

RECONNECTING WITH THE PAST:
TRADITIONAL TONGAN ARCHITECTURE AS AN EDUCATIONAL
DEVICE FOR THE TONGAN PEOPLE.

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To my wife Lose, and my daughter Kalesita

‘Ofa.-ki-Tonga Nonu.

Abstract

The complexity of the traditional Tongan *fale* has decreased over time, but there is a need for architects to revive the essence and the cultural aspects of the *fale*. This research helps increase the understanding of traditional Tongan architecture and find ways to incorporate in teaching the people of Tonga about this aspect of Tongan culture. I have a great responsibility as a Tongan architect to study and gain knowledge about the *fale* and use that knowledge to educate my people.

The traditional *fale* was more than just a building or shelter; it also helped to define the owner's status in society. Every part of the *fale* provides a significant contribution to its function and has uses beyond those of the building itself. These parts and terminology are very seldom used because they hardly exist today, and the few people who still use this vocabulary are mostly elderly. The construction process of the *fale* was important to everyone in the community. Everyone one, from the children to the elderly, had important roles in construction. They worked together as if it was their own house they were building. This process shows that helping each other is a vital part of the Tongan culture.

With the information and data from books, the internet, interviews and a survey, I hope to share my knowledge of the *fale* with the others and reveal its forms even in simple forms, such as bus stations.

Table of Contents

Abstract.....	iv
List of Figures.....	vii
Preface.....	xi
Introduction.....	1
Physical and Theoretical Context.....	4
Project Goal.....	8
Research Methodology.....	9
Research Documentation.....	10
How has the traditional Tongan <i>fale</i> evolved?.....	10
Different House Typology.....	16
Parts and significance of the Traditional Tongan <i>Fale</i>	22
Stone Architecture.....	29
How does Tongan architecture relate to the people?.....	33
What materials where used in the traditional Tongan <i>fale</i> ?.....	39
How was the traditional <i>fale</i> constructed?.....	43
Sustainability of the Tongan <i>Fale</i>	47
Driving factors of architecture in Tonga.....	53
Economy.....	53
Development.....	55
Hurricane Relief Programs.....	58
Resources.....	60
Case Studies.....	61
Case Study 1: Polynesian Cultural Center – Tongan Village.....	61

Case Study 2: Jean-Marie Tjibaou Cultural Center	66
Case Study 3: Gando Elementary School	70
Survey	77
Summary of the body of knowledge.....	80
Design Solution.....	84
Bus Station.....	85
Existing Bus stations in Tonga.....	86
Site Analysis	88
Location.....	88
Weather.....	92
Form	95
Cultural and Social Impact.....	99
Different Structural Material	101
Glulam.....	101
Concrete.....	103
Steel	105
Roofing Material.....	107
Study Models	111
Refined Models	120
Sketchup Models.....	126
Final Thoughts	128
Glossary	130
Survey Questions	137
Annotated Bibliography	140

List of Figures

Figure 1: Map of Tonga	7
Figure 2: Fale Hunuki.....	11
Figure 3: <i>Fale fata</i>	13
Figure 4: <i>Fale fata</i>	15
Figure 5: Earthen burial mound and <i>falehufanga</i>	16
Figure 6: Scene in Vava'u harbor	17
Figure 7: <i>Fale Tuku'anga vaka</i> in Vava'u	18
Figure 8: Store house and working space	19
Figure 9: Yam storage house in the island of Nomuka	20
Figure 10: Missionaries being shown the <i>Fa'itoka</i> of the Fatafehi family	21
Figure 11: Main Posts	22
Figure 12: Different parts of the <i>Fale</i>	23
Figure 13: Main structure layout.....	24
Figure 14: Structure of the <i>Fale</i>	25
Figure 15: Different parts of the <i>Fale</i>	26
Figure 16: <i>Taa'ifale</i>	27
Figure 17: <i>Ha'amonga 'a Maui</i>	29
Figure 18: <i>Maka Fakinanga</i>	31
Figure 19: Paepae 'o Tele'a.....	32
Figure 20: Source of stone slabs for building <i>langi</i> which found on many beaches in Tonga.....	32
Figure 21: Traditional Tongan Community	36
Figure 22: Traditional Tongan house	38

Figure 23: Thatched roof from <i>au</i> (sugar cane leaves) on a Tonga house.....	40
Figure 24: Woman stripping the bark from a stem of <i>hiapo</i> (paper mulberry).....	41
Figure 25: Woman pounding <i>hiapo</i> (paper mulberry) bark to make tapa cloth	42
Figure 26: Weaving.....	44
Figure 27: Example of a traditional roof-construction	45
Figure 28: Building of the <i>fale</i>	46
Figure 29: Traditional Tongan <i>fale</i> after the hurricane	48
Figure 30: Tongan <i>fale</i> after the hurricane	49
Figure 31: Damage from the hurricane.....	49
Figure 32: Panoramic view of Tongatapu.....	55
Figure 33: LDS Nuku'alofa Tonga Temple	56
Figure 34: St. Andrews church in Nukualofa in 1940.....	57
Figure 35: Church and bell tower made out of wood, Tongatapu.....	57
Figure 36: <i>Faleafa</i>	58
Figure 37: L.D.S hurricane relief support.....	59
Figure 38: Polynesian Cultural Center	62
Figure 39: Construction of the Queen Summer House.....	63
Figure 40: Traditional Lashing	64
Figure 41: Jean-Marie Tjibaou Cultural Center.....	66
Figure 42: Jean-Marie Tjibaou Cultural Center.....	67
Figure 43: Jean-Marie Tjibaou Cultural Center.....	68
Figure 44: Gando Village	70
Figure 45: School	72
Figure 46: Double roof systems	73
Figure 47: Construction of the school.....	74
Figure 48: Large Corrugated tin roof for shading	75
Figure 49: Existing Bus Station in Tonga.	86

Figure 51: Hala Vuna.....	89
Figure 52: Chosen site for the Bus Station.....	91
Figure 53: Average minimum and maximum temperature over the year.....	92
Figure 54: Average monthly precipitation over the year (rainfall).....	93
Figure 56: <i>Taa'ifale</i>	96
Figure 57: Study Model.....	97
Figure 58: Sun Angle between summer and winter.....	98
Figure 59: Richmond Olympic Oval.....	102
Figure 60: Production energy of different material.	104
Figure 61: Steel frame architecture.....	105
Figure 62: Thatching plastic bags roof.....	109
Figure 63: Roofing Structure.....	109
Figure 64: Study Model 1.....	111
Figure 65: Study Model 2.....	112
Figure 66: Study Model 3.....	113
Figure 67: Study Model 4.....	114
Figure 68: Study Model 5.....	115
Figure 69: Study Model 6.....	116
Figure 70: Study Model 7.....	116
Figure 71: Study Model 8.....	117
Figure 72: Study Model 9.....	117
Figure 73: Study Model 10.....	118
Figure 74: Study Model 11.....	118
Figure 75: Study Model 12.....	120
Figure 76: Study Model 13.....	121
Figure 77: Study Model 14.....	122
Figure 78: Study Model 15.....	123

Figure 79: Study Model 16.....	124
Figure 80: Study Model 17.....	125
Figure 81: Sketchup Model 1.....	126
Figure 82: Sketchup Model 2.....	126
Figure 83: Sketchup Model 3.....	127
Figure 84: Sketchup Model 4.....	127

Preface

This document has three main goals:

1. Allow architects and the people of Tonga to access the topic of the traditional Tongan *fale*.
2. Reveal the significance and depth of the traditional *fale* in relation to the family, culture, and society.
3. As a solution to combine modern and traditional architecture.

Architecture has been a passion of mine since my childhood in Tonga. As I studied this subject, gained admiration for Frank Lloyd Wright, I.M. Pei, and Santiago Calatrava, and the different buildings they designed. The more I learned about architecture, the more appreciation I had for different vernacular architecture, including the traditional Tongan *fale*. I was surprised to realize how little I knew about my own culture, customs, and traditions, yet I always took pride in my Tongan identity. I never felt so proud to be a Tongan and a Pacific Islander until I came to the United States. In the United States, it is “cool” and, in a way, special to be a minority here.

With this realization, I was willing to dig deeper to learn more about the traditional *fale*. I wanted to understand it from the ground up. I needed to learn about how it was built and the different parts with their proper names and meanings. I wanted to understand the significance of how the *fale* related to Tongan people, society and culture.

Some of the key elements of the *fale* need to be revived, helping to preserve Tongan culture for future generations. The *fale* was self-sustaining and it was one hundred percent “green.” With current technology, we should be able to learn from the knowledge and intentions of those who went before us to provide better architecture for people today.

It is ironic to find inspiration in the past that will better the present and future architecture in Tonga. It is my intention to obtain sufficient information about the *fale* to incorporate it within existing architecture in Tonga and educate people about their culture.

Introduction

Tonga is currently under the influence of heavy development. Most of the people of Tonga do not understand that architecture is an opportunity to strengthen their culture, improve their lifestyle and wellness, and act as an educational tool for current and future generations. The existing architecture in Tonga has little cultural relation and no connection to the identity and values of the traditional Tongan *fale*.

In this paper, I intend to focus on traditional Tongan architecture and how it can be incorporated with technology and modern invention to create better design solutions for Tonga. My research will answer these questions:

1. How has traditional Tongan architecture evolved?
2. How did the traditional *fale* relate to the Tongan people and society?
3. What are key principles that drive architecture in Tonga?
4. How can traditional architecture be represented in modern buildings?

To fully understand the traditional *fale*, it is necessary to understand historical and current Tongan culture. The traditional Tongan *fale* was fully sustainable. It was built from local materials and trees, such as coconut, *kamani*, *kou*, and *vesi* wood (Mahina). The form of the building corresponded to both the environment and the climate. Natural light and air ventilation were incorporated to create harmony in the building. In the summer time, for

instance, the building was cool; whereas in the winter, heat was naturally retained. The *fale* also was designed to withstand strong winds and extremely heavy tropical rainfall.

Beyond environmental advantages, the *fale* also incorporated strong cultural identity and social values. It is crucial to recognize how the *fale* reflects the cultural values of Tongan people before historical architectural culture becomes lost forever. We would not only lose a beautiful tradition of Tongan society, but also the option to integrate historical cultural architectural ideas into modern buildings in Western Society.

The purpose of this research is to educate the Tongan people about the traditional Tongan architecture. It will also help them to know more about their culture and gain an awareness of architecture in Tonga shifting from the past, through the present, and into the future. It will also contribute architectural data to all people residing in the South Pacific region because each South Pacific Island faces similar problems and issues. The information will also be helpful for architects working in the South Pacific.

At the end of this research, I will understand more about the traditional *fale*, as well as Tongan social culture. Moreover, I will integrate what I learn and use technology to modernize the traditional *fale*, which will enable me to confidently design a series of bus stations connecting Nuku'alofa and Popua.

These two places are very important. Nuku'alofa is the capital of Tonga the location of the existing government; it is where King Tupou VI has his palace. Popua today may look insignificant to most Tongans, but it was where 'Aho'eitu, the first king of Tonga, resided in 950 A.D. The bus stations will be carefully placed to connect these

two historic places. More than half of Tonga's population lives around the Nuku'alofa area and they take this route on a daily basis. These bus stations will provide learning opportunities for the people.

During this research, I found few sources regarding traditional the architecture of Tonga, and I admire and acknowledge those who paved the road before me. I hope that the people of Tonga will take advantage of it. Kaloni Tomui's thesis, "Tongan Architecture and Rationale," is instructive and insightful. I also find inspiration in the case study of Isileli Vea, who wrote "Changing shape of traditional house forms in Tonga." I appreciate the dedication of Paula Tu'ivailala regarding different Tongan house typology and the different parts of the *fale* in "Tala 'o Tonga." These writings were of great assistance to me in this journey.

It was an honor to interview Tevita Ka'ili, Viliami Toluta'u and Tu'ione Pulotu. These men of great knowledge and experience were of tremendous assistance to me as we discussed the history regarding traditional Tongan architecture.

Physical and Theoretical Context

The Kingdom of Tonga consists of approximately 170 individual islands in the Pacific Ocean.¹ Therefore, I will also consider looking at several of these outer islands for additional details about the traditional *fale*. Tonga is divided into three main groups of islands, which are Tongatau, Ha'apai, and Vava'u.

I will focus my investigation primarily on Tongatapu, the main island of Tonga. *Tongatapu* translates to “sacred Tonga.” In addition to being the geographically largest island of Tonga, Tongatapu is also the most populated island in the country with over 67,000 residents on this particular island alone. The development of Tonga is truly reflected through Tongatapu, as it is the most urbanized area in the entire country. The island is over 99 square miles and is moderately flat because it is built of coral limestone. The island is covered with thick, healthy soil fertilized with volcanic ash from neighboring volcanoes. At the steep southern coast, altitude averages at 115 feet above sea level and gradually decreases towards the north. Tongatapu is at its highest elevation around the villages of Fua'amotu and Nakolo, with altitudes of 213 feet.²

¹ Parrish, Ann. *Our World: Tonga*. N.p.: Our World: Tonga, 2015. 1. *Points of View Reference Center*.

The Kingdom of Tonga is also known as the "Friendly Islands." The name was given when Captain Cook visited Tonga in the late 18th century.³ It is the only Monarchy left in the Pacific and has never been conquered. Tongan society is divided into a three hierarchy: the first hierarchy consists of the king and his family, the second hierarchy consists of the nobles and their families, and the third hierarchy consists of the commoners. The islands are divided into geographical areas is divided, each having a noble that acts as a ruler of the people, but remains under the direction of the king.

Even today, Tonga is developing slowly and it is not westernized. Tongan people value their relationships with one another and are extremely family oriented. Even though there are no industrialized, western chain restaurants or chain stores (such as McDonalds or Walmart) in Tonga, there are no homeless people either. Everyone everywhere has a home because the Tongan people take care of one another. Because of how we are raised and taught, it is harder to feel, act, and think as an individual in Tonga. Even today, extended families live in the same homes together, and people typically live in the same place all their lives. Everyone is familiar with his or her own town or village, which causes visitors and outsiders stand out to the local people. That said, Tongans are tremendously friendly and interested in both learning from and sharing with tourists and visitors of all types.

Due to the small island size and the seemingly limited economic and educational conditions, opportunities are extremely limited for most Tongans living in the islands. There are actually more Tongans living outside of Tonga than there are living in the

³ Martin, John M.D. *Tonga Islands*. Tonga Vava'u Press, 1981, 22.

country.⁴ People moved out from the islands to further their education, find better jobs, and many other reasons. Simultaneously, other populations from countries, such as China and India, are migrating to Tonga for business and living. Because of this influx of new people and cultures, Tongans are gaining exposure to the outside world, leading to more development than Tonga has ever experienced before.

⁴ <http://www.migrationpolicy.org/article/tonga-migration-and-homeland> (accessed March 3, 2016).

Project Goal

The goal for this paper is to provide a reliable document to help improve architecture in Tonga by reconnecting current Tongan architecture with historical and cultural building methods. The information and data obtained from this study will be used to design a series of bus stations in the heart of Nuku'alofa. These bus stations will help the people of Tonga reconnect with the past and develop a greater appreciation for the environment and their historic cultural identity.

This project is also an opportunity to gain a greater knowledge about Tongan architecture in the past, present, and future. Tongan architecture of the past is a mystery to most modern Tongans. The materials, the culture, the names of the different parts of the *fale*, the intentions and values that were traditionally used, and how they related to the people have become lost for many Tongans.

I will investigate and learn about the shift from the traditional *fale* to the present buildings in Tonga today. This will present an opportunity to understand all the different factors that drive architecture in Tonga in the present and will influence it in the future. The information in this document will be a helpful source of data to solve current building problems in Tonga by taking inspiration from traditional architecture.

Research Methodology

I start by looking at the data and information I have gathered, as I think of the design for the new architecture in Tonga. In this research, I investigate documents and findings about the traditional architecture in Tonga using libraries, the internet, as well as my own direct personal experience growing up in Tonga. Additionally, I consult personal interviews I conducted with knowledgeable individuals. In personally interviewing Tongans, the survey is useful and necessary in finding greater depths of information. Additionally, other forms of writings, such as journals and articles, are greatly helpful. Beyond the aforementioned, I also visited Tonga personally to further my studies first hand.

Throughout the process, I found out as much information as possible about the traditional architecture in Tonga. With this knowledge and information, conducted interviews with master builders and carvers. I interviewed several Tongans and South Pacific historians. When I gathered their information, I used it to make a survey with questions relevant to the topics we discussed. Because of limited sources, I also read other theses and writings regarding this topic.

There is limited published information about traditional Tongan architecture. However, I used information from other South Pacific islands, such as Hawaii, Aotearoa (New Zealand), and Samoa. These islands have similar values and needs to Tonga.

Research Documentation

How has the traditional Tongan *fale* evolved?

Tongan architecture has evolved throughout history. The traditional Tongan *fale* were developed through by improving the structural system implemented. The builders were able to modify the structure to allow them to build better and larger *fale*.

According to Paula Tuivailala's research, the Tongans first lived in 'ana (caves).⁵ These naturally formed caves were located mostly around the coastal areas, though many were inland as well. These caves provided the perfect shelter from rain and stormy weather. Even today, some the caves in Tonga are famous for their unique beauty. For instance, 'AnaPekepeka, is located in the Vava'u group in the island of 'Otea. Ana means "cave" and pekepeka means "bats." Bats live in this cave and it is so dark that you can hardly see anything when you enter. Once you throw a rock or make a noise inside, it will start to lighten because the bats are woken by the noise and fly out of the cave, only returning once the cave is silent again.

After living in caves, the Tongan people built the *falehunuki*, which is similar to a tent. The *falehunuki* was a temporary structure that people lived in. People still build *falehunuki* for funerals and wedding gatherings today. The form of the *falehunuki* was either a rectangle or oval, and was heavily dependent upon the available local materials

⁵Tuivailala Paula, *Tala 'o Tonga* (Tonga: Government Printing Department, 1991), 146.

and resources. This building was similar to the Samoan *fale* because there were no walls. It was only a roof system structure.⁶

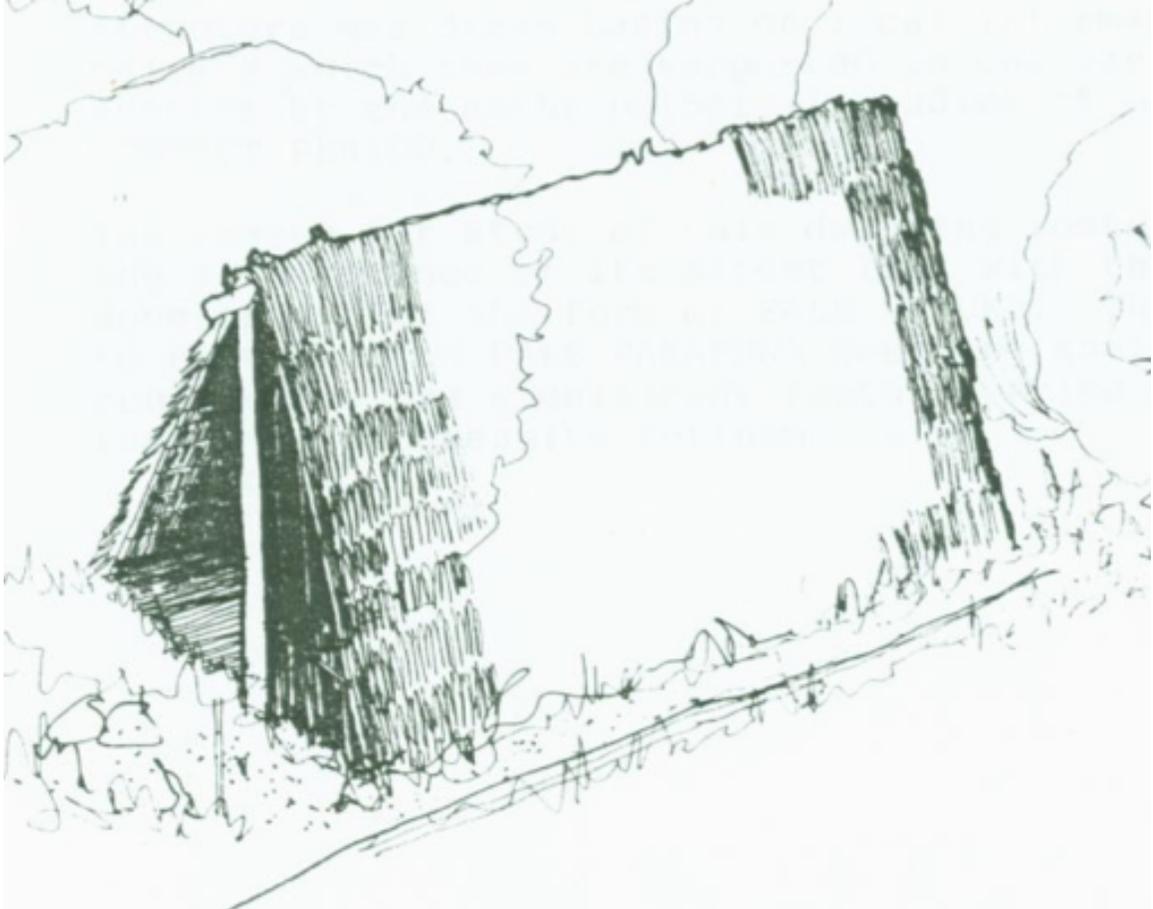


Figure 2: Fale Hunuki

Source: Vea, ‘Isileli. “Changing shape of traditional house forms in Tonga [1985].” Architecture & Building Department, PNG UNITECH, Port Moresby. Photocopy

Next came the *falefaha’iua*, which were similar to the *falehunuki*. The only difference was that the *falefaha’iua* had a low wall around the building. Both of them

⁶Viliani Toluta’u, interview by Folau Nonu, Brigham Young University of Hawaii, March 14, 2015.

were used for the same purpose, but the *falefaha'iua* was better able to handle the wind than the *falehunuki*. The *falefaha'iua* usually had two main vertical posts to which everything was connected.⁷

The *fale fata* was a step up from the *falehunuki* and the *falefaha'iua*. It had four or more main posts or *pou*. The structures consisted of both vertical and horizontal poles. Because of the addition of poles and posts into the *fale*, the size of the *fale* became bigger. The new structure allowed an additional space for living and storage above the *utupoto*, similar to an attic. The *fale fata* can have a double *utupoto* (upper roof structure) and is then called *falefataua*. This structure system allowed the *fale* to have more than one story.⁸

⁷ Viliami Toluta'u, interview by Folau Nonu, Brigham Young University of Hawaii, October 17, 2014

⁸ Tevita Kaili, interview by Folau Nonu, Brigham Young University of Hawaii, October 17, 2014.

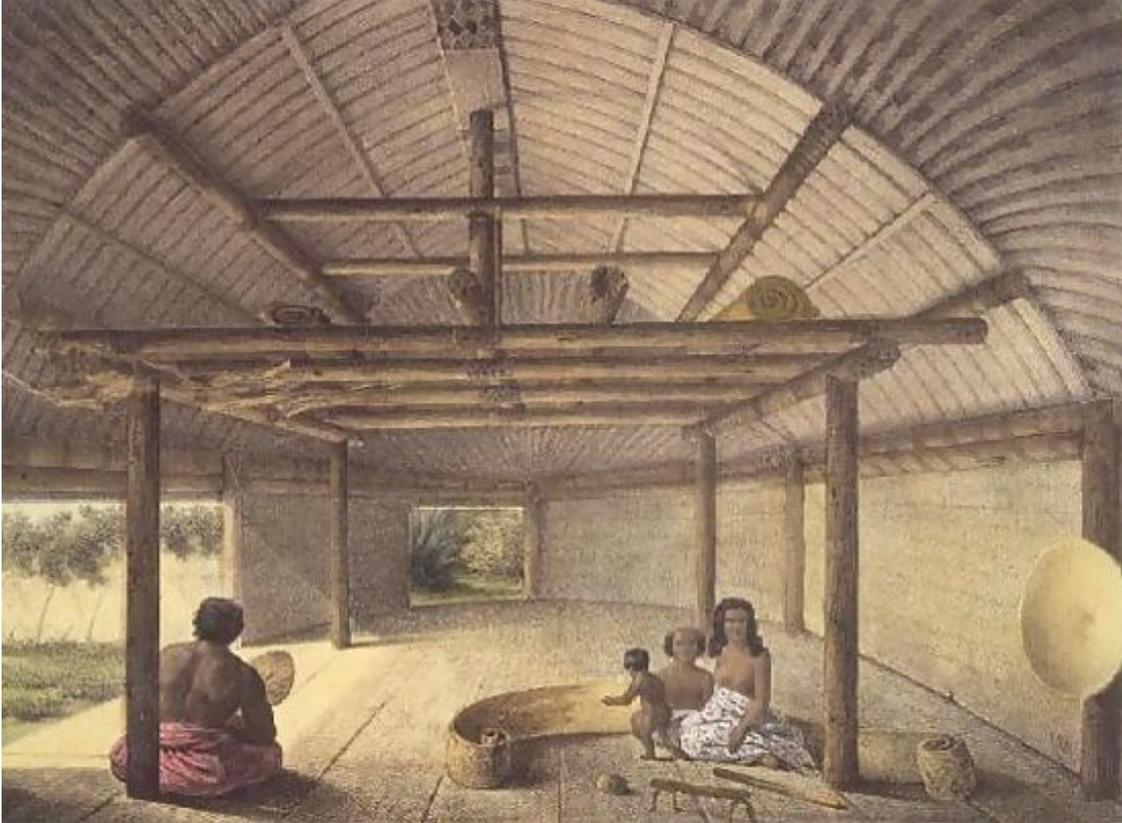


Figure 3: *Fale fata*

Source: <http://www.1st-art-gallery.com/%28after%29-Sainson,-Louis-Auguste-De/Interior-View-Of-The-House-Of-Chief-Palous-Wives,-Tonga-Tabou,-Plate-73-From-Voyage-De-La-Corvette-Lastrolabe.-Atlas-Historique,-Engraved-By-Jules-David,-Pub.-1833.html>. (accessed March 24, 2016).

Next, Tongans utilized other Polynesian house typologies, such as the Samoan *falefakamanuka*. This house had a similar structure to the *fale fata*, except there were no

walls. They would use this type of *fale* for weaving and meetings because the walls were not required. Without walls, these buildings were well ventilated.

The Fijian *falefakafisi* was also introduced to Tonga. This structure was a little different than the previous buildings; both the ceiling the roof were higher. The Fijians used the abundant sugar cane leaves for rooves and walls, whereas in Tonga, the predominant materials came from plentiful coconut leaves that were used for the roofs and walls. The high structures helped ventilate the space.

The *falepouono* and *falepouvalu* were typically built using six to eight columns. They were built according to how many nobles were in the area. Each noble would sit in front of a column, as it was symbolic of status. There were as many *pou* in the *fale* as there were nobles living in that area. The *pou* were symbolic of royalty in the community, which was the foundation of the *fale*. These were very large buildings, and were used for different community activities, functions, and ceremonies.

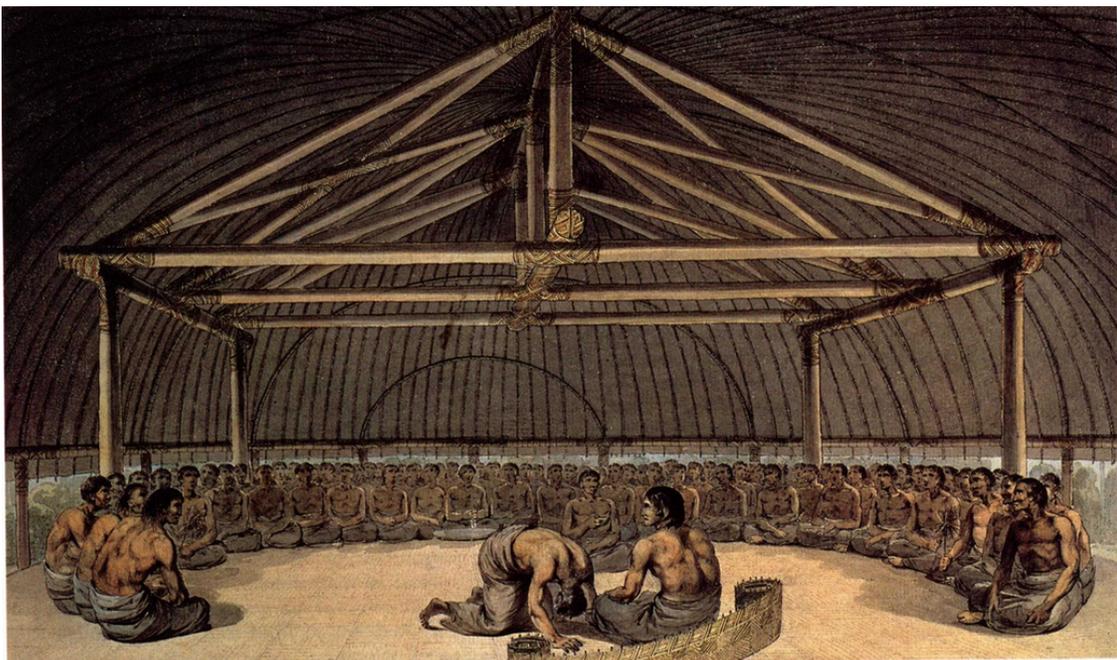


Figure 4: *Fale fata.*

Source : Joppien, Rudiger and Smith, Bernard. *The Art of Captain Cook's Voyages (vol 3)*. Oxford University Press in association with the Australian Academy of the Humanities, 1987, 37.

Reflecting on all of the different *fale* from the beginning, the structures slowly changed and the form of the *fale* grew. I find the *pou*, or columns of the different *fale*, interesting and exciting. The *fale 'ana*, or caves, have no *pou*. The *pou* were introduced when the people began to introduce the structure of the *fale*. As I interviewed Professor Tevita Ka'ili, who teaches anthropology at Brigham Young University Hawaii, I learned that the *pou* were more than the main posts of the *fale*.⁹ They were also highly symbolic. While working at the Polynesian Culture Center in La'ie, I learned the Fijian chief's house would have a warrior or an ancestor volunteer to be buried beneath the *pou*, and they would welcome and escort their master into the next life. According to Ka'ili, this was similar to the Tongan *fale*.

⁹ Tevita Kaili, interview by Folau Nonu, Brigham Young University of Hawaii, October 17, 2014.

Different House Typology

Historically, the people in Tonga were very organized. They would build houses for different functional uses of space. The typical residential house was used for sleeping and also for family meetings. Following are some of the different houses and their functional uses.

Falehanga: This was the weaving house, and it was built with open walls. Only women used this house, though the children were allowed to play both inside and outside. Men were not around or close to the weaving house.



Figure 5: Earthen burial mound and *falehufanga*

Source: Ferdon, Edwin N. *Early Tonga*. The University of Arizona Press, 1987, 159.

Faletolia: This was strictly used for funerals, and it was the space where the dead were placed during the ritual. It was heavily decorated with different kinds of mats and *tapa* cloth.

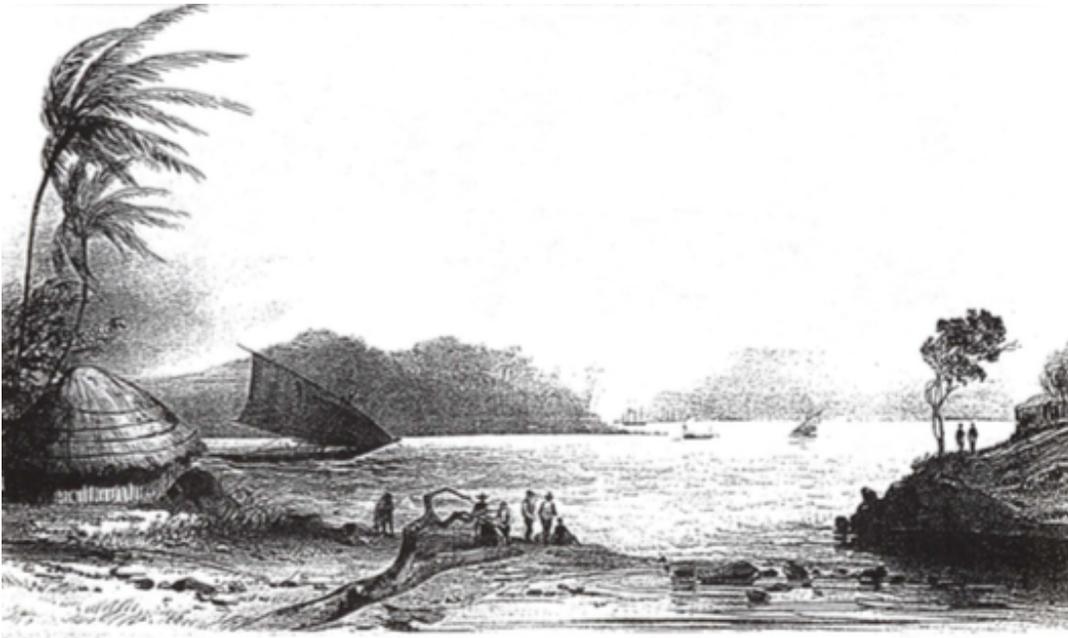


Figure 6: Scene in Vava'u harbor

Source: Childress, David Hatcher. *Ancient Tonga & The lost city of Mu'a*. Adventures Unlimited Press, 1996, 49.

Falesiu: This was the meeting house for the fisherman. They would perform rituals here before they went fishing in the sea. Women and children were not allowed in this space. There were also *tappoo*, and different rituals the fishermen that would occur in this house before they went out fishing or to war.

Falevai: This was the bathroom or water house; it was traditionally built separately from the main house. There were different *falevai* for men and women.

Faleta: This house is for injured people; it was similar to a clinic or hospital where the people were treated for injuries of war or for any kind of sickness or disease.

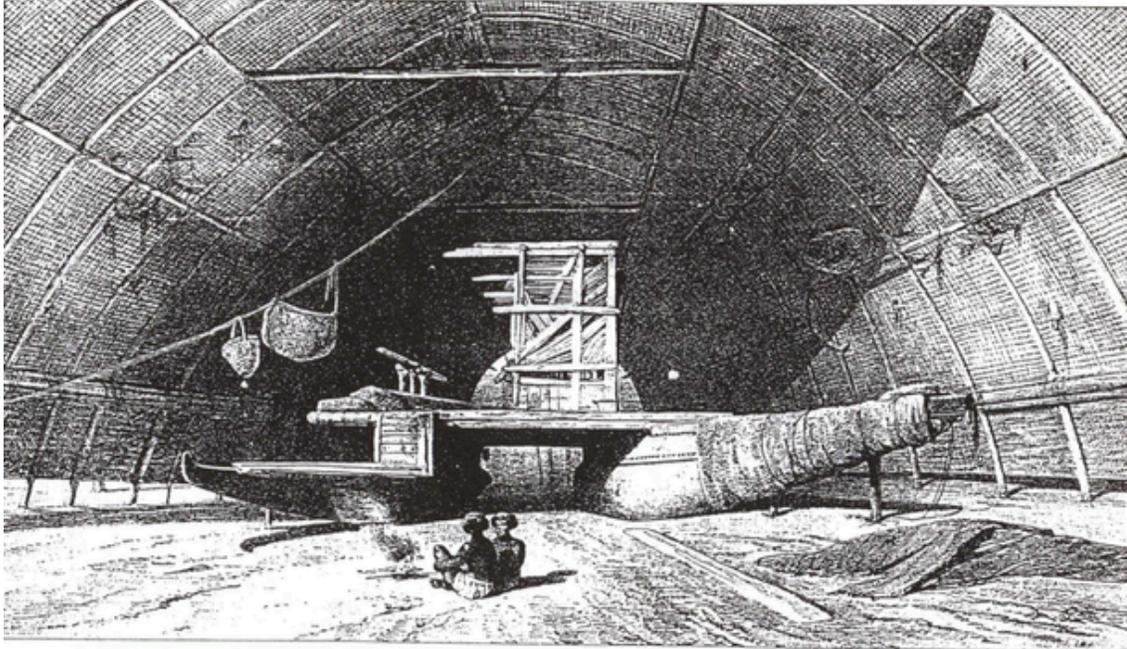


Figure 7: *Fale Tuku'anga vaka* in Vava'u

Source: Childress, David Hatcher. *Ancient Tonga & The lost city of Mu'a*. Adventures Unlimited Press, 1996, 46.

Alafolau: This was a storage space, mostly for fishing equipment. The nets, ropes, and bottles were made and stored in this house. Fishermen were usually the only people allowed in this space. This was also the boathouse. It was built close the beach, and boats were stored and repaired in this space.



Figure 8: Store house and working space

Source: During, Kurt. *Pathways to the Tonga Present*. Government of Tonga Printing Department Nuku'alofa, 1990, 95.

FaleAlea: This was the meeting house. It was a fairly big structure. It would have eight *pou* or more. This building was used for different social gatherings, celebrations, and ceremonies in the village.

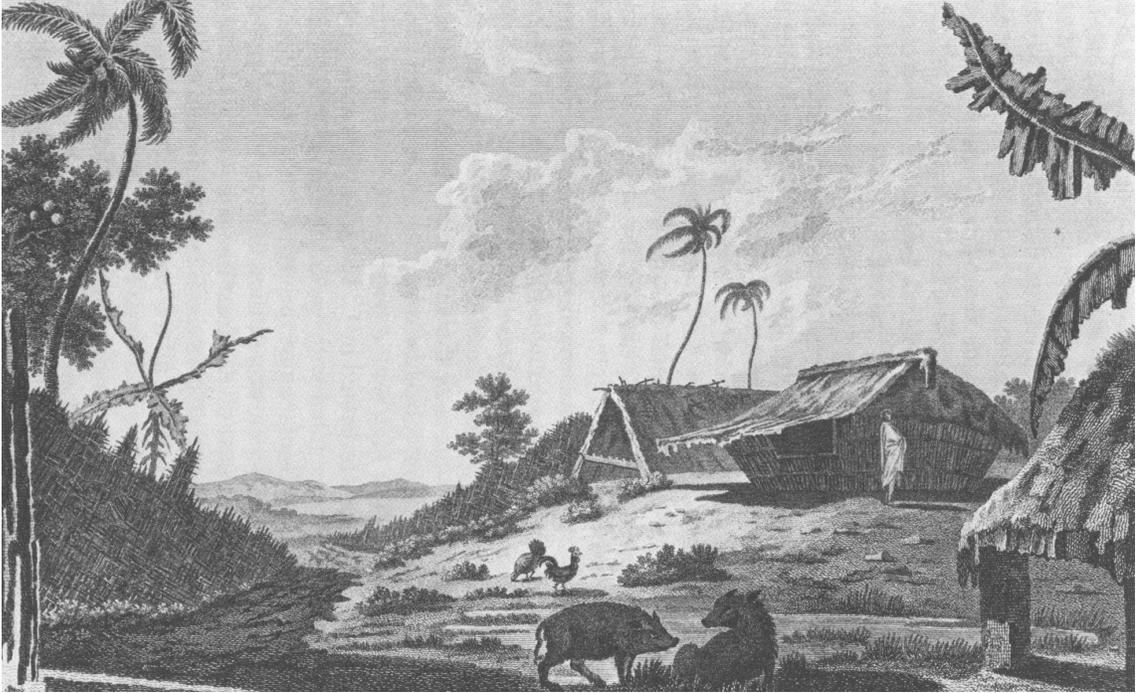


Figure 9: Yam storage house in the island of Nomuka

Source: Ferdon, Edwin N. *Early Tonga*. The University of Arizona Press, 1987, 213.

Feleoko: This was a food storage house. It was mainly used by farmers to store their crops, seeds, and whatever else they were going to plant during the following season.



Figure 10: Missionaries being shown the *Fa'itoka* of the Fatafehi family

Source: Ferdon, Edwin N. *Early Tonga*. The University of Arizona Press, 1987, 161.

Falehufanga: This was a sacred house on top of the cemetery. It was like a sacred refugee place. Anyone would be safe once he or she reached this space. A *Taula* (shaman) usually lived in this house. People respected and feared the *Taula* because they were believed to have great power and abilities.

These different houses were significant to the people of Tonga. There were also different rituals performed in some of the spaces, such as the *Falehufanga*. The names for the spaces help to explain the purpose of the building. This is not something unusual to the Pacific.

Parts and significance of the Traditional Tongan *Fale*

The traditional *fale* related to the people in different ways through its different parts. Each part of the *fale* had its own name. These names were based on their functional uses and they had a deeper meaning related to the Tongan culture. As I interviewed Viliami Toluta'u, he mentioned, “The impact of the word is the backbone and foundation of the Tongan tradition” (put citation here). These very words help to really understand the significance of the Tongan architecture weaving together with the culture.

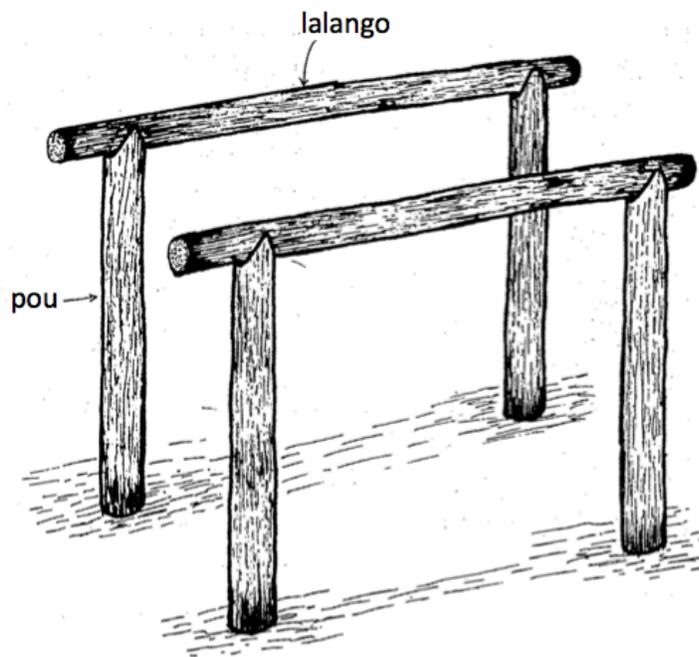


Figure 11: Main Posts

Source : Tuivailala, Paula. *Tala 'o Tonga*. Nuku'alofa, Tonga: Va'a Silapa, Potungāue Ako, 1990, 166.

The Tongan *fale* have *pou*, which are the main structure posts of the *fale*. *Pou* means “to support and hold.” The materials used to make the *pou* were local trees in Tonga, including *koka*, *toi*, and *toa* trees. It depended on the availability of the materials in the area. Coconut trees were never used for the *pou* because they rot quickly when they touch the ground. *Pou* were usually independent from the wall system. The size of the house would depend on the size of the *pou*, and also the number of the *pou*. A typical residential *fale* would usually have four *pou*, and meeting houses and spiritual buildings usually had more *pou*. There were also other *pou* in the wall system that helped to support the walls. They were called *poufehi* because they were made mainly from *fehi*. These were the end columns where the walls were hung to support the *kauta* and to hold the end structure.

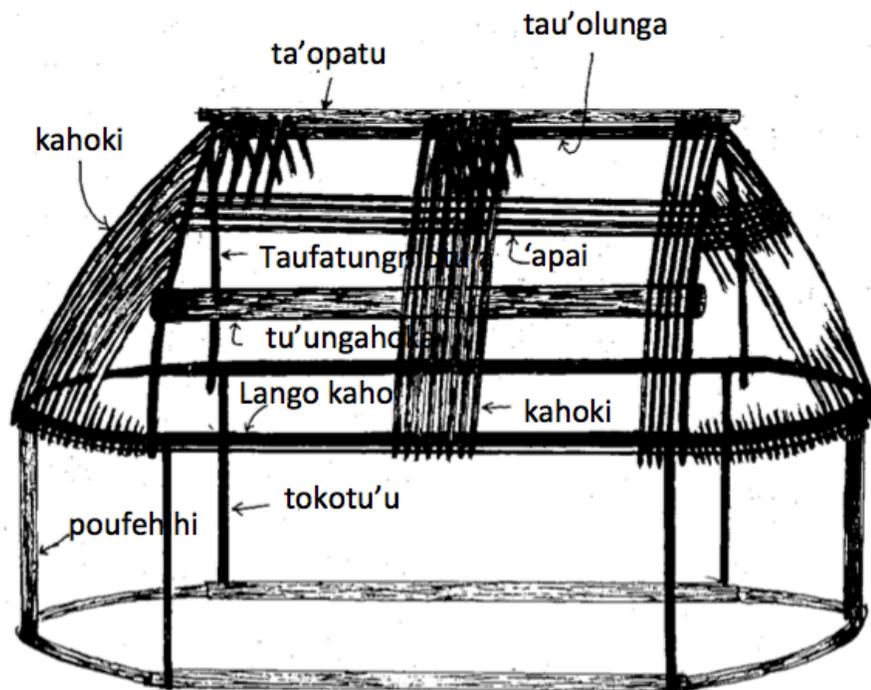


Figure 12: Different parts of the *Fale*

Source: Tuivailala, Paula. *Tala 'o Tonga*. Nuku'alofa, Tonga: Va'a Silapa, Potungāue Ako, 1990, 171.

The *tokotu'u* were the side columns where the walls hung. *Toko* means “push the canoe with the stick” and *tu'u* means “stand up.” These were mainly made from *kuava*, *fau*, *milo*, *tavahi*, *tamano*, *toa*, or any other materials that were strong enough. Because the walls were temporary, when the *pola* walls were replaced, the *tokotu'u* were replaced as well.

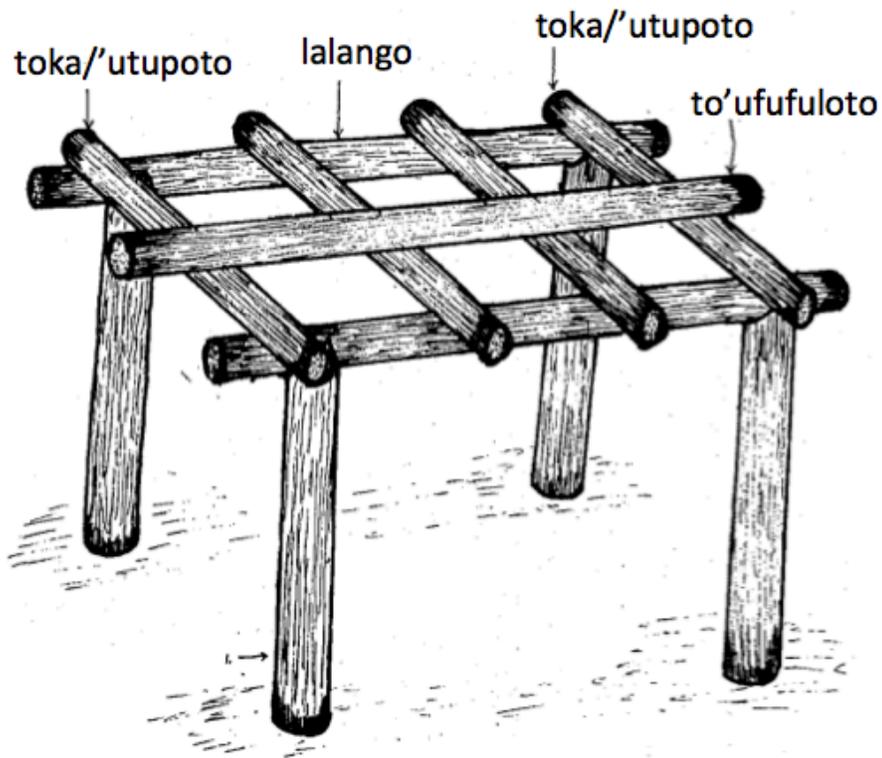


Figure 13: Main structure layout

Source: Tuivailala, Paula. *Tala 'o Tonga*. Nuku'alofa, Tonga: Va'a Silapa, Potungāue Ako, 1990, 167.

Toka was the horizontal beam structure. There were two different types of *toka*: the *ilano* and the *'utupoto*. The *toka* held the *lalango* together. The *lalango* was the main supporting beam of the *fale*, running from *pou* to *pou*. It was mainly made of coconut trees and whatever available straight hard wood was nearby. The bark was peeled off whatever wood was used. The coconut trees were used in the *fale* and were known as the *haumatutu*, which means the matured coconut. *Lango* means to “uphold or elevate.” Also, *lalango* means “headrest,” and it could be made either of wood, or stone. *Langokaho* is another type of *lango* and the material used to make it was *kaho*.

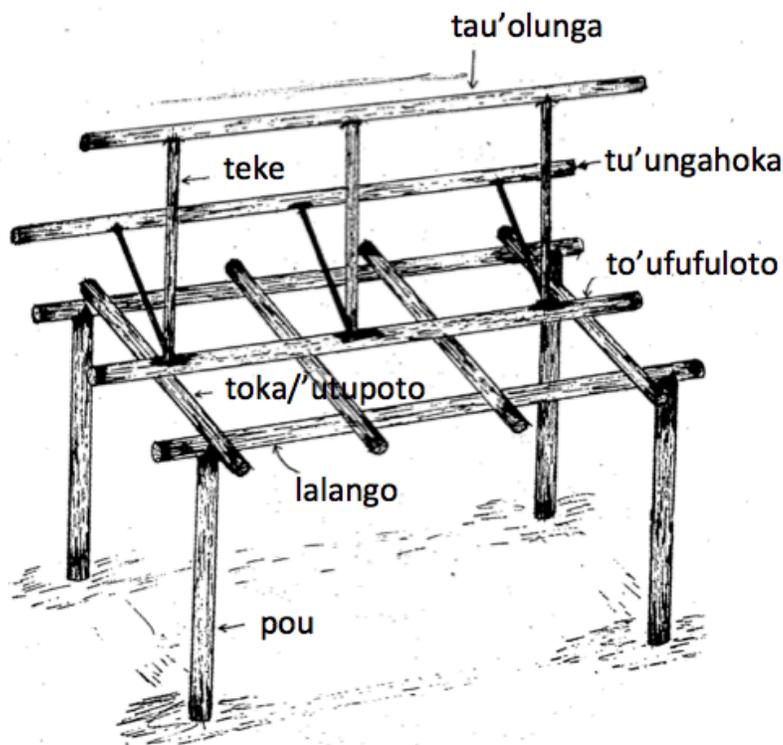


Figure 14: Structure of the *Fale*

Source: Tuivailala, Paula. *Tala 'o Tonga*. Nuku'alofa, Tonga: Va'a Silapa, Potungāue Ako, 1990, 169.

The *to'ofufuloto* is defined as follows: *to'u* means “same or similar,” *fufu* means “hidden or to hide,” and *loto* means “center or inside.” This was the center beam that connected all the *utupoto* to help support the roof. It was also where the *teke* was connected. This part was also argued to actually be the *taufatugamotu'a* because of the meaning of the word itself. For example, *fatu* means “to start,” and it was used to begin the weaving, or to compose a song. *Tau* means “to touch,” like the *tau'olunga* means “to touch the top.” *Nga* means together, but usually was used as a suffix or prefix to change the context of the word and its meaning, such as in *ha'u-nga*, *tau-nga*, and *nga-ngaue*. The *taufatungamotu'a* were beams usually made from coconut trees or whatever other kind of trees were available. All the *'apai* were lashed onto it.

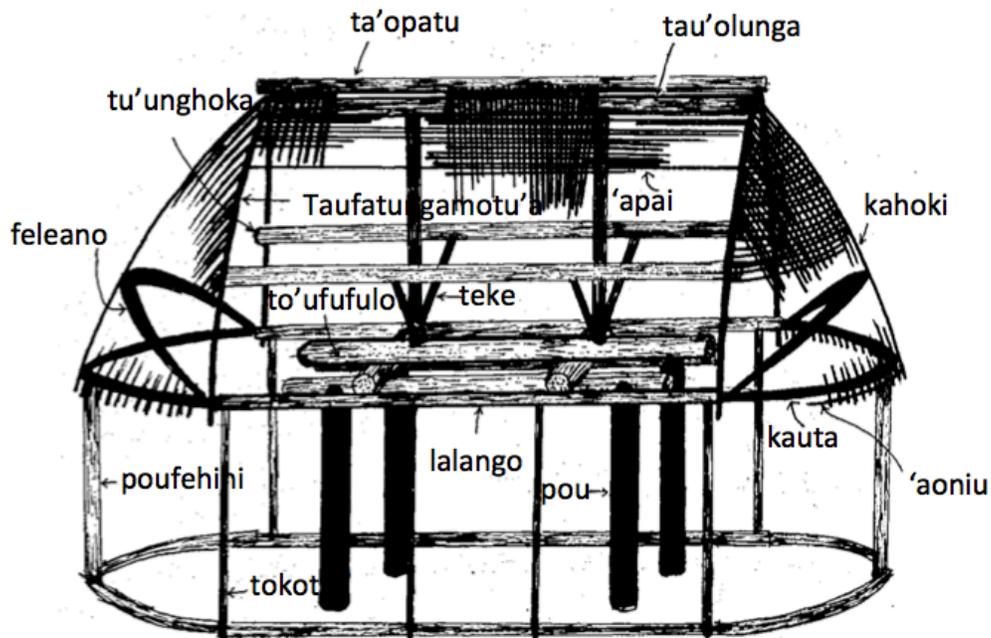


Figure 15: Different parts of the *Fale*

Source: Tuivailala, Paula. *Tala 'o Tonga*. Nuku'alofa, Tonga: Va'a Silapa, Potungāue Ako, 1990, 172.

The *teke* means “push or support.” It was lashed from the *tu'ungahoka*, which ran between the *taufafutngamotu'a*. The *teke* held the *taufatungamotu'a*. It defined the form of the roof structure as well. The longer the *teke* was, the higher the roof was. The *tau'olunga/to'ofufu* was used as structural support to help hold the roof from the top.

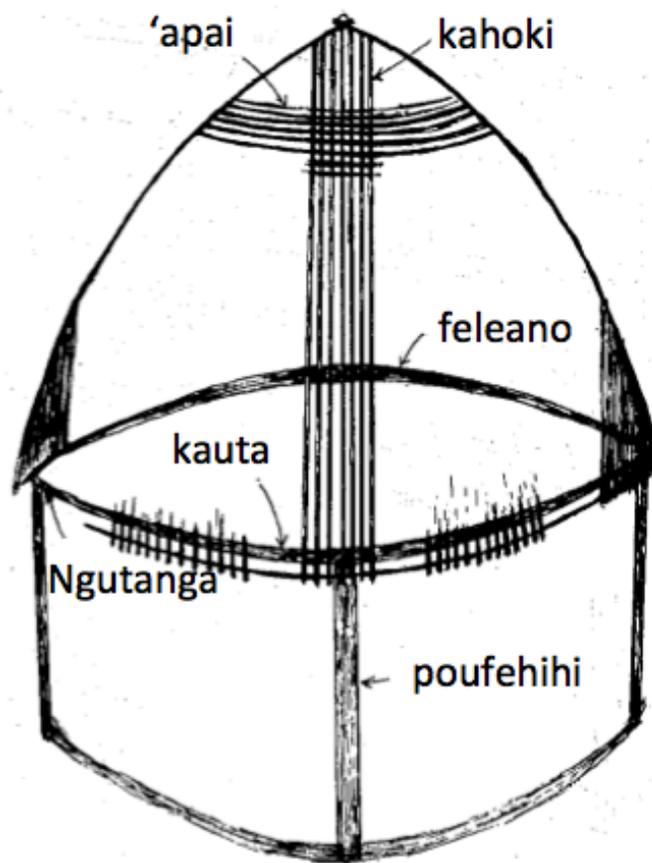


Figure 16: *Taa'ifale*

Source: Tuivailala, Paula. *Tala 'o Tonga*. Nuku'alofa, Tonga: Va'a Silapa, Potungāue Ako, 1990, 170.

The *ta'opatu*, *kauta*, and the *feleano* were used to hold and maintain the structure and the form of the roof. They were also made from coconut trees or whatever materials were available in the area. *Aoniu* means “unified” or “fully controlled,” and it was the very last ‘*apai* that held all the *kahoki*. Sliced or cut coconut trees were mostly used for this. ‘*Apai* was where the thatching was lashed, similar to rafters in a modern house. The *kahoki* helped to hold the thatching, as well as the ‘*apai*.

The *katupa* was a term that was used for the sides of the *fale*; where parents slept on one side and girls on the other. The boys and young men slept in a separate *fale*. The floor and walls were made using mats and *tapa* cloth.

These terms are seldom used today because modern houses do not typically have these different parts of the structure. Since these Tongan terms are not used anymore, most people do not know their meanings and do not have any idea of the how these words apply to their society. The impact and the significance of these terms will never be fully appreciated and understood without knowing and understanding them in relation to the traditional *fale*.

Stone Architecture

There is still existing evidence of stone architecture in Tonga today. *Ha'amonga 'a Maui*, which literally translates to “Maui’s burden,” is located on the east coast of the Tongatapu, the main island. The monument consists of three separate stones, two of them standing upright and the third crossing over and interlocking with the others. It was built in the twelfth century during the reign of Tu’i Ta-tui, the eleventh king of Tonga.¹⁰ The picture below shows how the *Ha'amonga 'a Maui* looks today.



Figure 17: *Ha'amonga 'a Maui*

¹⁰ O. Māhina; Ko e ngaahi 'ata mei he histōlia mo e kalatua 'o Tongá: Ke tufunga'i ha lea Tonga fakaako; 2006; ISBN 978-0-908959-09-9 (accessed March 14, 2016).

Source : Robert D., Craig. "Haamonga-a-Maui." *World History: Ancient And Medieval Eras* (2011): ABC-CLIO Social Studies Databases, Academic Edition, EBSCO host (accessed March 14, 2016).

The stones tower about seventeen feet above the ground, but how deep they go into the ground has not yet been discovered. The stones weigh approximately thirty to forty tons.¹¹ There are a lot of discussions and assumptions about how this was built, but nobody knows the true intent of this megalith, though some argue that it is the gateway to Heketa, where King Tu'I Ta-tui resided. There is also a rumor that the king had it built to remind his two sons of the importance of "brotherly love." Not long ago, a notch was discovered on the top of the stone that could have been used to point out the sun when it would rise from the east. Both of these are logical explanations, as they were as important then as they are today.

The *Maka Fa'akinanga* is located about fifty meters from the *Ha'amonga 'a Maui*. The stone was used as a shield for King Tu'I Ta-tui to make sure that no one would come from behind him because he was blind. He would sit and lean on the stone and make sure no one could sneak up on him. The stone itself signified his power and his throne. Tu'I Ta-tui also built stone vaults for his four children.

¹¹ <http://www.wondermondo.com/Countries/Au/Tonga/Tongatapu/HaamongaMaui.htm> (accessed March 5, 2016).



Figure 18: *Maka Fakinanga*

Source: http://www.muellerscience.com/borabora/19_TB_Tongatapu_Original.htm

(accessed March 14, 2016).

There are more than thirty different stone monuments that can be found in Tonga. Most of the stone monuments were *langi*, royal tombs or burial sites of the kings and their nobles. *Paepae o Tele'a* is the largest of them all and is located in Mu'a, which is the former capital of Tonga before it moved to Nuku'alofa. This burial site was built by the king for his dear wife.



Figure 19: Paepae 'o Tele'a

Source: <http://it.paperblog.com/langi-le-tombe-reali-di-tonga-626611/> (accessed March 14, 2016).



Figure 20: Source of stone slabs for building *langi* which found on many beaches in Tonga

Source: Campbell, Ian. *Island Kingdom (Tonga Ancient & Modern)*. Canterbury University Press, 1992.

How does Tongan architecture relate to the people?

In Tonga, *fale* means “family.” The *fale* used lashing or *lalava/ha’i* to connect things. In Tonga, when two people marry, it can be called *ha’ikainga*, which literally means they are “pounded or lashed together.” *Takaifala* is another word that is used for marriage. The literal translation of the word is “rolling the mat” and is symbolic of when you marry somebody, that you would do that chore of rolling the mat which was typically done by the lower ranking person, or children. Tongan society is family oriented. Everyone knows each other and watches out for each other.

Everyone belonged to a *fale*. Each *fale* had the *pou*, which were symbolic; the *pou* represented the ancestors. When the people would come into the house, they would sit and lean on the *pou*. The *pou* of the house were also the foundation of the *fale*. This meant the ancestors were the foundation of the *fale* and the family. When they leaned on the *pou*, they were showing they trusted and counted on their ancestors to watch over the family and also the *fale*.

Fale is used in many contexts to refer to family. For instance, *talatalaifale* refers to “teaching” or “advising” the family and usually comes from the father; the word itself is derived from the *fale*. The word can be broken down into three different parts: “*talatala*” is short for *tala* and means to tell, advise, counsel, or announce; “*i*” is referring to “places;” “*fale*” refers to the house. The literal translation of the words is to tell, teach, advise, and counsel in the house.

There is another word that means the same thing. *Fakalekesi* is a word derived from “*leke*,” which means “room of the *fale*.” The “*fakalekesi*” was where the mother would give advice from her room. The word “*fale’i*” also means to counsel, to advise, or to teach, and it refers to the closest person in the family who would give the advice or do the counseling.

Fatufale is also a term that was used for building the *fale*; this word meant “used for raising children.” Another term is *fatutama*, which means a child has been raised up in the right way with teachings and counseling from their parents and family, and is respected by the society. In this context, the child is compared to the *fale*, and he or she is especially responsible and helpful. This context has a similar meaning to a famous phrase in Tongan: “*Fatufatu fala fai ki falelalava*.” It means something is started right because it was brought up in the right place and in a safe environment.

Fetoka’i’aki is another term that is derived from the *fale*. The *toka* are the main beams of the *fale*. This phrase is used to mean “to care, love, respect, treat royally and watch out for each other.” There is no English word that can properly define this term *fetoka’i’aki* because it has a deeper meaning that is difficult to explain in another language. To understand it better, we have to think of the *fale*. There are two *toka* used to support the whole roof structure. If one of them gave in or broke, the *fale* would not hold. They play a crucial part in the strength and structure of the *fale*. Once we understand the value of the *toka* in the *fale*, we can have an idea and an understanding of the word *fetoka’i’aki*.

The Tongan society was very similar to the house; the society builder and the house builder were closely related. *Tufunga* is a combination of two words: *funga* means “above” and *tu* means “king, leader, or a dominant name” The definitions of these two words indicate the meaning of the combined word, which is that a king or leader is dominant above others. The nobles would usually sit or lean on the *pou*, which showed that they were the foundation of the society.¹² In Tongan culture, the commoners would volunteer to serve their nobles; the people would be honored to have the opportunity to give or do something for their nobles. The nobles were always served first with the best of anything the people were willing to offer.

The *fale* also relates to the people socially. In a typical village, the chief or the noble living there would have the biggest house. The picture below shows a town in Ha’ano, Haapai in the year 1870. It is possible to see from the photo where the chief of the village lived by the relative sizes of the buildings.

¹²Viliani Toluta’u, interview by Folau Nonu, Brigham Young University of Hawaii, October 17, 2014



Figure 21: Traditional Tongan Community

Source: During, Kurt. *Pathways to the Tonga Present*. Government of Tonga Printing Department Nuku'alofa, 1990, 93.

The *fale* also defined the hierarchy of the society. The *tau'olunga* refers to the king's face, and the king was the representation of god on earth. The *toka* represented the nobles who served the king. The floor of the *fale* represented the commoners who served the nobles. This hierarchy shown throughout the *fale* is also found in the Tongan language. There are three different levels of speech, the highest and most respected level being the king's level, known as *lea fakatu'i*. Below the king's level is *lea fakahou'eiki*, which is used for the nobles. The lowest level is for the commoners, and it is known as *lea tu'a*.

In Tongan society, working together also plays a big role. Even in the building of a *fale*, there were celebrations and rituals throughout the process. People celebrated before, during, and after the building of the *fale*. Existing architects of Tonga still

celebrate the *tanupou* (laying of foundation), *hikisa* (raising of the rafters), and *huufi fale* (open house, completed). These still have a connection to the culture today. Back then, they had a big feast and everybody was invited to come and help lift the roof structure and place it on the *pou*. This part of the construction always required a lot of people because everything was done by human labor, without any machines or technology.

During these celebrations – the *tanupou* (laying the foundation), for example – they would perform certain rituals and celebrations to bring luck during the construction and also to bless the *fale*. These rituals also had *tapu*, which were sacred rules they had to abide by for a period of time. After the construction had been completed, they would have another feast and bless the *fale* to be a safe place and a shelter for whatever purpose the *fale* was built for, as well as to release the *tapu*.

The picture below shows a typical *fale*. The door was intentionally built low so everyone who went through the door had to bow down to enter and exit. This simple act was used to remind the person who had gone through to be humble. Being humble is a particularly important attribute in Tongan culture.



Figure 22: Traditional Tongan house

Source: During, Kurt. *Pathways to the Tonga Present*. Government of Tonga Printing Department Nuku'alofa, 1990, 93.

What materials were used in the traditional Tongan *fale*?

The traditional Tongan *fale* was constructed with local material and mostly trees and stones that were found close to the site. The different parts of the house were built using different types of trees. The *pou* were the main columns of the *fale* and were always built with hard wood, like *toa*, *koka*, and *tavahi*. Some of the trees that are not found anywhere else in the world, such as *koka* and *tavahi*, can only be found in certain places on the island. Other structural parts of the *fale* needed a little flexibility. For this, they would use coconut, *kuava*, *fau*, and mangroves because they had hard wood that could flex.

The size of the *fale* was sometimes limited to the available materials in the surrounding area. However, Tongans used lashing techniques to join the materials together to help them build almost any size they wanted to construct. Some of the trees have limited sizes, such as *kaho*, *fehi* and *siale*, and were better used for the short beams in the structure. On the other hand, longer trees, such as *niu*, and *toa*, were used for the longer beams.

The lashing was all done using the coconut fiber that is known as *pulu*. The good *pulu* for the *kafa* (braided coconut fiber robe) were long. There were certain coconut trees grown and planted just to make *kafa*, and were used for nothing else. The *kafa* would be braided, and sometimes it would be put underground in the ocean or in mud to give it the right color. It was used for lashing and for decoration.

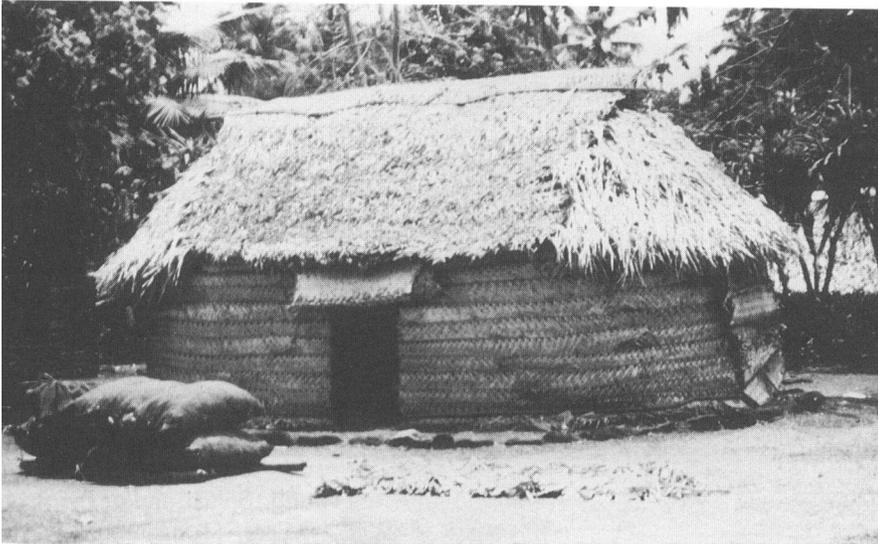


Figure 23: Thatched roof from *au* (sugar cane leaves) on a Tonga house

Source: Whistler, W. Arthur. *The ethnobotany of Tonga : the plants, their Tongan names, and their uses*. n.p.: Honolulu : Bishop Museum Press, 1991., 1991. *BYU-Hawaii Catalog*, EBSCOhost (accessed March 14, 2016), 23.

The roof and exterior walls were usually made with coconut leaves. However, some buildings used sugarcane leaves, as shown in the figure above. It was weaved in a special way. The thatching and walls used long coconut leaves, which had to be green because they were easier to work with and flexible enough for weaving while still being durable enough to not break.

The interior walls were made using *lauhala* mats, which were weaved from *hala* trees. There were different types of *hala* trees. Some of them were harder to gather than others, and some of them were harder to make. The owner of the *fale* decided which *lauhala* mat he would use for the wall and the floor. The interior of the *fale* and the kind

of decoration would convey the status of the owner in the society. For instance, the nobles would get the mats that were much finer than typical mats. The ceiling was open and sometimes it was covered with *tapa* cloth. The *tapa* was made by peeling and pounding the inner bark (*tutu*) from the paper mulberry tree (*hiapo*).



Figure 24: Woman stripping the bark from a stem of *hiapo* (paper mulberry)

Source: Whistler, W. Arthur. *The ethnobotany of Tonga : the plants, their Tongan names, and their uses*. n.p.: Honolulu : Bishop Museum Press, 1991., 1991. *BYU-Hawaii Catalog*, EBSCOhost (accessed March 14, 2016), 42.

The *fale* was built using local materials, which changed depending on what was available in the surrounding area. There were some structures that used imported materials from outer islands and neighboring countries, such as Fiji and Uvea. It was

common for the kings and nobles to bring in outside materials, but the commoners used only local materials. All the trees used in the *fale* had to have the skin peeled off to prevent bugs from hiding under the bark.



Figure 25: Woman pounding *hiapo* (paper mulberry) bark to make tapa cloth

Source: Whistler, W. Arthur. *The ethnobotany of Tonga : the plants, their Tongan names, and their uses*. n.p.: Honolulu : Bishop Museum Press, 1991., 1991. *BYU-Hawaii Catalog*, EBSCOhost (accessed March 14, 2016), 43.

How was the traditional *fale* constructed?

The traditional process of building a *fale* was quite interesting and poetic compared to present day home construction. First, the site and location were important. The houses of the nobles and the churches were always built on a hill. The hill was symbolic of their beliefs that their ancestors were underground, just as how they were buried to hold the family or the *fale* together and watch them from above. They believed that the ancestors were the foundation of the *fale*. They also believed that the higher the hill, the closer they were to the gods and their ancestors who were watching over them. At times they would build artificial hills known as *tanusia*. After the site was chosen, they would perform a ritual celebration to protect the site and bless the builders during construction.

Before putting the main columns in, builders would dig up the earth and place a big rock underground. This rock would be placed below the *pou*, and then more rocks would be used to hold the posts before they returned the dirt and compacted it. The number of the posts determined the size of the building. A typical residential house would have four *pou*, family meeting houses would have six to eight, community halls would have ten or twelve, and so on. Before the walls and the roof were put into place, the size of the building could be determined from the *pou*. The rest of the building was constructed on the ground separately, and then put together when everything else was finished.

The whole community participated in the process of building the *fale*. The little children would braid the rope, the men would lash the structure together, and the women did the weaving and preparing of the *tapa* cloth. These were part of the daily activities of the community as they built the *fale*.



Figure 26: Weaving

Source: During, Kurt. *Pathways to the Tonga Present*. Government of Tonga Printing Department Nuku'alofa, 1990, 148.

Everything was built on the ground, including the thatching that was lashed to the roof structure before being assembled. They would perform another celebration called *hikisa*, meaning “raising the rafters.” Everyone would come to help lift the roof structure and place it on the *pou*. The roof structure was heavy because of the hard wood, which is why they needed a lot of strong men to lift the structure.



Figure 27: Example of a traditional roof-construction

Source: During, Kurt. *Pathways to the Tonga Present*. Government of Tonga Printing Department Nuku'alofa, 1990, 94.

Some people argued that the roof structure was an upside-down canoe. On the other hand, some said the canoe was shaped like the upside-down roof system. While it is unknown if either of these arguments are true, they are both interesting ideas.

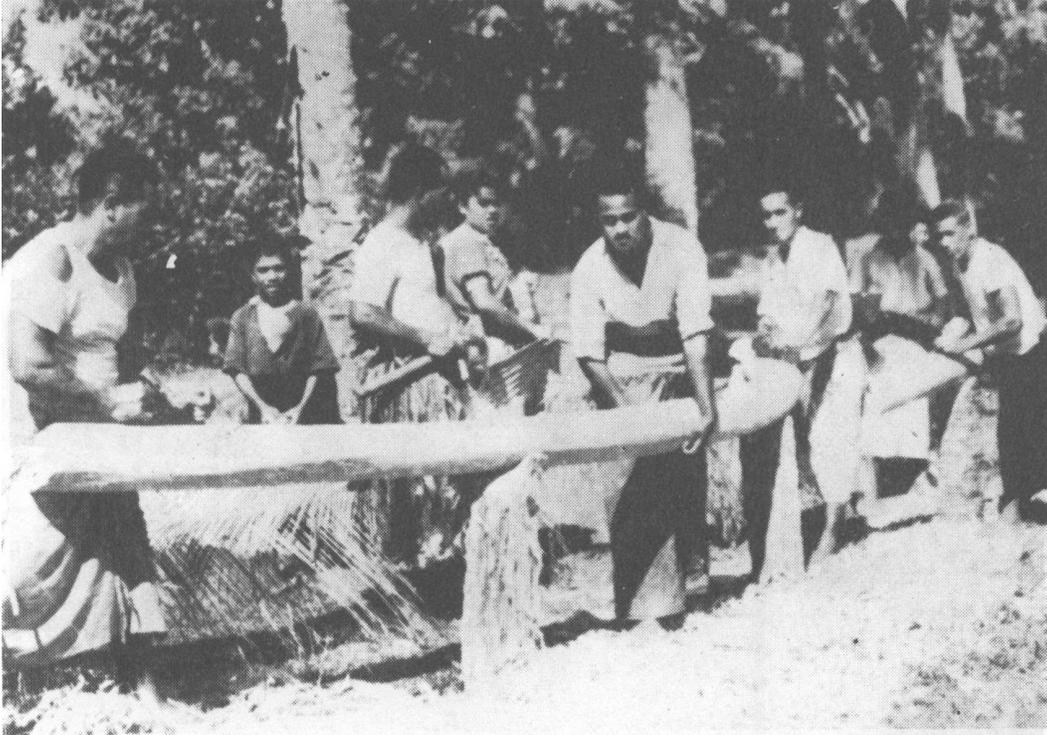


Figure 28: Building of the *fale*

Source: During, Kurt. *Pathways to the Tonga Present*. Government of Tonga Printing Department Nuku'alofa, 1990, 95.

The walls were lashed to the *poufehihi* and the floor and ceiling were attached to the structure. They would use the *kafa* for both heavy lashing and decoration on the structure. The walls were all temporary, as well as the roof. Every seven to ten years, the walls and thatching would be replaced, while the main structure of the *fale* remained. The *pou* would be replaced as well, but not as often as the other parts of the *fale*.

Sustainability of the Tongan *Fale*

The indigenous people of Tonga were fully self-sustainable. Their lifestyle and their survival skills were based on how well they lived with nature. People did not have to go to school to learn to be self-sustainable; they learned from firsthand experiences in their lives. As such, their impact on the environment was limited, yet planned and controlled. In fact, the term for environment is *fouua* in Tongan, in which land, animals, trees, and humans all played a part. Sustainable practices meant a balance between society, lifestyle, spirituality, culture, and ecology.

Additionally, *fale* were also fully sustainable and ecological. Everything was natural and therefore biodegradable. Of course, the *fale* would slowly break down completely over the years and become dirt, which in turn would nurture plants and, in turn, animals. All the building materials were local to the chosen location. Holding to the idea of keeping the historical *fale* local, Tongans were careful to not bring in new materials from other areas. For example, there were certain trees that were grown just for the purpose of building the *fale*, such as the *niukafa*, which was a specific species of coconut tree. The *niukafa* was grown and re-grown specifically for the coconut husk used for the *kafa*.

The people also reused different parts of the *fale* itself, especially the interior. For example, the *tapa* cloth that was used for the ceiling would need to be replaced after four or five years, but instead of throwing it away, it would be used again for flooring, and

even for clothing. Nothing used would ever be simply discarded; items would instead be used in new and creative ways.

The traditional *fale* had neither air conditioning nor any of the modern Western technologies. It was, however, extremely comfortable all year round. During the hot, humid summer in Tonga, the *fale* naturally ventilated the space and brought comfort to the people within the building. The high roof structure of the *fale* allowed the hot air to rise while the cool air dropped and ventilated the space. In winter, the sun would heat the stone foundation and would help warm the *fale* during cool nights. Additionally, the *fale* was large enough inside to build a fireplace. They would make a fire using wild hibiscus, called *fau*, for their wood for heating, as well as coconut shells. Periodically, they used coconut husks to create smoke for natural fumigation from insects, such as mosquitos.

In a hurricane, the main structure would hold together. This made it easier to rebuild it. The pictures below show different buildings after a hurricane. The main structure still held together; only the thatches need to repair.

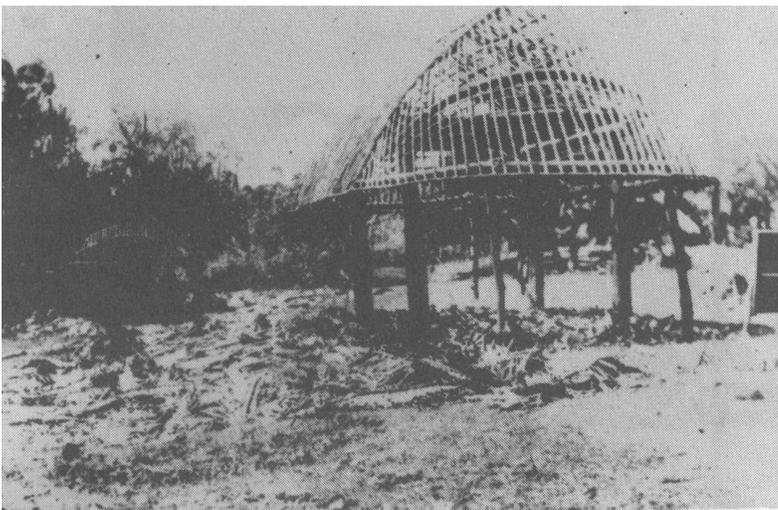


Figure 29: Traditional Tongan *fale* after the hurricane

Source: During, Kurt. *Pathways to the Tonga Present*. Government of Tonga Printing Department Nuku'alofa, 1990, 193.

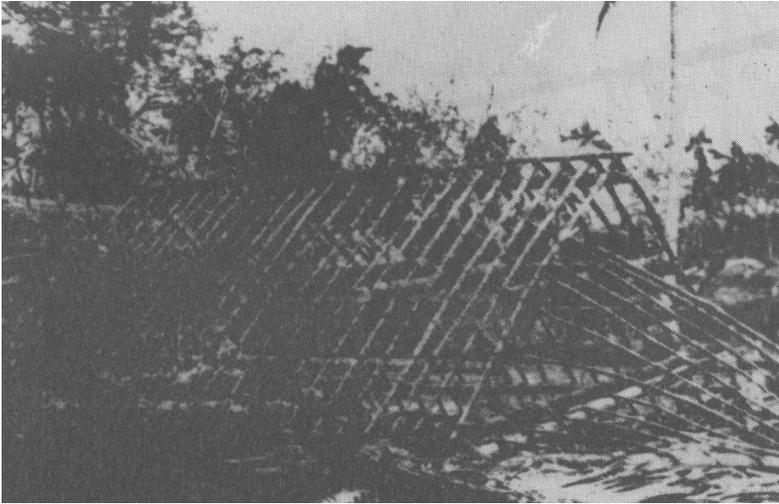


Figure 30: Tongan *fale* after the hurricane

Source: During, Kurt. *Pathways to the Tonga Present*. Government of Tonga Printing Department Nuku'alofa, 1990, 193.

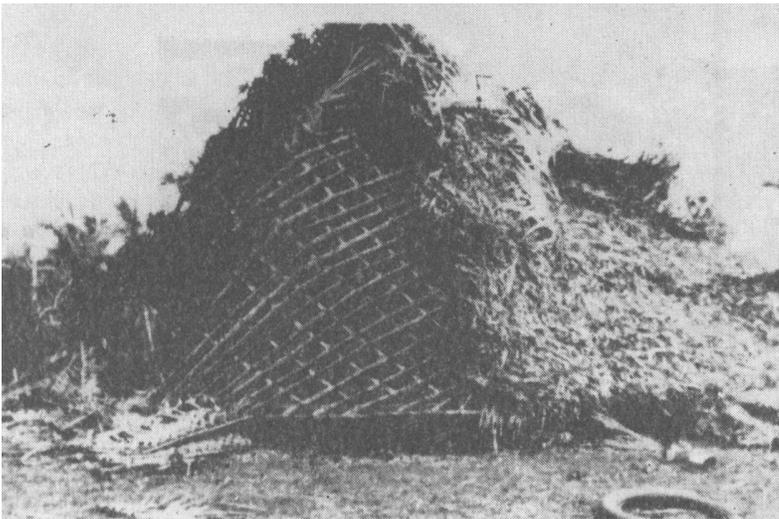


Figure 31: Damage from the hurricane

Source: During, Kurt. *Pathways to the Tonga Present*. Government of Tonga Printing Department Nuku'alofa, 1990, 193.

In comparison, Western homes after a hurricane were completely ruined and had to be rebuilt from the beginning.

Current Architecture in Tonga

The current architecture in Tonga does not resemble the rich values of the traditional *fale*. Development has played an important role in this shift from traditional ways to modern, Western building methods.

Tonga has three main groups of islands. The main island, Tongatapu, belongs to the island group of the same name, then there are the Ha'apai and Vava'u groups. The Tongatapu group has the most developed islands, thus there are hardly any traditional *fale* left there anymore. The other two island groups still have some traditional *fale*, as well as some *fale* that are a mix of traditional and modern style. For instance, one of the churches in the village of Lotofoa in the island of Ha'apai has a mixture of traditional and modern architectural style. Kaloni Tomui analyzed the building in his thesis.¹³

The existing buildings in Tonga are so much more diverse because of the different factors that have influenced the architecture of the country. Most of the people of Tonga, however, do not know much about the traditional architecture of their country. Learning about traditional architecture will help revive the culture. In this way, the people will be better able connect with Tongan culture than they can with the Western buildings currently being built.

¹³Tomui, Kaloni. 1990 Tonga: Architecture and Rationale. Bachelor of Architecture. Thesis., University of New South Wales, Sydney, 67-109.

The current architecture in Tonga uses new materials from all over the world. The forms of the buildings are changing and are more linear, with rectangular shapes being common today. The majority of the different parts of the traditional *fale* in most places in Tonga do not exist anymore, so children neither learn nor use the traditional cultural terms relating to the *fale* anymore. Additionally, the knowledge of building traditional *fale* is becoming lost with each passing year. Today, it is rare to find information about the *fale* and to find people that still have traditional *fale* knowledge.

Modern houses in Tonga force the people to rely on electricity for air conditioning and heating. As such, houses are not self-sustainable anymore because of modern technology and innovation. Predictably, the people think that using modern innovations will enhance their comfort, while not realizing that their ancestors had lived quite comfortably without these modern inventions.

Interestingly enough, I had not been aware of all of these things when I grew up in Tonga. I thought all was well until I moved to Hawaii and went to college; that is when I started to realize that what was, and is, happening in Hawaii *can* happen in Tonga. That is to say, architecture is just one of the factors being lost and has been lost in Hawaii, along with language, culture, and arts. Much in Hawaii that the ancestors treasured has been taken away. I fear that will happen to Tonga as well. Even the traditional *fale* has started to disappear, and I intend to do my part to prevent the loss of traditional culture in Tonga.

Driving factors of architecture in Tonga

Tongan Architecture has been changing over time. There are key factors that have forced this dramatic change from a traditional *fale* to what we have in Tonga today. I also think that through these changes it provided us with the opportunity to improve the architecture in Tonga.

Economy

Economy plays a significant role in the architecture of Tonga. In the general population, whoever has more money will most likely have a better house. Tonga's economy is characterized by a large, non-monetary sector with a heavy dependence on remittances from relatives and people who live abroad, mainly in the United States, Australia, and New Zealand. This is still the highest source of income for the country.

According to *Investor's Journalism*, "Tonga was ranked the 165th safest investment destination in the world in the March 2011 Euro money Country Risk rankings."¹⁴ There is great opportunity in Tonga for small businesses. There are no patent laws in Tonga so people can create and manufacture whatever they please. Handicrafts like weaving and wood carving contribute about 5% of the country's Gross Domestic Product. At the Langafonua Center, you find different varieties of handmade

¹⁴ "Euromoney Country Risk". Euromoney Country Risk. Euromoney Institutional Investor PLC. Retrieved 15 August 2011.

items such as “traditional tapa cloth and tapa crafts, woven crafts, Tongan jewelry, shopping bags and baskets, tablemats, trays, kiekie, diaries, fans, coasters, and wood carvings.”¹⁵

Agriculture is one of the main sources of income. People plant different varieties of crops for sale and family consumption. This includes growing bananas, yams, taro, vanilla beans, coffee, coconuts, and all different kinds of vegetables. In the early eighteenth century, copra or desiccated (dried) coconut was the main export from Tonga, often between Australia and Europe. Later in the century, vanilla bean became popular, so people started to grow vanilla. Lastly, the export of squash to Japan became popular for the farmers. Due to the market inflation and price fluctuations, the farmers grow a variety of different crops, rather than just focusing on one item.

Tonga has recognized the importance of the tourist industry, and it can provide a substantial financial support to the country; however, the tourist industry is relatively underdeveloped. Attempts to bring in cruise ships stop in Vava‘u and the outer islands which are well known for whale watching, fishing, surfing, beaches, exploring, and scuba diving.

Tonga’s economy is below the world average, and Tongans do not have sufficient income in general. It is hard to improve the architecture in Tonga today without money to do so. Today, labor and material are expensive, so the people mostly rely on remittances in order to build quality homes for their families.

¹⁵ <http://www.tongaholiday.com/listing/langafonua-a-fafine-tonga/> (accessed March 5, 2016).

Development

Before foreigners visited Tonga, the traditional *fale* were the main structures used by the people. Missionaries and foreigners brought Christianity to Tonga and worked to educate people. They also introduced the islands into “modernization.” The traditional *fale* were also modernized by using new materials such as glass, concrete, and metal.

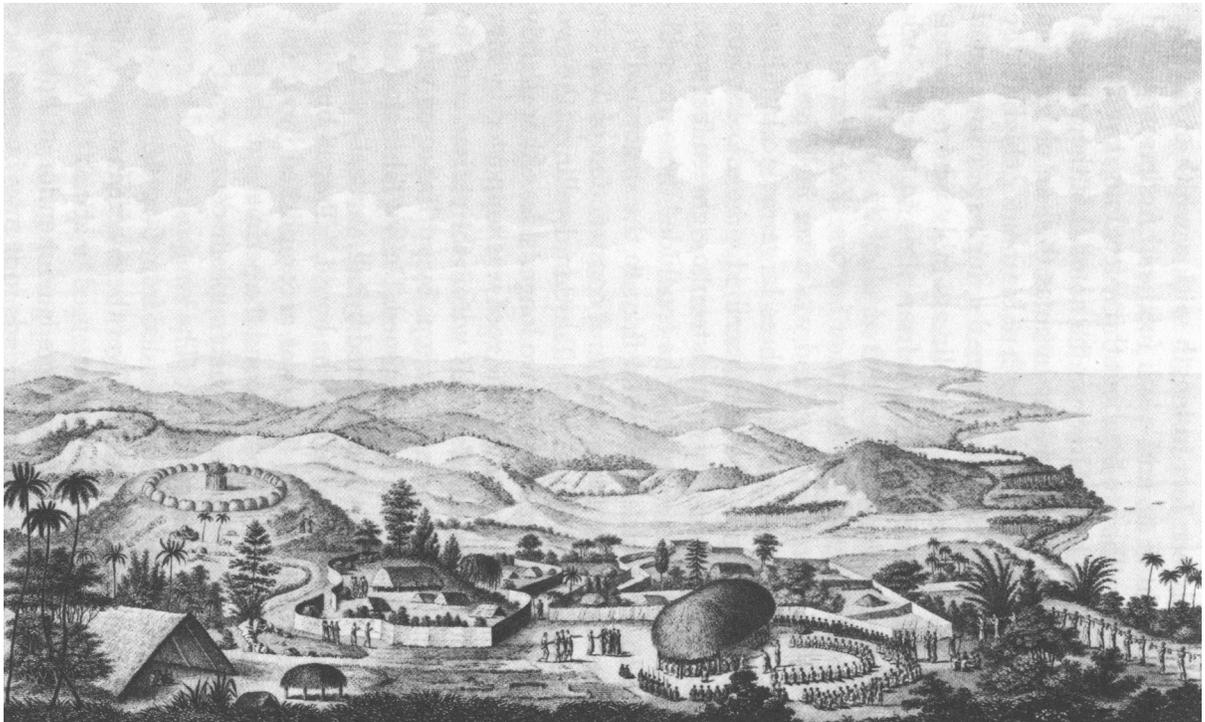


Figure 32: Panoramic view of Tongatapu

Source: Ferdon, Edwin N. *Early Tonga*. The University of Arizona Press, 1987

Christianity

Churches and religion also influenced the architecture in Tonga. When the missionaries arrived in Tonga, there were no organized congregations. People worshipped different gods and beings. Foreign missionaries taught people about Christianity and God. As part of their Christian worship, they built chapels and cathedrals. Today, different churches have their own style of architecture that people see and recognized immediately. For instance, The Church of Jesus Christ of Latter-day Saints, which is also known as LDS or “Mormons,” have church buildings with a unique design and form that you can tell apart from other churches. These church buildings most likely use concrete or concrete mason unit blocks. Here is an example of an LDS building in Tonga which known as the Nulu’alofa Tonga Temple.



Figure 33: LDS Nuku'alofa Tonga Temple

Source: <https://www.lds.org/church/temples/nukualofa-tonga?lang=eng> (accessed

March 14, 2016).



Figure 34: St. Andrews church in Nukualofa in 1940.

Source: During, Kurt. *Pathways to the Tonga Present*. Government of Tonga Printing Department Nuku'alofa, 1990, 96.



Figure 35: Church and bell tower made out of wood, Tongatapu.

Source: During, Kurt. *Pathways to the Tonga Present*. Government of Tonga Printing Department Nuku'alofa, 1990, 21.

Hurricane Relief Programs

Australia and New Zealand always help Tongans by providing shelters after hurricanes. These acts of service also help shape the existing architecture on the islands. The people were grateful to accept whatever buildings these countries offered them. Because the Tongan government does not have any building specifications, the relief program would build whatever was easiest, cheapest, and most convenient at the time. These events happen frequently in Tonga, so they end up having a house typology known as the *faleafa*.



Figure 36: *Faleafa*

Source: <http://web.worldbank.org/WBSITE/EXTERNAL/BANCOMUNDIAL/NEWS/ANISH/> web.worldbank.org. (accessed March 14, 2016).



Figure 37: L.D.S hurricane relief support

Source: <https://www.ldscharities.org/news> (accessed March 14, 2016).

The *faleafa* was introduced in 1982 after the extremely destructive Hurricane Isaac. The *faleafa* is a raised structure with a concrete post. The wall would be T1-11 type or similar. It has a pitched, corrugated metal roof. The houses usually have two bedrooms and a living room. It is a very simple structure that serves as a shelter for the people. It is also very common that people would add spaces to the original *faleafa* because the original building did not have restrooms or a kitchen inside. Because it is simple to build, the Hurricane Relief organizations would build hundreds of *faleafa* everywhere and it became one of the most common houses in numerous locations in Tonga.

Resources

Tonga has very limited resources. The country itself cannot currently supply the needs of the people, therefore, people are heavily relying on import resources from outside the country. Tonga's limited forest resources consist of natural hardwood forests, exotic plantation forests, and coconut plantations. Currently, natural hardwood forests can only supply a small and ever decreasing part of the domestic timber demand because of over-exploitation and depletion by clearing for shifting cultivation. It is estimated that only 4,000 acres remain of natural hardwood forests. It has been proposed that the remaining forests be protected as a national park because of its biological diversity.

In the 1950s, land was allocated for the development of forest farms. By September 1992, 579 acres of mainly *Pinus caribea* had been planted on exposed and infertile sites. Tonga's extensive coconut plantations are its largest timber resource, and will continue to be the major source of domestic timber production.¹⁶

Because of the limited resources, the people would use whatever they could find to build houses. Those that have money can afford the materials in the hardware stores. Some people would ask to use material and reuse them. The availability of resources helped shape the architecture in Tonga.

¹⁶ <http://www.fao.org/docrep> (accessed March 14, 2016).

Case Studies

Case Study 1: Polynesian Cultural Center – Tongan Village

ARCHITECT: Unknown

STATUS: Completed since 1963

SITE: Laie, Hawaii, United State

SIZE: 4000 ft.sq

CLIENT: Polynesian Cultural Center

This project is a series of buildings, and it resembles traditional Tongan architecture. This was a typical setting in Tonga before the foreigners visited. Each little village would have a noble who usually lived in the center of the settlement. There are also other buildings that are needed in a little village.

The Tongan village was built by volunteer missionaries from Tonga. One of the younger missionaries, Tu'ione Pulotu, is still alive today. I have interviewed him for this reasearch on several occations. He mentioned that the setting of the Tongan village at the Polynesian Culture Center is propably the only traditional one still left today, including those in Tonga.¹⁷

¹⁷ Tuione Pulotu, interview by Folau Nonu, Laie, March 1, 2015.

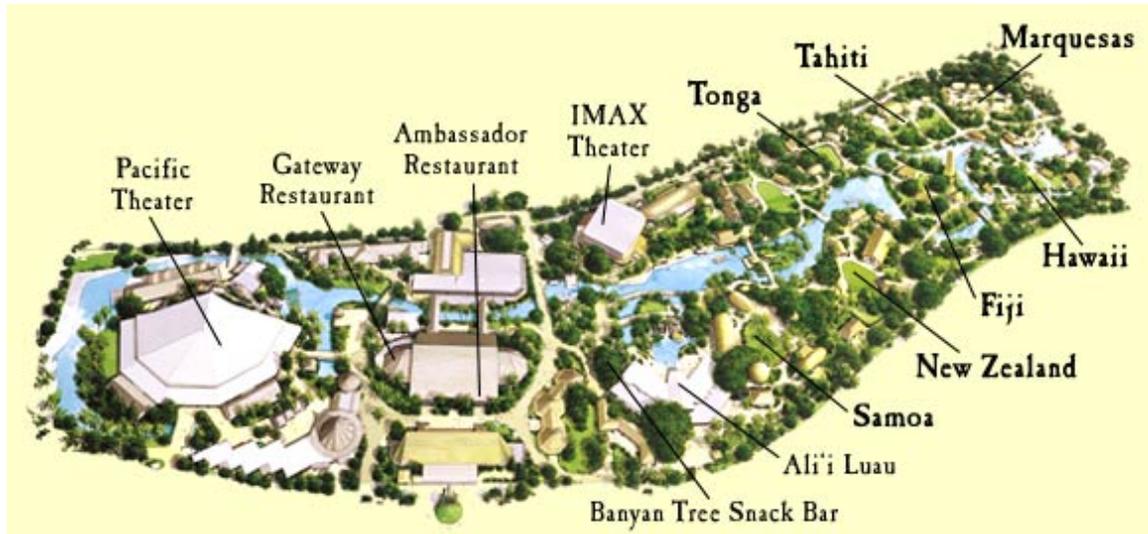


Figure 38: Polynesian Cultural Center

Source: http://www.laiebeachretreat.com/new_page_4.htm (accessed March 14, 2016).

Figure 37 shows a map of the Polynesian Cultural Center. It contains seven different islands in the south Pacific which are Samoa, New Zealand, Fiji, Hawaii, Marquesas, Tahiti, and Tonga. I will primarily look at the Tonga village in regard to this precedent study.

The Tongan village at the Polynesian Cultural Center has a *Fale Fakatu'i*, which resembles the noble's house. It is built after Queen Salote's "summer palace," but at a quarter inch scale. On different occasions, Tongan royalties have visited and admired the architecture. In 1977, the royal family and King Taufa'ahau Tupou IV, who succeeded

his mother Queen Salote, visited the Polynesian Cultural Center.¹⁸

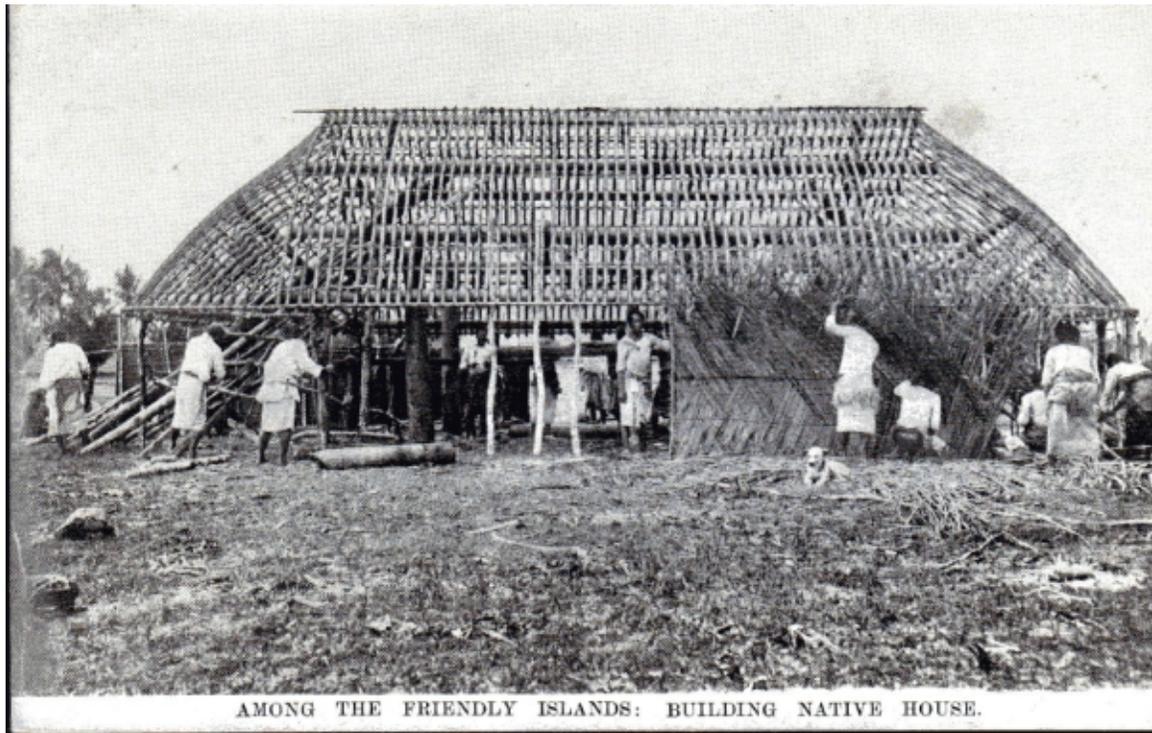


Figure 39: Construction of the Queen Summer House

Source: <http://www.stampboards.com/viewtopic.php?f=17&t=52100>. (accessed March 15, 2016).

As with many Polynesian royal building structures and homes, the *fale fakatu'i* is built on a platform. Its elevation above the ground symbolized rank in society, but also helped protect the structure from flooding. The building itself is supported by four main

¹⁸ http://www.polynesia.com/polynesian_culture/tonga/index.html#.Vvm5P17vb1o (accessed March 6, 2016).

ironwood posts. Braided coconut fiber was used to lash all the structure together, and was also used as decoration, which is known as *lalava*. Similar materials and methods were used in Fiji, Samoa, and throughout the Pacific.



Figure 40: Traditional Lashing

Source: <http://yournestdesign.blogspot.com/2014/02/windows-walls-ceilings-and-floors.html>. (accessed March 15, 2016).

The fine reed walls were lashed together with the *kafa*, and sugarcane leaves were used for the roofing. The interior was heavily decorated with fine mats and tapa cloth, which are some of the most value items in Tongan culture. Cowry shells hanging throughout the interior symbolized royalty in Polynesia. The palace walls were built from dried coconut leaves woven together.

Inside the building were pictures of King George Tupou I, who unified the different islands and allowed Christianity in Tonga. There is also a photo of King George Tupou II who followed in his father's footsteps, as did his daughter, Queen Salote Tupou III, who ascended to the throne in 1919 at age 18. This photo shows the importance of family and genealogy in the Tongan culture. We deeply admire and highly respect our ancestors, and always feel they are watching over us.

Another important building you find at the Polynesian Cultural Center is the *Fale Fakataha*, or meetinghouse. Every village in Tonga has a meetinghouse where all matters pertaining to the community were discussed by the elderly people. They would also hold the kava ceremony, a very important ritual during the meeting.

The Polynesian Cultural Center is a unique place for me because I learned about my culture by working there as a dancer and a carver. I truly got to appreciate my identity and take pride in being a Tongan by sharing and educating the tourists about Tongan culture and myself. As a Pacific islander at the PCC, I was always the center of attention to thousands of people visiting every day. It is a great feeling to see someone else take time to learn more about the culture. I hope that feeling of greatness and ownership will be applied to the Tongan architecture.

Case Study 2: Jean-Marie Tjibaou Cultural Center

ARCHITECT: Renzo Piano

STATUS: Completed since 1998

SITE: Noumea / New Caledonia

SIZE: 92,000 sq.ft

CLIENT: Government of New Caledonia



Figure 41: Jean-Marie Tjibaou Cultural Center

Source: <http://www.rpbw.com/project/41/jean-marie-tjibaou-cultural-center/>. (Accessed March 15, 2016).

This is one of my favorite projects by architect Renzo Piano, who brilliantly used local materials like wood and stone, and new materials such as glass, metal, and concrete

to marry the modern with the traditional styles of architecture. This showcase is one of the most famous buildings in the Pacific region.

The Cultural Center was commissioned by the Government of New Caledonia in memory of Kanak leader Jean-Marie Tjibaou, who was assassinated in 1989.¹⁹ The Tjibaou Cultural Center was also built to celebrate the culture of the indigenous Kanak people, who were recognized by the French government. It is a great landmark that signifies the native culture and the Kanak people. The Tjibaou Cultural Center connects the past, present, and the future. As mentioned, it is “... a bridge between heritage and creativity, between here and elsewhere, between work completed and work in progress”.²⁰



Figure 42: Jean-Marie Tjibaou Cultural Center

¹⁹ Waddell, Eric. *Jean-Marie Tjibaou, Kanak Witness to the World: An Intellectual Biography*. Manoa: Center for Pacific Islands Studies, School of Pacific and Asian Studies, University of Hawai‘i, Manoa, 2009. 17.

²⁰ *Tjibaou Cultural Centre*. n.p.: Nouméa, New Caledonia : Ngan jila centre culturel Tjibaou : ADCK, ©1998., 1998. *BYU-Hawaii Catalog*, EBSCOhost (accessed March 24, 2016). 11.

Source: www.rpbw.com/project/41/jean-marie-tjibaou-cultural-center/. (accessed March 15, 2016).

The site is about 10 km from Noumea, on a narrow, long piece of land with sea water on one side and land on the other.²¹ According to Renzo Piano, the Cultural Center had to be visible immediately to make a clear statement as it symbolizes the Kanak culture. The whole project was made to reflect the peaceful Kanak culture. The Kanak people also experience change as their customs and culture evolve over time. Renzo Piano was able to use transparency to symbolize the cultures and customs as they evolve over time.



Figure 43: Jean-Marie Tjibaou Cultural Center

²¹ <http://www.rpbw.com/project/41/jean-marie-tjibaou-cultural-center/> (accessed March 24, 2016).

Source: www.rpbw.com/project/41/jean-marie-tjibaou-cultural-center/. (accessed March 15, 2016).

The Center was designed as a little community where indigenous arts were displayed and live demonstrations were offered. The natural light allowed into the buildings helps to highlight different programs in the space. The buildings have an open floor plan and are exposed to nature as the interior space continues outside. Natural ventilation systems were used throughout the buildings as the main cooling system. The natural form of the site was very important to the architect, and carefully integrated in the design. As the architect mentioned, designing the Center was “a work taking care of nature, a humanistic realization where history, architecture, archeology and social sciences are brought together.”²²

²² Piano, Renzo, Yukio Futagawa, and Kenneth Frampton. *Renzo Piano Building Workshop*. Tokyo: A.D.A. Edita, 1997. 194.

Case Study 3: Gando Elementary School

ARCHITECT: Francis Kere

STATUS: Completed since 2001

SITE: Gando / Burkina Faso

SIZE: 3,337 ft.sq

CLIENT: Schulbausteine fuer Gando / Gando Village Community

AWARDS: Aga Khan Award for Architecture 2004 /Global Award for Sustainable Architecture 2009



Figure 44: Gando Village

Source: <http://cca2013cpm.pbworks.com/w/page/63489352/Gando%20Primary%20>.

School_FReid (Accessed March 15, 2016).

The village of Gando is located south east of Ouagadougou, Burkina Faso's capital.²³ Three thousand inhabitants still live in small mud huts with tin or straw roofs.²⁴ As shown in the figures above, mud brick was the primary material used in construction for the area. This is a very poor area, and it was financially impossible to build this school without a careful, well thought out plan that the architect, Francis Kere, and his friends conceptualized.²⁵

The project was built to accommodate 360 students and six faculty members with their families. The design included sanitary rooms, and the bathroom and kitchen huts are gathered in small community groups.

According to the UN Human Development Index in 2011, Burkina Faso is the 7th least developed country in the world. Lack of education, low income, and short life expectancy hold back the country's development. Most people are subsistence farmers, remaining dependent on the harsh climate. There is virtually no rain between October and June, and daytime temperatures can easily reach 113 degrees Fahrenheit.

²³ http://cca2013cpm.pbworks.com/w/page/63489352/Gando%20Primary%20School_FRaid (accessed March 24, 2016).

²⁴ Varanada, Fernando. "2004 On Site Review Report." *Primary School Gando, Burkina Faso*, 2004, 1. Accessed March 29, 2016. http://www.akdn.org/architecture/pdf/2920_Bur.pdf,

²⁵ Ibid.



Figure 45: School

Source: <http://www.kere-architecture.com/projects/primary-school-gando/>. (accessed March 15, 2016).

Francis Kere is a native resident of Burkina Faso, and has experienced this extreme weather. He went to Europe to study architecture, and came back to Gando for his first design project.²⁶ Cost, climate, resource availability, and construction feasibility were constraints he had to face. However, these hurdles became the driving force for the eventual success of the project. Natural resources, such as clay and mud, were abundant in the area, and comprised the primary materials. They were the traditional materials used

²⁶ <http://www.kere-architecture.com/projects/primary-school-gando/> (accessed March 15, 2016).

for construction in the region. According to Kere, “modified and modernized in order to create a more structurally robust construction in the form of bricks.”²⁷ The use of clay bricks cut down expenses because it was easy to produce. They also provided great thermal protection against the hot climate of Gando.



Figure 46: Double roof systems

Source: <http://www.kere-architecture.com/projects/primary-school-gando/>. (accessed March 15, 2016).

The large tin roof overhang protected the bricks from the rain but, also helped to absorb heat from the sun and keep the interior space cool. Gross ventilation plays an

²⁷ <http://www.kere-architecture.com/projects/primary-school-gando/> (accessed March 15, 2016).

important role in the design and helps the students feel comfortable. In this method, cool wind enters from the sides through the window and the hot air rises up through the dry-stacked perforated brick ceiling, then escapes to the corrugated metal roof. This method was successfully incorporated in the design process so air conditioning was not needed to cool down the space.



Figure 47: Construction of the school.

Source: <http://www.kere-architecture.com/projects/primary-school-gando/>. (accessed March 15, 2016).

The architect Francis Kere stayed true to his concept from beginning to end. Kere also mentioned, “*My intention was to achieve sustainability by emphasising the use of local materials, the adaptation of new technology in a simple*

way, and through the inherent potential of the local community”.²⁸ This is the very same goal that I intend to use on the bus station as a final design solution.



Figure 48: Large Corrugated tin roof for shading.

Source: <http://www.kere-architecture.com/projects/primary-school-gando>. (accessed March 15, 2016).

This was a great project that was able to use modern material like corrugated metal roofing available in the area, together with traditional mud brick. The involvement of the whole community set apart this successful project. It is common in Burkina Faso for everyone to work together in repairing homes. This project allows them to keep their

²⁸ Kéré, Diébédo Francis. "School in Gando, Burkina Faso." *Architectural Design* 82, no. 6 (November 2012): 66-71. *Art Full Text (H.W. Wilson)*, EBSCOhost (accessed March 29, 2016).

tradition, and they also learn more about modern technology that allows them to create better quality materials and methods they can use in their areas.²⁹

²⁹ <http://www.kere-architecture.com/projects/primary-school-gando/> (accessed March 15, 2016).

Survey

A survey of thirty two questions about the traditional Tongan *fale*, was given out to fifty Tongan people. The survey also collected answers on and how the people of Tonga view the *fale* today. Of the fifty people surveyed, forty two were from Tonga with eight of the Tongans being raised elsewhere.

According to the survey, each of the fifty participants had heard about and knew of the traditional *fale*. Sixty percent had not seen a traditional *fale*. However, fourteen percent of the people interviewed actually grew up in traditional Tongan *fale*. Ninety two percent of those raised in traditional *fale* were raised in the outer islands, and not on the main island of Tongatapu.

I was amazed that less than ten percent of participants were aware of the cultural significance of the Tongan *fale* and how closely they are related. Only four percent had a limited little knowledge of the *fale*, and the rest were unaware. Most of them knew and could relate to the current architecture in Tonga, but had little knowledge of the traditional *fale*.

Most of the people who took the survey felt that the traditional *fale* was a means of connecting them with their historical culture and the old-ways, but really did not understand the connection. The *fale* reminded them of stories of their grandparents and ancestors. The modern architecture in Tonga has received mixed reviews with most

people seeing at as simply the way it is, or as a means of improving architecture, yet some prefer the older ways.

Of those who were raised in traditional *fale*, most enjoyed being connected to the old-ways, while one person felt their home was not safe from environmental challenges like hurricanes and flooding.

One man felt that living in a traditional *fale* was uncivilized, but several others saw it as valuable. One man saw it as a way to feel “more manly” as he described it, and another saw it as a means to connect to the family. Additionally, one woman felt that she would not feel safe in a *fale*, but most women felt that it was a valuable way to get in touch with the old-ways and preserve tradition. They saw this as especially valuable for students and simply as a means to preserve the traditional culture.

From these survey responses, I found out that the Tongan people have very little knowledge of traditional Tongan architecture. I also understand that because of their lack of knowledge

Additionally, the conceptual design of each of the various models for the Tongan bus stop/stations were loosely based on input from the people obtained verbally, from the survey, and from my own architectural thoughts of Tonga. My perspective of Tonga is especially in relation to nature, specifically wave shapes, land and beach formations, naturally growing trees and plant shapes, sunshine patterns, and even the air currents flowing around the island; all of these relate to architectural design. Basing the architectural design on native Tongan flora, fauna, climatology, and geomorphology creates a harmonious blend of cultural, social, and natural aspects in this project. This

greatly excited me about the possibilities of future design projects in Tonga, as well as in other parts of the world as Tonga learns from other countries and other countries learn from Tongan design.

Summary of the body of knowledge

To discover the significance of the traditional Tongan *fale* requires an understanding of Tongan culture, for it is only with such knowledge that we can explore the value of *fale* of the past and how they can be transformed into a future cultural strength for Tongan people. *Fale* were very sustainable. They were built from local materials such as coconut, and other local woods like *koka*, *niu*, and *telie* wood.³⁰ The form of the building responds to nature and the climate. The natural light and air ventilation were well incorporated into the building. In the summertime, the building would remain cool, while in the winter, structures would retain heat. In addition, they could withstand strong winds and heavy rainfall. *Fale* also had strong cultural identity and social values attached to them. It is very important to see how the *fale* reflects the cultural values of the Tongan people.³¹

I interviewed Professor Viliami Tolutau about, and compared his information regarding how traditional Tongan *fale* reflects the cultural identify and values of Tongans to the information I received from the master carver and builder Sione Pulotu. They both mentioned that each part of the Tongan *fale* structure was named, had great cultural significance, and also that each name related to the building itself as well as to the people. Interestingly, the details of the building were also in strict architectural proportions in

³⁰Tuione Pulotu, interview by Folau Nonu, Laie, March 1, 2015.

³¹Viliami Toluta'u, interview by Folau Nonu, Brigham Young University of Hawaii, October 17, 2014.

direct relation with the social structure of the people of the specific building.³²

Because many of the South Pacific Island cultures such as Fijian, Maori, Samoan, and Hawaiian share similar cultural ideas, the materials for buildings were similar, yet restricted and differentiated from each other by local flora. Additionally, since the materials throughout the South Pacific were similar in many ways, likewise the forms and sizes of the buildings were also related, as well as the types and functions of the structures.

Educating Tongan people about traditional Tongan architecture is crucial for cultural identity and preservation. As a means of beginning to educate Tongan people, I have prepared a survey to find out how much Tongans know about traditional *fale*, as well as what value *fale* have in their lives. Additionally, the survey reveals what it will take for Tongans to learn about and become interested in the traditional *fale*. The people included in the survey are all Tongans ranging in age from youth, to college students, to working adults. The survey also reveals what Tongans feel are the driving factors of modern architecture of Tonga, including thoughts on the development and the influences of Western, industrialized countries on current Tongan homes as they relate to new ideas, new materials, and new construction methods shifting the architecture in Tonga.

Today, there are economic factors that tie in with this new architecture in Tonga, making all forms of architecture require monetary form which, in these changing times from traditional to modern, shift the cultural values of Tongans from memories of everything being free to now requiring lots of money. People remember when the whole

³²Tuione Pulotu, interview by Folau Nonu, Laie, March 1, 2015.

town used to build one house for someone using their own labor and naturally occurring materials, but now they see skilled labor required and unknown expenses not previously seen.

Prior to the arrival of foreigners and Christian missionaries in the 1800s, the traditional Tongan architecture had a strong relation with the culture and social function of the people of Tonga.³³ These connections were revealed by the form of the *fale*, construction process, and the names of the different parts of the buildings.

The Tongan *fale* had rounded ends on each end of the home and straight, parallel or slightly curved side walls. They were generally built on an elevated platform with commonly high roof structures. These high roofs acted primarily as a cooling and heating method, depending on the season, as well as for water runoff. The roof was supported by beams that ran around the perimeter of the *fale* and attached to a post which supported the rafters, over which were attachments that held the banana leaf, rush, and grass thatching in place (though the most common thatching was coconut palm leaf woven into mats). The typical thatched roof lasted two to three years before needing repair or replacement; however, the finest homes used dried sugarcane leaves that could last up to eight years. The entire framework of the *fale* was attached with coconut husk fibers that in some homes were dyed black, red, or yellow to add color and decoration.

In addition, there was a social and spiritual hierarchy in the society also evident in architectural structures. An example of this is seen in the Tongan's belief in numerous gods, and the taller the buildings, the closer the people were to their gods. Moreover, the

³³ <http://www.vavau.to/facts9.html> (accessed March 6, 2016).

size of the building also reflected the owner's status in society and additionally defined the functionality of the building.

Traditionally, each Tongan *fale* was built by the whole community with everyone playing important roles in the construction process. Women wove the thatches, children helped braid the *kafa* (braided ropes from coconut fiber), and men assembled the building structure. Each of the different parts of the *fale* had its own story and meaning related to the Tongan people. For example, *fale* is the Tongan translation for both family and the house itself. This symbolizes that the physical structure of the home is as important as the family itself in historical Tongan culture.

Design Solution

The design solution in Tonga for the future is still debatable, but I have suggestions that can help as we face the future. I believe the traditional Tongan *fale* needs to be reinvented with new materials, while keeping the same cultural intent that was present in the architecture of our ancestors.

First, the *fale* has to be self-sustainable, and it is critical to keep that in mind. The material would need to be more flexible. It was the intention of the indigenous people to build the *fale* with the best material available at the time. The traditional structure of the house should be revived and modified to fit with the present time. The reason for keeping the structure is that some of the Tongan terms would only be understood by referring to the structure of the *fale*. It will also help to revive the old Tongan terms for the children and the future of Tonga.

Francis Kere, who built the Gando School in Africa, is famous for working with very limited resources and having a great impact for design solutions. The same solution can be applied the bus stations in Tonga. They have to have cultural and social impacts while working hand in hand with the environment.

Bus Station

The initial idea at the beginning of the project was to design a house or school building that will help the people learn more about architecture. As I continued working on the project and thinking of the final design, I thought about something that was needed to be improved in architecture at Nuku'alofa, and also how it may impact the people living there. I know there are things that need to be changed or improved and can be used for a final design, but I was convinced as the thought of bus station/stop came to mind. I feel that if somehow I convey my message and educate the people through bus stations and bus stops, I can do it in any building typology.

The bus is the main system of transportation in Tongatapu (main island). People rely heavily on the bus. I also picked Nuku'alofa because about half of the population of Tonga lives in that area. Most of the businesses and stores are all located in Nuku'alofa. Also, six of the twenty-two high schools in Tonga are in Nuku'alofa. People who commute on the bus from the Eastern and Western sides of the island also have to go through Nuku'alofa.

Existing Bus stations in Tonga.

At the beginning of the design process of the new bus stop/station, I needed to look at the existing ones in Tonga currently. There are two main stations at the Nuku'alofa that serve all travel connections for the bus routes. They are about three to five minutes walking distance from each other. All the buses on the island end their route at one of the stations and then go back to its original destination. These two destinations are very important in the bus route because you have to know which bus goes to each of them so you can get on the right bus.

The picture below shows an example of one of the bus stations that used to be flat roofed and was rebuilt. This was a better design than the previous one. As it shows in the photo, it is a very simple shelter with a roof and seating.



Figure 49: Existing Bus Station in Tonga.

Source: <http://www.thecuriouskiwi.co.nz/tonga.html> (accessed March 15, 2016).

As far as the bus stops are concerned, there is currently no designated bus stop in Tonga. This problem also causes a lot of accidents in the road because the bus can stop wherever they want to stop for pick up and drop off. Having a designated bus stop will help the traffic and also increase the safety of the people in general.

Site Analysis

Location

As mentioned earlier, Tonga is located in South Pacific Ocean. *Tongatapu* is located on the longitude 175 degrees West and 21 degrees South latitude.³⁴ I am focusing on Nuku'alofa, which is the capital of Tonga because most of the population resides in that area.



Figure 50: Nuku'alofa Region

³⁴ <http://tonga.southpacific.org> (accessed March 2, 2016)

Source: Google Maps. <https://www.google.com/maps/place/Tonga/@-21.1965384,-175.3094135,11.51z/data=!4m2!3m1!1s0x7193b644bb9fd01d:0xf36dcccac55ee2a9>. (accessed March 15, 2016).

To be more specific, I have chosen the *Hala Vuna* which is about 5.3 km (3.3 miles), connecting the first palace in Tonga, which was in Popua, to the present one in Nuku'alofa. These areas have a very rich culture that most people in Tonga not aware of. I feel that there is a need to connect these two historical places and the bus stations can be a tool to emphasize their significance.

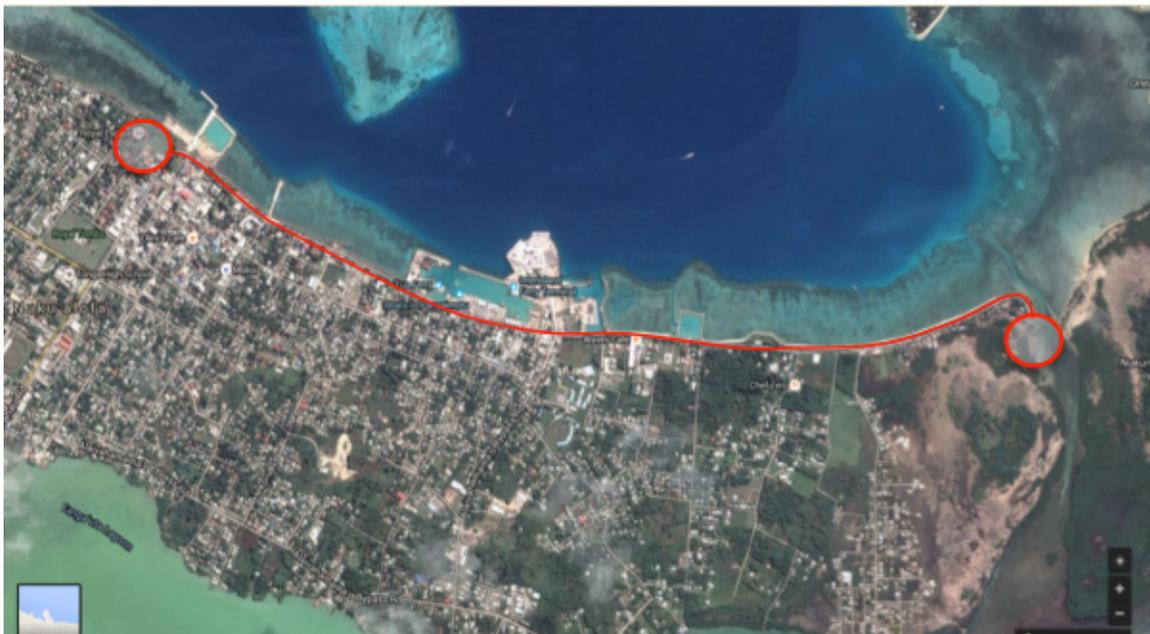


Figure 51: Hala Vuna.

Source: Google Maps. <https://www.google.com/maps/place/Tonga/@-21.137803,-175.2104474,14.68z/data=!4m2!3m1!1s0x7193b644bb9fd01d:0xf36dcccac55ee2a9>.

(accessed March 15, 2016).

The first bus stop would be located on the Northeast at Pa-Tangata, and the last station would be on the Northwest at Nuku'alofa beside the current king's palace, as shown in the figure above. Between these two stations, there are three different locations that need bus stations for the convenience of the people, counting from the East as the first palace station being the first one and the second one located in Popua and Houmakelikao which is a bus stop. This area is great for a bus stop because the villagers will all have access to it.

The third one would be located at Ma'ufanga in front of the biggest high school in Tonga, which is right across from the international wharf. This is a significant location because of different identities in the area. The headquarters of the Catholic Church in Tonga is also in the area. Small Tongan industries are also down the road from that station, so many people would use this route for school, work, church, and other reason. The fourth location is right in the center of the Northern part of Nuku'alofa. This is also where the supermarket and the international market are located. Most of the stores are around this area, and there is an existing bus station in this area that serves the East and the West of the whole island. The fifth and the last one would be in the intersection of Hala Vuna and Hala Taufā'ahau, which are the main roads in Tongatapu. Also, the

king's palace is right across from it. The figure below shows the different locations of the bus stops and stations



Figure 52: Chosen site for the Bus Station.

Source: Google Maps. <https://www.google.com/maps/place/Tonga/@-21.137803,-175.2104474,14.68z/data=!4m2!3m1!1s0x7193b644bb9fd01d:0xf36dcccac55ee2a9>.

(accessed March 15, 2016).

Weather

Tonga has a steady climate throughout the year with small temperature variations of highs and lows both daily and monthly. There is a cool and dry season between May through November with daily temperatures from 63 to 72 degrees Fahrenheit. The coolest month is August, and the warmest month is February.

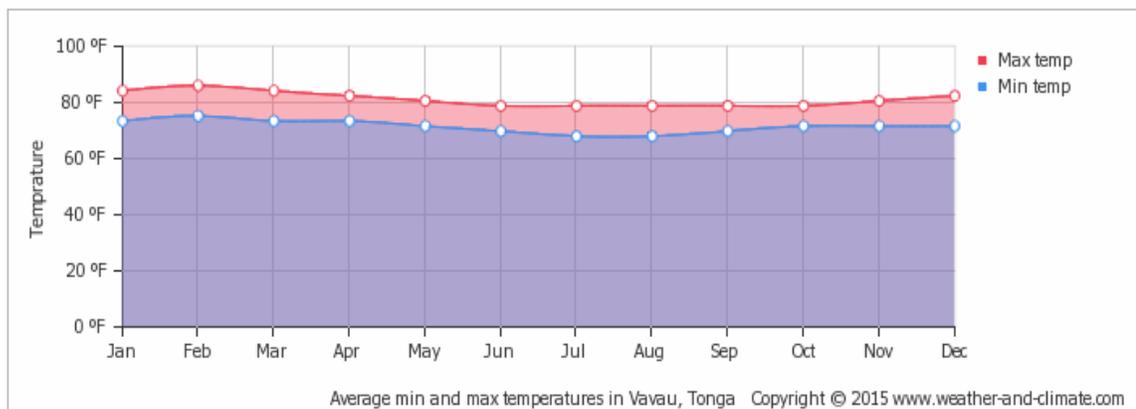


Figure 53: Average minimum and maximum temperature over the year.

Source: <https://weather-and-climate.com/average-monthly-Rainfall-Temperature-Sunshine,Vavau,Tonga> (accessed March 15, 2016).

Likewise, there is also a hot and wet season between December and April with temperatures between 72 to 91 degrees Fahrenheit. This is referred to as the Cyclone

Season, and while the air is humid, it does have the benefit of creating warmer seas for swimming. Also, June is the driest month with March being the wettest.³⁵

There are Southeast trade winds blowing 15 to 25 knots from November to April, which travel up the bus route towards the king's palace, bringing a sense of energy and news from the world to the Royal Palace during May through September in the summer months, the Northeast trade winds blow at 10 to 20 knots also blowing along the proposed bus routes along the 3½ mile long Vuna Road (Hala Vuna).

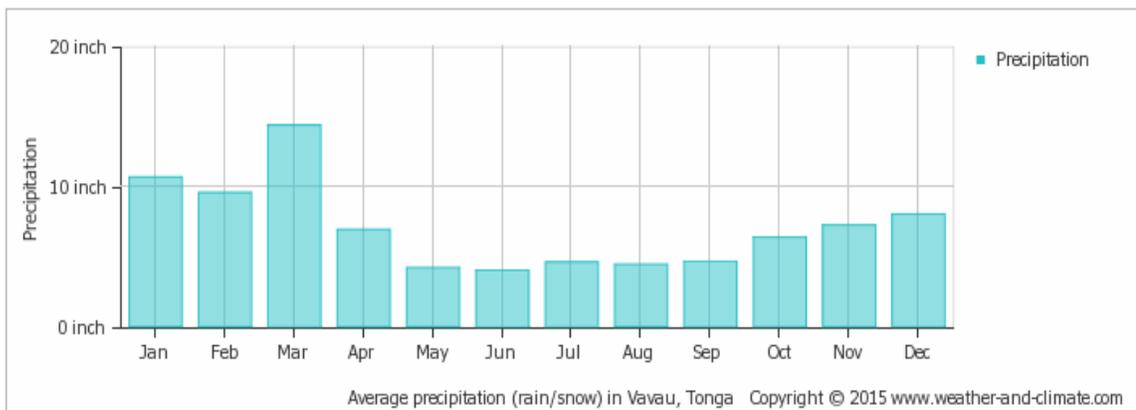


Figure 54: Average monthly precipitation over the year (rainfall).

Source: <https://weather-and-climate.com/average-monthly-Rainfall-Temperature-Sunshine,Vavau,Tonga> (accessed March 15, 2016).

Based on temperatures, amount of sunshine per day, and rainfall levels, the humidity produces a sense of warmth to most people about 85% of the time any given

³⁵ <https://weatherspark.com/averages/32714/Fua-amotu-Tongatapu> (accessed March 15, 2016).

day between November and May, while May through November feels more comfortable to most people typically about 85% of the time.

Form

The form of the bus station was modeled after different ideas. First, was the traditional *fale*. The “*taa’i fale*” is one of my favorite sections of the *fale*, which emphasized the curvilinear end part of the *fale*. Between the *tau’olunga* and the *aoniu* lies the *taa’i fale* which is highlighted with the red box on the figure below. The floor plan of the wall system also has a nice curve, which was incorporated in the structure and the roof of the bus station.

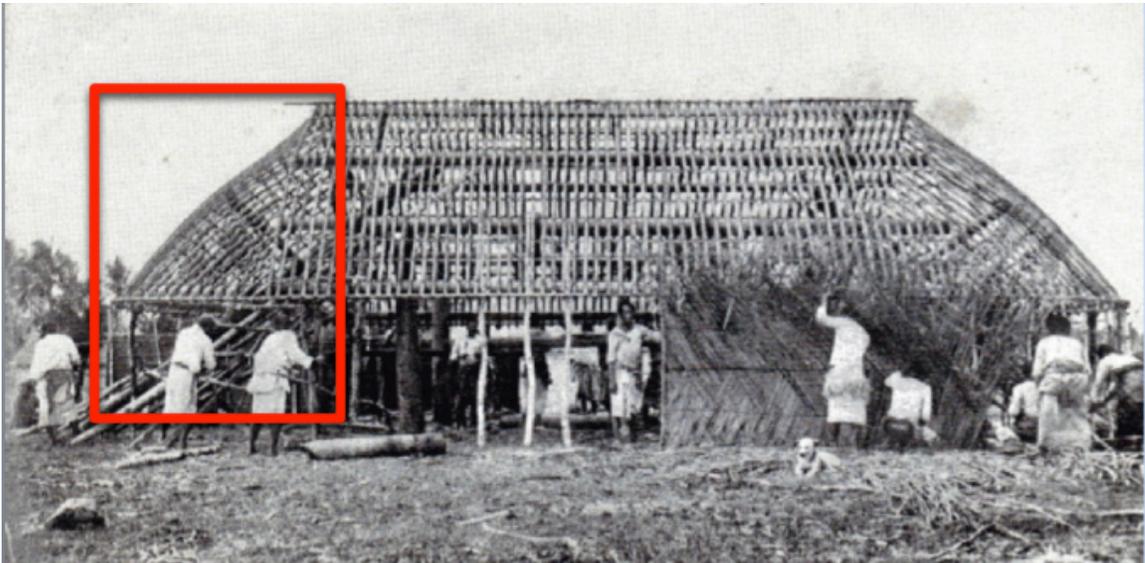


Figure 55: *Taa’ifale*.

Source: <http://www.stampboards.com/viewtopic.php?f=17&t=52100>. (accessed March 15, 2016).

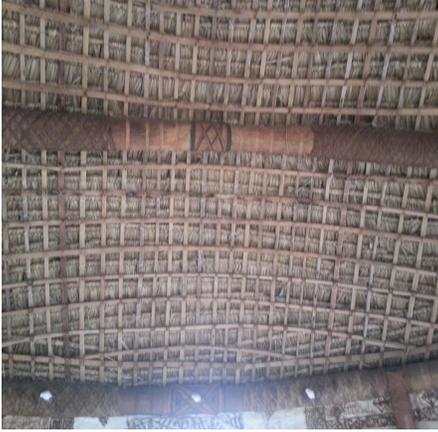


Figure 56: *Taa'ifale*.

Source: *Taa'ifale*, Laie. Personal photograph by the author. 2016.

There was also an awareness of environmental impact that has to be achieved in the project. The wind, rain, and sun were fully considered in the design process. The idea of the traditional *fale* was very adaptable to the weather conditions and were also a driving factor of the project. The people in the station should be able to be protected from sun and rain, and at the same time enjoy the cool breeze from the ocean. People, architecture, and nature should be considered as one like they used to be.

The figure below shows how the wind hits the bus stop. The form helps to divert winds that will allow natural air ventilation. This also helps to protect the station from strong wind and even rain

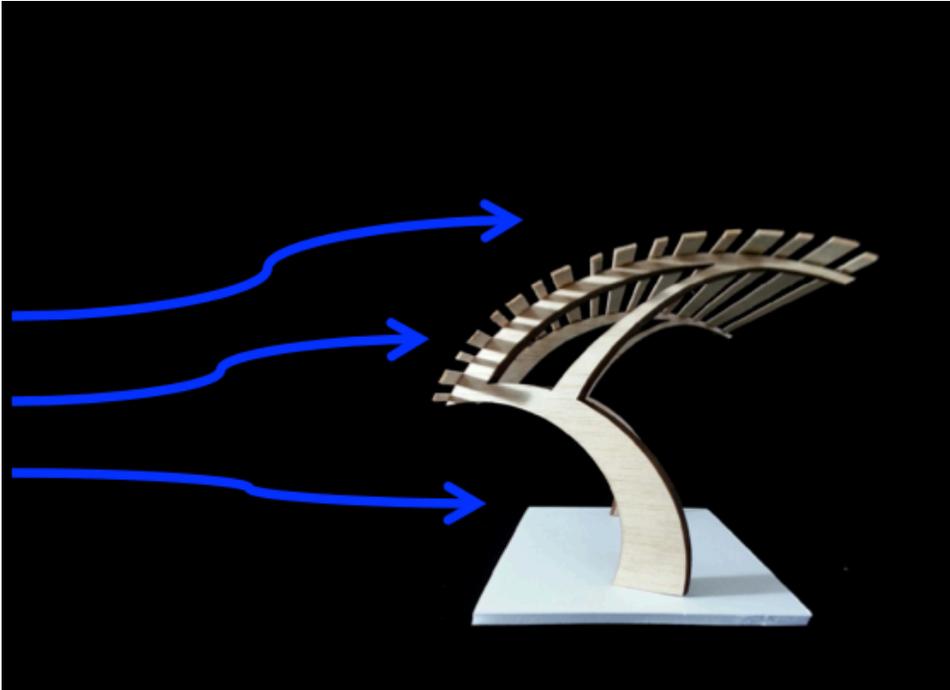


Figure 57: Study Model.

Source: Study Model, Laie. Personal photograph by the author. 2016.

The diagram above shows how the sun hits the roof. The red dotted lines show how the sun angles during the summer when it is hot. In the winter, the sun is at a lower angle, allowing the sun to warm up the station.

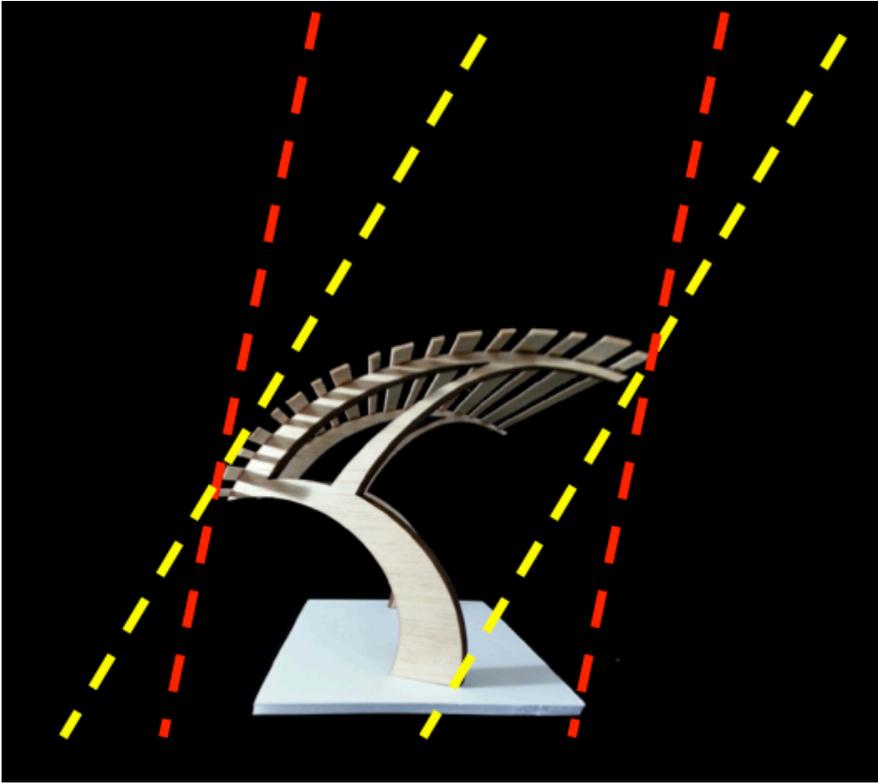


Figure 58: Sun Angle between summer and winter.

Source: Study Model, Laie. Personal photograph by the author. 2016.

These bus stations are located along the ocean. The form also resembles waves and the ocean. A lot of people rely on fishing as a source of income, including all the ocean activities that the tourists are attracted too, which is beneficial to all of Tonga.

Cultural and Social Impact

Creating a series of bus stops on Tonga will have beneficial cultural impact in many ways. The main focus of the design of the bus stops is for educational purposes for students as well as adults. By using signs and perhaps dioramas as well as actual architectural designs themselves, the Tongan people will learn about their historical connection to various structures, which will then be a means of impacting the second cultural benefit, namely historical spirituality as well as creating strong connections in social hierarchy between all the peoples of Tonga from the commoner to the King and Royal Family.

The base of the station has three different levels; these different heights symbolize the social hierarchy in Tonga. The lower level is the commoners, the middle level represents the nobles, and the highest level represents the king. This social structure is one of the foundations of Tongan society from the beginning and it is still practiced today. There are even three different dialects that Tongans use as we communicate with one another. For instance, one would speak normally to a commoner, and one would use a more respectful dialect to talk to a noble or the king. People need to use a respectful dialect which fits their status.

In the traditional *fale*, the *pou* represents the nobles or hierarchy in the home or in the village. If the *fale* has more *pou*, that means the size will be bigger and there are more nobles in town. The bus station will have the same idea. The *pou* in each station

will vary depending on the area and bus route. Station 2 would have less *pou* than Station 3 because more people will get in and out from Station 3 than Station 2.

Additionally, the creation of bus stops will also establish common meeting grounds for people as they travel about their business throughout the day, enabling them to get to know fellow travelers on their routes and times.

Different Structural Material

The three most common construction materials for architectural supports in Tonga are wood, steel, and concrete. All the bus stations will have a wood, concrete, or steel structure. Each material has its own benefits and weaknesses.

Glulam

The use of wood has few disadvantages other than some design challenges based on shaping the wood into desired or needed shapes in comparison to steel or concrete. Of course, with wood, the architect needs to factor in wood longevity in relation to service life. Glued, laminated timber, also called glulam, would be a great product to use in this project.

By laminating timber, small trees can be used to create a large structural beam and make any desired form.³⁶ Glulam can be utilized as much as steel and concrete regarding weight of support to load bearing. Additionally, wood is environmentally low impact and works well with humidity. Wood has a natural aesthetic appeal that fits the perceived Tongan cultural as a tropical paradise and thus as a tourist destination.

³⁶ *Product Guide, Form No. EWS X440* (PDF). APA – The Engineered Wood Association. *Product Guide, Form No. EWS X440* (PDF). APA – The Engineered Wood Association. 2008.2008.

The figure below shows an example of how glulam can be used as a beam and can span long distances. This is an interior image of the Richmond Olympic Oval located in Canada.



Figure 59: Richmond Olympic Oval.

Source: https://pl.wikipedia.org/wiki/Richmond_Olympic_Oval. (Accessed March 20, 2016).

Glulam is also slightly cheaper than steel and concrete, which is the greatest benefit over concrete and steel for the people. It is very flexible in shape and size. The strength is comparable to steel and concrete, and is very durable. Tonga is very humid so it has an advantage over other materials in a corrosive environment. Also, it is a very low maintenance product regarding its appealing appearance.

Concrete

Concrete is a common material in Tonga today. There are different companies that supply it locally throughout the island. The use of concrete falls behind wood regarding use in Tonga as a tourist draw since it is everywhere in the world. However, concrete offers pure strength and it lasts a long time. Concrete also is ecologically sound since it is made from a mixture of sand and limestone.

Concrete has versatility, which can be used in the foundation, base, and structure of the bus station. It also has very low maintenance compared to other material because of its compactness and nonporous surface, and it does not attract mold while maintaining its original form and strength over time. Concrete is also highly effective in fire resistance, and it takes very little carbon dioxide emission, compared with other materials, in the process of creating it.

A study by the National Ready-Mixed Concrete Association (NRMCA) explains that the energy required to produce one ton of concrete was 1.4 GJ/t compared to 30 GJ/t for steel and 2GJ/t for wood.³⁷ This information is critical to know and understand by the people as they are thinking of their homes and the right materials to use. Concrete is one of the materials with the lowest energy to produce.

³⁷ <http://www.wbcscement.org/index.php/en/about-cement/benefits-of-concrete> (accessed March 10, 2016).

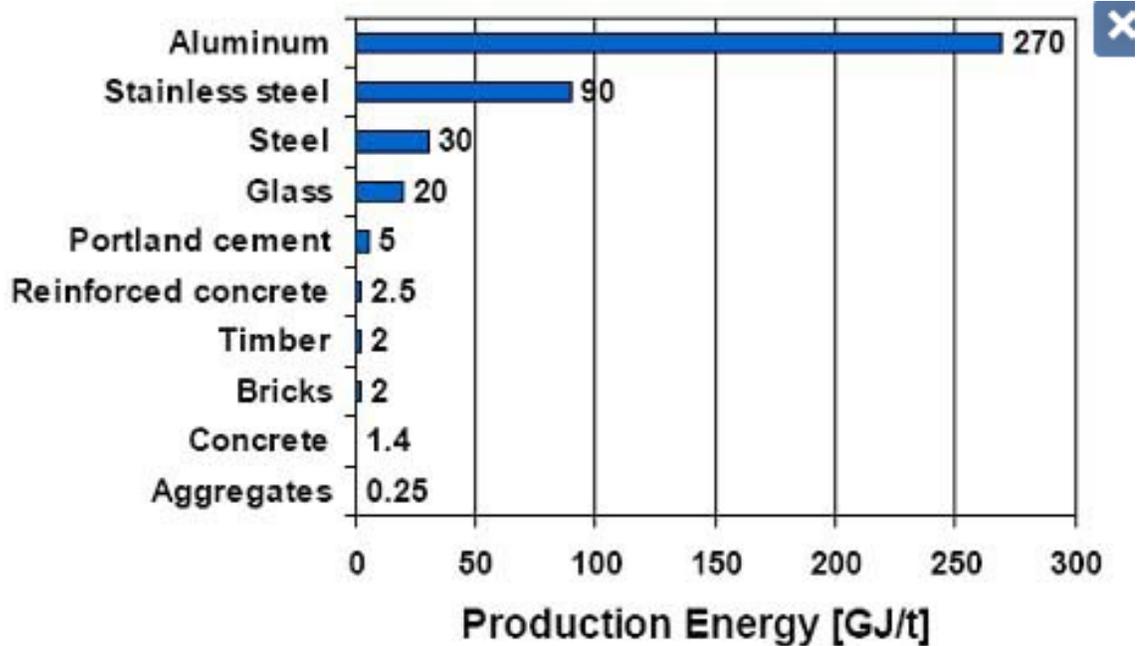


Figure 60: Production energy of different material.

Source: <http://www.arch.ttu.edu/courses/2013/fall/5334/Students/Ajanaku/13/Default.htm> (accessed March 10, 2016).

The figure above shows how much energy is required to make each material per ton. This will be a helpful graph to post in some of the stations so people learn more about different materials.

Steel

Steel is also used frequently in Tonga and has been increasing in the past decades. Steel structure is mostly done in a fabrication shop. This helps to cut down a big chunk of the construction process. Because of prefabrication, less labor is needed, and also allow a lower chance of errors in the process. According to Midwest Steel Inc., steel framing costs about 5-7% less than concrete.³⁸ The reason for this is the amount of labor that can be cut short.



Figure 61: Steel frame architecture.

³⁸ <http://www.midweststeel.com/structural-steel-advantages-over-concrete.html> (accessed March 20, 2016).

Source: <http://www.imoa.info/molybdenum-uses/molybdenum-grade-stainless-steels/stainless-steel-architecture.php>. (accessed March 20, 2016).

Steel is very strong compared to wood and concrete. It can also withstand up to 50,000 pounds per square inch in both compression and tension.³⁹ This attribute allows it to be an efficient material to work with. For example, steel can be slender enough to get the most space in the structure. The structure can be exposed to show the details, strength, slenderness, and transparency of the frame.

Because steel is manufactured and fabricated in controlled conditions, the strength, form, and production are easily predictable and controlled. This also helps the architect for the designing of the structure. It is also easier to modify the structure than wood or concrete.

Additionally, there is not as much waste with steel as there is with concrete and wood. Because steel is made of 88% recycled materials, it is fully recyclable into new steel products.⁴⁰

³⁹ <http://www.engineershandbook.com/Tables/steelprop.htm> (accessed March 20, 2016)

⁴⁰ <http://www.midweststeel.com/structural-steel-advantages-over-concrete.html> (accessed March 20, 2016).

Roofing Material

Traditionally roofs were made from coconut thatching. The men and women of the villages would weave them together. Today it is almost impossible to do the same thing due to the time consuming process. People now do not have the pleasure of time as in the past. Also, the availability of the material such as coconut leaves and others are crucial too. However, there are new materials that have been introduced to the island that can be used and people can learn from it.

Corrugated metal is a common material that is found in Tonga today. It is cheap and locally made on the island. It is great for protecting the structure from the water because of its waterproof nature. It is also easy to install to any kind of structure.

Wood and asphalt shingles are also found in Tonga. They are not as common as the metal roof, but still can be used in the bus station. This material will be slightly cooler than the metal roof. Tonga is warm most of the time, so this material can provide a cooler space for people.

Canvas material is something new in Tonga. In Hawaii, the Ward Theater and Hawaii Convention Center incorporate canvas in the roofing for shade. This new material will also provide a new opportunity in Tonga if it is well designed. It is waterproof and also very lightweight, which has its advantages.

Green roofs will also be incorporated in the roofing materials. Traditionally, coconut leaves were woven to make thatching; it is the same principle I want to explore in Tonga. The *fatai* trees can be incorporated in the roofing design. *Fatai* and Spanish moss can grow and survive in the air without touching the earth. This will make the space cooler than the metal and canvas. Recycled material like plastic bags and bottles can also be interesting for use in construction. This idea can also help Tonga in terms of preventing pollution.

The reuse of materials like plastic will have a good potential in Tonga because of heavy use by the people. Traditionally, fibers from coconuts were used to make rope for lashing of the *fale*. Plastic bags can be used in the same way by braiding them together; it is strong, plus it is a waterproof material. The figures below is an example of how to put it together and can be incorporate into the bus station roof.



Figure 62: Thatching plastic bags roof.

Source: Study Model, Laie. Personal photograph by the author. 2016.



Figure 63: Roofing Structure.

Source: Study Model, Laie. Personal photograph by the author. 2016.

The purpose of using different materials in the bus station is for people to learn by experiencing for themselves the different look, feel and smell of the materials. They will also understand and learn which material is better for each weather condition. I hope by doing that they can think of how to use those materials in their homes.

Study Models

Building study models helped me complete the final design. This series of study models was used to develop the forms and help with the different materials that can be use.



Figure 64: Study Model 1

Source: Study Model, Laie. Personal photograph by the author. 2016.



Figure 65: Study Model 2.

Source: Study Model, Laie. Personal photograph by the author. 2016.

The first idea shows a simple structure that many people preferred in the survey. The idea of waves comes to mind as the bus station is a continuation of the ocean. The wave itself becomes a shading device for the people. The material used for the structure is flexible: glulam, concrete and also steel could be used. The structure will only have two main posts to carry the weight of the roof.

In this model, four posts were incorporated because of the traditional *fale*. It was also intended to keep the structure in a simple form. The way the posts cross over can introduce a ceiling or some kind of insulation to keep the space cooler.

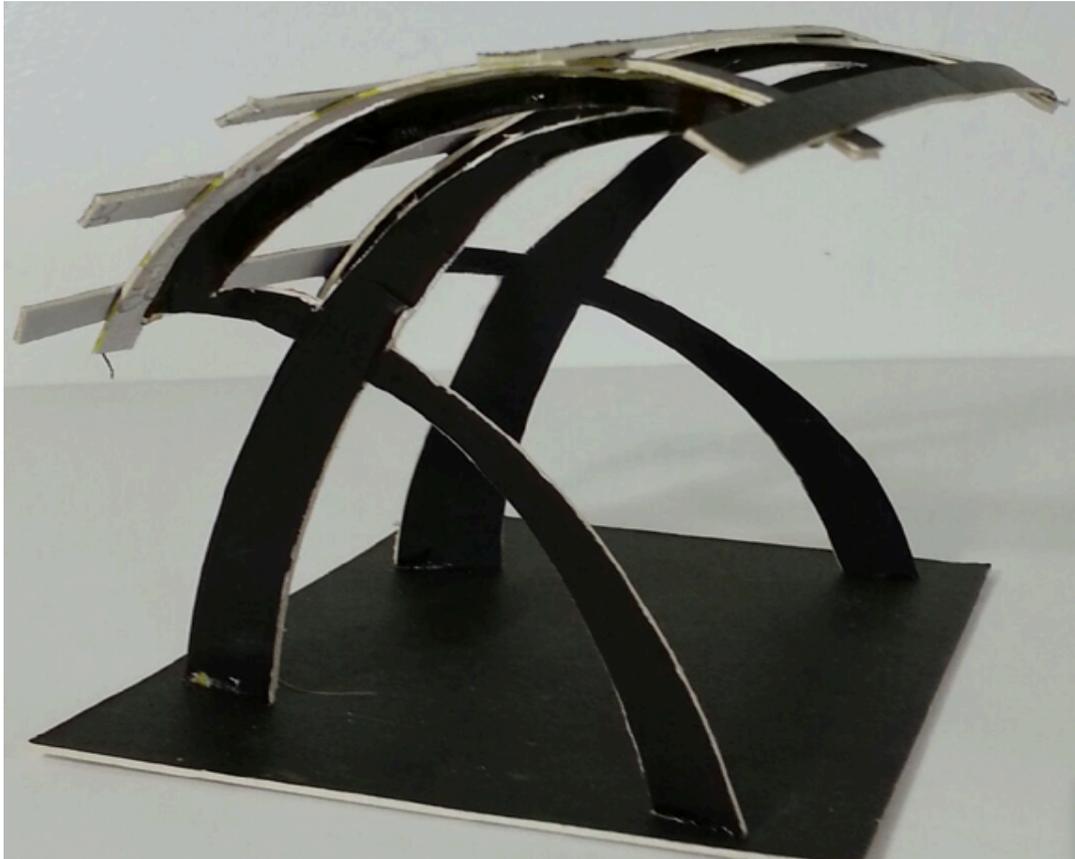


Figure 66: Study Model 3.

Source: Study Model, Laie. Personal photograph by the author. 2016.



Figure 67: Study Model 4.

Source: Study Model, Laie. Personal photograph by the author. 2016.

The material that can be used in this specific structure can vary depending on what is available. For the posts, it will be easier to prefabricate them in a shop. It will save a lot of time and money. The structure can be glulam, concrete, or steel. They all have their own positive and negative characteristics. For example, concrete is a great material because it can withstand the weather condition and will not rust, but it requires a bigger foundation than glulam or steel.

These were more study models built to help me in the process of brainstorming. These models were created from the mass models I build and draw on the computer. One benefit of building the models is I started to think of space in relation to the structure and the proportions. I also started to think of the different materials that can be used in the different parts of the bus station.

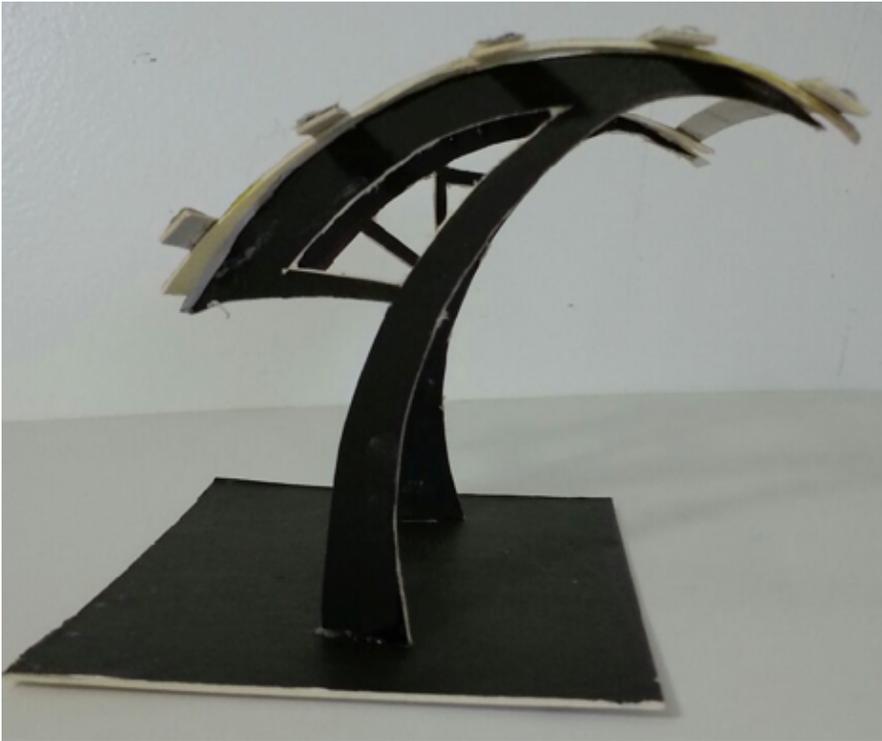


Figure 68: Study Model 5.

Source: Study Model, Laie. Personal photograph by the author. 2016.



Figure 69: Study Model 6.

Source: Study Model, Laie. Personal photograph by the author. 2016.



Figure 70: Study Model 7.

Source: Study Model, Laie. Personal photograph by the author. 2016.



Figure 71: Study Model 8.

Source: Study Model, Laie. Personal photograph by the author. 2016.



Figure 72: Study Model 9.

Source: Study Model, Laie. Personal photograph by the author. 2016.



Figure 73: Study Model 10.

Source: Study Model, Laie. Personal photograph by the author. 2016.



Figure 74: Study Model 11.

Source: Study Model, Laie. Personal photograph by the author. 2016.

Refined Models

After brainstorming, I refined the design. I built the model and deeply thought about the materials and the structure. I am going to use all three materials I mentioned earlier in each bus station and they are all available on the island.



Figure 75: Study Model 12.

Source: Study Model, Laie. Personal photograph by the author. 2016.

In this example, glulam was the structural material for this specific design. The roof will be wooden shingles that will be applied on top of the wooden structure. The

wooden structure will have spaces in between to allow warm air to escape between the shingles. This will make the space cooler during the hot summers in Tonga.

The base and foundation will be concrete, which is very strong and easy to maintain year round. I will also have stainless steel brackets that will be inserted into the concrete as it is poured into place. The glulam posts will be bolted to the bracket with one-inch stainless steel bolts.

This model shows a steel frame as the structure. The base will be concrete and have steel plates inserted into the concrete as it is poured into place. The steel frame will be bolted to the plates and can be adjusted in the height a little bit. As shown in the model, steel will be much thinner than the glulam frame. This nature of steel is crucial in working with small buildings. The roofing material is canvas.



Figure 76: Study Model 13.

Source: Study Model, Laie. Personal photograph by the author. 2016.

This model shows a concrete structure on top of a concrete base. The structure can be pre-cast and then bolted into the foundation base. This structure has a green roof. The *fatai* vines and the *tillandsia usneoides*, which is also known as the Spanish moss, will be used on the roof. Although the idea of a green roof seems new, traditional *fale* had a different but similar idea.



Figure 77: Study Model 14.

Source: Study Model, Laie. Personal photograph by the author. 2016.

This model shows a corrugated metal sheet which is one of the most common roofs used in Tonga at the moment. This material is made in Tonga and is inexpensive. However, it is very hot underneath the structure because metal is a heat conductor. With this kind of roof, an insulation barrier of some kind or double roof membrane can help eliminate the hot roof. Corrugated metal is a great waterproof material that will help keep people dry from the rain.



Figure 78: Study Model 15.

Source: Study Model, Laie. Personal photograph by the author. 2016.

These are some of the models also built. In each model, I use different materials to have different variations and to teach people in different ways. Each bus station will offer some basic knowledge about architecture and people can relate to each in a certain way. Both the cost and comfort of each station can be determined by the users themselves.



Figure 79: Study Model 16.

Source: Study Model, Laie. Personal photograph by the author. 2016.



Figure 80: Study Model 17.

Source: Study Model, Laie. Personal photograph by the author. 2016.

Sketchup Models

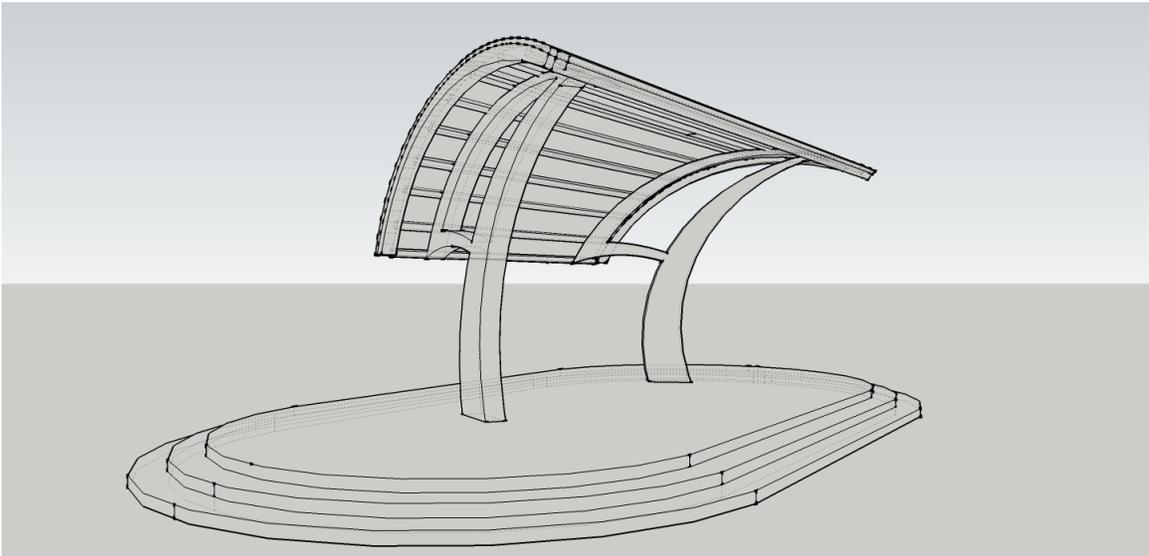


Figure 81: Sketchup Model 1

Source: Study Model, Laie. Personal photograph by the author. 2016.

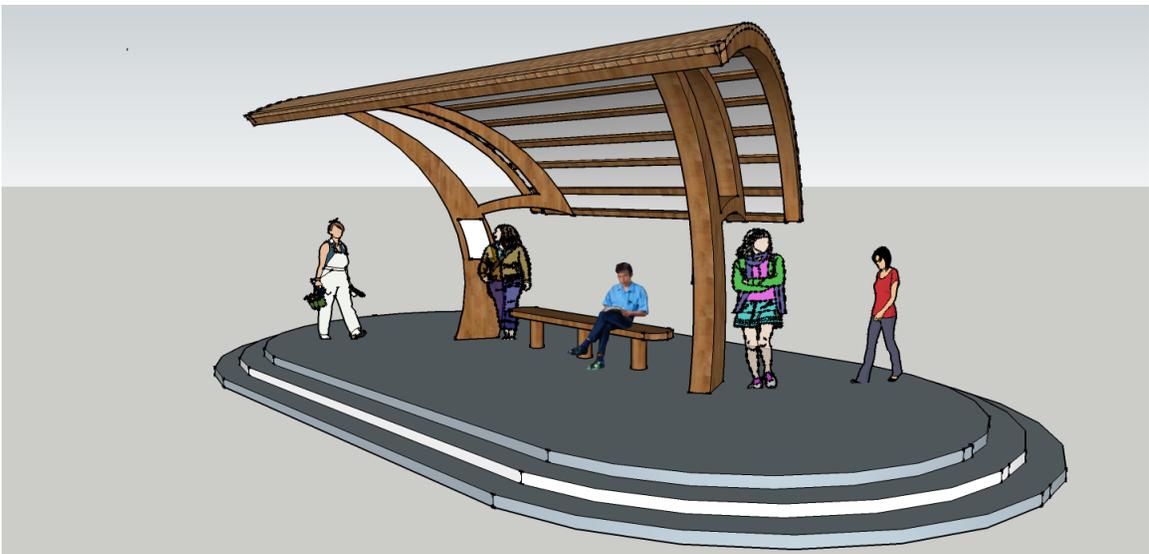


Figure 82: Sketchup Model 2

Source: Study Model, Laie. Personal photograph by the author. 2016.

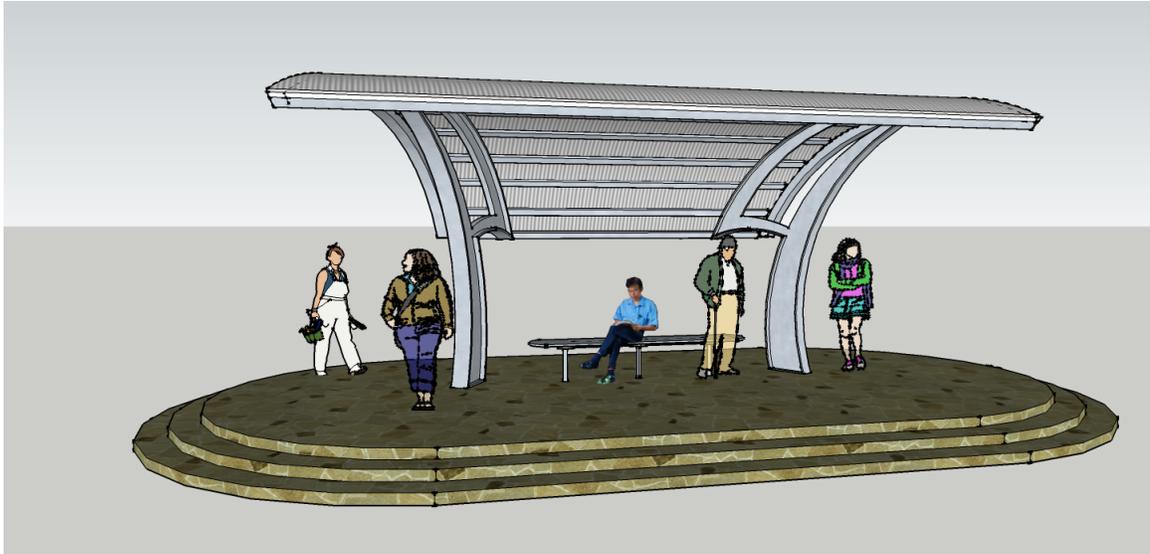


Figure 83: Sketchup Model 3

Source: Study Model, Laie. Personal photograph by the author. 2016.



Figure 84: Sketchup Model 4

Source: Study Model, Laie. Personal photograph by the author. 2016.

Final Thoughts

As I did this research, I realized that this problem of losing personal identity and culture through architectural changes is found in each of the South Pacific islands. There are many different factors that drive architecture today as well as in the future.

Additionally, I have found that most people do not fully appreciate traditional architecture, primarily because of limited knowledge about it. I feel as a Tongan student studying architecture, I am obligated to make the connection of the traditional *fale*, with the present and future architecture of Tonga by tying the architecture with the historical and cultural past so that traditions are not lost.

To utilize traditional *fale* ideas in modern architecture requires assistance from the government. Tonga does not have a building specification system at the moment, and this information and data can be a great resource to introduce building specs and policies. I believe personal identity and culture can be influenced by modern architecture in Tonga while remaining self-sustainable, as well as being as beautiful as the traditional *fale* assuming the Tongan people become educated about cultural history, are supported by the government, and aided by creative architects knowledgeable about Tongan culture, personal identity, and traditional *fale* building methods.

I believe that these bus stops can help and remind people about the different aspects of building materials. People can also learn from their own experience of how different materials can change the level of comfort. I hope also that people can relate to

them as their ancestors previously related to the traditional *fale*. These small buildings can teach the people of Tonga more about architecture and help them prepare for the future.

Glossary

Alafolau- storage space for voyagers

‘Ana- cave

Aoniu- unify or fully controlled

Aotearoa- long white cloud

Apai- carry or lift

Fakahou’eiki- caring for the noble

Fale- home

Faleafa- house typology that was built for hurricane relief.

Falealea- meeting house

Faleano- lower beam that holds the rafters

Falefaha’iua- two sided temporary building with a roof connecting to the ground using ground posts

Falefakafisi- Fiji style of house

Falefakamanuka- Manuka style of house with no walls.

Falefata- attic building structure

Falefataua- double height attic structure

Falehanga- weaving house for women only

Falehufanga- house of refugee

Falehunuki- temporary building made of coconut leaves roof connected to the ground by small posts

Falelalava- lashing house

Falepouono- six post/columns house

Falepouvalu- eight post/columns house

Falesiu- fishing storing house

Faleta- hospital

Faletolia- funeral house

Falevai- bathroom

Fale'i- teach, counsel and advice

Fata- carry

Fatufale- build or make a house

Fatutama- build or raising up children

Fatu- make or create

Fau- Wild Hibiscus tree

Fehi – Borneo Teak Tree: *Azelia bujuga*

Feleoko- food storage building

Fetoka 'i'aki- caring and respecting each other

Fonua- environment

Haumatutu- tall matured coconut tree

Ha'apai- one of the main group of islands in Tonga

Ha'i- tie or lashing

Ha'ikainga- marriage

Hiapo- mulberry tree

Hikisa- building the roof structure, raising the rafters

Huufihale- open house or construction completed

Ilano- name of the lower beam in the roof structure

Kafa- braided coconut husk rope

Kaho- type of tree that was used for making beam

Katupa- sides of the traditional *fale*

Kauta- supporting beams that hold the rafters

Koka- Bishop Tree: *Bischofia Javanika* - a rapidly growing evergreen, the hardest wood tree in Tonga.

Kuava- Guava Tree

Lalango- is the main sporting beam that run from post to post

Lalava- lashing

Lango- lift up, or support

Langokaho- use the *kaho* tree for support under the structure

Lauhala- type of tree that was used for weaving

Lea- speak or talk

Leke- room

Lotofoa- one of the island in the *Ha 'api* group

Milo- Portia Tree: *Thespesia Populnea*

Niu- coconut tree

Niukafa- curtain type of coconut was good for making the *kafa* rope

Nga- together

Ngangauae- work together

Pekepeka- bats

Pola- thatching

Pou- post or column

Poufehi-fehi column

Poufehihi- beam made of *fehi*

Puataukanave- Kou (Hawaiian translation) Tree Narrow-Leafed Bird Lime Tree: *Cordia*

Subcordata

Pulu- coconut husk

Siale- type of tree was use in the roof structure

Takaifala- marriage

Talatala- to announce, notify

Talatalaifale- advise or teach

Tamanu- tree

Tanupou- laying the foundation

Tanusia- building an artificial hill

Tapu- restricted or sacred rules to abide

Taula- shaman or spiritual leader

Tapu- restricted or sacred

Taufatungamotu 'a- one of the main beam of the roof structure

Tau'olunga- face of the noble, and also a Tongan traditional dance performed by the women

Tavahi- Sumac Tree: *Rhus Taitensis*

Ta'opotu- close or near

Teke- push or support

Telie- Kamani Tree: *Terminalia Catappa*

Toa- iron wood

Toka- beam

Toi- Ash or Sarsparilla Tree: *Alphitonia Zizyphoides*

Toko- to push or support

Tokotu'u- roof rafters

Tonga- South

Tongatapu- Sacred Tonga

Toufufu- attic

To'ofufuloto- center beam of the roof structure

Tutu- inner bark of the mulberry tree

Tu'a - commoners

Tu'ungahoka- push or support

Utupoto- name for the upper beam in the roof structure

Vava'u- one of the main group of islands in Tonga.

Vesi- Ipil Tree: *Intsia Bijunga* from Fiji used for making traditional canoes

'Api'uta- farm house

Survey Questions

1. Are you from Tonga?
2. Do you still live in Tonga?
3. At what age did you leave Tonga?
4. Did you grow up in a traditional Tongan *fale*?
5. Have you ever heard of a *fale*?
6. Have you seen a *fale*?
7. Do you know the cultural significance of traditional *fale*?
8. How do you view Tongan Traditional Architecture as it relates to your own sense of cultural identity?
9. How do you view the current modernized architecture in Tonga?
10. Do you see any significance of the architecture in Tonga as it relates to your everyday life?
11. What kind of home were you raised in and on which Island of which Island chain?
12. What did you like or do not like about the home you were raised in?
13. What would you have liked your home in Tonga to be like when you were growing up?
14. If you could have changed your home when growing up, how would you have changed it?

15. Do you think growing up in a traditional *fale* would have increased your sense of Tongan cultural identity?
16. Do you think that historical cultural preservation is important in ones home?
17. As a man, what are your thoughts on traditional homes in Tonga?
18. As a woman, what are your thoughts on traditional homes in Tonga?
19. What is your Educational level?
 - Less than high school
 - High school
 - 2 year college Associates degree
 - 4 year college Bachelors degree
 - Masters degree
 - Ph.D
20. Do you think educational levels influence traditional cultural values regarding *fale*?
21. Would living in a *fale* make you enjoy your home greater than if you lived in a modern home?
22. Would you find more interest in exploring traditional *fale* in relation to Tongan culture if you have a family with children?
23. In Tonga, did you live in an urban area such as a city
 - a. or did you live in a town
 - b. or a village
 - c. or in a rural country home

24. Do you think that people raised in the city would have different views of traditional *fale* than those raised and living in rural villages?
25. Which Island group are you from?
 - a. Vava'u
 - b. Ha'apai
 - c. Tongatapu
26. Which Island Group do you believe would most appreciate traditional *fale* and why?
27. What is your occupation in Tonga?
28. Do you think that ones occupation would influence a person's views on traditional *fale*? If so, how?
29. Would you like to see modern Tongan architecture influenced by and retaining ties to traditional Tongan *fale*?
30. Do you think that if modern Tongan architecture were to utilize traditional *fale* building ideas as a means of cultural preservation that it would benefit the Kingdom of Tonga?
31. Would you be interested in living in a modern interpretation of the traditional *fale* and what benefits do you believe you would gain from being a part of such cultural preservation?
32. Is there a place in the modern Industrialized Western world for buildings and homes with links to traditional culture?

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