Kūkū

A re-imagined fangufangu developed through a Kakala Design Framework

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“Think of your Ancestors because you are living the future that they dreamed for you”

—Kimberley Moulton (2020)

This thesis is dedicated to my grandparents, Tevita and Sesa Kaulamatoa, to whom I owe deep gratitude for grounding me in the values of my Tongan heritage, for encouraging me to take on opportunities they didn’t have the privilege of, and for always having faith in me. As two esteemed educators, I am grateful for all they have taught me. It is in their honour that I write this thesis.

I. Abstract

The fangufangu (nose flute) is a Tongan musical instrument that traces back hundreds of years. Each fangufangu possesses unique physical characteristics, contributing to its distinct sound. Highlighting its historical and cultural significance, one customary use was awakening nobility from slumber. Although rare today, practices of making and performing the fangufangu have been revitalized by Tongan communities in recent years. However, there is limited research on the fangufangu, particularly from a Tongan perspective. This practice-led creative research develops and applies a Kakala Design Framework to holistically and collaboratively explore possibilities of the fangufangu for modern musicians of the Tongan diaspora.

The culmination of this research is embodied in Kūkū, a re-imagined fangufangu that enhances specific musical, tangible and visual aesthetics by harmoniously weaving notions of past, present and future. Through an analogue approach to instrument design, primary elements of form and material contribute towards improving instrument playability and expanding sonic versatility. This accommodates use across diverse musical environments and individual playing styles. Guided by an Indigenised industrial design process predicated on Tongan worldviews and values, this exegesis reflects on the collaborative development of Kūkū with Tongan fangufangu practitioners.

Keywords: Fangufangu, Musical Instrument Design, Kakala Design Framework

II. Practice-led Documentation

This doctoral thesis is practice-based and formed in three parts: written exegesis, practice-led research, and the presentation of the research to the examination panel. A link to the practice-led documentation can be found here:
https://www.youtube.com/playlist?list=PLQuCD9ruWaVmL_zVNGzCqdz6J24DFRO04

This documentation showcases various prototypes which were integral to the initial inquiry and design development process, including footage from participant product concept evaluation at significant design milestones. Videos are ordered sequentially, and titled in reference to the corresponding exegesis chapter.

III. Acknowledgements

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IV. Preface

From a young age, I have felt blessed to be able to explore and pursue all of my passions. It is only by reflecting on my childhood and the upbringing afforded to me by my parents, that I realize the great privilege I have been given as a first-generation Tongan-European woman born in Aotearoa.

My mother, born and raised in Tonga – hailing from the villages of Niutoua, Tongatapu and Ta'anea, Vava'u – moved here at eighteen years old in search of better opportunities. My father, born in England – Bury St. Edmunds – was raised in Auckland from the age of four. Both my parents provided me and my siblings with many opportunities which they themselves did not have. It is to them, first and foremost, that I owe my deepest gratitude.

Alongside my parents, my grandparents played a significant role in my upbringing. They moved to Aotearoa after over thirty years of teaching as headmasters in Niutoua, Tonga. I am forever grateful to them for passing on their passion for education and instilling in me the values and knowledge of my Tongan heritage and ancestors.

Much of what I know, particularly regarding my Tongan heritage, has been passed down to me, often informally, by my parents, grandparents and Tongan family who I grew up closely with. In particular, I am grateful for being introduced to various customary art forms, which fueled my creative curiosity early on in life and have deeply inspired my practice as a designer today.

Alongside design, music has always been another passion of mine. Growing up, music was everywhere – at church, at home, at school – and I was fortunate to learn various instruments. My main instrument was the violin, and I performed in several orchestras and bands until my early twenties. However, during my time in secondary school, there was a noticeable gap in the education system, which only offered the learning of Western music and instruments. It was through my family and community that I learnt about Tongan music. Despite being familiar with certain Tongan musical instruments from a sonic perspective, I felt disconnected from these instruments, as they were physically absent from my family and community. This disconnect sparked a desire to bridge the gap and connect further with my Tongan heritage through music.

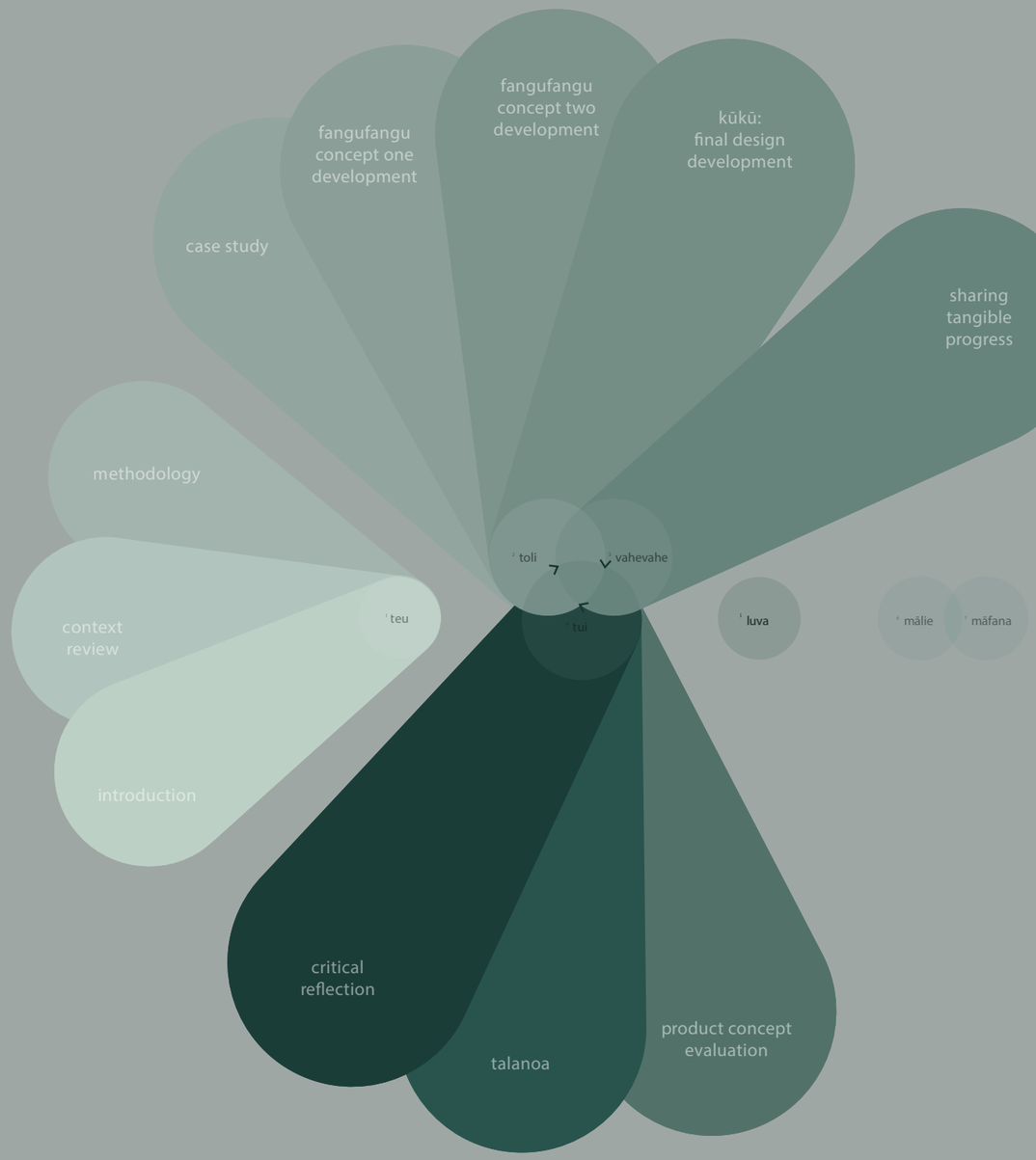
After studying industrial design at university for several years, I realized the potential to weave my passions for design and music with my Tongan heritage through musical instrument design. These connections shaped my final honours project, which allowed me to connect, reclaim and explore how customary forms of musical expression could be re-imagined for modern contexts of the Tongan diaspora. The outcome of this project was Patō, an electronic and tunable lali (log drum) for contemporary musicians.

After university, my professional experience came through working at a furniture design studio developing high performance task chairs for global markets. Although this enabled me to grow a specialized skill set and provided invaluable opportunities, it did not allow me to explore my true passion for culturally-centered and value-driven design. I wanted the opportunity to be unapologetically myself, and would often dream of how industrial design practice could be informed in both process and outcome by my own cultural values and worldview. This inspired my decision to return to university to pursue a practice-led doctoral degree in industrial design.

Today, I am motivated by not only wanting to explore aspects of my Tongan heritage through design, but also by the desire to contribute to preserving elements of Tongan culture. I dream that future generations will have access to the customary practices and knowledge that I, and many others, did not have the privilege of growing up with.

I hope this thesis contributes to realizing these dreams.

research through design and practice



building the foundation

dissemination and evaluation

experience testing and critical reflection

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V. Glossary

Tongan

Anga fakatonga Tongan culture/way of living/worldviews

Fafangu To awaken/to arouse

Faiva Song/to sing

Faka'apa'apa Respect

Fakahēhē Ornamentation
Aesthetic technique of Tongan music

Faka'ofa'ofa Beauty

Fakatōkilalo Humility

Fangu To blow through the nose

Fangufangu Nose flute

Fasi Melody

Feveitokai'aki Mutual care and generosity

Hikihikikī Ascending or descending of key
Aesthetic technique of Tongan music

Hikihikitā Ascending or descending of time/tempo
Aesthetic technique of Tongan music

Hikihikitō Ascending or descending of pitch
Aesthetic technique of Tongan music

Hiva Performance/to perform

Kakala A collection of fragrant flowers woven into a garland for a special occasion or person
Within Konai Helu Thaman's Kakala Research Framework 'Kakala' forms the research contribution(s)

Kofe Bamboo

Kūkū The coo of the kulukulu

Kulukulu Small blue/green dove

Luva A gift from the heart
Within Konai Helu Thaman's Kakala Research Framework 'Luva' is the final dissemination of the research outcome

Māfana Warmth/something heartfelt
Within Konai Helu Thaman's Kakala Research Framework 'Māfana' Final evaluation and transformation of the research

Mālie Beauty/to express appreciation
Within Konai Helu Thaman's Kakala Research Framework 'Mālie' is the initial evaluation of the research outcome

Me'a ifi Blown musical instruments

Ngaohi To make/construct/build

'Ofa Love/compassion

Ofe'i/Pikopiko'i The curving or bending of sound
Aesthetic technique of fangufangu performance (and broader continuity of sound within Tongan music)

Talanoa To talk (in an informal way), to tell stories or relate experiences

Tauēlangi Reaching the sky/climactic elation
Aesthetic value of Tongan performance

Tauhi vā Nurturing/maintaining loving relationships

Teu Preparation
Within Konai Helu Thaman's Kakala Research Framework 'Teu' is the initial phase of conceptualisation and preparation

Teuteu Decoration/ornamentation

Toli To pick a flower or choose an object
Within Konai Helu Thaman's Kakala Research Framework 'Toli' defines the research opportunity

Tū Tongan ground dove

Tūfunga Skilled craftsman/beating the form or surface

Tui To string/weave a garland
Within Konai Helu Thaman's Kakala Research Framework 'Tui' includes data analysis

Tukipotu Fangufangu composition

Vahevahe To share
Within the Kakala Design Framework 'Vahevahe' is the sharing/ celebration of collective progress with participants

Vela Fieriness
Aesthetic Value of Tongan peformance

V. Glossary

Music and Design

Amplitude Strength of a sound wave to which we perceive as loudness or volume

Blowing Hole An opening where nasal airflow is projected for the instrument to sound

CAD Computer-aided Design

Embouchure While this typically refers to the mouth, in this case it is specifically associated to nasal manipulation and positioning to control characteristics of sound

Finger Hole A hole in the instrument which can be left open or closed to alter the pitch

Fundamental Frequency (First Harmonic) The lowest perceptible tone of a musical pitch

Harmonic A frequency that is an integer multiple of the fundamental frequency

Overtone A higher tone produced simultaneously with the fundamental frequency. This is not necessarily an integer multiple of the fundamental frequency, however, it can be. All harmonics are overtones but not all overtones are harmonics

Pitch The frequency of a sound

Reconstruction A copy of an original artefact or a reparation of the original artefact

Scale Any set of musical notes ordered by fundamental frequency

SLA Stereolithography, a resin 3D printing technique known for its high-accuracy, isotropic, and water-tight print(s)

Spectrogram A detailed visual view of audio which represents time, frequency, amplitude and timbre in a single graph

Staccato A playing technique where notes are articulated in a short and disjointed manner

Sub-Harmonic A frequency that is a fraction of a fundamental frequency

Timbre The quality/characteristics of sound

Tonewood Specific wood varieties used for woodwind or acoustic stringed instruments

Tremolo The rapid reiteration of a musical tone or of alternating tones to produce a wavering effect

Vibrato A rapid slight variation in pitch

“I hope this generation does not take us back to traditional music, but brings traditional music to the future”

— Kelepi Tapa’atu (2023)

1. Introduction

Music is central to Tongan culture, providing a powerful form of creative expression. Customary Tongan musical instruments contribute significantly to both the musical landscape and the wider cultural context: not only are they a means to create music, but they are also used for communicating, signalling and storytelling (Diettrich et al., 2011; Moyle, 1990). These practices are ways of preserving history, and so, are fundamental in the current and future transmission of Tongan culture.

Since the arrival of missionaries in Tonga during the nineteenth century, the prominence of customary musical instruments, alongside other customary art forms, has rapidly declined, in both Tonga and across the Tongan diaspora [1](whose population is larger than Tonga's[2]). While this can be attributed to several factors, it appears this decline is predominantly a result of European influence and the introduction of alternative musical instruments. Moyle (1976; 1990) claims the disappearance of the fangufangu (nose flute) was largely due to the introduction of instruments offering more tonal variety, such as the guitar and ukulele. Consequently, the limited knowledge and practice of customary musical instruments within Tongan society has had a wide-ranging impact. My own experience as an Aotearoa-born Tongan, alongside the experiences of many in the wider Tongan community, suggest that a large proportion of Tongans – particularly younger generations and those across the diaspora – remain unaware of the existence of customary musical instruments and their diverse forms and variations.

In recent decades, the ongoing revival of customary Tongan musical instruments, particularly in Aotearoa, has contributed towards a significant growth of knowledge in regard to both customary and contemporary practices of instrument production and performance. Not only have these practices expanded and pushed the boundaries of aesthetics, materiality, knowledge acquisition, generation, and transmission; they have ignited curiosity into aspects of culture that have previously been overlooked. This has sparked new perspectives on how the practices of production and performance can be made more accessible, and relevant, within modern Tongan societies.

Various instruments have been at the forefront of these recent enquiries, however, inquiry into the fangufangu remains comparatively slim. Although recent literature has provided insights into the fangufangu in late 20th century Tonga, academic discourses surrounding practices of the Tongan diaspora are limited. Considering the growing interest and use of the fangufangu – primarily by Tongan scholars and practitioners across Moana Oceania[3] – the opportunity to investigate the evolving use of the fangufangu from a modern diasporic context is pertinent. Further, Moyle (1990) suggests that reconstructing 18th and 19th century artefacts can provide further insights into fangufangu tunings. While he has documented tunings of various fangufangu specimens within and outside of museum collections, the growth of acquired 18th and 19th century fangufangu artefacts within these spaces offers a valuable resource for tangible engagement beyond the literature.

The motivation for this research is not solely academic, but in pursuit of widening the cultural understanding of the fangufangu. Additionally, given my background as an industrial designer and recognising Tonga's rich design history, I am motivated both personally and professionally to explore and express my cultural heritage within a modern creative context. This desire to reconnect with ancestral cultural heritage and knowledge is shared by many across the Tongan diaspora. Therefore, given the context under which this research unfolds, this thesis focuses specifically on exploring possibilities of the fangufangu for modern musicians of the Tongan diaspora. However, it is likely that this work may also be of value to those born and raised in Tonga.

1 People of Tongan heritage living outside of Tonga

2 The most recent census figures available for Tongan populations in Tonga, New Zealand, the U.S. and the Australia respectively are 98,574 (Tonga Statistics Department, 2021), 82,389 (Statistics New Zealand, 2018); 67,221 (US Census Bureau, 2019); 55,730 (Australian Bureau of Statistics, 2021)

3 The term 'Moana Oceania' is used instead of the term 'Pacific' to give power and importance to Indigenous languages and perspectives, as the latter term is considered problematic and imposed. 'Moana Oceania' represents worldviews that are deeply linked to Aotearoa, New Zealand, but its origins can be traced back to the wider Moana Oceania region. Though Moana Oceania is my preferred term, at times throughout this thesis I use 'Pacific' but this is in reference to existing literature or technical terms (i.e. timber).

1.2 Towards an Indigenised Design Practice

The emergence of Industrial Design in the early 20th century stemmed from the growth of the Industrial Revolution – a period marked by groundbreaking technological advancements that transformed possibilities in product design and manufacturing. While these advancements enhanced design processes generally, it is important to recognise that the theoretical and methodological foundations underlying these practices have been predominantly informed by European design movements and worldviews. Moreover, the consequent and rampant effects of consumerism continue to have significant impacts on Indigenous communities. Not only do the principles of design for mass production contradict many Indigenous cultural values, but as Diehl (2006) highlights, the uniformity of such products contributes to the lack of diversity and ethnic-cultural design practice, through both process and outcome. As a result, the dominant influence and perpetuation of broader Western perspectives continue to shape the realm of design today, informing understandings of what design is, how objects are designed, and notions of successful design.

Conversely, non-Western perspectives and voices are often marginalised, underrepresented, and overlooked. This lack of diversity has shaped design education and pedagogy, where values of Indigenous peoples are so often oppressed. I was once told that “Pacific design is not good design”. Given the centrality of many artforms, including design, within all Pacific cultures, I knew this comment likely came from a place of ignorance. Regardless, it was a brutal reminder of the biases that pervade, and the lack of awareness that not only is design practised by all cultures, but it may exist in different forms and be experienced in different ways. Design exudes various meanings, representations, and interpretations that are shaped by unique perspectives and contexts. Measures of what defines “good design” are subjective and vary depending on the nature of the work, both in its process and outcome. To compare perspectives of “good design” requires reflection on differences in cultural values and experiences.

Anthropologist Arturo Escobar (2018) introduces the concept of ‘the pluriverse’, highlighting the coexistence of multiple worlds, realities, and ways of being. He challenges dominant worldviews and the concept of universal design, advocating for the inclusion of Indigenous and diverse knowledge systems. It is necessary to acknowledge and challenge biases to foster more inclusive and diverse practices that embrace the richness and plurality of design beyond a Western lens. By doing so, we can cultivate more equitable and impactful design practices.

Within Indigenous research, various culturally grounded methodologies have emerged in recent years, many inspired by Māori academic Linda Tuhiwai-Smith’s (1999) groundbreaking ‘Decolonizing Methodologies: Research and Indigenous peoples’. Tuhiwai-Smith emphasizes the importance of challenging Western approaches to research and guiding research with Indigenous peoples and cultural values, and re-shaping how Indigenous research is undertaken. These Indigenous methodologies such as the ‘Talanoa Methodology’ (Vaioleti, 2006) and the ‘Vanua Research Framework’ (Nabobo-Baba, 2011) have sparked transformative shifts in how researchers guide and engage with their work. While these accommodate both Pan – Pacific methodologies (Amituanai-Toloa, 2009; Bennett et al., 2013) and ethnic – specific methodologies (Vaioleti, 2006; Prescott, 2008; Nabobo-Baba, 2011; Otunuku, 2011; Suaalii-Sauni & Fulu-Aiolupotea, 2014) there has been little focus on how these can be adapted for use within design practices. With this in mind, this thesis proposes and demonstrates an approach towards an Indigenous design practice specific to Tongan peoples.

1.3 Methodology

This thesis explores how the Kakala Framework, originally developed by Konai Helu Thaman (1997), can be tailored specifically to guide practice-based research in industrial design. A representation of the Tongan process of garland-making, the Kakala Framework is rooted in Tongan philosophy, values and principles of reciprocity, sharing, respect and collectivism. Despite its wide use across the areas of health, education, and social sciences, its application within creative practice is limited. To my knowledge, the only person who has used this framework within creative-led doctoral research is Talita Kiume Toluta’u (2014). Consequently, the development and application of a Kakala Design Framework is demonstrated in this thesis. This developed framework provides a culturally grounded approach to engaging with Tongan participants while also employing certain Tongan-specific and design-specific methods to inform, develop, and present progressive design development. This included using talanoa as a form of Tongan narrative inquiry and the prototyping strategy, as outlined by Karl Ulrich and Steven Eppinger (1995), for four primary purposes: learning, communication, integration, and milestones. Furthermore, model-making through various modes of analogue and digital manufacturing was used, in addition to observation of instrument interaction, alongside sonic visualisation as a method for sound analysis and reflection.

1.4 Research Context

Much can be learned from customary musical instruments, particularly with regards to developing present and future traditions for musical practice. Considering this, the main objective of this practice-based thesis focusses on how design can guide the exploration of the fangufangu for musicians of the Tongan diaspora through creative-led design practice. This thesis explores the revival[4] of the fangufangu at the intersection of cultural preservation and creative practice. By adopting a holistic approach to identify and understand existing knowledge beyond that solely in written literature, these insights have garnered a current understanding of fangufangu practices, informing the re-imagining of the fangufangu through design practice. Despite my formal education and professional experience in industrial design, it is important to note that the tangible design outcome of this research has not been developed or intended for the purpose of commercialisation or mass production. Instead, this practice is value driven, drawing from elements of design to assist in the generation of new scholarship – this will be discussed further in *Chapter 3*. The final design outcome is a re-imagined fangufangu, entitled Kūkū. While this thesis presents a single instrument, upon dissemination of the research, Kūkū will be handcrafted for each research participant. This is reflective of luva, a gift that is given with heartfelt sincerity, humility, and honour; a process of returning the gift of knowledge to those who have so generously contributed to the project.

1.5 Researcher Positionality

As a design researcher and practitioner who navigates the intersection of two distinct cultural heritages, my positionality is shaped by these influences in the context of Aotearoa, the land that I have been privileged to live and reside in for my whole life. Born to a Tongan mother and British father, my positionality is not mutually exclusive of either insider or outsider, rather, I navigate the relational space between. The space between allows for fluidity throughout the research process, which is inherently influenced by both the researcher and its participants. Fluidity is necessary as it allows the opportunity to come to terms with one's position once one has been immersed within a particular environment. However, it is important to acknowledge that my upbringing in Aotearoa was guided by Anga Fakatonga (the Tongan way) within my kainga (family) and wider community. Growing up, I was instilled with a deep appreciation for the customs, language, worldviews and values specific to my Tongan roots. Although I was exposed to Western cultural influences, particularly within my formal education in Aotearoa, the dominant influence of my Tongan heritage has and continues to guide my professional and personal life. This cultural positionality has shaped the research methodology for this research. While I share Tongan heritage and cultural values with the participants of this research, I acknowledge my limited knowledge of the fangufangu prior to starting this study. Thus, I came in as a learner, and as an outsider to the established community of fangufangu practitioners.

4 By using the term 'revival' I embrace all elements of cultural production, past and present, which in recent years have been the subject of both academic and community efforts

1.6 Research Objectives and Questions

Positioned as a creative and practice-led inquiry, this thesis asks:

How can design assist with exploring musical possibilities of the fangufangu for modern musicians of the Tongan diaspora?

To guide this inquiry, the following objectives and their corresponding questions are outlined as follows:

Questions

1. **How can the Kakala Framework be adapted for specific use in industrial design?**

2. **How can design assist with yielding further knowledge in respect to fangufangu construction, sonic characteristics and playability of customary artefacts within museum archives?**

3. **In what ways or contexts is the fangufangu used today; and how can these inform opportunities for design development?**

4. **How can the fangufangu be explored to reflect influences and experiences of the Tongan diaspora?**

Objectives

1. **Develop and employ a Tongan-centred framework to accommodate specific use within industrial design practice.**

2. **Foster an understanding for how the fangufangu has evolved, and how it can be further explored to support use within modern musical contexts.**

3. **Gain an understanding of customary and contemporary fangufangu crafting processes, and performance, by engaging with Tongan fangufangu practitioners.**

4. **Design and handcraft a fangufangu that thoughtfully considers aspects of materiality, versatility, playability, and cultural values within diasporic contexts.**

1.7 Chapter Summaries

This exegesis structure is made up of eight chapters. *Chapter 1* has introduced the research context, objectives and questions shaping the study. It discussed the impact of industrial design on Indigenous peoples, emphasizing the need to re-align towards Indigenised practices for specific cultural contexts. Further, it outlined the methodology, researcher positionality, and chapter summaries.

A brief summary for the subsequent chapters is provided below:

2. Context Review

Chapter 2 starts with a brief summary on the initial research of this study and describes how the fangufangu became the focus. More importantly, it provides an overview of the fangufangu from its origins through to the present day by adopting a holistic approach to gathering knowledge. Drawing from written literature, oral knowledge systems, museum archives, and inquiry through practice, this chapter offers insights into both customary and contemporary approaches to making and performance.

3. Methodology

Chapter 3 outlines the research design underpinning the study. It introduces the Kakala Framework (Thaman, 1997) guided by Anga Fakatonga (the Tongan way) as a culturally grounded approach for research with Tongan participants. The opportunity to develop this framework for specific use in industrial design is discussed, resulting in the proposal of a Kakala Design Framework to inform the practice-led research inquiry. Methods used within this framework are also discussed, including talanoa (Vaioleti, 2006), prototyping and modelling strategy (Ulrich and Eppinger, 1995), and artefact reconstruction.

4. Fangufangu Case Study

Chapter 4 focuses on a specific fangufangu artefact within Te Papa's Pacific Collection. Through artefact reconstruction, insights into the instrument's construction, playability, and sonic characteristics are provided. This chapter seeks to offer further knowledge of the fangufangu within museum collections, and to build the foundation for practice-led design research.

5. Fangufangu Concept One

Chapter 5 initiates the practice-led design inquiry with participants. The chapter identifies the core values which underpin the practice-led research, outlining how they have informed the initial design milestone. It presents a refined set of objectives and criteria for the design cycle, shaped by insights gained from initial talanoa. Additionally, it provides documentation of the design development, product concept evaluation, and the collective critical reflection with participants.

6. Fangufangu Concept Two

Chapter 6 builds upon the insights from *Chapter 5*, advancing to the second phase of product development and refinement. It details how the refined objectives and criteria have guided this phase, showcasing the evolution of the design with additional customizable components. The chapter includes an in-depth look at the second phase of product concept evaluation, along with documentation of the ongoing design development and collective critical reflection with participants.

7. Kūkū: A re-imagined Fangufangu

Chapter 7 introduces Kūkū, the final design concept of this practice-led research. It outlines the refined design features of this handcrafted instrument, showing how they respond the overarching research question. The chapter also explores how Kūkū contributes to the soundscapes of modern music by adapting to diverse musical environments and playing styles. Additionally, it discusses how the design reflects the principles of the Kakala Design Framework, blending traditional and contemporary elements through an iterative and collaborative development process.

8. Conclusion

Chapter 8 reflects on the development of Kūkū through the Kakala Design Framework. It provides a breakdown of the research contributions and identifies potential opportunities for further exploration beyond the study's scope. The chapter also describes the process of disseminating the research findings to participants and concludes with a brief personal reflection on the journey.

Preliminary Research

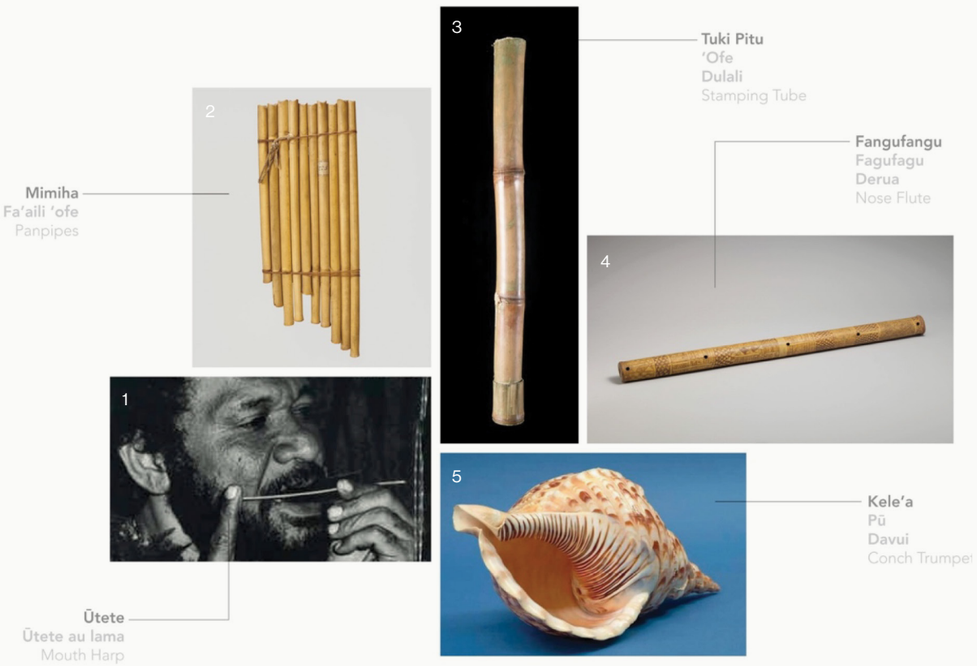


Fig. 1—5. A collectionof customary musical instruments shared across Fiji, Samoa, Tonga (and beyond).

The research focus stemmed from an initial exploration of customary musical instruments across Fiji, Samoa and Tonga. This primarily included the fangufangu (nose flute), kele'a (conch trumpet), mimiha (panpipes), tuki pitu (staping tube), and ūtete (mouth harp). This broad investigation was due to the mutuality of these instruments across this region and the desire to gain a deeper understanding of the similarities and differences of such instruments before situating the research. Initial investigation included both primary and secondary research. More significantly, this involved the practice of making certain instruments and learning how to play them. After a year of exploration, I gravitated towards further study of the Tongan fangufangu as one of few customary melodic instruments in Tonga. Appendix I includes four (of twenty) short case studies for some of these instruments. The rest of this chapter, however, is solely focussed on the fangufangu.

2. Context Review

Introduction

The fangufangu is a customary Tongan musical instrument that holds significant historical and cultural value. Academic scholarship of the fangufangu has predominantly been undertaken by European academics before the 21st century who have addressed the general construction of fangufangu, tunings, and its use concerning its cultural context in Tonga. To date, there has been no academic scholarship focussed on how fangufangu practices have evolved, particularly across the diaspora. Furthermore, no practice-based research has addressed how design can contribute towards knowledge generation, transmission, and new perspectives of fangufangu making and playing.

The purpose of this context review is to provide an understanding of the fangufangu as we know it, from its early documentation in Tonga to its most recent practices across the diaspora. While there are only a handful of fangufangu practitioners today, its recent revival has continued to preserve aspects of this art form. In recent years, there has been a growing movement towards reviving Tongan customary musical instruments in Aotearoa. These efforts have drawn upon oral traditions, community efforts, and the knowledge of Indigenous scholars and practitioners. These sources provide valuable insights into the past and present practices of Tongan musical instruments.

This chapter will overview the fangufangu from its origins through to the present day. By adopting a holistic approach to gathering knowledge, this chapter draws from written literature, museum archives, and primary research with Tongan practitioners and scholars. Recognising the importance of expertise and oral traditions beyond written literature is particularly vital for topics like this, for which limited published information exists. More importantly, acknowledging the critical role that Indigenous knowledge systems offer is crucial for developing a more comprehensive understanding of any Indigenous subject and practice.

2.1 Previous Research

Over the last six decades, written literature on customary Tongan music and instruments, including the fangufangu, has been enhanced by contributions from three primary academics: Adrienne Kaeppler, Richard Moyle, and Hūfanga-He-Ako-Moe-Lotu ‘Ōkusitino Māhina.

Kaeppler, an American anthropologist, conducted extensive research in Tonga in 1966, studying dance, music and visual arts (1974; 1978; 2019). Her research focussed on the interrelationships of these creative outlets within Tongan social structures. Though her documentation of the fangufangu is limited, she provided insights into how the fangufangu was used within broader Tongan music and its role in society.

Moyle, an ethnomusicologist from New Zealand, undertook years of research in Tonga between 1973–1976, studying customary music and instruments, including the fangufangu (1976; 1987). He offered detailed insights into its unique characteristics, use, and tunings. Further, he provided an understanding of wider Tongan musical aesthetics – while not specific to the fangufangu, this has been particularly influential in the development of new scholarship within this practice-led inquiry.

Māhina, a Tongan social anthropologist and artist, provided valuable insights into the fangufangu from an Indigenous perspective (1984), within and beyond[5] the literature. One significant contribution from Māhina (Maiava, 2021) is his definition of the three primary arts[6] involved with fangufangu construction and performance, including: the material arts of ‘tūfunga ngaohi fangufangu’ (nose flute making) and ‘tūfunga teuteu fangufangu’ (nose flute decoration); and the performance art of ‘faiva tā fangufangu’ (nose flute playing).

Beyond written literature, it is important to also recognise other Tongan practitioners (artists and musicians) and their contributions towards knowledge preservation, generation, and transmission of the fangufangu. While this context review references the literature, it is important to acknowledge my ongoing contextual learning of the fangufangu through engagement with Tongan communities, which has significantly shaped my growing knowledge of this instrument.

2.2 A Brief Historical Overview

The first published documentation of the fangufangu can be traced back to the early 17th century, with the arrival of Dutch navigators Schouten and Le Maire in 1616. Written and visual accounts from the 18th century, including those from Captain Cook’s voyages between 1773 and 1777, provide the most detailed and comprehensive historical[7] information of the fangufangu before the 20th century (Moyle 1987). At the time of initial European contact, the nose flute, including the Tongan fangufangu, was considered the most widespread instrument across Polynesia (Kaeppler, 1974). Historians commonly believe that the spread of this instrument across Tonga and Samoa, in addition to broader material culture, can be attributed to migration from the neighbouring islands of Fiji. This is important to note, considering similarities between a specific 19th century fangufangu artefact and the Fijian dulali (nose flute) which will be discussed further in *Chapter 4*.

While once a commonly used instrument in Tonga, fangufangu practices experienced a rapid decline after the introduction of Western music by the missionaries in the early 19th century. Consequently, alternative forms of musical expressions were introduced, including but not limited to, strings and brass instruments. It is understood that these musical instruments gradually supplanted the use of the fangufangu, alongside other customary musical instruments. By the turn of the 1970s, during fieldwork in Tonga conducted by Moyle, he claimed that the fangufangu was on the verge of obsolescence (Moyle, 1976).

5 Beyond the literature, Māhina has been at the forefront of fangufangu revival in Aotearoa

6 These subdivisions stem from the overarching divisions of Tongan arts: ‘tūfunga’ (material arts), faiva (performance arts) and nimamea’a (fine arts) as defined by Māhina. While the above terms are specific to fangufangu practices, it is important to note that there exist many subdivisions and specialisations of these three principle genres within Tongan arts

7 In this context, using the term ‘historical information’ refers to certain encounters where knowledge of the fangufangu was documented from a European perspective, which was largely disconnected from Indigenous understandings

2.3 Cultural Significance

Fig. 6. Webber, J., (1787). *A view in Annamooka, one of the Friendly Isles* [Print]. Alexander Turnbull Library. https://natlib.govt.nz/records/22813043

Since its earliest documentation, to mid – late twentieth century discourses, the fangufangu is known to have played an important role in Tongan culture. While there is some debate around the origins of its name, it is believed to derive from either ‘fangu’, meaning ‘to blow’, signifying its manner of playing, or ‘fafangu’, meaning ‘to awaken’, reflecting one purpose of its use (Moyle, 1976). The latter, although now considered obsolete, reflects one of the primary uses of the fangufangu to gently awaken royalty or nobility from slumber (Moyle, 1990; McLean, 1999; Atherton, 2010). Other uses of the fangufangu also included serving as a means for private entertainment and accompanying the now-obsolete lullaby, called the ‘upe.

An early visual record of the fangufangu in John Webber’s illustration titled ‘A View in Annamooka’ published in 1788 (see Fig. 6), dates back to Captain Cook’s third voyage when he visited Tonga in 1777. It depicts a seated figure playing the fangufangu. However, it is interesting to note two opposing interpretations of this image regarding the players’ gender. On one hand, the National Library of New Zealand notes a woman playing the nose flute accompanied by a man, while Mervyn McLean (1999) describes a male figure playing the instrument. This discrepancy highlights the complexity of interpreting historical visual records, and questions the gendered nature of fangufangu performance, which was considered a male prerogative (Moyle, 1987).

A notable example of the fangufangu being used to awaken royalty from sleep occurred in 1953 when four esteemed fangufangu players, namely Ve’ehala, ‘Alekiso’ Ahio, Malukava and Fakahafua, awakened late Queen Elizabeth II and the Duke of Edinburgh at the Royal Palace, Nuku’alofa, during their visit to Tonga. Fig. 7 illustrates this event. As Moyle points out, the players here are posing for the photograph, not playing their instruments in harmony (Moyle, 1987).

Something that is not discussed in the literature, is the physical attributes (i.e. size) of the fangufangu relative to the cultural practice of awakening royalty or nobility from slumber. The use of larger instruments to create lower frequencies possibly suggests an intentional choice to generate a softer and more gradual awakening instead of the potentially jarring effect of a sharper, high-frequency sound. This idea aligns with awakening those of high social stature in a calm and respectful manner.

Fig. 7.
Photograph of Tonga’s then remaining nose flute players posing with their instruments outside the Royal Palace, *The Polynesian Nose Flute*, 1953 (Moyle, 1987, p. 32)

Today, the practice and knowledge of fangufangu remain scarce, and there is a general lack of understanding of this instrument and its history within Tongan communities. However, a familiar recorded melody by the late Hon. Lord Ve'ehala is played daily as the opening tune for A3Z, the Tongan radio station in Tonga. For many Tongans, their initial introduction to the fangufangu is through this melody. While this has contributed towards the preservation of the fangufangu from a sonic perspective, practices remain limited today. A handful of current fangufangu practitioners, particularly in Aoteroa, have expanded practices of making and performance since the most recent documentation. The following sections will provide a brief overview of this, drawing from written literature, oral knowledge systems, engagement with Tongan practitioners of the field, and initial inquiry through practice.

Within existing literature, Moyle structures his analysis of Tongan musical instruments within a general and Western system of musical classification. This is defined by what vibrates to create sound, and is divided into four categories[8]: aerophones (air), idiophones (body), membranophones (membranes), and chordophones (strings). Acknowledging Māhina's divisions of Tongan arts (Maiava, 2021), including those specific to fangufangu practices, the following sections are structured using the three respective subdivisions. This includes the material art of 'tūfunga ngaohi fangufangu', the material art of 'tūfunga teuteu fangufangu' and the performance art of 'faiva tā fangufangu', providing an Indigenous perspective for how the fangufangu sits within the broader landscape of Tongan arts, and the elements which contribute to each of these practices.

8 This divisions sit within the 'Hornbostel-Sachs System' used to typically categorise instruments within an orchestra or symphony

2.4 Tūfunga Ngaohi Fangufangu

This section will provide a brief overview into the material art of fangufangu making, including material, form, size, finger holes and tunings of the fangufangu.

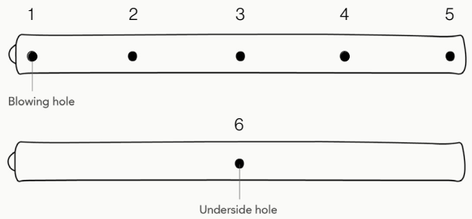


Fig. 8. Line drawing of the fangufangu outlining the order and number of finger holes

Materiality, Form & Size

According to all known accounts, the fangufangu is made from a single length of kofe (bamboo), enclosed at both ends with a natural node (Moyle, 1990). It appears that the use of kofe was partly due to it being a common and accessible material, but also that its natural hollow form provides a suitable structure for musical instrument making. Although the fangufangu appears visually simple, Māhina (1984) importantly notes that there are practical skills required for producing a high quality sound. While literature describes the fangufangu as cylindrical in form (Hoekje, 2005), it is crucial to recognise that while kofe resembles this geometry, it is an organic material that embodies irregularities due to its natural growth patterns, composition, and environmental conditions. These nuances can develop as subtle or pronounced variations in colour, texture, and structure within a single shoot and among different species. Consequently, one of the defining characteristics of the fangufangu is that each embodies a unique individuality in respect to its appearance, structure, and acoustic properties.

Regarding its physical size, the fangufangu varies in length. According to an early account by St. Johnston (1883) he describes one about sixteen inches long and two inches in diameter. Within museum collections today, it is common to find eighteenth century specimens that measure almost twice this length. An example of this lies within Te Papa's Pacific collection, artefact FE000712[9], which measures 640mm (25 inches) in length and 55mm (2 inches) in diameter. Although smaller fangufangu exist, the large artefacts within museum collections have stirred curiosity for many practitioners.

9 A link to this artefact can be found here: https://collections.tepapa.govt.nz/object/162530

Finger Holes

While there are variations in the number and positioning of finger holes, the most common construction, as seen in museum collections, including nineteen specimens studied by Moyle (1990) and one by Māhina (1984), contains six holes – five evenly spaced along the top and one directly beneath the central (third) hole. Like their spacing, finger hole diameter is generally uniform in size. Although this appears to be most common, it is evident that other variations in finger hole number and placement exist (St. Johnston, 1883) – this will be further discussed in *Chapter 4*. Moyle (1990) suggests finger hole positionings followed a mathematical approach rather than one influenced by sound. While current practice largely reflects this, sonic exploration of finger hole positioning is common. While the use of shells to create the holes was once common practice, the use of power drills has become standard practice as its speed helps to prevent fibres from splitting.

Tunings

Tunings of the fangufangu are defined by the length and diameter (internal and external) of kofe, as well as the size and placement of finger holes. Moyle (1987) claims the fangufangu was not tuned to preconceived instrumental or vocal scales, instead, the natural dimensions of the kofe (with five equidistant holes) defines the musical scale for each individual instrument. While this approach to making is still commonly used, many modern practitioners now fine tune certain holes to achieve specific pitches or scales. The most common reason for this is in the achievement of certain intervals to reproduce specific melodies. These tunings relate to the 'scales' of which two are documented in the literature, including the first (low key) – this is considered the most common practice, producing four pitches in total, using only holes 2 and 5. The second (high key) produces a total of eight pitches through using only holes 2, 3 and 6. Kaeppler (1983) provides an example of the 'low key' within a Western system of musical notation (the scale is described as roughly f#-a-b-c) but emphasises the scale for each instrument varies.

In the past, to my knowledge, not all holes were used in practice. However, some modern musicians have begun to explore using all finger holes for increased sonic versatility. The ability to produce different pitches with a single finger hole (i.e. half notes or quarter notes) is not discussed in the literature. This can be achieved by partially covering the finger holes, thereby increasing the overall range of possible pitches. While the extent of this is dependent on hole size, this technique is commonly used by modern fangufangu players – the nuances of this are discussed in *Section 2.6.3*.

2.5 Tūfunga Teuteu Fangufangu

In this section we will briefly discuss the material art of fangufangu decorating, covering both customary and contemporary techniques, and its cultural significance.

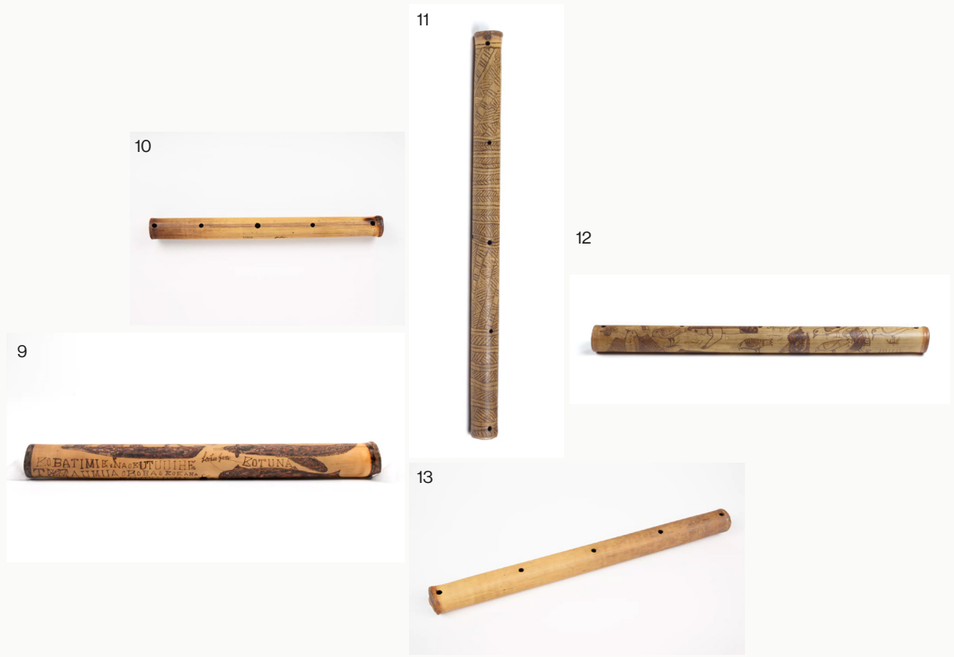


Fig. 9—13. Five fangufangu from within various museum collections in Aotearoa.

The material art of fangufangu decoration involves engraving the external surface of the instrument – the method employed for this art is usually pyrography[10]. While descriptions and analysis of fangufangu decoration is limited, Kaeppler (1978) notes that some fangufangu are incised with patterns and figures. Through ongoing conversations with current fangufangu makers, it appears that modern approaches to fangufangu decoration still commonly include using heat to scorch certain areas of the instrument. However, other mediums, such as paint, wax, and synthetic fibres are also used to explore both visual and sonic aesthetics.

10 Free handed art of decorating materials with burn marks. Usually, this is done through controlled application of a heated tool, such as a poker

While some fangufangu from the 18th and 19th centuries held in museum collections are inscribed with images, words, and names, many are also left undecorated. Some examples can be seen in Fig. 9–13, which illustrate the diverse approaches to fangufangu decoration across these time periods. On the other hand, Fig. 14 shows the evolution of teuteu through the use of waxed polyester braid and minimal pyrography.

Despite the variations in fangufangu decoration, there is little focus reflecting this in the literature. The only in-depth focus on this has been by Mahina (1984) in his article ‘Observations on a the Tongan Nose-Flute’ where he discusses the significance of a specific fangufangu artefact in the Auckland Museum, and its decoration as a form of storytelling through inscriptions that visually depict cultural narratives.

Fig. 14. Example of fangufangu made by Sam Tu’itahi and exhibited in *Inasi—First Fruits*, 2023

2.6 Faiva Tā Fangufangu

This section discusses the performance art of fangufangu playing, providing information on customary and contemporary techniques.

Manner of Playing

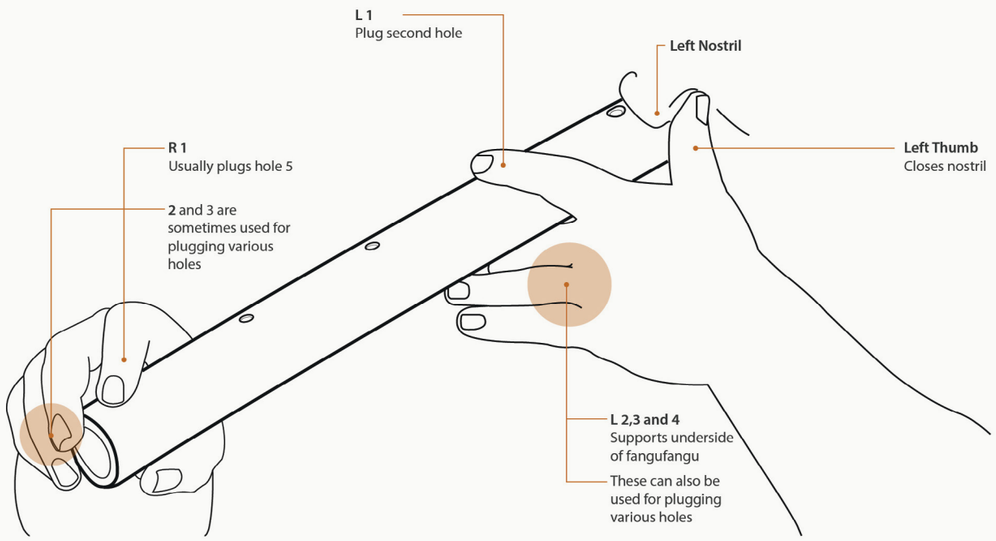


Fig. 15. Line drawing exemplifying the customary manner and posture for playing the fangufangu

As the name of the fangufangu suggests, sound is produced by gently blowing the air through the nostril into the blowing hole (hole 1), which is held against the upper lip, and positioned just below one nostril. For example (as illustrated in Fig. 15) if playing in the 'low key' (holes 2 and 5), typically, the thumb of one hand (personal preference) closes the nostril, while the second or third finger of that hand operates the closest finger hole. The other hand holds the non-blowing end and uses one or two finger holes. While the fangufangu can technically be played from either end, Kaeppler (1983) notes that one end is often preferred, exemplifying the importance of comfort in performance. Contrary to the rest of the literature, St. Johnston (1883) claims another form of playing, noting one specific musician who produced various effects during performance by plugging different holes with pieces of tapa (bark cloth).

While Fig. 16 illustrates two primary 'scales' as described in the literature, for many modern musicians today (refer to previous *Sub-section 2.4.3*) it has become common practice to use all of the finger holes. Depending on the size of the individual fangufangu, this involves shifting the entire arm to navigate between the finger holes. This is comparable to the technique of 'shifting' between frets on guitar, thereby introducing a completely new technique to the performance art of fangufangu playing.

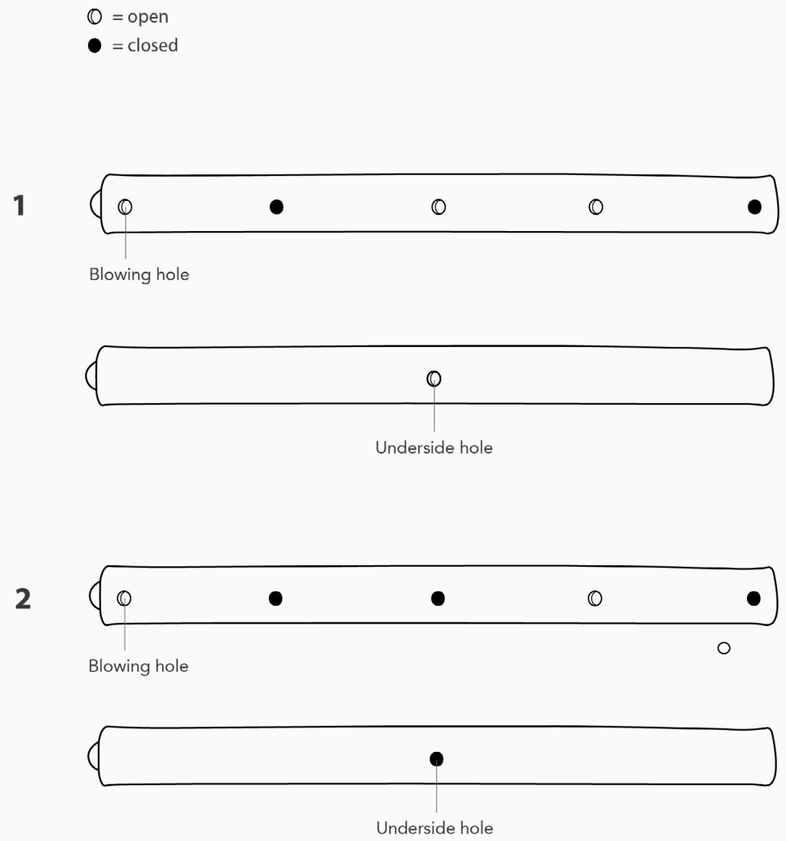


Fig. 16. Diagram of respective finger holes used to perform in the low key (1) and high key (2)

“The call of the tū is a resonant, mournful coo, monotonously repeated, coo-a-coo, coo-a-coo, coo-a-coo”

(Watling, 1982, p. 80)

Performance and Sonic Qualities

According to literature, the fangufangu was typically used to awaken royalty or nobility from their sleep. Kaeppler (1983) notes that using any other means to do so was considered taboo. Martin’s (1817) documentation reflects a particular form of this cultural practice, which involves the ‘upe, a lullaby specifically composed and performed in honour of royal or noble children. He notes that the fangufangu always accompanies the lullaby, and describes the melody as monotonous. The monotonous sound of the fangufangu is exemplified in the performance for Queen Elizabeth II and the Duke of Edinburgh, as previously discussed in *Section 2.3*. During this group performance, a single person would play for a specific duration, and upon concluding their melody, they would sustain a single note, providing a seamless transition for the next person to start playing. This approach enabled an uninterrupted and continuous musical performance to awaken the Queen gently. This performance technique embodies the aesthetic value of fakahēhē (ornamentation) which is common within Tongan song performance. This will be discussed further in *Sub-section 2.6.3*.

An early account from Keats (1973, as cited in Moyle, 1976) describes the sonic characteristics of the fangufangu. He claims that all fangufangu compositions are called tukipotu, which intended to emulate the sound of the tū, the native Tongan ground dove. Through conversations with Tongan practitioners, it was noted that they draw similar comparisons between the fangufangu and the Kulukulu species of dove, which is known for its gentle and echoing sound.

Aesthetic Techniques and Values

There is nothing in the literature that describes aesthetic techniques and values associated with playing the fangufangu. Through conversations and practice with fangufangu practitioners as part of my ongoing primary research, it is clear that there are certain aesthetic techniques and values which inform practices today. While these largely draw from wider musical values as described and analysed by Moyle (1987), understanding how these are valued and integrated in modern fangufangu performance and composition is crucial, as it highlights how the fangufangu has evolved.

An account from St. Johnston (1883) describes fangufangu finger techniques as not intricate. Of course, such an observation is subjective, and it is possible that technical intricacies were overlooked. Certainly his account does not reflect contemporary fangufangu practices today as performance has evolved to include increasingly complex techniques. One primary example is the technique of ofe’i (bending of pitch) which is used by modern fangufangu players as an expressive aesthetic technique. This can be used for melodic embellishment, but also in the achievement of fakahēhē[11] (ornamentation) as an aesthetic value. Ofe’i is achieved by pivoting the finger over the finger hole to gradually open or close the hole. This technique is demonstrated by Tongan fangufangu practitioner ‘Uluaki Maka Kaivelata[12] (Bluwave TV, 2023, 32:06).

In his book Tongan Music, Moyle (1987) defines various elements of Tongan song performance. He describes two conscious and deliberate approaches to achieve mālie (beauty) which include: hikihikitō[13] (changes in overall pitch) and fakahēhē as earlier mentioned (ornamentation). While this was not specific to the fangufangu, it is understood that there were similarities between intervals used in vocal music and those of the fangufangu. These aesthetic techniques and values have sparked influence and parameters for elements of fangufangu design development which will be later discussed in *Chapter 6*.

11 See: Tongan Music, p. 36 (Moyle, 1987)
12 Sounds of the Moana | Ft. Tauiliili Alpha Maiava and ‘Uluaki Maka | The Pacific Morning Show
13 See: Tongan Music, p. 35 (Moyle, 1987)

2.7 Inquiry Through Practice

Fig. 17. Photograph of 10 fangufangu made from different variations of bamboo and timber. This included inquiry into tunings and finger hole positions

Initial inquiry through practice was an important part of this context review, providing first-hand learning of fangufangu making and performance practices. Despite the restrictions of COVID which largely prevented in-person engagement with Tongan practitioners, I was fortunate to have been introduced to various fangufangu makers and players online, who kindly shared their expertise with me. While I was unable to source kofe from Tonga, I found a local supplier in Aotearoa. This initial inquiry enabled the expansion of making and playing techniques to understand tangible and intangible aspects of the fangufangu.

While the literature touches on the practice of rinsing the fangufangu in saltwater as a means for cleansing the instrument in between uses (Moyle, 1987), something that is not discussed is the treatment of kofe as part of the preparation process. Ideally, this involves storage in a stable environment until the bamboo is dry and suitable for fangufangu construction. Sometimes, this can take years. Given the time sensitivity of this research, I explored various treatments to speed up this process, including the use of a heat gun and blow torch to extract the wax and burn the outer layer. While this produced interesting visual effects, the bamboo still held a lot of moisture. This influenced the exploration with other materials such as timber.

Through a systematic testing process involving a diverse range of materials, hole sizes and positions, I gained valuable insights into the implications of fangufangu sound production. By varying these elements, I was able to explore a range of tonal qualities and playing characteristics, which ultimately informed design considerations and ideas for the later fangufangu conceptual development. One test included the angled drilling of the blowing hole to support air splitting[14] and ease of playing – a method used by contemporary makers to assist players in facilitating sound production. While a detailed exploration of these findings is not included in this document for the sake of space and primary design focus, it is important to note that these investigations grounded my introduction to the practice of both customary and contemporary fangufangu making and playing.

2.8 Chapter Summary

This chapter provided a brief introduction into the fangufangu, drawing from written literature, oral knowledge systems, engagement with Tongan practitioners of the field, and initial inquiry through practice. Insights included both customary and contemporary influences, highlighting the evolution of the fangufangu and opportunities for further investigation.

Fig. 18. Photograph of 7 fangufangu made from different variations of bamboo, timber and plastic. This focussed on understanding implications of sound across different materials and finger hole variations for same or similar dimensions.

14 This refers to the intentional directing of airflow towards the sharp edge of the blowing hole which causes the air to 'split' and create sound vibrations

3. Methodology

This research is grounded in a Tongan epistemological framework, integrating Tongan and creative-based methods to access and generate knowledge. This chapter introduces the theoretical and methodological approaches employed through design practice and engagement with Tongan scholars and practitioners. Drawing from the original Kakala Framework (Thaman, 1997), this research has developed and demonstrated a Kakala Design Framework to guide the practice-led design exploration of the fangufangu from a culturally grounded and design-specific context. This framework supported engagement with Tongan scholars and practitioners through the cyclic process of inquiry and conceptualisation, prototyping and modelling, and product concept evaluation.

3.1 Kakala Research Framework

The Kakala Framework (Thaman, 1997) draws from the customary Tongan fragrant garland-making process. Initially developed by Tongan poet and academic Konai Helu Thaman, the Kakala Framework intended to highlight and challenge the imposition of Western values and methods within education and pedagogy. Rooted in Tongan philosophy, values and principles of reciprocity, sharing, respect and collectivism, the original model was proposed as three stages: toli – the gathering of flowers (data collection), tui – the making of the garland (data analysis), and luva – the presentation of the finished kakala (data dissemination).

These three stages have since expanded through further contributions from Taufe'ulungaki, Johansson Fua, and Manu'atu, forming what we know today as the Kakala Research Framework (Johansson Fua, 2014) – an extension of the original Kakala Framework. With the addition of three stages: teu – the preparatory stage before work begins (preparation), mālie – the evaluation of the whole research process (evaluation), and māfana – the transformation phase (final evaluation), the Kakala Research Framework currently consists of six stages.

Johansson Fua (2014) emphasises that the Kakala Framework offers a sense of agency over Pacific research and empowers students to embrace Indigenous worldviews in their thinking and learning. By supporting Indigenous ways of engaging with Indigenous communities and knowledge systems, the Kakala Framework serves as a metaphor, representing each stage of the research process (Naepi, 2019). It provides a solid foundation for interweaving diverse knowledge and experiences to create culturally responsive and meaningful research outcomes for participants and wider communities. The Kakala Research Framework is described as follows:

"[...] it is a communal process that demonstrates collaboration, sharing of resources and the passing of skills to the next generation. But at the same time, it is a process with a distinct focus on preparing a designed garland for a particular occasion and with a definite person in mind. It may seem from afar to be disorganised and chaotic, but it is purposeful, strategic, and done with meticulous attention to fine detail."

(Johansson Fua, 2014, p. 58)

3.1.1 Stages of the Kakala Research Framework[15]

(Johansson Fua, 2014, pp. 53 – 54)

Teu – to prepare
Teu basically means to prepare; it is the preparatory stage before the work begins. It is a time for conceptualising, designing, and planning for the work ahead.

Toli – to pick a flower
Toli means to pick a flower, or choose an object. When picking flowers for a garland, the flowers are purposely selected and carefully picked depending on the design that has been chosen during the Teu stage. In the research process this is the data collection stage.

Tui – to string a garland
Tui has several meanings in the Tongan language, including “belief”, “knee” and to “string a garland”. In the Kakala Research Framework, Tui is used to refer to the analysis stage of the research process. Tui in a garland process always follows a particular pattern in accordance with the event and the person that the garland is intended for.

Luva – a gift from the heart
Luva means a gift from the heart. To Luva a gift usually means that the gift is given with heartfelt sincerity, humility, and honour.
In the Kakala research process, the Luva process refers to the reporting and dissemination stage, signalling a process of returning the gift of knowledge to the people who had given the knowledge.

Mālie – evaluation
Mālie is said when an audience appreciates a performance; it is an expression of “bravo” or “well done”. It means that the audience, at least in the Tongan protocols for performing arts, has not only understood, but appreciated the inter-play between the music, the dance, the costumes, and the performers.
For the Kakala research framework this is a point where we evaluate the whole research process, asking such questions such as:
Was it useful? Was it worthwhile? Who was it useful for?

Māfana – final evaluation
Māfana refers to the warmth of something that is heartfelt and has touched one emotionally. In the context of a Tongan performance, one observes māfana, when a member of the audience, in appreciation of the performance, joins the performers, either dancing with them or putting money or tapa cloth around a performer.
Māfana, then, is seen as the final evaluation process of the Kakala research framework, where we seek whether transformation, and application and sustainability of the transformation, has taken place.

3.2 Cultural Values & Research Ethics

Ethics approval for this research (4000023651 – Appendix: Human Ethics Approval) was obtained from the Massey University Ethics Committee and assessed as low risk.

Given the context of this research, which involved engagement and collective design development with Tongan scholars and practitioners, embodying cultural values rooted in Anga Fakatonga to inform knowledge negotiation and the shaping of research outcomes was integral to achieving ongoing respectful and ethical engagement with Tongan participants. Ethical issues and concerns were discussed with various Pacific academics to ensure appropriate engagement with Tongan participants.

Fig. 19. Diagram of the core Tongan cultural values which were integral in guiding the engagement and research with participants

15 The following definitions have been extracted from Johansson Fua (2014); however a complete summary for each stage can be found here: https://core.ac.uk/download/pdf/77223133.pdf

3.3 Creating the Kakala Design Framework

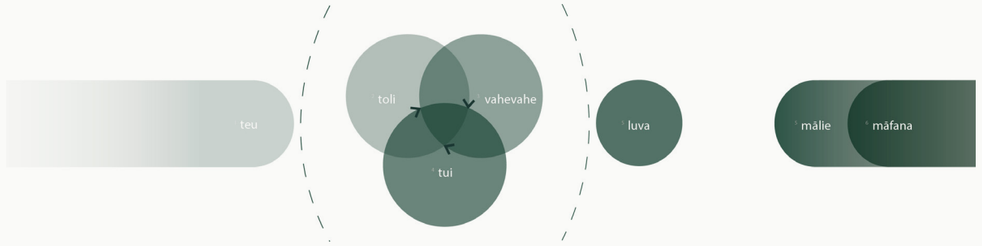
While the Kakala Research Framework has been utilised by researchers in diverse fields, largely within education, health, and social sciences, its use in creative-based research has been limited. Johansson Fua (2014) emphasises that while the Kakala Research Framework continues to be used by emerging Tongan researchers, much remains to be explored. As a Tongan researcher, I explored various Pacific methodologies, but was drawn to the Kakala Research Framework, which aligned with mine and my participants Tongan heritage. As the Kakala Research Framework is grounded in a Tongan creative practice, it felt important to give it voice and opportunity within the design space. Given the context of this research, which aims to explore design possibilities of the fangufangu informed by engagement with Tongan participants, there was an opportunity to develop the Kakala Research Framework to reflect and guide this creative-led design process. This section builds upon the Kakala Research Framework (Johansson Fua, 2014) by creting a Kakala Design Framework tailored explicitly for practice-based design research.

3.3.1 Reflecting an Iterative Process

Design is iterative, involving the repeated process of prototyping, product concept evaluation, and analysis. The garland-making process is similar in nature, described as one of negotiation and readjustment, where it is common to send the girls out again to gather more flowers to complete the desired pattern (Johansson Fua, 2014). However, this is not clearly reflected in the Kakala Research Framework, which is communicated in a linear way. While researchers may use this framework in a non-linear way, there was an opportunity to explore how the Kakala Research Framework could more explicitly support the iterative cycle of research, specifically within design.

Initially, I explored the re-arrangment and clustering of toli, tui and luva to form an iterative and cyclical process. The intention was to create multiple ‘garlands’ to reflect numerous product milestones[16] and the sharing of these with participants. However, I kept returning to the notion of luva as a selfless gift without expecting anything in return. In the Kakala Research Framework, luva is indicated by the final dissemination of research outcomes. Given the collaborative nature of this research, where participants were involved in the iterative design cycles, it was important to acknowledge their ongoing feedback and engagement as part of this process. With this in mind, I instead decided to add a new stage to the Kakala Research Framework.

Fig. 20.
Diagram of how vahevahe is introduced to form an interative and cyclical design process



3.3.2 The Addition of Vahevahe as a New Stage

I introduce a new stage, ‘vahevahe’, to the Kakala Research Framework. Vahevahe, meaning ‘to share’, is positioned as an intermediary stage between toli and tui. These three stages form an iterative and cyclical process, which when combined with teu, luva, mālie and māfana, results in the Kakala Design Framework.

In this new framework, vahevahe is a stage to share tangible design milestones with participants. Underpinned by values of ‘ofa, tauhi vā, and faka’apa’apa, vahevahe de-centers the researcher by acknowledging the equal contributions from each participant and their influence in shaping the design outcomes. In this specific practice, vahevahe is the sharing of fangufangu concepts at the end of each significant phase of design development.

Vahevahe also supports the stage tui (product concept evaluation). Like the process of design, our interactions and experiences with objects are dynamic. Sharing tangible design milestones with participants, allows for regular moments of reflection, and the maturing of response and insights beyond temporal and spatial limitations. This is contrary to contemporary product concept evaluation, matrix screening and scoring (Ulrich & Eppinger, 1995) which engenders fast-paced, formal, and prescribed feedback.

The addition of vahevahe not only supports the iterative and cyclical nature of design practice but it acknowledges the ongoing and collaborative contributions from participants which inform the design direction and process.

16 In this case, ‘product milestones’ refers to tangible and refined fangufangu prototypes

3.4 Visualising the Kakala Design Framework

to pick a flower
Defining Opportunity
Conceptualisation / Prototyping

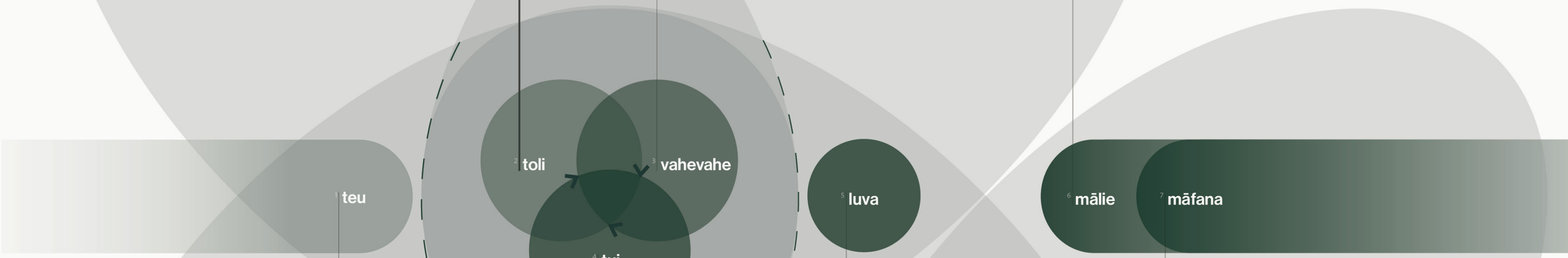
Toli seeks to define and refine the research focus, develop forms of knowledge and understanding, and cycle through the transformation and development of concepts. In the last iterative cycle, toli is the final stage.

to share
Sharing of Tangible Knowledge and Project Milestones

Vahevahe acknowledges tangible knowledge transformation through sharing project milestones with participants. This symbolises shared progress, through iterative cycles of collective talanoa, product concept testing, and critical reflection.

to express appreciation
Initial Evaluation

Mālie marks the beginning of the evaluation phase. In Tongan culture, it is expressed by the audience as an acknowledgement of appreciation and mutual understanding with the performers. Mālie aims to assess whether the community's expectations have been met and whether the work has been understood.



to prepare
Preparation

Teu establishes the research paradigm, develops connections and relationships, gains knowledge of relevant existing research and practice, and identifies the reasoning + significance of the project

to string a garland
Product Concept Testing

Tui involves the building of relationships with respective products beyond usual restrictions of tā (time) and vā (space). Further, it is the critical reflection of these experiences through collective talanoa. This supports ongoing engagement and collaboration with participants to inform following cycles of design development.

a gift from the heart
Research Dissemination

Luva is the offering of the final product to the individuals and communities involved. It intends to recognize and show respect for the commitment, contribution, and voices of the participants throughout the entire journey.

something heartfelt
Final Evaluation

While evaluation is an ongoing process, māfana is viewed as the final evaluation phase where the application and transformation of the research takes place. Māfana recognizes the implementation and impact of the work in the community. A positive indication of having reached māfana is the experience of 'ofa, which represents a successful, productive, and empowering research outcome.

Fig. 21.
Diagram of the Kakala Design Framework. Each stage is interpreted from the perspective of design, with the addition of 'vahevahe' to create and visually represent its iterative and cyclical nature.

3.5 Kakala Design Framework

The following definitions have been shaped by the core understanding of each phase as outlined by Johansson Fua (2014). However, they have been adapted to provide insight into how they can inform a practice-based approach for product design.

Teu, to prepare
preparation

Teu builds the foundation for the research project. It seeks to establish the research paradigm, develop connections and relationships, and gain knowledge of relevant precedent within and beyond the literature. Together, these contribute towards understanding the reasoning and significance of the project.

Toli, to pick a flower
defining the opportunity, design development

Toli initiates the cyclical design process by defining the research focus. It aims to develop new forms of knowledge and understanding, and transform intangible – tangible ideas through numerous phases of prototyping and refinement.

Vahevahe, to share
acknowledging and sharing collective progress

Vahevahe acknowledges significant points of tangible progress shaped by collective talanoa, experience testing and critical reflection. This is achieved through the sharing of artefacts to participants which are kept to mark important milestones, and are later used for experience testing in the following phase. Vahevahe honours the notion of tauhi vā by allowing a way to nurture and grow our relationships with material objects without the typical restrictions of time and space.

Tui, to string a garland
product concept evaluation & critical reflection

Tui is the process of growing relationships with refined prototypes through product concept evaluation, and the critical reflection of these experiences primarily through collective talanoa. Tui offers ongoing collaboration with participants to collectively inform the following cycles of design development.

Luva, a gift from the heart
research dissemination

Luva recognizes and honours the commitment, sacrifice, and contribution of the participants throughout the entire research journey. One way this is shown is through offering the final design outcome as a body of tangible knowledge for those involved.

Mālie, to express appreciation
evaluation

Mālie marks the beginning of the evaluation phase – this is often expressed by the audience as an acknowledgement of appreciation and mutual understanding with the performers. Mālie is a critical point of understanding whether community expectations have been met, and if the research has had a positive impact.

Māfana, something heartfelt
transformation

While transformation is an ongoing process, and although māfana is not limited to a single point in time, this is considered the final evaluation phase where the application and transformation of the research takes place. A positive indication of having reached māfana is the experience of ‘ofa (love).

3.6 Notions of Successful Research

In the final stage of the Kakala Design Framework, experiencing māfana is a positive signal of successful and impactful research. Considering the focus of this research, the criteria for design is value driven rather than commercially driven. While this design practice can contribute towards supporting musical aesthetics, these can only be achieved in tandem with the musician. As such, the instrument relies on the performance of the musician, and the performance of the musician relies on the instrument. Thus, while this thesis presents a final design outcome, it is intended to be part of a larger collection of individualised fangufangu customised for each participant.

Culturality and Musical Aesthetics

In order to understand dimensions of performance, notions of success, and potential for design exploration, it is necessary to also understand musical aesthetics within a cultural context. Musical aesthetics embody aspects of technicality, musicality and performativity, as well as the reception of these elements by the audience. However, the nature and value of these components is defined by context, where diverse perspectives influence the degree to which performance is considered beautiful, meaningful or impactful.

According to Māhina, in Tongan culture, the internal aesthetic values of tauēlangi (climactic elation), māfana (warmth) and vela (fieriness) are measures of mālie (pleasure) and faka'ofa'ofa (beauty) – the experience of these is a sign of positive impact in the arts[17]. From a musical context of song performance, these can be achieved by intentionally using certain aesthetic techniques such as hikihikitō (changes in the overall pitch) and fakahēhē (ornamentation).

Considering the use of the fangufangu within contemporary composition and performance, these musical aesthetics offer criteria for instrument design and determine the instrument's contribution towards the impact of performance, specifically in the broader desire to achieve tauēlangi. However, it is equally important to prioritise aspects of the fangufangu relating to contemporary use, adaptation and innovation. To achieve māfana, this practice-led research considered culturality and musical aesthetics throughout the design process, in an effort to align the final design outcome with Tongan aesthetic values and techniques.

3.7 Research Participants

Five participants consented to this research – four male and one female – all fangufangu players of the Tongan diaspora. Some participants were also makers, composers, and scholars. However, only three participants were involved in the creative-led design process – the number of participants involved in this process was restricted given the approach to design development, which required building multiple functional fangufangu prototypes for each participant at every significant design milestone. These participants will be introduced at the end of this chapter.

Six formal talanoa sessions were undertaken as part of this research, each held on Zoom and lasting two hours on average. After gaining permission from individual(s), audio and/or video recordings of talanoa were created and shared with participants. These were later transcribed and sent to individuals for review upon request. Following each talanoa, a me'a' ofa (gift) was offered to acknowledge each participant's time, effort, and contributions – an essential part of the talanoa method as a gesture of respect.

3.8 Recruitment Process

Vaioleti (2006) emphasises that before acquiring information about customs from Indigenous knowledge holders, it is essential to demonstrate the personal worth of receiving such wisdom. Before research began, talanoa (in-person and online) and email communications were used to connect with and get to know potential participants, who were recruited through family and community connections. These initial interactions were essential in building trust with potential participants, informing my understanding of my researcher positionality and expanding my knowledge of current fangufangu practices from Indigenous perspectives. Individuals who showed interest in participating were then contacted with specific information regarding the research, and to schedule a time to continue our talanoa.

17 See: Tā, Vā, and Moana: Temporality, Spatiality, and Indigeneity (Māhina, 2010)

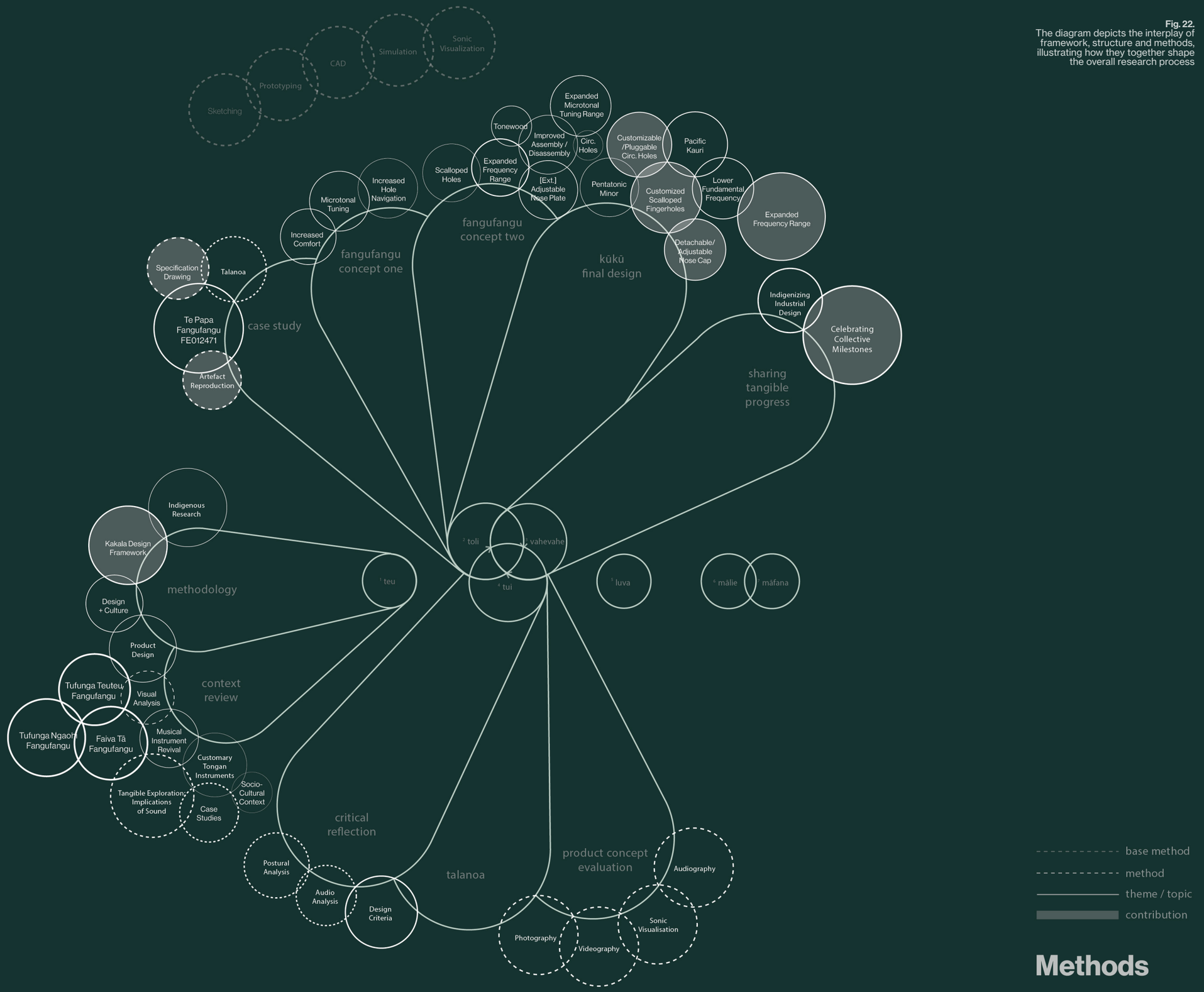


Fig. 22.
The diagram depicts the interplay of framework, structure and methods, illustrating how they together shape the overall research process

3.9 Research Methods

This section briefly overviews the primary methods used throughout the research, including specific methods taken to gather, develop and analyse information. These methods encompass tangible, visual, sonic, and oral techniques, each serving a unique purpose in exploring and understanding different facets of the research. Fig. 22 depicts the interplay of framework, structure, and methods, illustrating how these elements shape the overall research process. Three methods were primarily used to gather, analyse and create new knowledge. This included talanoa – as part of the research inquiry, conceptualisation, and critical reflection; prototyping – to explore and develop design concepts; and product evaluation – to analyse refined prototypes and understand how participants valued them.

3.9.1 Talanoa

Within Pacific research, talanoa is a primary method used in all disciplines across the diaspora as a form of engagement that is culturally grounded in diverse nations, including Cook Islands, Fiji, Hawai'i, Niue, Samoa, Solomon Islands, and Tonga (Prescott, 2008). Talanoa is a qualitative and culturally appropriate research approach as it adopts a narrative inquiry developed from Indigenous oratory tradition (Naepi, 2019). While this is shared and underpinned by mutual cultural values such as respect, reciprocity, collective responsibility, humility, love and service, it is essential to acknowledge that distinct variations exist within each culture (Naepi, 2015).

From a Tongan perspective, the term talanoa can be defined as 'talking about nothing in particular' but is commonly understood as an informal or formal personal encounter where two or more individuals freely and safely share stories or discuss specific topics that naturally arise (Vaioleti, 2006). An important aspect of this is that there is no pre-determined structure; instead, the beauty and significance of this method lies in its fluidity, which supports open discussions with no set agenda. While talanoa is context-specific, this approach alleviates power imbalance by de-centring the researcher, allowing the opportunity for participants to implement agency. As Vaioleti (2006) highlights, this provides opportunities to probe, challenge, clarify and re-align the research.

While talanoa is usually face-to-face, due to ongoing COVID-19 restrictions over this research period and location limitations, it was necessary to engage with participants online over email and Zoom.

While this form of online engagement has become common as a response to the ongoing impact of the global pandemic, adapting to the transformative shift in talanoa of this nature is an ongoing process. Discussions regarding the emergence of what some now refer to as "e-talanoa", an online method grounded in the talanoa employed within research contexts across the diaspora (Fehoko et al., 2022), are starting to surface. Considering the circumstances, remote talanoa for this research offered flexibility and ease of engagement across diverse temporal and spatial settings nationally and globally; however, it also limited the ability to engage with certain individuals and displaced the natural setting for which the talanoa would ideally take place.

Using Talanoa in the Kakala Design Framework

Talanoa was employed as a primary and qualitative method across various aspects of this research, including establishing relationships, inquiry, conceptual development and critical reflection. Each talanoa varied depending on the purpose – for example, it was initially used to connect with and get to know Tongan fangufangu practitioners online and in person where possible, before inviting individuals to participate in the project. Throughout the research development, talanoa was used to grow my understanding of current practices through an ongoing contextual inquiry and as part of the creative-led design development during conceptualisation and product concept evaluation.

3.9.2 Prototyping and Modelling

Prototyping and modelling are two integral aspects of the product development process, enabling ways to understand tangible properties such as functionality, materiality, and visual aesthetics. Within product development, Ulrich and Eppinger (1995) identify using prototypes for four purposes: learning, communication, integration, and milestones. Each of these informed the research project in the following ways:

Learning

In understanding and developing aspects of the fangufangu, elements of this instrument were investigated using focused prototypes. For instance, inquiry through reproduction enabled personal interaction through a close copy of an ancient fangufangu to learn aspects of making and playing. Further, it offered profound insights into understanding physical (i.e., form, materiality and playability) and sonic (i.e., timbre, volume and frequency) properties. Other prototypes explored the sonic implications of materiality, increased versatility, comfort, form and scale, and understanding of instrument tunings.

Communication
Prototypes effectively communicated specific design elements through ‘looks like’, ‘feels like’ and ‘works like’ representations. Sometimes, a blend of these approaches was used within a single prototype to introduce certain material elements or components progressively. This allowed for a focused product concept evaluation for participants by emphasising certain details. For example, the fangufangu reconstruction embodied a combination of ‘looks like’, ‘feels like’ and ‘works like’ qualities. This was achieved by creating a close resemblance to the original form with a different material.

Integration
Designing components and sub-components to work harmoniously was critical to this practice. This involved extensive simulation, analysis and refinement across various stages of conceptual development. Developing certain features to offer optimised assembly and ease of maintenance for participants was particularly important, especially considering remote engagement. More significantly, designing the smooth motion of certain components for use in play was essential for an enjoyable playing experience.

Milestones
The progression of the design development included four primary milestones, each serving a distinct purpose and level of functionality. For example, the first collective milestone was the first fangufangu prototype, which was consciously designed to focus on playability and sonic versatility through form, scale and integrated sub-components.

While each prototype was made with specific intentions, they facilitated alternative forms of engagement through innovative exploration by each participant which inspired opportunities for innovation and development. Modelling prototypes involved various analogue and digital processes.

3.9.3 Artefact Reconstruction

This was employed as a primary research method for gaining insights of a specific fangufangu within Te Papa’s Pacific Collection. By creating a reconstruction of an ancient instrument, analysis of construction, materiality, playability and acoustic properties supported the start of the design process. This method is discussed further in *Chapter 4*.

3.9.4. Sonic Visualisation

This method allowed a way to translate sound data into visual representations, providing a deeper understanding of each fangufangu’s acoustic properties. Sonic Visualiser (SV) is an open-source application for analysing, visualising, and annotating music audio files (Cannam et al., 2010) and was used to support this research method. Based on waveform and spectrum, SV supports investigating acoustic properties outside of a theoretical context (Thompson, 2021). The use of this throughout the design development process allowed a visual understanding of sound characteristics from the player’s perspective. Moreover, it allowed the ability to analyse primary aspects such as frequency and timbre. This was particularly helpful in making material choices to achieve specific sonic attributes.

Recordings of prototypes were taken using an iPad Pro’s *‘Voice Memo’* app at a sampling rate of 48kHz, a bit rate of 64kb/s and lossy compression mode. These recordings were taken from my personal playing to maintain accuracy across protoypes. Later, they were analysed in Sonic Visualiser through produced spectrograms using the following settings:

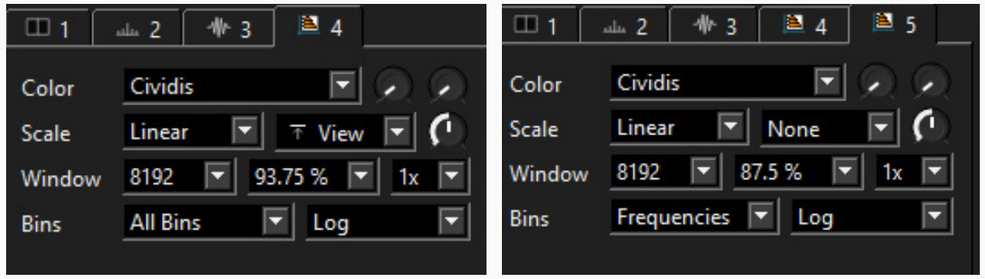


Fig. 23.
Screenshot of two main sonic visualiser settings for melodic range spectrogram (left) and spectrogram (right)

3.9.5 Product Concept Evaluation

Product concept evaluation is a method used to help designers understand how people value developed concepts and is undertaken at various stages throughout the design process. While this is usually carried out in a controlled environment (van Boeijen et al., 2020), instead, this research supported evolving user experiences with each instrument without spatial or temporal limitations. In doing so, insights reflecting both the initial interactions with the instrument, as well as how this developed over a certain time period were gained. At each significant design milestone, a refined and functional prototype was sent to each individual for product concept evaluation. This included an information pack outlining the different components and features of the instrument. Participants had the opportunity to engage, experiment and document their experiences over several weeks for each prototype.

3.9.6 Observation

Another implemented research method was observation through looking and listening systematically and meaningfully (McKechnie, 2008). Two approaches to this were employed. First, this included observing photographs and pre-recorded videos by participants from their product concept evaluation experience. As some participants did not prefer this method, real-time observation during our talanoa sessions was an alternative approach, as it was paramount to offer flexibility with how participants wanted to document or share their experiences. While approaches varied among participants and across different product tests, observation aimed to identify individual performance aspects and interactions with each instrument visually. Insights from these observations were discussed through talanoa to ensure participants could speak to these experiences.

3.10 Introducing the Participants

It has been an honour to collaborate with numerous talented and inspiring fangufangu artists over the last three years. While a wider community of respected artists and scholars have supported and inspired this study, three fangufangu experts in the field were involved in the practice-led development of this research. A short introduction for each participant is included:

Adriana Māhanga Lear (Pā'utu-'O-Vava'u-Lahi) is a contemporary and interdisciplinary Tongan-Australian artist and academic. She is a doctoral student at the University of Wollongong, where her creative practice also focuses on the fangufangu. As an esteemed musician, composer, visual artist, and academic, she has made significant contributions to the research and practice of Tongan arts and music.

Saia Tu'itahi is a contemporary Tongan artist who is based in Tāmaki Makaurau, Aotearoa. He is an esteemed maker, player, and composer of the fangufangu. Renowned for his role in the revival of this traditional instrument, Saia has recently released an album titled *Fangufangu 'Inasi.* This EP blends the distinctive sounds of the fangufangu with contemporary beats, bridging traditional and modern musical landscapes.

Sam Tu'itahi is a contemporary Tongan artist esteemed for his contributions as a respected fangufangu maker and player. He has been instrumental in the revival of the instrument, particularly in Aotearoa. Also based in Tāmaki Makaurau, his approach to crafting is highlighted in *'Inasi–First Fruits* which showcases a collection of fangufangu which navigate influences of past and present. This work is featured in an exhibition by Kava Book Club.

4. Fangufangu Case Study

Fig. 24.
Fangufangu FE012471 from Te Papa's Pacific Collection. This was donated in 2009, after the most recent museum inquiry into the fangufangu

The primary practice-led research in this chapter commences with a focus on studying a specific fangufangu within Te Papa's Pacific Collection, providing a comprehensive approach to gather and generate knowledge that informs the design practice. This section will begin by introducing the primary objectives, followed by an analysis of visual, tangible, and sonic characteristics. Subsequently, a reconstruction process will be outlined, which serves as a method to provide deeper insights into the fangufangu to inform the subsequent design practice with research participants.

Te Papa houses a diverse collection of koloa (treasures) from across Moana Oceania, including three Tongan fangufangu from the nineteenth century. Artefacts of this era are scarce within Tongan communities, thus access to this collection offers a valuable opportunity to gain insights into the materiality, construction and specifications of the fangufangu–information that would otherwise be difficult to obtain.

During my initial visit in 2020, I was privileged to be introduced to these fangufangu by Pacific Collections Manager Grace Hutton, who generously shared her expertise and passion for preserving Pacific cultural heritage. This encounter presented opportunities beyond my learnings from literature alone; allowing me to personally appreciate each instrument's unique visual, tangible, sonic and performative qualities. I became particularly interested in one donated by Derek J. Wilson in 2009, as pictured in Fig. 24.

This fangufangu was notably distinct from the others as it had two holes around the circumference, and I was unable to make it sound. Given the lack of individual artefact analyses within the literature, a case study was undertaken to ground my research. The reasons for selecting this specific fangufangu are threefold, informing the following objectives:

a) To investigate why sound production is noticeably more challenging compared to other artefacts.

b) To offer an understanding of sonic qualities and parameters, particularly concerning the additional two finger holes and their unconventional positioning.

c) To better understand its scale and form and how it influences the playing experience.

Fig. 25. *Fangufangu,* ca. 1800s, photograph, Museum of New Zealand, Te Papa Tongarewa, Pacific Cultures Collection, FE012471

4.1 Tūfunga Ngaohi Fangufangu

This section briefly overviews insights associated with fangufangu making.

Materiality and Form
This fangufangu is constructed from a single length (580mm) of hollow kofe (bamboo). While its overall structure is cylindrical, there is a 3.5mm variation (measuring between 38.5 mm and 42 mm) in outer diameter. It features two intact nodes that close off each end: one concave, and one recessed with a domed centre. There appears to be minimal structural damage, with two cracks at each end node measuring approximately 75mm long (see Fig. 26). It seems restoration work has been attempted, as the cracks appear to have been sealed with glue.

Finger Holes
One unique aspect of this artefact is the uncommon number and positioning of finger holes. Instead of the usual six holes, it features eight holes – five of which are spaced relatively evenly along the top of the instrument, but located on different planes. The remaining three holes wrap around the circumference, closest to the central hole, at varying distances from the blowing hole. All holes appear uniform in diameter at 6mm and taper downwards at approximately 11.3°. Given the customary use of finger holes two and five, the purpose of the added circumference holes is uncertain. According to Moyle, the Fijian dulali (nose flute) has three evenly spaced circumference holes around its centre. While these holes were not fingered, he suggests they lower the instrument's overall pitch (Moyle, 1990). This may also apply to the Tongan fangufangu.

Texture
There are noticeable variations in the surface texture of the fangufangu as can be seen in Fig. 26. Certain areas exhibit a matte finish, lacking the natural wax coating that has likely deteriorated over time and through use. In contrast, the rest of the instrument maintains a subtle sheen from the waxy outer layer of kofe. These contrasting textures highlight the impact of age and usage on the visual appearance of the fangufangu, providing valuable insights into its history and material characteristics.

Fig. 26.
Detail of crack and texture at the end node of fangufangu FE012471

4.2 Tūfunga Teuteu Fangufangu

This section briefly overviews insights associated with fangufangu decoration.

The surface of the fangufangu is pyro-engraved and characterised by two recurring motifs that wrap around the circumference and extend along the length. The detailed patterns add visual depth to the instrument, highlighting the complexities of craftsmanship and performance that are often overlooked in undecorated specimens. In contrast to the other two artefacts, a distinct characteristic of this instrument is the use of line-only decorations (without any names, words or figurative illustrations).

Fig. 27.
Inverted photograph of external fangufangu patterns. This depicts two primary motifs

Fig. 28.
Photograph of author attempting to play fangufangu FE012471

4.3 Faiva Tā Fangufangu

This section overviews insights associated with fangufangu playing, specifically in regards to playability and comfort.

Finger-Holes
Despite its smaller scale compared to other artefacts, I found using finger holes two and five quite uncomfortable, especially over extended periods. Additionally, it was difficult to utilise all the finger holes as this required shifting my entire arm to jump between them. Though this technique is unique in its own right, it also poses limitations for how the finger holes can be navigated, articulated and utilised in ways that extend beyond customary practice.

End Nodes
The end nodes felt uncomfortable against my maxilla, causing some discomfort during prolonged playing sessions – even my preferred end had a sharp edge rim that stimulated pressure points in the maxilla region, leading to discomfort. Finding the sweet spot for optimal airflow was challenging due to the distance between the blowing hole and end node and finding the optimum angle to suit my nose shape. The end node absorbed nose moisture easily, even during short playing sessions. Given the fibrous nature of kofe, increased moisture content can cause the fibres to swell and ultimately crack. Conversely, decreasing moisture content can cause the fibres to become brittle and crack, and environmental conditions can cause the fibres to twist.

Fig. 29.
Photograph of end node (author's preferred end for playing)

Sound Generation
A significant challenge I encountered was the difficulty in producing sound from the instrument. It was crucial to overcome this obstacle, as sounding the instrument was essential for testing and evaluating other aspects of its design and functionality. Upon reflection, I identified three possible contributing factors:

Airflow Disruption
Cracks can significantly impact the overall playing experience and adversely affect sound quality. This is caused by airflow escaping through the cracks instead of passing through the designated holes, resulting in a loss of air pressure and resonance/vibration required to produce clear and consistent sound.

Embouchure
This refers to how the player's nose and breathing interact with the instrument to produce sound. It involves positioning the blowing hole under one nostril while using breathing techniques to shape and control the airflow. The diameter and shape of the blowing hole directly contribute to this, influencing the instrument's pitch, tone, volume and responsiveness. A larger blowing hole produces a louder and more resonant sound, while a smaller one produces a softer sound.

Circumference Holes
An increased number of holes introduces additional points for air to escape and can lead to a loss of air pressure and altered acoustic properties. This can result in difficulty controlling the sound, decreased tonal quality, and potential disruptions in the overall pitch and resonance of the instrument.

Recognising the limits of interacting with a museum artefact, I chose to develop a reconstruction, allowing for engagement without risking damage to an original artefact. This approach offered the opportunity for a deeper and more comprehensive investigation, allowing me to delve into the intricacies of the artefact beyond the archives' limitations.

4.4 Reconstruction

Moyle (1990) suggests that the reconstruction[18] of 18th and 19th century artefacts can provide further insights into fangufangu tunings. Aligning with the objectives of this case study, which aimed to explore both the sonic and tangible aspects of the fangufangu, an artefact reconstruction was created. In the context of this study, reconstruction was a valuable tool for research, providing a tangible reference and alternative means for physical interaction with the fangufangu. Moreover, it offered a journey of discovery through the process of making.

Recognising the inability to measure internal features, the primary objective of reconstructing the artefact was to gain insights into the playing experience, comfort, and functionality. Further, it was a valuable foundation and reference for exploring design opportunities.

While the reconstruction aimed to capture the overall construction of the fangufangu, its material differed from the original artefact. This meant that the reconstruction could not accurately replicate the same sonic characteristics of the original. However, it still served a functional purpose, as a base for learning to play the instrument and understanding its indicative tunings. Through this practice, I could eventually sound the original fangufangu and yield information on its tunings and sonic characteristics.

At the time of the study I was a beginner player. Practicing with the reconstruction significantly improved my ability, through facilitating a more personal understanding of the fangufangu's nuances and complexities without the limitations and de-contextualisation often associated with museum artefacts. This in turn provided me with a more profound experience when interacting with artefacts housed in museum archives.

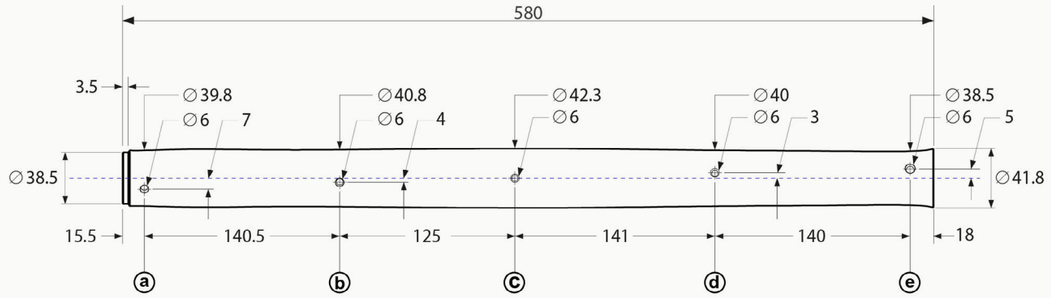
Measuring

To establish a foundation for reproduction, multiple measurements were undertaken using both manual and digital methods to determine the most accurate approach. Firstly, manual measurements were taken using a ruler, tape measure, string, callipers and scales to document properties of length and diameter, hole size and positioning, form, and weight. Three separate attempts obtained consistent and comparable results. 3D laser scanning was tested, however, these results were inaccurate for various reasons. Measurements primarily focused on external dimensions, as it was challenging to obtain internal data due to the closed end nodes. The only internal measurement that could be obtained was the wall thickness of the bamboo at each hole. Employing radiography would be the preferred method to achieve a more comprehensive understanding of the internal structure and material properties. This would allow for visualising critical features such as overall wall thickness variation, bamboo density, and material structure. Unfortunately, this was not possible within the scope of this study.

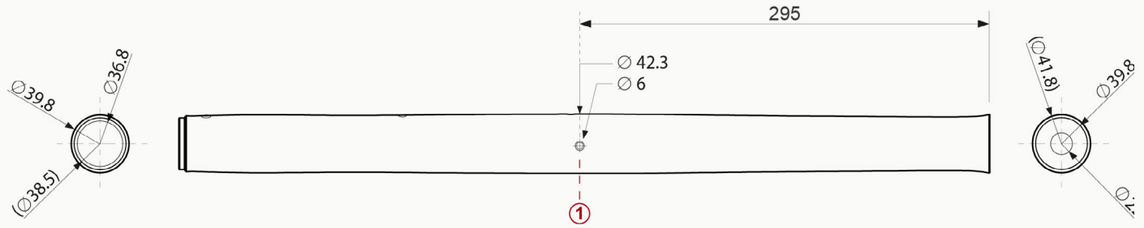
Specification Drawing

Necessary measurements were then translated into a specification drawing to document the physical construction of the artefact visually. The value of this was twofold: to support the reconstruction process and to serve as a base resource for the preservation, education, and research of fangufangu.

18 Reconstruction can be defined as either a copy of an original artefact or a reparation of the original artefact. While the intent of Moyle appears unclear, the term 'reconstruction' in this research is defined as a copy by way of re-creation



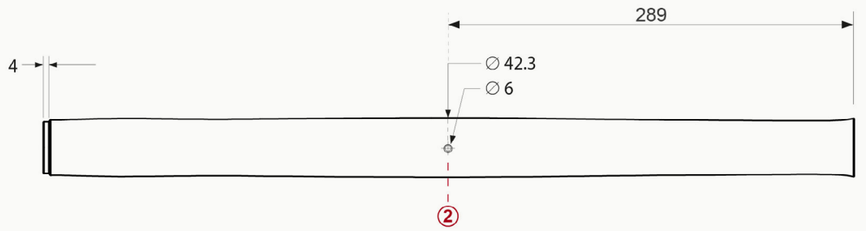
PLAN VIEW



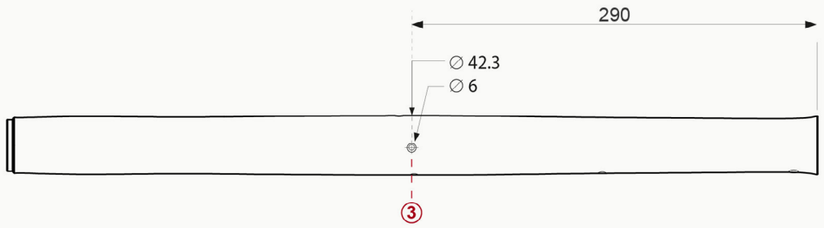
LEFT ELEVATION

FRONT ELEVATION

RIGHT ELEVATION

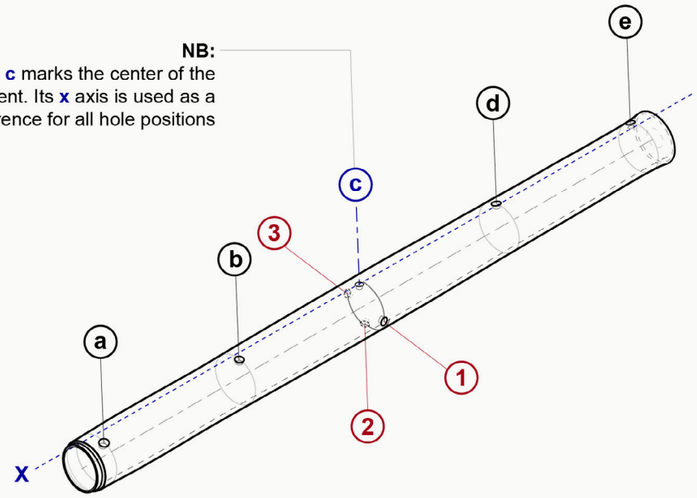


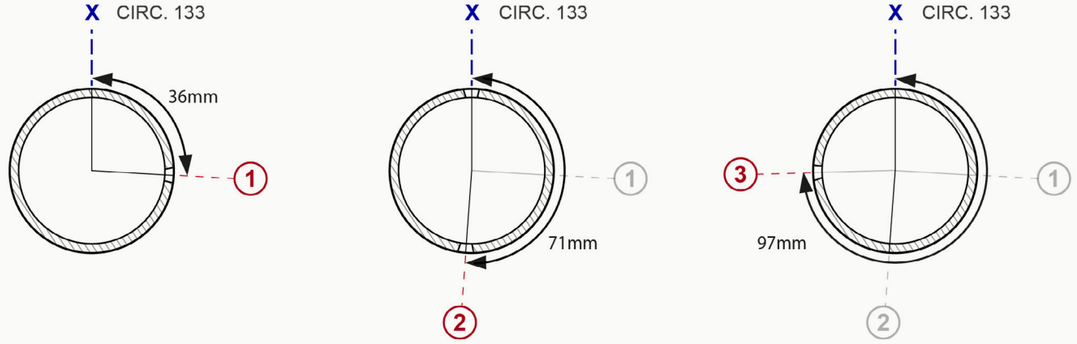
BOTTOM VIEW



BACK ELEVATION

NB:
Hole **c** marks the center of the instrument. Its **x** axis is used as a reference for all hole positions





HOLE 1 SECTION

HOLE 2 SECTION

HOLE 3 SECTION

CIRCUMFERENCE HOLES SECTIONS

NB: These holes are on different planes

Title: **Artefact Specification Drawing** **Drawn by:** Rachael Hall	Item: **Fangufangu** Registration Number: **FE012471** Collection: **Pacific Cultures** Museum: **Te Papa Tongarewa**	Scale: 1:4	Materials: Kofe	Notes: There are 9 holes in total: 5 accross the top plane and 3 around the center circumference. They each taper downwards at approx. 11.3°
		Tolerance: ±	Weight: 124g	
		Units: mm, g	Drawing No. 01 of 01	THIRD ANGLE PROJECTION

Fig. 30. Specification Drawing of Fangufangu FE012471

To create the reconstruction using additive manufacturing, a CAD model of the artefact was made and processed for 3D printing technology. As it was impossible to obtain internal measurements, the wall thickness was modelled based on the depth of each finger hole. This is illustrated in Fig. 32 through a cross-section of the artefact. Stereolithography (SLA) printing was used to print the reconstruction given its high-accuracy, uniform, and watertight properties. However, due to limitations in bed size and volume, the model was printed in two parts and glued together with a thin layer of epoxy. To assess the potential sonic impact of this, I created an extruded cylinder PVC reconstruction for comparison. This confirmed minimal difference, which did not compromise the purpose of the study or any insights gained. Making the reconstruction from bamboo was considered; however, due to time restraints and the irregular nature of bamboo, it made sense to utilise 3D printing to achieve an accurate external surface.

Fig. 31.
Photograph of SLA printed fangufangu artefact FE012471. Due to its size, this was printed in two parts

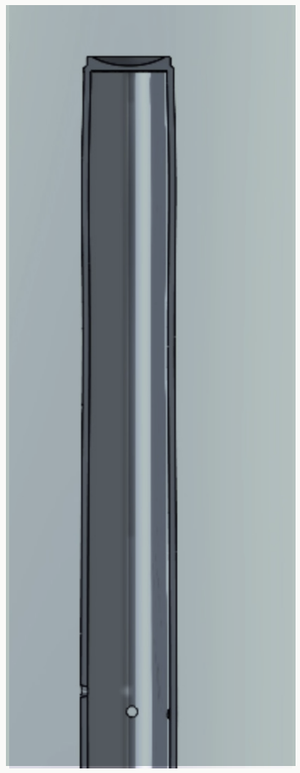


Fig. 32.
Section drawing of CAD modelled fangufangu FE012471

Fig. 33.
Photograph of fangufangu FE012471 reconstruction printed in SLA resin

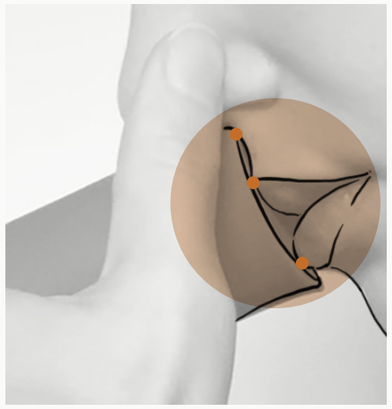
Fig. 34.
Collage of photographs illustrating close up details of the fangufangu reconstruction

4.4.1 Insights

Pressure Points

Fig. 35 depicts the various pressure points that need to be engaged (for me) in order to achieve the optimal position for sound production, as previously discussed in *Section 4.3*.

Fig. 35.
Illustration of pressure points on the lips and maxilla



Nasal Airflow / Breathing

While exploring trying to make the instrument sound, I encountered challenges in maintaining consistent airflow and pressure, which directly affected sound production and timbre. Even the slightest variations in breathing caused the instrument to shift into overtones, requiring careful control and technique. Breath control plays a crucial role in defining the nasal airflow and shaping the timbre and resonance of the instrument. Consequently, I understood the direct relationship between breathing speed and the frequency produced, with slower breaths resulting in lower frequencies and weaker volume. In comparison, faster breaths produced higher frequencies and greater volume.

One fascinating aspect of my experience was playing in the lowest register. Achieving this required exhaling minimal air, which called for precise stomach control. The connection between breath, embouchure and sound production highlighted the instrument's sensitivity and the significance of breathing to both generate and shape sound.

Fingerings/Frequencies

After extensive experimentation with the reconstruction and multiple visits to the museum archives, I successfully made the original artefact sound, enabling the following analysis of fingerings, frequency and timbre.

Moyle's Analysis

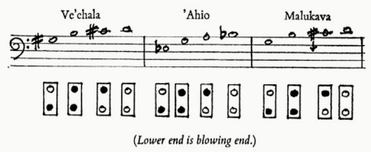


Fig. 36.
Tunings and respective fingerings of three Tongan fangufangu, Moyle, Richard M. "Tongan Musical Instruments." The Galpin Society Journal, vol. 29, no. 1, 1976, pp. 64-83

Moyle's analysis of three fangufangu belonging to Ve'ehala, 'Ahio, and Malukava (Moyle, 1976) illustrates the fingerings for an ascending scale in Fig. 36. It shows that the lowest pitch is achieved by closing the finger hole nearer to the blowing-hole. However, according to Moyle's article on Polynesian Nose Flutes, "a unique feature of the Fijian flute is that the lowest pitch is achieved by closing the hole nearer the blowing-hole only, whereas flutes from elsewhere in Polynesia achieve their lowest pitches by closing all fingered holes" (Moyle, 1990, p. 31). In the context of Tongan fangufangu, "all fingered holes" include holes 2 and 5. Considering this, it is evident that the above fingerings – and their respective pitches – do not align with this proposed idea. Instead, they align with the suggested fingerings of the Fijian dulali. This discrepancy suggests that finger hole configurations of the fangufangu may exhibit more variation than previously assumed, or perhaps this is simply an error in documentation. In order to compare Moyle's analysis with the original Te Papa artefact, I recorded and analysed the ascending frequencies from the four customary fingerings:

My Analysis

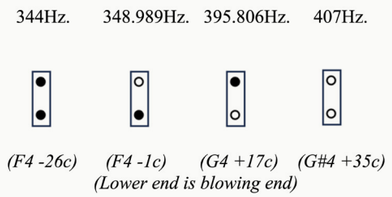


Fig. 37.
Diagram showing ascending and descending frequencies (and respective fingerings) for the original fangufangu FE012471

As illustrated, the fingerings align with Moyle's suggestion that closing holes 2 and 5 achieves the lowest pitch for the Tongan fangufangu. The difference between the two lowest frequencies is subtle at approximately 5Hz; however, this became more distinct and noticeable after warming up the instrument.

Note that the visible cracks on the instrument, particularly at the end of the fifth hole, likely impacts the obtained frequencies to some degree. However, it should be noted that the frequencies recorded reflect the sound produced by the artefact during my playing at a specific moment in time. Out of curiosity, I briefly analysed the fangufangu artefact FE012470, which dates back to nineteenth-century Tonga. It resulted in the following frequencies:

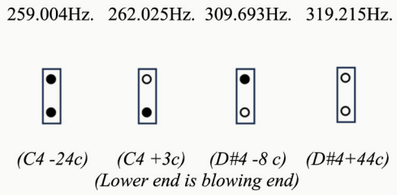


Fig. 38.
Diagram showing ascending and descending frequencies (and respective fingerings) for fangufangu artefact FE012470

Again, this aligns with the idea that the lowest pitch is generated by closing holes 2 and 5. The difference between the two lowest frequencies is similar to artefact FE012471, with an approximate difference of 3Hz – a sonic visualisation of this is illustrated below, representing the four customary fingerings from highest to lowest frequency. To gain insights into different aspects of sound, including fundamental frequency, harmonics, and overtones, it is important to understand the fundamental aspects of spectrogram analysis.

The vertical axis represents frequency, ranging from low frequencies at the bottom to high frequencies at the top. The horizontal axis represents time, with the progression of time from left to right. Amplitude (energy) is represented by colour or shading, where brighter colours indicate higher energy or volume – in this case, red is high energy. Peaks or lines indicate the presence of specific frequencies, while patterns and contours reveal the overall shape, range, and characteristics of sound. Note that the spectrogram may also capture incidental sound and ambient noise present during the recordings. By examining the contours and analysing the frequency and timbral variations, we can better understand the instruments' tonal nuances and dynamic range.

Furthermore, it is essential to highlight that the spectrogram presented here directly reflects my personal experience playing the fangufangu artefact. The frequencies, timbre, and nuances captured in the spectrogram may vary significantly depending on the individual player, as each musician brings their unique style, technique, and expressive qualities to the instrument, resulting in variations in sonic characteristics. Therefore, the spectrogram offers insights into the instrument's sound and performance as interpreted through my own musical expression. The finger holes are arranged in the following manner – this diagram will be referred to for the remainder of the thesis, and adapted where necessary to reflect specific fangufangu finger holes.

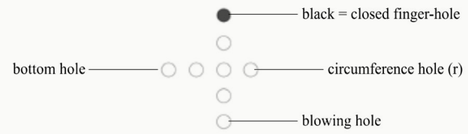


Fig. 39.
Diagram outlining the finger hole positioning and coverage (i.e. open or closed). This will be used and adapted throughout the rest of this thesis

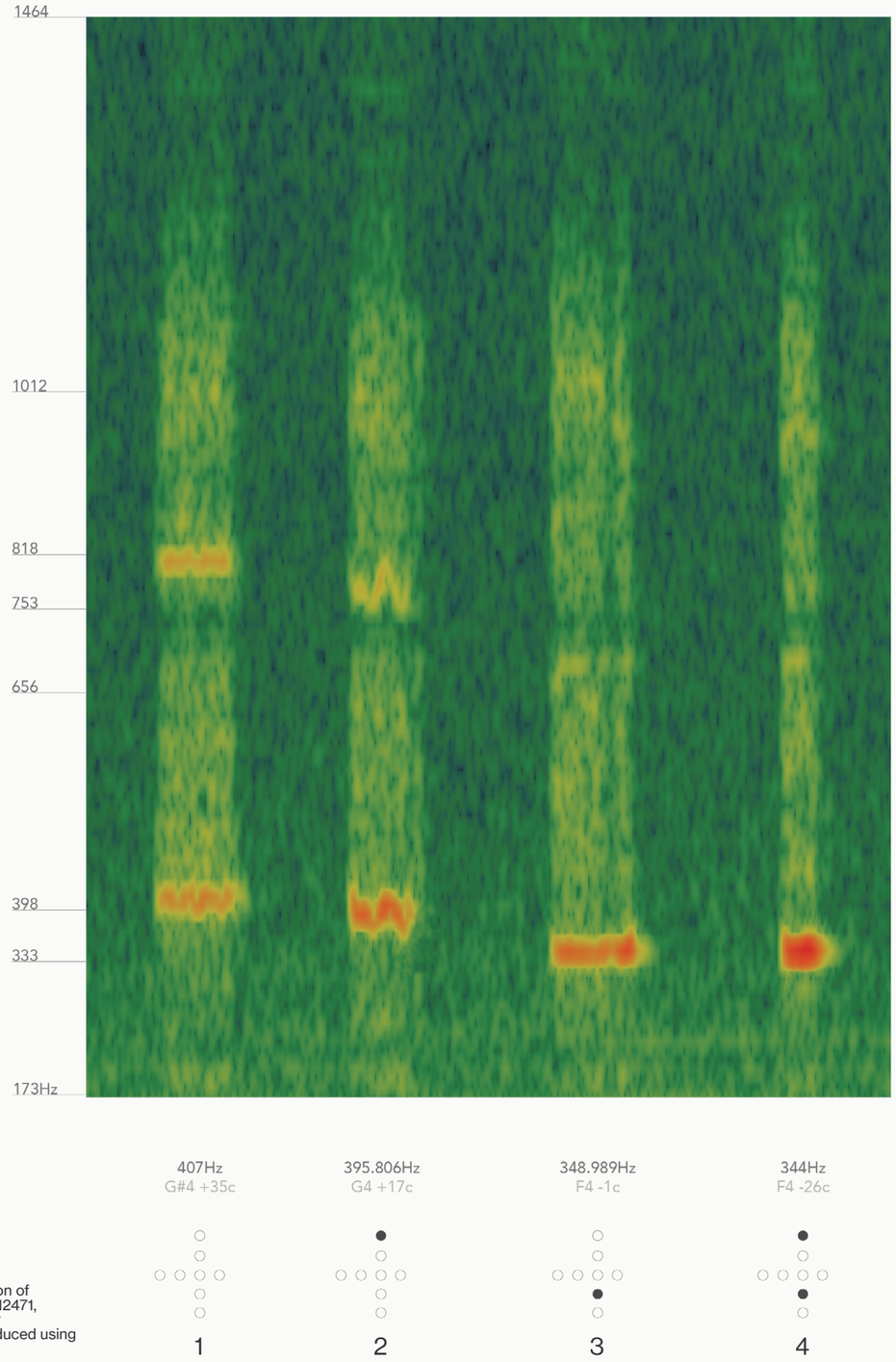


Fig. 40.
Sonic visualisation of fangufangu FE012471, showing the four frequencies produced using holes 2 and 5

Freq. 1
- Fundamental Frequency: 407Hz
- Frequency Contour: Even wavering contour indicates consistent and regular fluctuations of frequency. Represents reasonably smooth and controlled variation.
- Frequency Stability: Relatively consistent fluctuations in frequency.
- Intensity: Overall amplitude is moderate, as indicated by shades of yellow and orange – slight dynamic variation.
- Harmonic Structure: Balanced harmonic structure with a strong second harmonic at 814Hz and weaker overtones that extend into higher frequencies
- Timbre: Few high-frequency components characterise warm and mellow tonal qualities.

Freq. 2
- Fundamental Frequency: 395.806Hz
- Frequency Contour: Uneven wavering contour suggests an irregular pattern of frequency fluctuations. Represents less controlled variation, with varying intervals between each fluctuation. Implies instability of sound, potentially caused by factors such as inconsistent airflow or unintended variations in the performance technique (i.e. vibrato or tremolo).
- Frequency Stability: Inconsistent fluctuations in frequency.
- Intensity: Overall amplitude is moderate – strong as indicated by shades of yellow, orange and red. There is a slight dynamic variation.
- Harmonic Structure: Moderate second harmonic, peaking at 791.612Hz and weaker overtones that extend into higher frequencies.
- Timbre: Few high-frequency components characterise warm and mellow tonal qualities.

Freq. 3
- Fundamental Frequency: 348.989Hz
- Frequency Contour: Even and fine-grained wavering contour indicates consistent frequency fluctuations with minimal intervals between each wavering point. Represents smooth and controlled variation.
- Frequency Stability: Consistent fluctuations in frequency.
- Intensity: Overall amplitude is moderate – strong as indicated by shades of yellow, orange and red. There is a slight dynamic variation.
- Harmonic Structure: Weak second harmonic at 697.987Hz and weaker overtones that extend into higher frequencies.
- Timbre: Few high-frequency components characterise warm and mellow tonal qualities.

Freq. 4
- Fundamental Frequency: 344Hz
- Frequency Contour: Even intricate wavering contour indicates consistent frequency fluctuations with minimal intervals between each wavering point. Represents steady and controlled variation.
- Frequency Stability: Consistent fluctuations in frequency.
- Intensity: Overall amplitude is strong, as indicated by deep shades of orange and red. Steady dynamic.
- Harmonic Structure: No suggested second harmonic. Weak overtone at 698Hz and weaker overtones that extend into higher frequencies.
- Timbre: Few high-frequency components characterise warm and mellow tonal qualities.

The analysis reveals that frequency contours vary, representing both even and uneven wavering contours. The intensity of the sound is generally moderate to strong, with slight dynamic variation. The harmonic structure consists of weaker overtones and, in some cases, a strong second harmonic. The fangufangu's timbre is warm and mellow, with few high-frequency components. These findings allow for a visual understanding of fangufangu's sonic properties without imposing a Western musical classification system.

Circumference Holes

While existing literature associates circumference holes primarily with the Fijian dulali, it is important to acknowledge the historical connections and cross-cultural exchanges within Western Polynesia which have influenced the acquisition and evolution of instruments like the fangufangu. Therefore, the existence of circumference holes in this artefact – considered of Tongan origin – suggests a potential variation of its design that is reflective of nineteenth-century specimens.

Based on Moyle's (1990) findings, it was suggested that the central ring of holes on the Fijian dulali serves to lower the overall pitch. However, my exploration shows that the circumference holes have the opposite effect. In the case of this particular artefact, the presence of additional holes increases the points for air to escape, resulting in a raised overall pitch regardless of finger combinations. This insight challenges the previously proposed notion and highlights the need for further investigation and understanding of the fangufangu's design and acoustical properties that reflect different instrument variations.

The effect of the circumfence holes offered interesting insights. One significant example is that the circumference holes only sound (as well as the other holes) in the lowest register (first harmonic range), generating 300Hz with all holes open. The only other instance in which the circumference holes sound, is in its third harmonic range which generates 600Hz with all holes open. However, in this range, all other finger holes do not change in frequency.

On the other hand, the circumference holes on the original artefact sound when fingered in the two different registers I could play in. A spectrogram of the circumference holes on the original artefact is shown in Fig. 41, illustrating the elevation of the overall tuning as each finger is removed.

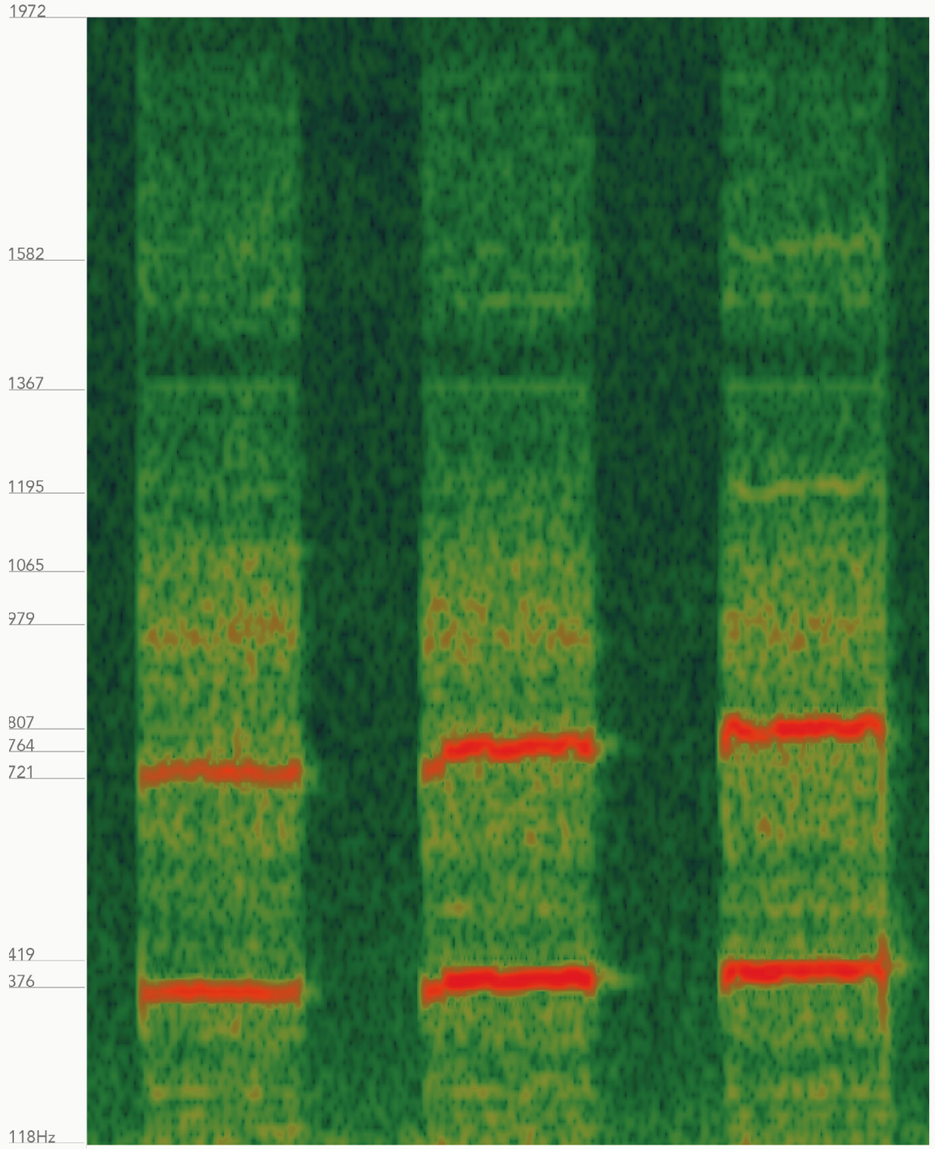


Fig. 41.
Sonic visualisation of fangufangu FE012471, showing the three frequencies produced using the two circumference holes (7 and 8)

Freq. 1

- Fundamental Frequency: 364.725Hz
- Frequency Contour: Steady and defined contour indicates consistent fluctuations of frequency. Represents smooth and controlled variation.
- Frequency Stability: Consistent fluctuations in frequency.
- Intensity: Overall amplitude is strong as indicated by shades of red.
- Harmonic Structure: Strong second harmonic at 729.45Hz and moderate scattered overtones that extend into higher frequencies.
- Timbre: Moderate high-frequency components characterise brighter and clearer tonal qualities.

Freq. 2

- Fundamental Frequency: 387.002Hz
- Frequency Contour: Steady and defined contour indicates consistent fluctuations of frequency. Represents smooth and controlled variation.
- Frequency Stability: Consistent fluctuations in frequency.
- Intensity: Overall amplitude is strong as indicated by shades of orange and red.
- Harmonic Structure: Strong second harmonic at 774.004Hz and moderate scattered overtones that extend into higher frequencies.
- Timbre: Moderate high-frequency components characterise brighter and clearer tonal qualities.

Freq. 3

- Fundamental Frequency: 402.442Hz
- Frequency Contour: Steady and defined contour indicates consistent fluctuations of frequency. Represents smooth and controlled variation.
- Frequency Stability: Consistent fluctuations in frequency.
- Intensity: Overall amplitude is strong as indicated by shades of red.
- Harmonic Structure: Strong second harmonic at 804.884Hz and moderate scattered overtones that extend into higher frequencies. Overtones are evenly spaced.
- Timbre: Moderate high-frequency components characterise brighter and clearer tonal qualities.

The analysis reveals that each frequency exhibits a steady and defined contour, indicating consistent fluctuations with controlled variation. Moreover, frequency stability remains consistent throughout all three frequencies. In terms of intensity, all frequencies display a strong overall amplitude, with shades of red and orange. This indicates a robust and powerful sound. The harmonic structure of each frequency showcases a strong second harmonic and scattered overtones extending into higher frequencies. These overtones contribute to the subtle brightness and clarity of the instrument's timbre. It seems the circumference holes result in a more powerful and dynamic sound.

4.4.2 Summary

The artefact reconstruction proved an effective way to learn more about the original fangufangu and translate written knowledge into practice. Furthermore, it allowed for immersive exploration and interpretation, which was the foundation for my design practice. While not an exact copy, the reconstruction served its purpose exceptionally well as a valuable tool for research, exploration, and learning. It provided insights that would have been challenging to obtain solely through literature or observation. These insights have enriched my understanding of the instrument and contributed towards grounding the following design practice.

Key findings and opportunities:

1. **Expanding sonic possibilities**
   The circumference holes present a unique feature with the potential to enhance sonic possibilities of the fangufangu. Exploring innovative designs or adjustments to these holes can provide opportunities to expand the fangufangu's sonic range and capabilities, contributing to a more versatile musical experience.

2. **Improving the comfort of the end nodes**
   The study identifies a need for enhancing the comfort of the end nodes. Consideration of ergonomics can be explored to optimise the comfort of the end nodes, ensuring a more comfortable and user-friendly experience for musicians.

3. **Optimising sound across the full range**
   There is an opportunity to explore how sound can be optimized across the entire range of the instrument. Practice-led research can possibly refine the construction and acoustics to achieve optimal sound quality across all notes and registers, addressing potential challenges and enhancing overall musical performance.

4. **Improving the navigation of finger holes**
   Navigating all of the finger holes is essential for how many modern musicians play the fangufangu. Placement of holes or the overall size of the instrument can be explored to enhance ease of navigation, providing musicians with improved control and precision during performance.

Fig. 42.
Photograph of the original kofe fangufangu next to the SLA reconstruction

5. Fangufangu Concept One

This chapter initiates the collaborative and practice-led research process and will discuss the development of fangufangu concept one. First, the key themes which emerged through talanoa with fangufangu practitioners and scholars, and the development process of the first fangufangu concept will be discussed. While engagement with numerous Tongan practitioners was undertaken to develop an ongoing contextual understanding of the fangufangu from both customary and contemporary perspectives, three primary participants were directly involved in the design development. This process started with an initial talanoa where we shared our fangufangu experiences, and identified desires and possibilities for innovation. This was crucial in grounding the general design direction, and informing the objectives for the first fangufangu concept development.

Key insights were gained during the talanoa, which informed conceptualising and prototyping, and inspired fangufangu concept one. This was sent (with an information sheet) to participants, who had several weeks to explore and document their experiences. A collective talanoa was then held to critically reflect on these experiences and inform further design development. The structure of this chapter reflects this process by introducing the key themes first, followed by the design objectives, and then the refined concept including an outline of various features, their development, and the collective talanoa with participants.

5.1 Key Themes

The dynamic and collaborative design process drew from insights gained throughout the context review, artefact case study, and talanoa with fangufangu artists. While these insights shaped the overall research foundation in various ways, the specific directions for creative exploration were largely defined by the initial collective talanoa with those involved in the research's design development. These conversations prompted us to share and explore critical insights into perceived meaningfulness based on personal experiences with (and understanding of) the fangufangu. This contributed towards shaping potential possibilities for exploring the fangufangu through the Kakala Design Framework. While these possibilities remained fluid throughout the research progression, it was important to acknowledge that so too would our perspectives and journeys in relation to tūfunga ngaohi fangufangu, tūfunga teuteu fangufangu, and faiva tā fangufangu. While a breadth of topics were discussed, four primary themes emerged:

5.1.1 Sonic Versatility

Discussions on this were varied but largely focussed on aspects of tunability such as tuning two fangufangu to each other (harmonising), and tuning the instrument's overall scale (by maintaining the sonic and physical relationships of the holes). Though the latter can be partially achieved through controlled breathing techniques (which shift the frequencies into upper or lower registers), alternative approaches to properly achieve a scale change were considered.

> In terms of tuning [...] I tune my Western instruments like the flute to the fangufangu [...] Like you, I really think that the fangufangu gives us a sense of our traditional or ancient sound relationships. (Adriana)

A mutual value of significance among participants was preserving customary approaches to tuning instead of conforming to the dominant musical influence of the Western equal temperament scale. This emphasised the importance of tuning the instrument's overall scale to support the connection, understanding, and transmission of musical customs[19].

5.1.2 Playability

With respect to playability, enhancing comfort during extended performance was a central focus–more specifically, reducing pressure around the maxilla[20], which induced irritation and redness in the nose area. Furthermore, interest in optimising finger hole size and overall instrument footprint was expressed, with the aim to enhance the navigational ability of all the finger holes, thereby expanding the range of possible finger combinations and frequencies.

> [...] with my little fine fingers, when I play the fangufangu, sometimes the holes are hard to close for me. Often, I have to move my hand to close the hole completely. (Adriana)

One breathing-related difficulty is generating adequately strong airflow, which is required to shift into higher register playing and to reach overtones. Conversely, some fangufangu (e.g. the Te Papa artifact) require extremely gentle airflow to play in the lowest register. While each instrument presents a unique level of playing difficulty, the force of nasal airflow is equally challenging to maintain at both the upper and lower registers. This affects musical vocabulary, articulation and comfort level when performing for prolonged periods of time.

> [...] if you can somehow modify it so that we don't have to push out as much air, maybe that would also contribute towards getting it up into upper registers. (Sam)

19 Two approaches to tuning the top finger holes include: five equidistant holes; or five equidistant holes that are fine-tuned to reflect intervals of iconic fangufangu melodies

20 Bone that forms the upper jaw: this encompasses the area of contact between the fangufangu and face

5.1.3 Materiality

The discussion around materiality mainly focussed on the significance, influence and value of materials considering their geographical context, particularly pertaining to diasporic cultural experiences. Relationality was a frequent topic of conversation, highlighting the significance of acknowledging and responding to our surroundings to reflect our evolving journeys and influences.

> [...] everything to me at the end of the day, has its own value – the kofe fangufangu, to me, are amazing, but also experimenting with some of these new materials and some of the new lands that we're in, I think is also exciting. It might push the boundary in some new ways that we just can't see now. (Sam)

From an acoustics perspective, the influence of materials in achieving desired sonic characteristics was an important factor. Structural properties were also considered relating to contemporary methods of making. We discussed the implications of working with different bamboo species, and compared insights into fangufangu made from different varieties of bamboo, such as kofe and locally harvested bamboo from Aotearoa. This highlighted the importance of understanding the physical and acoustic characteristics of materials and their influence on responsiveness, playability and broader sonic qualities. It also emphasised the interplay between materials and form, and how they interact to shape the aforementioned aspects.

> [...] people struggle with some of the NZ bamboo that I've made fangufangu from compared to the kofe one that I have. It could be the case that this kofe one is really easy to play and quite responsive. But there might be something there about the difference in material as well. (Saia)

5.1.4 Culturality and Musical Aesthetics

As discussed in *Chapter 3*, ongoing consideration of culturality and musical aesthetics is important to understand dimensions of performance, and potential or design exploration. Considering the use of the fangufangu within contemporary composition and performance, these musical aesthetics offer criteria for instrument design and determine the instrument's contribution towards the impact of performance, specifically in the broader desire to achieve tauēlangi. However, it is equally important to prioritise aspects of the fangufangu relating to contemporary use, adaptation and innovation.

5.2 Design Objectives and Deliverables

This section introduces the design objectives and deliverables which inform the design development throughout this chapter. These are based on the key themes identified at the start of this chapter, namely: sonic versatility, playability, and culturality and musical aesthetics. It is important to note that this fangufangu concept did not focus on materiality. The reason for this was to gradually introduce elements into the product concept evaluation process.

Objectives

Develop an adjustable nose cap

- Explore materiality and form to accommodate both comfort and hygiene
- Explore whether this component can support variations in timbre rather than having to change the angle/position of the instrument

Optimize finger hole navigation

- How does the length/diameter of the body, as well as finger hole positions impact this?

Design a method to raise the over instrument ‘scale’

- What value does this bring to contemporary approaches to fangufangu playing?

Deliverables

Adjustable Nose Cap

- Offers a way to adjust and the distance between the end of the instrument and the blowing hole in order to accommodate comfort for individual facial profiles, comfort, and support variations in timbre

Body

- Shorter length allows ease of navigation of all finger holes in an effort to increase sonic versatility and aspects of playability for contemporary approaches to playing

Tuning Dial

- Enables the ability to fluidly raise the overall ‘scale’ of the instrument

Fig. 43.
Photograph of the refined fangufangu prototypes for participants. This outlines the four primary features which were developed in the first design cycle

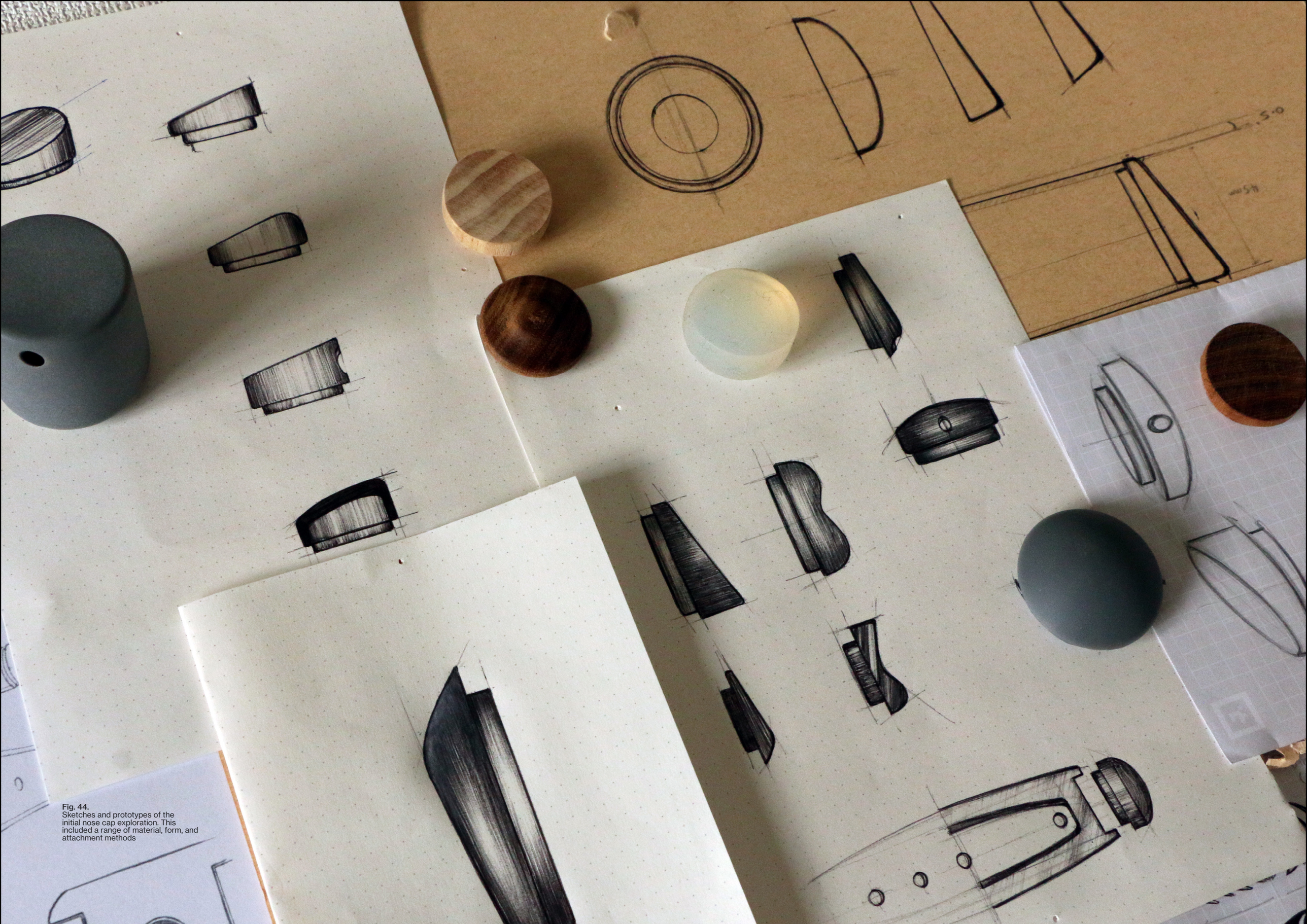


Fig. 44.
Sketches and prototypes of the initial nose cap exploration. This included a range of material, form, and attachment methods

5.3 Adjustable Nose Cap

In an effort to improve playability and increase general comfort around the nose, exploration into an adjustable nose cap was undertaken. Development primarily focused on materiality, form and customisation. This focus derived from insights gained in *Chapter 4* as well as the initial talanoa, where Adriana noted:

> I get really red and raw around my nose (Adriana)

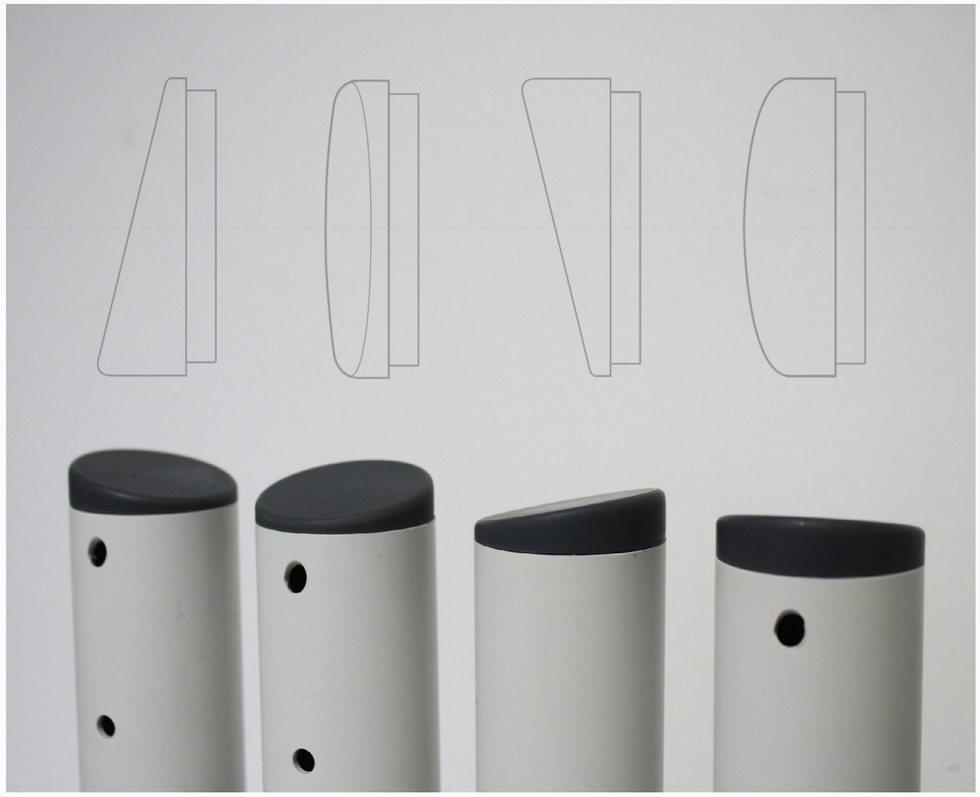
The concept of a separate nose cap was inspired by the experiences of playing over extended performance periods where it can be challenging to collectively balance the ability to produce sound, achieve desired timbral effects, and ensure optimal comfort. Additionally, considerations of hygiene and personal preference were taken into account, emphasizing the potential for a component that would be easy to clean and allow opportunities for customisation. While these challenges vary from one individual to another, and depending on the instrument, they highlighted possibilities for exploring an adjustable nose cap in an effort to enhance aspects of comfort, sonic versatility, and customisation.

As illustrated in Fig. 45, the nose cap development included a diverse array of forms and materials, as well as an integrated blowing hole design as part of the nose cap. While certain materials, such as silicone, proved exceptionally functional in regards to hygiene, ease of cleaning, and increased comfort, they also imposed negative implications in regards to sound production. Moreover, these materials introduced an unfamiliar feeling and visual aesthetic, which did not align with the collective preference for exploring natural materials to connect with our surrounding environments.

Exploring more natural approaches, I undertook extensive trials using wood shavings to enhance the visual aesthetics. The intention was to explore the potential of using a single primary material source to create varying effects for different components. Shavings were combined with bio-resin to mimic the appearance of tree gum for the adjustable nose cap. This not only intended to enhance the visual appeal of the instrument but also make the surface easy to clean.

Fig. 45.
Prototypes of nose cap material and colour exploration. This included a range of different resins, natural rosins, and wood shavings

Fig. 46.
Refined adjustable nose cap. The image demonstrates different angles of rotation. While only four positions are depicted, the nose cap allows for 360º of fluid rotation



In developing form, the primary focus was to facilitate precise adjustments in the distance and angle between the end of the instrument and the blowing hole. The reason for this was to enhance sound production by assisting players to find the instrument's optimal resonance (the 'sweet spot') and support variations in both timbre[21] and frequency.

These effects can be achieved through the simple rotation of the nose cap which alters the angle and distance (3mm—11mm) of the nasal airflow. While the precise position to attain specific sonic qualities differs between individuals, a variety of effects are possible for each person by utilizing different horizontal and vertical positions.

Supporting its sonic function, the nose cap was also designed to enhance overall comfort around the nose and reduce pressure points of the maxilla[22] which was a primary cause for discomfort during prolonged playing sessions. The form was developed in consideration of different facial profiles – more specifically, the nasolabial[23] angle which varies extensively among individuals. Different facial profiles were analyzed in order to understand how the nose cap design could accommodate and increase comfort for a more enjoyable playing experience. This involved taking photographs of three Tongans across three generations of one family, illustrating the evolution of facial profiles, and the opportunity to adapt the fangufangu across generations. Together, these considered elements balance both form and function to increase the overall sonic versatility and provide a tailored experience that caters to individual facial profiles, preferences, and playing styles.

Fig. 47.
Illustrating diverse variations in facial profile, specifically nasolabial angle across three generations of a Tongan family

21 The ability to vary the timbre can also be achieved by rotating the fangufangu from side, however, this is not always optimal for extended performance
22 Bone that forms the upper jaw: this encompasses the area of contact between the fangufangu and face
23 The area between the nose (nasal) and the upper lip (labial)

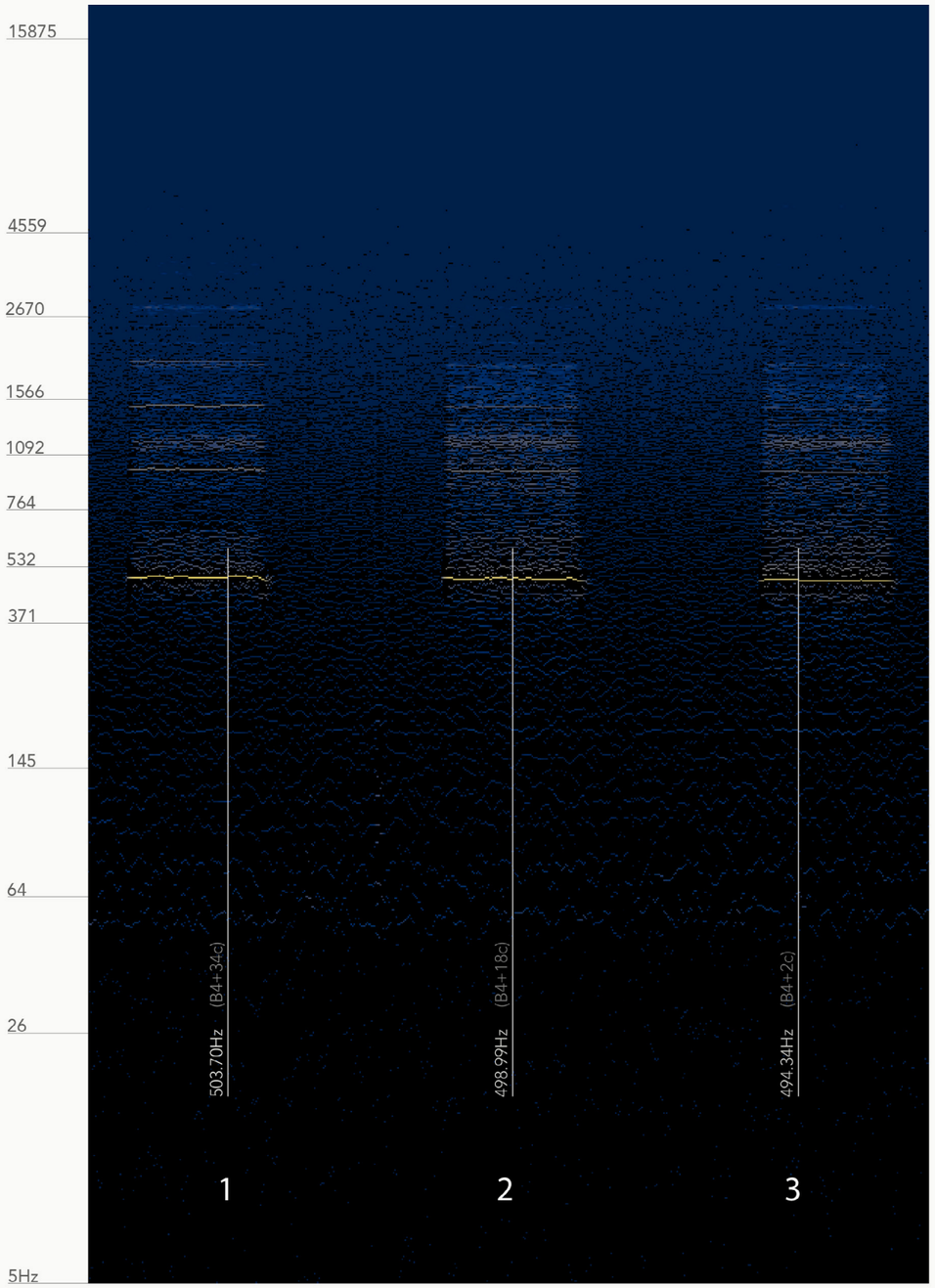


Fig. 48.
Spectrogram demonstrating three nose cap positions and their respective frequencies and timbral characteristics

—
Aperture: Open
Holes: Closed

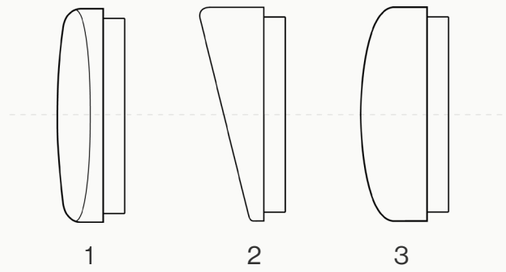


Fig. 49.
Plan view: corresponding nose cap positions for the spectrogram shown in Fig. 48

5.3.1 Frequency and Timbral Reflection

As illustrated in Fig. 48, the instrument's tone changes as the nose cap is adjusted to different positions. This is due to assisted variations in hole coverage[24] and the angle of nasal airflow projection[25] which support a range of positions and interactions with the blowing hole. Recordings were taken using an iPad pro at 218kbps, with the analysis performed using sonic visualiser – settings are outlined in *Chapter 3*.

Position 1
Peak frequency is 503.70 Hz *(B4-34c)* with a strong second harmonic of 1007.4 Hz *(B5-34c)*, strong third harmonic of 1511.10 Hz *(F#6-36c)*, moderate fourth harmonic of 2014.80 Hz *(B6-34c)*, and weak – moderate overtones in between.

Position 2
Peak frequency is 498.99 Hz *(B4-18c)* with a strong second harmonic of 997.98 Hz *(B5-1c)*, moderate third overtone of 1250.45 Hz *(D#-8c)*, and weak – moderate – strong overtones in between.

Position 3
Peak frequency is 494.34 Hz *(B4-1c)* with a moderate – strong second harmonic of 988.45 Hz *(B5+2c)*, weak third overtone of 1250.45 Hz *(D#6-8c)*, and weak overtones in between.

It is clear that minor changes in frequency occur when the nose piece is adjusted, however this changes with varied finger combinations. More notable is the significant variation in timbre. Personally, the instrument is clearer in sound when playing in position one – this also produces the most and strongest number of overtones in comparison to positions two and three. While these effects can be somewhat achieved by rotating the fangufangu body and altering the horizontal or vertical distance between the nose and blowing hole, the range is not as broad and it is often harder to control and sustain in a comfortable manner.

24 The amount the blowing hole is covered by the nostril
25 The angle of projected air into the blowing hole

5.3.2 Collective Critical Reflection

The reflection of product concept evaluation was undertaken through collective talanoa with participants. Through this, individual experiences with the first fangufangu concept were shared and discussed for each primary design component in an effort to define the following stage of design development.

> I felt that when you angled it, you could get that sort of airy tone that you get more with the bamboo ones, but then you could also angle it to get a more clear tone. (Adriana)

> It's pretty awesome playing all the different angles [...] the range was really surprising, all in the one single product [...] when making bamboo ones, there are different features you like about all the different ones you make, and so you switch between. Here's something you can almost go between a range of different sounds. (Sam)

The nose cap obtained positive feedback in regards to the range of angles and their respective sonic effects, which allowed players to achieve diverse timbral qualities. Additionally, it facilitated subtle adjustments of pitch through adjustments in horizontal and vertical distance between the nose and the blowing hole. Notably, the same position yielded different tonal qualities for each individual, highlighting the opportunity to develop customizable components to support the individual preferences of players.

> I was so amazed at the tones that you were getting, and the notes you were playing. When I was playing in the same position that you were, with the cap leaning in, I was trying to get something that sounded sort of cohesive–it was a little bit all over the place, it wasn't like a proper scale or anything. But your video sounded like you had something good going on [...] (Sam)

Although the rotational range was effective, there were difficulties in achieving a smooth and effortless motion. This was a result of the nose cap attachment method which was press-fitted into the instrument body. While this was a necessary measure to prevent air from escaping, it was not intuitive and compromised the user-experience.

> [...] I did find it a bit hard to twist it. Maybe wood would be a little different, where it's a little bit smoother to twist around and maybe this was a little bit too tight. (Saia)

From the perspective of comfort and ergonomics, the overall form was considered excellent as it effectively adapted to accommodate the individual facial profiles of each player. Moreover, it was successful in relieving skin irritation and redness around the nose.

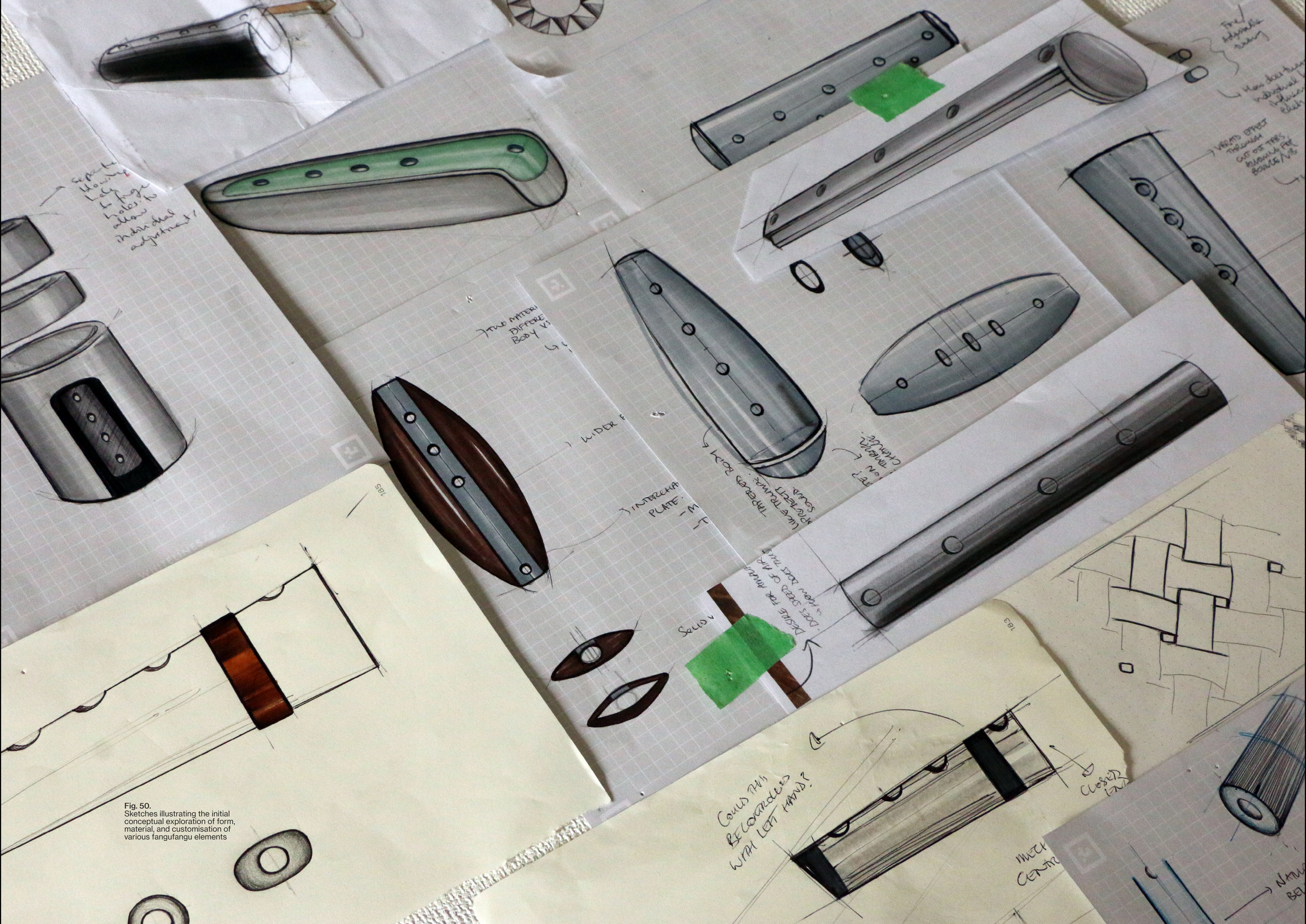


Fig. 50.
Sketches illustrating the initial conceptual exploration of form, material, and customisation of various fangufangu elements

5.4 Body Form and Size

As mentioned earlier in the chapter, one of the primary objectives was to enhance the instrument's playability and versatility by facilitating easier finger hole navigation and the ability to produce different frequencies. This was achieved by reducing the length of the body and overall instrument footprint. Drawing from the Te Papa fangufangu as earlier discussed in *Chapter 4*, the dimensions for the first prototype were based on one-third of its length, its average diameter, and the average hole size. Although a variety of forms were explored, the decision to draw inspiration from the natural subtleties of bamboo was decided.

This was for two reasons: firstly, in consideration of the two added moving components (adjustable nose cap and tuning dial) where implications were yet to be understood, and secondly, in the desire to embrace and enhance the inherent formal properties of bamboo.

Materiality of the body was not prioritized for the first fangufangu concept. Instead, the use of polyvinyl chloride (PVC) pipe was chosen to focus on the new components in regards to overall scale, function and playability, rather than the sonic qualities of the material. This simplified the creation of multiple iterations, supporting precise refinement of design elements for the initial phase of experience testing.

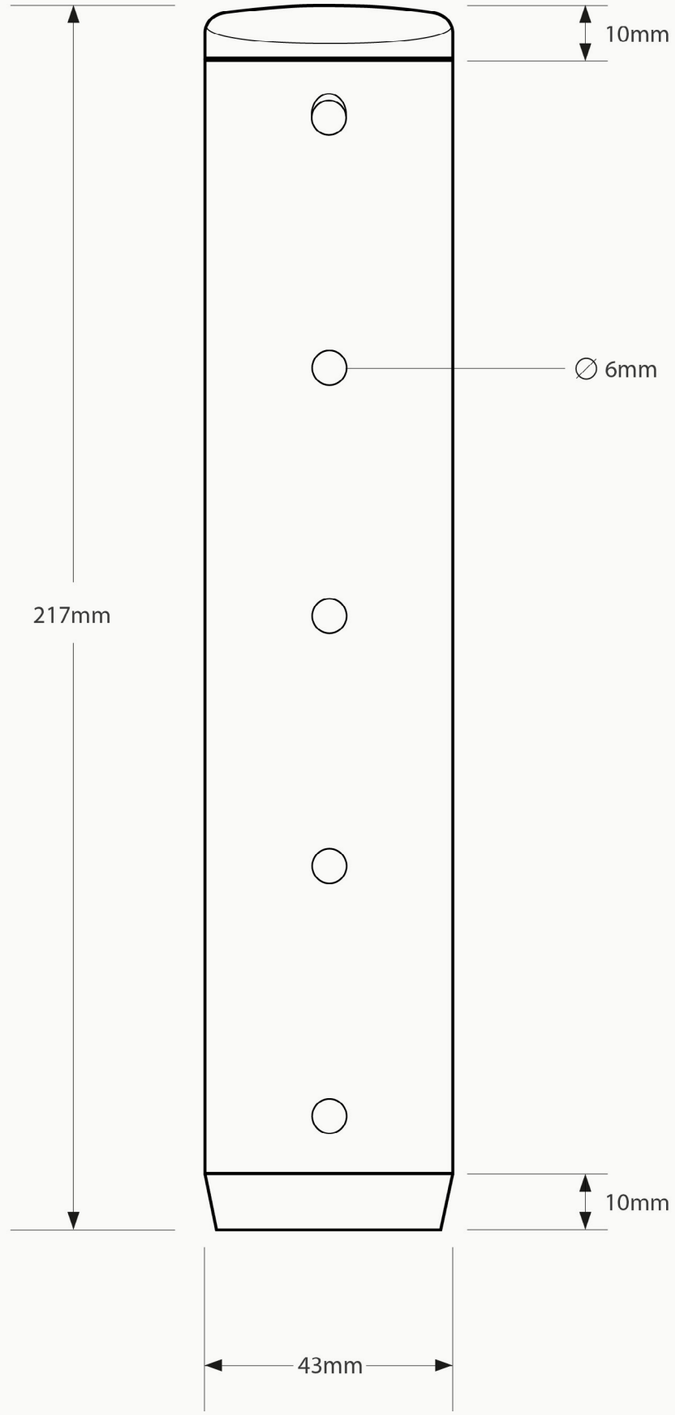


Fig. 51.
Plan view of the refined prototype scale and form

5.4.1 Collective Critical Reflection

The overall scale of the instrument had both positive and negative implications. This was primarily due to the varying hand spans of participants which led to two distinct outcomes: effortless navigation of all finger holes for those with smaller hands, while others felt constrained by limited space. Although it did not accommodate everyone, a mutual enthusiasm was expressed in regards to the ability to experiment with diverse finger combinations. This enhanced the instrument's sonic versatility and encouraged exploration of all finger holes for those who typically play with customary fingerings.

> My hands are quite small, so the space between holes allowed me to easily achieve different fingering combinations. (Adriana)

> I found it an awkward length, my two fingers were so close that it kind of made my thumb movements feel a bit more disjointed. [...] I don't know if it's just me being used to spreading my thumb and fingers out more [...] being able to cover almost everything–it's an interesting size to be playing with [...] (Sam)

> It's really nice being able to actually experiment with everything (Saia)

Expanding further on finger hole navigation, the videos from experience testing highlighted a distinct approach to playing without occluding the nostril. This exemplifies the significance of prioritizing access to holes beyond customary fingerings, and emphasizes a shift in the use of the fangufangu in contemporary musical contexts.

> I don't even block to be honest. I don't know if you noticed in the videos but I don't block, even with the other fangufangu. I just find it easier to have my hands free, and I think we talked about that, if you could plug your nose it'd be better because you could have your hands free. (Adriana)

While the finger hole size supported smaller hands, it also compromised the extent of certain aesthetic techniques (e.g. ofe'i or pikopoko'i/fakahēhē) relative to other fangufangu. This was due to limitations of the smaller holes which underscored the challenge of accommodating smaller hand sizes while also providing large enough holes to articulate a range of incremental pitch changes.

> [...] the size of holes allow for easy coverage while still being able to be half-covered to achieve a half-tone and/or sliding across to achieve techniques of pikopiko'i / fakahēhē (Adriana)

> [...] I struggle to do that with this one because of how small the holes are. You're always just covering it if you're trying to sort of shade it a little bit. You can do it, but I need to practice it a little bit more. (Saia)

> Something I noticed with the other fangufangu with the larger holes, I can get quite a few different pitches. With this one, I could still get the half but I couldn't quite get another one, like a quarter. [...] I can slide over it and get a nice sort of dip, but even though I loved how small they are, I think slightly bigger you could get more pitches in there, by covering it in different ways. (Adriana)

Although materiality was not a focus for the first prototype, a critical insight emerged in regards to texture. For reference, it is important to note that two of the prototypes sent out were damaged during the experience testing phase – this primarily resulted from the smooth texture of the instrument's body and its fragility. This highlighted the important consideration of texture in facilitating aspects of playing, but equally its role in the practicality of handling the instrument.

> I dropped it–it rolled off the table. (Sam)

> [...] The material isn't too different from bamboo in terms of the surface, but I feel like it's maybe a little bit more slippery than bamboo and can easily just slide out of your hands–I was always wary. I mean, knowing what happened with the first one, I was a lot more cautious around how I treated this one. (Saia)

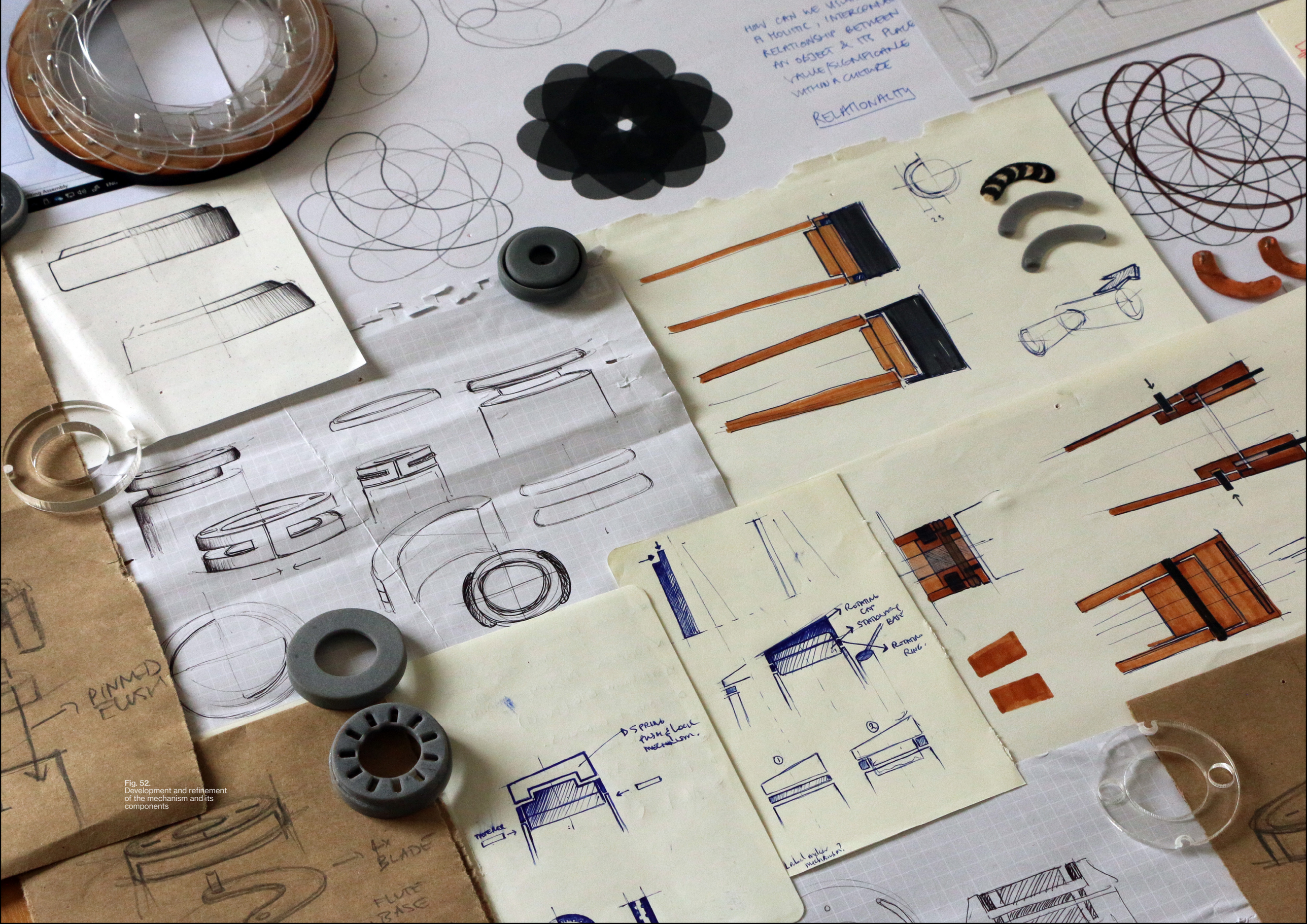


Fig. 52.
Development and refinement of the mechanism and its components

5.5 Tuning Dial

The concept of tuning surfaced through exploring opportunities to broaden the sonic parameters and versatility of the fangufangu *(see Sub-section 5.1.1).* Initially, an interchangeable finger hole plate was created to better understand the implications of sound, which also served as a method to experiment with customized tunings and timbres through material and finger hole variations. This aligned with tuning the overall 'scale' of the instrument while maintaining customary finger hole relationships, as previously discussed. However, while this exploration was valuable, it posed issues in regards to structural integrity and sound quality.

To achieve a more integrated approach, the idea of tuning to microtonal intervals emerged. Drawing from insights gained during the initial practice of making, it was clear that the most effective way to achieve this at maximum capacity was to either design a resonating body which could adjust in length, or an end cap that could adapt to various apertures. In terms of player experience, and in an effort to design an optional and natural extension of the instrument, the concept for an adjustable end cap seemed a better approach.

Although several methods were considered, inspiration was drawn from the natural biological structure and motion of the iris diaphragm[26]. This is used extensively in the field of optics with its most common application found in the camera shutter dial. However, its use beyond this context is limited – to my knowledge, it has not been explored from the perspective of sound or musical instrument design. As an established method for aperture adjustment, I was curious to explore the parameters and materiality of the dial as an integrated component of the fangufangu.

Numerous prototypes were designed and made in order to understand the components tuning limitations and its impact on sound. Given the instrument's scale and the aim to expand its frequency range, CAD was used for exploration and simulation to effectively balance necessary tolerances within an optimized range. Materials such as sheet copper and plastics were tested, however, due to the complex parts – especially considering its scale – and the necessity to create multiple refined prototypes, 3D printed SLA was used as an initial material approach for testing its functionality.

One of the key obstacles in developing this component was due to the instrument's scale and the number of components necessary to achieve a seamless motion and broad frequency range. Upon initial testing, the complexity of maintaining sonic relationships between the finger holes when the tuning dial was in use was expected, and encountered. These relationships varied depending on the combination of both finger hole configuration and aperture size.

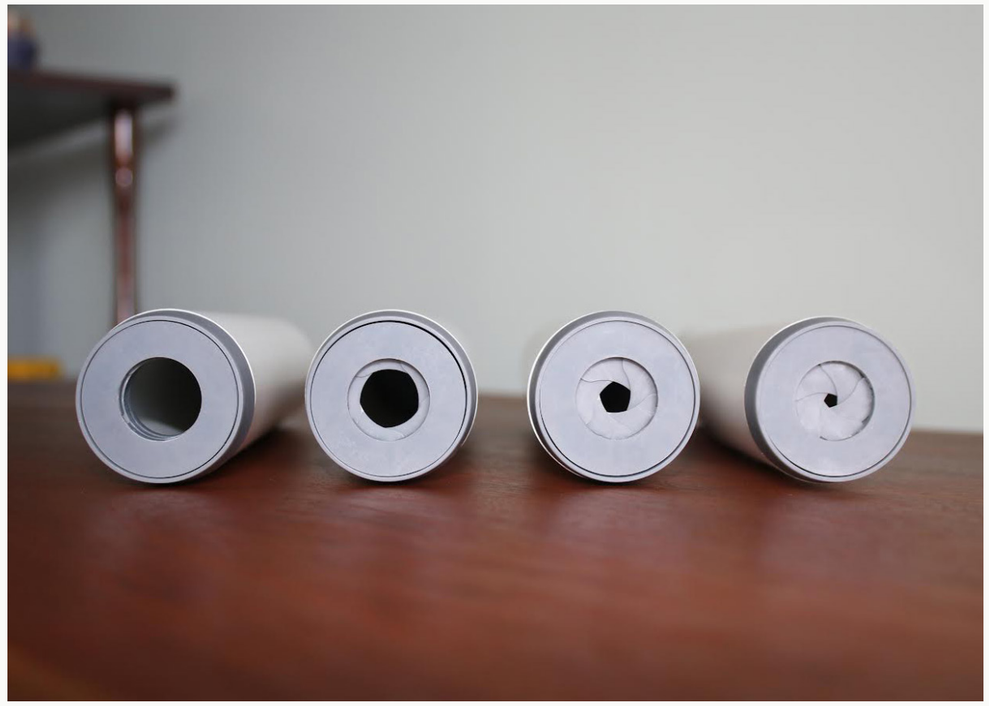


Fig. 53.
3mm – 19mm aperture range
across four identical prototypes

26 See www.wikipedia.org/wiki/Diaphragm_(optics)

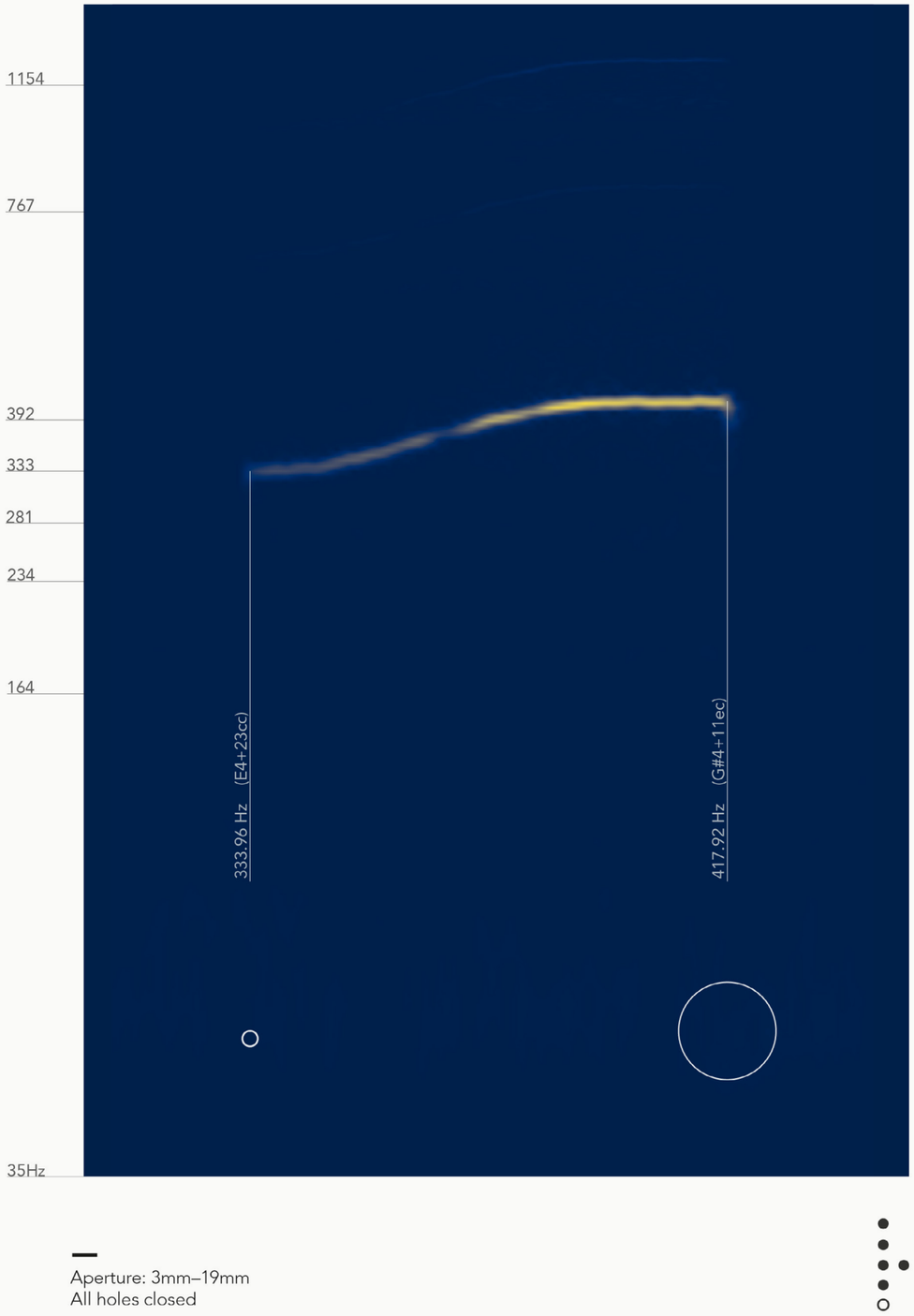


Fig. 54.
Melodic range spectrogram, illustrating the tuning dial parameters. Recording was taken on an iPad at 60kbps

5.5.1 Pitch Analysis

When all holes are closed the broadest frequency span is achieved. This ranges from 333.96 Hz *(E4+23c)* at the minimum aperture of 3mm to 417.92 Hz *(G#4+11c)* at the maximum aperture of 19mm. As a point of reference, this corresponds to a major 3rd. Figure 54 illustrates this gradual increase in frequency between the two apertures, and shows the growing intensity in amplitude as the mechanism opens up – this is depicted by the saturation of colour.

It is important to note that the more finger holes are open, the smaller this range becomes as there are more opportunities for air to escape. Considering this, while the broadest range is equivalent to a major 3rd, this varies depending on how it is used, and the finger combinations. Furthermore, we can also see as the aperture opens, overtones become more defined – a second harmonic is evident at 835.82 Hz *(G#5 +11c)* and a third harmonic at 1253.75 Hz *(D#6 +13c)*.

5.5.2 Collective Critical Reflection

This dial aimed to provide musicians with a more versatile and precise way of achieving microtonal intervals on their instruments by allowing smooth adjustments of pitch within a microtonal scale, thereby providing a greater range of expressive performance possibilities. Regarding the functionality of the tuning mechanism, participants concluded that closing the tuning hole resulted in greater difficulty finding a sweet spot, and therefore in achieving a clear sound. From my perspective, this was partly due to choice of materials, as the SLA resin seemed to significantly absorb the sound.

> When I was experimenting before, I was able to immediately get some sound as opposed to the cap being closed which sort of required looking for a bit of a sweet spot to find it. (Saia)

> When you close the tuning hole, it's harder to find the sweet spot, I guess because the air is being trapped in a way to get it out. (Adriana)

Multiple issues arose with regards to the structural integrity, design and assembly of the prototype. For instance, it was noted by participants (on three occasions) that certain components of the tuning dial broke due to insufficient durability. This highlighted key issues with materiality and overall design.

> But I mean, I love the design, I love the thought you've put into it. It's just quite a bit on 2 little pins aye. But when it was working, I mean I could still reconstruct it and chuck it on and still play with the different tunings–I thought that was an awesome feature. (Sam)

Various playing techniques were discussed during our talanoa, alongside their impact on musical aesthetics. The functionality and simplicity of the tuning dial was well received, and despite its initial intention being to intermittently raise or lower the overall pitch of the instrument (hikihikitō), experience testing highlighted its ability to facilitate alternative aesthetic techniques.

> Yeah, they roll on the guide so well–just, mindblown. So simple, but so good. (Sam)

> Facilitation of hikihikitō/hikihikitā/hikihikikī (as an aesthetic technique), in achievement of tauelangi (as an aesthetic value), particularly in tandem with fakahēhē and continuity of sound. (Adriana)

Moreover, one participant creatively used the tuning dial to alter the pitch in real-time, as an alternative to achieve the aesthetic technique of ofe'i.

> [...] it's so simple to use it as you're playing, which I really liked. (Adriana)

One issue which negatively impacted playability was the relationship between the fifth hole and the tuning dial – specifically, the distance between them being too close together such that it resulted in the inadvertent rotation of the tuning dial. A suggested remedy was to consider textural details on the rotating dial in order to improve its functionality.

> One thing I did find when I was stretching out to the furthest hole, if my finger was off it and I wasn't paying attention, because of how easy it is to twist it, I'd find myself just rolling as I was playing it. And I think it's just because of the length and how close it is, this hole at the end. It just rolls so smoothly–a little bit too smoothly. (Saia)

> You could almost have a grip, like a little pinky grip, just a little surface area that's rough enough so you can sit there, almost like a pitch bending little wheel. (Sam)

In regards to the overall frequency range, this varies depending on finger combinations – from a minor 2nd (with all holes open) to a major 3rd (with all holes closed). The addition of microtones to the overall scale was considered a significant contribution to the sonic versatility of the instrument. In saying this, there was a desire to further enhance this range. While the aim for maintaining the sonic relationships between holes (when using the tuning dial) was not quite achieved, its ability to support Tongan musical aesthetics was highly valued.

> Great addition of microtones to the overall 'scale' of the instrument. (Adriana)

Fig. 55.
Close up of the tuning dial showing the full range of aperture diameters

5.6 Summary

This chapter has provided a comprehensive summary of the design foundation, process, and collective critical reflection of the first fangufangu concept. While numerous prototypes were created as part of the design development, refined product concept evaluation was undertaken by practitioners of the field. The concept was largely well received, however, specific aspects for improvement were highlighted. Collectively, these insights informed the design objectives for the second prototype development, which is outlined in the following chapter.

Positive contributions

Nose Cap

- Well refined form which alleviated redness and discomfort around the nose
- Accommodated different facial profiles
- Assisted with expanding aspects of sonic versatility (e.g. timbre and pitch)

Form and Body

- Scale encouraged exploration of varied finger combinations
- Supported players with smaller hands and fingers

Tuning Dial

- Facilitated Tongan aesthetic techniques (e.g. hikihikitō/tā/kī, and fakahēhē – specifically ofe'i/pikopiko'i)
- Offered the inclusion of microtonal intervals beyond semitones and quarter tones

Areas for improvement

Nose Cap

- Method for rotation was not intuitive
- Motion of rotation was not consistently smooth
- Materiality

Form and Body

- Overall scale was too small to comfortably accommodate larger hand-spans and fingers
- Form easily rolled off the table which led to damage
- Materiality

Tuning Dial

- Difficult to sound the instrument when the aperture was closed
- Easy to 'accidentally' use due to its close positioning to the fifth finger hole
- Prone to damage due to the design and attachment of components
- Increased parameters in frequency range could better assist aesthetic techniques and elevate the achievement and aesthetic value of tauēlangi

Other

- Thumb was not always used to block the nostril – this was in order to optimize the use of both hands, thus enhancing finger hole navigation

6. Fangufangu Concept Two

This chapter continues the collaborative and practice-led research process and will discuss the development of fangufangu concept two. Similarly to *Chapter 5*, fangufangu concept two was sent (with an information sheet) to participants, who had several weeks to explore and document their experiences. One notable difference this time round was that this also came with a box of interchangeable components. An unboxing video highlighting the assembly and function of these components was filmed and sent to participants online.

After several weeks of product concept evaluation, a collective talanoa was then held to critically reflect on these experiences and inform the final phase of design development – this shaped the second fangufangu concept development towards aspects of aesthetic refinement and sensory experience. Development included enhancing previously explored concepts, such as the adjustable nose cap and tuning dial, and also introduced various new elements into the design framework.

The structure of this chapter reflects this process by first introducing the design objectives informed by insights gained in the previous chapter, and then the refined concept including an outline of various features, their development, and the collective talanoa with participants.

This section introduces the design objectives and deliverables which inform the design development throughout this chapter. These are based on the key themes identified at the start of this chapter, namely: sonic versatility, playability, and culturality and musical aesthetics. It is important to note that this concept did not focus on materiality. The reason for this was to gradually introduce elements into the product concept evaluation process.

6.1 Design Objectives

Develop a component to occlude the nostril

- How can this positively impact the comfort and function of fangufangu playing?

Optimise the tuning dial for use while/between playing

- How does the length/diameter of the body, as well as finger hole positions impact this?
    - How fluid should the motion be?
    - What is the ideal frequency range?
    - What form and texture will enhance maximum control of this component?
- How can the components be refined for intuitive assembly and durability?

Explore how subtle variations in form can:

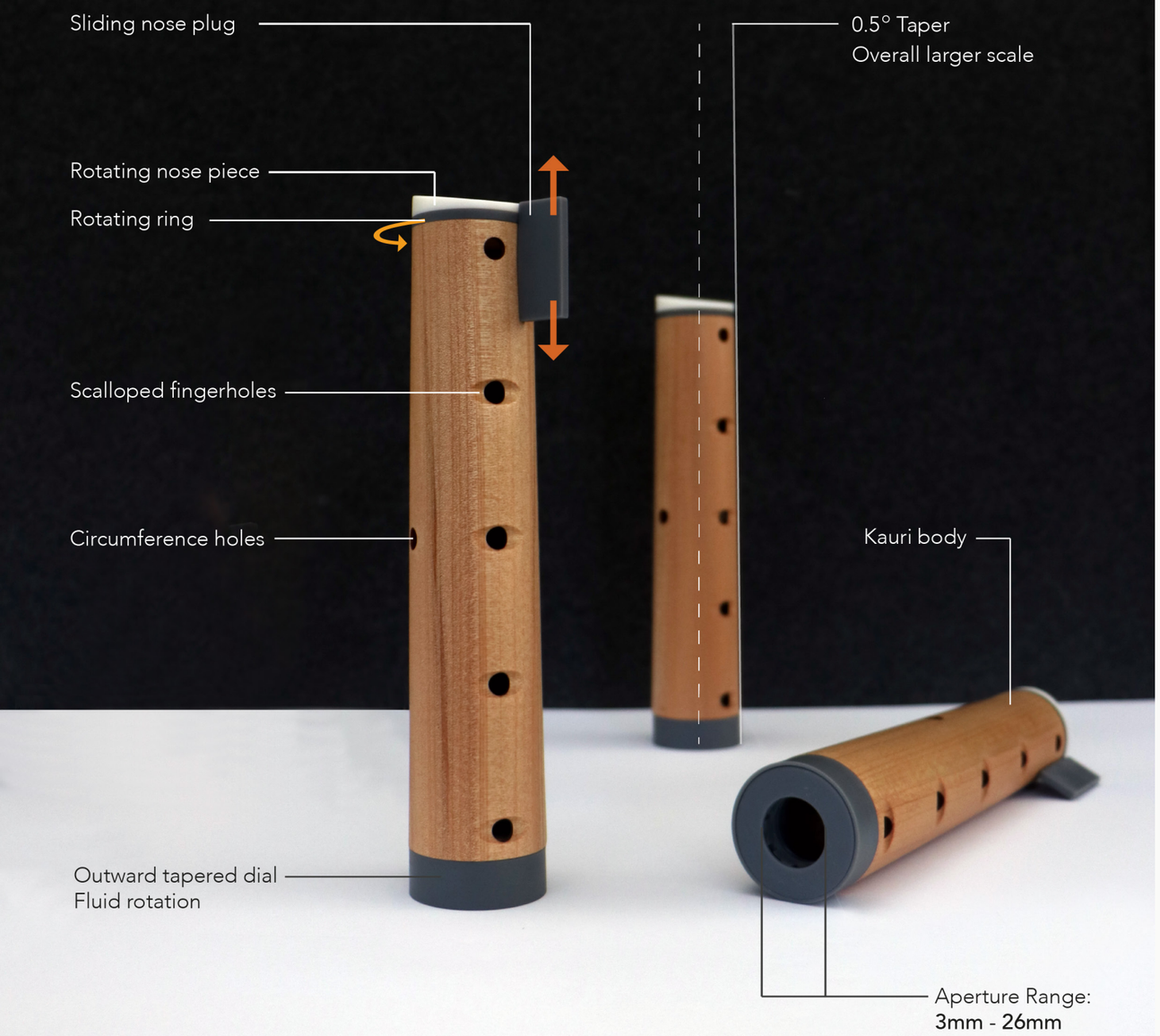
- Support a more symbiotic relationship between the body and the instrument
    - Assist the technique of ofe'i
    - Provide alternative approaches to manipulate or control sound
- Increase the overall resonance and/or volume of the instrument
- Help establish a secure method for intermittent placement

Experiment with different tonewoods for the fangufangu body

- Experiment with different tonewoods for the fangufangu body
- What best resembles the visual and acoustic qualities of kofe?

This chapter will closely examine the refined fangufangu prototype by breaking it into its key elements. Firstly, the overall concept outcome will be introduced. This will be followed by an overview of each component, encompassing its function, development process, and the critical insights gained. The primary components include: a) Rotating Nose Plug, b) Scalloped Finger Holes, c) Circumference Holes, d) Tuning Dial, and e) Materiality.

Fig. 56.
Breakdown of the primary design features for the second fangufangu concept iteration



6.2 Design Deliverables

Sliding Nose Plate

- Slides up and down to fit different nose lengths
- Offers a hands-free way to plug the nostril. This expands the ability to navigate the finger holes–especially those around the circumference.

Rotating Nose Ring

- Rotates around the circumference of the fangufangu, supporting different nose widths
- Secures the nose plate, and provides customized adjustment for its distance from the blowing hole.

Scalloped Finger Holes

- Primarily inspired to support the technique of ofe'i
- Explores expanded possibilities of sonic expression and playability.

Customizable Circumference Holes

- They can be used as an extension to the top holes, or plugged specifically to explore different frequency possibilities, or preferred positionings
- Draws from the Te Papa Artefact FE012471 as a way to explore the sonic and playability implication of additional circumference holes.

Outward Tapered Dial/Tuning Mechanism

- Rotates to decrease/increase aperture size. Range 3mm - 26mm
- Form allows for a larger tuning mechanism (and subsequently frequency range) and follows the outward taper of the Kauri body. Rotation of the dial is more fluid in motion for ease of in-playing use.

Kauri Body

- Light weight and golden softwood, with a relatively even/straight grain
- Explores the sonic influence of materiality through the use of tone-woo, and physical influence of weight. Tapered body allows for increased scale of the tuning mechanism, a new perspective of playability through form, and possible acoustic benefits.

Fig. 57.
Sketches and prototypes illustrating the exploration of the nose plug form and function

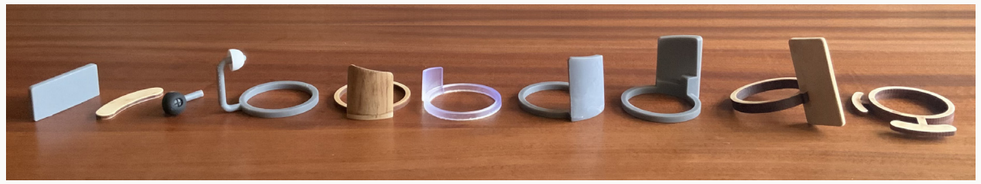


Fig. 58.
Prototypes of different methods for internally and externally plugging the nostril

6.3 Nose Plug

Development of the nose plug aimed to explore more comfortable and effective ways for occluding the nostril without using the thumb. Regarding playability, this intended to optimize the dexterity of both hands while also expanding the instrument's versatility by accommodating additional finger configurations and improving the ability to attain a broader range of frequencies easily.

The concept of a nose plug emerged from a key insight during the previous round of product concept evaluation and talanoa. During this phase, we observed Adriana playing the fangufangu without plugging either nostril; instead, she used both hands to navigate the finger holes. This approach improved the finger hole accessibility for both hands by eliminating the constraints associated with using the thumb to block the nostril. To block her nostril, she would use an ephemeral solution as she notes:

> I personally don't hold my nostril when playing, but if I need to, I plug my nose with tissue. (Adriana)

While this method enhances overall finger hole navigation, it inherently influences the instrument's tone, resulting in a sound that is airier rather than clearer due to the dispersed airflow and, therefore, reduced pressure in each nostril.

> [...] you can play without having to block your nose as well. I suppose it's just that you can't get as long a note; you'll probably run out of breath faster (Sam)

Additionally, it introduces certain performance limitations, primarily related to breathing techniques. However, the nature of these influences, whether positive or negative, depends entirely on the player's desired timbral qualities and playing style. The most significant impact of this method is the inability to sustain notes for extended periods – this is attributed to the accelerated release of air through both nostrils instead of just one.

Upon exploring various possibilities, two distinct approaches emerged. The first involved a soft internal component designed to expand inside the nostril to prevent air from escaping. The second involved a rigid external component designed to resemble the customary manner of blocking (i.e. with the thumb) by applying focused pressure to the outer surface of the nose. Considering the desire to foster a sense of familiarity among experienced fangufangu musicians, it was preferable to develop an external component to reflect the established playing technique. Moreover, this direction was more suitable from both a safety (to prevent accidental inhalation of an internal component) and a hygienic standpoint and would better support the individuality of different nose forms.

The development sketches and prototypes Fig. 57 investigated diverse approaches for occluding the nostril by integrating an additional component attached to the instrument. A key focus was offering options for customisation by designing the connection between the fangufangu body and the component to enable seamless detachment and attachment options. Aspects of adjustability were thoroughly explored to provide each player with the means to discover the optimal position tailored to their unique nasal anatomy.

Fig. 59.
Schematic photograph showing the rotation and translation for the nose plate and ring

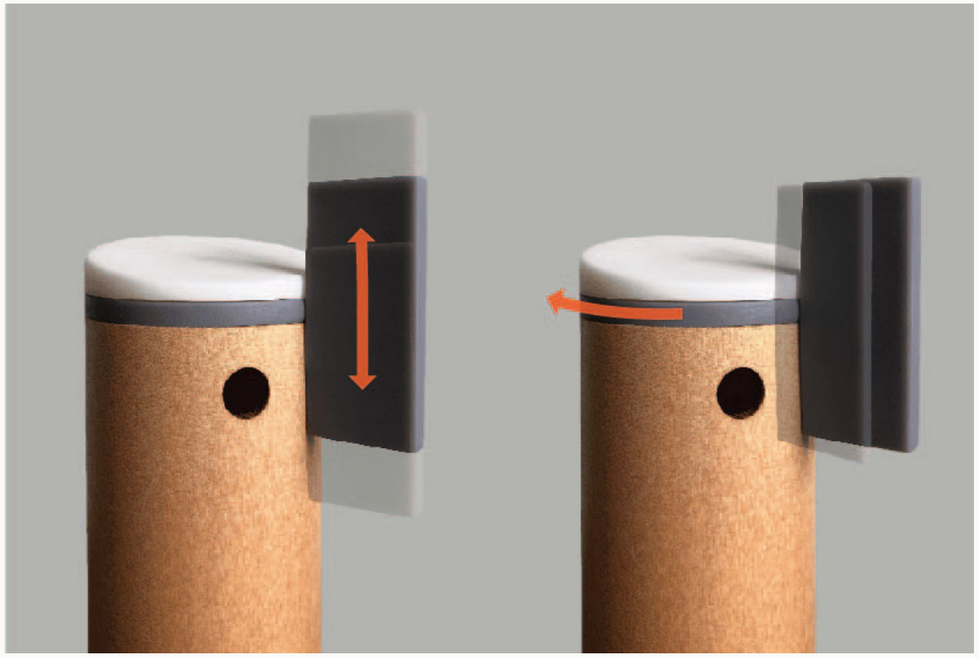


Fig. 60.
Photograph demonstrating the use of the nose plate in performance

The refined method for occluding the nostril is illustrated in Fig. 60. Resembling the surface of a thumb, the nose plate was designed with a slight bow in its form and the ability to adjust in depth by sliding up and down along an internal plate. The design of this was explored through an interlocking joint, supporting a fluid motion driven by friction; and a two-part magnetic system, offering haptic feedback for measuring specific predefined micro-intervals. This specific prototype relied on friction to adjust both the nose plate and ring.

Given the ring had a built-in appendage for the attachment of the plate, a substitute was made, in case the nose plug was not needed or desired. This was necessary due to the form of the fangufangu body being tapered, meaning the nose cap would not fit securely without it. As the intention of this component was to simply test function, materiality was not explored during this phase. Instead, I utilized CAD to develop a range of 3D models for rapid prototyping, testing and the final printing in SLA resin.

6.3.1 Collective Critical Reflection

While there was enthusiasm around the idea of the nose plate, achieving optimal function and comfort was difficult. This highlighted the vast diversity of nose shapes, personal preference, and the need to adapt the approach for design from an individual perspective.

> [...] it's a really cool innovation and I think for a lot of people it would do wonders because you now have an ability to use both your hands [...] but I did find the nose plate to be a bit uncomfortable and that made it difficult to play the fangufangu [...] I personally would prefer to have a tool that blocks my nostril rather than a plate. (Adriana)

> I really like how it was easily adjustable, you can take it on and off [...] I think just from the practical point of being able to block the nostril entirely, for me I just felt like I wasn't able to do that with the current prototype. (Saia)

In expanding on the function of the nose plate, it was evident this caused issues with the quality of exhaled airflow. Considering the limitations in the effectiveness of its design, this resulted in a significant amount of air loss white playing. This effect was felt on both a physical and sonic level, and further created a sense of hesitancy during performance.

> [...] I adjusted it so that I could try to block the nostril as much as possible, but it seemed like there was always some sort of partial gap there which allowed air to flow through. It didn't stop me from creating sound, as you'll see in the video, but I guess one part of it was sort of mental. I was thinking to myself, I'm not getting the maximum air flow through a single nostril with one being blocked. With that said, it just made me less comfortable playing with it on and made me just want to use my thumb to fully block my nose. (Saia)

> I felt like I was losing a lot of air and I could actually kind of hear that as well. (Adriana)

Another aspect in regards to the function of this specific design was that it limited the freedom of playing. This was in regards to the instrument's tone as impacted by the nose plate design, but also by way of physical movement. The latter caused restrictions for how the instrument could be positioned as it provided a prescribed way or engagement.

> I found it a bit hard just where it was to kind of play as freely as I usually would (Adriana)

These insights supported the desire for a separate and internal nose plug, instead of an integrated extension of the fangufangu itself. With this in mind, we discussed the potential benefit of this component for beginner players, rather than experienced fangufangu musicians as they already have a developed manner of playing. This idea is similar to that of training wheels on a bike, where it would provide a step by step focus by initially familiarising yourself with the manner of nasal blowing, and later adapting to the use of the thumb.

6.4 Scalloped Finger Holes

Scalloping the finger holes was motivated by two primary considerations. Firstly, it entailed an acoustic exploration inspired by the performance technique ofe'i – the smooth bending of pitch or transitions between pitches. While this effect can be achieved by simply pivoting the finger forward or backward over the finger-hole, I was curious to explore whether the form of the finger-hole surface could enhance this technique or offer alternative ways to control characteristics of sound, such as pitch modulation (e.g. vibrato or bending) and articulation (e.g. the manner in which sound is initiated, sustained, and ended). Additionally, this aspect intended to foster a more symbiotic relationship between the musician's body and the instrument by enhancing the physical and sonic expressive possibilities for musical performance. This was explored through haptic feedback in order to facilitate a more nuanced control over the instrument's sound.

Secondly, this development was approached with careful consideration of visual aesthetics, drawing inspiration from the sonic harmony between the fangufangu and the tū. Considering the fangufangu is known to emulate the gentle sound of this bird, I wanted to explore how the finger-hole design could echo a tangible and visual resemblance of its eyes. The reason to incorporate this specific feature was primarily motivated by its distinctive shape and its potential to elegantly complement the form of a finger, thus supporting the acoustic aspect of the exploration. The design philosophy behind this approach was guided by a desire to create a holistic sensory experience through connecting the instrument's sound and appearance.

Another instrument that takes design inspiration from other animals, is the Māori pūtōrino[27], a unique taonga pūoro[28] which descends from Hine Raukatauri, the guardian spirit of all Māori flutes and their respective music. It is said that Raukatauri loved her flute so much that she lived in it (Flintoff, 2004). The instrument's shape tapers at both ends, imitating the appearance of a case moth cocoon. This insect holds profound significance in a larger narrative surrounding the pūtōrino's male and female voices[29].

Fig. 61.
Flintoff, A Casemoth Hanging from the flowers of a Pohutukawa, Photograph, 2004

Fig. 62.
Te Papa, *Pūtōrino,* Photograph, circa. 1971

27 Pūtōrino is considered a bugle flute because it has two voices (male and female)
28 Māori musical instrument, or singing treasure
29 Nunns, Richard, and Allan Thomas. "The Search for the Sound of the Pūtōrino: 'Me Te Wai e Utuutu Ana.'" Yearbook for Traditional Music, vol. 37, 2005, pp. 69–79

Fig. 63.
Finger hole exploration through sketching and prototyping. Focus was largely on comfort, playability and visual resemblance to the eye of the tū

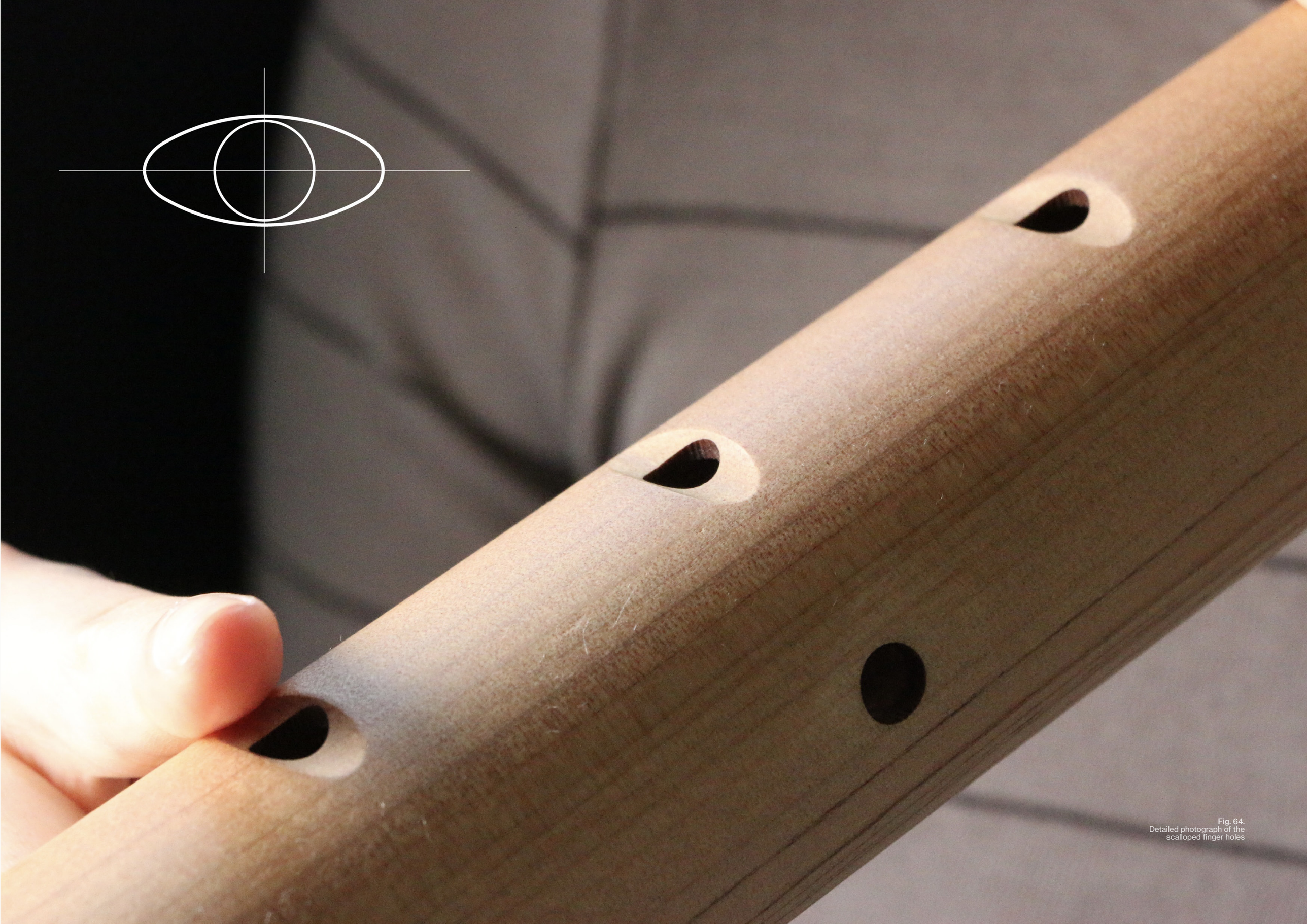


Fig. 64.
Detailed photograph of the scalloped finger holes

To achieve the optimal finger hole shape, I experimented with different variations to balance the visual, tactile, and sonic aspects while aligning with the design objectives. As illustrated in Fig. 63 this involved sketching and physically testing various eye shapes to understand the implications of form, depth, and sonic characteristics. While I knew there would be variations in finger sizes among the players, I was eager to keep this element uniform across each instrument to build a foundation for development and to compare differences in individual experiences.

Given the need to replicate the refined prototype multiple times for each participant, a method was designed to ensure consistency in form across all instruments. A special jig was built for this process, which served multiple functions. Not only did it ensure the uniform length of each fangufangu body but it also served as a tool for the precise cutting of finger holes, and the shaping of its surface through a guide that controlled horizontal and vertical parameters.

The refined form is illustrated in Fig. 64, measuring 10mm x 23mm with an 8mm hole. Notably, the circumference holes were left unshaped due to the specific posture required to use them. Through the combination of personal experimental practice and participant product concept evaluation, three primary techniques were established during this exploration. These were supported by the scalloped form which facilitated novel approaches to achieving ofe'i and engaging with the instrument.

Explored Ofe'i Motions:

1. **Vertical Pivot**
   This motion supports a detached lift over the finger hole, similar to staccato. In this specific case, however, this is achieved by uncovering the same finger hole in a staggered motion. The depth of the scalloped design gently cradles the finger, facilitating a controlled execution.

2. **Lateral Sweep**
   The second example supports a gentle sweeping motion across the finger hole, producing a softer and subtle bending of pitch. When this motion is accelerated it creates a more fluid effect that resembles the combination of ofe'i and tremolo.

3. **Front/Back Rotation**
   Lastly, this technique is an alternative approach to achieving ofe'i. The scalloped form enables secure contact of the body and an enhanced tactile

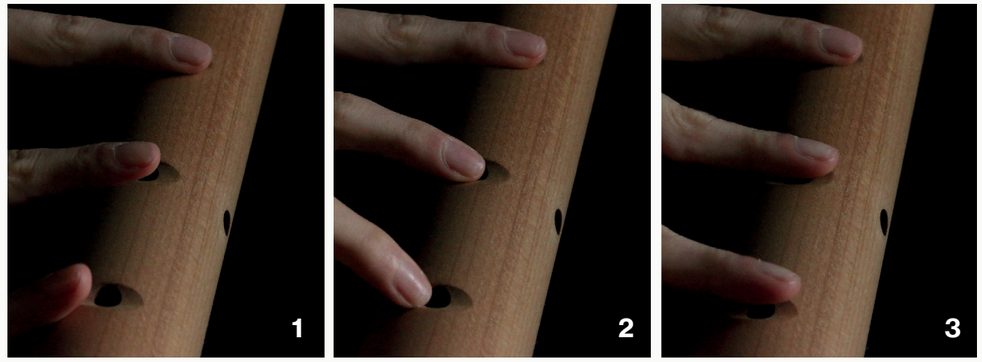


Fig. 65.
Detailed photograph of how the scalloped finger holes assist with the performance of ofe'i and inspire new approaches to manipulate sound

6.4.1 Collective Critical Reflection

In general, the scalloped finger holes were well received and considered a positive addition in respect to both the form and function of the fangufangu development. Participants agreed that it assisted with achieving different ways for controlling sound.

> Superb! Really love this feature [...] it helps you navigate where the holes are when you're playing but also to slide across them using different covering degrees of the hole. I thought that was really nice. It looks beautiful but also it's quite functional. (Adriana)
>
> I love the scallops – they're so clean. (Sam)

During our talanoa, we discussed whether the scallops assisted or hindered the use of specific techniques and whether they could be enhanced further to support these motions, or to explore alternative approaches.

> It's really nice to be able to push (and hold) and I think it helps to assist with sliding it back and forth. I think one thing for me, a call back to what we talked about before [...] I can imagine if the size of the scalloping matched my finger, it'd be a lot more comfortable and feel a lot more intense. So in that sense, because I do a lot of shading and covering, I like the ability to feel the edges of the hole on my finger tips [...] I think the solution for that is probably to have a larger scallop for my larger fingers. (Saia)

As identified during the development of this component, experience testing further highlighted the need to customize the form of the scallops in order to cater to individual finger sizes. A key insight from our talanoa, was the emphasized importance of precisely understanding the degree to which the finger covers the hole, as this is important in gaining a deeper physical – sonic connection with the instrument.

6.5 Circumference Holes

Drawing from the fangufangu artifact case-study *(Chapter 4)* which identified the unusual addition of two circumference holes positioned at the center of the instrument, these were incorporated into the second prototype. The intention was to design them in a manner that allowed for the customisation of how they could be used. For example, by having the ability to plug either hole, this would allow for custom adjustments suited to the player's preference. The intention was to increase the instrument's sonic versatility through an enhanced frequency range, and possibilities of finger hole configurations; and its playability through the ability to plug the holes for ease of comfort when adapting to expanded finger hole configurations, or when certain holes need to be plugged for extended periods.

Given the numerous aspects for development during the second phase, masking tape was used to explore the validity of this concept, and to offer a straightforward method for experience testing. This was effective in gaining a general understanding of whether this would be a useful addition. Although a temporary approach, it achieved an identical effect to that of a finger or plug, providing a practical solution within the scope of development. As the navigation of finger holes has been key in defining the physical scale of the fangufangu, it was important to ensure the addition of the circumference holes would allow a comfortable and efficient performance execution.

For a more comprehensive understanding of the extended frequency range resulting from the addition of circumference holes, I have included two spectrograms below. These illustrate the sonic characteristics when the circumference holes are used with both the aperture closed and open.

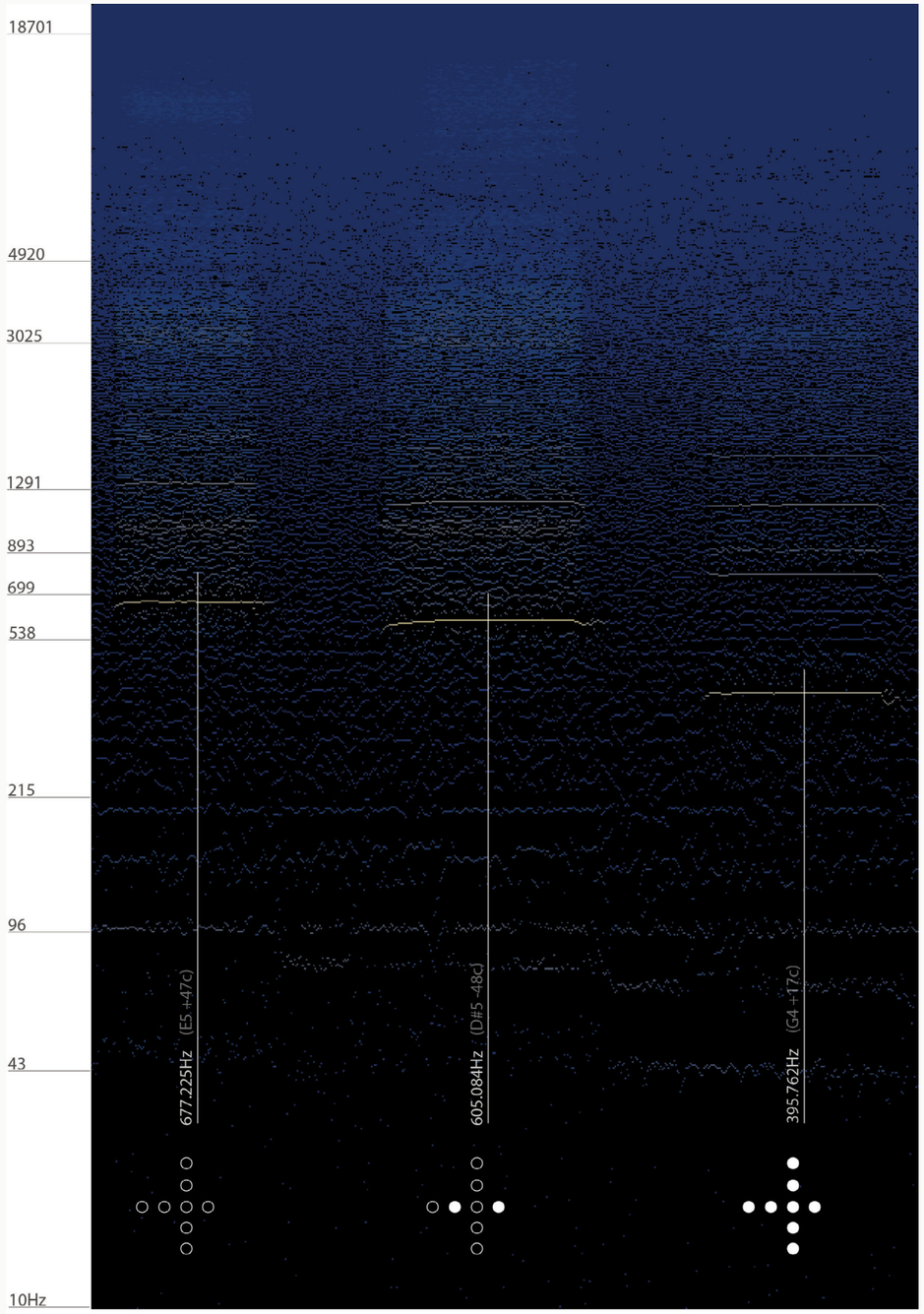


Fig. 66.
Spectrogram: opened aperture and use of circumference holes

— Aperture: Open

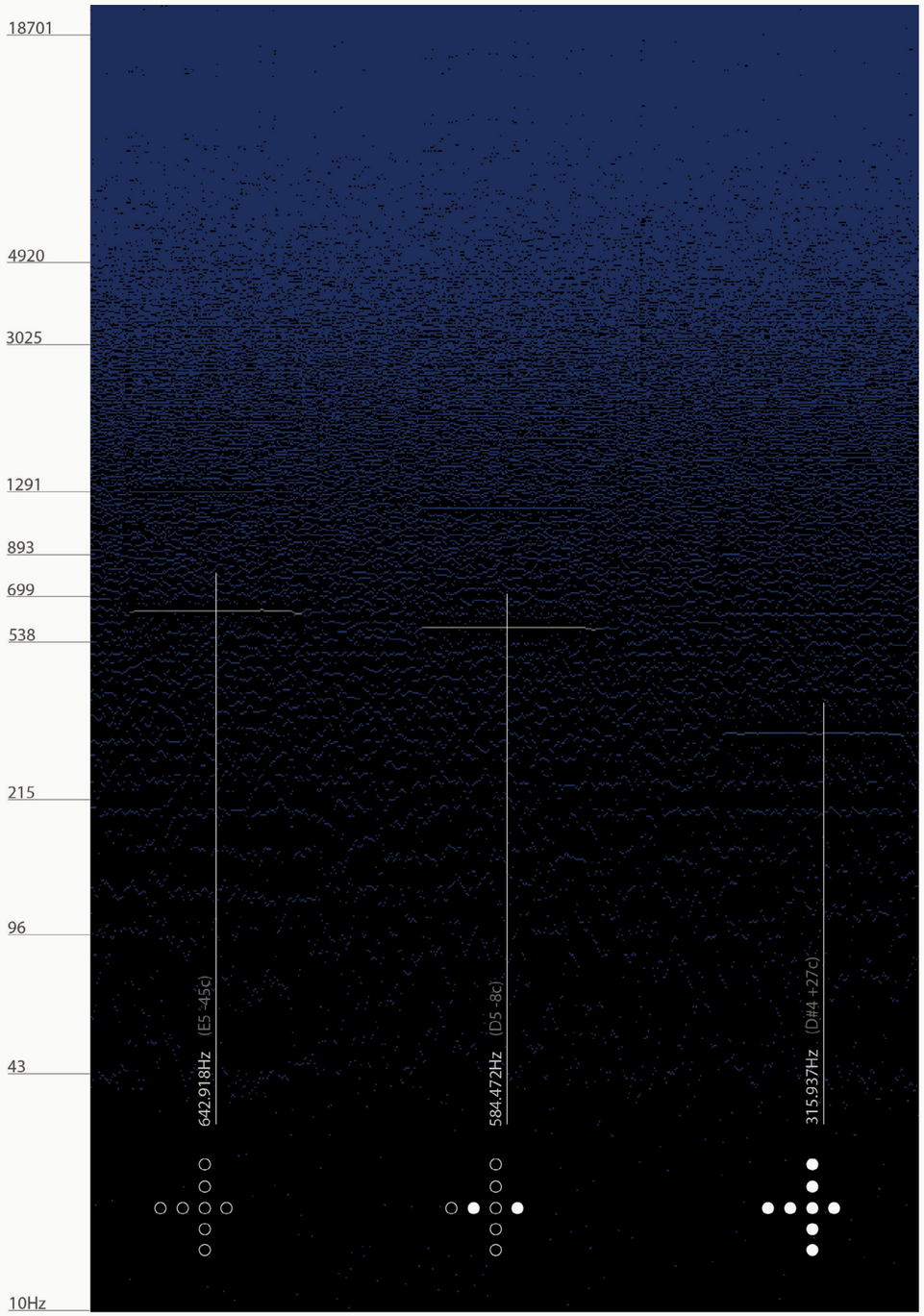


Fig. 67.
Spectrogram: closed aperture and use of circumference holes

6.5.1 Pitch Analysis: Open Aperture

With all holes open, the peak frequency reaches 677.23 Hz *(E5+47c)*, accompanied by a moderate second harmonic of 1354.45 Hz *(E6+47c)* and softer higher overtones. The amplitude is moderate, producing a warm and airy tone.

When the circumference holes are closed, the peak frequency reaches 605.08 Hz *(D#5-48c)*, accompanied by a strong second harmonic of 1210.17 Hz *(D#6-48c)* and softer higher overtones. The amplitude is strong, producing a warm and clear tone.

When all holes are closed, the peak frequency reaches 395.76 Hz *(G4+17c)*, accompanied by a strong second harmonic of 791.52 Hz *(G5+17c)*, a strong third harmonic of 1187.29 Hz *(D6-18.51c)*, a moderate fourth harmonic of 1583.05Hz *(G6+17c),* and softer higher overtones. The amplitude is moderate, producing a warm and airy tone.

Comparing characteristics in the spectrogram, it is clear that the instrument is higher in amplitude and clearer in tone when the circumference holes are closed. However, as more finger holes are closed, an increased breadth of overtones are achieved.

6.5.2 Pitch Analysis: Closed Aperture

With all holes open, the peak frequency reaches 642.92 Hz *(E5-43c)*, accompanied by a very soft second harmonic of 1285.84 Hz *(E6+43c)* and even softer higher overtones. The amplitude is weak – moderate, producing a warm and airy tone.

When the circumference holes are closed, the peak frequency reaches 584.47 Hz *(D5-8c)*, accompanied by a soft second harmonic of 1168.94 Hz *(D6-8c)* and even softer overtones. The amplitude is moderate – strong, producing a warm and clear tone.

When all holes are closed, the peak frequency reaches 315.94 Hz *(D#4+27c)*, accompanied by a soft second harmonic of 631.87 Hz *(D#5+27c)*, and even lighter overtones. The amplitude is soft, producing a warm and airy tone.

Similar observations can be understood from the second spectrogram. Closing the circumference holes leads to a higher amplitude, while the overtones are mostly consistent in nature across all variations.

6.5.3 Frequency Range

Regarding the overall frequency range, it extends from 315.94 Hz *(D#4+27c)* when both the aperture and finger holes are closed, to 677.23 Hz *(E5+47c)* when the aperture is open with all finger holes open. For reference, this range corresponds to a minor ninth interval (octave + minor second).

For the circumference holes alone, the frequency range spans from 677.23 Hz *(E5 +47c)* to 605.08 *(D#5-48c)* when the aperture is open, equivalent to a minor second interval. When the aperture is closed, this range shifts from 642.92 Hz *(E5-43c)* to 584.47 Hz *(D5-8c)*, equivalent to a major second interval.

6.5.4 Collective Critical Reflection

This component, in addition to the concept of general finger hole plugs, demonstrated a beneficial influence on performance versatility and had raised exciting possibilities for advancing current approaches to fangufangu playing.

> It provides greater versatility and a wider range of frequencies to play with. I really like this feature. Positioning of the holes is great and easy to use. I like the idea of having the option to plug the holes if you don't want to use them [...] I think even if you don't end up using the circumference holes in your final product, having plugs for the player is really useful. Like if you were gonna play a melody where you wanted to have it plugged with any of the holes plugged the whole time, I think that's really useful. (Adriana)

> I'd be keen on that as well, curious to see how that sounds. I feel like when I play, I default to the same kind of things that I'm familiar with, and so just having one hole plugged on the top supports me to try something different, without having to put an extra finger on there the whole time. (Saia)

Now that we have gained a deeper understanding of the implications regarding the circumference holes and frequency range, it is unsurprising that participants encountered particular challenges when using them in specific positions. A notable issue was in the ability to produce a clear and sustained sound when these holes were unplugged. While the exact cause of this issue remained uncertain, it likely stemmed from the quantity and placement of holes around the instrument's circumference and the proportion of air released relative to its scale.

> I just found that when the holes were open, I struggled to get a sound out. I just cover them up every time and then immediately the sound would come out. I tried to play around with it for a bit, but it just seemed like it made it a little bit more difficult. (Saia)

> Trying to get the other tones out of it was a bit tricky for me, I found it quite challenging [...] so I found most of the time I kept the two on the side taped playing it straight. It was really nice I think the aspect [...] I imagine the addition is a really good avenue to explore the other tones and what you can get out of it. (Sam)

Conversely, the spectrum and control of tonal variety and volume was significantly improved compared to the initial prototype, which primarily served as a test of form, function, and playability. These enhancements can largely be attributed to the choice of materials and the tuning dial, both of which will be discussed in the following sections.

> Something I did notice was the volume control on the instrument – I could get soft, I could crescendo really easily [...] Tones are really pure and clean. Easy to change volume between soft and loud, and projection is quite significant. (Adriana)

During our talanoa, we discussed individual preferences regarding ideal fangufangu characteristics. A significant focus of this revolved around the instrument's tuning. An interesting insight from this was that the choice of tuning depended on various factors, including the context of the performance and individual playing styles. This revealed that there is no single or universal approach to fangufangu tunings or scales; rather it is a matter of personal taste and suitability for specific musical contexts.

> Every time I'm making a fangufangu I try to get those three kinds of sounds when I'm playing those finger positions [...] and so when I talk about struggling to create a scale, it's just in reference to that minor pentatonic sort of sound – which is maybe the intention for the original one of this, they probably played it a different way. (Saia)

> Yeah, it's funny, again, it's your approach to the instrument because I think some people look for the scale and they try and find it in the instrument. I just play with whatever that fangufangu is producing itself. But I know for a lot of people who would like to play the Malukava and Ve'ehala melodies, they want to have the ability to do that. (Adriana)

> Yep, that's my ideal because there tends to be, but maybe that's a subjective thing, like cos that's the scale that we've heard and that we're trying to reproduce for the Tongan music that we're wanting to recreate, so we're sticking to recreating that pentatonic minor scale. (Sam)

For some, the essence of fangufangu performance lies in recreating melodies from the past, such as those composed by Ve'ehala and Malukava. With this in mind, the instrument should reflect the intervals found in these musical scales, which typically align with a pentatonic minor (as defined by various fangufangu makers). On the other hand, some contemporary musicians see value in broadening existing approaches of fangufangu tunings, or celebrating the individuality of each instrument, shaped by its distinctive material and form, and the inherent scales influenced by these characteristics.

6.6 Tuning Dial

The development of the tuning dial involved a thorough process of refinement and simulation within computer-aided design (CAD). These iterations aimed to enhance several key aspects, including the assembly and maintenance of components, the fluidity of motion, and an enhanced microtonal frequency range. This work was conducted with several primary objectives in mind, each playing a pivotal role in shaping the design:

Enhanced Frequency Range
A primary focus was achieving enhanced tuning capabilities. This required precision in the design and calibration of the tuning dial to ensure that the fangufangu could produce a wider and more precise range of musical tones, allowing for the exploration of nuanced scales and intensified dynamic crescendo.

Fluid Motion for Playability
In addition to tuning precision, the dial's fluid motion was a critical consideration. It was important that the tuning adjustments could be made seamlessly during performance, without causing disruptions or affecting the musician's playing experience. Smooth, effortless motion was a key criteria.

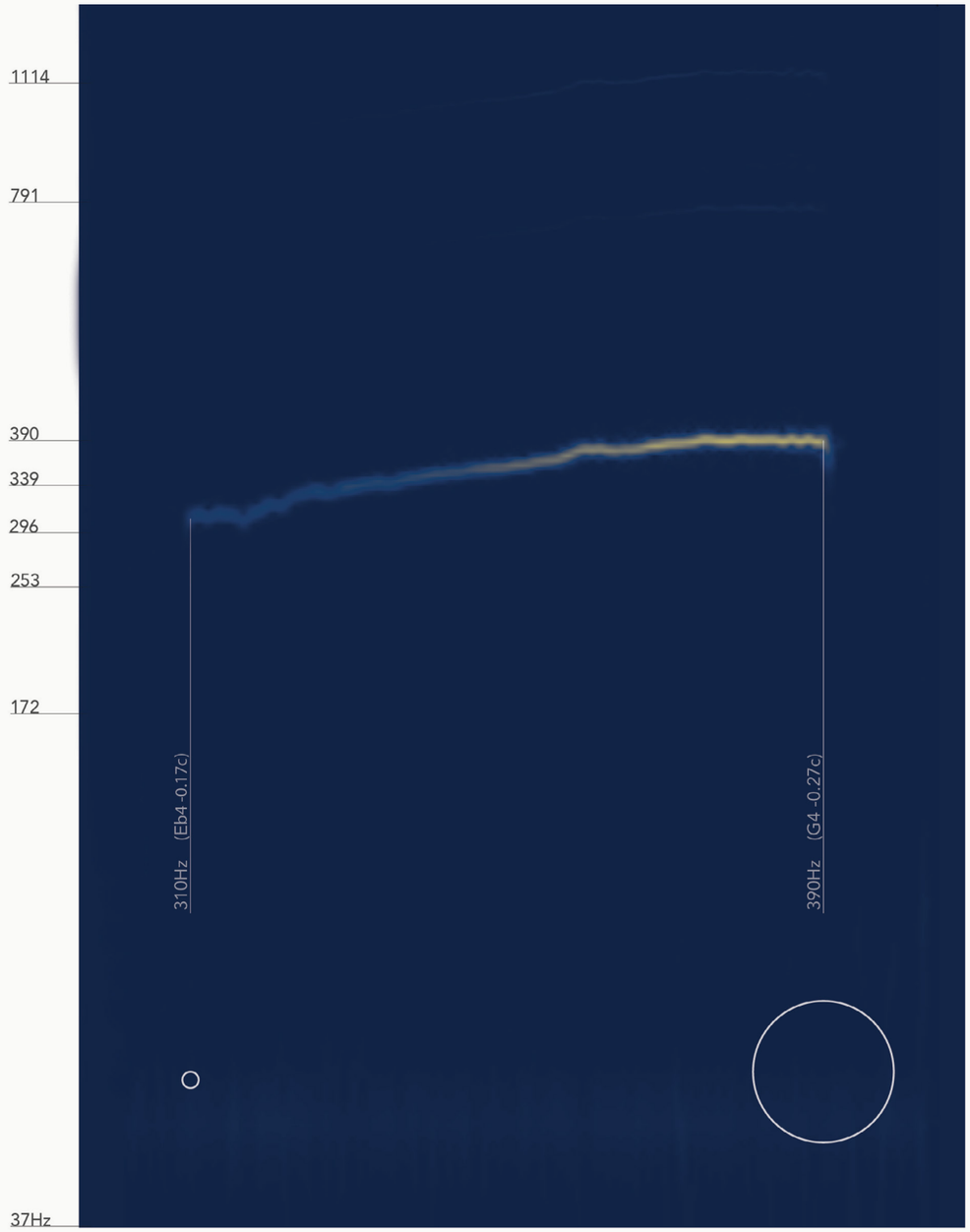
Ease of Assembly and Maintenance
Recognising the practical needs which stemmed from the previous experience testing, the design also prioritized ease of maintenance and repair. This meant that components needed to be easily accessible and adjustable, ensuring the longevity of the instrument.

The tuning dial adapts to different frequency ranges based on the specific fingerings employed. When all holes are closed, it achieves its widest frequency span, ranging from 310 Hz *(Eb-0.17c)* at the minimum aperture of 3mm to 390 Hz *(G4-0.27c)* at the maximum aperture of 26mm. As a point of reference, the frequency range in this configuration is equivalent to a major 3rd, with the added capability to produce incremental frequencies within this interval. This is illustrated in the spectrogram below which highlights the gradual increase in frequencies as the aperture opens, andthe evolving dynamics of sound inherent to this motion. As the aperture opens wider, the frequencies increase[30] and the sound undergoes a crescendo in amplitude, enhancing the instrument's resonance.

Together, these sonic characteristics, in addition to the potential applications of this component, facilitate innovative methods for supporting the Tongan musical aesthetic concepts of hikihikitō and fakahēhē.

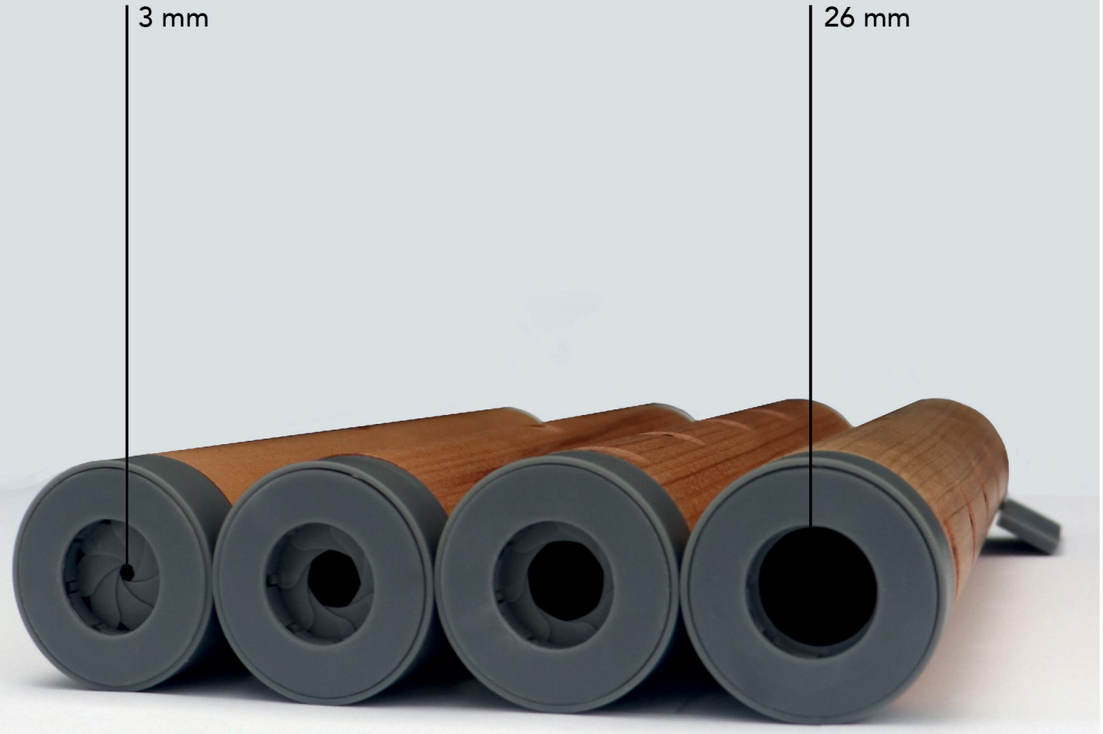
30 As the fundamental frequency increases, so does the presence of overtones

Fig. 68.
Melodic range spectrogram, illustrating the tuning dial parameters



Aperture: 3mm–26mm
All holes closed

Fig. 69.
Illustrating parameters of the aperture range between 3mm – 26mm



6.6.1 Collective Critical Reflection

The experience testing and critical talanoa of this component was positive as participants considered it a significant improvement to the previous design, particularly in regards to its frequency range.

> Tuning mechanism is really cool, Rachael. Especially this time around – the range is quite significant (Adriana)

Participants found that it was easy to utilize in play and in-between use. One negative aspect was that the top plate fell off easily due to the weak magnet, limiting the manner of playing. Opening the dial made it easier to project sound and adjust the volume, and the texture on the dial was considered sufficient for its function both during and in-between use.

> It's easy to use while playing and while not [...] Having it open was easier to project the sound. Yeah, even just on one note, it was nice to be able to kind of change volume. (Adriana)

> I like the new tuning mechanism. A lot more solid than the first prototype. I notice that the face plate/disc falls off easily which appears to be due to the weak magnet. I experienced the mechanism not opening entirely at times because the mechanism itself became loose and was no longer binding to the wood so when you turned it, it would turn the entire mechanism rather than the tuning hole. (Saia)

In regards to the texture and form of the tuning dial, which was outwardly tapered, instead of inwardly tapered like the first concept, it provided enough grip and was easy to use in play.

> I think the current design is fine as it is – it makes sense and pretty easy to grip onto and use. (Saia)

Overall, the second iteration was well-liked for its improved range as it successfully met the technical demands of precise microtonal tuning and also offered a fluid motion for better playing experience. Although there was a product development issue with the top plate magnet, the assembly of components allowed for straightforward maintenance and easy accessibility if required for part maintenance.

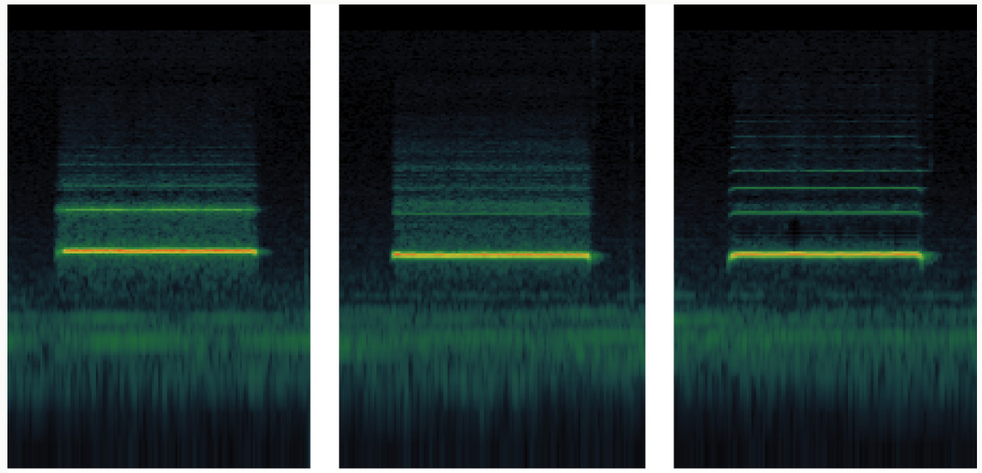
6.7 Body, Form and Size

During this phase of development, and the main goal was to investigate the materiality of the fangufangu body, with specific focus on tonewoods. The aim was to identify accessible timbers with optimal sonic properties. This was especially important considering the first fangufangu concept was entirely (and intentionally) made from plastic. Experimentation with certain tonewoods was undertaken, primarily including Pacific Kauri and Rosewood. These were turned[31] to form a hollow and tapered tube. Variations in wall thickness, diameter, taper and length provided insights into how these aspects of form influenced sound. In comparing the different tonewoods, Pacific Kauri proved better suited to the crafting processes employed, and reflected more comparable visual and sonic properties to bamboo.

Rosewood Fig. 71 demonstrates a wide range of overtones with good sustain. The intensity of overtones is strong and clear in comparison to the bamboo and Pacific Kauri, possibly explains its brighter and clearer sounding timbre. On the other hand, Pacific Kauri appears to have a weaker and smaller range according to its harmonic spectrum, as its higher harmonics decay the most rapidly.

Fig. 70.
Exploring turned and tapered bodies with different timbers

Fig. 71.
Comparing and reflecting on the timbre produced across different tonewoods



Bamboo | Pacific Kauri | Rosewood

As discussed in *Sub-section 5.1.3*, exploring materials that reflect similar visual, tangible and sonic properties as kofe[32] was thoughtfully considered. Pacific Kauri, which can be harvested from various areas of Polynesia, provided a beautiful and accessible material for the development of this design. Moreover, it came with a story of migration that is relatable for those living in the diaspora, making it a meaningful choice for the project. In many cases, Pacific Kauri is sourced from Fiji which connects with the origin of the fangufangu which is known to have come from Fiji.

After reflecting on the insights outlined in *Chapter 5*, the body of the instrument was extended to accommodate players with larger hand spans. The diameter of the body was turned with a 5° taper – although a variety of forms were explored, the decision to draw inspiration from the natural subtleties of bamboo was decided. This was for two reasons: firstly, in consideration of the two added moving components (adjustable nose cap and tuning dial) where implications were yet to be understood, and secondly, in the desire to embrace and enhance the inherent formal properties of bamboo.

31 The process of fashioning wooden pieces or blocks into various forms and shapes by means of a lathe
32 As discussed in *Chapter 2*, preparation processes of kofe and Aotearoa-grown bamboo prevented the use of this material in the design development process

Fig. 72.
Fangufangu tonewood exploration

6.7.1 Collective Critical Reflection

The second iteration of the fangufangu design was an improvement in terms of its overall size, yet there was still a desire to extend the length of the body to cater to players with larger hand spans. However, this was also supported by those with smaller hand spans – the reason was not that the size was uncomfortable but that it would allow for a lower overall pitch. This highlighted the importance of balancing the size in consideration of both ergonomics and sonic preference. On the other hand, the finger hole size supported both smaller and larger finger sizes. This supported broader parameters for articulating a range of incremental pitch changes (e.g. ofe'i).

> Yeah for me it's just the length, that's the main thing. I think a slight amount more would for me make it feel less compact. For me it's relative to the circumference of it. Otherwise I really love the way you're pushing it. (Sam)

In regards to materiality and form, a range of insights emerged from the product concept evaluation. First, the use of Pacific Kauri (despite the larger size of this instrument compared to fangufangu concept one) was notably light in weight which was positively commented on. The most significant was the tonal variety. In comparison to fangufangu concept one, there was a considerable increase in the ability to cresecendo, and control aspects of volume and tone. From my experimentation with different tonewoods (and earlier, plastics) this can be attributed to the use of Pacific Kauri in combination to its size and slight taper which, together, supports diverse tonal variety.

> Something I did notice was the volume control on the instrument – I could get soft, I could crescendo really easily [...] Tones are really pure and clean. Easy to change volume between soft and loud, and projection is quite significant. (Adriana)

It is commonly understood that the fangufangu can technically be blown from either end. However, usually there is a personal preference for each individual instrument or player. The development of the adjustable nose cap and the tuning dial, however, gives the fangufangu an end to play from.

The visual appearance of Pacific Kauri was also received well, especially in consideration of the key themes from the initial talanoa which highlighted the preference for using natural materials.

> The new material is so much more aesthetically pleasing than the previous one [...] natural materials for me are my preference. (Sam)

> Plastic is very practical and very convenient but then that reflects the society that we live in [...] (Saia)

6.8 Summary

This chapter has provided a comprehensive summary of the second fangufangu concept, including reflections from product concept evaluation by practitioners of the field. The concept was largely well received, however, specific aspects for improvement were highlighted, forming the final set of design objectives for this research project:

Final Design Objectives

Create a longer fangufangu body

Refine the materiality and assembly of the tuning dial

- How can materiality increase the fluidity of motion, durability of components, and projection of sound?
- How can natural timber grain provide grip?
- What is required for straightforward and intuitive assembly?

Design an attachment method for the adjustable nose cap

- What is the best method for creating fluid and stable motion?

Design a way for the body to attach to the nose cap and tuning dial

- Is there a way for this to enhance acoustic properties of the instrument?
- The ability to achieve overtones/higher register more easily

Refine the scalloped finger holes size and form

- Create a friendlier form both visually and physically

Explore desired tunings with different finger hole configurations

- How can the addition of a single circumference hole influence or expand desired musical scales?
- Minor pentatonic scale/specific iconic melodies

Explore materiality and teuteu

- How can materiality enhance the visual and sonic aesthetic of the instrument?

Fig. 73.
Tonewood Exploration

Fig. 74.
Kūkū: final handcrafted
fangufangu design

7. Final Conceptual Design

Kūkū: A Re-imagined Fangufangu

The final design represents the culmination of an iterative and cyclical process of practice-led design development and reflections, as presented in the previous chapters. The outcome of this practice-based research is *Kūkū*, a re-imagined fangufangu concept developed through an adapted Kakala Design Framework. By exploring how possibilities for tūfunga ngaohi fangufangu and faiva tā fangufangu can be expanded through the process of design from a diasporic context, this concept draws from both customary and contemporary influences to provide a new perspective from this cultural heritage.

7.1 Primary Features

Kūkū opens a new world of possibilities for fangufangu players by enabling novel expressive and performance experiences. Through its refined design, Kūkū incorporates progressive features such as an adjustable nose cap, scalloped finger holes and tuning dial to enhance comfort, playability, sonic quality, and versatility for individual preferences and diverse playing styles. Kūkū offers various visual, tangible and sonic features which contribute towards the enhancement of comfort, playability, sonic quality and versatility. The primary features are as follows:

Adjustable Nose Cap
The unique balance of form and fluid 360° rotation enables flexible tonality and enhanced comfort to increase playability for optimal experience. Through a simple magnetic connection, this component can be easily detached for cleaning.

Tonewood Body
Handcrafted from Pacific Kauri, the body is elegantly tapered for amplification, broadened sonic parameters, and upright storage in between uses. With an even and fine grain, this material supports consistent sound characterized by warm and clean properties with a range of timbral qualities. Additionally, it naturally embodies a sonic, tangible and visual likeness to kofe through its timbre, texture and golden appearance.

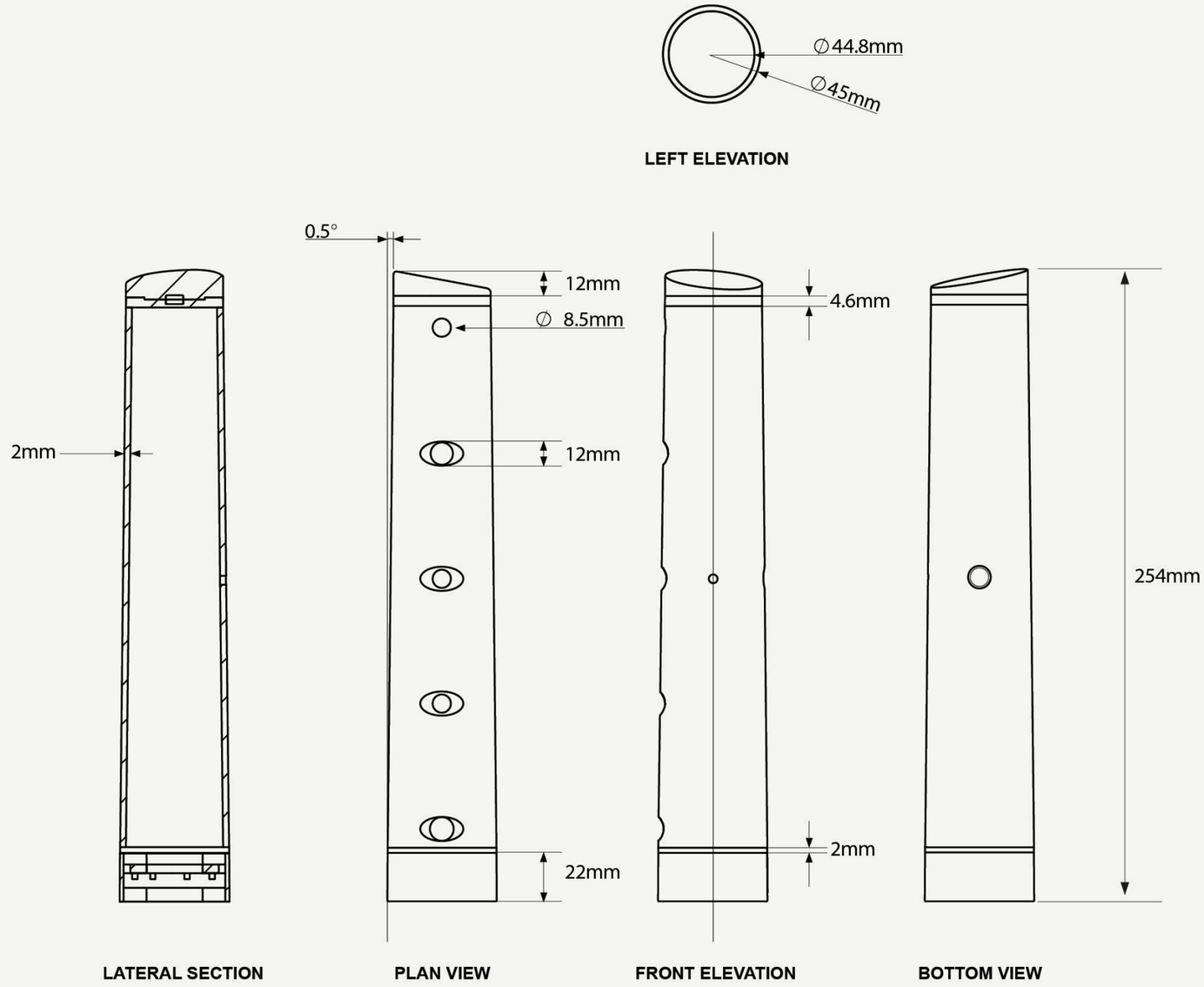
Scalloped Finger Holes
Thoughtfully designed to resemble the eye of the tū, the sculpted form is a subtle homage to the native Tongan dove, which the fangufangu emulates. From a sonic and user experience perspective, it enhances expressive techniques, creating a symbiosis between the body and the instrument.

Circumference Hole
While the instrument supports the playing of iconic melodies, an added seventh circumference hole broadens sonic possibilities for exploring expanded pitches and scales. Its careful positioning aptly maximizes the use of the nose-plugging hand.

Tuning Dial
Introduces an expanded frequency range while also assisting enhanced expressive Tongan aesthetic techniques and values such as hikihikitō (pitch modulation), hikihikikī (key modulation), ofe'i (pitch bending) and fakahēhē (continuity of sound). This is achieved through an integrated, acoustic and adjustable aperture design, which can be utilized during or between performances.

Visual Aesthetic
Through thoughtful consideration of materiality, form and teuteu, Kūkū's visual appearance subtly imbues shades of customary and contemporary influence.

7.2 Specifications



Title:	Drawn By:	Date:
Kūkū Specification Drawing	Rachael Hall	3/11/2023

Fig. 75.
Specification drawing

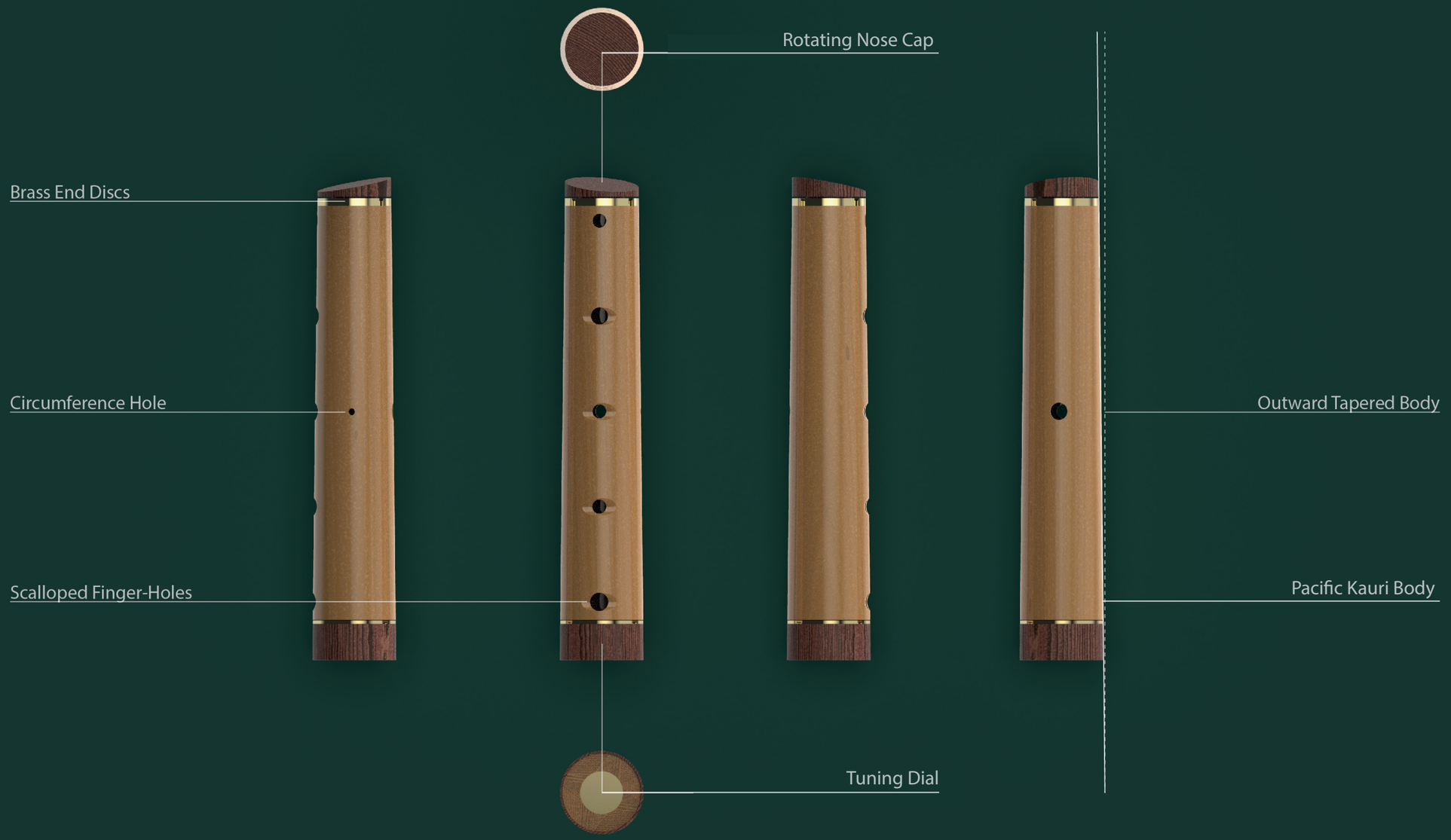


Fig. 76.
Orthographic views and
outline of key features

7.3 Components

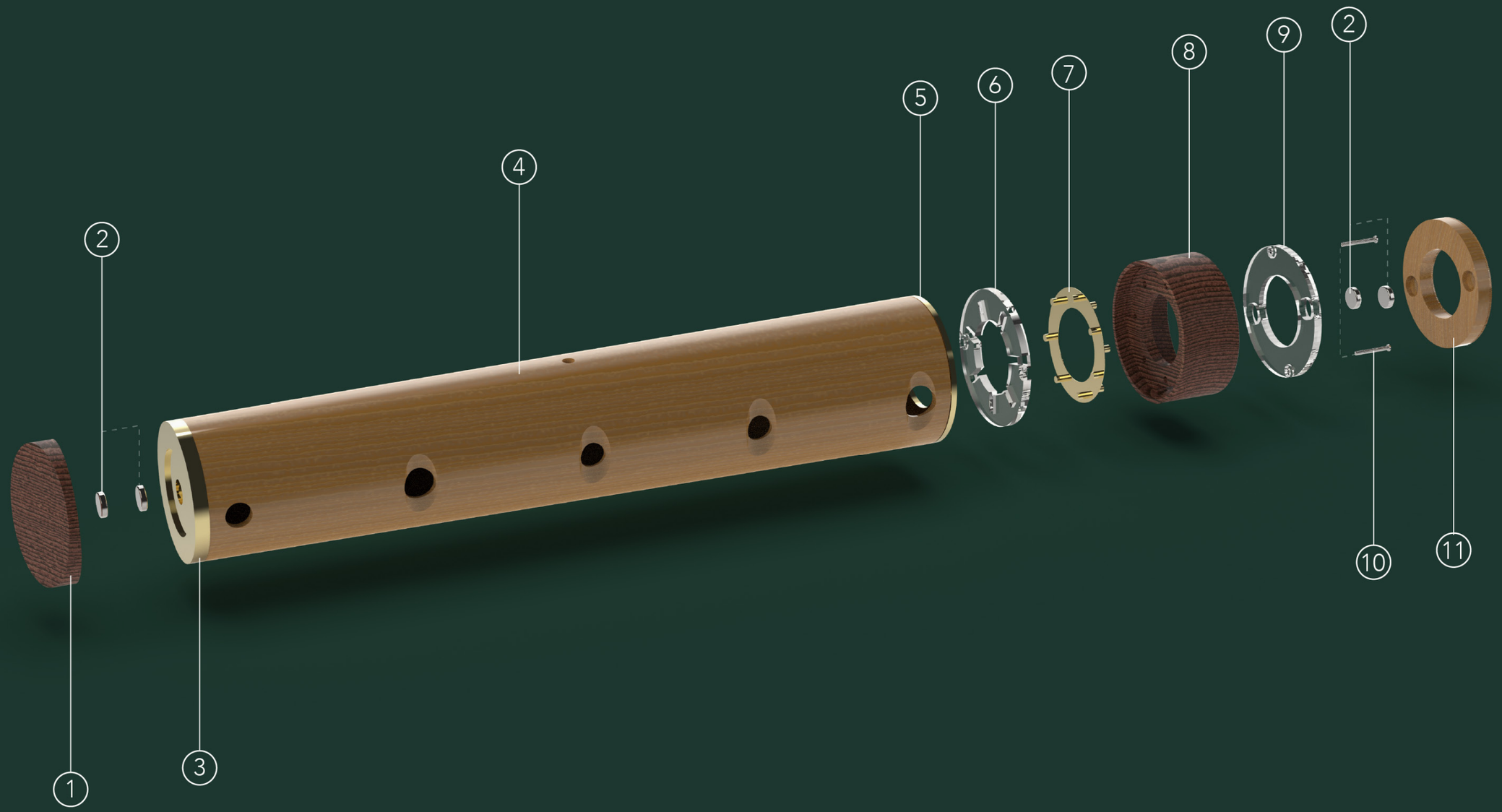


Fig. 77.
Exploded render of components

#	COMPONENT
1	Rotating Nose Cap | Black Walnut (sealed)
2	Magnet
3	Top Disc | Brass (polished)
4	Body | Pacific Kauri (waxed)
5	Bottom Disc | Brass (polished)
6	Actuation Plate | Acrylic
7	Blades | Brass (polished)
8	Rotating Dial | Black Walnut (waxed)
9	Housing | Acrylic
10	Screws
11	Engraved Plate | Pacific Kauri (sealed)

Fig. 78.
Component and material breakdown

Fig. 79.
Detailed photograph of the adjustable nose cap attached to the top brass disc

7.4 Adjustable Nose Cap

Visual Aesthetic | Materiality
The form of the nose cap harmoniously extends from the tapered tonewood body, creating a seamless transition between components. Turned from black walnut and finished with a water-based sealant and beeswax skin, it prevents the build-up and absorption of nasal moisture. The contrast in material, notably its colour, intentionally separates the nose cap from the body, highlighting the motion of this feature. Moreover, it physically resembles the warmth of kofe against the lip.

Comfort | Playability
The nose cap is carefully designed with comfort in mind. Its angled form fluidly rotates 360°, supporting precise micro-adjustments for individual comfort. It accommodates left and right handed players, in addition to varied facial profiles by alleviating friction-induced discomfort of the nose and upper maxilla. In turn, it supports increased playability over extended performance periods. Two magnets are embedded in the walnut nose cap and brass top disc, functioning as a pivotal axis for smooth rotation. This enables a practical method for component removal, allowing for easy interchange and cleaning.

Sonic Versatility | Timbre
From a sonic perspective, the nose cap supports tailored adjustments in distance and angle between the nostril and the blowing hole. This enables the easy catch of nasal airflow, delivering excellent response and resonance across the entire range of the instrument. Moreover, this provides a comfortable and useful way to achieve diverse timbral effects.

Fig. 80.
Macro shot detailing the Pacific Kauri tonewood grain

7.5 Tonewood Body

Visual Aesthetics | Materiality
Crafted from locally sourced Pacific Kauri, the soft tonewood body shares comparable structural and visual characteristics with kofe's straight and even grain, warm golden tone and moderate lustre. Turned to a 2.5mm wall thickness, its tapered form is shaped to subtly emphasize the natural and distinct irregularity of kofe. Brass discs cap either end of the body – these enhance the overall resonance of the instrument and contribute towards the ability to control broader parameters of sound projection and tonal depth. This material choice holds cultural significance, reflecting the increasingly profound influence of brass instruments in modern Tongan music[33]. The sonic and visual properties of brass complement those of Pacific Kauri, creating a harmonious blend that not only enhances the visual appearance of the instrument but also contributes to its unique sound.

Finger Holes
The body has five evenly spaced holes on the top and one on the central underside, which is reflective of most customary fangufangu. An additional hole is positioned on the left central circumference of the instrument – this is further discussed in the following sections. Because of this, the tuning process involved careful consideration of the seventh hole to achieve desired frequencies.

Comfort | Playability
The 5° taper allows for stable upright storage between uses. In contrast to the customary fangufangu, the form – in tandem with the adjustable nose cap – provides the instrument with a distinct end to play from. The scale of the instrument supports increased sonic versatility and playability through effortless navigation of all finger holes.

Sonic Versatility | Timbre
The acoustic properties of Pacific Kauri support the achievement of beautifully rich harmonics and overtones. Combined with brass, Kūkū embodies a clear and warm tone with strong resonance which easily shifts into higher registers. The outward taper was not only a visual and practical consideration of form but it also intended to enhance the projection of sound, and optimize sonic parameters of the tuning dial.

33 Kaeppler, Adrienne L. "Tongan Brass Bands: An Expanding Tradition." The World of Music, vol. 8, no. 2, 2019, pp. 39–56. JSTOR, https://www.jstor.org/stable/26828536

Fig. 81.
Detailed photograph of the scalloped finger holes

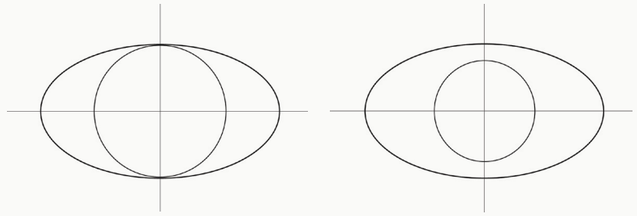


Fig. 82.
Vector drawings of the variation in finger hole size (these are custom made for specific tunings)

7.6 Scalloped Finger Holes

Visual Aesthetic

This feature draws inspiration from the sonic likeness between the fangufangu and the tū. With a desire to create a holistic sensory experience by connecting the instrument's associated sound with its appearance, the scalloped form harmoniously resembles the tū's distinct eye shape – a subtle homage to the native Tongan dove. Through its refined form, this feature creates a soft and inviting appearance.

Comfort | Playability

The scallops ensure secure contact with the instrument's body, enhancing tactile awareness of finger movements and offering nuanced control through haptic feedback. Sculpted depth ensures fingers are gently cradled, facilitating the use of expressive techniques while also enhancing general grip and control, particularly when exploring non-traditional finger hole combinations. By complementing the form of a finger, this usability feature enhances aspects of playability and encourages acoustic exploration. While this accommodates players with small – medium finger sizes, this feature can be customised to ensure optimal comfort for individual needs and preferences.

Sonic Versatility | Functionality

This feature supports enhanced expressive techniques, creating a symbiosis between the body and instrument through broadened physical and sonic possibilities. Notably, this includes the aesthetic technique ofe'i – the smooth bending of pitch or transitions between pitches, through forward backward finger rotation. Additionally, it facilitates envelope – attack, sustain, and decay of a sound. Through a gentle lateral sweeping motion across the finger hole, this produces a softer and more subtle pitch bend; when this motion is accelerated, it creates a fluid effect that resembles a combination of ofe'i and tremolo. A vertical pivot motion (detached lift of finger from the hole) resembling staccato is also supported – this is achieved by uncovering the finger hole in a staggered motion. Lastly, the form allows the fingers to freely and securely oscillate within the scallop, as an alternative method to achieve vibrato.

Fig. 83.
Demonstrating the use of the added circumference hole through extension of the pinky finger

7.7 Circumference Hole

Comfort | Playability
With comfort and ergonomics in mind, and considering the customary manner of playing, the placement and size of this additional hole is positioned to aptly maximize the use of the nose-plugging hand by a natural extension of the pinky finger.

Sonic Versatility | Tuning
As the reproduction of iconic fangufangu melodies was desired by various participants, the tuning of Kūkū reflects one composed and played by the Ve'ehala (Fanshawe, 2002). This melody features four fundamental frequencies, traditionally achieved by utilizing holes two, three and six – known as the high key. However, considering the equal interest in exploring alternative or expanded scales, Kūkū accommodates both musical preferences by including a seventh hole, positioned on the left center circumference. Initially, this feature drew inspiration from the Te Papa fangufangu artifact, which had two distinct side holes. While it is claimed that their function was to lower the fundamental note of the instrument without being fingered, exploration of these with the intended use to expand sonic opportunities proved a positive addition.

While Kūkū supports the playing of this iconic melody, the added seventh hole broadens sonic possibilities through expanded finger hole combinations and frequencies. In addition to the reproduced frequencies, the circumference hole also supports a minor blues scale – an extension to the minor pentatonic scale which many modern fangufangu are tuned to.

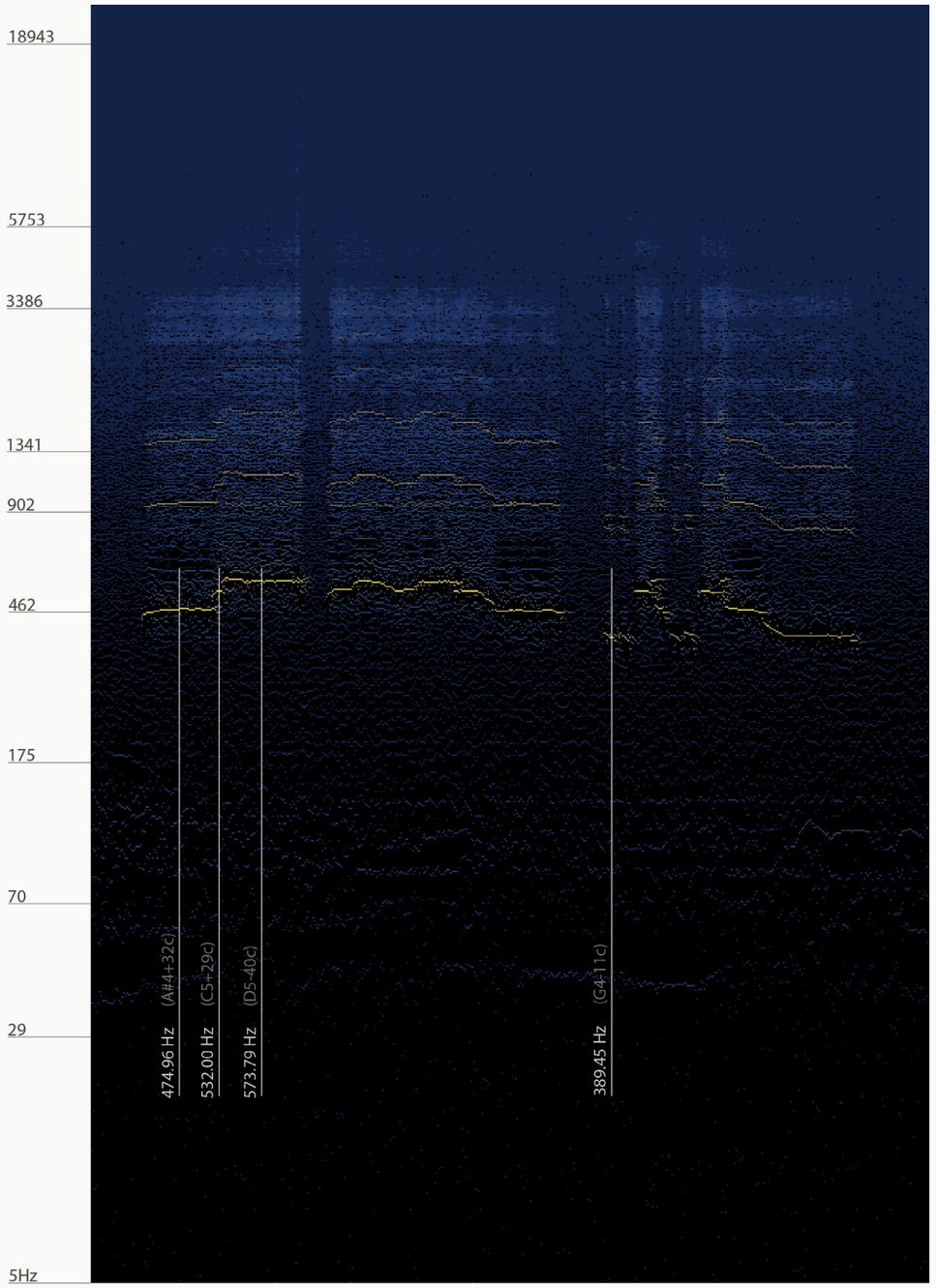


Fig. 84.
Spectrogram of the reproduced melody by Ve'ehala played with Kūkū

Pitch Analysis

As previously discussed, Kūkū produces the four fundamental frequencies as heard in Ve'ehala's iconic melody. However, given the addition of the seventh finger hole, these are achieved using different finger-hole configurations. The frequencies include the following: 474.96 Hz *(A#4+32c)*, 532.00 Hz *(C5+29c)*, 573.79 Hz *(D5-40c)* and 389.45 Hz *(G4-11c)*.

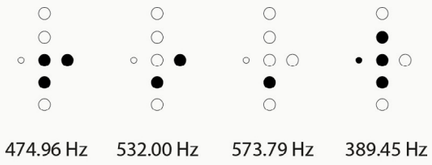


Fig. 85.
Respective fingerings used to reproduce Ve'ehala's melody

Each is strong in amplitude, producing a clear and warm tone. As illustrated in Fig. 85 above, the instrument is rich in harmonics and overtones across its frequency range and demonstrates a smooth transition into higher registers.

Frequency Range

The overall frequency range extends from 314.75 Hz *(D#4+20c)* when both the aperture and finger-holes are closed, to 660.03 Hz *(E5+2c)* when the aperture is open with all finger-holes open – this corresponds to a minor 9th (1 octave + minor 2nd). While the range remains consistent with that of the second prototype, this demonstrates a notable advancement considering the sonic implications of the longer body, a single circumference hole, and larger finger-holes of the final instrument.

In respect to the future production of Kūkū for participants, the potential to adjust these features will enable the opportunity to achieve personalized preferences. For instance, this may include specific tunings and their respective finger-hole configurations, or a lower/higher fundamental note, should this be desired.

Fig. 86.
Detailed photographs of the tuning dial demonstrated through actuation using the pinky finger

7.8 Tuning Dial

The tuning dial refinement centered around three primary aspects: enhancing the fluidity of motion, streamlining component assembly, and carefully considering materiality and teuteu in regards to both acoustic properties and visual elements.

Enhanced Motion
A primary focus was to enhance the rotational motion in respect to both fluidity and strength. The goal was achieved by utilizing materials to reduce the depth of the blades while also offering a smooth texture for less friction.

Optimised Assembly and Durability
Given the fragility of previous prototypes, it was important to explore methods to facilitate straightforward and intuitive detachment and assembly of components.

Materiality and Visual Aesthetics
As previous development primarily concentrated on the mechanical properties of the tuning dial, the final refinement aimed to address aspects of materiality and teuteu. This was considered in regards to visual aesthetic but also function to enhance the haptic feedback of the dial.

Visual Aesthetic | Materiality
Similarly to the adjustable nose cap, the tuning dial naturally extends from the outward tapered body. Handcrafted from black walnut, it visually separates the component, highlighting it as a moving part. Its grain is carefully oriented for strength and to provide a natural grip for secure rotation. Unlike most fangufangu where teuteu typically wraps around the external body, Kūku integrates this into the tuning dial at the end of the instrument. This streamlines the body, emphasizing the sculpted details and material properties. Moreover, the discrete positioning aligns with my personal approach for decorating handcrafted products.

Comfort | Playability
The outward tapered form comfortably and naturally supports finger extension. A primary focus was to enhance the rotational motion in respect to both fluidity and strength – this was achieved by utilizing brass to reduce the depth and strengthen the blades while also offering a smooth texture for movement.

Sonic Versatility
The tuning dial supports expanded microtonal capabilities and enhanced expressive techniques such as ofe'i, hikihikitō, vibrato and tremolo. This component offers alternative and increased ways to accommodate various Tongan aesthetic values and techniques – especially in the greater achievement of tauēlangi.

Frequency Range
When all holes are closed, Kūkū achieves its widest frequency span, ranging from 314.75 Hz *(D#4+20c)* at the minimum aperture of 1.5mm to 355.84 Hz *(F4+32c)* at the maximum aperture of 25mm. This range is equivalent to a major 2nd – while this is smaller than prototype 2, it reflects the documented notation of hikihikitō. While this concept is not limited to this interval, extending this range was not feasible for this research given limitations of materials and tolerances. To achieve this in future, the diameter of the mechanism would need to increase, or the body length would need to reduce.

Fig. 87.
Melodic range spectrogram, illustrating the tuning dial parameters

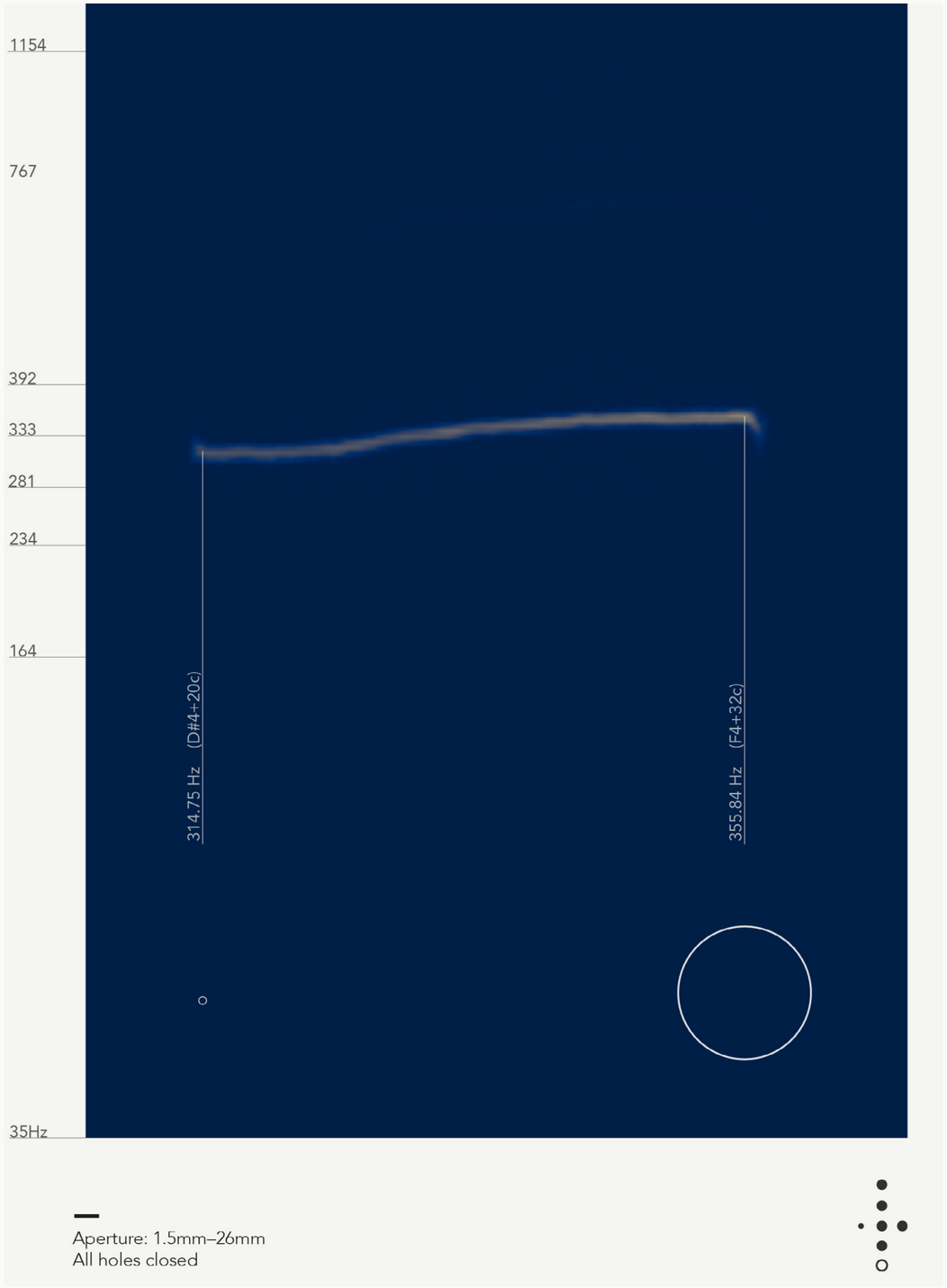


Fig. 88.
Teuteu: Photograph of the detailed engraving

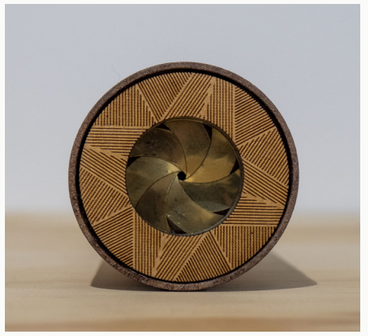


Fig. 89.
Detailed photograph of the tuning dial with all refined components at its smallest aperture

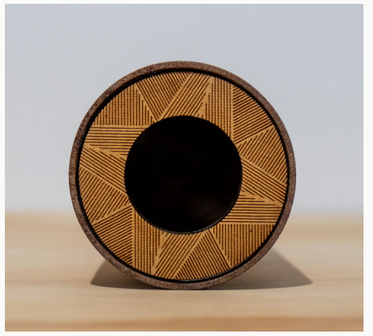


Fig. 90.
Detailed photograph of the tuning dial with all refined components at its largest aperture

Through thoughtful consideration of sonic, tangible and visual elements, Kūkū subtly imbues shades of customary and contemporary influence that offers a rich, nuanced tonality over a wide dynamic range. Through careful selection of materials, each component has been designed to achieve optimal comfort, playability, sonic properties and versatility for individual preferences and playing styles.

Kūkū has been designed as a customisable instrument to embody the unique individuality of fangufangu. While this concept introduces various progressive features, each component is designed for ease of assembly, maintenance and personalisation. Together, these elements have been developed as integrated analogue components, preserving the acoustic playing experience.

8. Conclusion

This concluding chapter will summarise the findings and insights of this creative study, followed by opportunities for further research uncovered through the research development. Positioned as a creative and practice-led inquiry, this thesis asks:

How can design assist with exploring musical possibilities of the fangufangu for modern musicians of the Tongan diaspora?

To guide this inquiry, the research began by highlighting the need to accommodate diverse cultural perspectives and practices beyond a Western lens within the industrial design landscape. This resulted in developing a Kakala Design Framework to inform creative-led exploration of the fangufangu from a culturally grounded and design-specific context. The application of this framework was then demonstrated through collaborative and iterative exploration of this instrument with Tongan practitioners. The final instrument outcome of this process resulted in Kūkū, a re-imagined and handcrafted fangufangu for modern musicians.

8.1 Contributions to the Field

This study proposes three primary contributions to knowledge and experience. Considering the interdisciplinary nature of this research, these are not limited to a single form of knowledge or academic field.

Kakala Design Framework
First, from a theoretical perspective, this research has contributed a Kakala Design Framework tailored specifically for industrial design – this is presented in *Chapter 3*. By introducing the notion of vahevahe as an intermediary stage between toli and tui, a three-phase iterative cycle was proposed to support the dynamic nature of design practice. Vahevahe de-centers the researcher by sharing collaborative milestones throughout the design development process. Additionally, vahevahe enhances the experience of product concept evaluation, which is traditionally bounded within temporal and spatial limitations.

Application of the Kakala Design Framework
Second, concerning both theory and praxis, this research has positively demonstrated the application of the Kakala Design Framework to holistically and collaboratively explore expanded possibilities of the fangufangu for modern musicians of the Tongan diaspora. This is exemplified throughout the entirety of this thesis, from the context review in *Chapter 2*, to the introduction of Kūkū in *Chapter 7*. By using a combination of culturally grounded and design-specific methods, the outcome of this research has resulted in a distinctive fangufangu design informed by numerous cycles of talanoa, development, and product testing. Due to restrictions of location and COVID-19, the use of Zoom was the primary method for engagement with participants. While an in-person approach was preferable, Zoom enabled a way to adapt to the contextual circumstances appropriately and effectively.

Kūkū: A Re-imagined Fangufangu
Third, from a practical viewpoint, this thesis offers a re-imagined and distinctive fangufangu design inspired by aspects of the past, present and future. Kūkū – as presented in *Chapter 7* – is an analogue approach to instrument design that is responsive to both traditional and contemporary practices. By enhancing specific musical, visual and tangible features, Kūkū expands sonic versatility, playability, and materiality to accommodate use across diverse musical environments, individual playing styles and comfort. This is achieved through the integration of innovative design features such as the tuning dial, rotating nose cap, and scalloped finger holes. Kūkū pushes current boundaries of tūfunga nagohi fangufangu, tūfunga teuteu fangufangu, and faiva tā fangufangu by exploring alternative approaches for modern contexts. Kūkū is a culmination of the iterative practice-led inquiry which involved cycles of physical prototyping and modelling, and concept product evaluation by expert fangufangu musicians.

8.2 Further Research

Design Practice
Although this thesis has created and utilised the Kakala Design Framework to explore expanded possibilities of the fangufangu, its application across the broader realm of design offers a novel approach to investigate aspects of other cultural heritage through creative practice. For example, this could include other Tongan instruments such as the mimiha (panpipes) and tuki pitu (stamping tube) for use within other contexts and demographics.

There is potential to extend beyond the scope of this research by continuing this study through further cycles of design exploration. Specifically, I am interested in developing aspects of materiality, such as exploring teuteu through different methods of treating or texturing timber to achieve varied visual or sonic effects. Further, I would like to further investigate processes for crafting kofe as initial inquiry through research in *Chapter 2* highlighted the potential to provide novel approaches to fangufangu making through using the customary material in new ways.

Considering the knowledge developed in both process and outcome from the fangufangu reconstruction as presented in *Chapter 4*, it is evident that there are valuable opportunities to extend this study. I would also like to explore how design can assist with creating accurate (visual, tangible and sonic) reconstructions of archived fangufangu within museum spaces. Considering the limitations of engaging with objects in these contexts – for example, the risk of damaging historical artefacts through interactions – this would provide a powerful opportunity to increase engagement of this instrument within Tongan communities.

Learning the fangufangu is an ongoing and evolving process – this creative practice has exemplified the vast possibilities for instrument design. In turn, and considering the customisable nature of Kūkū, numerous opportunities exist to explore designing context-specific components for fangufangu musicians with varying experiences. For instance, certain components – such as the 'nose plug' as discussed in *Chapter 6* – highlighted its better use in aiding fangufangu practice for beginners. This exemplified the potential to engage with different demographics (e.g. children) to investigate design opportunities for the process of learning.

8.3 Luva—A Gift from the Heart

This practice has drawn from elements of design to assist in the generation of new scholarship. While this thesis has presented a final design outcome, this is intended to be part of a larger collection of fangufangu customised for each participant of this research. The dissemination of these individualised fangufangu is reflective of luva, a gift that is given with heartfelt sincerity, humility, and honour; a process of returning the gift of knowledge to those who have so generously contributed to the project. As the fifth stage to the presented Kakala Design Framework in *Chapter 3*, while this is beyond the scope of thesis submission, luva is an important stage for the research to come full circle.

8.4 Closing Comments

This journey has been one of the most fulfilling and humbling experiences I have undertaken. While I did not know where this research would lead, the process of discovery through creative-led inquiry has not only inspired me, but challenged me for the better. I am grateful for the opportunities this research has provided, especially the relationships that have blossomed along the way. While this study has focussed specifically on the Tongan fangufangu, I hope this work will serve as a valuable resource for all creatives across Moana Oceania.

This thesis is a me'a'ofa to everyone who has so generously poured their love into supporting me and this research.

Fig. 91.
Photograph of author performing with Kūkū

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APPENDIX I

Faofao / Pū

Samoa

Function
The Faofao, or Pū, is used in contemporary Samoan village life to signal various events such as nightly curfew, church meetings, evening prayers, school summons for children and group spearfishing activities.

Sound
Arrangement / Performance:
Formerly, there were certain restrictions around blowing the conch. For example, in some areas, the faofao/pū was held sacred as a representation of a war God and could only be blown in times of crisis. Chiefs carried two large shells in their canoes to announce their passage; only a high chief was permitted to blow the conch in his canoe.

In contemporary life, these restrictions appear to be no longer enforced, as the associated social and religious activities of the past become increasingly irrelevant.

When a priest blew the trumpet in warfare, it was believed the God would supply either an omen of success or failure, distinguishable by the tone the trumpet blew; 'clear and euphonic' signalling the former, and 'rough and hollow' the latter.

Sound Production / Manner of Performance:
Sound is produced by blowing either the side or end of the shell, and it is described to have generated a great volume.

Tunability
——

Construction
Materials
Tritonis and Cassis Shell

Process
A single hole (apprx. 1.5cm) is knocked in the third, fourth or fifth whorl from the point. No mouthpiece was added - this was only common in Eastern Polynesia.

Mimiha

Tonga

Function
It is suggested that the panpipes emulated the sound of two nose flutes, and was essentially a commoners substitute for a fangufangu, which could have been reserved for chiefs.

Sound
Arrangement / Performance
Each reed pitch of the mimiha is said to represent the outline of a stereotyped melody.

Sound Production / Manner of Performance
Sound is produced by blowing the top of the beveled reed. This bevel helps to direct the air down only one tube. When playing a stereotyped melody (specific to Tonga), the player will begin at one end of the mimiha and proceed towards the other, with occasional directional reversals as the melody requires.

Tunability
The pitch of the reeds is determined by their physical dimensions (e.g. length and diameter of the bamboo).

Construction
Materials
Bamboo, Coconut-husk fibre

Process
The reeds consist of varying lengths of bamboo (8-10 reeds) laid in a single row with the upper open ends in a straight line and the lower closed ends forming an irregular line (except in the smallest instrument). The open ends are trimmed both at the back and front into a concave curve. This curve on one surface is usually deeper than the other; a feature supposedly unique to Tonga. The reeds are then bound with two horizontal rows of coconut-husk fibre, an upper row a little below the open ends, and a lower row just above the level of the closed end of the shortest reed.

There is no documentation of a mimiha having existed which contains the notes of an entire octave.

Derua

Fiji

Function
The derua was used to mark the beat in musical performances and occasionally accompanied the meke (dance form) sung by both men and women.

Sound
Arrangement / Performance
Played by back-up singers in performances.

Sound Production / Manner of Performance
Held vertically with the closed end facing the ground. It was struck on the ground or on woven mats.

The sound is described as a dull, low thud.

Tunability
To tune the overall 'pitch' the length is trimmed.

Construction
Materials
Bamboo - ranging in lengths.

Process
Generally, the derua was of a large circumference. It was hollowed out with a single natural node - one end open, one end closed.

ʻūtete

Tonga

Function
The ʻūtete is used to privately communicate during courting, and for personal amusement.

Sound
Arrangement / Performance
Played individually or between two people when courting. They come in various sizes, depending on the sourced leaf.

Sound Production / Manner of Performance
The ʻūtete is gripped on one end by the teeth, with the other end held in the hand. The midrib is then twanged to produce sound, as the mouth functions as a resonating chamber.

A 'permanent' type of ʻūtete has been documented, which was fashioned out of bamboo and made only by skilled artisans called toakofe.

Tunability
Although it seems this has not been documented, the dimensions of the leaf as well as the mouth would surely affect the overall tuning.

Construction
Materials
a) coconut leaf
b) bamboo

Process
a) A section of coconut leaflet – apprx. 25cm long and 3cm wide

Current Use
Present use is supposedly rare. On rare occasions when ʻūtete is used in the present day, it serves only as a child's plaything.

It is important to note that these initial case-studies were part of a larger body of work. Additionally, while these instruments exist across other regions, the case-studies reflect certain countries. In some cases, images were not available, and information was limited.