

# O – : An Epistemic DMI for a Cross-Cultural Reflection on Time and Music

Hanyu Qu  
Computational Media and Art,  
Hong Kong University of  
Science and Technology  
Guangzhou, China  
hqu817@connect.hkust-  
gz.edu.cn

Francesco Ardan Dal Rí  
Dept. of Information  
Engineering and Computer  
Science,  
University of Trento, Italy  
francesco.dalri-2@unitn.it

Hao Zou  
University of Missouri  
Kansas City, United States  
zouhaocomposer@gmail.com

Hanqing Zhou  
School of Design,  
Southern University of  
Science and Technology  
Shenzhen, China  
12331483@mail.sustech.edu.cn

Raul Masu  
Conservatorio F.A. Bonporti  
Trento, Italy; and  
CMA, Hong Kong University of  
Science and Technology  
Guangzhou, China  
raul@raulmasu.org

## ABSTRACT

This paper introduces a Digital Musical Instrument (DMI) that inscribes a linear and a circular conception of time, inspired by Western and Eastern time philosophies. The DMI employs two 3D-printed boards equipped with ESP32 chips for wireless communication and WS2812 LEDs providing visual representation feedback, and interactive boxes, each fitted with a light sensor and ESP32 Mini boards. Such interface is designed to be coupled with a software counterpart for sound generation. The project originates from a collaboration with two composers from diverse cultural backgrounds - one Chinese and one Italian. Through collaborative design and co-composing practice, the proposed DMI emerged as an epistemic tool, promoting cultural understanding and critically highlighting the socio-cultural role of technology. Through such process, the significance of rediscovering time in contemporary globalization and philosophy was explored, challenging the conception of time as a mere measurement parameter and striving to reveal the importance of understanding the role of time across different cultural contexts. This project wishes to expand the constitutive role of musical time, demonstrating its diversity and prompting a reflective layer of the perception of performative and musical time in NIME.

## Author Keywords

Time in Music, Time Conception, DMIs, Co-Composition, Culture

## CCS Concepts

• Human-centered computing → Human computer interaction (HCI); • Applied computing → Sound and music computing;

## 1. INTRODUCTION

Being both a cultural artifact and temporal art, music encodes distinct philosophies of time. Western traditions, shaped by teleological narratives of progress and eschatology, tend to prioritize linear structures in music [38, 12]. Conversely, Eastern traditions, rooted in cyclical concepts of rebirth and natural recurrence, manifest in music through recursive forms [15]. These temporal frameworks are not merely aesthetic choices but embodied cultural epistemologies —ways of knowing time through sound.

Although recent NIME research has enriched the discourse on time [40, 37, 35, 23], only two recent NIME papers directly engage with cultural time perspectives. Recently, Tindale and Clark critiqued grid sequencers and proposed an ansiorhythmic grid with dynamic subdivisions to better reflect the fluidity and diversity of musical time [40]. In contrast, Reid and colleagues explore temporal perception through the MIGSI trumpet, an augmented instrument that employs sensors and real-time DSP to challenge linear time and reconsider the perception of musical time in performative musical practice [37].

Understanding how temporal conceptions embedded in instrument design may influence compositional choice and cultural narratives remains overall overlooked. This leads to a number of questions that we want to examine with this paper. If instrument design mediates temporal frameworks, how do these structures shape composers' creative decisions? Moreover, what cultural narratives emerge when musicians co-compose with instruments that foreground time as a malleable, charged parameter?

This project seeks to explore these intricate dynamics by integrating a conception of time into a novel Digital Musical Instrument (DMI) that we called "O —" - from the English characters O and the Chinese —, pronounced "yi". The interface's design metaphorically incorporates dual time representations - a linear and a circular boards paired with nine light-sensor embedded cubes, sending messages via OSC<sup>1</sup> to control sound algorithms.

The original interest in investigating time came from the first author who originally designed the instrument. Two composers with different cultural backgrounds (one Italian composer, and one Chinese, authors 2 and 3 respectively)



Licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0). Copyright remains with the author(s).

*Proceedings of the International Conference on New Interfaces for Musical Expression (NIME'25)*, June 24–27, 2025. The Australian National University, Canberra, Australia.

<sup>1</sup><https://opensoundcontrol.stanford.edu/>

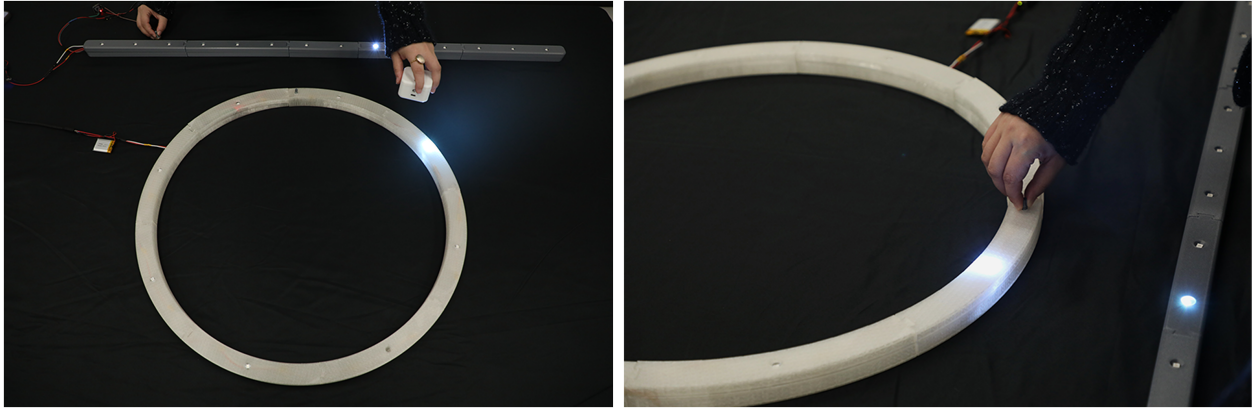


Figure 1: Time Instrument, O —

were involved - they informally knew about the idea and were keen to explore the relationship with time considering their different musical perspectives. Thus, the project unfolds as a multi-movement co-composition. By working on composing with the instrument, we wanted to explore this intimate relationship between entangled time and compositional ideas.

Using the DMI, the two composers freely choose their preferred platform for implementing their musical system, aligning with their usual practice. Throughout the creative process, the entire team adopted an autobiographical approach [33], documenting the experiences through diaries, notes, and recorded conversations - a common practice in many NIME research (e.g. [8, 10, 36]). This approach results in a collection of time-informed musical works, accompanied by reflective diary archives. Within the autobiographical frame, we opted to use Reflection-on-Action [32], an approach that allows researchers to reflect on their practice afterward. As such, we chose not to interfere with the compositional processes, focusing instead on post-hoc self-analysis. Such process revealed key insights into the interplay between the DMI, the composers, and the temporal dimensions of music. Finally, we discuss the reflection emerged through this epistemic tool, highlighting the entangled dynamics that emerged during the co-composing activity.

This research explores how instrument design not only reflects but also actively produces cultural understandings of time, looking at how DMIs reshape our perception of musical time, fostering deeper engagement with temporal and collaborative cultural narratives. Ultimately, this work seeks to bridge NIME’s technical focus on temporal representation with broader questions of cultural influence and social meaning, expanding the constitutive role of musical time by showcasing its diversity, and encouraging a reflective approach to its perception in performative practice.

## 2. BACKGROUND

### 2.1 Cultural Conceptions of Time

Conceptions of time have varied across cultures and historical periods. Rooted in eschatological thought and Enlightenment progress narratives, Western cultures have viewed time as linear, goal-oriented, and culminating in an endpoint [12, 1]. This idea traces back to ancient Greek philosophy (Heraclitus) and extends through Christian and modern thought. The modern Western conception of time, which we referred to in this paper, centered on measurable and tech-

nical understandings, has been dominant in shaping societal structures and individual experiences [34]. Albeit such view being overall predominant, it is still worth noticing that scholars also recognized nonlinear conceptions in Western traditions, as demonstrated through graphical timelines by Rosenberg as well as Gell [38, 12].

In Eastern cultures, particularly China, time has traditionally been conceived as cyclical, emphasizing recurrence closely tied to natural rhythms like lunar cycles and seasonal changes [43]. Chinese philosophy views time as a dynamic, interconnected process. Texts like the *I-Ching* [39] and Daoist and Confucian philosophies emphasize the fluidity and interdependence of time, space, and nature [43]. Jullien explores how Chinese thought diverges from Western frameworks in his work *Du Temps* [19], highlighting the lack of verb tenses in the Chinese language, which reflects a less rigid and more holistic view of time.

### 2.2 Musical Conceptions of Time

Western music traditions also emphasize linearity, evident in established forms such as the *Sonata* or the *Minuetto*, where harmonic resolutions and motifs drive the musical discourse toward a perceived endpoint [20]. Structural progression reinforces the temporal flow which aligns with teleological narratives of development. For instance, Husserl explored how melodies unfold temporally, linking musical structure to time perception [18]; Kramer distinguishes “musical time” - a self-contained framework - from absolute, linear time, underscoring music’s capacity to transcend daily temporality [21]. On the contrary, eastern musical traditions prioritize cyclical time. Improvisational oral practices and recursive forms (e.g. *Gamelan* [2] and Japanese *taiko* [11]) embody this cyclicity. Chinese music intertwines with natural cycles and cosmology, as seen in *Yue Ling* (月令) [24], which assigns seasonal tones, blending philosophy and artistry.

While musical time concepts often align with Western linearity or Eastern cyclicity, cultural traditions resist rigid binaries: for instance, Chinese opera blends linear narrative progression with malleable, subjective temporal flows [5, 6]; Western cyclicity often emerges in minimalist works, e.g. Steve Reich’s *Piano Phase* or Terry Riley’s *In C*.

### 2.3 Composition as Cultural Technology

Magnusson presents Digital Musical Instruments (DMIs) as “epistemic tools”, emphasizing their role in shaping knowledge and creativity [25]. In his conversation with Molitor

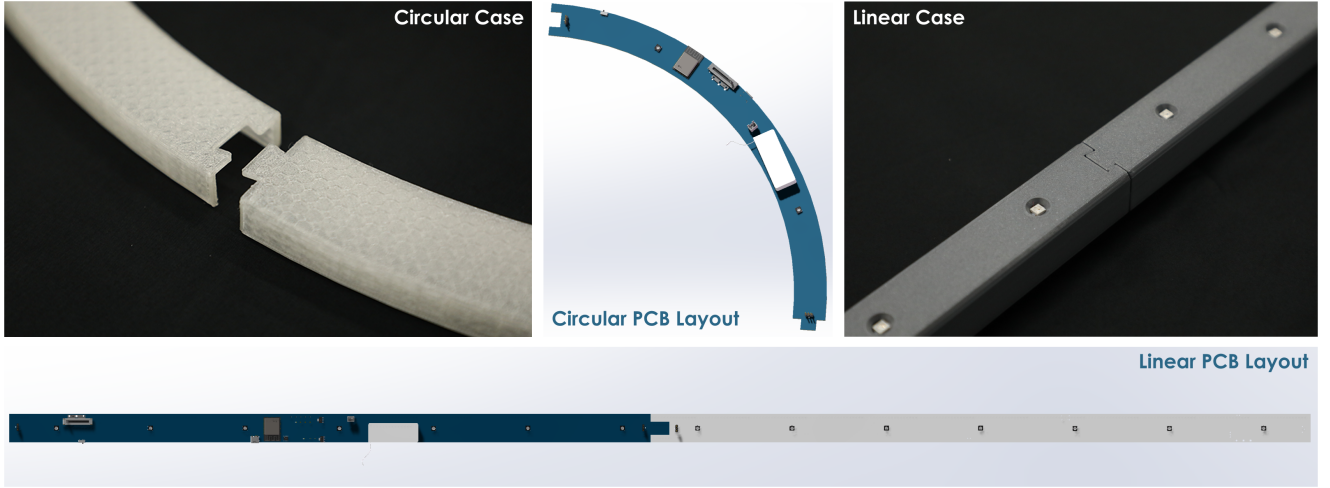


Figure 2: Layout and Design

[30], he challenges the dominance of traditional Western music technologies and advocates for the inclusion of diverse cultural expressions. By integrating non-Western conceptions of time and cultural practices into the design and use of DMIs, NIME research can more fully reflect the global diversity of musical creation (ibid.).

Building on this discussion, studies in NIME argue that technology is not a universal commodity but is shaped by regional practices and cosmologies. Initiatives such as the LATAM NIME Network<sup>2</sup> support this view by offering platforms for sharing context-specific resources and collaborative practices that challenge dominant Eurocentric models. This is further exemplified by Kuzmin’s work on cosmotronics, linking technical creation with local environments and cultural narratives [22].

### 3. O-, A TIME INSTRUMENT

To explore the relationships between time conceptions inscribed into a DMI, we developed a hardware interface that explicitly represent different time conceptions. The original design was conceived by the first author, and the musical mechanisms were fine tuned during the compositional process, described later, along with two composers (authors 2 and 3).

The interface is composed of two boards: one circular - “O”, and one linear - “—”, metaphorically reflecting Eastern philosophies and Western teleological perspectives, respectively. 3D-printed chassis enclose a custom designed PCB with WS2812 LED strips, and harnesses ESP32-WROOM-32 chips for Wi-Fi-enabled control functionalities, allowing for real-time adjustments.

Central to the technical architecture of this DMI are nine interactive boxes, each outfitted with an LDR sensor, meant to act as triggers/controllers when illuminated by lights from the boards. The boxes utilize either an ESP32 Mini board or a Xiao ESP32 sense, powered by individual batteries, facilitating portable and responsive interactions.

Traditionally, a DMIs is composed of an hardware controller and a software synthesizer counterpart [7]; the core of our design is oriented towards the former, while we create the audio platforms afterwards, together with the composers, according to their own preferences and workflow (see Section 4).

<sup>2</sup><https://latam.nime.org/>

### 3.1 Time Boards

The PCBs design follows a modular approach to facilitate easy assembly and disassembly, ensuring long-term adaptability - a key consideration for longevity and sustainability in NIME instrument design [31, 29].

For both boards, we implemented a brightness control using a sliding potentiometer allowing for precise control. The brightness modulation is achieved through Pulse Width Modulation (PWM) output from the ESP32 microcontroller, dynamically adjusting the WS2812 LED strip. In the current prototype, a sliding switch is used to toggle the boards, with the ESP32 detecting input via its GPIO pins to control the WS2812 strip. Finally, as an arbitrarily choice, we 3D-printed O with a semi-transparent Polylactic acid (PLA), enhancing the visibility of internal lighting effects and allowing for a diffuse light, and — in solid gray PLA to produce segmented, concentrated light. (Fig. 1).

#### 3.1.1 “O”

The circular PCB layout is designed to centralize all critical electronic components on the main board (ESP32-WROOM-32, WS2812, battery, and brightness adjustment). Surrounding this core, three additional circular boards house LEDs only, with each module containing two lights, with a total of eight evenly distributed LEDs. The structure follows a concentric design with an inner ring diameter of 50 cm and an outer ring diameter of 56 cm. The 3D-printed enclosure adopts a traditional Chinese *dovetail* joints technique, (Fig. 2).

#### 3.1.2 “—”

The linear PCB layout follows the same centralized design as the circular one. It consists of two modules with a length of 70 cm, each containing seven evenly distributed LEDs, totaling 14 lights across a 140 cm structure. The casing, like the circular version, is 3D-printed and utilizes a traditional *dovetail* joint design, ensuring durability and easy reconfiguration while adapting to the linear form factor (Fig. 2).

### 3.2 LDR Cubes

We also design nine interactive boxes, each incorporating a single LDR sensor, an ESP32 Mini board or Xiao ESP32 Sense, and a rechargeable lithium battery. Boxes commu-



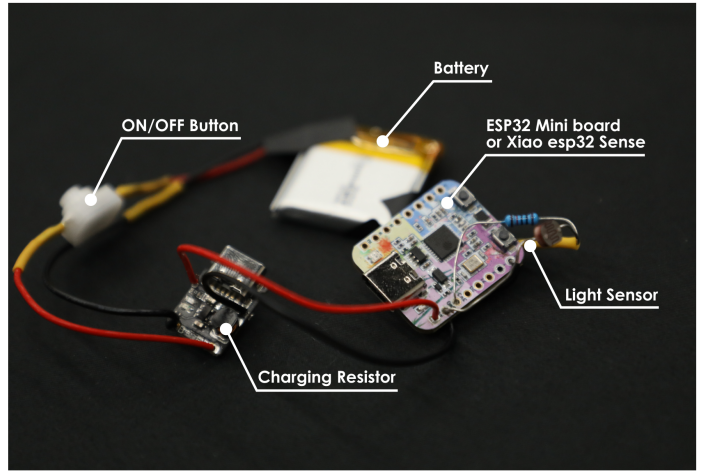
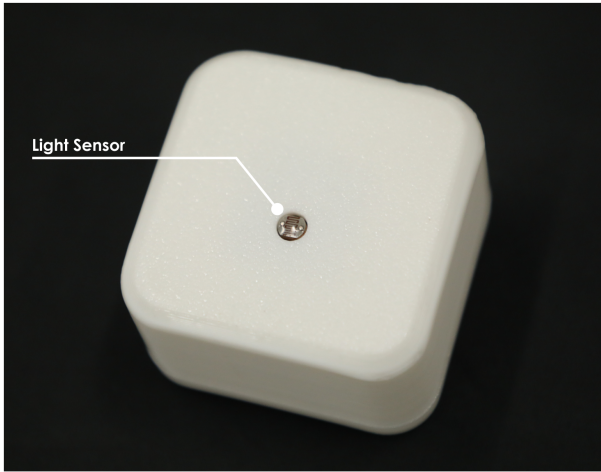


Figure 3: LDR Cube

nicate with the computer via OSC messages. To ensure efficient power management, each box includes a charging circuit with a resistor and an on/off switch. To enhance light sensitivity, a small opening is incorporated at the bottom of each LDR cube, allowing the sensors to be exposed just enough to effectively capture incoming light signals. Each cube is design to offer flexibility in configuration, and can be programmed to achieve one of the following behaviors: 1) acting as a trigger, thus incorporating a threshold over the amount of light being exposed, or 2) acting as a continuous controller, thus constantly send normalized light intensity values at configurable sample rate (Fig. 3).

## 4. CO-COMPOSING ACTIVITIES

After the overall design of the interface was defined, we composed two pieces using O —, in parallel with author 2 - an European composer - and author 3 - a Chinese composer - closely collaborating with the main designer. The purpose of such activity were twofold: on the one hand, to gather concrete insights for refining the instrument’s design and features; on the other, to practically explore how O — could support diverse cultural perspectives and creative processes with respect to the boards’ inscribed time conceptions. The processes were documented with diaries containing logs of all the conversations and ideas emerged, with three diaries being produced. This material has been used during a self reflecting process using Reflection-on-Action [3] - an approach derived by social science that allows practitioners to derive insights by self reflecting on their own practice, widely applied in recent NIME research (e.g. [8, 36, 10]).

The reflections was carried out collectively, and we propose here a summary of the key insights that emerged, along with a brief description of technical and choices and broader musical conceptions. We acknowledge that our sample is limited, and we do not claim this work to be representative of all perspectives; however, we still believe the reflections that emerged may provide valuable insights for researchers and practitioners working at the intersection of interface design and cross-cultural composition. Indeed, during the post-hoc discussions, we realized a significant divergence in the composer’s approaches due to their different cultural backgrounds. To better illustrate these differences, the following subsections present each perspective individually.

A detailed analysis of the composition is beyond the scope of the paper; as such, we simply provide a general overview of the composer’s background and main musical ideas to

help contextualize the subsequent paragraphs. For those interested in the actual musical outcome, we refer to the accompanying demo recording <sup>3</sup>. After each overview, we use the first-person voice to emphasize individual viewpoints.

## 4.1 Western Composer Approach

The first composer is European and has a strong background in free improvisation, electroacoustic composition, and Western music theory. He is a proficient SuperCollider user and has 10 years of experience in the contemporary music field.

### 4.1.1 Musical Conception and Interaction Design

I conceived the piece around three elements: a looping audio track of a *found* (field-recorded) urban environment, a counterpoint of synthesized high-pitched bells and low-pitched drones, and a digital degradation process that gradually acts on the loop, inspired by William Basinski’s *The Disintegration Loops*. Musically speaking, such loop serves as a structural foundation, as its repetitions are very recognizable, while the other sounds acts as disruptive intervention.

There is no pre-defined score to follow, just a system to explore trough interaction. Indeed, the performer may use up to four cubes: two triggers the individual sounds, and two modulates their parameters - e.g. pitch or timbre. Musical articulations is created trough the choice of actions with the cubes on O —. However, every trigger linearly increases the amount of degradation, making each action consequential and leading the loop toward complete dissolution. The modes of interaction have been deliberately kept fairly simple: it was my intention to explore the conception of time rather than to design a complex musical system.

Theoretically, the loop could play indefinitely; nevertheless, any musical gesture - metaphorically, action - inevitably introduces change, whose effects clearly manifest in the present but also have subtle future repercussions, that accumulate and cannot be undone. This reveals the metaphor at the core of my musical idea: even if loops may represent a continuous, repetitive temporal imaginary, every action irreversibly alters the perception of repetition and establishes a “before-and-after”, returning a sense of linear development.

<sup>3</sup><https://youtu.be/sSMZUzL3kpE>

### 4.1.2 Personal Reflections

Ontologically, in my perspective, I realized that there's no such thing as "circular time", as I conceive any musical act - as linear in its development over time. I'm used to performing with loops which constantly repeat themselves indefinitely, however, their displacements eventually unfold in a linear conception. This is influenced by the minimalist idea of musical development. While this perspective is grounded in Western musical studies, where structure and forms are foundational of composition, I was not actively aware of this perspective. Working with O - forced me into an extremely constrained condition that allowed me to actively engage with such idea - for instance, realizing the linear nature that loops have in my musical conception.

From an interaction design perspective, in the presence of an actual artifact involved in the composition process I cannot disentangle the musical idea from the instrument itself. Therefore, for me it was very important to understand exactly the details of the interface, as to work with it in a performative fashion. For instance, since the performer has to put or move blocks to interact with the system, I have to take this into account, as the number of actions that the performer can actively apply are physically limited. On the other hand, if too many automations are used in the synthesizers, then the original metaphor may get lost in the complexities. This is why I bent the original interaction and had both boards controlling sounds linearly, while leaving the loop to be played independently by the machine (that was in any case conceived in a linear form as discussed above).

## 4.2 Chinese Composer Approach

The second composer is Chinese and has a strong background in Chinese traditional music performance and composition. Trained at Western conservatories, the composer is a proficient pianist, as well as pipa and erhu player. The composer has 16 years of experience blending traditional Chinese timbres with contemporary orchestral and chamber compositions.

### 4.2.1 Musical Conception and Interaction Design

The technical setup is built around Pure Data as the primary audio platform. The sound architecture is built around three main thematic elements, through five curated sound excerpts. These are drawn from Chinese operatic, folk, and percussive traditions, namely: *Huangmei* (黄梅戏) - first excerpt includes pipa melodies mixed with operatic singing and humming; *Woven Imprints* (锣鼓经) - two rhythmic sections from a Chinese Luogu concerto, with b1 focusing on gong and drum patterns, and b2 using oboe reed extended techniques to alter the listener's sense of rhythm; *Gan Sheng Ling* (赶牲灵) - based on a Shanbei folk theme, with c1 highlighting Erhu, Sheng, and Tanggu, and c2 employing the Suona for a strong, impactful sound.

Conceptually, the piece explores the multiplicity of temporalities within Chinese musical traditions. Each theme enacts a distinct temporal logic: *Huangmei* embodies the psychological elasticity of operatic time, *Woven Imprints* conveys cyclical and ritualistic pulse, and *Gan Sheng Ling* evokes immediacy and embodied presence. Their juxtaposition foregrounds how musical vocabularies carry different philosophies of time, memory, and identity.

These five excerpts are mapped to triggers within a networked OSC environment, controlled by LDR cubes modulating parameters like amplitude, delay, and spectral filtering. The cube's proximity to LEDs influences the modula-

tion - closer gestures produce sharp articulations; distant ones, softer transitions - inviting subtle bodily expression. With no fixed score, the performance's logic embodies a time concept where music is not linear but cyclical and ever-evolving, where the performer guides the system echoing the unhurried temporal flow of Chinese culture.

Interaction design combines structured initiation with improvisational freedom. The first cube placed on the board (O) sets the sonic foundation, with subsequent triggers added sequentially. A real-time feedback system constantly analyzes audio and loops back the data, shaping performance dynamics. This self-regulating setup mirrors a harmonious, cyclical relationship between performer and machine, emphasizing interconnectedness between humans and nature, and a responsive - rather than controlling - interaction with the environment.

### 4.2.2 Personal Reflections

I reflected on the challenges faced by many Chinese composers when confronted with the cultural dilemmas of our time. There is a pervasive sense of lagging behind - a sentiment that is well encapsulated in the works and writings by figures such as Chou Wen-Chung[41], who framed musical aesthetics through the lens of Chinese philosophical concepts of time and space. The approach of combining ethnic elements with Western musical techniques - sometimes referred to as "local specialty" (tǔ tè chǎn) - has been a longstanding method, used by successive generations of composers. Yet, despite its historical significance, this approach hindering my composing activities is I am afraid of the approach often seems superficial, as it tends to simply juxtapose traditional melodies with Western frameworks without fully reconciling their inherent differences.

After actively engaging with this system, I have come to view the instrument not only as a tool for musical creation but also as a means of alleviating creative anxiety. While the traditional method of transplanting ethnic elements directly into Western musical forms remains influential, I believe that the new technologies at this disposal offer fresh perspectives. These boards along with my composed trigger, allow for a more nuanced exploration of cultural time: - could serve as an existing rule or framework which I can continue to study and refer to, while O would be the freeing and seeing how Chinese musical time stands out. The process of separating time in two conceptions with physical interaction to trigger musical ideas has provided me with insights into how modern technology can enhance our understanding of musical time and my own compositional narrative continuity.

## 5. DISCUSSION

The core difference between the Chinese and Western time logic lies primarily in the understanding of **change** and **continuity** in time, as well as the **role of action** within the temporal framework.

The Western composer is rooted in a progressive understanding of time. The loop serves as a foundation, but it is fundamentally subject to a process of degradation driven by deliberate, irreversible actions. Despite the repetitive nature of such loop, this degradation introduces a **linear narrative**, where each action builds upon the last, leading toward an endpoint. The metaphor lies in the idea of *before-and-after*, where time is not a continuous, undulating flow, but a series of discrete actions that lead to a tangible result - a change that cannot be undone.

On the contrary, in the Chinese logic, time is cyclical and

fluid, without a definitive beginning or end. The loops do not simply repeat: rather, they reflect an ongoing cycle. Here, the passage of time is not something that is actively shaped, rather something that is experienced through subtle shifts reflecting a sense of unity and continuity. Within this framework, actions might slightly alter the cycle, but do not break it - there is no irreversible progression; instead, time continues to move, evolving yet remaining grounded in its circular nature.

This divergence highlights how designing the same interface can lead to different cultural-depending forms of musical engagement, pointing to what Hayes and Marquez-Borbon identify as *sociotechnical entanglements* in NIME: the cultural, historical, and political layers shaping interaction design [14]. Thus, this work exemplifies a fundamental contrast in how time and change are treated:

1. **Chinese Circular Time** emphasizes continuity and subtle change, where the past and future remain interconnected within a non-linear flow.
2. **Western Linear Time** focuses on progressive, irreversible change, with a sense of beginning, middle, and end.

## 5.1 Time, Culture and Music in our practice

The main focus of this project was to explore in a practical way a reflection on different conceptions of time which we metaphorically inscribed in our instrument. Indeed, during the co-composition activities and reflections, a strong difference emerged in terms of time conception and its implication. The Western composer delved into his linear conception of time. Accustomed to musical structures where sounds and gestures unfold directionally over time (similar to what outlined in [38]), he found it difficult to embrace a form that prioritized recurrence, fluidity, and non-hierarchical development, even in presence of repetitive patterns or loops. This aligns with the dialectic and structural approaches that have long characterized Western thought [12, 1]. Conversely, the Chinese composer has been strongly influenced by Eastern philosophies, and often highlighted his roots in Chinese culture. While composing with O —, he could experience the tension between Chinese music conception and Western terminology as exemplified in the use of 锣鼓经 (Luogu Jing) that is grounded on Beijing opera's rhythmic structure that cannot be explained using Western concepts of musical meter.

Such discrepancies resonates with the works by Feng [43] and Cheng [4], both highlight the contrast between the linear, measurable time of Western thought and the cyclical, process-oriented time of Chinese philosophy. Also, we can speculate on the cultural influence on time perception especially in the Eastern culture. For instance, modern Chinese scholars provide valuable insights into how time is understood and represented in Chinese philosophy and cultural manifestations, revealing a rich, dynamic tradition that challenges Western temporal frameworks. The temporal culture of China was compelled to adapt to the establishment of modern timekeeping systems under during the late Qing Dynasty, as traditional chronological frameworks underwent significant transformation in response to globalization and technological modernity [42, 17, 16, 13]. In the book *The Global Transformation of Time: 1870-1950*, Ogle [34] pointed out:

*“The nineteenth-century preoccupation with progress and modernity was built on similar notions of linear historical and naturalized, evolutionary time. [...] In the non-Western world,*

*mechanical clocks thus became status symbols, displaying the owner's keeping up with modern times”*

Such an idiosyncratic relationship has been indeed pointed out by Author 3, who reflected on compositional methods which intertwine Western and Eastern approaches, perceiving such processes as a “cultural dilemma”.

## 5.2 Time Perspectives and new DMIs

Both composers overall highlighted the role of the hardware interface in fostering such process, albeit differently. Overall we conclude by highlighting three main aspects of time-instrument relationship: cultural inscriptions, personal mediation, and form-related affordances.

1. As Magnusson widely discussed, instruments has theories inscribed in their design [26]. We expand on this by suggesting that these inscriptions are also culturally informed, and instruments may carry with them peculiar conceptions of time and value outside dominant Western academic paradigms. As such, they can serve as bridges between diverse epistemologies, enabling new forms of musical knowledge and practice to emerge.
2. The time inscribed in the instrument is mediated through the lens of musicians' own cultural and personal background. While the time conceptions inscribed in the instruments determined specific musicking strategies, composers' individualities played a pivotal role in the final pieces. This is in line with [27], where the authors observed that the background of musicians can at times overcome the specificity of a system. Indeed, the mapping flexibility of DMIs allows and promotes nuanced negotiation between pre-configured structures and embodied musical perspectives.
3. While the idea that the instruments embed a certain music theory is overall well established [26], studies on the relationship between instruments and broader musical forms are relatively recent (e.g. [9, 28]). By examining how different temporal concepts are embedded in and activated by instruments, we gain insights into how musical form itself can be shaped by the temporal affordances and constraints of the interface.

These three dimensions reinforce the fact that DMIs are not merely tools for realizing temporal structures, rather active participants in shaping them. In this sense, thinking through time in relation to design choices opens possibilities for more inclusive, reflexive, and contextually grounded musical practices.

## 6. CONCLUSION

In this paper, we present a practice-based exploration of the relationship between time, musical instruments, and cultural background. The work consists in a collaboration of three practitioners, designing and composing O —, a custom-made DMI. Building the different cultural background of the authors (Chinese and Western), a number of different reflection have emerged; in the discussion, we outlined a few points that connect such reflection to recent literature in the hope it can support NIME practitioners to incorporate reflection on time and its cultural implication in their design.

## 7. ACKNOWLEDGMENTS

The author gratefully acknowledges PCB designer Hongda Huang and his company 闭环科技 (广州) 有限责任公司 for their technical expertise, Prof. Mark Grimshaw-Aagaard for his invaluable insights, and deeply appreciates Prof. Hans Kretz for his philosophical guidance throughout this project.

## 8. ETHICS STATEMENT

The paper aligns with the NIME ethic code. The music is developed using open sources platforms (Pure Data and SuperCollider). Furthermore, the paper wishes to contribute to cultural diversity within NIME debate.

## References

- [1] Adrian Bardon. 2013. *A Brief History of the Philosophy of Time*. Oxford University Press.
- [2] Judith Becker. 1981. Hindu-Buddhist time in Javanese gamelan music. In *The Study of Time IV: Papers from the Fourth Conference of the International Society for the Study of Time, Alpbach—Austria*. Springer, 161–172.
- [3] Benjamin Carey and Andrew Johnston. 2016. Reflection On Action in NIME Research: Two Complementary Perspectives. In *Proceedings of the International Conference on New Interfaces for Musical Expression*. Zenodo, 377–382. <https://doi.org/10.5281/zenodo.1176006>
- [4] Chung-ying Cheng. 1974. Greek and Chinese views on time and the timeless. *Philosophy East and West* 24, 2 (1974), 155–159.
- [5] Zheng Chuanyin. 2012. 中国戏曲文化概论 (*An Overview of Chinese Opera Culture*). Peking University Press. 417 pages.
- [6] Zheng Chuanyin. 2020. 古代戏曲与东方文化 (*Ancient Chinese Drama and Eastern Culture*). 长江文艺出版社 Changjiang Literature and Art Publishing House Co., Ltd. 496 pages.
- [7] Perry Cook. 2017. 2001: Principles for designing computer music controllers. *A NIME Reader: Fifteen years of new interfaces for musical expression* (2017), 1–13.
- [8] Kelsey Cotton, Pedro Sanches, Vasiliki Tsaknaki, and Pavel Karpashevich. 2021. The Body Electric: A NIME designed through and with the somatic experience of singing. In *NIME 2021*. PubPub.
- [9] Francesco Ardan Dal Rì and Raul Masu. 2022. Exploring musical form: Digital scores to support live coding practice. In *NIME 2022*. PubPub.
- [10] Francesco Ardan Dal Rì, Francesca Zanghellini, and Raul Masu. 2023. Sharing the Same Sound: Reflecting on Interactions between a Live Coder and a Violinist. In *Proceedings of the International Conference on New Interfaces for Musical Expression 2023*.
- [11] Michael Gardiner and Joyce S Lim. 2014. Chromatopes of Noh: An Analysis of Timbral Progressions in the Introductions to Three Plays. *Asian music* (2014), 84–128.
- [12] A. Gell. 2021. *The Anthropology of Time: Cultural Constructions of Temporal Maps and Images*. Taylor & Francis.
- [13] Wu Guosheng. 1996. 时间的观念 (*Ideas of Time*). 中国社会科学出版社 (China Social Sciences Press). 266 pages.
- [14] Lauren Hayes and Adnan Marquez-Borbon. 2020. Addressing NIME’s prevailing sociotechnical, political, and epistemological exigencies. *Computer music journal* 44, 2-3 (2020), 24–38.
- [15] Zeynep Helvacı, Jacob Olley, and Ralf Martin Jäger. 2017. *Rhythmic cycles and structures in the art music of the Middle East*. Ergon Verlag Würzburg in Kommission, Würzburg.
- [16] Wu Hung. 2022. *Chinese Art and Dynastic Time*. Vol. 48. Princeton University Press.
- [17] Wu Hung. 2022. *End as Beginning: Dynastic Time and Revolution*. Vol. 48. Princeton University Press, 261–286.
- [18] Edmund Husserl and James S. Churchill. 1964. *The Phenomenology of Internal Time-Consciousness*. Indiana University Press. 189 pages. <https://doi.org/10.2307/j.ctvh4zhv9>
- [19] François Jullien. 2001. *Du temps: éléments d’une philosophie du vivre*. le Grand livre du mois.
- [20] Jonathan D Kramer. 1981. New temporalities in music. *Critical inquiry* 7, 3 (1981), 539–556.
- [21] Jonathan D Kramer. 1996. Postmodern concepts of musical time. *Indiana theory review* 17, 2 (1996), 21–61.
- [22] Iurii Kuzmin, Zhengyang Ma, and Raul Masu. 2024. Locality and Digital Musical Instruments Design: A User Study. In *Proceedings of the 19th International Audio Mostly Conference: Explorations in Sonic Cultures*. 1, 1, 468–478.
- [23] Eric Lee and Jan Borchers. 2005. The Role of Time in Engineering Computer Music Systems. In *Proceedings of the International Conference on New Interfaces for Musical Expression*. Vancouver, BC, Canada, 204–207. <https://doi.org/10.5281/zenodo.1176766>
- [24] Wang Li. 2014. 中国古代文化常识 (*Essentials of Ancient Chinese Culture*). Beijing United Publishing Co., Ltd. 272 pages.
- [25] Thor Magnusson. 2009. Of epistemic tools: Musical instruments as cognitive extensions. *Organised Sound* 14, 2 (2009), 168–176.
- [26] Thor Magnusson. 2019. *Sonic Writing: Technologies of Material, Symbolic, and Signal Inscriptions* (first published ed.). Bloomsbury Academic. <https://doi.org/10.5040/9781501313899>
- [27] Raul Masu, Mela Bettega, Nuno N Correia, and Teresa Romão. 2023. Investigating performance ecologies using screen scores: a case study. *Personal and Ubiquitous Computing* 27, 5 (2023), 1887–1907.
- [28] Raul Masu and Francesco Ardan Dal Rì. 2023. Visual Representations to Stimulate New Musicking Strategies in Live Coding. *Organised Sound* 28, 2 (2023), 218–230.

- [29] Nicolo Merendino, Mela Bettega, Adam Pultz Melbye, John D. Sullivan, Antonio Rodà, and Raul Masu. 2024. Sustainable Digital Fabrication in NIME: Nine Sustainability Strategies for DMI Production. In *Proceedings of the International Conference on New Interfaces for Musical Expression*. Zenodo, 266–274. <https://doi.org/10.5281/zenodo.13904850>
- [30] Claudia Molitor and Thor Magnusson. 2021. Curating experience: Composition as cultural technology—a conversation. *Journal of New Music Research* 50, 2 (2021), 184–189.
- [31] Fabio Morreale and Andrew McPherson. 2017. Design for Longevity: Ongoing Use of Instruments from NIME 2010-14. In *Proceedings of the International Conference on New Interfaces for Musical Expression*. Aalborg University Copenhagen, Copenhagen, Denmark, 192–197. <https://doi.org/10.5281/zenodo.1176218>
- [32] Hugh Munby. 1989. Reflection-in-action and reflection-on-action. *Current issues in education* 9, 1 (1989), 31–42.
- [33] Carman Neustaedter and Phoebe Sengers. 2012. Autobiographical design in HCI research: designing and learning through use-it-yourself. In *Proceedings of the Designing Interactive Systems Conference*. 514–523.
- [34] Vanessa Ogle. 2015. *The Global Transformation of Time: 1870–1950*. Harvard University Press. 279 pages.
- [35] Taylor J Olsen. 2020. Animation, Sonification, and Fluid-Time: A Visual-Audioizer Prototype. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, Romain Michon and Franziska Schroeder (Eds.). Birmingham City University, Birmingham, UK, 625–630. <https://doi.org/10.5281/zenodo.4813230>
- [36] Courtney N Reed, Charlotte Nordmoen, Andrea Martelloni, Giacomo Lepri, Nicole Robson, Eevee Zayas-Garin, Kelsey Cotton, and Andrew McPherson. 2022. Exploring experiences with new musical instruments through micro-phenomenology. In *NIME 2022*. PubPub.
- [37] Sarah Reid, Ryan Gaston, and Ajay Kapur. 2019. Perspectives on Time: Performance Practice, Mapping Strategies, & Composition with MIGSI. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, Marcelo Queiroz and Anna Xambó Sedó (Eds.). UFRGS, Porto Alegre, Brazil, 234–239. <https://doi.org/10.5281/zenodo.3672940>
- [38] D. Rosenberg and A. Grafton. 2013. *Cartographies of Time: A History of the Timeline*. Princeton Architectural Press.
- [39] E.L. Shaughnessy. 1997. *I Ching*. Ballantine Books.
- [40] Adam Tindale and Colin Clark. 2024. Reshaping Time - Exploring Grid Interfaces for Anisotropic Patterns. In *Proceedings of the International Conference on New Interfaces for Musical Expression*. Zenodo, 302–305. <https://doi.org/10.5281/zenodo.1390486>
- [41] Chou Wen-Chung. 1971. Asian Concepts and Twentieth-Century Western Composers. *The Musical Quarterly* LVII, 2 (April 1971), 211–229.
- [42] Fang Yong. 2023. 逝者如斯夫：20 世纪中国哲学中的“时间”观念 (*The Flow of Time: Temporal Concepts in 20th-Century Chinese Philosophy*). 上海人民出版社 (Shanghai People’s Press). 419 pages.
- [43] Feng Youlan. 1948. *A Short History of Chinese Philosophy*. Macmillan Inc. 400 pages.