Form and Function: Examples of Music Interface Design

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This paper presents observations on the creation of digital music controllers and the music that they generate from the perspectives of the designer and the artist. In the case of musical instruments, what is the role of the form (the hardware) where it concerns the function (the production of musically interesting sounds)? Specific projects are presented, and a set of operational principles is supported from those examples. The associated encounter session will allow delegates to experiment with the interfaces exhibited, further informing these principles.

Music, Interface, Algorithm, Embodiment, Dance

1. ACOUSTIC MUSICAL INSTRUMENTS

With a few notable exceptions (Wagner tubas and saxophones, for instance), most acoustic musical instruments have developed gradually over time. There are now very few significant differences between available forms of most standard musical instruments, and it is clear that there is little chance of significant further development of these instruments. The reasons for what might be seen as this 'stagnation' are many and various and in part rest on the petrification of musical development that seems to be enclosing western 'classical' music. This lack of change also arises from the progressively specialized nature of the genre: the manner in which musicians have approached performance has itself changed over time; today there is much emphasis on virtuosity and precision.

These factors may have led developers of music technology instruments to view their interfaces with similar conservatism. A significant part of commercial research and development has been in areas other than the development of novel interfaces, and musically the latter remain unadventurous, typically maintaining links with established harmonic and melodic practices.

Attendance at any live music event demonstrates the importance of the physical appearance of musical instruments. Professional players, pop groups and orchestras know that appearances can be crucial, although not all might agree on a particular style. While function is of crucial significance, form is important, if only from a cosmetic or stylistic view. The fact that a trumpet utilises valves in a metal superstructure separates it fundamentally from the violin. The summation of the form really does fully describe its function; the music that is created is

comprised of the subsequent interaction between performer and hardware.

2. OTHER INTERFACE EXAMPLES

Early figures in the development of hardware interfaces for music include Leon Theremin, whose eponymous electronic instrument has some superficial similarities to one of the author's instruments described below, and Harry Partch. It is important to note the different approaches existing in this work. Theremin is an inventor whose creations were experiments in new interface design. Harry Partch was a musician and composer whose motivations concern creative expression as much as they do experimentation. The approach presented in this paper is more similar to that of Partch, rather than Theremin.

There have also been significant contributions to the field by popular music artists and fine artists with an interest in sound. Examples include Laurie Anderson, Janet Cardiff and Christian Marclay. Musicians such as David Tudor and Alvin Lucier, amongst others, have also explored the interface from a creative and experimental perspective utilising electronics.

Over the last twenty years the investigation and implementation of physical computing and embodiment has become increasingly popular. Whatever the reasons for this - the familiarity of standard computer interfaces breeding contempt (although there already seems a role for nostalgia in some places [7]), the rise in interest in making, do-it-yourself and recycling which has also cultivated interests in hardware hacking and circuit bending [3], [9] - the number of performances and analyses of hardware has grown dramatically recently.

Perry Cook's intriguing instruments [6] and some of the offspring of the MIT Media Lab, (for instance [24]) have, along with contributions from the New Interfaces for Music Expression conferences and Make magazine [13] changed the academic status of novel interface development in music significantly. Amongst many significant contributions are issues of Computer Music Journal [4], (14:1, 14:2, 22:1, 26:3) and Organised Sound [17], (7:2, 7:3). Wanderley and Battier [23] and Miranda and Wanderley [15] provide introductions to the area of physical control of digital methods in the creation of sound and performance. Specific to physical computing is O'Sullivan and Igoe [19] and specific to the Arduino is Banzi [2].

There are a number of specific texts, which are of particular interest with regard to this project. Marrin Nakra's 'Conductor's Jacket Project' [14] is particularly illuminating regarding her use of multiple sensors to create and analyse a total music output. Rovin et al., [21] Orio [18] and Hunt et al. [11] investigate how data mapping effects 'real' instruments.

Probably the artifact closest to the current version of the unit called Gaggle described presently [10] is the 'Sound=Space' installation by Gehlhaar [8]. This installation is described as having a number of configurations and purposes: including use as sound-art installation, use for dance and therapeutic use. The principal disadvantage apparent in this system concerns its lack of flexibility. The installation is based around a number of units each of which used a single pair of ultrasonic sensors. These are set up around a space (rather than in it) and the topography is put in place to express particular kinds of activity and in order to obtain particular results. My own experience with Gaggle is that while further developments certainly involve more work on different topographies, significant areas for development lie in other types of interfaces made from clusters of varying sensors, materials and environments. The realization of a monolithic scene that is capable of being flexible enough to display sufficient quantity and quality of expression is, I think, optimistic.

3. PRESENTED EXAMPLES

The examples presented here are those that have been developed to a practical, if prototypical, level. They are not proposed as being in any way definitive in either form or function.

3.1 Gaggle

The Gaggle interface [10] was originally conceived as an improvisatory interface for the control of algorithmic, automatic music for use at the HCI 2009 conference in Cambridge UK [16]. Generative aspects would control most aspects of the music. The

purpose of this was almost entirely in order to help me understand the creative process itself through developing software that emulated it, and a very clear part of that emulation has always been recreating, or at least taking account of those elements of 'liveness' that inevitably make live performance so satisfying. These elements, investigated in depth elsewhere [12], include aspects of indeterminacy, most obviously the repetition of melodic, rhythmic and timbral material with variation and the software encapsulation of various global structures such as the length and order of particular groups of material. The Gaggle interface comprises nine ultrasound sensors: in this case 'Ping' units manufactured by Parallax [20]. These units work by instructing an emitter to output a 40 kHz frequency sound for 200 μ s. The pulse is then read on its return and duration of echo calculated. This provides a quite precise indication of the distance of any solid object positioned directly in front of the unit to a manufacturer's limit of 3m. The ultrasound units are held in place with 'goose-neck' stay-put tubing (hence the name Gaggle) allowing for the customization of placement of the units.

The data collected from the sensors is used to control sounds generated in the SuperCollider audio environment. The parameters were manipulated in a number of ways: the 'pitch', the modulation index of a frequency modulated sound, the amplitude of a sounds component, the data triggers certain algorithms that control a number of these parameters.

Figure 1. Dancers interacting with Gaggle

For HCI2009, we were commissioned to collaborate with the choreographer Jane Turner [22], and it was the way that her dancers interacted with Gaggle that was of particular inspiration in the development of these units. Figure 1 is an example of one particular interaction. In this case, the dancers, through structured improvisation, arrived at the point where they found that this pulsing movement provided a rewarding sonic/movement-based result. A particular movement could produce a variety of controlled but relatively unpredictable outcomes; the latter is an

important issue in this work.

The relationship that could be seen developing between the dancers and Gaggle puzzled and inspired me; in particular it made me consider other aspects of interaction that might occur. Without any special prompting from Jane, they moved around the space, utilizing its features, such as a large tubular pillar and the Festival attendees themselves, building up an interactive space in which their relationship with the unit and their environment could develop.

Figure 1 is also an example of one of the key motivators in the performance: the attempted control of the sound by physical gesturing. A primary use of the analysis of the dancers' behaviour in this situation for a composer is the incorporation of such physical gestures into subsequent designs of both interfaces and algorithmic responses. It is this mapping which is the metaphor itself and the extent to which actions should correspond or contradict the relevant metaphor is of crucial significance in determining the nature of the resulting work.

At one point the dancers circled Gaggle with some velocity, sweeping their arms up and down outlining 'waves' around the unit. This suggested that the dancers felt (correctly) that more movement indicated a greater number of audio events. The metaphor used in this particular case was that greater movement means greater sonic activity: the movement reflects the 'design' of the unit in that circling it is the best way of creating movement near it and so generating the movement required of the metaphor. There are further details and analysis of these movements elsewhere [10].

3.2 Wired

Wired is a prototypical interface utilising the high input impedance of the trigger pin of the 555 Integrated Circuit (IC). When the IC is triggered by the induced voltage of human body the output goes high for a time determined by the values of a resistor and a capacitor. This enables a simple structure such as a wire to be used as touch sensor.

The design has been very much influenced by the use made of Gaggle. The experience of working with dancers and their freedom of expression through physical movement showed that they very much enjoyed interactions with interesting and novel objects. The device has been demonstrated at the Museum interfaces, Spaces and Technologies (MIST) workshop in Cambridge in March 2010 and showed again how eager delegates were to experiment and investigate unusual devices. The device was praised for ease of use and for enabling those with little or no musical experience to 'perform' in a pleasing and expressive way.

3.3 Touchable/Approachable

The Approachable is a unit currently in preparation. The catalyst is, again, experience of work with dancers as well as from seeing interactions with the public. It seemed clear that to approach a unit was one of the most natural of actions, as shown in Figure 2. However, when interacting with the Gaggle, investigators were not enthusiastic about touching the unit, so the Approachable was conceived to react to both proximity and pressure. Performers could investigate positions from a point of significant distance from an object to a point allowing physical contact and pressure.

An example might include use by multiple performers from multiple perspectives. The position of a performer on one side of Gaggle might determine the nature of what might happen with the data from a performer on the other side: so, the closer the first performer was, the more violent and active the general algorithms were (although the detail of the movement might be controlled by the second performer), until the first performer reached a certain point, when the whole texture might change to something very gentle and soft.

4. ISSUES

Cook in an entertaining paper [6] suggests that programmability is a curse, and that one should write music, not develop controllers. He also gives an indication of some of the pitfalls of interface design and suggests principles that might be considered. Ten years after the publication of Cook's paper it might be possible now to consider again issues and questions that could be used in the continuation of this research.

4.1 Form versus Function

How feasible is it to discuss how Beethoven's Violin Concerto is influenced by the design of the violin? The relationship is fundamental but the two are so intimately linked that the link seems almost tautological. Is this not equivalent to saying that function and form are in practice the same? We have been so used to the idea that electronic replicas or extensions of instruments, (even laptops themselves) are musical instruments, perhaps we find it hard to see clearly in this subject. Existing instrumental designs also effect the way one wants to play them: the typical use of a keyboard to control synthesisers encourages users to play them like pianos, whatever the sound or texture is being played or is most appropriate.

4.2 'The instrument is the composition'

While there have been many attempts at making new instruments to replace existing ones, so far the replacements have in general signally failed to make

much impact on the usual selection of 'standard' instruments. This may be because performance on a musical instrument is the totality of the experience of a real human manipulating a real object. Devices such as the iPod show that it is not necessarily the functionality of any particular device that is important, but the balance between capability and ease of use. The latter might quite explicitly require a reduction in functionality. Another option is both a combination of these and a rejection: the instrumental design becomes a part of the creative process itself and is no longer assumed to be an independent item.

4.3 Is programmability a curse?

Programmability is not possible in the domain of the 'real' musical instrument. One has only 'real' options: physical interferences such as muting, mutating and hacking. Things that are programmable do not possess that solid boundary beyond which we cannot go. We have either a flute or a clarinet. Replace a flute's mouthpiece with a clarinet's and what do you have – a soprano saxophone? Maybe, but not a flute. However, your 'hyperflute' can be anything you wish – a flute, a trumpet; even a drum machine! So what is it, exactly? A synthesiser.

4.4 Performer, composer or improviser?

How have attitudes towards instrumental playing changed and how have these changes resulted in practical changes in performance? Performances before the twentieth century could be very different in quality, tone and content from what we might expect [5]. Today there is a more acute interest in precision, virtuosity and exactitude in approaches to 'classical music'. This interest may have isolated this genre from other more popular and experimental activities.

There is a difference between 'interaction with things and the creation of music' and 'a musical instrument'.

Aesthetic design plays a significant role in defining how a 'performer' might interact with any given object.

In a gallery-type environment, does the visitor become a performer? What do they want from such an experience? How much prior experience/learning should be involved?

If a musician or other deliberately chosen performer is the object, do they require more from a unit? Would they want more potential for control in order to increase possible expression? Most people are unable to coax a musically sophisticated sound from a violin at first, but the violin has enormous potential for expression.

Finally, how feasible is it for a unit to 'perform' well in these different contexts? Experience suggests that an initial surge of interest soon wanes without an intriguing structure or some other activity to engage attention.

4.5 Conscious control

While in comparison to their technological counterparts acoustic instruments may seem simple, in reality they are not. We are familiar with these interactions and find it easy to ignore the quantity of information available from any 'simple' act of expression. This information comes about through the use of continuous control information on a simple parameters. A flute has a fixed number of finger holes, but the breath control is continuous and there are unlimited ways of controlling a flute's tone through breath (also finger holes need not be fully opened): it is certainly the most significant factor in expression on the instrument. Any 'standard' acoustic instrument has similar factors. A musician practices using these continuous controllers and if they becoming a good player usually means no longer needing to utilise conscious control; lower level activities such as fingering and breathing become automated, allowing more concentration on higher level tasks such as musical expression.

One of the main experimental strategies in developing new units is in concentrating controllable parameters in particular areas and using particular sensors so that conscious control of all parameters is difficult or undesirable.

4.6 Latency and responsiveness

This is a technical issue involving the speed and quality of response. Imaginative users frequently gesticulate as in Figure 2, starting slowly in order to ascertain how the unit will react, but soon after they will use sharp and sudden movements to see how quickly the unit responds. Gaggle has not been set up to respond in this way, although it could be programmed to be more immediately responsive. The Arduino card used in the current configuration is not enormously fast, and although a fairly large amount of quite high-resolution data (0-1023) is transmitted, with nine sensors there is inevitably some latency. This matter can easily be overcome by using a faster interface such as the Teabox [1] which operates at audio rate, but as this product is significantly more expensive than the Arduino board developer may wish to be meticulous in deciding when to use each board. It is also sometimes possible to overcome such latency with specific programming.

5. CONCLUSIONS

Each individual's 'encounter' with the units provides a unique insight into that person's previous experience and methods of interaction, as well as into their 'requirements' in creative terms.

Aesthetic design ultimately affects the way in which the user encounters the unit, and this experience plays a fundamental role in that users understanding of that encounter. How this understanding changes and develops in time is a fundamental question in music.

6. REFERENCES

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