array

the journal of the ICMA

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array

Array, Journal of the ICMA

Editor: Christopher Haworth
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Letter from the President
by Tom Erbe

February 3, 2016

Dear Readers,

It is my pleasure to welcome you to the second issue of Array, with editor Christopher Haworth. This important publication reflects our work and our community, and I would like thank Christopher for making Array an active and lively publication once again. We encourage you to contribute your event reports, music reviews, and other articles.

This also represents the first issue of Array that is available to all readers. Array was previously only available to ICMA members - but we feel strongly that we need to grow the computer music community by making this publication open to all readers. A wider awareness of our activities as researchers and musicians can only make our yearly conference stronger and more vital.

Finally, on behalf of HKU University of the Arts Utrecht, HKU Music and Technology and Gaudeamus Muziekweek, I would like to invite you to join us at the next International Computer Music Conference in Utrecht, the Netherlands. This conference promises to be a very special one, not only for its location, but also for its intriguing theme: "Is the sky the limit?"

The paper and music deadlines have been extended to February 29th, so there is still time to participate. I hope to see you there next September.

My very best,

Tom Erbe
President, ICMA

Letter from the Editor
by Christopher Haworth

Hello and welcome to the 2015/16 issue of Array. As well as the usual assortment of keynotes, CD and concert reviews, we are honoured to be able to devote part of this issue to a tribute feature on the musician and scientist David Wessel, who died at the end of 2014. David Wessel was a pioneer in so many of the subdisciplines that make up our field, and played an instrumental role in the disciplinary formation of Computer Music. He was involved in the organisation of the very first ICMC at Michigan State in 1974, and continued to maintain a presence at the conferences up until the last years of his life. Thanks to John Chowning and Chryssie Nanou for collating these tributes; they provide a unique glimpse into his life and achievements.

As Tom noted, Array is always keen to hear from its readers. If you would like to write something for Array, have ideas for future issues or blog posts, would like to advertise in the journal, or want to get in touch concerning anything else then please email array.journal@gmail.com. Those interested in writing a review should also include a mailing address and any particular areas of interest, so that any materials can be mailed to you. CD/DVD and book reviewers will be able to keep review copies.

The next issue of Array will be a little bit different to normal. Co-edited by PerMagnus Lindborg and Suzy Styles, it will feature the proceedings of Si15 2nd International Symposium on Sound and Interactivity, which was held 20-21 August 2015 in Singapore, as part of Soundislands Festival. In a second break with tradition, this issue will arrive hot on the heels of this one, in the first quarter of the year. Stay tuned...

Christopher Haworth
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David Wessel Remembered

After the sad news of David Wessel's death at the end of 2014, John Chowning collected the following tributes from David's friends, colleagues and former students. Array is pleased to be able to publish a selection here (with special thanks to Chryssie Nanou).

John Chowning

In my first years of teaching at Stanford University, I was listed as faculty in percussion in addition to computer music and theory. I was approached in 1966 by a graduate student in Psychology who asked me to give him percussion lessons and thus began a friendship with David Wessel that continued until his sudden death on Oct 13, 2014. In fact, he was already an accomplished jazz drummer, but he wanted to work on new music repertoire—reading and performing. I was intensely interested in what he knew about perception and he was equally interested in the work that I was pursuing in computer music. He saw immediately the vast research and musical potential of Max Mathews' application of the sampling theorem to music. It became the seed from which most of his work sprouted because it allowed the manipulation and study of sound in a new way - and even David's most abstract ideas and creations were never far from sound!

It is not easy to write about someone who has been such a close friend and colleague for so many years. Writing thoughts and feelings about David seems to stop him in place, when his personality and ideas were always evolving — in motion. I am also aware that my knowledge of David is bounded by my own limitations; there is much of David's work that is beyond my capacity to know. And so I asked colleagues and friends to write a few sentences regarding David, whether as artist, teacher, colleague, friend — whatever. Thus, we find solace in reading these tributes. We see how his ideas sprout ideas that continue to evolve — in motion — through generations!

David was remarkable and so are those who worked with him — and that is not by chance, I believe.

Jean-Claude Risset

David Wessel has been a most inspired and inspiring figure in computer music. His inventiveness, his insight, his imagination, his curiosity, his dedication, his communicative enthusiasm, his generosity, his warmth have been great assets to the development of computer music. His numberless contributions were of great importance for musical creation, performance and theory. His speculative ideas were potent and audacious, well organized and clearly formulated. His bold visions were always practical. He was instrumental in establishing standards helping to share musical data and to make the development of computer music resources a collective endeavor.

David contributed to make the notion of timbral space familiar and useful. As a performing musician with deep skills in mathematics and psychology, he developed methods to establish personalized timbre maps permitting predictions about the combination of sounds. Such maps provided navigational help for musicians interested in exploring the continuum of timbre.
David was like a beacon. Many musicians, scientists, and students were set in motion by David's flow of suggestions. David played an extremely useful role in IRCAM in the 1970s and 1980s, and he created and developed CNMAT, a most original and active institution for musical research and creation. I always enjoyed working with David, and I am personally deeply grateful for his help and his incentive proposals. His death is a great loss for the community, but he leaves a path to continue and an example to follow.

Roger Reynolds

We encounter, in the course of our lives, many people. But also few. Some categories of people have only one occupant. David Wessel was one of those. He had a singular ability to catalyze creative awareness and growth, whatever the circumstances. His capaciousness of mind was disconcerting. I encountered him at Ircam in the early 1980s. He seemed almost magical, a migratory bird, a stork of the intellect who delivered bundles of useful insight and perspective both inevitably, and inexhaustibly. It was like this: the geometry of Ircam involves several levels of offices and studios. Different (often very) individual researchers and teams inhabit these spaces. David followed a meandering path through the facility that resulted, for the occupants of each space, in unexpected visits. One day he would appear. He wanted to know what you were up to, what difficulties you might be

having, what discoveries were emergent. He was a gifted listener in that he grasped quickly what the center of the situation was – whether all was well or whether components in the mix needed to be realigned in some way so as to become more productive. He gave away insights, references, parallels, enabling connectivities and proposals for action in a prodigious way. Then – suddenly realizing that something else called he would exclaim (it always seemed genuine) "I'll be right back!", upon which he would exit the space and continue his unknowable route through 'the house'. His return could easily be weeks later, but he would pick the discussion up where it had been left as though it had only been a few minutes. Anyone who knew David could tell story after story of ways in which his zest for life, for ideas, for experience, and for the tenderly caramelized pleasures of food and drink and companionship was made manifest for them. (I remember the perilous elasticity of the ancient floors in his Rue Quincampoix apartment, and the delicious experience of enduring Syberberg's 5-hour Parsifal with him.) David made not one but many impacts on my life for which I will be always and deeply grateful. His accomplishments as a person and as an actor in this pageant of life we inhabit are to be admired and remembered for themselves but also because of the generosity of mind and spirit that they displayed. Always.

François Bayle

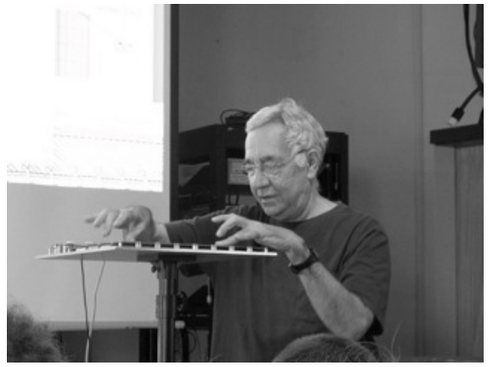
David Wessel, with his lucid and generous sensitivity: an emeritus figure of our beautiful musical history!

Vijay Iyer

Today my dear friend and mentor, Professor David Wessel of University of California, Berkeley, passed away very suddenly.

It's difficult to convey the impact this man had on my life. Twenty years ago I was in a confused spiral out of a physics PhD program, and he found me, took me under his wing, calmed me down and helped me study music on my own terms, in the special place that he founded -- the Center for New Music and Audio Technologies (CNMAT).

I spent those next four years in constant contact with him. He taught me about the ear, the brain, the body, pitch, timbre, rhythm, improvisation, perception and cognition, mathematics, computation, neuroscience, signal processing, statistics, and psychology. Through him I met George Lewis, Roscoe Mitchell, Jonathan Harvey, Oliver Johnson, J.D. Parran, Erv Hafter, Anthony Braxton, Steve Lacy, David Zicarelli, Salamat Ali Khan, and dozens of other amazing folks. I programmed in Max, witnessed the beginnings of MSP, and learned about electroacoustic music. I gave my first conference talks, saw my first academic publications, and wrote a dissertation under his guidance.



We also made music together: me on piano, and David on his interface of choice -- a keyboard connected to a sampler, or the Buchla Thunder, or finally his own Slabs (shown above) -- along with computers that fit in two suitcases and later in one backpack, running programs he created that implemented ideas he developed. Inspired by the creative music movement and by experimental psychology, he was a totally original artist who thought for himself.

A true leader, teacher, and friend, David Wessel left an immeasurably huge legacy of ideas. He changed dozens if not hundreds of lives. He will always be a guiding force in my life and work.

So long, David. I don't know where I would be right now if you hadn't intervened at that moment in 1994, but I know that this was the better path by far.

Chris Chafe

This might not be well known. In addition to everything David and I did together (mentor, boss of the best kind, colleague, musical partner, advisor) he had a campus radio show in Michigan when I was a college student living in the same town. The music was the finest selection of new work from all over the world with a special focus on Chicago and his colleagues in improvised music. It was awe-inspiring and life-changing.

Adrian Freed

David certainly did exactly as Jean-Claude Risset described at IRCAM then, and it was a pleasure to help him in that endeavor by using the awkward opportunity of replacing the PDP10 with the UNIX system. One of my first memos as Responsable du Service Informatique was sent to the entire staff. I introduced the new system and mentioned that everyone's desk would have a terminal on it so we could e-mail each other and use the system for word processing, music production and scientific research and analysis. This caused an uproar from the factions who thought the system should be for them exclusively. Boulez called a plenary meeting to sort it out, listened carefully to everyone's concerns and posturing, and then simply declared that everyone should cooperate with my

proposal. I had never seen such power wielded so quietly before - the efficiency of a mostly benevolent dictatorship. Underwriting the promise was hard work, but the resources kept appearing to do it - another staff member, consultants from the US etc. David was behind that.

David loved this environment of 'rolling up the sleeves' to move things forward and made it easy for me to forge friendships and collaborations with Bennett Smith, Steve MacAdams, Xavier Rodet and so many others.

These last days I have been called very much to the present and future - helping David's family and the CNMAT family through this difficult time.

Thanks for bringing me to think back to those early days with David - the beginning for me of a fabulous ride on that magic carpet he made for us to fly on.

Fred Lerdahl

David and I became acquainted in the early 1980s, first at a music-brain conference in Ossiach, Austria, and then during residencies that I had at Ircam. He was a living library of information in experimental psychology, music perception, and computer music. His brain was the ultimate parallel processor. When he had an abstracted air, as he often did, it was because he was juggling five trains of thought at once. He also exuded personal magic, a reflection of his boundless enthusiasm and generosity of spirit. Exchanging ideas with him was always exciting.

At Ircam he was my first and most important instructor in psychoacoustics and computational thinking. He helped guide my attempts to adapt the theoretical constructions in A Generative Theory of Tonal Music (at the time not yet published) as a computer aid to composition. A few years later, inspired by his pioneering work on timbral spaces and by our many conversations about the role of timbre in contemporary composition, I explored the proposition that timbre could be organized hierarchically. This project, though only a qualified success, proved to be fruitful in a larger sense, for it set me on the path toward a far more successful model of pitch space. Thus much of my work in music theory and cognition is indebted to conversations with David. This is typical of him: all his life, out of his vast knowledge and imagination, he sparked ideas in students and colleagues, ideas that changed their careers.

After the Ircam years we saw each other intermittently. But in 2011, while I was the visiting Bloch professor at UC/Berkeley, we resumed our conversations in earnest and devoted several sessions of my graduate seminar, which he regularly attended, to issues of timbral organization. It is unspeakably sad to realize that the conversations are over. I will remember him above all, beyond his intellectual brilliance, for his personal kindness.

Mark Applebaum

I think that this tribute could even invite some mention of his passion for the culinary arts, particularly molecular gastronomy and other super fussy, meticulous, assiduous approaches involving subtle techniques and esoteric apparatuses for making delicate foams and the like. David so often had a twinkle in his eye. But it was particularly bright when he discussed his latest culinary obsession. I always inferred that the acumen he demonstrated in the musical lab as a creative thinker, researcher, and artist—brilliant, insightful, and often with a twinge of 'naughty nerd'—was applied in parallel service of his foodie fetish. It struck me as a kind of portable genius personality trait.

(On another food note: I once had dinner with David and Matt Wright at a restaurant near IRCAM; midway through the meal he looked around and, as if having a flashback, noted 'I had dinner here once with Karlheinz Stockhausen.') More generally, the quality that I so appreciated was his kindness and support. He was such an important mentor for so many people—both formal students and everyone else who came in contact with him. That was an important 'competence' that, particularly for the community he touched, is equal to his impressively broad 'disciplinary' legacy.

Aaron Einbond

When I was a young graduate student at CNMAT in Berkeley, in one of his seminars generously overflowing with ideas, David said, paraphrasing Paul Klee, that he wanted to 'take a walk in timbre space'. All of my own composition and research since then has been inspired by this idea. But it was his way of life as well: moving in a multi-dimensional space, always curious, crossing borders and categories, sharing knowledge and joy with everyone along the way.

ICMC | SMC 2014 Keynote Address
Mathews' Diagram and Euclid's Line: Fifty Years Ago

by John Chowning
Onassis Cultural Centre, 16 September 2014

Abstract

Making the science and technology of computer music comprehensible to musicians and composers who had little or no background therein was a part of Max Mathews' genius. In this presentation I will show how a simple diagram led to the essential understanding of Claude Shannon's sampling theorem, which in turn opened up a conceptual path to composing music for loudspeakers that had nothing to do with wires, cables and electronic devices, but led to learning how to program a computer—to write code. The change from device-determined output (analog) to program-determined output (digital) was a major change in paradigm that led to my realization of an integral sound spatialization system that would have been impossible for me to achieve in any other medium. Along the way, the discovery of FM Synthesis provided a means of creating diverse spectra that, coupled with a ratio from Euclid's Elements, produced an unusual and productive connection between spectral space and pitch space.

1. Introduction

Claude Shannon's 1948 paper, A Mathematical Theory of Communication [1] is the hard-edged theory that underlies the flow of information in today's complex digital world of computers, large and small, tablets, mobile phones, pads and pods—capable of 'sensing' sound, image, touch, location—all complex machines, the complete understanding of which is beyond the capacity to know of any single human being. It is a summation of Shannon's own work and that of his colleagues and predecessors. The timing was propitious as the first stored-program computers were just being developed. The paper includes the first use of the word 'bits'.[1] And theorem 13, the sampling theorem, is critical to the connection between continuous and discrete signals. In his article, The Origins of the Sampling Theorem, H.D. Luke traces a rich history of the sampling theorem that extends back to 1848 [2].

Shannon's paper is the first reference in Max Mathews' famous 1963 article The Digital Computer as a Musical Instrument [3], because the sampling theorem is the foundation on which Mathews based much of his early work. His research included speech, hearing and computer music where the loudspeaker is the ultimate sound source. Mathew's diagrammatic representation of the sampling theorem opened the door to my understanding of what was otherwise incomprehensible because of my own non-scientific background.

Euclid's line, to which I refer in the title, is its division into extreme and mean ratios, now commonly known as the golden ratio. This ratio became of interest to me after composing *Turenas* (1972), in which I made extensive use of both harmonic and inharmonic spectra. I looked for other irrational numbers to produce inharmonic spectra and found that the Golden ratio had particularly interesting properties in this application.

2. Mathews' diagram

My interest in composing music for loudspeakers stemmed from a few musical experiences that had a profound effect on the way I thought about composing. From 1959 until 1962 I studied in Paris where contemporary music was notably present. Some concerts included electroacoustic music— the Domaine Musicale concerts at the Théâtre de l'Odéon and the Groupe de recherches musicales (GRM) presented concerts at the French Radio that were exclusively electroacoustic. Some of the music, composed for four channels was, quite literally, head turning. From my youth I had a fascination with cavernous spaces and echoes, their disorienting effect on otherwise familiar sounds and the spatial aspect of this music provoked a desire to compose for loudspeakers—to put imagined sounds in imagined spaces.

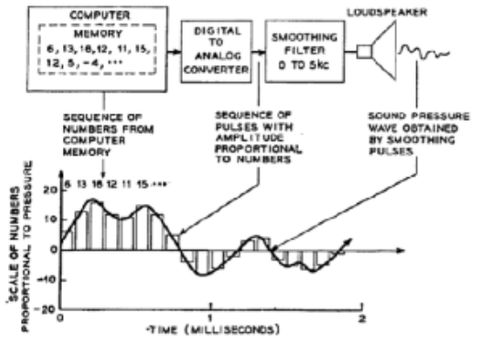


Figure 1. This is Mathews' schematic diagram of the sampling process from 1963 [3], at which time electro-acoustic music was exclusively in the analog domain.

However, I was well aware that the stringent technical requirements, knowledge and means to create music for loudspeakers in the 1960s were inaccessible to all but a few composers.

In 1964, because of a bit of serendipity, I was given Mathew's article. It was the first diagram, which caught my attention (see Figure 1). It presented a comprehensible face of the sampling theorem that, for

me and perhaps others, was suggestive and inspiring. It carved out a path to electroacoustic music that bypassed (what for me was) technological clutter; a path that would allow the composition of 'any perceivable sound' [3] bringing musical creation to the edge of my imagination.

2.1 Sampling's Simplicity

Immediately striking in the diagram is that there are but three devices and a computer, none of which have changed over time in their functional relationship, but all of which have changed over time in their cost, quality and precision—for the better!

Now, dear reader, imagine a 29 year old graduate student composer, fifteen years from his last math class, never having seen a computer, but with vivid imaginings, however vague and inchoate, of composing music in space. Imagine further, the conceptual breakthrough when with images in mind of electroacoustic music studios—filled with electronic equipment, cables, wires, multiple microphones, spinning loudspeakers and austere-looking engineers in white coats—I understood the implications of Mathew's Figure 1.

2.2 The Soft Complexity Behind the Samples

Already familiar with complex symbols as representation of sound, musicians seemed to be undaunted by learning to program a computer to do the same. Having read Mathew's article early in 1964 and the comprehensive article by James Tenney, Sound Generation by Means of a Digital Computer [4], in April, I took a new course offered at Stanford University called, Computer Programming for Non-Engineers. With the confidence that I could program a computer, I set about to learn acoustics and psychoacoustics, the latter highlighted in Mathew's article as an area of special importance to music perception.

Tutored by the undergraduate math major, tuba player, and incipient hacker, David Poole (my angel!), by September 1964 (just 50 years ago!) we had generated our first sounds using Mathew's Music IV program.[2]

The Artificial Intelligence Laboratory provided me off-hour computer time and a population of skilled researchers in fields ranging from linguistics to philosophy, speech, physics and, of course, computer science and electrical engineering - any one of whom could answer the many questions that I posed as I developed a sound spatialization program. After cajoling an electrical engineering student to build me a 4-channel DAC, I realized a quad system in 1968 (Figure 2).

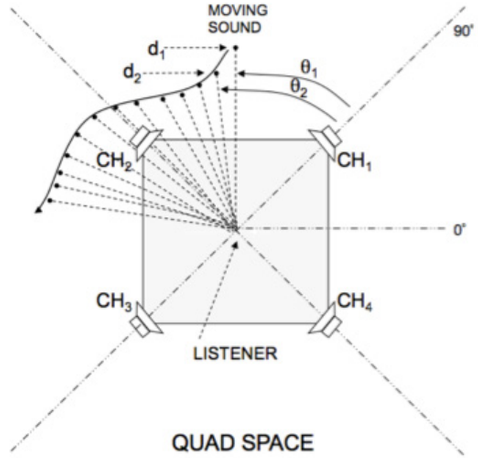


Figure 2. Finding a graphic solution: the distance, azimuth and velocity cues of a moving sound are captured by plotting points along the trajectory at a constant interval of time. Doppler shift is derived from the radial velocity. I used the Cartesian quadrants for naming the channels.

Completing the quad spatial system was a very important moment in my personal history, and in the direction that the Computer Music Project—and eventually CCRMA—would take. There are several reasons for this:

• While computers were not yet powerful enough to synthesize and process sound in real-time—hands-on and favoring immediate response—they would be some day (as we know very well with today's technology).

• Computer synthesis provided the composer direct control of the material of music, as a painter has with paint and canvas, allowing the accomplishment of two very different but complementary processes — joining the structure of the sound itself to the structure of musical form.

• I realized that those having motivation and perseverance, but no special competence in building electronic devices, were presented with a means to engage in a medium, and at a high level of abstraction, that was a defining musical advance in the 20th century—music composed for loudspeakers.

The discovery of FM Synthesis in 1967 was the result of searching for lively sounds that had some internal dynamism that made them easy to localize. Armed with insights[3] derived from Jean-Claude Risset's analysis-synthesis of trumpet tones, [5] I spend the next few years developing FM synthesis.

After seven years of development and study, I had acquired sufficient knowledge to build sophisticated enough tools to be able to realize two compositions—Sabelithe (1971) and Turenas (1972). An extensive account of this early work, Turenas: The Realization of a Dream, was presented at the Journées d'Informatique Musicale in 2011 [6].

3. Euclid's Line

Euclid defines what is now known as the Golden ratio in Elements, Book VI, Definition 3 [8]. It reads:

A straight line is said to have been cut in extreme and mean ratio when, as the whole line is to the greater segment, so is the greater to the less.

$$AB : AC = AC : CB \qquad (1)$$

or

$$j = \frac{1+\sqrt{5}}{2} \qquad (2)$$
$$j = 1.618033...$$

The ratio in its algebraic form (equation 2) is one of the most studied of numbers, with many claims being made over the centuries as regards its presence in nature, art and music (many are probably extravagant claims). The ratio is implicit in the formation of the pentagram and perhaps known to the Pythagoreans almost three centuries earlier. However, my interest in this ratio came from another point of view.

3.1 The Golden ratio and FM Spectra

In FM synthesis the distribution of the spectral (side-band) components are determined by the relationship between the carrier and the modulating frequencies. For inharmonic spectra in *Turenas*, I used a carrier-to-modulating frequency ratio of 1:√2. Looking for other irrational numbers that satisfied the constraint that their fractional part not be small (as is, for example, π) I explored the sound and attributes of the golden ratio. When the carrier and modulating frequencies are both different powers of ϕ, four of the resulting partials are also powers of ϕ (see Table 1).

SIDEBAND (SB) FREQUENCIES FOR $f_c=1000 * \varphi^0$ and $f_m=1000 * \varphi^1$				
order	Lower SB			Upper SB
0	* *Hz*	1000	f_c	*Hz*
1	618.03	f_c-f_m	f_c+f_m	2618.03
2	2236.07	f_c-2f_m	f_c+2f_m	4236.07
3	3854.10	f_c-3f_m	f_c+3f_m	5854.10
4	5472.14	f_c-4f_m	f_c+4f_m	7472.14
5	7090.17	f_c-5f_m	f_c+5f_m	9090.17
* lower sideband frequencies are the absolute value				

Table 1. Shaded cells show the four low-order partial frequencies that are powers of ϕ when both the carrier and modulating frequencies are powers of ϕ (but not equal).

This unique attribute caught my attention, as this is not the case with √2 or any other irrational number that I am aware of.

3.2 The Golden ratio and the Pitch Space

I then 'discovered'[4] that powers of ϕ were related in the same way as Fibonacci numbers, as seen in Equation 3.

$$j^{n+1} = j^{n} + j^{n-1} \qquad (3)$$
$$n = 1, 2, 3...$$

Expanding out powers of ϕ in log frequency results in an equal intervallic division of pitch, as is the case with powers of 2. I have referred to the interval based on this division as a pseudo-octave [7], with an equal tempered division of the pseudo-octave into nine scale steps. I call this the 'Stria scale' (StrScl), after the composition in which it was first used.

In three of my compositions I exploited this division of the pitch space and the complementary inharmonic spectra based on the ϕ and FM synthesis (ϕFM) shown in Table 1.

- *Stria* (1977) used ϕFM spectra [9]
- *Phoné* (1981) used harmonic spectra of synthesized singing voice mixed w/ϕFM spectra and synthesized singing voice.
- *Voices* (2005, v.3 2011) used harmonic spectra of soprano's voice mixed with ϕFM spectra and synthesized singing voice.

Together with a longstanding interest in aspects of Greek mythology and history, especially the Pythia and her origins, the golden ratio and the Oracle of Delphi came together in *Voices* for soprano and interactive computer. Along the way, I became fascinated with the singing voice.

3.3 The Singing Voice: Phoné and Voices

In 1978 Jean-Claude Risset invited me to spend a year at IRCAM. Based on Michael McNabb's demonstration that capturing the fundamental frequency (phonation frequency) of a sung female vowel tone through time is to capture the signature of the singing voice, even if it is a sine wave (this is demonstrated in his work *Dreamsong*, 1978), I set about to synthesize the singing voice with FM synthesis. Taking advantage of McNabb's important insight and Johan Sundberg's vast knowledge of the science of the singing voice, I profited greatly from his presence at IRCAM and was able to synthesize a number of sung vowel tones.

By setting the modulation frequency at the phonation frequency (pitch frequency), and the carrier frequencies at the closest harmonics to a given vowel's formant frequencies, I successfully modeled the target spectrum, as shown in Figure 3. The relationship of the spectral model to the signal generation can be seen in Equation 4. With an appropriate mix of a piecewise linear random function, and a periodic sinusoidal function to approximate the micro-modulation of pitch (phonation frequency) through time, the simulations were convincing. This work is described in my paper, Synthesis of the Singing Voice by Means of Frequency Modulation [10].

$$e = A_1 \sin(2\pi f_{c1} t + I_1 \sin 2\pi f_m t) \qquad (4)$$
$$+ A_2 \sin(2\pi f_{c2} t + I_2 \sin 2\pi f_m t)$$

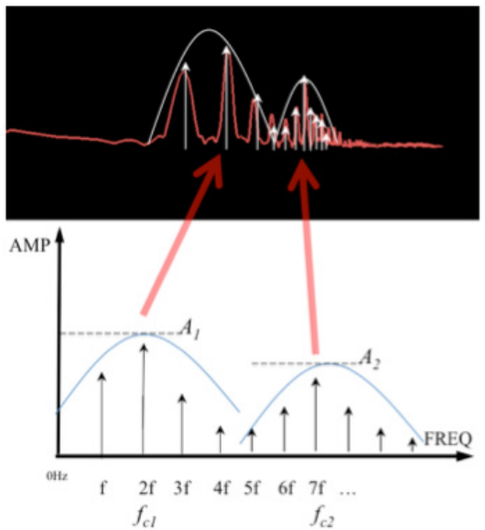


Figure 3. Spectral modeling of the singing voice (or any sound having prominent resonances) can be realized by setting the carrier frequencies, fc1 and fc2 at the harmonic frequencies, 2f and 7f, closest to the resonance peaks. The target spectrum in red, was captured by sndpeek. Bandwidths of the resonances (blue curved lines) are determined by the indices I1 and I2, here ≈ 1.0.

One might ask: why synthesize a singing voice when one can sample and then process a real voice? One answer lies in the kind of control one has over the details of the sound material. With synthesis, sound can be formed in ways that are not possible in transformations of sampled sounds.

John Pierce's *Eight-tone Canon* (1966) [11] could only have been realized by synthesis because the timbres are composed of precisely arranged partials that are ordered but not in the harmonic series. So, too, in Jean-Claude Risset's *Mutations* (1969), where a set of pitches is heard, first as melody, then as harmony, and finally folded into timbre [7]. It is the last stage which, again, is composed of precisely tuned partials from the set of pitches. It gives it an inharmonic, gong-like sound an ineffable quality of sounding 'imprinted' pitches.

It was *Mutations* that inspired me to extend Risset's powerful idea to another level of control based on my research with the singing voice and perceptual fusion [12]. *Phoné* was premiered at IRCAM in 1981.

Over several years I developed the SAIL[5] code around the idea of continuous transformations of sounds through detailed control of the partials and the conditions in which they cohere, or fuse, to be perceived as a single source rather than individual partials. As noted above, Risset demonstrated in *Mutations* that sinusoids that begin together with amplitude envelopes that are exponential in shape, and then fall off in duration with increased pitch height, sound 'gong' or 'bell'-like, yet they are imbued with harmony. The onset of such a tone is shown in Figure 4.

Extending this process to another level of complexity in *Phoné*, each of these sinusoids is the f_{c1} of a two carrier FM process as shown in Equation 4. The amplitude envelopes A_1 do not decay to 0. Rather, they rise and are joined by the other three components of the Equation 4, A_2, I_1 and I_2, as the micro-modulation is faded into the mix—a smooth transformation to multiple singing voices.

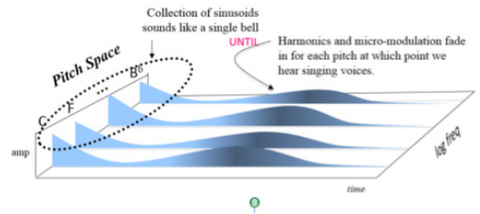
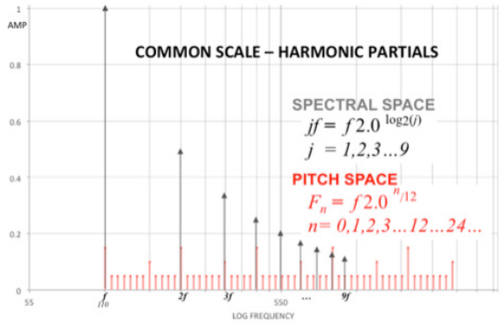
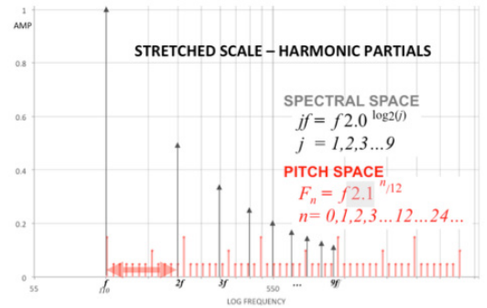
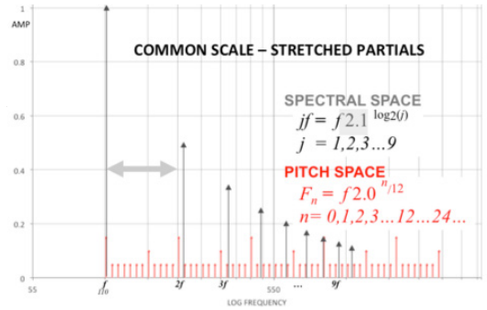


Figure 4. A collection sinusoids with frequencies from the pitch space sound like a bell at the onset. Continuing, they each become a harmonic in singing voice tones, where the change in hue represents the additional harmonics.

Voices makes use of synthesized sounds only and the amplified and processed sound of a soprano. The sounds and pitches are based upon ϕFM spectra and the StrScl (and its pseudo-octave). The question at the outset was whether or not a well-trained singer could comfortably sing in an unfamiliar spectral complex and in an artificial tuning system? [7]







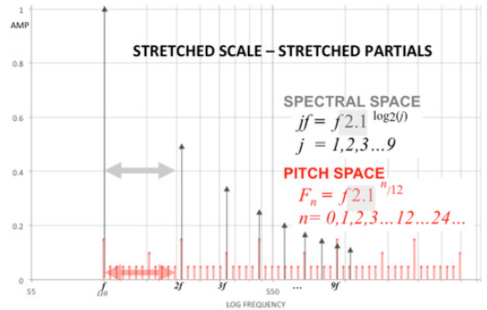


Figure 5.4

The answer seems to be yes and I have found independent confirming evidence as to why this may be so.

4. Partials and Tuning

Hiding (from me, at least) in the ever increasing corpus in the hearing sciences, is a demonstration CD that is an astonishing and relevant example that shows the importance of the complementary relationship between spectral space and pitch space. It is astonishing partly because the example is not cast in the context of new music, where it is often difficult to make critical, objective judgments because both material and context are unfamiliar. This example is a synthesized Bach chorale [13] without artifice, where the tones are composed of partials produced by individual oscillators, the amplitudes of which are similar to those of a sawtooth wave. However, it is not a sawtooth wave and could not be!

The chorale is presented four times where each iteration sounds a different relationship of tones and tuning. The spectral/tuning renderings of the chorale are represented in Figure5.1-4 by a tone having a pitch frequency of 110Hz, where the red colored equation and division along the x axis stand for the pitch space scale and the gray equation and grey partial components their frequency relation to the pitch space.

• In Figure 5.1 the base of both equations is 2.0.

• In Figure 5.2 the base of the pitch equation is increased by 10% to 2.1.

• In Figure 5.3 the base of the spectral equation is increased by 10% to 2.1.

• In Figure 5.4 the base of both in increased by 10%

The 1st corresponding sound example sounds as expected - simple and boring. The 2nd and 3rd sound examples sound out-of-tune - again, as expected. But the 4th example, where both tuning and partials are stretched was not as expected. I had expected it to sound out-of tune, but in a different way than the previous two. In, fact it sounded good, surprisingly—more interesting that the 1st sound example!

When I formed the theoretical underpinnings for *Stria* and began the time-consuming sound realization, I had wondered if its lissome sound surface was unique because of its ϕFM spectra. And so with *Phoné*. Engaing a soprano in *Voices* was a special challenge, because I was unsure how the digital precision of synthesis would interact with the suppleness of a real singing voice. But again, the piece is built on the same 'plinth' as *Stria* and *Phoné*. Finding the Tones and Tuning with Stretched Partials [13] example pointed toward, and gave weight to, a generalization: building sound structures where pitch space and spectral space are complementary may open to an entirely new soundscape.

5. Conclusions

Understanding the implications of Mathews' diagram freed musical ideas that led me into a field of study, research and creation that I could not have anticipated. The golden ratio fell into my 'ear lap' simply because it was 'in the air'— in the culture of the 1970s with M.C. Escher t-shirts, computer graphics, and D. Hofstadter's *Gödel, Escher, Bach: An Eternal Golden Braid*.

Much of my inspiration is close to the bits and bytes of sound, the spectral-temporal detail. But also to the programming language itself, abstract and cool in its generality, but often provocative and animating when engaged.

6. Notes

1. 'If the base 2 is used the resulting units may be called binary digits, or more briefly bits, a word suggested by J. W. Tukey' [1].

2. The program was run on an IBM 7094, a 1301 disk drive, which was shared with a Digital Equipment Co. PDP-1, whose graphics display's x, y ladders provided DACs.

3. Joined by Leland Smith, then in 1968 by J. "Andy" Moorer and then later by John Grey and Loren Rush, the research at the Computer Music Project flourished. The Center for Computer Research in Music and Acoustics (CCRMA) was founded in 1974.

4. This was a 'discovery' in that in 1974, I knew that the ratio between consecutive numbers of the Fibonacci sequence were an approximation of ϕ, but I had no knowledge of the same relationship between the pow-ers of ϕ.

5. Stanford Artificial Intelligence Language is a procedural language developed at Stanford in the 1960s-70s. The Phoné code was derived from the Stria code in the same language.

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ICMC | SMC 2014 Concert Reviews
Athens, Greece

Monday 16 September
Platonic Rhizomes in Computer Music: A Tribute to the Platonic Concept of the Mathematical Nature of Music
20:00-21:30
Outdoor Theater, Plato Academy

by Danielle Sofer

The satellite event at Plato's Academy brought together the music of two contemporaneously living Greek composers, Iannis Xenakis (1922-2001) and Anestis Logothetis (1921-94). In constellation with Plato's timeless ideas, the two shared a philosophical and theological curiosity, and both frequently turned to multimedia works aimed at the fusion of sight and sound towards greater, all-sensory experiences. The concert comprised one work from each composer, respectively, opening with Xenakis's La Légende d'Eer (1977-8) and concluding with Logothetis's Globus (1978). Both works deliberately appeal to a certain degree of indeterminacy, and both aspire to engage equally with visual and auditory aspects, though, ad oculos, neither included visual elements in this performance.

Prior to the 8pm concert was a round table with some of the greatest minds of computer music to date. Shaded by olive trees, and flanked on either side by a 1st Century gymnasium and a sacred house from the Geometric era, the speakers, Jean-Claude Risset, John Chowning, Gerard Assayag, Marcus Novak, Agostino Di Scipio, Makis Solomos, Alan Marsden, Peter Nelson, Cort Lippe and Clarence Barlow, gathered to discuss the significance of ancient philosophy for our current age. Material chaos was staged as a metaphor for musical composition; the garden in our midst was transformed into an infinitely animated plateau of transmigrating souls; and, not least, were we reminded of Plato's enduring comment that 'music is an analogy of proportionality'.

Logothetis's **Globus** is orchestrated for 'flute or also other solo instruments with or without orchestra', leaving the performance somewhat open to interpretation. The composer wrote that the work reflects a 'less optimistic world view', one as 'equally dangerous as it is endangered'—and this danger did not elude the audience. Flutist Katrin Zenz performed alone with the electronic part, and to our amazement she also performed without a microphone stand, such that, in order to achieve balance with the amplified electronic sounds, she was reading the printed score and playing into the microphone. Zenz's excited physical navigations complemented the ephemerality of the work's program, as inspired by 'the superimposition of two sound layers', the microscopic, chromatic meandering of the individual flute and the macroscopic undulations of continuously fragmenting global phenomena. Set outdoors, and illuminated only by spotlight and the nighttime stars, Zenz, who has previously recorded the work under the Naxos label, gave a captivating realization of Logothetis' esoteric graphic score. Though it was late in the evening after a long, eventful day, her beguiling performance was undisturbed by restless observers—outside, that is, of the ambient drone of chirping crickets.

Xenakis's monumental **La Légende d'Eer** takes its name from Plato's famous myth in the Phaedrus. As Socrates tells it, cicadas were once human. Utterly enchanted by the muses, they were moved to dancing and singing, and were eventually lulled into an uncontrollable state of ecstasy—ek-stasis, meaning to be out of place or out of body. The enraptured were so enamored with the feeling induced by the muses that they stopped eating and sleeping, and they soon perished. Given their loyalty to the muses, however, they were rewarded with a life of immortality - the only catch being that they remain in the physical form of cicadas. Like Plato's imagined dialogue, Xenakis collapses the divide between the internal mind and the expanse of the external world. The work opens with piercing 'shooting stars', to use Xenakis' charming terminology – piercing sinusoidal sounds that gradually fragment into the instrumental sounds of the African Kundi, the Japanese Tsuzumi, the mouth harp and the thumb piano. Twittering insects sonically adjoin two metaphorical realms, the real and imagined, marking the boundary between rational control and unconscious thought, and the intersection between the grounded and manic. These so-to-speak worldly sounds, the insects and instruments, are counterpointed by the synthetic electronic sounds so dominantly characteristic of Xenakis's compositions. The intersection of the natural and electronic environments was, at this performance, ever more apparent, since the simulated insects were also confronted by the live interjections of those in their surrounding native habitat.

This cross-epochal exchange between fourth century BCE, the mid-twentieth century, and the year 2014, reduced the temporal gap between then and now to almost zero. Yet as it turns out, it's still possible to rain on one's parade. Though a video by Marcos Novak was due to be screened alongside Xenakis's La Légende d'Eer, somewhat uncharacteristically for

the Mediterranean coastal climate (but well within character for outdoor events in general), the rehearsals were greeted with a torrential downpour, leaving inadequate time to run the planned video. Fortunately, the rain stopped in time for the round table, and the concert sans video proceeded without a hitch. Perhaps it was lucky for us that the video didn't work, since this turn of events forced us to focus on the sound of Xenakis's not-so-timeless piece. La Légende d'Eer is definitely a product of its time, the sounds bound to the temporality in which they were conceived. And yet, this fact was of course the inescapable charm of this concert: the incomparable experience of listening to the music of our community's idolized precursors at the birthplace of Western philosophy.

Wednesday 17 September
Music for String Quartet / Music for Solo Strings
20:30-22:00
Onassis Cultural Centre, Main Hall

by Juan Parra

The evening concert on the Wednesday was devoted to works in which the interaction between strings and electronics was the main focus.

First up was Than van Nispen tot Pannerden's **NLN-live**, an application for live non-linear and interactive music performances, which presented a component of audience participation that, although not necessarily straightforward in terms of its influence on the musical result, provided an entertaining and light element to an otherwise quite conservative concert situation. A member of the audience was asked to join the ensemble onstage and play a game of Space Invaders that at some level seemed to determine the duration of the piece being performed. I volunteered to be the gamer, but being a child of the 1980's, my hunger for alien destruction put the game (and the rendition of the musical output) to a halt too prematurely. This motivated the call for a new volunteer, who struggled with Space Invaders for long enough for the piece to run a longer curse.

Later in the program the notion of interactivity with a visual element was revised by Richard Hoadley's **Calder's Violin**, a piece for violin and electronics. In this particular case, the linear relationship between the visual aspect (a score being generated on the spot) and the friction with Giorgos Panagiotopoulos' attempt to "sight read" the score provoked an interesting musical result, where the structural tensions and twists were caused more by the fact of the score being generated in real time than by the actual musical challenges presented in the notation.

Other pieces of note were Takayuki Rai's **Active Figuration** for violin and computer (again performed by Giorgos Panagiotopoulos). Rai has a peculiar and distinct musical language, where the relationship between instrumental material and electronic sounds play with questioning the relational interdependence of causality and non-causality. Active Figuration showed a level of maturity that is rarely seen in composers dealing with computer media as their primary source of musical expression.

Giulio Colangelo's **Organismo aperto no.1** was one of several pieces performed in the concert by the Audio String Quartet. I found it to be the most convincing of the lot in the way it dealt with the exchange of statuses between instrumental and electronic media within a piece. What was created in the electronic part clearly informed the composer's decisions in the instrumental score, to such extent that the media itself seemed to be rendered irrelevant: one could just enjoy.

Friday 19 September
Music with Solo Instruments IV / Music with Harp
16:40-18:00
Onassis Cultural Centre, Upper Hall

Music for ensemble II (with The Paxos Ensemble and Guests) / Music with Voice(s), Conductor: Alexandros Diamantis
18:00-19:30
Onassis Cultural Center, Main hall

Invited Composers' Concert, with The Paxos Ensemble and Guests, Conductor: Alexandros Diamantis
20:30-22:00
Onassis Cultural Center, Main hall

by Alyssa Aska

The musical program on the evening of the Friday was extensive and diverse, with concerts containing music for ensemble and electronics; solo and electronics; video music; and fixed media. The Friday also featured the Invited Composers' Concert, where works by some of the leading composers in the field were presented. It was a rather successful evening, with great performances of well-composed pieces. Unfortunatley, logistical concerns concerning the festival organisation proved to be a challenge. The concerts were booked without any time between them, and many of them started or ended late. This made it impossible for one to attend all of the concerts in their entirety. Additionally, the evening was more tightly packed with music than other nights, and the concerts seemed to be rather less attended than those of previous nights. As

Friday was the last day of the conference, this was likely due to listening fatigue. The following is a review of a few select pieces of the evening, with a particular focus on the Invited Composers' Concert.

Mark Bokowiec's **Dialogue for Cello and Prosthetic Spine** was performed at the Music for Solo Instruments III concert in the afternoon. The work consisted of accessible, yet refined and idiomatic cello writing. The melodic and harmonic components were pleasing to the ear, and the electronics blended well with the cello. The composer stated that the piece intended to emulate a dialogue between the cello and the prosthetic spine. Although the dialogic elements were not always persistent on the surface, the prosthetic added an interesting visual and dramatic element to the performance. The lack of clear dialogic correlation may be perhaps related to the specific motions that were required to move the spine. Using an interface that allows for more abrupt and specific gestural control might have highlighted the movement-sound connection and made the dialogue more superficially apparent. However, the overall interaction between electronics and live instrument was well-crafted and interesting. The prosthetic spine, developed at McGill University by Joseph Malloch and Ian Hattwick, attaches to the performer outside of their body, replicating their actual spine. The device has an alien-like appearance; it is translucent and emits a blue glow. The theatre was darkened, which gave the spine a prominent visual focus on stage. The use of prosthetic and the concept of dialogue also touches on a subject often discussed philosophically regarding computer music, which is the attempt to unify electronics with acoustic sound. Dialogues can be seen as a human and machine analog as the human is connected to this prosthetic device. This fusion between man and machine is a very unique approach to gestural controllers, as they are often more object-like in design and function, somewhat analogous to acoustic instruments.

The performance of Juraj Kojs's **Pastoral Care** was captivating from beginning to end. The piece began with the performer, dressed completely in white martial-arts-inspired clothing, interacting with a cloth on the floor. The performer frantically searched through the cloth while the audience watched in suspense, and eventually located a small part of the fujara, a slovak shepherd flute. Once the performer had unearthed this small fragment, he immediately began to produce sound, which was processed by the composer sitting onstage. The performer continued to locate more pieces of the fujara as the piece progressed, and the sonic result therefore kept changing throughout. This also had very apparent visual and dramatic implications; the construction of the instrument during the performance gave the work a sense of the performer's journey and discovery, an idea that was also reinforced by his dramatic reactions onstage. The electronic elements of the work were meditative and aesthetically pleasing, while also retaining an element of the dramatism that propelled the work. They appeared to be generated in real-time; however, it was unclear the extent to which the composer was affecting the electronics during the piece. It was also not directly apparent why the composer chose to be present onstage, as there didn't appear to be any visually performative elements on his part. The piece concluded as the performer constructed the flute in its entirety, then proceeded to walk offstage.

Marta Gentilucci's work, **…Tutt'ochi**, for Contralto, ensemble, and live-electronics was the winner of the "Best Student Composition" festival award, and thus a highlight piece for the evening. It ought to be expected that the performance and technical elements would be executed with near perfection; however, that wasn't the case during this conference. The stand-out work suffered from a technical error that unfortunately seemed to be far too common at this event. Due to poor organisation, many of the rehearsals were booked last minute, and technical set-ups were left with little time. Despite the hiccups, it was clear that the instrumental writing of Gentilucci's work was exceptional, and that the vocal writing was particularly well-executed - often a challenge in contemporary music. Marta composed a vocal line that was both musically interesting and challenging, yet suited the performer's voice type perfectly. The instrumental writing was additionally clean, yet charged with energy. The instrumental lines added forward motion to the dramatic and intense vocal line. The dialogue between the instruments and the voice was well-developed and performed with precision. Even with the technical constraints, it is easy to see how this piece won the award. It would have therefore been nice to have heard ...Tutt'ochi as the composer intended.

Clarence Barlow's **Approximating Pi** initially appeared unpleasant, aurally grating, and difficult to withstand. However, there are many intricacies involved in the listening of the work that made it intriguing. Prior to the performance, we were all informed by the composer that the piece was to be extremely loud and relied on phase differences to some extent. Clarence Barlow describes in his program notes a very precise and carefully calculated method for determining frequencies and amplitudes of waveforms, and although the listener could not hear this superficially during the performance, it undoubtedly had a subtle effect on the work.

Approximating Pi was one of the more unique acousmatic works I have ever heard, and I appreciated the fact that the composer did not conform to typical compositional devices and/or forms in the work. The phase differences in the performance were initially quite fascinating; the composer told the audience beforehand to move their heads during the performance to hear them. However, after a couple of minutes this effect lost its novelty, although it was interesting. The piece was quite long for the material but likely would not have had the same effect if the duration was shorter.

Curtis Roads's contribution, **Then**, was played immediately after Barlow's, and was also a very loud and aurally present piece. The materials were quite contrasting, however, as Roads implemented many motivic and rhythmic devices. This work avoided the precise calculations used in Barlow's piece and instead explored material through more compositionally conventional means. Roads also stated in his program note that the work made use of analog tape; this was actually quite pleasant as the recorded sound had the warmth that is quite typical of analog recordings. This is a stark contrast to the previous piece, which was digital and relied on numerical processes. The composer used the contrast between some of the long textural material he generated and the quick pulses throughout this work and this was quite effective. Roads did make use of many processes that are common in electroacoustic music, such as feedback and delay, but employed them in such a way that the sonic result was novel and interesting rather than contrived and fatigued.

With the elimination of Agnostino Di Scipio's work [1], Cort Lippe's **Music for Septet and Computer** marked the only work for live instruments and electronics in the concert. This septet was therefore quite welcome as by this point in the concert one's ears were beginning to grow tired of purely acousmatic works. The performance of this work was quite solid and invigorating, and the ensemble writing really allowed this piece to shine. Lippe composed several sections for interaction with smaller subsets of the ensemble, and the dynamic of interaction and relationships between the instruments appeared to be an important element of the piece. It is also reflected in the composer's title; although it would be appropriate to title the work 'Music for Septet and live-electronics', Lippe used the word 'computer', implying that the computer was an ensemble member. The program notes also clearly stated that the work was intended to facilitate interaction between the performers and the computer in a very organic way. It was apparent to the audience that the electronics were influenced by the performance, and that some degree of liveness and interactivity was present; however, this wasn't quite as visually or audibly obvious as the interactions between the instruments. Regardless, the electronics themselves were very well blended with the acoustic instruments, and made a positive contribution to the piece, which is not always the case with works for electronics and large ensemble.

Vocalscapes on Walt Whitman by Georgia Spiropoulos also proved to be an interesting addition to the Invited Composers' Concert. The work involved many recorded excerpts of Walt Whitman's Leaves of Grass, which were then modified and spatialized. Vocalscapes was not an attempt to have the precise words of the poetry audible at the foreground in the entire piece, and instead throughout the work different excerpts were highlighted, while at times there were many voices speaking at once and none was at the foreground. Rhythmic use of the voice was used effectively, and the work had nice contrasts between rhythmic sections containing speech fragments and sections that were more text-driven. The composer did an excellent job of placing the voices in the space, and in using both space and dynamics to foreground speech when necessary. The contrast between solo and ensemble was therefore very pronounced. It was also additionally interesting to hear a work spatialized in 6 channels after an entire concert of 8-channel works. The work was at once dramatic and light-hearted, and always engaging. It was a solid conclusion of the concert, and left the listener with slightly invigorated ears after a day of intense listening.

The concluding night of the ICMC-SMC joint conference was full of many featured works and overall presented a diverse body of music. The night could have been improved with looser programming which would have freed up some of the timing constraints and perhaps allowed more time for technical troubleshooting. Minus these limitations, the night was a successful conclusion and an excellent showcase of current electroacoustic music.

Notes

[1] Due to organisational problems that left the performers with only a short time to rehearse his work (KOINO TOPOI), Agostino Di Scipio withdrew his piece from the festival. See: http://agostinodiscipio.xoom.it/adiscipi/dearfriends.pdf

ICMC 2015 Concert Reviews
University of North Texas, Denton

Sunday 27 September
Concert 8
Merrill Ellis Intermedia Theatre
13:30

by Jason Fick

The afternoon concerts in Merrill Ellis Intermedia Theatre (MEIT) at ICMC 2015 were the most appealing to me. This was largely because the events were all sixty minutes in length, and the sound immersion in this space was ideal for electroacoustic music. I have always loved fixed media pieces and was most fascinated by the Monday and Sunday afternoon concerts. Having recently attended Jonty Harrison's Illustrated Demonstration on Diffusion and Adrian Moore's paper on Cross-Modality in Multi-Channel Acousmatic Music, I believe that concerts 8 and 13 (reviewed later) best exemplified current practices in fixed media, including well-defined gestures, highly directional movement, and vivid orchestration paired with rich aural sensations.

Concert 8, presented on Sunday at 1:30, including one for image and sound. I found these compositions very stimulating because each embodied a highly defined character. The first piece, **Modernist** by Ryan Maguire, was written for video and 2-channel electroacoustic music. According to the composer, 'the audio is comprised of lost .mp3 compression material from the song Tom's Diner'. I found Mr. Maguire to be very creative in his abstraction of the source, and as a result, he constructed several beautifully dense, noisy textures. As the piece opened, the audience was introduced to active material presented in both sonic and visual media. The individual elements were constantly evolving, containing great variety in rhythmic spacing, density, and gesture. This piece had a wonderful essence, and while his materials seemed primed for development, its brevity left me wanting more.

Within and Without was composed for 8-channel electroacoustic music and diffused live from the center of the room by the composer, Andrew Walters. I thoroughly enjoyed this piece: his materials were highly inventive, vivid in nature, and shaped in a stimulating manner. He stated in the program that the source material came from the unwanted sounds that were made while playing the piano. 'I took these sounds we normally do not notice or try to eliminate and created this piece'. The composition opens with dense textural material, which was diffused around the space. As the piece progressed, each idea transitioned from various dense and sparse abstractions in a logical and exciting manner. The composer's use of diffusion contained a wide range of spatial perspectives, which characterized the experience quite nicely.

Judy Klein's **Railcar** for 8-channel electroacoustic music made an extremely impactful statement. The composer framed the experience with her program note, which read: 'at one end of the railcar was a glass bin, filled with paper clips. I added the few I had brought with me, in memory of the lives of so many'. This acousmatic work was highly effective in conveying an engaging sense of movement and breadth. The piece was calm and played at a low intensity throughout. After a series of meaningful progressions, a woman's voice enters from the left side of the room. The woman described the experience of arriving in Poland on a train and losing sight of her family amidst the chaos. The orchestration of this moment was very powerful, and it presented the audience with a poignant aural commentary on the effects of such a devastating loss.

The noisy, abrasive, and highly exciting presentation of Dan Tramte's **Euthanasia** for 8-channel electroacoustic music provided a welcome contrast from the emotional intensity of the previous piece. 'You're on your death bed. The only two sounds you hear—your nervous system and the machine keeping you alive—are now your entire world', writes the composer. The sound material contained several distortions–noises, pops, clicks, and extreme frequencies–and Tramte's shaping of these materials was very inviting. The piece began with beeps and clicks, an obvious reference to hospital machines. As it progressed, these various distortions were beautifully shaped and orchestrated in both active and calming textures. The narrative was very engaging, and Tramte's live diffusion further strengthened the identities of his sound characters. This presentation was one of the most artful forms of noise music featured at the conference this year.

The strong sense of motion and direction created a highly stimulating effect in **Cercles et Surfaces** for 8-channel electroacoustic music by Elsa Justel. As the composer states, this piece 'answers to the principle of musical gestures in space, creating a flow of seemingly chaotic sound patterns that approach each other and meet in arborescence creating a new order. The multitrack discourse contributes to create a polyphonic texture that accompany the gestural movements in the space. While Justel was not present to diffuse the work live, the fixed media

version contained great variety in spatial perspective. The colorful and active interaction among the various materials in the opening struck me immediately. Although this composition was a bit long for my particular taste, I was fascinated by the meaningful construction of gesture, detailed spatialization tactics, wide range of timbre, and brilliant orchestration.

In my opinion, the most electrifying piece on the program was **Nothing that Breathes** by John Nichols III for 8-channel electroacoustic music. I was captivated from the opening attack to the final release. In the program note the composer describes the sound material and aesthetics of the piece as related to wind and breathing. This composition featured many thrilling swooping and crashing gestures that ramp into the foreground and terminate in a goal-directed manner. Nichols provided great variety among these hits through varying the duration, amplitude, and textural activity within each instance. The composer diffused the piece live and presented a highly directional and invigorating performance to close the concert. I enjoyed this event immensely because of the strongly defined character of each work and the masterful programming on behalf of the organization committee.

Sunday 27 September
Concert 12
22:00
Lyric Theatre

by Jorge Variego

Remarkably enough given the selection process at ICMC, the program of Concert 12 offered a clear consistency both in the age of the featured composers and in the year their works were composed. For as well as being of the same generation, all of the pieces that were performed were written within the last year. This statistical anomaly did not influence the aesthetic of the concert, however, which was sonically very diverse.

froTH (2014) by Elizabeth Hoffman started off with an invitation to meditate through a series of subtle improvisatory textures built by the flutist and the computer. The success of the piece resided in the space Hoffman created between the flautist's phrasing and the water-like granular textures. They achieved the effect of drawing the listener closer and closer to the naïve sound of the low register piccolo part.

Two Wings (2014) by Michael Rothkopf opened with a bassoon solo enhanced by electronics (it could have been the other way around!) while the soprano sung both in English and Spanish, suggesting a three-part counterpoint. For moments, the computer seemed to provide an improvisational canvas for the voice and the bassoon. In other instances, the electronics enriched the timbre of the live performers. Well balanced and performed, this work could be the starting point of a multimedia opera.

Third in the program came my piece, **La Jungla** (2014), which presented a wild soundscape created through computer automation. The speaker configuration in the Lyric Theater allowed me to play with sound diffusion, creating a trajectory that slowly moved from the wide back to the narrow front field.

Tim Kreger's **Firehose** (2014) followed, its sound palette presenting a stark contrast with my own piece. Firehose is a real-time improvisation using the Twitter live stream API, which provides access to the live stream head, also known as the firehose. This work uses a filtered form of the latter to generate a musical stream for the live performer to react to.
Featuring a live electric guitar and visuals, Kreger projected short tweets generated live from Twitter relating to visceral emotional topics: love, happiness, loneliness and so on. These apparently disjointed tweets invited the audience to complete them, whilst the striking minimalism of the colors helped one to build one's own version of the story.

unfold (2015) by Rolf Wöhrmann focused on rapid movements of clean sounds in space.
This algorithmic composition is based on the idea of densities that evolve and change radically, always challenging the listener's ability to identify the sonic objects. The trajectories served to invited the listener to follow each imaginary path through space. It invited me to get lost and find my own way out.

v->t->d (2014) by Christopher Jette was a work of engaging simplicity realised with the utmost complexity. A projected video showed the live saxophonist from different angles, filtered and distorted through various image processes. The instrumentalist appeared to control all the data streams: both the video processing of his performance, and the electronic sound processing applied to his instrument. For example, the amplitude of his playing controlled the quantity of 'image grains' that we could see on the screen. After a few iterations, I started to appreciate the way the distinct coupling of image and sound changed my orientation to the piece as a listener.

With **past every exit …** (2014), Jason Palamara brought a monolithic block of sound that served to punctuate the concert thus far. Containing almost no formal variation, the piece offered a highly intense free improvisatory texture (think

free jazz of the 60's) from beginning to end.

In **Imaginary Universe** (2014), Takuro Shibayama exploited the distinctive array of loudspeakers in the Lyric Theatre to create an environment that was equal parts concert performance and sound installation. Utilising an automated diffusion patch created in Max, the work drowned the audience in massive moving sound structures. The most novel part of the piece for me was in Shibayama's application of subtle modulation to the arrival times of the sounds at each loudspeaker. It achieved the effect of making each audience member's spatial experience unique.

Telepresent Storm: Rita (2013) by Thomas Rex Beverly was an audiovisual piece that used sonified and manipulated data harvested from storm 'Rita'. Far from being a metaphorical representation of the sonic experience of a storm, the piece was an experiment in translating one set of data to another. Hearing and appreciating the composer's mapping choices – from atmospheric data to sound – was the chief interest of the piece for me.

The final piece, **Shared Buffer** (2014), was a collaborative live-coding performance that made me rethink the entire concept of musical expectation. Seeing lines of code written in real time invited the listener to imagine what sounds might come, or how they might affect or transform the sounds that we were listening to, before the code was executed. From remote locations on the globe, Eldad, David, Ian, Alex and Alexandra managed to keep the audience enraptured, in continual anticipation of sounds not yet heard.

Monday 28 September
Concert 13
Merrill Ellis Intermedia Theatre
13:00

by Jason Fick

Concert 13 was presented in the MEIT on Monday at 1 pm. There were six pieces on the program–five for fixed media (one with video) and one for laptop. I found this concert appealing for the ways in which the pieces maintained a strong relationship to their original source materials. James Caldwell's **Deep Pocket Music** (Nos. 11-16) was composed for 2-channel electroacoustic music and featured gestures created from sound sources that came from his pocket. These included 'finger cymbals, a pencil run over the rungs on the back of a chair, dresser handles, the bag from a bunch of apples from the grocery store, and marbles poured into the bottom of a hand drum'. Each miniature was very alluring due to creatively shaped sound entities, which I thought transitioned very well with each other. Each movement was played attacca, and they were all strong musical statements. With that said, I wish the composer had presented a more engaging spatial mix.

Trittico Mediterraneo was composed for 2-channel electroacoustic music and diffused live by the composer, Konstantinos Karathanasis. He states in the program note that this work is 'a three-movement piece inspired by summer themes'. The first movement was a brilliantly orchestrated section crafted from bell samples. The second segment featured the sounds of children playing paired with abstracted derivative manipulations. The material of the third section, made from the sound of cicadas, was quite captivating, first introduced as a transitional gesture, then becoming the foundation of the final movement. I was quite impressed with the detail and clarity in terms of spatialization, especially considering that this was a two-channel piece. This composition was very pleasing due to its intricate textures, vivid sound characters, and invigorating transitions.

The third piece on the program was **Accretion Flows**, composed by John Thompson for video and 8-channel sound. According to the composer, the piece presents a tightly coupled 'relationship between the audio and the visual. This coupling is accomplished by allowing an underlying system to act as the substrate from which is medium will grow. In Accretion Flows, audio and visual particles are created and directed within a gravitational system. The composition is the organized sequencing and layering of these patterns and orbits'. The sound and visual elements of this piece regularly mimicked each other. Both media were particle-like in nature and contained a great amount of diversity among their textures. The music was comprised of active patterns with popping and snapping sounds that were blended with sustained tones. The video element was equally busy, its material including segments of dots, lines, moving sketch-like doodling, and firework-like shapes. I enjoyed the great diversity that existed among the dense and elaborate textures presented throughout the piece.

Kyle Vanderburg's **Reverie of Solitude** for 2-channel electroacoustic music was a reflective piece that was diffused live by the composer. He states, this piece 'serves as both an exploration of and an invitation to reverie; providing a space wherein the listener is asked to reconsider their idea of what it means to daydream'. The composition opened with the sound of a crowd and transitioned to a train passing, before leading to river water, and then returning again to the crowd

idea to close the work. The progression of the piece was slow with each instance of ambient recording juxtaposed with constructed shapes that bubbled up and eventually overtook the previous idea. Overall, I found the transitions interesting, but this work lacked the engagement of the other pieces on the program.

Wind Chimes Clatter through the Mist and Fog by Jon Fielder written for 8-channel electroacoustic music had a great sense of purpose and an alluring progression. As the composer states, 'the piece plays with the concept of distance and perception of space'. I was captivated from the opening moment when vivid, chime-like sounds with a spring delay appeared from different positions throughout the hall. After this idea, we are presented with a calmer and more ethereal section, also containing a great deal of chimes. Throughout this segment, a few goal-directed ideas appeared, and the ending contained some low and juicy granulated materials. The sound characters were extremely rich and the gestures were very inventive. I was captivated by the wonderful sense of breadth, shaping, and vibrant orchestration in this piece.

The concert concluded with Kerry Hagan's **s/d** for 8-channel computer music with procedural algorithms rendered in real-time. This composition was noisy, active, and grabbed my attention immediately. I was fascinated by the intricate textures Ms. Hagan created, as one was able to perceive many layers of colorful noise characters with a great amount of diversity in rhythm, articulation, and dynamics. Hagan used stochastic theories and algorithms to devise the material in real-time to an excellent effect. The layering was very detailed and quite pleasing, with great care spent on orchestration.

In closing, each of the pieces on concerts 8 and 13 paid great attention to spatial perspective, orchestration, gesture, and sonic identity. These events were very appealing, and the works therein epitomized the techniques addressed in the two presentations on aesthetic approaches to fixed media by Jonty Harrison and Adrian Moore. I believe that the programming of each work was well thought out, and the duration of afternoon concerts allowed one the adequate time to effectively process and fully appreciate each composition.

CD Reviews

David Berezan
Allusions sonores
empreintes DIGITALes, 2013
IMED 13122-CD

Martin Bédard
Topographies
empreintes DIGITALes, 2013
IMED 13121-CD

Pierre Alexandre Tremblay (Chen, Laporte, Nicolls, Roche)
La marée
empreintes DIGITALes, 2013
IMED 13123/124-CD(2)

Andrew Lewis
Au-delà
empreintes DIGITALes, 2013
IMED 13125-CD

Reviewed by Valentina Bertolani

Between 2011 and 2013, empreintes DIGITALes issued four compelling composer profiles, following in the tradition of the label. They are devoted to the Canadian composers David Berezan (Allusions sonores), Martin Bédard (Topographies), Pierre Alexandre Tremblay (Quelques reflets) and the English composer Andrew Lewis (Au-delà). Except for the last composer, whose work is represented by compositions spanning from 1987 to 2012, the work of the Canadian composers is showcased through their activity in the past ten years or so.

If at a first listening these recordings might seem very different from one another in style and inspiration, one might argue that they all pay homage to the music of Francis Dhomont and, in particular, to his Cycle du son – a piece also released by empreintes DIGITALes in 2001. Many aspects of these CDs nod to the aesthetics of the French composer; however, David Berezan and Andrew Lewis are the two that make the link between Dhomont's activity and their compositional work more explicit. The former acknowledges in an interview Dhomont's Cycle du son as one of the most seminal listening experiences he ever had [1]. Besides this, Berezan is also the director of the research centre Novars, in Manchester, and the centre itself has been named after one of the movements of Cycle du son. Andrew Lewis has also devoted some of his scholarly work to the analysis this work [2].

Notwithstanding this common interest, the two releases by Berezan and Bédard could not be more different. Berezan's title Allusions sonores is appropriate and indicative of the particularly appealing geography of this disc. In fact, inspirations for Thumbs (2011) and Galungan (2010) come from Balinese sounds, a region that the composer has been familiar with since the 1990s. The wooden floors of Japanese temples and buildings (namely, of Nijō Castle in Kyoto) and sea buoys - their actual sounds and metaphorical meanings - inform Nijō (2009) and Buoy (2011), respectively. Since all these locales are well known to the composer, he is able to capture them in their most mysterious and elemental aspects. Particularly fascinating is Badlands (2008), a rendition of the homonymous region of Southern Alberta, close to Berezan's native city of Edmonton. The piece is a holistic representation of this region that takes into account its culture, its history, and its prehistory: through use of Edmonton's natural sounds and allusions to the city's notoriously rich deposits of dinosaur fossils.

The nostalgic and inspiring atmospheres created by Berezan could not be further removed from the hyperenergetic, restless CD by Martin Bédard, entitled Topographies. Not only is the general allure of the album different; Bédard also gleans material from more industrial and urban atmospheres. The inspirations for his pieces come in a number of guises: from the history of the composer's hometown of Quebec City (Champs de fouilles, 2008); to the symbolic redemption of Quebec City jail, which becomes an occasion to explore musical narratives of freedom and captivity (Grand dehors, 2011); to the symbolic choice of metal as a compositional material, which becomes a metaphor of life and its toils in Métal fatigue (2012). Throughout the album, Robert Normandeau's concept of "cinema for the ears" is very present, such as in Push & Pull (2010), a powerful composition inspired both by the sounds of trains and the song Kid Gloves by Rush (a teenage favourite of Bédard's).
In order to have a real dialogue with popular music, though, you need to listen to Pierre Alexandre Tremblay's Quelques reflets. The pieces presented in this DVD are partially the outcome of practice-based research that Tremblay has been carrying out since 2001. The composer tried to find a synthesis of his previous musical experiences - studio composition, post-free-jazz improvisation, DSP coding, and a strong past background in popular music production - without relying on the physical presence of the performer/improviser. In his own words, Tremblay aims 'to bring critical improvisation practice in the studio to propose embodied post-acousmatic composition' [3]. The DVD includes compositions that reflect on the problems and dilemmas that the pursuit of happiness yields in the modern world. In Reflets de notre société crépusculaire (2009) the composer tries

to reconcile 'his happiness [… and the] recognition of it at the expense of the rest of the planet' (see CD booklet). Les trois petit c… (2010) and Ces énigmes limineuses (2010) are also engaged with the pursuit of happiness: the former focusing on women's resilience, and the latter a reflection on those moments that give us the feeling of a stillness or slowed time amidst the noise and commotion of contemporary life. The description of Walk That Way. Tuesday, Turn (2006), which certainly deserved the Mention it received at the 35th Bourges International Electroacoustic Music and Sonic Art Competition, gives as simple and unambiguous a depiction of the concerns that underpin Tremblay's compositional practice as could be hoped for. Indeed, its simplicity leaves the listener literally breathless: 'Inhale. Exhale. Repeat until life ceases'.

Unlike Tremblay, who explores the burden of simplicity, Andrew Lewis's Au-Delà provides a luminous and hopeful taking on weighty matters. Ascent (1994-97) showcases wide, static sounds derived from the natural soundscape around Bangor University. Similarly, Time and Fire (1987-90, 2013) and Cân (1997) engage with natural forces and soundscapes. In Lexicon (2012) and Scherzo (1992-93), the opening and closing pieces of the CD respectively, the sounds become less abstract with the introduction of children's voices. In fact, the latter piece uses the voices of the composer's daughters and the former, also available in a videomusic version, is based on a poem written by a 12 year old boy about his experience with dyslexia. With these four issues, the record label reinforces its aesthetic consistency. Leaving aside the very inconvenient packaging, which fails to protect the CDs, empreintes DIGITALes successfully navigates the dual roles of being both a safe harbour for the connoisseur of high quality art music, and a talent scout for new and off-the-radar composers.

References

[1] Soundcloud interview with David Berezan. 2013. https://soundcloud.com/sscloud1/sets/interview-with-david-berezan Last accessed 15 March, 2015.

[2] Lewis, A. 1998. 'Francis Dhomont's Novars', Journal of New Music Research 27, no. 1/2: 67.

[3] Tremblay, P.A. /Mixing the Immiscible: Improvisation within Fixed-Media Composition', Proceedings of the Electroacoustic Music Studies Network Conference, Meaning and Meaningfulness in Electroacoustic Music, Stockholm, June 2012, 3. http://www.ems-network.org/IMG/pdf_EMS12_tremblay.pdf

[4] See CD booklet

Book Review

Eric Lyon
Designing Audio Objects in Max/MSP and Pure Data
Middleton: A&R Books, 2012

Reviewed by Christopher Haworth

Cycling '74's Max/MSP, or 'Max' as it is now called, is easily the most widely used multimedia programming software worldwide. Over the past ten years it has achieved an unparalleled popularity amongst artists, designers, creative technologists, audio professionals and educators, far eclipsing its former running partner Pure Data, as well as Supercollider and Csound. The great success of Max owes much to CEO David Zicarelli's continuing efforts to improve the software's learning resources, workflow and documentation. Starting with Max 5 in 2008, and continuing to the present version 7, the company has invested a great deal of effort in the experience of new users, generally making Max programming appear less daunting to the uninitiated. The learning resources for the early and intermediate stages of Max apprenticeship therefore excel, but harnessing Max's more advanced features, especially programming external objects in the C language, has traditionally been a more treacherous path. Those for whom Max is the only programming language with which they are familiar would often complain about feeling stranded, since the available Max resources – the Max API, Software Developers Kit folder, developer forums, and the odd online PDF – all assume knowledge of procedural programming and integrated development environments like Xcode (tools that many initially turned to Max to avoid).

Eric Lyon's Designing Audio Objects for Max/MSP and Pd is written precisely for this audience. It will become an essential textbook for readers whose 'native' language is graphical programming but who wish to develop skills in audio DSP coding. From even the briefest glance at the opening pages it is clear why, despite the clear need for such a book, others may have balked at the task of writing it. Providing a comprehensive introduction to external development for both Max and Pd necessitates keeping multiple combinations of programming environments, C compilers, and operating systems in balance; a hard enough task in itself, but complicated by the violent cycles of change and renewal that Max has undergone over the last decade [1]. A mammoth task then, but as anyone who has encountered Eric Lyon at an ICMC, or used his FFTease externals for spectral analysis and synthesis in

Max will know, he is ideally suited for the job: an accomplished and prolific composer, audio researcher and teacher, and seemingly untiring in energy and zeal. His enthusiasm for all things computer music-related transports completely intact onto the pages of this book. From building a step sequencer (chapter 6, 'a sample accurate step sequencer'), to implementing avant-garde noise generators (chapter 13, 'dynamic stochastic synthesis'), one couldn't wish for a more engaging, more knowledgeable guide.

The book is organised into fifteen chapters, bookended by a foreword by David Zicarelli and an afterword by Miller Puckette. It ships with a CD-ROM containing the source code, compiled externals, and supplemental patches that are used as examples in the book. While it helps to have these files to resort to when things go wrong, I would recommend coding from scratch when following the examples. The learning curve of the book is nicely considered, beginning with exhaustive line-by-line explication of the code, and developing to increasingly abridged accounts that leave more up to the reader. It is complemented by a set of practical exercises that append each section; although easy to bypass, these sections are well considered in terms of the skills they aim to nurture, adding much to what precedes them.

The opening chapter covers the basics: the OS X and Windows development environments (and the use of Terminal in Linux), the Max SDK, as well as general practical considerations to bear in mind concerning external development.

Chapter 2 provides a useful refresher on digital signals, walking the reader through the process of writing it into a buffer using javascript inside Max. The chapter essentially functions to indicate the general level of competency that is required for readers of the book to progress: reasonably fluency with a text-based coding language is expected.

Chapter 3 is probably the crucial chapter in the book, and an invaluable resource for anyone that has ever gazed, bamboozled, at the source code of a Max external. It walks the reader through the entire process of designing, coding, compiling, and testing an external in Max and Pd, providing an extensively annotated line-by-line account of the key elements that make up the anatomy of a Max object: the header files, object structure, class pointer, function prototypes, initialisation routine and perform routine. Lyon's decision to omit any consideration of objects that run at the control and event rate means that the jump from chapter 2, where we discuss filling a buffer in Max, to chapter 3, where we develop a signal multiplication object ('multy~') from scratch, will be steep for most readers. Personally, I appreciated the sole focus on objects that run at signal-rate, but one should expect to return to this chapter a few times over the course of learning to fully absorb its contents.

One of the nice features of the book is that, with the exception of the demo externals of chapter 1 and 3, all of the objects that are described offer functionality that doesn't already exist in the native Max environment. As well as providing useful additions to one's own external library, this strategy serves to push home a smart development ethic: given the required time and persistence, it is only worthwhile implementing ideas that aren't already catered for by Max or the wider development community. Chapter 4, 'Variable Feedback with Delay', perfectly exemplifies this principle by showing how developing externals offers a means to overcome the native limitations of the Max environment. Specifically, it covers the design of a variable delay ('vdelay~') whose lower time limit is unaffected by Max of PD's signal vector size (a restriction that affects tapin~/tapout~, delay~, and delread~/delwrite~), thereby making such sound synthesis techniques as feedback FM possible in Max. Through the example, we address fundamental DSP and coding topics such as dynamic memory allocation, how to account for with changes to the global sample rate, and sample interpolation.

If chapter 4 provides an essential grounding in basic audio processing, then chapter 5 gets the reader started on sound synthesis. In this chapter we go through the process of implementing a new oscillator complete with options to set arbitrary wavetable sizes, as well as perform dynamic waveform allocation (triangle, square, sawtooth) and direct additive synthesis. The chapter introduces new topics such as normalisation and parameter-passing in Max, but by now much of the nuts and bolts of building externals have already been introduced. It allows Lyon to slightly ease up on the detailed explication of the previous two chapters, focusing only on the essentials. After a long and 'improvisatory' chapter on sequencing, where a simple premise – the design of a sample accurate sequencer – is taken in a more exploratory direction through the implementation of novel list manipulation algorithms, chapter 7 introduces non real-time buffer editing and processing. Here, Lyon details how to link to buffers inside Max, print internal buffer information to the Max window, and perform various editing operations including cutting, pasting, normalising and – a welcome thing in the Max world – reversing edits.

Chapter 8 marks the 'advanced' stage of the book. It covers the development of

two externals designed to be used inside the pfft~ system in Max: one, an adaptive noise reduction algorithm whose threshold changes in response to the amplitude of the input signal ('cleaner~'); and the second a spectral scrubber that allows for dynamic playback of spectral frames from a buffer ('scrubber~'). This chapter will be primarily of use to Pd users, firstly because it is not quite as clear why one would want to implement these functions in C rather than stay in Max and Jitter; and secondly because, differently to the other chapters, the rewriting of the external for Pd requires a complete redesign to account for the lack of a Pd equivalent to the pfft~ system. Working through this complex chapter should furnish the reader with a fairly high level understanding of advanced DSP coding that is transferable to VST plugin design, or designing objects for other environments like Supercollider.

Barring a chapter on Xenakis's dynamic stochastic synthesis (chapter 13), the remaining sections either focus on developing the reader's programming skills or on making use of new Max-specific features in external design. Debugging, code optimisation, benchmarking / profiling, and porting code from one platform to another all feature in these later chapters, whilst others focus on adding attributes to your externals (a new feature in Max 5), integrating externals into Max for Live devices, and updating one's externals to make use of the post-Max 6 64-bit processing (this last chapter is included on the accompanying CD-ROM).

In closing, I want to turn to my earlier-mentioned comments about the great challenge a book like this faced: not only in terms of keeping track of overhauls to the various development environments, but also in staying abreast of changes to the target environments. These latter can have the effect of either 1) rendering pre-existing code obsolete, or 2) adding functionality that is not accounted for in the book. Two years after the publication of the book, a revision to the Max SDK was introduced that amply satisfied the first condition; though trivial, it broke every single external in the book, meaning that the code on the CD-ROM now needs to be updated in order for it to compile [2]. Yet it is condition two that presents the biggest threat to the longevity of the book. The introduction of Gen in Max 6 has so improved the experience of programming in Max for advanced users that it is now possible to achieve many of the gains that one would normally build an external for without leaving the Max environment. Among other things, Gen allows one to bypass the signal vector limitation and create single sample delays, whilst also affording more efficient use of CPU resources. It also offers a choice between patching and code, which improves the readability of complex signal graphs. A recent addition has even provided the option to export code for use with other companies' SKDs, such as Steinberg, thereby filling the hole that the discontinuation of Pluggo left.

For the intermediate and advanced users I described in the opening, it may be that the introduction of Gen is enough for them: it has obviated many of the reasons to develop third party externals, and hence, the need for this book. However, just as the changing ecology of Max has direct effects on the skills and literacies needed of its user base, wider technological change can often cause them to return in new guises. Cycling '74 has been slow to interface with the iOS and Android operating systems, for instance, meaning that audio coding in Xcode remains an essential skill for app development. For this reason and others, I predict a long and prestigous shelf life for Designing Audio Objects by Eric Lyon. As the only textbook in the field designed for migrating from graph-based programming to audio coding in text-based languages, the transferable skills it will nurture in audio technologists will prove invaluable.

Notes

[1] First, the version update from 5 to 6, which introduced 64-bit processing to Max; and second, the introduction of Max for Live, the much-vaunted bridge between the worlds of Max and Ableton Live.

[2] The updated CD-ROM package can be found here: http://disis.music.vt.edu/eric/DAOCD_Update_2014/