score, which allows for objective evaluation of the proposed algorithm. Our results show that among 48 fugues, 19 had the main theme in the top ten most significant melodies. This greatly helps the user as there was an average of 483 melodies per fugue. By empirically tuning all the parameters the following combination turned out to work best: pitch difference in semitones, notes’ rhythm ratio, maximum theme length: 23, required min. number of occurrences: 2, $B_{max} = 4$, $B_{min} = 60$, $C_1 = 128$, $C_2 = 23$, $C_3 = 91$.

Application also offers other functionalities. It allows user to listen to the whole score, selected voices or only specific melodies. If the analyst is interested in a specific melodic or rhythmic pattern he can search for it using the LilyPond syntax. The p- and m-suffix tree views allow user to flatten the tree for example to sort the results by specific attribute like the melody rank. Tight integration with Canorus allows selecting a melody and showing all its occurrences on all degrees in the score. Harmonia also provides score statistics like the note count per voice or instrument and the number of nodes in both p- and m-suffix trees. It can also visualise score statistics, for instance the melody distribution according to their length and frequency.

![Figure 4](image.png)

**Figure 4**. Screenshot of Harmonia showing the m-suffix tree for J. S. Bach’s Fugue no. 2, WTK 1. Upon selecting the melody, all its occurrences were also selected in Canorus visible on top.

6. CONCLUSION

Determining the “true” theme of a musical piece is a difficult and, in general, subjective process, so completely automated analysis of melodic patterns is impossible. The best we can hope for is a computer tool to assist the analyst in the process of sorting out the frequently occurring interesting patterns.

We presented a data structure that can be used to discover, store and explore interesting melodic patterns in music, and a heuristic function for ordering the patterns by their supposed interestiness. Although we empirically showed that proposed heuristics work well, the true contribution of our work is the working application for interactive analysis of patterns, implemented as a part of Harmonia suite.

We believe that the proposed technique can (and needs to) be extended even further. Perhaps the most obvious direction is to improve the evaluation heuristics by incorporating some aspects of aesthetics and, even more importantly, to let the tool recognize variations of a theme as the same theme.

7. REFERENCES


**ALLOTROPE – WORKS FOR SOLO TRUMPET, LAPTOP, PEDALS, AND GUITAR AMPLIFIER**

Dr Peter Knight  
Northern Metropolitan Institute of TAFE

1. ABSTRACT

This paper traces the development of a series of works for solo trumpet with laptop electronics, pedals and guitar amplifier. Through a reflection of the author’s experience as a trumpeter/composer/improviser living and working in Australia while also taking account of broad movements in contemporary music particularly in improvised forms.

Following a practice-based research model it investigates how composition and improvisation intersect in the author’s practice. It also describes and reflects upon the use of electronic processing, sampling, and layering in the author’s improvisational and compositional language as he outlines the broadening of his practice through the integration of this media. The study and practice of extended techniques for the trumpet and their application in this electroacoustic setting are also briefly documented here.

2. INTRODUCTION

“Allotrope: Any of two or more physical forms in which an element can exist - diamond and graphite are allotropes of carbon” (Macquarie Dictionary, 1991, p. 46).

“The solo project creates the possibility for opening, expanding, and focussing technique, from the aspect of ensemble playing that can be constraining. It is also a setting wherein the comfort zones offered by ensemble playing are stripped away. It is a difficult, vulnerable, but rewarding place” (Peter Knight Journal entry 2/4/08).

I am a trumpet player and composer with a background in jazz. I began to expand my practice through the incorporation of electronic media around six years ago. The solo project, Allotrope, which I describe during the course of this presentation, involved the development and refinement of a language of sounds created using the trumpet and real time laptop processing along with a range of other pedals and a guitar amplifier. This project led me to examine my practice in new ways, to learn new skills, and new approaches to performance. In it I bring together contemporary approaches to the trumpet and technology to develop an idiosyncratic and highly personal sound world focussed on texture and timbre. Minimal and abstract, it also incorporates melodic material. Rhythmic elements are often obscured – pulse or ‘beat’ gives way to breath and gesture.

3. FREEDOM THROUGH LIMITATION

Early in the development of this work I decided to limit myself to using only sounds generated by the trumpet as the raw material for digital processing. This removes an array of possibilities offered in the digital realm such as synthesised sounds and samples from other sources. This limitation was an important step for me as it gave the project focus and enabled me to move forward – in a sense it gave me freedom.

Stravinsky talks about the apparent contradiction of freedom created through self-imposed constraint in The Poetics of Music (1942). He describes “a kind of terror” at the “abyss of freedom” that confronts him in the moment of setting to work on a composition. He writes: “Let me have something finite, definite matter that can lend itself to my operation only insofar as it is commensurate with my possibilities” (1942, p. 64). Perhaps the range of possibilities one confronts with digital media is even more terrifying than that which Stravinsky describes because literally anything is possible without even the limitations of technique, as material from any source can be ‘flown in’ at the mere push of a button. This ‘democratisation’ of music making, which has accompanied sampling and processing of sound using computers has in a sense made musicality even more of a premium – while, with a laptop and the appropriate software, anyone can put sounds together to create an ambience or a ‘soundscape,’ fewer can use the same materials to delve deeper into the craft of composition to explore structure and other formal elements.

I hasten to add that, for the purposes of this discussion, my definition of ‘soundscape’ relates to the creation of ambient sound works rather than to the usage of the word pioneered by Murray Schafer (1994) and others in the 1970s, which relates more generally to the acoustic...
environment and environmental sound. The definition of works such as 'soundscape' as well as 'composition' are slippery so for this discussion I define music composition as the creation of a piece of music that requires a complete listening to be properly 'read.' In my view, this is distinct from 'soundscape,' which I define as a piece of music or a sound work that can be listened to at any point in its duration for any length of time and be understood. In addition it is worth noting that the creation of soundscape is an entirely valid form of composition, but it would argue it is a different form of expression from that of music composition.

From the outset my aim has been to create compositions rather than soundscapes. And for me it doesn’t really matter whether you are writing a pop song, a symphony, creating musique concrète, or indeed a spontaneous composition (improvisation), what we do when we compose music is balance consistency and variation to create interest, and to create a sense of ‘unfolding in time.’ This is something one of my teachers, Mark Pollard, impressed upon me and it is one of the most valuable lessons I have had. It makes sense of the various strands of my diverse practice, connecting what I do when I play jazz to what I do when I create in more abstract settings (improvisation), what we do when we compose music or a sound work that can be listened to at any point in its duration for any length of time and be understood.

Critical processes in the development of Allotropes are in balance. Music is balance consistency and variation to create interest, and to create a sense of ‘unfolding in time.’ This is something one of my teachers, Mark Pollard, impressed upon me and it is one of the most valuable lessons I have had. It makes sense of the various strands of my diverse practice, connecting what I do when I play jazz to what I do when I create in more abstract settings (improvisation), what we do when we compose music or a sound work that can be listened to at any point in its duration for any length of time and be understood.

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Max MSP is one of the most popular sound processing programs currently in use and is favored by many electronic musicians.

A Ableton is a platform on which you can run any number of sound processing programs that process sound in various ways from within the Ableton environment. I spent a great deal of time experimenting with a wide range of these plug-ins narrowing down a selection that suited my purposes. Some of these are part of the Ableton Live ‘bundle’ (they come with the programs). These include Autotune, which enables a squashing or expansion of the sound envelope and Erosion, which distorts the sound and gives it a ‘low-fi’ finish. Like many of them they can be mid-mapped allowing the parameters of the plug-in to be controlled via my foot pedals or USB controller.

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Ping Pong Delay creates a delay and bounces it from one side of the stereo pan to the other in the manner suggested by its name. This plug-in is effective in creating an immersive aural environment disguising the attacks of shorter sounds and swirling longer sounds across the stereo image. I used this plug-in to process long breath sounds to enhance the sense of the movement of the breath in space.

When working with breath sounds I also, at times, employed the Resonator plug-in, which alters the timbre of a sound and gives it a tone or pitch even if the original signal is unpitched. I used this plug-in with the pre-set Berlin often to create a drone often in conjunction with a reverb pre-set called Frozen Build Up. This reverb has an extremely long decay and a shimmering sound quite unlike that of conventional reverbs that attempt to mimic the sound of a room. At times Frozen Build Up can sound almost like feedback, leaving notes reverberating for many seconds. This allowing an opportunity for further processing of the sound or the creation of dissonant or consonant harmony through the layering of other notes. The plug-ins mentioned above process the sound in a ‘linear’ manner, which means, in simple terms, the ‘output’ of a plug-in is another type of processing called granular synthesis, which Opie describes as “a method by which sounds are broken into tiny grains which are then redistributed and reorganised to form other sounds” (2009). Granular synthesis has a rich history in contemporary music since it was first pioneered by Graney in the late 1960s and early 1970s and used by Xenakis and other composers who created the effects by cutting up tapes. There are a range of plug-ins I used during this project that process

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the sound via granular synthesis including Transverb and Scrubby, which are both made by a company called Destroy FX.

The Hipno suite of plug-ins (now discontinued), made by Cycling 74 the creators of MAX MSP, also employs granular synthesis as a primary mode of processing. I focussed on one of these plug-ins called Drunken Sailor throughout the course of this project. Drunken Sailor is particularly interesting and effective because of the way its ‘buffer’ works. It samples a small amount of material and then processes it using numerous parameters, which change depending on where the puck is located in the coloured circle (see Figure 1).

The position of the puck can be controlled using the expression pedals on my foot pedal board enabling a very intuitive approach to the processing parameters.

“Drunken Sailor can be a hard instrument to control or predict but I enjoy the randomness and have stumbled across sounds I would never otherwise have found” (Peter Knight Journal entry 06/05/2009).

8. PROCESSING OF EXTENDED TRUMPET TECHNIQUES

In addition to the time spent developing my digital processing environment, during the course of this project I also focussed on expanding my range of acoustic extended trumpet techniques. These form much of the raw material that I use for the ‘noise-germ’ but that is not the whole story. We have also employed acoustic manipulations carried out in Ableton. As mentioned in my introductory paragraphs, one of the limitations I placed on this project is to only use sounds I can produce with the trumpet. Limiting my sound palette in this manner has helped bring focus and consistency in terms of how I work with the computer and it has also helped to push me into interesting realms of trumpet playing.

The world of extended techniques in trumpet playing continues to be explored by a number of significant players including Arve Henriksen, Peter Evans, Scott Tinkler and Axel Dorner. I have developed a range of idiosyncratic extended techniques in addition to the large number of techniques that have become standard in contemporary trumpet playing.

In my playing I employ all of these standard techniques, and during the course of the development of Allotrope also developed my own personal approaches and preparations. As I outline in paragraphs to follow some of these were influenced by the languages of other players who I have worked with, others come from players who I have heard live and on recordings, and some I have ‘discovered’ myself. With these techniques I am able to create sound worlds that are abstract yet specific to the trumpet. They include glottal stops, which I tend to process via granular synthesis plug-ins such as Drunken Sailor re-pitching the original signal. This is very effective especially in the lower register. At times I also take these processed signals and route them into a new channel so I can sample them and re-process them setting up off kilter loops that can be sent to any of my plug-in return channels.

I make extensive use of un-pitched breath sounds, which form some of the fundamental timbral and textural effects of this work along with other sounds that are traditionally considered ‘improvises’ to be avoided in the production of trumpet ‘tone.’ I relish these ‘undesirable’ sounds: the hissing of air, the clunking of valves and the squeak of a ‘misplayed’ note. An essay by Henry Cowell, entitled ‘The Joys of Noise’ is relevant in which he states, “Since the ‘disease’ of noise permeates all music, the only hopeful course is to consider the noise-germ, like the bacteria of cheese, is a good microbe, which may provide hidden delights to the listener, instead of producing musical oblivion” (In Cox & Warner, 2007, p. 22).

Another of the techniques I employ to explore this ‘noise-germ’ is involving using my two clip-on bell microphones to careful effect. I take out the second valve slide slide for the side of the trumpet (refer Fig. 2) and clip one of the microphones to the side of the trumpet to pick up the breath sound escaping from the valve slide then I clip the other onto the bell as another means of creating a ‘slide’ in preparation in combination with a hard stereo pan between the two microphones we hear the breath from two separate (and mutually) exclusive sources along with valve clunks dancing from side to side in the stereo image. I tend to also add a high-pitched whistle that I make in the mouthpiece. When processing is added to these sounds (often with the Transverb and Scrubby plug-ins) some very interesting effects emerge.

With the same microphone set-up and processing environment I also create popping and thudding sounds with the valves. This is a technique I discovered for myself as a boy pulling my trumpet apart. When the first or third valve slide is pulled, pressure builds up. It can be released by popping the slide all the way off by depressing the valve corresponding to the slide being pulled. When the valve is depressed, the air pressure is released creating a popping sound. This turns the trumpet into a kind of a percussion instrument except that the sounds do not resemble sounds that can be made using any instrument other than a brass instrument. And this is important to me: it is important that the sound world I create using these techniques remains, however abstract, connected to the trumpet.

Similarly I aim to maintain this connection in the processing techniques I apply. I try to focus on techniques that will enhance and explore the properties of the trumpet rather than render them unrecognizable. In truth though, I am sure most listeners would not be able to discern the sources of many of the sounds (either raw or processed) I use in Allotrope if they listened acoustically, but nonetheless the sounds remain recognisable and linked for me and this is crucial. Again this is about focus and creative direction achieved through, to some extent, limiting one’s palette.

9. REFLECTIONS

With Allotrope, as in my music practice in general, it is important for me to somehow create a balance between the conceptual and the direct – the sensual and the cerebral. The contrasting approaches of trumpeters such as German based, Axel Dorner (2004) and Norwegian, Arve Henriksen, who have both exerted influence on my practice and in particular in the context of this solo work, are relevant.

Dorner uses a trumpet modified with integrated contact microphones and processes the sounds created through various electronic means. He challenges our notions of what trumpet
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Figure 1: Ableton Live screenshot of 'Drunken Sailor' plug-in

7. GUITAR AMPFLIFIER, PEDALS AND SIGNAL ROUTING

As well as processing my trumpet through the laptop I expand my processing environment by using two clip-on bell microphones, volume pedal, distortion pedal and guitar amplifier. One of the microphones is a dynamic microphone, which does not (therefore) require phantom power, which I route to a volume pedal following by a RAT distortion pedal and then into a guitar amplifier. The second clip-on bell microphone (a condenser microphone) is routed straight into my laptop via my MOTU soundcard and is used to capture the natural trumpet sound. Finally, I also run a direct line from the guitar amplifier into laptop via the MOTU so I can process the amplifier signal.

This set-up enables me to generate and control feedback from the amplifier through the use of the volume pedal. I can set the feedback off using the clicking of valves or with breath blown through the trumpet and also then also process the sound of the feedback. I used these sounds in juxtaposition with the sounds of the ‘clean’ trumpet to create a dialogue between the two.

One of the most satisfying aspects of this set-up is that it relies on the physical gesture. The note produced by the feedback of the amplifier changes depends on the proximity and position of the trumpet and on which valves are depressed. In addition I can modulate the feedback by the movement of my hand over the mouthpiece of the trumpet. As I have worked more and more with this I have developed a physical language that incorporates the movements of my feet across the pedals and my trumpet in space.

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Dorner uses a trumpet modified with integrated contact microphones and processes the sounds created through various electronic means. He challenges our notions of what trumpet
play can be, developing an aura that has more in common with an industrial soundscape than conventional trumpet playing, and which brings to mind Russolo's futurist music manifesto, L'arte dei Rumori [The Art of Noises] (1916) in which Russolo envisions 'noise music' replacing traditional melodic music. Nonetheless, 'noisy' as it may be, Dorn's sound world could not be produced without the trumpet and his explorations at the outer limits of instrumental and performance practice have had a discernable impact on my working process.

In contrast, Arve Henriksen employs processed and unprocessed trumpet to create a shimmering ethereality. His music is often melodic and direct and engages on a sensual level – in short much of his work is ‘beautiful’.

I wanted this project to occupy a space somewhere between these contrasting conceptions: to invite melody as well as abstraction, to be conceptually interesting and also sensual, to balance the Apollonian and the Dionysian. Whether I succeeded in these artistic aims it is hard for me to say and in truth it is difficult to evaluate one's own work. Certainly though, in the course of this project I challenged my own conception of the trumpet and succeeded in finding new ways to broaden my practice using extended trumpet techniques, trumpet preparations and laptop electronics while also connecting with my own history with the extended trumpet techniques, trumpet recording. UK: PSI Records


10. REFERENCES


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ITERATIVE SYNAESTHETIC COMPOSING WITH MULTIMEDIA SIGNALS

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ABSTRACT

This paper explores the use of orchestrated feedback as an integrational theme in an interactive multimedia composition entitled Annular Genealogy. The composition is performed by two players, each of whom use a separate digital interface to create and interact with the parallel iterative processing of compositional data in both the aural and visual domains. In the aural domain, music is generated using a stochastic process that sequences tones mapped to a psycho-acoustically linear Bark scale. The timbre of these tones and the parameters determining their sequencing are determined from various inputs, including especially the 16-channel output of the previous pass fed back into the system via a set of microphones. In the visual domain, animated, real-time graphics are generated using custom software to create an iterative visual feedback loop. This software runs on the iPad tablet and uses a custom fluid dynamics system, a vector visualization technique, and custom image processing filters to generate complex, evolving visual structures. Additionally, information from each of the domains is transferred into the other domain in real-time over a wireless network: sonic data is used to control the image processing parameters and visual information influences the generative parameters of the audio component. Interactive control of the composition is available through multi-touch interaction via the iPad tablet (for the visuals) and via the use of SuperCollider as a live coding environment (for the audio).

1. INTRODUCTION

Annular Genealogy is an interactive multimedia composition for two performers using multi-channel speakers, a projector, and a tablet computer. The performance is organized around a generative music composition and its visual analog. Both the audio and visual components are explorations of feedback processes that encourage the performers to interactively shape aleatory elements and transmute them into appealing, transient structures. The composition engine works with a stochastic sequencer that uses Brownian motion as a guiding metaphor. Similarly, the visualization engine depicts colored fluid energy as a representation of dynamic, ephemeral structures. In addition to exploring these feedback processes independently of each other, each engine also directly influences the other via networked communication: both the visual and audio processes broadcast data via OSC signals to control music parameters; and the sequencing parameters controlling the generation of the composition as used in inputs to control image processing parameters.

In addition to having cybernetic properties of interconnected feedback systems, we underscore the piece as being fundamentally synaesthetic. That is, the mixing of the mutual generative processes confounds the aural with the visual or vice versa [4]. Through the continuous interlinking of the two engines (via the performers and via the data sent over the network) a single interconnected multimodal signal is created. The output of this signal is represented simultaneously in multiple domains. Figure 1 shows a high-level chart of the relationship between the performers, the audio, and the visualization and composition engines. The performers input information to software in parallel using live coding and the multi-touch capabilities of the iPad. The outputs of each of the software engines then are fed back into themselves and into each other in various ways.

Figure 1: High-level overview of the Annular Genealogy project showing processes at three tiers: performer, computer, and audience member. The darker lines indicate the main feedback loops where the output of one process is piped in as the input to another.

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