EIVIND GROVEN'S PURE-TUNED ORGAN IN HISTORICAL AND AESTHETIC PERSPECTIVE

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> As far as satisfying the sense of hearing is concerned, we stand in reality a long way back in cultural development. We are perhaps only at the break of dawn. [1]

Eivind Groven considered his work with the pure-tuned (or just intonation) organ as an attempt to satisfy the sense of hearing, as a step closer to perfection. He wished to realize a dream that he believed had been held for centuries by "thousands of musicians",[2] the dream of pure tuning: "just" intonation.

The theme of tuning and tuning systems has recurred throughout the history of music. It has presented itself as particularly problematic in regard to keyboard instruments, in which pitch frequencies are fixed. Today, if we wish to move away from the equal-tempered compromise and take a large step closer to purity of temperament (for example with new kinds of organs), it is not unreasonable to look to past examples of different types of unequal temperaments for models. When Groven sought to realize his dream of a pure-tuned system he chose a solution for tuning keyboard instruments that might be considered somewhat radical. Nevertheless, it is not difficult to find several like-minded individuals in the broader sweep of music history. In recent years, growing interest in tuning methods other than twelve-tone equal temperament, sometimes with elements of microtonal intervals, appears to be a sign that only now is the time ripe to appreciate the pioneering work of Groven.

Eivind Groven (1901-77) is so far the only Norwegian composer to have grown up playing the indigenous folk instruments the hardingfele (harding fiddle) and seljefløyte (willow flute). Alongside his compositional work he developed into a creative tradition-bearer and pioneering researcher into folk music.[3] As a youth, when Groven travelled from his rather isolated West Telemark district, which had a rich, living, folk music tradition, to Oslo, where a pronounced art-music style had established itself, it was a truly long journey to undertake,

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[1] *Eivind Groven,* Temperering og renstemming *(Oslo: Dreyer, 1948), 82.*

[2] *Groven,* Temperering*, 81.*

[3] *Groven was co-editor of* Norsk folkemusik, Serie I: hardingfeleslåtter*, bind 1-7 (Oslo 1958-81), and also transcribed and published in photocopy format Helge Ingstad's collection of recorded melodies from the Nunamiut (1949-50) as* Eskimomelodier fra Alaska *[Eskimo Melodies from Alaska], (Oslo, 1956): see Ingstad,* Songs of the Nunamiut: Historical Recordings and Transcriptions of an Alaskan Eskimo Community*, ed. Sigvald Tveit (Oslo: Aschehoug, 1998). He transcribed in total approximately 2,000 folk tunes, and reflected much on which transcription practice should be employed to most faithfully render the folk music's tonality and rhythmic structures.*

precisely because the gap between rural and city culture was so great at that time. His encounter with the capital city set his own musical origins in perspective: they had a timely effect on his artistry, and stimulated a great deal of reflection. These reflections encompassed culture in general and music in particular: formal language, sound use, style, acoustics, and tonality.

Already as a thirteen year old, Groven had come up against the problem of "just intonation" when he attempted to tune a harpeleik that his brother Sverre had won at a bazaar. He could not get the instrument tuned purely in all keys. Was there something wrong with his ears? From a neighbour he learned that one couldn't tune an organ, for example, "quite accurately". There would always be "something wrong with it".[4] What this "something wrong" consisted of would come to occupy Groven for the rest of his life. The work of realizing pure tuning crystallized not only in several organs with a built-in tone-shifting device, but also in several theoretical treatises on the topic: *Naturskalaen* [The Scale of Nature, Skien, 1927]; *Temperering og renstemming* [Tempering and Pure Tuning] (1948, 1968), where Groven describes unequal tuning systems; and *Renstemmingsautomaten* [The Pure Tuning Device] (1968), where he explains the principles of his automatic retuning device.[5]

In 1936 Eivind Groven built his first "just intonation" instrument, a harmonium. He kept the normal keyboard, but each key had three pitches. There were, in other words, three possible pitches for every pitch-class. Without Groven being aware of it, there was another instrument built in Stuttgart ten years earlier that was based on the same principles, but that harmonium was more awkward to perform upon: during performance one had to manually engage those pitches that at any given moment would produce pure harmonies. Groven's instrument employed an electronic switching mechanism but still took its toll on the performer, since it was only partially automatic. One bright July night in Summer 1939 Groven suddenly understood that it must be possible to build a pitch-switching device that "could be directly guided by impulses from the keyboard manual".[6] The small time-interval between when the finger touches the key to the moment it strikes the tone could be utilized. In this manner, the pure harmonies would occur automatically during performance, thereby relieving the performer of this task.[7]

The first time around, Groven built his unique device out of discarded relays from the telephone company. Laboriously he forged ahead: testing, rejecting, succeeding, failing, and starting again from scratch. Money was in scant supply. In 1953 a pipe organ, originally conceived as a test organ, was finished. It had one voice and thirty-six possible pitches per octave. In collaboration with Ragnar Bogstad, in 1965 Groven completed one of the first electronic organs in Norway. The instrument produced thirty-three timbres, including rare

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[4] *Olav Fjalestad, ed.,* Eivind Groven. Heiderskrift til 70-årsdagen 8. oktober 1971 *(Oslo: Noregs boklag, 1971), 38.*

[5] *See also Eivind Groven, "My Untempered Organ",* Organ Institute Quarterly *5 (1955): 34-40.*

[6] *Groven,* Temperering og renstemming*, 38.*

[7] *Groven resided out in Tjøme at his cottage and worked on his second symphony. He thought it was a great trial (suffering) to hear the large major thirds and the small minor thirds as he sat with his little tempered harmonium and composed. In his Festschrift he tells about the thoughts he had that night of 9 July 1939 (*Eivind Groven. Heiderskrift*, 80).*

voices such as bukkehorn, seljefløyte, and sekkepipe. The organ had two manuals plus pedals, and forty-three pitches per octave. With this instrument the pure-tuning device's relay logic was converted to transistor circuitry. Bjørn Raad at the Central Institute for Industrial Research carried out the work following Groven's diagrams and instructions. This instrument is no longer in use today. In the 1970's Groven made yet another pure-tuned electronic organ out of a mass-produced organ. For this he returned to his previous solution of thirty-six pitches per octave.[8]

Throughout history, many have attempted to build instruments that avoided equal temperament, but most of these instruments were particularly awkward to play upon. A keyboard with two additional upper manuals demands considerable dexterity. Equally demanding were examples such as Giovanni Battista Doni's three-manual cembalo from 1635 with sixty-eight keys per octave, or Julian Carrillo's 1/16-tone piano from the twentieth century with ninety-six keys per octave! For Groven, the over-riding goal was always to construct an instrument which would not cause the performer great difficulties. Therefore he always desired to stay with the standard piano keyboard. Meanwhile, the crucial question became "how many pitches are *sufficient* in order to attain pure intervals in every key?".

Theoretically, just intonation is the establishment of pitch frequencies in which the ratio between pitches are whole numbers. By this definition, musical "pureness" is not a matter of taste as determined by certain conventions, but is to be understood as an objective concept. The so-called natural scale is comprised of such whole-numbered (integer) frequency relations: "Physically, it is the same result produced by harmonic overtones as mathematics: the consequence of natural numbers".[9]

In the opening of *Renstemmingsautomaten* Groven writes that just intonation builds upon a combination of three basic intervals: the octave (1:2), the fifth (2:3), and the major third (4:5). When he explains why twelve pitches are not adequate to be able to render pure intervals in every key, he adds:

> It appears however that these three ratios are of such a nature that by powers they ca not "add up" to each other. More specifially, one cannot stack on top of each other, for example, a series of fiths in such a way that one gets the same tuning as from a series of octaves. Nor is it theoretically possible to get a series of fifths and thirds to form a common "point of intersection". In other words, one can not make pure octaves out of fifths, nor out of pure thirds.[10]

If one wishes to preserve pure intervals as a scale modulates from one key to another, it is necessary to have several pitches for each pitch-class. However, if one uses a system with

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[8] *This organ is supplied with an extra set of oscillators, which were necessary in order to be able to render pure intervals in addition to the tempered ones.*

[9] *Jórn K. Arvidsen, "Eivind Grovens renstemte orgel med automatisk toneoppvalg",* Norsk kirkemusikk *8 (1982): 295-303, here p. 296.*

[10] *Groven,* Renstemmingsautomaten*, 7.*

only twelve pitches per octave, one or another adjustment must take place. There must be one or another form of balancing (tempering) between the intervals.[11]

For Pythagoras (582-496 BC) and the Pythagoreans, the octave stood out as the best of all ratios (2:1). Pythagoras proposed leaving the pure major thirds out of consideration and using only those pitches that arose out of the sequence of fifths. In constructing scales, one then marked off two perfect fourths within the outer tones of the octave. As such, the tuning system's solid pillars were erected—the octave, fourth, and fifth—which were considered to be consonant intervals. The interval which arose between the two intervals of the fourth is called *tonos* (9:8). This was considered the fundamental tone-step and received *a priori* preference in the building of the scale. Two *tonoi* following each other resulted in the compound interval *ditonos*, the Pythagorean third: (9:8)x(9:8) = 81:64. The pure third, the natural third, is derived from two different whole-tone steps (9:8)x(10:9) = 90:72 = 80:64, or 5:4. Under this system the Pythagorean major thirds became 18 millioctaves[12] (approximately one-fifth of a half-step, or 20.5 cents) larger than the *pure* major third, a difference which has been given the designation "syntonic comma".

Ove Kr. Sundberg points out that among the Greeks there were two types of sensibilities with regard to intervals.[13] The harmonic intervals consisted of the octave, fifth, and fourth. The third, on the contrary, stood out in a completely other sense as a melodic interval. The principle of harmony did not sound forth through the third, but only through the consonant intervals. Therefore, in spite of the large "impure" third, the Pythagorean tuning system could be understood as a realization of the cosmic order, as an audible manifestation of supreme beauty.

One of the first steps toward twelve-tone temperament was made by reducing the fifths from 585 to 580.5 millioctaves (702 to 696.5 cents), namely enough such that a sequence of four perfect fifths created a pure major third (4:5 ratio). This produces so-called "mean tone" temperament. Within this tuning system the most frequently used keys become "pure", while the less common keys must stand a distinct degree of impurity. The worst is the unusable "wolf-fifth", a fifth-interval which is really a diminished sixth of 614.5 millioctaves (737.4 cents). Many attempts have been made to lessen the "wolf", some of which have resulted in different kinds of unequal temperaments.

In the end, the pure thirds were completely relinquished. As twelve fifths, all alike, became levelled out from 585 to 583 1/3 millioctaves (702 to 700 cents), twelve-tone “equal temperament” became a matter of fact. With this one gets a pitch system with major thirds that are eleven millioctaves (13.2 cents) higher than the just major third. The intention was that all equivalent intervals should sound the same irrespective of transposition.[14] The result

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[11] *Knut-Einar Skaarberg,* Algoritmer for renstemt klaverinstrument *(Oslo: Hovedoppgave i Fysisk institutt, Universitet i Oslo, 1995), 28.*

[12] *Rather than cents, Groven used the system known as millioctaves to measure the precise size of intervals. In this system, the octave is divided into 1,000 millioctaves (as opposed to 1,200 cents).*

[13] *Ove Kristian Sundberg,* Pythagoras og de tonende tall *(Oslo: Tanum-Norli, 1980), 166 and following.*

[14] *Skaarberg,* Algoritmer*, 30.*

was that the “spiral” of twelve pure fifths which, with C as a starting point, ends on B#, becomes a closed circle of fifths. The "pythagorean comma" was removed.

Even though twelve-tone equal temperament makes it possible to modulate freely from key to key, it met with considerable resistance because of the impure thirds. People did not turn to this new system as quickly as one might think. In 1719, Johann Mattheson asked: "Wo ist denn diese gewünschte gleichschwebende Temperatur? Ich habe sie noch nirgend, als in des Herrn Neidhardts Buche angetroffen".[15] People preferred one or another form of unequal temperament according to the piece to be played at a given moment. One might show favor to a few simple keys or simply tolerate wide fluctuations in the degree of pureness/ impureness. Moreover, some people even liked the colouring that an unequal temperament could offer.

In music history, Johann Sebastian Bach's name is readily connected to equal temperament due to his *The Well-Tempered Klavier*. It has been a prevailing belief that Bach's "Wohltemperierung" was identical to equal temperament. It appears, however, that Bach ought no longer to be given the credit for the twelve-part logarithmic division of the octave.[16] Moreover, he used different types of unequal temperaments. On the organ, with its sustained tones, impurity comes forth more distinctly than on other keyboard instruments, and 12-tone equal temperament was introduced last to this instrument—indeed, first around 1800 in Germany, and only around 1850 in England.[17] As late as 1774 Johann Philipp Kirnberger writes:

> Jeder Orgelbauer und Instrumentmacher suchte, so gut er konnte, eine Temperatur, die den wenigsten Unbequämlichkeiten untertroffen war; und so stehen die Sachen noch gegenwärtig.[18]

Friedrich Wilhelm Marpurg (1718-95) records that the elderly Georg Philipp Telemann (1681-1767) was annoyed by the all too high thirds in a neighboring church's carillon. In the end he had to move "um sich das Gehör nicht zu verderben" (Marpurg etter Kroman 1917:5, 48).[19] Indeed, it has been pointed out that not until the beginning of the twentieth century did

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[15] *" Where is this equal temperament? I have found it no other place than in Mr Neidhardt's book." In Johann Mattheson,* Exemplarische Organistenprobe im Artikel vom General-Bass *(Hamburg: Schiller- und Kissnerischen Buch-Laden, 1719), 99.*

[16] *See Herbert Kelletat,* Zur musikalischen Temperatur, I: Johann Sebastian Bach und seine Zeit *(Kassel: Merseburger, 1981), 16.*

[17] *Kai Kroman, "Wedell's 31-System",* Musik. Tidsskrift for Tonekunst *1 (1917) no. 1, 6-7; no. 2, 13-14; no. 5, 46-48; and no. 6, 58-61. Nineteenth-century guitars were not tuned in equal temperament, but showed a tendency to rendering, for example, low major thirds. The highly respected Norwegian instrumentmaker from the end of the eighteenth century, Amund Hansen in Fredrikshald (Halden), very clearly allowed for unequal temperament when he made his string instruments.*

[18] *"Each organ builder and instrument maker tried as best he could to find a temperament which caused least discomfort; and that remains the state of affairs today". Johann Philipp Kirnberger,* Die Kunst des reinen Satzes in der Musik *(Berlin: Bey Decker und Hartung, 1774), 10.*

[19] *"In order not to destroy his hearing". Friedrich Wilhelm Marpurg,* Versuch über die musikalische Temperatur *(Breslau: J. F. Korn, 1776), cited in Kroman, "Wedell's 31-System": 48.*

it become common to tune pianos in twelve-tone equal temperament such as is practised today. Mathematically precise equal temperament was still not employed: "No one tuned equal temperament on pianos before the twentieth century [...] because they did not have the technical ability to do so".[20]

Thus it was in response to the equal-tempered compromise that Eivind Groven created his vision of musical perfection combined with practicality. When presenting his just-intoned pitch array he writes: "As aforementioned […], a sequence of 8 fifths from F to C# creates a pitch for C# which is equivalent to Db, the pure third below the starting pitch F".[21] The distance from C# to F is 320 millioctaves (384 cents). The pure third Db-F is 322 millioctaves (386.4 cents). This difference is so small, says Groven, that we can, without risk, interpret these as enharmonic equivalents. By making a small adjustment which the ear is not capable of detecting, Groven could create a pure-tuned solution with only thirty-six pitches per octave: "This time, however, it becomes a matter of dividing and cutting 2 millioctaves (2.4 cents) over 8 fifths; while in equal temperament one must distribute a difference of 18 millioctaves (21.5 cents) over 4 fifths".[22]

Throughout the years Groven experimented with different degrees of subdivision of the scale,[23] and showed the flexibility to try different tuning systems. Nevertheless, in the long run he chose to settle upon the thirty-six-tone partition. In this he was choosing a system in which the octave, the fifth, and the third were pure. In addition to the possibility to establish pure major- and minor chords, one may choose pre-sets with so called "blue notes", tunings that are usual in traditional Norwegian folk music.

Not only in the historic context, but also in his own time, Eivind Groven knew that he did not stand alone in his wish to find an alternative to the twelve-tone tuning system. For twenty years Groven corresponded with Adriaan Fokker of the Netherlands. They received encouragement from each other, but could never agree on what was the "ideal system".[24] Fokker built an organ in Haarlem with thirty-one pitches and thirty-one keys per octave, within which the pure fifth was absent. In his books, Groven constantly refers to others, both from previous periods and within the twentieth century, who have proposed different degrees of subdivision of the scale. He analyzes, compares, and debates these proposals, whether they concern systems with equal-divisions that employ nineteen-, thirty-one-, or fifty-three parts, or systems with unequal divisions, such as the twenty-four-tone system represented in John Haywood Compten's British patent of 1933. In rejecting these various solutions Groven based his decisions either on their degree of difficulty of use in actual practice, or, more importantly,

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[20] *Owen H. Jorgensen,* Tuning: containing the Perfection of Eighteenth-Century Temperament, the Lost Art of Nineteenth-Century Temperament, and the Science of Equal Temperament: complete with Instructions for Aural and Electronic Tuning *(East Lansing, MI: Michigan State University Press, 1991), 4.*

[21] *Groven,* Temperering*, 35.*

[22] *Groven,* Temperering*, 36.*

[23] *Eivind Groven, "Temperering av tonesystemer",* Fra fysikkens verden*, vol. 1 (Trondheim: Norsk fysisk selskap, 1948), 34.*

[24] Eivind Groven. Heiderskrift*, 203.*

their lack of the desired purity. After much deliberation, he came to the conclusion that pure tuning, or "just" intonation, was preferable to the other solutions. The flaw he rightly enough finds in this system can explain, he indicates, why many musicians have turned away from it:

> This system has only one disadvantage: namely the need for comma-displacement within certain chord combinations. This seems to be the little straw which breaks the camel's back. There are certain organists who have maintained that they would rather avoid that little stumbling block, which in other respects lies just inside the door to the very holiest, and put up with tempered intervals.[25]

In Groven's lifetime his work received considerable positive interest at home and abroad (especially the latter) where, over time, so many had occupied themselves with similar problems. Albert Schweitzer wrote in a letter to Groven that it would be the fulfilment of a old dream to one time get to hear a purely tuned organ.[26] When Schweitzer came to Norway to receive the Nobel Peace Prize in the Fall of 1954 he got the opportunity to play Bach on the little pure-tuned pipe organ which was then installed at the Trefoldighet's Church in Oslo, and this resulted in his oft-quoted remark "This is the most interesting thing I have heard […] You must build a large such organ".[27] The international interest also had practical consequences: at the request of Heinz Wunderlich, professor of church music in Hamburg, the organ manufacturer Walcher & Co. (Ludwigsburg) started building a test organ in 1967 under Groven's direction.

During the Nordlyd festival in 1995, the German-Austrian contemporary composer Johannes Kotschy gave a lecture titled “The World of Small Pitches”. When history gets written, he points out, one has a tendency to give more weight to certain events, while other perhaps equally significant events receive minimal focus, if they are taken into consideration at all. Kotschy selects the year 1923 as an example. In Vienna, Arnold Schönberg had completed his theory of twelve-tone composition. Not far away in Salzburg, during the first ISCM festival, the Amar Quartet from Frankfurt presented Alois Hába's quarter-tone string quartet. The viola player in this instance was none other than Paul Hindemith. Neither of these events can be considered in isolation: Schönberg and Hába were exponents of two different currents or tendencies that had their roots many years earlier. It is Kotschy's intention to shed light upon the path for which Hába stands as a representative, but which has garnered a lesser degree of attention in European music history. Europeans have had a bias, says Kotschy, to regard the world from a narrow, European vantage point. As such, the equal-tempered scale in particular has functioned as the reference mark in describing or evaluating the scale systems of non-European cultures:

> Those cultures use microtonal intervals, and they have used them for thousands of years. Compared with our 300 years’ tempered tuning we hardly could have reason to be proud of it.[28]

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[25] *Eivind Groven,* Renstemningsautomaten *(Oslo: Universitetsforlag, 1968), 114.*

[26] Eivind Groven. Heiderskrift*, 84.*

[27] Eivind Groven. Heiderskrift*, 87.*

[28] *Johannes Kotschy, ”The World of Small Pitches” (unpublished lecture presented at the Nordlyd Festival, Trondheim, 1995).*

The American musicologist David Løberg Code of Western Michigan University maintains that the problem is not that the piano's tuning system is so wrong, but that it has become the unchallenged hegemonic standard. Historically, the piano has become a "colonizer", a term that he explains as follows:

> When a fretless instrument such as a violin gets introduced to a new culture, it adapts to the indigenous musical language, as for example in India. When a piano gets introduced, however, the indigenous music must conform to the piano's tuning system.29

The piano's privileged cultural status has made twelve-tone equal temperament seem more legitimate than other tuning systems. Music which uses alternative tuning systems, especially music from other cultures, writes Code, is still perceived as irrational, archaic, experimental, exotic, or just plain out-of-tune.[30]

Ferruccio Busoni (1866-1924) gave twelve-tone temperament the designation "the diplomatic 12-tone system".[31] He was of the belief that traditional musical instruction had caused the ear to perceive pitches deviant from the twelve-tone system as impure. In his *Entwurf einer neuen Ästhetik der Tonkunst* (1907) Busoni points out that by designing instruments in which the octave is partitioned into twelve identically-sized steps, we have prevented ourselves from hearing pitches which lie over, under, or in between. Keyboard instruments especially have trained our ear such that we are no longer capable of hearing anything other than tempered intervals - without perceiving them as impure. Nature, however, has created an infinity of scales: "Und die Natur schuf eine *unendliche Abstufung - unendlich!* Wer weiss es heute noch?".[32] Nevertheless, to construct an instrument in which all pitches in an expanded tuning system would be made instantly available was a dream which Busoni never thought could be a reality.

An awareness of non-tempered scale types and of previous efforts toward making music in just intonation has prompted a number of composers in our century to assess the use of microtonal intervals within the context of art music. As we delve into the world of microtonal music it would be appropriate to examine the relationship of "just" intonation to microtonality. Lars Frandsen at Aalborg University characterizes just intonation's aesthetic as either microtonal or not:

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[29] *David Løberg Code,* Pianoets elfenbensbur *(unpublished article, November 1998), p. 3. Code has written extensively about Groven and his work. See, for example, his "Eivind Grovens 'Rein'boge: det renstemte orgelet som folkeinstrument",* Årbok for norsk folkemusikk *10 (2001): 100-10; "Acting Natural: Eivind Groven's* Naturskalaen *and the* Renstemte *Organ",* Norsk Folkmusikklags skrifter *15 (2001): 68-78; "Groven, Max: an Adaptive Tuning System for MIDI Pianos",* Computer Music Journal *26 (2002): 50-61; and "The Groven Piano: in Tune with Nature",* Piano Today *(2002).*

[30] *David Løberg Code, "Not Equal: Feminism, Tuning, and Theory Pedagogy",* Theory and Practice *20 (1995): 1-12 (here p. 8); idem.,* Pianoets elfenbensbur*, 3; and website http://vms.cc.wmich.edu/~code/groven/*

[31] *Ferruccio Busoni,* Entwurf einer neuen Ästhetik der Tonkunst *(Charlottenburg, 1907), 23.*

[32] *"And Nature created an* infinite number *of pitch steps*—infinite! *Who knows that any more?". Busoni,* Entwurf*, 23.*

> When Groven employs “irregular intervals” the intention must be considered microtonal; however, the argument that just intonation ought to replace the customary equal temperament is hardly microtonal.33

Microtonal music makes use of either "tempered" or "just" scalar material. Conversely, we can establish that a broad definition of just intonation will admit microtonal intervals. Martin Vogel is of the opinion that just intonation includes something more than simply “major” and “minor” chords:

> Da nun auch Vierteltöne, ja überhaupt alle Arten von Mikrointervallen zum Zuge kommen, ergibt sich eine Fülle neuer Akkorde, eine neue Harmonielehre.34

The central question for those composers of our century who wished to employ microtonality in their work was: how should the scale be subdivided? The first stage was to divide the half-step by starting with the twelve-tone equal tempered scale as a basis, and dividing each half-step into two quarter-tones. In the 1920s quarter-tone music became popular with many composers, and once the boundary of twelve tones was broken, the development could quickly go further. The foremost representative of microtonal music in the 1920s and 1930s was the Czech composer Alois Hába (1893-1973), who visited Groven during a stay in Norway. Slovak folk music, with its “mystic exceptional steps”, fascinated him. Both in theory (in his *New Harmony Teaching*) and in practice (in a series of compositions) he gave attention to microtonality. He wrote several works for a new quarter-tone piano, seven composition for 3/4-tone harmonium and a string quartet in 1/6-tone system: hardly anyone knows these works today.[35] Mordecai Sandberg (1897-1973), from Romania, took part in the rebuilding of the state of Israel. During a stay in the Middle East he became familiar with Arabic music and its microtonal structures, and developed a scale system with forty-eight pitches per octave. As a result of the Second World War he emigrated to the USA and set to work on a tremendous project to compose music to the Bible in a microtonal language.

Kotschy attributes the fact that so much of the microtonal music from the first part of the twentieth century is generally a well-kept secret to an intentional effort to make it invisible. The Darmstadt School, which to a great extent embodied the development of twentieth-century music, denied microtonality's legitimacy and sided exclusively with the Second Viennese School and later serial music. When individual composers from this tradition, for example Karlheinz Stockhausen and Luigi Nono, use microtonal intervals, it is in order to give their music a special color: it does not move entirely into the microtonal pitch field. In the light of this, it is of interest to mention that in 1969 Eivind Groven landed himself in a controversy with Carl Dahlhaus, via Groven's correspondent Martin Vogel. In a letter to Groven from Bonn dated 29 September 1969, Vogel told Groven that he intended to send an article to the press challenging Dahlhaus, who himself obviously had no qualms about equal

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[33] *Lars Frandsen,* Livsløgnen og drømmen om det fuldkomme. Om anvendelsen af ren stemming i forbindelse med det saedvanlige 12-tonige klaviatur, med udgangspunkt i Eivind Grovens renstemte Orgel *(Allborg Universitet, 1995), 79.*

[34] *"Now quarter tones, indeed, all kinds of microtonal intervals, are also being employed, making possible a large number of new chords—a new theory of harmony." Martin Vogel,* Anleitung zur harmonischen Analyse und zu reiner Intonation *(Bonn: Verlag für systematische Musikwissenschaft, 1984).*

[35] *See Torbjørn Knutsen, "Alois Hába",* Norsk musikkgranskning *1 (1937): 63-66.*

temperament, on a couple of points. Vogel and Groven thus responded to "…dieses dumme Wort von der Irrelevanz des syntonischen Komma".[36] Vogel further wondered how a learned man such as Carl Dahlhaus could consider this central theme so superficially. Nevertheless, it should be acknowledged that Arnold Schönberg, one of the representatives of the Second Viennese School, in 1911 recognised twelve-tone equal temperament as only a temporary solution:

> Das temperierte System war ein Notbehelf; ein genialer Notbehelf, denn die Not war arg und die Hilfe Gross. Es war eine geniale Vereinfachung, aber es war ein Notbehelf. […] Man hätte nie vergessen dürfen, dass das temperierte System nur ein Waffenstillstand war, der nicht länger währen darf, als die Unvollkommenheit unserer Instrument ihn nötig macht.37

Eivind Groven was aware that his American peer, Harry Partch (1901-74), had developed a forty-three-tone scale system that subsequently formed the basis for all of the instruments Partch constructed.[38] The equal-tempered system was, in Partch's opinion, a complete fake, a compromise in which the ancient idea about simple ratios was scrapped: “Having fallen into a sea of compromise, it was the most natural thing in the world for musical Europe to sink”.[39] Given the opportunity, the human ear has the capacity to accurately evaluate and classify intervals. Partch believes it is surprising that teachers complain about student's lack of “ear” when their own “ears” have been exposed to a deception for half a generation. He takes comfort in the fact that, fortunately, the time-honoured sensibility of intervals is not dead. It has survived in the general population among “sailors, soldiers, gypsies” (*op. cit.*), and flows like a deep stream over the whole world. Partch took an interest in the musical culture of ancient China, had studied ancient Greek scale structures and been taken up by Pythagoras' harmonic ideas. Partch perceived the microtonal world as kindred to the Pythagorean tuning system: antiquity met the present.

When Partch died, his music continued to be perceived as "cryptic experiments".[40] His friend and former student, music professor Ben Johnston (*b*. 1926) tried to make Partch's music known. Through his own works Johnston endeavoured to use so-called “extended just intonation”. He did not garner the same popularity as another student of Partch, Dean Drummond (*b*. 1949), who is the best-known microtonal composer in New York today. And one should not neglect to mention the large, still unfinished project *The Well-Tuned Piano*, one of the most important keyboard works of contemporary American music, composed for

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[36] *"This foolish talk about the irrelevance of the syntonic comma".* Eivind Groven. Heiderskrift*, 191.*

[37] *”The tempered system was a makeshift; a brilliant makeshift, because the need was dire and the assistance great. It was an ingenious simplification, but it was a makeshift. [...] One should never forget that the tempered system was only a truce, which should not last any longer than required by the imperfection of our instruments.” (Arnold Schönberg,* Harmonielehre *(Leipzig: Breitkopf & Härtel, 1911), 350-51.*

[38] *Groven,* Renstemmingsautomaten*, 111.*

[39] *Harry Partch, "Bach and Temperament: 1941", in* Bitter Music: Collected Journals, Essays, Introductions, and Librettos*, ed. Thomas McGeary (Urbana, IL: University of Illinois Press, 1991), 163.*

[40] *Kotschky,* World of Small Pitches*.*

piano with pure harmonies by the New York minimalist LaMonte Young (*b*. 1935).[41] The work was presented on tape for the first time in 1964.

In Norway, Bjørn Fongaard (1919-80) and Lasse Thoresen (*b*. 1949) have worked with microtonality. Fongaard's system is based on the equal-tempered system with the upper registers of the overtone series as its point of departure. Thoresen has been influenced by Norwegian folk music and by Harry Partch's "just intonation" system. In the 1970s, Franz Richter Herf and Rolf Mädel, teachers at the Institute for Ecmelic Music at the Mozarteum Academy in Salzburg, proposed writing microtonal music based on a seventy-two-tone scale. They made an organ that could play different microtonal intervals (e.g. a $1/12^{th}$ step). Richter Herf and Mädel call the music they create "ecmelic" (i.e., outside traditional *melos*) and their organ an "ecmelic organ". One can also play oriental scales on this instrument. Johannes Kotschy himself, also from Salzburg, writes music with both a seventy-two-tone scale and based on intervals from the overtone series. In Fall 1995 he got to experience Groven's pure tuned organ. In a Christmas letter to Groven, he places Groven's work within a larger context. When it comes to using pitches outside the equal-tempered scale, Eivind Groven is among the successes, states Kotschy: "I believe he succeeded" (Kotschy, letter to Groven, 21 December 1995).

The technological developments since Groven made his inventions have made relevant the idea of new solutions and new systems.[42] Today, Groven would possibly have met with other choices, and have pushed the boundaries of the automatic pitch selection device to other places.[43] His own words about the three main tasks of his life's work would suggest as such. In the first place, he wished to compose; second, to look after Norwegian folk music; and third—the great quest: "to bring forth an instrument which could assemble within it all possible kinds of tuning systems".[44] It is important to understand that Groven never considered his project to be complete. He left open many possibilities, and continually contemplated alterations, not the least of which concerned the operation of the automatic pitch-selection device.[45] As mentioned previously, consideration for the performer was essential. Groven intended, for example, that because of a piece's harmony, character, or genre, one sometimes had to limit the use of pure thirds and instead employ Pythagorean intervals to a greater extent.[46] In other words, of course Groven was an inventor and a scholar,

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[41] *See Kyle Gann, "LaMonte Young's The Well-Tuned Piano",* Perspectives of New Music *31 (1993): 134-62; Paul Griffiths,* Modern Music and After *(Oxford: Oxford University Press, 1995), 209-10; and K. Robert Schwarz,* Minimalists *(London: Phaidon, 1996), 39-43.*

[42] *Code, website (see footnote 30).*

[43] *In his university thesis* Algoritmer for renstemt klaverinstrument*, Knut-Einar Skaarberg raises certain objections to Groven's pure-tuned solution. He misses the fact that Groven's system does not provide any opportunity for tempering chords.*

[44] Eivind Groven. Heiderskrift*, 46.*

[45] *See Frandsen,* Livsløgnen og drømmen*.*

[46] *Groven,* Renstemmingsautomaten*, 77, and Easley Blackwood,* The Structure of Recognizable Diatonic Tunings *(Princeton, NJ: Princeton University Press, 1985), 133.*

but he must most especially be understood as a composer and a musician, even when he designed the automatic pure tuning device.

In spite of great flexibility, his target goals were nevertheless clear to him: (1) to find a replacement for the equal-tempered compromise; (2) to make accessible those pitches that lie outside our normal pitch system. In particular he had in mind the old scales which arose naturally within the folk music of different lands, but in which art music had shown minimal interest.[47] When Groven himself composed for the pure-tuned organ, or perhaps particularly when he arranged folk tunes, he chose a fixed setting for the automatic device, a fixed field of pitches, generally with an element of "irregular intervals" (Groven's term). Stately differently, in Eivind Groven's universe, just intonation represented a multiplicity of possibilities.[48]

Why "just intonation"? The arguments Eivind Groven uses to assert just intonation's legitimacy, and indeed even its primacy, are of both a musical and aesthetic nature. Groven learned in his childhood years that folk fiddlers and singers abstained from the use of tempered intervals. Thus it was not first and foremost out of theoretical speculations or ideological conceptions that he set out to replace the equal-tempered system. It was against the background of his innate sense of tonality that he could describe twelve-tone equal temperament as "a practical disease" that had come with the evolution of art music but had not "infected" folk music.[49]

> 12-tone equal temperament is and continues to be for my ears untidy and vulgar in relation to pure tuning. I go so far as to characterize the compromise which 12-tone tempering involves as music's life-lie.50

When Ingmar Bengtsson attempts to explain why, for several decades, Western culture has used equal temperament, and consequently a scale system with only one pure interval (!), he states that the premiss for twelve-tone temperament is that the human ear can tolerate intonational abberations as long as these remain within certain boundaries.[51] What, then, when the human ear *does* have problems tolerating all of the audible intonational aberrations, because it has, from the start, not learned to live with the tempered compromise? Groven asserts that even though our ears can become accustomed to tempered intervals to a certain degree, we cannot ignore the fact that in the long run the system "damages musician's nerves", creating, he claims, "mental disturbance or unrest".[52] Tempering "vulgarizes the music" in Groven's judgment (*op. cit.*, 25). "Beating" in the tempered intervals gives them a "husky impression", while a purely tuned chord is "pleasantly clear and calm" (*op. cit.*, 15). Hermann Helmholtz used a similar expression when he characterized the difference between pure and tempered intervals. The tempered appeared "rough, muddy, trembling and

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[47] *Groven,* Renstemmingsautomaten*, 125.*

[48] *Frandsen,* Livsløgnen og drømmen*, 76.*

[49] *Groven, "Temperering av tonesystemer", 114.*

[50] *Groven,* Renstemmingsautomaten*, 114.*

[51] *Ingmar Bengtsson, "Stemming",* Cappelens musikkleksikon *(Oslo: Cappelen, 1980).*

[52] *Groven,* Temperering og renstemming*, 15.*

restless".[53] Groven pointed out, for that matter, that his just intonation system was closely based upon Helmholtz (see Helmholtz's *Die Lehre von den Tonempfindungen*).[54] When Groven describes the difference between just intonation and twelve-tone temperament, he compares them to a clean and dirty window pane:

> The tempered or almost tempered sounds obscure or spoil the impression of the music the same way as an impure, rough pane of glass blurs the vision. […] As soon as one changes over to pure tuning it is like looking through clear air. Just as the eye, without knowing it, tires of the constant irritation of looking through hazy panes of glass, it is reasonable that the constant influence of tempered beating irritates and tires the ear.55

If Groven's account of just intonation's effect has a grain of truth to it, the matter may have relevance within today's steadily growing field of music therapy.

Martin Vogel ascertained that less accessible tonal music (e.g. that of Max Reger) could be more easily comprehended if it was presented on a "justly tuned" instrument.[56] Groven maintained that harmonies in atonal music (e.g. those of Fartein Valen) obtain greater "clarity and beauty" within the system of just intonation.[57] He made the further point that choirs, soloists, and instrumentalists had a natural tendency to aim for pure intervals when they were not "forced" into the equal tempered system by an accompanying equal-tempered instrument. Paul Hindemith says in his *Unterweisung im Tonsatz* that all musicians, except those who play a twelve-tone equal tempered instrument, play untempered, including singers, string players, and wind players.[58] Martin Vogel was in agreement with Hindemith when he asserted that "…das Ohr hört im Sinne der rationalen Verhältnisse der reinen Stimmung".[59] Groven similarly declared that twelve-tone equal temperament only exists as a theoretical concept, while "just intonation represents the precise reality in our feelings".[60]

At this point it might be fruitful to place Groven's work on the issue of pure tuning in a wider aesthetic, ontological perspective. Groven stated that, all things considered, only perfection is good enough, and that pure-tuned intervals speak to a truly substantive part of our emotions. Thus said, it might be appropriate to delve into Plato's thoughts within our culture. While Pythagoras considered music to be a reflection of the cosmic order (and thus music could function as a way for people to understand the latter), Plato, on the other hand, considered music to be a passageway for Goodness and Truth, by way of Beauty. What if the entire

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[53] *Kroman, "Wedell's 31-System", 1, 6.*

[54] *Hermann Helmholtz,* Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik *(Braunschweig: F. Vieweg, 1863).*

[55] *Groven,* Temperering og renstemming*, 81.*

[56] *Martin Vogel,* Anleitung.

[57] *Groven,* Temperering og renstemming*, 79.*

[58] *Paul Hindemith,* Unterweisung im Tonsatz: theoretischer Teil *(Mainz: Schott, 1937), 61.*

[59] *"The ear hears according to the rational relations of pure tuning". Vogel,* Anleitung.

[60] *Groven,* Temperering og renstemming*, 80.*

harmonic universe which we encounter in and by the equal-tempered system is an acoustical "shadow" of the true intervals found in the "world of ideas" (to borrow from Plato's "Myth of the Cave" metaphor)? Have we, through the long course of our musical life, turned ourselves around so that we see the shadows as reality? Should it not be possible to come closer to the sunlit world of "idea-intervals" and present them to people? And yet, how would people then respond to the real thing? Perhaps they would not wish to be freed from the shadows, like the captives in Plato's metaphor receding away from emancipation (Plato: *The Republic*, book 7, chapter 1)?[61] To continue with Plato's metaphor, Groven's motive for finding a replacement for the equal tempered system was to present something closer to intervals' true form, their "idea". When music emerged in its tempered shadow-nature, Groven noted with sorrow that the listener was cut off from "the full impression of beauty".[62] He had been fortunate enough to enjoy such an impression of beauty during childhood, and he wanted to pass it on.

It was probably not completely by chance that Timothy Hill, one of the singers in the Harmonic Choir, found his way to Groven's Organ House at Ekeberg in Oslo in the 1980s. The Harmonic Choir (founded in 1975 by David Hykes) has perfected its own technique of overtone singing, inspired by ancient traditions from Tibetan buddhism and by vocal techniques known from western Mongolia. A fundamental tone and its overtones are used in this song in different ways. People's inherent overtone spectrum is explored such that the acoustic orderliness (laws) come forth as a picture of the larger universal order. Such music, David Hykes believes, can help people to live in a disharmonious world.[63] In many respects, the vocal style of this choir can stand out as a concrete manifestation of Pythagorean musical ideas.

It has been stated that Lasse Thoresen is the first Norwegian composer to integrate folk music's non-tempered intervals into art-music.[64] This must mean that Groven's compositions and arrangements with so-called "irregular intervals" have lived quite literally a quiet, almost unheard life. Let us, in closing this article, bring forth *Balladetone*, one of Groven's compositions for the pure-tuned organ.[65]

The music travels meditatively and longingly between major and minor, based upon a kind of neutral scale. The tonic is D, but in relation to the pure minor scale, the third, seventh, and fourth are raised. Arne Nordheim's poetic salute for Groven's sixtieth birthday in 1961 can serve as a description for the tuning of the music:

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[61] *Platon,* Staten*, ed. Henning Mørland (Oslo, 1946).*

[62] *Groven,* Temperering og renstemming*, 15.*

[63] *See the recording* Hearing Solar Winds *(Harmonia Mundi France, CD 558 607 HM52).*

[64] *Norvall Skreien, "Festspillene oppfuller min største drøm",* Amoroso *5 (1996): 20-25 [interview with Lasse Thoresen].*

[65] *See the recording* Some symra rein og blå *(P NCP 1985 HO 7033), in which Kåre Nordstoga plays the piece in a recording from Eivind Groven's organ house. In a later version,* Balladetone *was also arranged for two harding fiddles.*

> If anyone asks for the way to Groven's place, they will get as an answer that they need only follow their own longing. It is east of noise and west of today's hectic pace—close to a lake in the woods. And on the other side someone is playing.

The pure-tuned pipe organ and the two pure-tuned electric organs are now located in the Eivind Groven Organ House, Oslo. The 1965 electronic organ with forty-three pitches per octave is out of action.The pipe organ and the newer electric organ are still used for concerts, recordings and other performances, even though the pitch-switching device ("renstemmingsautomat") shows signs of age and needs restoration.

Visitors from Norway and abroad continue coming to see, hear and study Eivind Groven's pure-tuned organs. Today, musicians interested in just intonation have grasped the possibilities offered by modern technology. In the 1980s and the 1990s, computer programs based on Groven's instructions were made by Jørn Arvidsen (1982) and Lars Frandsen (1995).[66] These programs were not intended for real-time performances, but Knut-Einar Skaarberg (1995) adapted Groven's tuning logic into a program that controlled the MIDI pitch-bend function of an electronic synthesizer in performance.[67] Further, David Løberg Code developed an acoustic piano (the Groven Piano) based on Groven's organ of thirty-six pitches per octave. This was demonstrated in Norway during Groven's 100th anniversary in 2001, and in Kalamazoo, Michigan, during the Irving S. Gilmore International Keyboard Festival in May 2002 : see http://www.wmich.edu/mus-theo/groven. The Groven Piano represents the continuation of hundreds of years of development and evolution in piano technology. From a technological perspective alone, the Code project is noteworthy for its integration of computers with acoustic instruments during live performance. As one of the first uses of a digital network with acoustic instruments, the project has applications which extend well beyond issues of piano temperament. A joint project is under way between the Eivind Groven Institute for Just Intonation, the University of Oslo's NoTAM (the Norwegian network for Technology, Acoustics and Music) and Western Michigan University's Groven Piano Project to renovate the pure-tuned organ in Oslo and replace the aging electronics of the almost forty-year-old transistor device by a computer-controlled system. This new system creates new modes of recording and performances that can be used during demonstrations for visitors to the Groven Organ House in Oslo. Recently David Løberg Code has written about this work and the exciting perspectives of the future—a musical and scientific collaboration between universities, musicians and countries:

> Moreover, the synthesizer, computer, and software could be used as a stand-alone system which could be transported to other concert venues outside of the Organ House and allow Groven's work to reach a much larger audience. It will even be possible to connect the organ to the internet for live remote performances. Organists from around the world could perform on remote MIDI keyboards and be heard live by audiences at organ house. Likewise, organists in Norway could have their performance transmitted over the internet to be simultaneously realized by a MIDI instrument at another location, such as the Groven Piano installed at Western Michigan University in the United States. This brings Groven's work full circle from a local network of telephone switchboard relays to the global network of the internet. Finally, this latest version of the renstemmingsautomat permits researchers to continue Groven's musical and scholarly work with adaptive tuning. [...] The renstemmingsautomat is a specialized artificial

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[66] *Jørn K. Arvidsen, "Eivind Grovens renstemte orgel med automatisk toneoppvalg",* Norsk kirkemusikk *8 (1982): 295-303; Frandsen,* Livsløgnen og drømmen.

[67] *Skaarberg,* Algoritmer for renstemt klaverinstrument*; David Løberg Code, "Groven* ex machina*: the Evolving Technology of Tuning",* Studia musicologica norvegica*, forthcoming.*

intelligence representing a rather comprehensive musical system of consonances and dissonances. Via the keyboard, it receives input from the real world, processes it and makes decisions about how the music should be performed based upon its knowledge of tuning, tonality, and harmony. This process is intended to simulate the intuitive choices of intonation made by human performers, like those in a string quartet or vocal ensemble.68

[68] *Code, "Groven* ex machina*".*