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MICROTONALITY AND THE TUNING SYSTEMS OF ERV WILSON

Terumi Narushima

Microtonality and the Tuning Systems of Erv Wilson

This book explores the emerging area of microtonality through an examination of the tuning theories of Erv Wilson. It is the first publication to offer a broad discussion of this influential theorist whose innovations have far-reaching ramifications for microtonal tuning systems. This study addresses the breadth and complexity of Wilson's work by focusing on his microtonal keyboard designs as a means to investigate his tuning concepts and their practical applications. Narushima examines materials ranging from historical and experimental tunings to instrument design, as well as musical applications of mathematical theories and multidimensional geometry. The book provides an analysis of some of Wilson's most significant theoretical ideas, including the Scale Tree, Moments of Symmetry, Constant Structures, and Combination-Product Sets. These theories offer ways to conceptualize musical scales as patterns with structural integrity and whose shapes can be altered to produce infinitely varying forms. The book shows how these structural properties can be used to map scales onto a microtonal keyboard by providing step-by-step guidelines and clearly illustrated examples. Most importantly, it brings together theoretical and practical methods of tuning to enable composers, performers, and instrument designers to explore previously uncharted areas of microtonality, making a significant contribution to the fields of music theory, composition, and music technology.

Terumi Narushima is a senior lecturer in music at the University of Wollongong, Australia. She is a composer, performer, and sound designer specialising in microtonal tuning systems. Her projects include acoustic and electronic music, works for film and theatre, and a research collaboration to develop microtonal flutes using 3D printing.

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For Kraig Grady,
and in memory of Erv Wilson who
sadly passed away before this book went to print.

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Foreword

Ervin M. Wilson was arguably the most creative music theorist in the world of alternative scales and tunings. He was also one of the least accessible because he chose to work alone and to share his prodigious discoveries and inventions personally, rather than teaching courses, writing formal papers, or publishing textbooks on his remarkably fruitful musical theories. This long-awaited book remedies this situation, for Dr Narushima is both an academic musicologist and an accomplished composer who fully understands and utilizes Wilson's theories in her writings and compositions. At her suggestion, I will recount how I met Ervin Wilson and had the good fortune to study and collaborate with him.

I first met Erv, as he preferred to be called, in the early 1960s when I was a graduate student in Biology at the University of California, San Diego. At that time, UCSD was located on the beach at the Scripps Institution of Oceanography, and the atmosphere was so intense that graduate students were given keys to the university library stacks. One evening I got tired of reading about molecular biology and genetics, so I decided to peruse the holdings of the *Journal of the Acoustical Society of America*. Soon I discovered that a certain Tillman Schafer had constructed a 19-tone electromechanical musical instrument at Mills College in the late 1940s, and that he had worked for the U.S. Navy in Point Loma, a suburb of San Diego. Hoping that he still lived in the San Diego area, I called the facility and asked to speak to him.

As it turned out, Schafer was still in San Diego and invited me to his home where I saw the instrument, but more importantly, was given the names of other people interested in microtonal music. One of these was Ivor Darreg, who then lived in Los Angeles; so I drove to LA and met Ivor, who in turn referred me to Ervin Wilson. Just prior to this meeting, I had attended a seminar at the Salk Institute by David Rothenberg, a composer and theorist from New York City, who is best known for his theories on the perception of musical tones in scalar contexts. Remarkably, David also knew Wilson and was visiting him the same time I was. So, through this network of associations, I met Erv Wilson and became one of the fortunate few who have had the opportunity to learn firsthand of his work.

As a graduate student, I had access to a large mainframe computer, so in 1968 I asked Erv if there were any computations I could do for him. We decided that a table of all the equal temperaments from 5 to 120 tones per octave would be useful, especially if I also computed the errors in a set of small-number ratios for each system. I did this, and at Erv's suggestion, sent a copy to Professor Fokker in The Netherlands. Fokker was the leading proponent of 31-tone equal temperament in Europe, and the author of a number of articles as well as a composer in that system. Having finished this study, Erv and I also compiled a very large table of just intervals and distributed multiple copies to other workers. Other projects included equal divisions of 3/1 and other integers, as these can approximate divisions of the octave with improved representations of certain harmonically important intervals. In recent years, other composers such as Heinz Bohlen, John Pierce, Kees van Prooijen, Enrique Moreno, and others have also become interested in divisions of 3/1.

At this point, I had to stop and finish my dissertation, which was on the genetics of the tryptophan pathway in *Neurospora crassa*, if I were ever going to graduate from UCSD. (One of my graduate advisors had started referring to me as "graduate student emeritus".) After getting my doctorate, I moved around the country, and became involved in research and teaching in the fields of microbial genetics, industrial microbiology, biochemistry, and biotechnology, eventually returning to UCSD. Through all of these peregrinations, I continued to correspond with Erv and pored over his sometimes puzzling letters, intriguing keyboard diagrams, and cryptic worksheets. An invitation from Larry Polansky to spend a summer writing at Mills College followed by a part-time research position again at U.C. Berkeley allowed me to complete my book, *Divisions of the Tetrachord*, a task that was originally suggested by Lou Harrison. Much of this book was directly concerned with Erv's theories and musical discoveries.

So, it gives me great pleasure to see that Erv's theories are finally made available to musicians and musicologists who don't have access to his original papers and diagrams as I and a few other lucky students have had.

Central to Erv's work and among his first discoveries are his keyboard designs. To play microtonal music with the same skill and expression as is done in 12-tone equal temperament, one needs instruments that are designed for alternative tunings. Dr Narushima has done a magnificent job of explaining Erv's keyboard designs and how they may be applied to many different tuning systems. This is one of the most valuable aspects of this book, not only for understanding Wilson's contributions, but as a guide for designers and builders of instruments to play music outside the standard 12-tone equal temperament.

Wilson was also one of the most intuitive mathematicians one is likely ever to meet outside of academia, though he had little or no formal training in the subject. In addition to being able to visualize and geometrically plot musical scales as objects in higher dimensional space, he rediscovered or

reinvented a method equivalent to the approximation of irrational numbers by continued fractions (The Scale Tree), and characteristically applied it as an organized system for discovering new musical scales of the type he terms Moments of Symmetry (MOS). Dr Narushima's explanation of this mathematical process is crystal clear without losing sight of its musical significance, particularly as it applies to keyboard design.

Other key concepts of Wilson's musical theories are Constant Structures, which are scales in which every occurrence of a given interval is always divided by the same number of smaller intervals. These may be considered as a generalization of MOS and have comparable structural stability. They exist in both equal temperaments and ratiometric tunings (extended Just Intonation) as do another class of scales, the Combination-Product Sets.

CPS are found by multiplying a set of *n* harmonic generators, *m* at a time. The prototype is the Hexany, a six-note set generated from four integers representing harmonic functions such as 1, 3, 5, and 7, two at a time. The resulting set of pitches is partitionable into four pairs of (generalized) triads and their inversions. Others are the Dekany (two out of five or three out of five), and the Eikosany, four out of six. These in turn may be divided into smaller CPS: Dekanies into Hexanies, and Eikosanies into both. These structures are especially fascinating because they are harmonic without being centric as any note or none can function as the tonic. They are also defined in equal temperaments, but are generated by addition rather than multiplication.

Needless to say, there is much more in this comprehensive exposition of Wilson's contributions to music theory. Dr Narushima, as well as Kraig Grady and Warren Burt, among others, have composed innovative and aesthetically significant music based on materials invented and discovered by Ervin M. Wilson, thus proving that his work is not empty speculation and audibly imperceptible theoretical invention.

John H. Chalmers, PhD.
Author of *Divisions of the Tetrachord*
Founding Editor of *Xenharmonikôn*
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I gratefully acknowledge permission from the incomparable Erv Wilson to reproduce copyrighted material from his vast collection of papers. Thank you, Erv, for your enthusiastic support for the publication of this book. I hope it meets your approval.

The bulk of the research presented in this volume is based on my PhD thesis which I completed at the University of Wollongong in 2013. I wish to thank my supervisors, Associate Professor Greg Schiemer who piqued my interest in microtonal music in the very beginning and has continued to support my work, and Professor Catherine Cole for guiding me through the writing process and for her wonderful mentorship. I would also like to express my deep gratitude and respect to my examiners, Professor Bill Alves and Dr John Chalmers, for their generous and insightful comments which gave me the impetus to pursue the writing of this book. Thanks also to Heather Jamieson and the anonymous reviewers who gave valuable feedback on my book proposal, and to my editors at Routledge, Emma Gallon and Annie Vaughan, for their attention to detail. I gratefully acknowledge the Faculty of Law, Humanities, and the Arts at the University of Wollongong for granting me study leave to complete this manuscript.

My sincere appreciation also goes to members of the tuning community, especially Stephen Taylor, Marcus Hobbs, Warren Burt, Michael Dixon, David Doty, David Finnamore, Neil Haverstick, Mykhaylo Khramov, and Dante Rosati, who have at various times responded to my queries or engaged in tuning-related discussions.

And most importantly, my thanks to Kraig Grady for permission to include his diagrams and lattices of his Centaur tuning and the Bohlen–Pierce scale (Chapter 5), his tireless effort in making Erv Wilson's work accessible to the public through the Wilson Archives, for unselfishly sharing his knowledge and answering my questions on tuning with patience and thoughtfulness, for assembling the many diagrams for this book, for constant feedback and encouragement, and for being an inspiring and supportive partner.

Abbreviations

COMP	complement
CPS	Combination-Product Set
ET	equal temperament
GEN	generator
JI	just intonation
MOS	Moments of Symmetry

1 Microtonality and the enigma of Erv Wilson

Microtonality is a rapidly growing field among contemporary musicians who are searching for new melodic and harmonic resources to expand their musical vocabulary. The label "microtonal" suggests music with very small intervals, but it can also refer to music that uses any intervals not found in the standard Western system of 12-tone equal temperament. The latter interpretation of microtonality encompasses not only experimental tuning systems but scales found in different musical cultures around the world, as well as historic intonation systems, from ancient Greek scales to temperaments that predate the gradual adoption of 12 equal divisions of the octave in the West. An even broader, more pluralistic approach is to view microtonality as a musical continuum that embraces "all intervals and tuning systems", of which 12-tone equal temperament is "only *one* of the myriad of possibilities" (Schulter 2012).

The chief instigator for a renewed interest in alternative tuning systems in the twentieth century was the iconoclastic composer, theorist and instrument maker Harry Partch (1901–1974). During his lifetime, Partch built a large ensemble of instruments tuned to a scale he developed with 43 tones per octave and these were used to perform his musical and theatrical works. He also wrote *Genesis of a Music*, a seminal book which was to inspire subsequent generations of musicians to explore microtonal scales. While Partch was a proponent of just intonation – a tuning based on intervals found in the natural harmonic series – other musicians such as Ivor Darreg have experimented with scales that divide the octave into different numbers of equally spaced intervals other than 12. These include scales that divide the semitone into smaller intervals such as quartertones, sixth tones and eighth tones (e.g., Julián Carrillo, Alois Hába and Ivan Wyschnegradsky), as well as scales that closely approximate just intervals such as 19-tone equal temperament (e.g., Joseph Yasser, Joel Mandelbaum) and 31-tone equal temperament (e.g., Adriaan Fokker), to name but a few. Still other musicians have proposed scales that are non-octave-based, such as the Bohlen–Pierce scale (Bohlen 1978; Mathews, Roberts & Pierce 1984) or Wendy Carlos' Alpha, Beta and Gamma scales (Carlos 1987, pp. 42–43). Such examples of microtonal tuning systems provide musicians with a vast

range of pitch resources with which to play. They offer a palette of vibrant colours that would otherwise not be available from the "black and white" notes of conventional tuning. Although a majority of contemporary musicians still work with 12-tone equal temperament as their standard tuning, there is a growing awareness of alternate scales as more musicians are seduced by the endless possibilities offered by microtonal tuning systems.

A parallel concern for microtonalists has been the development of new instruments that are capable of performing music in different scales. This has led to the invention of a variety of keyboards – including R.H.M. Bosanquet's generalized keyboard, Adriaan Fokker's 31-tone organ, George Secor's generalized keyboard for the Motorola Scalatron and Erv Wilson's MicroZone – as well as refretted guitars, tuned percussion, electronic and other original instruments. It has also offered new explorations with wind instruments and non-Western instruments. Significant advances have been made in the development of computer music programs that can play microtonal pitches, of which Manuel Op de Coul's Scala tuning software (2016) deserves special mention, alongside Marcus Hobbs' Wilsonic app (Satellite 2016) which is specifically designed for users to explore the tuning systems of Erv Wilson. These developments are discussed in greater detail in Chapter 2, with a particular focus on microtonal keyboard instruments. Indeed, a study of Wilson's keyboard designs and their potential applications in the exploration of new territories in microtonal tuning forms the basis of this book.

I first became interested in microtonal music in the late 1990s as a composition student at the Sydney Conservatorium of Music. At the time I was writing music with quartertones and other pitch inflections in an attempt to draw on harmonic resources beyond 12 tones per octave, so a study of more systematic approaches to tuning seemed a logical step for me to take. Through a series of introductory lectures given by composer and teacher Greg Schiemer, I was exposed to the pioneering work of Harry Partch as well as other contemporary musicians working in non-standard tuning systems, such as Jacques Dudon, Mamoru Fujieda, Ellen Fullman, Kraig Grady, David Hykes, Larry Polansky, Terry Riley, Carter Scholz and William Sethares. For my final Masters project at the Conservatorium I explored the relationship between tuning and timbre by creating a sound installation for synthesized bells whose overtones related to the scales in which they were played. The tuning system I used was a set of scales called Tritriadics which were developed by contemporary American theorist John Chalmers. My work was influenced by the new tuning ideas to which I was exposed and this creative engagement made me want to explore microtonal composition further.

Of the musical examples I heard, I was particularly attracted to the work of Kraig Grady (1952–), a composer, performer and instrument builder belonging to the Californian group of experimental musicians who continue Partch's legacy today. Grady's music is directly informed by the ideas of Los Angeles-based tuning theorist Ervin Wilson (1928–2016), an influential but

enigmatic figure in microtonal music, who has been described as "one of the most prolific and innovative inventors of new musical materials extant" (Chalmers 1993, p. 3). Wilson, a skilled draftsperson, assisted Harry Partch with the second edition of *Genesis of a Music* by producing new illustrations and diagrams for his book (Partch 1974, p. 267, note 9).

The breadth of Wilson's contribution to tuning is conveyed in the following description:

> Since the 1950s, Wilson has categorized and catalogued equal temperaments and developed generalized Bosanquet-type keyboards and notations for them. He has also discovered and characterized many different new classes of just intonation scales, and his discovery of the Combination-Product Set method of generating just tunings has been called "a giant step forward" for just intonation theory. Since that time, Wilson has explored aliquot scales, tunings based on Pascal's triangle, and many different numerical series. His work continues today with unabated imagination and originality.
>
> (McLaren 1997)

Wilson's innovations in tuning have far-reaching ramifications, not only from a theoretical or analytical perspective, but by providing practical tools for the performance and creation of new music. His scales offer novel approaches to melody and harmony that can be applied to a variety of musical contexts and styles. Testament to this is the diverse range of musicians who have studied with Wilson or have been influenced by his ideas. These include – but are not restricted to – composers, performers and instrument makers working in experimental music, jazz, rock, free improvisation, film composition, electronic music and world music. People who studied with him at different times include Gary David, Kraig Grady, Scott Hackleman, Jose L. Garcia, Marcus Hobbs, Craig Huxley, Chuck Jonkey, Todd Manley, Rod Poole, Glen Prior, Michael Stearns, Stephen James Taylor and Daniel Wolf. Others who have been influenced by Wilson's ideas include Lydia Ayers, Warren Burt, David Finnamore, Neil Haverstick, Dave Keenan, Pete McRae, Andrew Milne, Paul Rapoport, Greg Schiemer, Margo Schulter, Ron Sword and Robert Walker. In addition to Partch, Wilson also collaborated with various people, including tuning theorist and astrobiologist John Chalmers, North Indian musician Amiya Dasgupta, instrument designer Larry Hanson, physicist Walter O'Connell, percussionist Emil Richards and musician George Secor.

One of Wilson's leading protégés is the aforementioned Kraig Grady who studied with Wilson for 30 years. According to Grady, Wilson was a remarkable teacher and mentor who tailored his material to benefit each individual according to their specific needs and creative interests, and as a result many of his students learned different things from him. Wilson's theories were often based on a re-evaluation of existing systems of tuning, both

historical practices as well as examples from the various musical cultures of the world (Grady 2012). What impressed Grady about Wilson's teaching was his ability to extrapolate the inherent structural properties of the systems that hitherto may have been overlooked, and to transform their patterns into general principles that could then be applied and extended to generate new scales. This was a very powerful assertion. Whereas some theorists tried to prescribe all the rules within a specific closed system, Wilson's work was especially appealing for its dynamism and open-endedness: his theories were "not just some mathematical games…. [They] were actually filled with immense beauty" (Grady quoted in Taylor 2011) and had the potential to inspire countless interpretations and creative applications.

I met Wilson for the first time at MicroFest 2001, a conference and festival of music in alternate tunings held at the Claremont Colleges, California. MicroFest, which was organized by composer Bill Alves, was a formative event in my development as a musician, as it gave me the chance to meet with and hear the work of the chief exponents of contemporary microtonality. At the conference, Wilson gave a perplexing presentation on multidimensional tone lattices. To represent these structures, he had built a series of physical models from molecular model kits, the type normally used for chemistry lessons. Intriguingly, he proceeded to show each model, holding them up in his hands and rotating them one by one, but the presentation offered few verbal clues or explanations. I, like many others in the audience, was left bewildered. Despite my early enthusiasm, I quickly realized that a great deal of research would be required on my part if I wished to gain a more sophisticated understanding of Wilson's work.

Following the conference, a face-to-face meeting was arranged with Wilson and Grady, as well as Stephen James Taylor, a film and television composer who had also studied with Erv Wilson. Upon discovering my Japanese cultural heritage, Wilson recounted his experience of hearing samples of Japanese court music for the first time through a meeting with the Japanese musicologist, Dr Hisao Tanabe. This took place soon after World War II when Wilson was a young man in the US Air Force in Japan. He particularly remembered hearing the interval 8/7 played on the flute, and he was deeply affected by the experience. Although I was baffled by Wilson's earlier presentation at the conference, I was struck by his personal charisma during this initial encounter and felt compelled to pursue his ideas further. Exactly what I would discover I was not sure, but I was certain that I would learn something new and that this would somehow influence the direction of my own work.

Shortly after I returned to Australia, I received from Wilson a single sheet of paper with a diagram labelled "The Tanabe Cycle" on one side, and a chart of intervals titled "Parallelogram from the Tanabe Cycle" on the reverse side. At first the information I was able to decipher seemed trivial but the diagram also seemed to suggest a puzzle whose deeper significance was hidden beneath the surface. This sheet of paper became an invitation for me

to delve further. Since that time I have actively sought to improve my understanding of Wilson's work by studying his charts and diagrams, reading any written material I could find about his theories and communicating with other musicians who had engaged with his ideas. However, it has taken me several years to appreciate the full implications of Wilson's paper, and my findings are discussed later in Chapter 4.

A brief biography of Erv Wilson

Unfortunately, not a great deal has been written about Wilson's life, but the following short biography aims to give an overview of what information is available.

Ervin McDonald Wilson was born on 11 June 1928 in Colonia Pacheco, a remote mountain village northwest of Chihuahua, Mexico. He was the second son of a large Mormon family who had migrated from Utah to Mexico by wagon in 1926. Colonia Pacheco was a small community originally established by Mormon exiles fleeing from the United States in the 1880s. His childhood was spent helping with the family ranch, tending goats and other animals as well as cultivating crops, while attending grade school. Life during this period was probably arduous as it was the time of the Great Depression.

Wilson cites as his early musical influences Mormon hymns and popular Mexican songs. He also learned to read music and play the reed organ from his mother. Reed organs were "common on the frontier because they were light, easy to transport and tended to remain in tune" (Wilson, G 2009, p. 3). Apparently Wilson was eager to compose music from a young age, but was confounded when some of the notes he could hear clearly in his head, such as the Mexican vocal tunes, could not be reproduced on the organ. He claims that this germinal experience launched his lifelong inquiry into musical scales (Wilson 1989).

At age 15, Wilson's family moved to Oregon in the USA, where he attended high school for a year before being sent to live with his aunt in Salt Lake City, Utah. As a teenager he developed an interest in Indian music, and started studying the subject on his own by borrowing and reading books from the library. Eventually Wilson joined the US Air Force and served with the US occupation force in Japan at ages 19 and 20. In Japan, "a chance meeting with a total stranger introduced him to musical harmonics, which changed the course of his life and work" (Wilson 2001). Legend also has it that test results from around this time revealed his extraordinary powers of visualization which were applied to the analysis of aerial photographs. These abilities were later put to good musical use for visualizing complex tuning structures.

After serving in the US Air Force, Wilson briefly studied music theory at Brigham Young University, but being unable to find an explanation for "his concept of 'missing' keys in the musical scale" (Wilson, G 2009, p. 4), he was lured away to California which by comparison was a hive of musical activity

at the time. There he continued his musical education through self-study and interaction with other microtonalists. He filled countless notebooks with charts, diagrams and written explanations as a record of his ideas and activities over several decades. These reveal his meticulously systematic and thorough approach to problem solving, and also an incredibly fertile mind that could perform breathtaking leaps of imagination. He also kept copies of letters he sent to various people with whom he corresponded about music and tuning theory. One of his chief correspondents was John Chalmers, his long-time friend and colleague, as well as founder and editor of the journal *Xenharmonikôn* (1974–1979, 1991–1998), and author of *Divisions of the Tetrachord* (1993).

In the 1960s, Wilson and his father formed a small culinary and medicinal herb business that distributed herbs from the Sierra Madre of Northern Mexico to various outlets in the US (Burns 1986, p. 2). Through this work he "became intensely interested in the cultivation and propagation of various medicinal herbs" (Wilson, G 2009, p. 4), and this led to his ongoing preoccupation with collecting and breeding plants, an endeavour that has persisted alongside his musical pursuits. Especially significant was his work with high-lysine corn which is a hybrid developed to improve the protein in corn over ordinary varieties. These efforts were motivated by his desire to help people living in countries like Mexico where corn is a staple of their diet. Influenced by his work in breeding plants, Wilson "began to think of the musical scale as a living process" (Wilson 2001). He saw each kind of scale as a plant species that had the potential for growth and transformation, but was also subject to the forces of evolution where some species might survive while others may not. As Grady explains, "Erv is the great seed scatterer… he's scattered all these different seeds and he's not really sure which one of these plants will take hold and continue to grow. I think that's the nature of his work" (Grady quoted in Taylor 2011).

For most of his adult life Los Angeles was Wilson's home, thus placing him firmly with the American West Coast movement of microtonality that includes Partch, Lou Harrison (1917–2003), La Monte Young (1935–) and Terry Riley (1935–), many of whom he knew personally. He became a magnet for musicians from a diverse range of backgrounds and styles who came to visit him, or study and be mentored by him for varying periods of time. Wilson says that the goal of his research into tuning was to make scales "musically accessible to the composer and the listener…. I sculpt in the architecture of the scale. Other people come along and animate it" (Wilson 2001).

Between the years 1974 and 1989, Wilson published a dozen or so articles in *Xenharmonikôn*, an informal journal established by fellow theorist John Chalmers for the purpose of communicating ideas relating to tuning "among active workers in the field of experimental music" (Chalmers 1974, p. 2). These articles covered many areas of Wilson's early research, including tetrachordal modulations, Combination-Product Sets (CPS), notation systems, microtonal keyboards and other instrument designs. Today, most of

Wilson's documents on tuning theory are readily available online through the Wilson Archives,[1] a vast collection of articles, letters, charts and meticulously hand-drawn diagrams. The Archives are managed by Kraig Grady who has remained one of Wilson's most dedicated advocates. Grady is responsible for digitizing, collating and publishing Wilson's files through his own anaphoria.com website as an on-going research commitment. Initially Wilson was reluctant to have his work disseminated through such a channel because he preferred the oral tradition of teaching: he would give his papers to individuals as an illustration to accompany a verbal discussion. According to Grady, problems began when Wilson found that copies of his work were being distributed freely without his consent, and he was concerned that his ideas were being misinterpreted and misappropriated by others without proper acknowledgement. After much persuading, Wilson eventually agreed to have his papers published online and as a result, people such as myself, who were not able to have individual lessons with Wilson in Los Angeles, can now benefit from his work.

In 2010, due to unforeseen changes in his living circumstances, it became necessary for Wilson's enormous collection of papers and personal possessions to be consolidated. Several of his supporters, including Grady, Taylor and myself, were enlisted to assist. My task in the archival process was to make digital scans of nearly 300 of Wilson's documents on tuning, including papers that had not yet been published. This undertaking gave me a unique appreciation of the immense breadth and depth of Wilson's oeuvre, the rigour of his endeavours and the intricate beauty of his many charts and diagrams which number in the thousands, if not tens of thousands.

With such an abundance of Wilson's material now available to the public, one might expect his ideas to have reached a wider musical audience than they have so far: but why has this not been the case? First, the often discouraging obscurity of his work has meant that many musicians continue to find his material difficult, and choose to ignore rather than engage with his ideas. As Brian McLaren says, "Reading a Wilson article is like being hauled up from the bottom of the Cayman Trench in a bathyscaphe – rapidly. The effort to decompress Wilson's gnostic piths and gists provokes acute vertigo" (1998, p. 80). Even as a committed supporter of Wilson's ideas, I too found that his theoretical papers were often highly esoteric and mostly written for a small circle of microtonalists who were already familiar with his musical language. As a result, much of his work remains impenetrable to a reader who has not been initiated into his ideas. In his PhD thesis, *Algorithms, Microtonality, Performance: Eleven Musical Compositions*, the composer Warren Burt playfully describes Wilson as a "non-academic researcher", whose "work does not indulge in either the clear explications or aesthetic justifications of academic writing". Burt also notes, however, that "the bulk of microtonal research in the 20th century was, indeed, carried out by non-academic researchers", and only "in recent years has an interest in microtonality become academically respectable…" (2007, pp. 37–38).