Toward Musical Cosmotechnics: the case of *zhu nao* 竹脑 — a bamboo-based instrument

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ABSTRACT

This paper aims at contributing to the discussion of DMI design within specific cultural contexts. It presents a reflection on designing and performing with *zhu nao* - a new DMI grounded in Chinese culture. In our attempt to avoid stereotypes commonly associated with the orientalist imaginary of Chinese culture, we based the design of our instrument on the notion of *cosmotechnics* proposed by the Hong Kong philosopher of technology Yuk Hui as a way to reconcile nature and technology by acknowledging the influence of locality and local cosmologies on the development of scientific and technical thinking.

Author Keywords

Cosmotechnics, Bamboo, DMI design

CCS Concepts

•**Applied computing** → **Sound and music computing;**

1. INTRODUCTION

In recent years, there has been a growing interest in non-Western approaches to NIME research [26, 56, 2, 2, 46, 9, 66, 34] consistent with the ongoing process of decolonization within technological disciplines [21, 37, 43]. The Latin American NIME (LATAM NIME) community[1] has taken a particularly proactive stance in this regard [6, 39], establishing itself as a viable model of a cross-border research and practice community with a distinct identity.

At the moment, the precedent set by the LATAM NIME research network is yet to be recreated in other regions. Despite the diverse range of electronic sound practices in China—from electroacoustic composition, recently explored in the special issue of Organised Sound [7],to a plethora of experimental music scenes [25][50] and ways of incorporating sound in contemporary art[29][59]—Chinese sonic cultures are still underrepresented in NIME, and only a handful of papers directly concerned with the Digital Musical Instruments' (DMIs) building in the region have been published [11, 55, 63, 62, 27].

This paper aims at contributing to the discussion of DMI design in China. It presents a reflection on designing and performing with *zhu nao*, a new DMI deeply grounded in Chinese culture. As authors of this paper come from different cultural backgrounds, we were conscious of the dangers of portraying Chinese culture as the "Oriental Other": either in the "high tech" techno-orientalist (or sinofuturist) light [13] or as an atemporal, always-traditional entity [49]. In our attempt to avoid these stereotypes, we based the design of *zhu nao* on the notion of **cosmotechnics**, proposed by the Hong Kong philosopher of technology Yuk Hui as a way to reconcile nature and technology by acknowledging the influence of **locality** and local cosmologies on the development of scientific and technical thinking[30].

As a result, the design of *zhu nao* is inspired by a specific locality—the outskirts of Guangzhou (Guangdong province, China)—where the development of the instrument began as a cross-cultural collaboration between the first and second authors. The experience of everyday life in this place suggested local reference points that heavily informed the design. Specifically, we focused on **bamboo craftsmanship** as, simultaneously, an archetypal technical practice in East Asia and an articulation of symbolic and practical dimensions of the material. Furthermore, our design drew inspiration from **environment improvisation**—an approach to free improvisation grounded in the aesthetics and philosophy of *shanshui*—traditional Chinese landscape painting and the associated way of forming affective relations with the environment [59]. Following Hui's proposal, the two main Chinese references—bamboo craftsmanship and environment improvisation—are framed as cosmotechnical activities.

We hope to further the conversation on digital lutherie as a cosmotechnical activity, not exclusive to the Western-centric understanding of technology. At the same time, it can be considered a complementary approach to the study of NIME craft [4]. Overall, with this paper we hope to contribute to the discussion of **technodiversity** in NIME and how **cosmotechnical thinking can support such diversity.**

2. AUTHORS' SITUATED POSITIONS

The core idea and the initial artistic conception of the instrument arose from the first author's experience as a foreigner living and working in South China and his practice of learning, making and performing alongside Chinese artists

[1] https://latam.nime.org/

NIME'24, 4–6 September, Utrecht, The Netherlands.

for almost a decade. The actual development has been conducted in close collaboration with the second author—native Chinese—responsible for parts of technical development. The theoretical framing has emerged in numerous discussions among the authors.

3. BACKGROUND

3.1 Music Technology in China

Over the past two decades, a number of Chinese and international researchers turned their attention to Chinese electronic music and sonic arts, focusing on their various aspects.

A recently published special issue of Organised Sound focused on electroacoustic music in China [8]. The contributions range from the analysis of specific pieces [64], stylistic and regional variations in Chinese electroacoustic compositions [47] and practices of individual composers [65] to inquiries into aesthetics and philosophy of electronic music in China [15, 33]. Additionally, Routledge Research Companion to Electronic Music [17] and Electroacoustic Music in East Asia [7] both feature articles on China's academic electroacoustic music [36, 68]. The former presents Leigh's overview of strategies of cultural retention in China' s electroacoustic music [36], while the latter contains a firsthand account of the early electroacoustic music development in the region and its future prospects [68].

In a chapter of the book *Half Sound Half Philosophy*, which examines sonic arts in China through the lens of China' s philosophical legacy, Wang addresses the role technology plays in the diverse sonic landscape of today's China. Aside from the gallery-based sound art works she also examines practices of silicon luthiers in China, specifically pointing out Xu Cheng's circuit bent instruments, Meng Qi's post-digital lutherie and Tian Jinqin's pioneering EMI design work in the 1970s [59].

A number of studies have addressed the question of musical technology in China. Zimmermann analyzed how musical devices, mostly designed in the West, play out in non-Western contexts, observing how material and cultural dimensions of technical objects are mediated in their use by Chinese musicians [69]. Meanwhile, Lindtner et al. conducted an ethnographic study of the elderly electronic hacker community in China, particularly noting that their practices do not quite fit into the emancipatory narrative of DIY in the West [40].

Despite the richness of this field, a very small number of NIME research has focused on this region. From a keyword search of the archive of NIME proceedings a following pattern emerges: out of the entirety of published articles, only five explicitly refer to China, with three papers focused on culturally-grounded NIME design [55, 11, 27], a case study of inter-generational continuity in China's NIME community [63] and a comparative study of platforms for production, dissemination and consumption of electronic music in China and UK [12].

With this paper, we hope to further the debate on Chinese NIME, as others [6, 39, 56] have, for instance, done for the LATAM NIME.

3.2 Music and Technodiversity

Recent LATAM NIME scholarship has briefly touched upon the idea of **cosmotechnics** in DMI-building discourse with the discussion of *gambiarra* as a locally-grounded form of knowledge [56]. The concept of cosmotechnics was originally developed by the Hong Kong philosopher Yuk Hui in his book *The Question Concerning Technology in China* [30] as a way to the reconcile the opposition between nature and technics, prominent in Western philosophy. Hui proposed to **re-examine indigenous approaches to technology** in different cultures around the globe, stating that technical and cosmological thinking can not be understood in isolation. [32]. In this sense, a cosmology does not necessarily refer to the cosmic phenomena but is rooted in local geography, everyday life and imagination of the people and embeds itself in relations between humans and non-humans within a given culture. This line of thinking opens the way to what Hui calls *technodiversity*—a pluralistic view of different, culturally and cosmologically specific technological lineages coexisting with each other, rather than being dominated by a single totalizing narrative [31].

Another perspective pertinent to our discussion is that of *regional futurities*, which began with retrospectively labeling the 1960s radical innovations in music driven by the African diasporas as afrofuturism [25]. Afrofuturism proposed an **alternative** to the dominant narratives in the history of Western electronic music as a **linear progression** from Stockhausen to techno; instead it opens the possibility, in Kodwo Eshun's words: "to go back into a Ghanaian or Indian or Vietnamese sonic past is to go forward into a new future" [19]. To illustrate this idea, Sun Ra's work is often used as the prime example of the afrofuturist aesthetic and political agenda [54].

These approaches offer a way of including local ways of knowledge in the development of technical systems and have informed the design and the theoretical framing of the instrument we present in this paper.

3.3 The Issue of Orientalism(s)

Orientalism—famously diagnosed by Edward Said in his eponymous book—is a colonial worldview that portrays "the Orient" as a fundamentally distinct entity, both ontologically and epistemologically. This allows for "the Occident" to exercise its authority by strategically *dispatching* elements of Western modernity [49]. An orientalist worldview does not necessarily present the Other in a negative light. A musical example is a particularly favorable portrayal of Turkish people in *Il Seraglio* by Mozart; this attempt to a sympathetic representation only serves to emphasize the difference. In NIME, this question has been recently addressed in a short paper by Hatakeyama, who built her works as an ironic commentary on the perceived monolithic character of the "Asian culture" [24].

Another form of quasi-orientalism paradoxically evolved from the emancipatory discourse of afrofuturism [18]. However, while former has emerged as a self-reflective term, **sinofuturism,**—a concept that gained some prominence in the discourse surrounding art, music and literature coming from China or inspired by it—is a different matter altogether. The term was coined by Steve Goodman—Scottish philosopher and electronic music producer, once adjacent to the Cybernetic Culture Research Unit (CCRU) of Warwick University (UK) [16]. One of the CCRU's text, authored by Nick Land and later adapted into a audio-visual piece *Meltdown*, served as the inspiration for the term, prophesying the arrival of "Neo-China from the future" [35].

Originally a philosophical project, it eventually came to fruition as a futuristic (predominantly) sonic aesthetic rooted in the pre-millennium geopolitical anxiety and echoing William Gibson's techno-orientalist fantasies of the cyberpunk Japan. As such, it has been criticized as a brand of quasi-orientalism rather than being an "an incisive provocation of Chinese futures concretely rooted in the Chinese condition" [67].

Sinofuturism is, paradoxically, equally rooted in the emancipatory narrative of afrofuturism and colonial logic of orientalism as theorized by Said in the 1970s [49]. The link between sinofuturism as *inverse orientalism* and orientalism "proper" lies in their denial of the ability of the Other to effectively represent itself. De Seta, citing Fabian, calls this phenomenon the refusal of coevalness, understood as a forceful imposition of a distinct temporality never quite synchronized with the Western time [16].

While the debate on the sinofuturism lies outside the scope of this paper, it nonetheless influenced the design of the instrument. In the essay published in the SFRA Review special issue on Sinofuturisms[2], Zhang stresses that sinofuturism is not a stable entity [67]: outside the sprawling megacities, there are rural and transitional zones such as urban-rural fringes that are also exemplary of the Chinese futurity in the making. Such a place was the site of the design of our instrument.

Both sinofuturism and orientalism, while radically different, represent two extremes of a stereotyped vision of China that is still prevalent in Western culture. With our paper, we try to avoid both of them: we infer our design from constant contact with the locality, trying to enact a DMI design approach that accounts for the existence of multiple cosmotechnics.

4. ZHU NAO DESIGN

zhu nao(竹脑), translated literally bamboo brain or bamboo mind, is a colloquial term that refers to the topmost leafy part of a bamboo stem and, at times, to the underground part of the plant. Intended as a homophonous pun (omnipresent in Chinese languages) the name echoes the literal translation of the Chinese word "computer" *dian nao* (电脑 - literally electronic brain) and serves as a lighthearted acknowledgment of computational processes at the core of the instrument and its botanical origins.

4.1 Cultural References

The design of the instrument was **motivated by the lived experience** of the first author working and residing at the far periphery of Guangzhou. This specific location is currently undergoing rapid development and is often described as an "**urban-rural fringe**". Urban-rural landscape of this place encompasses contours of infrastructure in the making (high-speed train lines, highway interchanges, a mesh-work of 5G towers), large-scale construction projects (building sites, industrial areas, newly-built university campuses) and still prevalent rural areas (fields, farms and villages). All of these elements combined, amount to a fascinating environment, best described by Chinese artists Gong Jian and Li Jinghu: "The urban-rural fringe is a place rife with imagination, a place in which various possibilities and contingencies are manifest." [3].

Based on the experience of living in this context, we initiated a speculation on how to render the experience peculiar to this location in a new DMI tailored for experimental electronic music performance. We proceeded by looking for activities grounded in this particular locality that could be labeled as "cosmotechnical". The first activity—**environment improvisation**, a musical approach pioneered by the Chinese soundartist Li Jianhong, came along thanks to the first author's familiarity with the Chinese experimental music scene. The second activity—**bamboo craft**—serendipitously emerged from the experience of everyday life in the urban-rural environment: it does not take long for one to stumble upons some form of bamboo-based objects in such places. The timing of these mundane "bamboo encounters" coincided with the first author's search for the possible design direction of our instrument, we swiftly reconnected bamboo to a rich milieu of craft and philosophical investigations of this material.

4.2 Environment Improvisation

As stated above, one of our main goals was to explore the concept of **environment improvisation** developed by Chinese sound artist Li Jianhong. Li is widely acknowledged as one of the underground pioneers of improvised music in China [52]. Li's explorations of free improvisation as a means of retaining memories of familiar places and sounds of everyday life drove him to incorporate extra-musical influences into his practice, one of them being the philosophy of *shanshui* (山水) commonly associated with Chinese landscape painting [58]. According to Wang, *shanshui* exemplifies reciprocity between aesthetic, cosmic and moral qualities. By the late 00s the concept of environment improvisation was developed enough to be formalized and applied to several recorded works. What began as a simple impulse to "make music with the rain" while weathering the heavy rainstorm in the Faxi temple in Hangzhou [58] developed into a consistent artistic strategy drawing on the intimacy of personal experience and memory tuning into the "tacit resonance" (known as *moqi* 默契) with the environment [59].

Wang further explicates environment improvisation as a non-dialogical form of musicking, contrary to the habitual understanding of improvisation as a collective, communicative activity. For example, the ambient sound of raindrops so prominent in Li's *Twelve Moods* is entirely independent of his actions. This sets Li's concept apart from similar environmentally aware approaches to creative sonic practices, such as deep listening, field recording or soundscape-related work.

4.3 Material Reflection

Figure 1: *zhu nao*.

Bamboo bears a particular significance in Chinese culture, technics and ecology. The crucial role of bamboo in the history of technology is not exclusive to China, as bamboo is commonly found in many other countries, especially in East Asia. That said, the nature of the project has nar-

[2] https://sfrareview.org/50-2/

[3] http://www.leapleapleap.com/2012/11/what-is-the-urban-rural-fringe-and-why-is-it-the-urban-rural-fringe/

rowed the referential frame to that of Mainland China and Hong Kong—the areas that the authors are most familiar with. Species of bamboo native to southern China (predominantly *mao zhu* and *huang zhu*) have been used for millennia to erect temporary or semi-permanent structures (e.g. gardening supports, scaffolding) and make various tools. The mythological origins of bamboo craftsmanship in China are sometimes traced all the way back to the urarchitect Youchao [60], while the earliest technical descriptions of the use of bamboo in carpentry and construction are attributed to the legendary carpenter and tool-maker Lu Ban（鲁班）, believed to have lived in the *chunqiu*（春秋）period (771-476 BC) in China [48].

Among myriads of bamboo applications, many of the traditional musical instruments in China are made of bamboo, for example *di*（笛）and *xiao*（箫）flutes, mouth organ *sheng*（笙）, bowed instruments such as *jinghu*（京胡）and plucked instruments such as tube zithers. Moreover, it has been noted that the physical properties of bamboo are so distinct, that the material determines form and function of the resulting instrument to a higher degree, compared to more malleable materials. This contributes to what some consider a distinct organological category of cross-cultural bamboo instruments [22]. Bamboo and its derivatives (e.g. flexible strips used in our design) are still used in a variety of traditional crafts: furniture-making, basket-weaving and construction of bird-cages among others [61].

Beyond its utilitarian function, bamboo has had an enormous influence on the development other cultural forms, both as an early medium of writing, *Bamboo Annals*（竹书纪年）being one of the earliest examples [53], and a raw material in paper manufacturing, as well as exerting a significant influence on art, literature and other intellectual pursuits. A prime example of it is *Seven Sages of the Bamboo Grove*（竹林七贤）, a subject matter that has appeared in numerous artistic works over the centuries: from Jin Dynasty (266-420AD) tomb engravings to Yang Fudong's experimental video art.[4]

Another notable example is the story of Ming era Neo-Confucian intellectual Wang Yangming [51], who famously (and unsuccessfully) attempted to infer the nature of things by gazing at the bamboo reeds in his garden - the process known as *gezhu*（格竹）—*bamboo investigations* [41]. Wang Yangming's legacy is a essential part of the intellectual history of China and still serves as a source of inspiration for artists, as seen, for example, in Zheng Bo's work *Bamboo as Method*[5].

5. TECHNICAL IMPLEMENTATION

In our attempt to counteract the two-fold orientalist stereotyping discussed above, it was decided early on that rather than attempting to mimic centuries-old traditions of Chinese artisans and luthiers, emphasizing the instrument's computational aspects or exploiting the perceived difference between the two, we would attempt to strike a balance between actualization of the material's cultural and material properties, intrinsic geometries that bamboo affords, and technologies of sensing and communication that define a DMI as such.

Technically, *zhu nao* follows a typical DMI architecture, consisting of three fundamental blocks: 1) tangible interface, 2) data mapping hub and 3) a sound engine. These

[4](https://www.mplus.org.hk/tc/magazine/from-the-collection-seven-intellectuals-in-a-bamboo-forest-by-yang-fudong/)

[5]https://zhengbo.org/2018_BAM.html/

Figure 2: Full view.

subsystems communicate with each other via Open Sound Control (OSC)[6]

The microprocessor in the tangible interface transmits sensor readings as OSC messages to the sensor-processing hub via the UDP protocol. At that stage, the environmental and gestural data are fused together, processed by the Machine Learning (ML) algorithm and mapped onto the sound engine parameters. Additionally, the performer's gestures are routed and directly mapped onto the sound engine, bypassing the ML.

5.1 Tangible Interface (Material and sensors)

To achieve our material-related goals, we used a heat-treated 1.5m long bamboo pole of the *mao zhu* species sourced from Zhejiang province with the cross-sectional diameter of 3.5cm [Fig.2]. The nodal diaphragms inside the bamboo pole were then punctured to form a continuous cavity housing electronic components and sensor wiring.

The instrument uses three sensors connected to the ESP32 microcontroller: a pair of flex sensors (conditioned with an op-amp-based buffer), a ground moisture sensor and an omnidirectional antenna extender that simultaneously acts as a WiFi signal strength sensor and transmits OSC messages to the data-mapping hub. The intended player posture came along during the prototyping stage: seated behind the instrument, left and right arms holding the bamboo strips, while the moisture sensor acts as the end-pin anchoring the

[6]https://opensoundcontrol.stanford.edu/files/1997-ICMC-OSC.pdf

instrument in addition to serving its primary function. Electronics, micro-controller, Li-Po battery, a switch, wiring and the antenna plug are mounted inside the protective shell made of a thicker bamboo at the top of the instrument [Fig 1.].

The player twists and bends two stacks of three 0.5mm thick flexible bamboo strips with flex sensors sandwiched inside. These stacks are bent and inserted into slots in the main body of the instrument on the left and right side similarly to a mortise-and-tenon joint. The stacks are wrapped in the middle with nylon string, indicating the intended position of player's hands. This structure allows the instrument to be quickly assembled and disassembled for transportation.

5.2 Data Mapping

The ESP32 micro-controller sends sensor readings to sensor-processing hub via OSC messages for sensor fusion, data processing and mapping. Flex sensors readings are scaled and directly mapped onto the sound parameters of the audio engine in a "one-to-many" configuration. The mapping of flex sensors is not linear and their response curves were tweaked and adjusted to "feel right" rather than following any strict procedure.

Conversely, the environmental data (ground moisture and WiFi signal strength) are processed using Machine Learning (ML) to predict different states according to the previously recorded values, thus retaining "memories" of past performances. In this case, the workflow is similar to Wekinator [20] and the multi-sensor Topics [7] setup was inspired by the Robot Operating System (ROS) framework [8].

Two different machine learning algorithms are implemented and can be chosen for non-time sensitive/time-sensitive situations: Deep Neural Network (DNN) and Long-Short Term Memory (LSTM). For each prediction, a window of an adjustable size of messages is selected and passed into the algorithm. We trained these networks using recordings of past interactions with the instrument.

Finally, the prediction results (along with the raw sensor readings) are parsed as OSC messages and sent (via UDP) to the sound engine running on a local machine for co-located performances or to a remote computer for telematic performances by using a reverse proxy setup.

5.3 Sound Design

The sound design of *zhu nao* was intentionally simplistic. Nonetheless, it resulted in a timbral range that proved to be constrained enough to remain distinct yet varied enough to warrant exploration: from subtle resonant ringing to distorted walls of "runaway" feedback reminiscent of Li Jianhong's electric guitar feedback pieces.

The sound engine was built in *Pure Data*[9]. The core of the sound engine is a twin network of resonant bandpass filters processing white noise. The filtered signal is then fed into the delay line, after which its two outputs are routed back into the filter network. Twisting and flexing the left sensor translates into the Q-value of filters in both networks and the attenuation of the main output: fully bent strip results in the highest amplitude and the most pronounced resonant frequency that gets softer and eventually cuts off as the bamboo strip returns to its original state. The right sensor determines the overall pitch by controlling the cutoff frequency of the filter bank, constrained within the range of approximately two octaves.

The environmental data processed by a neural network is used to modulate the amount of feedback in a delay line shifting the balance between the immediate output of filter banks and full-blown feedback. In this particular case, our use of ML was meant as a reference to the role that memory plays in the practice of environment improvisation. This setup creates a feedback loop between the performer and the past and present environments mediated by the instrument.

6. ZHU NAO ON STAGE

The first author had a chance to perform with *zhu nao* on two occasions: an experimental music festival in Shanghai organized by the China Academy of Art and a telematic performance within the academic context of the authors' home institution.

Generally speaking, the audience of the first event was accustomed to experimental music, while in the latter case the audience consisted of primarily sci-tech students, most of whom were unfamiliar with the field, but knowledgeable in the computational media.

After the concerts we engaged in conversations with the audience who were predominantly Chinese. The material of the instrument itself attracted some attention and generated some discussions, with people commenting on the craftsmanship required to make the instrument and bringing up the "organic" relation between the materials, performing techniques and the sonic output while others commented on the "ritualistic" quality of the setup and presentation. Meanwhile, the link between environmental data, Machine Learning and its influence on the sound remained somewhat ambiguous. Some of the audience members questioned whether there was more "trickery" and automation occurring at the software level.

While we did not record these conversions and thus cannot refer to them as formal sources of validation, these interactions as well as the actual experience of performing with the instrument were integral to our work on the instrument and thus influenced the reflections developed in the following section.

7. DESIGN CONSIDERATIONS: A REFLECTION ON ACTION

We relied on the "reflection on action" approach [57] - which "takes place after the activity and enables the exploration of what happened and why in order to develop questions, ideas and examples about the activities and practices in focus" [**?**] to develop several design reflections based on the experience of designing and performing with *zhu nao*.

In particular, performing with the instrument quickly proved that the relation to environment improvisation through the use of environmental data and ML was rather oblique to the audience and was easily overshadowed by the "stage presence" of the material, thus most of the discussion focused on the role of bamboo. Additionally, while environment improvisation largely determined the design of the interactive schema, it did not pose significant challenges in terms of technical implementation. On the contrary, bamboo required us to develop a new skillset and look into an unfamiliar tradition. For these reasons the considerations that we proposed here mainly revolve around bamboo as a material of DMI craft.

7.1 Crafting Bamboo

[7] `http://wiki.ros.org/Topics`
[8] `https://www.ros.org/`
[9] `https://puredata.info/`

zhu nao contains many elements that bridge artisanal practices with the more conventional DMI design workflow. The choice of material limited the possibilities for digital fabrication, which prompted us to rely on **manual manipulations** instead. For example, using long metal rods to crush the diaphragms inside the bamboo pole and binding the body of the instrument near the cut slots to prevent it from splitting. Interestingly, both of these techniques belong to the arsenal of traditional techniques of luthiers in Asia, for example Chinese bamboo flutes *zhu di* (竹笛) makers. From this perspective, the material possesses a degree of agency, imposing a specific *music-making framework* [4] determining the choice of tools and the margins of interventions. While NIME has been discussed as a form of digital craft [42] and contrasting it to other forms of non-digital craft and lutherie [3], bamboo comes with its own set of perspectives that we outline below.

The element that was already present at the ideation stage but fully manifested itself while traveling and maintaining the instrument was the high workability and inherent **modularity of bamboo** structures. This type of intrinsic modularity essentially predates the modular design approach, often necessitated by mass production, and is closely related to the craft of quickly assembling, extending and dismantling bamboo structures such as scaffolding. Techniques of bamboo scaffolding are still prominent in Hong Kong and China and only require bamboo poles and nylon strings, both of which were used in our design. This aspect of bamboo construction became crucial when faced with the practical issues of transporting and maintaining the instrument: e.g. the flexible parts subjected to mechanical stress are simply inserted into the body of the instrument and, in case of an accident, can be replaced with minimal effort.

As a fast growing plant, bamboo is a sustainable and cheap material, which makes it a valuable asset for DMI crafting, especially in light of the recent discussions of longevity and sustainability in NIME [44][23]. Combined with the aforementioned intrinsic modularity, the use of such materials can extend the lifecycle of an instrument, as its parts can be easily and affordably replaced in case of damage.

Interestingly, the use of bamboo is consistent with ongoing discussion of assemblages in NIME. In line with the Ingoldian proposition of Bowers and colleagues to "follow the materials"as they come together as *things* [10] we attempted to emphasize semi-permanence and "effortlessness" in the way multiple components are assembled in our design. This type of modularity afforded by crafting techniques intrinsic to the material can arguably offer a valuable non-western perspective to NIME practice.

7.2 Bamboo As Storied Material

Bamboo's symbolic dimension plays an important role in the cultural landscape of China. From its associations with the literati culture and numerous mentions in poetry and painting, bamboo has often been portrayed as a subject possessing a degree of agency unfolding in its relations with people [1]. The famed Chinese poet Su Shi suggested that to paint bamboo stalks one must "carry the bamboo in her mind"referring to the ability to render the hidden vitality of a material object in an artwork, which constitutes a mutual becoming: the artist becomes bamboo through internalizing the vital principle of the plant, while bamboo becomes externalized as an artwork [1].

This rich iconicity inscribed in bamboo presents a way of creating a narrative by just using the material and offers new ways of communicating with the audiences. Discussions that we have engaged in while designing and performing with *zhu nao* showed that almost everyone we talked to had something to say about it, commenting on the materials, craftsmanship and presentation. It often served as a source of jokes and puns or as a ground to share personal stories and historical anecdotes. This discursive dimension opened up many layers of the cultural history of bamboo that the authors were initially unfamiliar with.

The fact that musical or cultural ideas are inscribed in instruments is well established in DMI literature but the fact that it can be inscribed in the material itself remains relatively unexplored, with the exception of some works influenced by the media-archeological approach [38, 28]. In contrast, investigations of both physical and conceptual properties of materials are relatively common in practice-led and artistic research [45]. Bringing this sensibility into the design of DMI could be a way of going a layer below the found object approach [14].

8. A REFLECTION ON COSMOTECHNICS

The concept of cosmotechnics presents the multiplicity of culturally specific technical practices as local ways of knowing and being [32]. In Hui's words cosmotechnics proposes a "way to unify moral and cosmic orders through technical activities" by rediscovering technical lineages grounded in specific localities [32]. While Hui tends to emphasize the value of tradition, cosmotechnics cannot be reduced to the caricature of "rejecting modernity and embracing tradition" but rather should be considered as a way of breaking down the myth of technological universalism. As every piece of technology comes inscribed with specific epistemological and cosmological assumptions, for Hui the path to genuine technodiversity begins with addressing these assumptions [30].

While the concept of cosmotechnics on its own does not explicitly present a normative framework or a design methodology, the nature of the material itself and the key references guided us towards this idea in our design reflections. We rely on it as a means of foregrounding a specific sensibility towards creative practice and a way of rethinking the relations between environment, culture and technology. Cosmotechnical thinking extends itself to all of the main references in the design of *zhu nao* from bamboo crafting to contemporary creative practices such as environment improvisation. In this sense, cosmotechnical thought could be considered as the source of relational *consistency* that holds together this specific type of NIME-assemblage (as theorized by Bowers and Haas) [10].

Making musical instruments is one of the oldest crafts known to humanity and, while it could be considered a universal activity—a *technical tendency* in the words of anthropologist André Leroi-Gourhan, the diversity of *technical facts* is precisely where instrument building presents itself as an essentially cosmotechnical activity [5]. Making new instruments (digital, post-digital or otherwise) in the 21st century belongs to this continuum as much as it is a speculation of the possible futures of musicking. Designer's attunement to the locality as a form of knowledge, to the material and conceptual agencies of materials and crafting techniques is therefore required to make sure that these futures are not projected from the outside but grow out of a given environment (material or otherwise) much like bamboo shoots.

This paper presents our attempt to enact this principle in a DMI design. We argue that designing musical instruments aligned with region-specific traditional material cultures and contemporary artistic strategies has a potential to

contribute to the growing vocabulary of NIME design approaches. As a side contribution, the practical experience that we gained while building *zhu nao* has allowed us to distill possible design considerations for future bamboo-based DMIs. Finally, we hope that by incorporating the diversity of cosmotechnics into the NIME ethos, we can contribute a new perspective to the ongoing discourse of decoloniality in the field.

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10. ETHICAL STANDARDS

All photo video and audio documentation was made by the authors, no unauthorized assets were used while working on the projects. All relevant sources were cited. The microcontroller used in the instrument is ESP-32, programmed with open-source Arduino IDE. All sounds were created in freeware Pure Data (vanilla distribution). The instrument was built using renewable materials (locally-sourced bamboo). Electronics and the only 3D-printed part (battery compartment) were transferred to each successive iteration to minimize waste. The instrument uses a single rechargeable Li-Po cell and no disposable batteries were used during the work on the project.

11. REFERENCES

[1] K. Ahn. Becoming bamboo: Reassessing su shi's painting theory from deleuze's angle. *The Philosophical Forum*, 54(3):161–184, 2023.

[2] Z. Argabrite, J. Murphy, S. J. Norman, and D. Carnegie. Technology is land: Strategies towards decolonisation of technology in artmaking. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, The University of Auckland, New Zealand, jun 2022.

[3] J. ARMITAGE, A. McPherson, et al. Crafting digital musical instruments: An exploratory workshop study. 2018.

[4] J. Armitage, F. Morreale, and A. McPherson. The finer the musician, the smaller the details: Nimecraft under the microscope. In *New Interfaces for Musical Expression*, 2017.

[5] F. Audouze. Leroi-gourhan, a philosopher of technique and evolution. *Journal of Archaeological Research*, 10:277–306, 2002.

[6] J. P. M. Avila, J. Tragtenberg, F. Calegario, X. Alarcon, L. P. C. Hinojosa, I. Corintha, T. Dannemann, J. Jaimovich, A. Marquez-Borbon, M. M. Lerner, et al. Being (a) part of nime: Embracing latin american perspectives. In *NIME 2022*. PubPub, 2022.

[7] M. Battier and K. Fields. *Electroacoustic Music in East Asia*. Routledge, 2020.

[8] M. Battier, K. Fields, and A. Y.-L. Liu. Editorial: Chinese electroacoustic music today. *Organised Sound*, 27(3):273–274, 2022.

[9] S. M. A. Bin. Discourse is critical: Towards a collaborative nime history. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, Shanghai, China, June 2021.

[10] J. Bowers and A. Haas. Hybrid resonant assemblages: Rethinking instruments, touch and performance in new interfaces for musical expression. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 7–12, London, United Kingdom, June 2014. Goldsmiths, University of London.

[11] N. Bryan-Kinns and Z. Li. Reimagining: cross-cultural co-creation of a chinese traditional musical instrument with digital technologies. *In NIME' 20*, pages 1–6, 2020.

[12] N. Bryan-Kinns, Z. Li, and X. Sun. On digital platforms and ai for music in the uk and china. In *International Conference on New Interfaces for Musical Expression (NIME), Birmingham, UK*, 2020.

[13] V. L. Conn and G. de Seta. Sinofuturism(s). *Verge: Studies in Global Asias*, 7(2):74–99, Sept. 2021.

[14] P. R. Cook. Principles for designing computer music controllers. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 3–6, Seattle, WA, 2001.

[15] A. P. De Ritis. Mixed Blood and Aesthetic Evolution in China' s Electroacoustic Music Today. *Organised Sound*, 27(3):307–315, 2022.

[16] G. De Seta. Sinofuturism as inverse orientalism: China' s future and the denial of coevalness. *SFRA Review*, 50(2-3):86–94, 2020.

[17] S. Emmerson. *The Routledge research companion to electronic music: Reaching out with technology*. Routledge, 2018.

[18] K. Eshun. Further considerations of afrofuturism. *CR: The New Centennial Review*, 3(2):287–302, 2003.

[19] K. Eshun. *Kodwo Eshun: More Brilliant than the Sun: Adventures in Sonic Fiction*. Verso, 2018.

[20] R. Fiebrink and P. R. Cook. The wekinator: a system for real-time, interactive machine learning in music. In *Proceedings of The Eleventh International Society for Music Information Retrieval Conference (ISMIR 2010)(Utrecht)*, volume 3, pages 2–1. Citeseer, 2010.

[21] R. Fiebrink, D. Trueman, C. Britt, M. Nagai, K. Kaczmarek, M. Early, M. Daniel, A. Hege, and P. Cook. Toward understanding human-computer interaction in composing the instrument. 03 2012.

[22] T. C. Grame. Bamboo and music: A new approach to organology. *Ethnomusicology*, 6(1):8–14, 1962.

[23] S. Harrison, D. Tatar, and P. Sengers. The three paradigms of hci. 01 2007.

[24] A. Hatakeyama. — kubomi. In *NIME 2022*, jun 22 2022. https://nime.pubpub.org/pub/bnbb91b0.

[25] C. Herold. China's sonic fictions: Music, technology, and the phantasma of a sinicized future. 08 2020.

[26] L. P. C. Hinojosa. Kanchay_yupana: Tangible rhythm sequencer inspired by ancestral andean technologies. In *NIME 2022*. PubPub, 2022.

[27] E. Ho, A. de Campo, and H. Hoelzl. The slowqin: An interdisciplinary approach to reinventing the guqin. In *NIME*, pages 256–259, 2019.

[28] D. Holzer, H. Frisk, and A. Holzapfel. Sounds of futures passed: Media archaeology and design fiction as nime methodologies. In *NIME 2021*. PubPub, 2021.

[29] J. Huang. Phonographing borders: Writing acoustic territories in sinophone sound art. *ASAP/Journal*, 7(1):61–83, Jan. 2022.

[30] Y. Hui. *The question concerning technology in China: An essay in cosmotechnics*, volume 3. mit Press, 2019.

[31] Y. Hui. *Recursivity and contingency*. Rowman & Littlefield, 2019.

[32] Y. Hui. *Art and cosmotechnics*. U of Minnesota Press, 2021.

[33] W. Jing. Electroacoustic improvisation and life nourishment. *Organised Sound*, 27(3):379–386, 2022.

[34] A. Kapur, E. Singer, M. S. Benning, G. Tzanetakis, and T. Trimpin. Integrating hyperinstruments , musical robots & machine musicianship for north Indian classical music. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 238–241, New York City, NY, United States, 2007.

[35] N. Land. *Fanged noumena: Collected writings 1987-2007*. MIT Press, 2011.

[36] L. Landy. Cultural retention in contemporary chinese electroacoustic music. *The Routledge Research Companion to Electronic Music: Reaching out with Technology*, page 77, 2018.

[37] S. Y. Lazem, D. Giglitto, M. S. Nkwo, H. Mthoko, J. Upani, and A. N. Peters. Challenges and paradoxes in decolonising hci: A critical discussion. *Computer Supported Cooperative Work (CSCW)*, 31:159 – 196, 2021.

[38] G. Lepri and A. P. McPherson. Mirroring the past, from typewriting to interactive art: an approach to the re-design of a vintage technology. In T. M. Luke Dahl, Douglas Bowman, editor, *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 328–333, Blacksburg, Virginia, USA, June 2018. Virginia Tech.

[39] M. M. Lerner. Latin american nimes: Electronic musical instruments and experimental sound devices in the twentieth century. In *NIME*, pages 228–233, 2019.

[40] S. Lindtner. Hacking with chinese characteristics: The promises of the maker movement against china' s manufacturing culture. *Science, Technology, & Human Values*, 40(5):854–879, 2015.

[41] M. Lu. The cogito and onto-being of the mind. *Philosophy East and West*, 69(1):176–196, 2019.

[42] A. McPherson, J. ARMITAGE, S. BIN, F. Morreale, R. Jack, et al. Nimecraft workshop: Exploring the subtleties of digital lutherie. 2017.

[43] F. Morreale, S. M. A. Bin, A. McPherson, P. Stapleton, and M. Wanderley. A nime of the times: Developing an outward-looking political agenda for this community. In R. Michon and F. Schroeder, editors, *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 160–165, Birmingham, UK, July 2020. Birmingham City University.

[44] F. Morreale and A. Mcpherson. Design for longevity: Ongoing use of instruments from nime 2010-14. 05 2017.

[45] N. Nimkulrat. Paperness : expressive material in textile art from an artist's viewpoint. 2009.

[46] L. Pardue and S. M. A. Bin. The other hegemony: Effects of software development culture on music software, and what we can do about it. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, The University of Auckland, New Zealand, jun 2022.

[47] Z. Qian. Compositional techniques and sound spatialisation in shanghai-based electronic music since 2000. *Organised Sound*, 27(3):294–306, 2022.

[48] K. Ruitenbeek. Craft and ritual in traditional chinese carpentry: With a bibliographical note on the" lu ban jing". *Chinese Science*, 7:1–23, 1986.

[49] E. W. Said. *Orientalism*. Penguin Classics, London, England, 2003.

[50] E. Sanderson. *An Underground Music Venue in Beijing: fRUITYSPACE*, pages 205–223. 03 2021.

[51] D. Schäfer. *The crafting of the 10,000 things: knowledge and technology in seventeenth-century China*. University of Chicago Press, 2019.

[52] G. D. Seta. The noise connection: Experimental music in china as a networked subculture, 2012.

[53] E. L. Shaughnessy. Philosophy or bamboo: The reading and writing of warring states manuscripts, 2012.

[54] P. Stapleton and T. Davis. Ambiguous devices: Improvisation, agency, touch and feedthrough in distributed music performance. *Organised Sound*, 26(1):52–64, 2021.

[55] W. W. Tang, S. C. Chan, G. Ngai, and H. V. Leong. Computer assisted melo-rhythmic generation of traditional chinese music from ink brush calligraphy. In *NIME*, pages 84–89, 2013.

[56] J. Tragtenberg, G. Albuquerque, and F. Calegario. Gambiarra and techno-vernacular creativity in nime research. In *NIME 2021*. PubPub, 2021.

[57] W. Visser. Schön: Design as a reflective practice. *Collection*, (2):21–25, 2010.

[58] J. Wang. Shanshui-thought in experimental music practices: China and beyond. *Organised Sound*, 25(3):292–301, 2020.

[59] J. Wang. *Half Sound, Half Philosophy: Aesthetics, Politics, and History of China's Sound Art*. Bloomsbury Publishing USA, 2021.

[60] D. WATERS. The craft of the bamboo scaffolder. *Journal of the Hong Kong Branch of the Royal Asiatic Society*, 37:19–38, 1998.

[61] J. Wenren. *Ancient Chinese Encyclopedia of Technology: Translation and Annotation of Kaogong ji, The Artificers' Record*. Routledge, 2014.

[62] J. Wu, Y. Yeh, R. Michon, N. Weitzner, J. Abel, and M. Wright. Tibetan singing prayer wheel: A hybrid musical- spiritual instrument using gestural control. In E. Berdahl and J. Allison, editors, *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 91–94, Baton Rouge, Louisiana, USA, May 2015. Louisiana State University.

[63] J. C. Wu. Today and yesterday: Two case studies of china's nime community. In *NIME 2022*. PubPub, 2022.

[64] Z. Xiaoyu and S. Zhenwei. Alternative approaches to chinese imagery: Audiovisual aesthetics in a reflection in the brook. *Organised Sound*, 27(3):358–368, 2022.

[65] W. Xinyu and H. Ting. A symphony of sound images: Spatial composition strategies in zhang xiaofu' s yarlung zangbo. *Organised Sound*, 27(3):346–357, 2022.

[66] D. Young and I. Fujinaga. Aobachi: A new interface for Japanese drumming. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 23–26, Hamamatsu, Japan, 2004.

[67] G. Zhang. Sino-no-futurism. *Verge: Studies in Global Asias*, 7(2):92–99, Sept. 2021.

[68] X. Zhang. The power of arterial language in

constructing a musical vocabulary of one' s own: Inheriting the inspiration and gene of innovation in electroacoustic music from chinese culture. *Contemporary music review*, 37(1-2):126–134, 2018.

[69] B. Zimmermann. *Waves and forms: electronic music devices and computer encodings in China*. MIT Press, 2015.