MANDALA MUSIC – DESCRIPTION INSTALLATION WORKSHOP

GUIDO KRAMANN[1]

KRAMANN@TH-BRANDENBURG.DE

ABSTRACT

Mandala Music is a composition method for amateurs. Similar to sudoku, but in a larger area and according to rules that allow more freedom, the user enters numbers from 0 to 9 in a square matrix. Through continuous updates, the resulting number structure is transformed into a musical composition and provided to the user as feedback. The rules of Mandala Music require the user to create rhythmic patterns with the numbers, which should also be reused in parts if possible. In this respect, the rules force the user into musical thought patterns and challenge him to act creatively within these thought patterns.

1 INTRODUCTION

There have been and still are many approaches to transforming the course of a game into music, including very prominent ones such as John Cage's sonification of chess games as a happening [Cross 1999]. In general, these examples do not claim to be tools for comprovization, or even for composing. Typically, the game and its rules exist beforehand and an automatic musical accompaniment to the game is implemented, the style of which at best adapts to the

1. Technische Hochschule Brandenburg.

game situation, see e.g. [Hamilton 2014].

On the other hand, there are already many approaches to converting non-musical, voluntary movements into music, for example on the basis of sensory physical gestures, see e.g. [Zbyszynski et al. 2021]. In contrast to the approach with sonified gameplay, the resulting music is not merely a by-product of the independent gameplay, but the user can learn via the musical feedback to use his gestures to make a certain musical statement, and via embodiment (see also [Merleau-Ponty and Schroeder 1996]) this approach is even particularly predestined to be able to realize particularly emotional and musically rich performances. This is a useful and widely used approach for comprovization. It is less useful for composing, as the musical event is ephemeral and difficult to reproduce. This in itself would not be sufficient reason to reject the approach for composing. However, this approach denies the user an essential mode of action for composing: Due to the lack of reproducibility and the inability to record anything, it is not possible to make incremental, small, evolutionary improvements to a musical structure in the making.

1.1 A THIRD WAY

With Mandala Music, a third way is proposed here compared to the musicalization of games and the musicalization of physical gestures, in which the focus corresponds more to the requirements of composing and less to those of performance or improvisation, and which aims to make this skill accessible to laypeople in an intuitive way.

(Gaming) rules are more than just setting boundaries. In fact, they are the reason to become active in a game in the first place. They challenge the user to prove that their intellect is capable of mastering the game while adhering to the rules. This fact is exploited in Mandala Music on the one hand to avoid the horror vacui, i.e. the helplessness that sets in when you look at a blank musical score. On the other hand, the starting point for the concept of Mandala Music was the requirement to implement compositional rules directly as rules in a game in order to allow game decisions to become immediate compositional decisions by the user. When implemented as a computer program, it is possible to automatically monitor whether the rules are being adhered to. The rules of the game take on the role that music theory plays in composition. The course of the game is then the production of the composition on the basis of a specific music theory.

1.2 CLASSIFICATION OF MANDALA MUSIC IN THE MODERN COMPOSITION LANDSCAPE

First of all, it is important to clarify what is actually meant by “composing a piece of music” in the context of Mandala Music. A modern composer of New Music would at most use the system presented here to get inspiration for the musical structure to be created, but would certainly be far from calling what is created in Mandala Music a “composition”. This is because in New Music, valid conventions are typically called into question with every new composition. Modern composers develop their own tonal language. Conventions

and rules retain their validity at most over the course of a limited cycle of successive works (Sofia Gubaidulina, Karlheinz Stockhausen, Giörgy Ligeti), or are at least tied to the person of the composer (Arvo Pärt, Philip Glass), see [Gottstein 2024], pp. 92-98, 114-124, 151-155, 227-232. In the case of younger composers, one would not want to make such an assessment at an early stage. Nevertheless, it would be wrong to say that everything that is rule-based in composing is merely the composer's own ideas. As an indication of the opposite, it may suffice to say that in music studies, much more so than in art studies, a huge body of theory continues to be taught to all students. Rhythms, harmonic sequences, larger musical structures - all this still forms the theoretical background for what composers do, or what they try to set themselves apart from. Mandala Music attempts to capture something of this in its rules, at the cost of a certain limitation of possibilities, but with the benefit of offering an introduction to composing for amateurs.

2 DESCRIPTION OF THE GAME LEVEL AND THE COMPOSITION LEVEL IN MANDALA MUSIC

The rules of Mandala Music are as follows: Enter outlines of squares consisting of the digits 1 to 9 into the square matrix initially filled with zeros. The sequence of digits within these squares should consist of a fixed sequence of digits that is repeated several times in full. In this sequence, the same digit should never directly follow each other several times, see example in Figure 1.

The higher goal in mandala music is to try to get

such squares to overlap, so that parts of the sequence of numbers in one are used simultaneously in another (interlacing), see Figure 2.

A square with an edge length of N matrix places has a length L of L=(N-1)*4 matrix places. The possible period lengths Pi of the digit sequences that can be entered in it correspond to all real divisors of L that are greater than or equal to 2 and smaller than L. For example, N=4 results in a length L=(4-1)*3=12 and therefore the periods Pi = {2, 3, 4, 6}.

0	0	0	0	0	0	0	0
0	0	**5**	**4**	**5**	**3**	**2**	0
0	0	**6**	0	0	0	**1**	0
0	0	**2**	0	0	0	**2**	0
0	0	**1**	0	0	0	**6**	0
0	0	**2**	**3**	**5**	**4**	**5**	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

FIGURE 1. FORMING A SQUARE OUTLINE OF DIGITS (CYCLE) ACCORDING TO THE RULES: STARTING FROM THE TOP LEFT AND RUNNING ANTI-CLOCKWISE, THE SAME SEQUENCE OF DIGITS IS PRODUCED TWICE IN SUCCESSION, NAMELY: 5,6,2,1,2,3,5,4. THE MATRIX SIZE OF 8X8 CHOSEN IN THE EXAMPLE SERVES AS AN EXPLANATION AND IS JUST SUFFICIENT TO PRODUCE A MUSICAL PHRASE. LARGER COMPOSITIONS REQUIRE CONSIDERABLY LARGER MATRICES

FIGURE 2. THREE FURTHER CYCLES HAVE BEEN ADDED HERE USING PARTS OF THE CYCLE FROM FIGURE 1

2.1 SYMBOLS INSTEAD OF NUMBERS AND MANDALA MODE

The numbers in the game are displayed as mirror-symmetrical symbols. This is done to improve the visual aesthetics and to make the rhythmic sequences more eye-catching. Another reason for this is to ensure that the game board can be easily viewed from any direction. And finally, it is also done because the numbers do not have to be reckoned with in the game, see Figure 3.

Finally, there is the option of mirroring the current figure twice in order to obtain something that comes a little closer to what you might imagine a mandala to look like, see Figure 4.

2.2 REWARDING INSTEAD OF PUNISHING AND FREEDOM INSTEAD OF CONTROL

The implementation of the game, see

http://www.kramann.info/25_UbiMus/02_Mandala_Music) supports the pursuit of the objectives of the game stated above, i.e. the creation of valid cycles that are as interlinked as possible, by highlighting existing cycles when you move the mouse over them. Furthermore, the music is created from the set of complete cycles. So you only get to hear something if you actually use Mandala Music to create correct cycles.

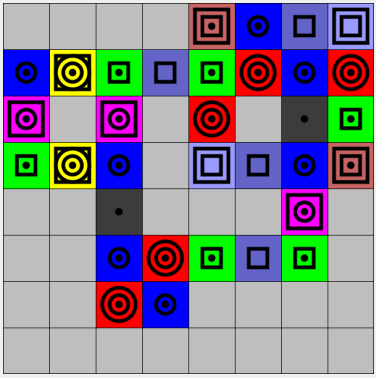

FIGURE 3. ILLUSTRATION OF THE SAME ARRANGEMENT AS IN FIGURE 2, BUT USING SYMBOLS

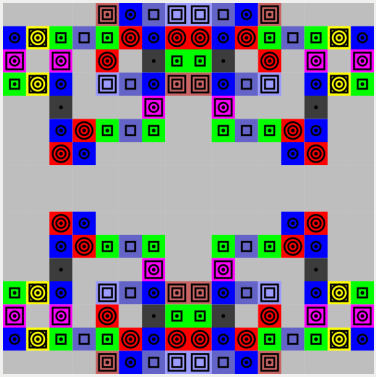

FIGURE 4. CORRESPONDS TO THE ARRANGEMENT IN FIGURE 3, BUT HERE IT IS SHOWN MIRRORED TWICE

Adherence to the principle of interlacing in turn ensures that the resulting musical phrases in the voices are similar to each other. If this is accepted as a criterion for the quality of the resulting piece of music, it can be said that the resulting music is better in this sense when efforts are made to interweave. In addition, variety in the composition of the number sequences of the phrases and their length generally also ensures music that sounds versatile. However, we deliberately refrained from quantifying the named criteria and implementing them as a measure of quality for the resulting composition. This is because the user should be free to choose his own goals. The only orientation for the design of the creative process should be the aesthetic judgment of the user with regard to both the visual form in the matrix and its sonic implementation.

3 FROM MANDALA TO MUSIC

> "The Tao produced One; One produced Two; Two produced Three; Three produced All things..." (Chapter 42 from the Tao Teh King [Laozi and Legge 1891]).

The game algorithm constantly searches for all existing cycles in real time, starting from the center of the matrix and moving outwards in a clockwise spiral. Initially, exactly one period of each sequence of digits found is displayed one below the other in the list, see Figure 5.

If the desired number of voices V and E is the number of entries that are to be used per voice in a time step to form a sound event, the first M=V+E-1 lines of the list are used first. The smallest common multiple K of the M lines is formed and all periods are repeated until each of the lines has

the length K, see Figure 6.

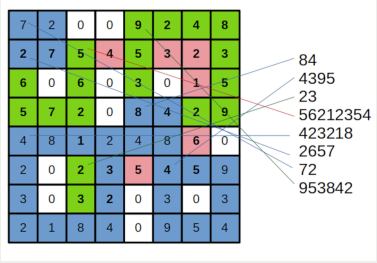

FIGURE 5. AS FIGURE 2, BUT WITH THE ADDITION OF FOUR MORE CYCLES. NEXT TO IT: LIST OF THE NUMERICAL SEQUENCES OF THE PERIODS OF ALL EIGHT CYCLES FOUND BY THE ALGORITHM IN THE MATRIX FIGURE

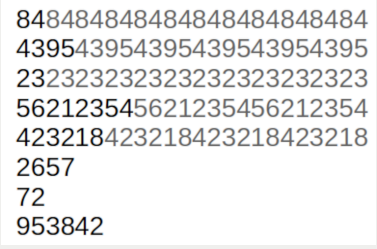

FIGURE 6. LIST FROM FIGURE 5. V=3, E=3, M=3+3-1=5 (SEE TEXT). SMALLEST COMMON MULTIPLE OF THE FIRST FIVE LINES K=24. ALL PERIODS OF THE FIRST FIVE LINES ARE REPEATED UNTIL THE LENGTH K IS REACHED

Now look at the top E numbers in each column and multiply them together. This product P, multiplied by a fixed factor F, represents the frequency frq=P*F, from which the nearest midi tone is then formed and – if within a previously defined range – played by the musical instrument assigned to this voice. Proceed in exactly the same way with the other voices, moving down one row in each case and then multiplying the next E values with each other from there. Moving one column to the right means calculating the notes to be played in the next time step. Once all K time steps have

been processed, you move down just one row again and from there take M=V+E-1 rows from the list again and proceed in the same way, see Figure 7.

Because the tones for the individual voices are only ever moved down one line, the change in pitch from the tone of one voice to that of the next is only determined by the division of a small number from 1 to 9 - namely the one in the line that has been left and the multiplication of a small number from 1 to 9 - namely the one in the new line that has been added. This ensures that the frequencies of the tones are in simple numerical relationships to each other.

The harmonic and rhythmic structure of the resulting music also changes in small steps. This is ensured on the one hand by the cyclical character of the lines, but also by the fact that as the composition progresses after reaching time step K, it only moves down one line, see the musical result of the example described here: http://www.kramann.info/25_UbiMus/02_Mandala_Music/mandalamusic.mp3 and also a second small example in Figure 8 and its corresponding sonification here: http://www.kramann.info/25_UbiMus/02_Mandala_Music/mandalamusic2.mp3.

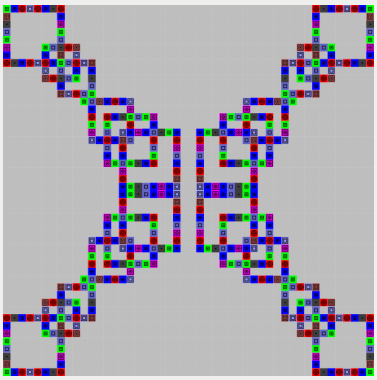

FIGURE 8. MANDALA REPRESENTATION OF A SECOND SMALL EXAMPLE

4 WORKSHOP AND INSTALLATION

Mandala music can be realized as an installation by creating as many voices (parameter V) as there are available sound sources. By assigning voices that are close to each other in terms of sequence to sound sources that are close to each other, there is a smooth transition to which voices are combined with each other when walking through the corresponding room. In the cloister of a monastery, the sound source could be positioned every ten meters to another of, for example, 12 voices, whereby the voices would then lie one behind the other in their natural sequence, i.e. 1,2,3,...12, see Figure 9.

Wiring the sound sources from an amplifier could be a problem in terms of cost and aesthetics. It would be better if the sound sources were designed as autonomous but synchronized modules. There are two options here: To use twelve laptops each with an active loudspeaker and to realize the synchronization via W-LAN, or to transfer the sequence of the cyclically repeated midi commands to microcontroller

modules, which in turn control Mdi sound modules connected to active loudspeakers and to start the microcontrollers synchronously once at the beginning by means of a reset button connected to all microcontrollers in a temporary manner. The latter variant would be the most cost intensive, as less available standard components would be used, but would probably lead to the most aesthetically pleasing result.

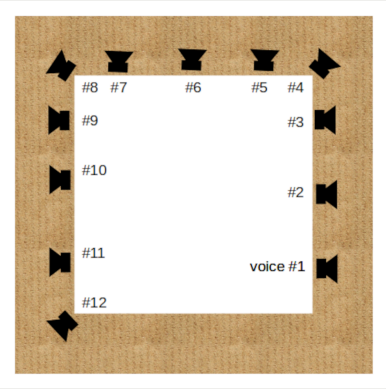

FIGURE 9. EXAMPLE OF THE ARRANGEMENT OF A SERIES OF 12 SOUND SOURCES, EACH FOR ONE VOICE OF A MANDALA MUSIC INSTALLATION IN THE CLOISTER OF A MONASTERY

The corresponding mandala matrix could take place wi-thin a workshop in which interested laypersons work together to create the mandala on a large touchscreen, ideally placed on a table around which the participants are grouped.

All the components mentioned in the description above would be provided by the author if necessary and could also be set up on site by the participants themselves.

5 IMPROVEMENT OF EVERYDAY USABILITY

It has not yet been possible to conduct an extensive user

survey. However, the current experimental version of the mandala music app was made available to three people of different ages and genders (female 12, male 18, male 60) to try out, in order to obtain at least some feedback on the app's suitability and then incorporate this into the further development process.

The twelve-year-old female participant was unable or unwilling to understand the overall concept and use the app properly. Therefore, in future, I will start with young adults as the target age group.

Like the sixty-year-old, the eighteen-year-old male participant also found the game concept appealing, but complained that the music resulting from the transformation process was only updated after pressing the corresponding button. This was immediately incorporated into further development: users can now activate continuous real-time updating. This means that the acoustic equivalent of every action on the mandala is immediately perceptible.

The sixty-year-old participant could imagine spending more time with Mandala Music, the eighteen-year-old participant was unsure about this, while the twelve-year-old participant could not imagine doing so.

In contrast, the eighteen-year-old participant (see session: https://youtu.be/o44dH6uGSqY) stated that he could discern a vague connection between the current mandala structure and the accompanying music, while the other participants denied this.

The ability to switch between different views, especially between mandala and piano roll, was viewed positively by the two older test subjects. The 60-year-old test subject felt that the display on a smartphone was much too

small and would have preferred a larger device as a basis. In fact, the practical implementation now uses a giant Androidbased tablet. In addition, the sound quality was improved in the practical implementation by using four-channel sound and professional physical modeling software on a laptop, Figure 10.

FIGURE 10. TEST SETUP WITH QUADRAPHONIC SOUND, TRANSMISSION OF MIDI DATA VIA WI-FI FROM TABLET TO LAPTOP, AND IMPROVED SOUND QUALITY THROUGH THE USE OF PHYSICAL MODELING SOFTWARE

In addition to the improved sound quality, the next version of Mandala Music will also feature impressive musical compositions created using the system, which should increase motivation to explore Mandala Music. One example is this piece for clarinet and piano entitled “Pan,” which was created using Mandala Music: http://www.kramann.info/99_Musik/alg_Pan_clarinet_piano_082025_kramann.mp3,http://www.kramann.info/99_Musik/alg_Pan_clarinet_piano_082025_kramann.pdf,https://youtu.be/ze9IG4i_Ahg,https://youtu.be/N7yhh_-zvuE, Figure 11.

6 AN ATTEMPT TO RELATE "MANDALA MUSIC" TO THE RITUAL ASSOCIATED WITH THE KALACHAKRA MANDALA

In the ritual associated with the Kalachakra mandala, monks in the tradition of tantric Buddhism painstakingly create a finely structured mandala measuring around two meters in diameter from coloured sand over a period of several days. Just one day after completion, it is destroyed again by sweeping up the sand and pouring it into a richly decorated bag. This bag is then carried in a procession to a river and the sand is poured into the water. This ritual has since been practised by Buddhist monks in many western cities, as was organized in 2016 by the art house "Sans Titre" in Potsdam, which is not far from the location of the upcoming UbiMus Symposium in Brandenburg an der Havel https://www.youtube.com/watch?v=uBZTRRK7AQI.

The meaning of the depictions in these mandalas is highly complex and can hardly be fathomed by outsiders. An essential feature, however, is a fivefold division of the mandala, consisting of the areas in the four cardinal points and the center, based on the five elements that make up the human being according to the tantric view. Formation and subsequent destruction are obviously connected with birth and death, but also with the Buddhist insight into the lack of essence behind the phenomena in which the world shows itself to us, i.e. the realization that after the removal of the structures of understanding that are valid for us, only emptiness would remain, see e.g. [Brauen 1995].

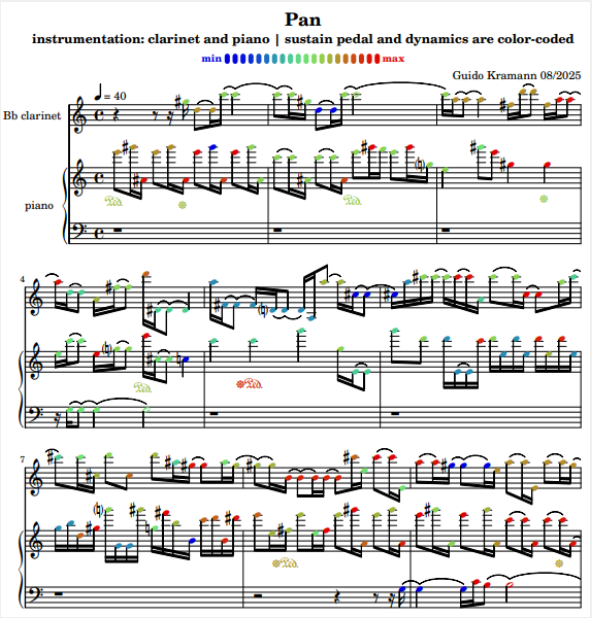

FIGURE 11. EXCERPT FROM THE SCORE OF THE COMPOSITION "PAN" CREATED WITH MANDALA MUSIC

Of course, an artistic performance can never come close to the depth of meaning that the Buddhist mandala ritual possesses, as the former is based on a millennia-old tradition and the latter merely corresponds to the unique realization of an individual, creative idea. However, in the case of "Mandala Music as a Happening", the reference to the external form of the traditional ritual can lead to the people involved being able to engage better and more deeply with what is happening on the spot, so that they are more involved. The parallel, that here and there a group is busy creating the mandala over a longer period of time, suggests to the visitor that it is something significant, rather than if the mandala were simply finished in front of her or him, as here the effort it takes to create it can be experienced. The

parallel that all visitors are made aware that the mandala will be destroyed again at the end makes it clear that it is urgently necessary to get involved in the performance now, at this moment, because there will be no more opportunity to do so later.

7 DISCUSSION

The concept for cooperative composing presented here is characterized by a great openness to results, since although certain rules specify how tonally effective structures should be designed in the matrix, it does not specify which particular characteristics the large form of the mandala should have. It is to be expected that in the course of continued work on mandala music, users will develop a certain intuitive knowledge. Over time, you will learn that the use of the 7 tends to produce somewhat dissonant sounds. It will become clear that the combination of period durations that correspond to prime numbers in terms of length leads to a greater variety of different musical phrases and harmonies than the choice of lengths that are in simpler relationships to each other. And you will notice that the choice of the factor F, which is applied before the transformation into a miditone, decisively determines the tonal character, but also whether anything sounds at all.

Mandala Music joins the long line of contributions to Ubiquitous Music that deal with daily creative practice, called ”little c” [Keller et al. 2014]. A certain advance over previous approaches is that the approach to composing is intuitive, but offers the practical opportunity and time to make progress in composing. The simple representation of

the results as a matrix of digits ensures that what has been compiled is permanently available and also allows results to be easily exchanged between users. Finally, the entire concept is so simple and completely transparent that it invites other developers to create a wide variety of implementations.

At this point it could be excusably remarked that the simplicity of the whole concept would mean that not all aspects of music creation could be incorporated into the creative framework of Mandala Music, in that although the arrangement of musical motifs with fixed pitches can be shaped within a larger rhythmic and harmonic overall structure, no other musical parameters such as dynamics, timbre, articulation or spatial sound can be influenced. However, both the simplicity of the concept and the focus on motifs, rhythm, harmony and musical form have been carefully considered. This focus was based on the conviction that it is the right one for an application intended for laypeople. In order to be able to master Mandala Music intuitively, the entire concept follows the basic idea of docking onto what is generally known and familiar. The docking to the familiar begins with the expectations that the name "Mandala Music" evokes as something that is reminiscent of coloring books for adults and that can be done on the side to relax at home or while traveling, continues with the relative similarity to sudoku and ends with the musical result that docks to the music with defined rhythms and pitches in a tempered mood that surrounds us every day. But docking onto something does not necessarily mean that it is the same as what is being docked onto. Mandala music leads the user from the familiar to something new. What is important about this sentence is: it LEADS to

something new, and not: it CONFRONTS the user with something new. In this endeavour lies the deeper reason for all the conventional elements that characterize Mandala Music.

On the other hand, this transparent description of this music theory-free approach to composing may also offer others the opportunity to revisit it themselves in order to make something else out of it, which does not necessarily follow the same paradigms as the current version. Finally, it should be mentioned that in the current implementation for piano sound, the control over velocity, tempo and sustain pedal automatically adapts to the progression of the musical shape. To put it another way, in Mandala Music the unaffected musical parameters are a private matter for the user.

8 FURTHER WORK

In addition to improvements to the setup and implementation of Mandala Music in order to improve the user-friendliness of cooperative composition, it also makes sense to explore the possibility space of Mandala Music by means of search and optimization processes. Specifically, evolutionary algorithms could be written and tested that produce mandala matrices of a given size and with given properties. In this regard, there may be an opportunity to adapt the Ant Colony algorithm to Mandala Music, because as in the most prominent application of this optimization algorithm, the traveling salesman problem, paths also play an important role in Mandala Music [Dorigo and Stützle 2004]. On the one hand, this can also serve to assess

what could be achieved by user groups. On the other hand, such automatically generated mandala matrices can be made available in a gallery so that users can use them as a starting point from which new mandala matrices can be created and tested by making modifications. Finally, a distributed system consisting of several software agents could be created, which try to find strategies for the cooperative creation of Mandala matrices. This can be used to draw conclusions about a meaningful design for human users working cooperatively on a mandala, but may also provide interesting results in itself, for example in a scaling that is far removed from what humans can achieve and thus generate a special virtual ecology of a creative process, see [Lazzarini et al. 2021]. And finally, one could also go in the opposite direction and instead of proceeding with the virtualization of the whole, develop a physically functioning version with a game board and game pieces, or be inspired by the ritual character of Buddhist practice when further elaborating the design of the cooperative creation of a mandala, see e.g. [Bedeaux 2024].

Just as there are amateur choirs, pottery classes, chess clubs, and the like, techniques such as those exemplified by Mandala Music could perhaps one day form the basis for something like composition clubs. As in the other examples mentioned, this would be an opportunity to immerse oneself deeply in an activity and experience a coherence between the environment and inner experience that represents a counterpoint to an increasingly fractalized world. Or, in the words of philosopher Matthew B. Crawford:

> "Skilled practices serve as an anchor to the world beyond one's head – a point of triangulation with objects and other people who have a reality of their own" (Crawford 2015).

REFERENCES

Bedeaux, R. (2024). The tibetan sand mandala: A short history. Minneapolis Institute of Art. url: https://new.artsmia.org/stories/the-tibetan-sand-mandala-a-short-history.

Brauen, M. (1995). Das mandala - der heilige kreis im tantrischen buddhismus en: The mandala - the sacred circle in tantric buddhism. page 16. DuMont, Köln.

Crawford, M. (2015). The world beyond your head – on becoming an individual in an age of distraction. page X. Farrar, Strauss and Giroux, New York.

Cross, L. (1999). Reunion: John cage, marcel duchamp, electronic music and chess. John Cage Trust. url: https://www.johncage.org/blog/cross reunion.pdf.

Dorigo, M. and Stützle, T. (2004). Aco algorithms for the tsp. In Ant Colony Optimization, pages 67–69. The MIT Press, Cambridge.

Gottstein, B. (2024). Der klang der gegenwart (en: The sound of the present). Reclam, Regensburg.

Hamilton, R. (2014). Musical sonification of avatar physiologies, virtual flight and gesture. In Aramaki, M., Derrien, O., Kronland-Martinet, R., and Ystad, S., editors, CMMR 2013, Sound, Music, and Motion, pages 517—-532. Springer, Heidelberg.

Keller, D., Lazzarini, V., and Pimenta, M. (2014). Ubiquitous music. pages 29–30. Springer, Heidelberg.

Laozi and Legge, J. (1891). Tao teh king. Wikisource. url: https://en.wikisource.org/wiki/T

Lazzarini, V., Keller, D., Otero, N., and Turchet, L. (2021). Ubiquitous music ecologies. pages 1–22. Routledge, London.

Merleau-Ponty, M. and Schroeder, J. (1996). Das primat der wahrnehmung. trans. jürgen schröder. 5th ed. frankfurt am main: Suhrkamp, 2016. print. trans. of le primat de la perception et ses consequences philosophiques. Éditions Verdier, Paris.

Zbyszynski, M., Donato, B. D., Visi, F., and Tanaka, A. (2021). Musical sonification of avatar physiologies, virtual flight and gesture. In Kronland-Martinet, R., Ystad, S., and Aramaki, M., editors, CMMR 2019, Perception, Representations, Image, Sound, Music, pages 600 —-622. Springer, Heidelberg.