematic coherence between the works, we reinforced the local single speaker systems with a global two channel system – cf. proposals in [5] for creating a 'sensorium' of overlaid sound environments. This enabled performers to move their sound from being local to being part of the global system. This facilitated transitions between different stations and cuing between performers, and convinced us that the evening's events should be two continuous multi-episode performances with an interval. The performance closed with a group improvisation during which JB went up to individual audience members to show them a video which had been submitted by Will Edmondes (WE), one of our participants who could only attend the collaboration's first leg. This showed an uninvited roadside performance in Hungary by a band he plays in, *Yeah You!*

In addition, Steve Jones (SJ) developed a performance system to complement what was available in the makings and the musics. This involved projecting information about the research collaboration itself, hashtags for tweeting, how to connect to a localised wi-fi network for the performance of *One Nation Under A Knob*, and an invitation to the audience to keep their phones on and to move around the performance space. SJ also streamed a live feed from a GoPro camera projecting a roving performer's point-of-view onto a large screen while also documenting the proceedings. (JF also recorded his point-of-view: https://www.youtube.com/watch?v=DFqD5_h48FU.)

To accompany the group finale, SJ decided to walk out of the venue and introduce the sounds and environment of the street. A GoPro's capacity to stream images is limited to 250m. As its signal began to weaken, the image stuttered and glitched, until the device was switched off leaving a message to reconnect to the wi-fi. At the same time WE's movie was faintly heard from JB's mobile phone making a serendipitous collage which, by chance, the audience accepted as a coda, laughed, applauded, and so the performance was brought to a conclusion.

5. AN ANNOTATED PORTFOLIO

Our performance was extremely well received and, while gratifying, this should prompt a more extended analysis of audience response. We do not have space for that here. Rather, we want to draw out some of the important features of the work we have done and begin to connect these with research issues in the NIME community. In this way, we hope to show how our methods of curated research, making and public performance are, for us, primary means by which we do NIME research.

To help with this we follow Bowers and Gaver's concept of an 'annotated portfolio' as a means for communicating research through art and design. While Bowers [3] goes into some depth explicating this concept and arguing that it offers an alternative to more 'scientistic' ways of understanding the research value of creative work, what is relevant here is how an annotated portfolio is a way to communicate the summative implications of a collection of related work by charting the similarities and differences within the collection. It is imagined that creative work (say by the same studio or research program or in answer to the same provocation) might have a family resemblance, a mesh of interrelated concerns, rather than a series of defining features. Let us bring out five annotations which, to us, map the work we have presented here and present challenges to how interaction and artefacts are commonly conceived in NIME.

5.1 Raw Data/Raw Sound

In several of our makes, the restriction of OKTRTA has encouraged us to think of strategies for using sensor data as the raw material for sound synthesis. For example, in *Fractal Knob* and *ball* data from (respectively) a knob and an xyz accelerometer are directly read into wavetables. Relatedly, in *Colossus* and *Turing Tape Machine* raw data and analogue voltages corresponding to or derived from them are used to live code. This contrasts somewhat with those conventional paradigms for interaction with sound in NIME which work with a separation between controller (often seen as a generic device) and sound synthesis engine [cf. 4].

5.2 Objects, Things and Assemblages

In a number of writings Tim Ingold [e.g. 13] has followed the philosopher Martin Heidegger and distinguished between 'objects' (which have a finished, bounded, reproducible character) and 'things' (which retain a notable connection to the specific socio-material conditions of their production). Earlier we saw A. Telier [7] making similar remarks about 'design things'. There is variation between our various makes in this regard. *Hyperpot* has an object-character and JF has made available instructions for how to make one. In OKTRTA, we discovered more about *Hyperpot* 'best practice', e.g. what pot designs work best. In contrast, *Colossus* and BF's constructions retain an open, close to materials, still (and desirably still) breadbroaded nature. In addition, some of our makes have the character of 'assemblages' [for this concept in NIME, see 6] – contingent bringings-together which may fall apart at any time (see NS's turntable, vinyls, gas pipes, mixer, elastic bands etc.). Following [4, 6 and 12], we would urge an extension of NIME research perspectives beyond the single, finished object to provisional, contingent things and their performed assemblages.

5.3 Restrictions and Openness

In literature the Oulipo (a French concatenation and abbreviation of, approximately, 'workshop for potential literature') have long argued for the productivity of restrictions [16]. We should not see constraints as the enemy of enablements, or restrictions as the antithesis of openness, or however else one wants to make the point. Those trade-offs and oppositions only occur in static 'finite worlds' or 'zero-sum games'. By contrast, much creative action is transformative in the sense that doing (or withholding, for that matter) can change the range of possibilities for what is to come [13]. In NIME, Bowers and Archer [4] argued along these lines for 'infra-instruments' which have very constrained functionality and could be surprisingly liberating by virtue of this. The one knob restrictions of *Hyperpot, Fractal Knob,* BF's pieces, and the unanalyzed 3DOF sensing of *ball* are anything but restrictive in performance. While this point might be easy to agree with, a great deal of the rhetoric surrounding commercial controllers and also some notable contributions to NIME is about liberating expressivity from constraint, quite often by

capturing very many streams of sensor data from the performer. Our work suggests the equal viability of the exact opposite.

5.4 Playable Perversity

It has to be admitted that some of our makes have a willful perversity about them. We have already discussed NS's assemblages. But there is perversity in JB and JR's mating of a Pd patch embodying a Turing Machine with a feedback network of analogue voltages under the rubric of 'live coding'. JB (through 'fractal expansion' again, but we have no space to give details) specifies, with knob gestures, all of the rules needed for a Turing Machine with a 7x7-bit tape. All of this is done so that a single voltage can be computed and passed to *Colossus* where it might not even have an influence. It would be much simpler to press a key on a keyboard, to be sure. But the perversity of this interaction creates a performance situation which JB and JR have to creatively and thoughtfully work at, listening carefully to the emergent effects of their actions. The perversity also remains playable. If required, big gestures can be performed with very likely a dramatic effect. The perversity also enables JR and JB to raise questions about the cultural, aesthetic and historical situation of their work. It is no accident that they are referring to the history of computation in how they name their pieces. Similarly, JB's *Ghost Radio* may seem like an elaborate way of getting control data but, again, it is playable and enables provocative cultural connections (e.g. to Subotnick and questions of the inaudible in music). Less controversially, we can argue that *One Nation Under A Knob's* creative appropriation of network latencies and how they interact with the non-linearities of the sound synthesis methods deployed is also a perverse accepting of a material phenomenon that many are at extreme pains to hide or work round [cf. 10].

5.5 Shifting Agency

Much research in the traditions of Human Computer Interaction (HCI) has avowedly taken a user-centred view on how design should take place. Seeing the needs or requirements of the musician (whether novice or expert) and audiences as primary commonly underwrites much NIME research too. However, much of the work we did in response to OKTRTA takes a more slippery view of agency. We like things that, to use feminist theorist Karen Barad's turn of phrase, 'meet us half-way' [1]. We find devices which create challenges for us more performable than those which simply bend to our will. We made many things which had a life of their own either through algorithmic (e.g. JR's *Colossus* coding, JB's methods of fractal expansion or BF's generative programming) or physical (e.g. NS's fragile assemblages) means, or by exploiting sensitivities, uncertainties and divergences (e.g. TS's response to latency and *ball's* unpredictable responsiveness). In all these respects, we are suggesting a different model of interaction for NIME – one where *agency shifts in the mid-ways between person and thing*. As a number of feminist writers on technology argue [e.g. 1], it is in these half-way zones that we might rearticulate gender and power. Consistent with this, we hint how the knob's masculinity of control can be disrupted, how work build on craft practice traditionally associated with women, and how we can design prioritising tactility and textility over power [cf. 20].

6. DISCUSSION: CURATED RESEARCH

We hope that we have given an indication of the distinctive character of the creative work we have done and how, through its presentation as an annotated portfolio [cf. 3], it might offer an alternative view of interaction and musical design for NIME. Let us finish by returning to the notion with which we started – the idea that creative work might be facilitated through 'curated research'. Clearly, our work here is just beginning but we would like to chance a preliminary sketch of the 'sensitivities' we found ourselves following in OKTRTA. We can only be very brief. *Requisite provocation:* the OKTRTA thematic was compactly provocative and enabled a range of related responses. *Reduction and expansion:* the OKTRTA thematic presented a very reduced design 'brief' which enabled expansive research responses. *Light touch productivity:* our emphasis was on people making things quickly and with encouragement, we did not conduct 'crits'. *Ad hoc collaboration:* we looked out for emergent opportunities for work coming together but we did not force this – autonomous, single-handed work was very welcome too. *Family resemblance:* we encouraged things to relate in a mesh of emergent similarities and differences and did not enforce an overarching design. *Performance and public orientation:* our work was committed to public delivery and we took steps to design how our things were performed so that our research style was available to the audience. While OKTRTA was a focused collaboration between two like-minded research groups, we have begun to think about how these ways of working can be extended to much larger-scale collaborations and ones where participants' interests are harder to align [21].

Etymologically, curation is about giving care. We hope by curating research in the way we have we have begun to explore a three-fold care-giving: care for our research, care for our participants, and care for our music.

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