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THE FIRST LESSON IN GRASS HOUSE ARCHITECTURE

The following events took place near the town of Shanklin, on the eastern coast of the isle of Wight in the English Channel about the time of the American Revolution, as far as we remember. Author Unknown.

Ah, very, very poor was she, old dame pig and her children three
Robust, beautiful little ones were those three sons,
Each wearing always, without fail,
A fanciful little knot in his tail.

But never enough of sour and sweet had they to eat
And so one day with a piteous squeak
Did the mother speak,
"My sons, your fortunes you must seek."
So out in the world as they were sent,
The three pigs went.

Trotting along the first one saw
A man who carried a bundle of straw.
"Give me some straw for a house and bed,"
The little pig said.

Straightway, not waiting even a bit
The kind man did as he was bid,
And the little pig built a house of it.

But he was no more than settled before
A wolf came along and knocked on the door
Tap-tap, and cried, "Little pig, little pig
Let me come in."

But the pig replied, "No, no, by the hair of my
Chinny, chin, chin!

The old wolf grumbled and added beside,
"Then I'll huff and I'll puff
And I'll blow your house in!"

He was gray and big,
And he huffed
And he puffed
And he blew the house in
And he ate the poor little pig.
It is believed that the first settlers in Hawaii arrived already having the knowledge of the vertical walled house with ridge, rafters, and plates. The form it took was in time modified by materials available, climatic conditions, individual inventiveness, and by customs and superstitions.

Russell A. Apple points out in his book *The Hawaiian Thatched House* that there are today no surviving authentic prehistoric Hawaiian grass houses. We do have, however, one draftsmanlike drawing that has come down to us from the past—the interior elevation of a gable-end grass house drawn in 1838, when such houses were in use, and included in Malo's *Hawaiian Antiquities*.

By superimposing a grid on this drawing we find that the roof slope is 18" in 12"—which accounts for the lofty appearance of many of the grass houses depicted by artists accompanying early voyages of discovery. This slope, much in use today, shows that the early Hawaiians possessed construction logic remarkably like that of today.

But, as Apple points out, any grass house built today, based on surviving descriptions, can only be said to be such as could have been built by the early Hawaiians. This is true of the many grass houses built by the compiler of these notes, including the Hilo Hawaiian Village which, soon after its completion, was washed out to sea by the tidal wave of 1946.
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In 1902, Dr. J.F.G. Stokes, then curator of the museum, brought to Honolulu the dismantled frames of three grass houses that were standing on the Knudson land in the Kekaha district of Kauai. Using selected members from the three frames and working in the traditional manner, skilled Hawaiian craftsmen erected the Museum House.

In the process of dismantling the old frames, the lashings made from olona fiber had to be discarded, and were replaced in the reconstruction by lashings made from uki uki grass. The original thatch was replaced by new pili grass thatch, all applied, as mentioned above, in the traditional manner.

The diagram at the right shows a comparison between the roof slope of the gable-ended house of the Malo drawing (18” in 12") and that of the hip roof of the Museum House (approximately 8” in 12"), and indicates that the Hawaiians, too, realized that a small change in proportions made a great change in appearance.
As far as materials were concerned, the Hawaiians at the time of Captain Cook's arrival were living in the Stone Age, without metal to make tools, weapons, implements, or vessels.

Hawaii's substitute for the steel cutting tool was the stone adze, which served as chisel, plane, and saw. This was a shaped piece of rock, or shaft, varying from finger length to about 24 inches and sharpened at one end. It was used for all kinds of chipping, cutting, and carving, for felling trees and hollowing out logs to make canoes, as well as for shaping the ends of house framework and cutting notches for the lashings.

The adze was made from the hard flintlike rock often found near volcanic craters. This brittle rock had the advantage that it could be sharpened easily and resharpened, along with the disadvantage that no hole for a handle could be made without splitting and breaking the rock at that point.

Sometimes the adze was lashed to a wooden handle, as in the above made from a well-preserved specimen in a private collection. The rock had been worked and chipped to produce deep grooves to accommodate the lashings of olona fiber. The lashings probably had to be replaced frequently, because of the heavy work for which the adze was used, such as the final hollowing out of a hard, heavy koa log 18 to 20 inches in diameter and more than 20 feet long.

The Hawaiians, lacking iron from which to make nails or spikes, bound the parts of their house frames together with lashings. Lashing material was usually made by rolling the tough inner bark of the olona plant (Hawaiian flax) between the palm of the hand and the upper leg into cord which could then be plaited into a three-strand braid, approximately 3/8" wide and 3/16" thick, called sennit. This was usually done by the women, sitting in a shaded circle and singing as they worked. The huge balls of sennit were to the building of a grass house what the kegs of nails are to the building of a frame house today.
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If olona was not growing near the building site, uki uki grass could be worked into cord and braided to make the sennit. Sennit could also be made from the fibers of the coconut husk, but the difficulty of climbing a 35-foot tree, using the tree rings as footholds, of pulling the coconuts loose, and, once more on the ground, the difficulties of tearing the husk from the nut and the time consumed in drying the husks so the fibers could be pulled loose—all this before the process of making the sennit was even begun—made this the least popular material for making lashings.

Incidentally, the sennit made from the olona fiber was so strong that the Hawaiians continued to use it long after rope was available.

Another tool used by the Hawaiians was the shark's tooth knife. It was made by lashing a piece of shark's jawbone in which a tooth was still firmly embedded to a small wooden handle. This made a sharp and durable tool with a finer cutting edge than the stone adze. The material to be cut was stretched on a flat wooden block. It is believed that the shark's tooth knife was also used for cutting hair, with the hair held taut and the shark's tooth knife drawn across it in a sawing motion. If this proved too painful, fire was recommended.

Other cutting tools were made of shell. For more delicate operations, such as cutting the umbilical cord at birth or for circumcision, a serrated knife made of bamboo cane was used. This provided the sharpest cutting edge that could be obtained, but since it could not be resharpended, it had to be replaced frequently.

The Bridges of East Molokai

Precast concrete planks were used to build a number of bridge decks on East Molokai's coastal road, Kamehameha V Highway, at a reasonable cost, in a minimum time, and with virtually no disruption of traffic. These short span bridges, expected to last a lifetime without repair, resurfacing, or the need for re-routing traffic, are an example of what's expected of pre-cast, Hawaiian-Made concrete.

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A chief's menage consisted of six houses.
1. Aina—Women's eating house.
2. Noa—The place where the family life was lived—without kapu.
3. Mua—Men's eating and meeting house.
4. Kua—Place for the women's work.
5. Heiau—The chapel where the ceremonies of the gods were performed.
6. Pe'a—Women's retiring house.

Captain Cook, in the journal of his third voyage, describes Kailua-Kona as a village of seven or eight hundred dwellings, mostly small huts. From remaining stone platforms we assume that many were about 6 by 8 feet, with a height of 4 to 5 feet—not high enough for a man to stand erect and just room enough to sit or recline.

Since the Hawaiians lived mostly out-of-doors, these huts were probably used for storage of personal belongings and for occasional protection from heavy weather.

Captain Cook also described some larger structures 12 to 20 feet high and up to 50 feet long. These were probably canoe houses with open ends.

Generally speaking, the grass house was built on a stone platform raised 12 to 18 inches above the surrounding ground level, undoubtedly for drainage purposes. An even surface was achieved by fitting small water-worn pebbles into the spaces between the large stones, then covering the entire floor with sand. A lauhala mat over this made a comfortable place to sit, and a pile of mats and tapa in the corner provided a comfortable place to sleep.

The common man usually had only one house, so placed and built that its ridge would not rise higher than that of any chief or ali'i living nearby.

According to Lorrin Andrews, author of the first Hawaiian-English dictionary, every man of any wealth was supposed to have at least the following houses:

1.—The heiau (house of worship where the idols were kept).
2.—The mua (eating house for the husband, kapu to the women).
3.—The noa (a separate house for the wife but free for the husband to enter; the house of family living).
4.—The hale aina (the women's eating house).
5.—The kua (a workshop for the women to beat tapa, weave mats, etc.).
6.—The pe'a (house of separation for the wife during periods of infirmity).
These drawings, taken from Malo's book, show the carpentry details of ridge, rafters, and posts, including the remarkable way in which the rafters and posts were positioned by means of a spikelike tenon protruding upward through a forklike mortise fashioned on the lower end of the rafter.

To this compiler, it is surprising that with all their other structural logic they did not develop the diagonal brace.
After the kuhikuhi puuone (architect) had determined the size and location of the house, the wall posts were set. The life of the structure depended on the stability of these posts and the firmness with which they were embedded in the ground.

Since the Hawaiian Islands are volcanic in origin and the soil is shallow and hard and full of rocks, and because of the lack of proper digging tools, the embedding of the wall posts was not always as deep as it should have been. This was compensated for by a rock plinth, that is, by building up at the time of setting those portions of the stone platform of the house floor immediately surrounding the posts, by very careful placing of each stone and by frequent tamping.

The placing of the intermediate posts was determined by folding the alignment cords into equal lengths for purposes of spacing.

Since the plate was an uneven natural log, setting the posts was a laborious undertaking. It required first setting the post in its hole, marking it, removing a heavy 6-foot post and trimming it, rearranging the stones, resetting the post while using the horizon as a level, repeating the process time and time again to achieve the proper joining of plate and tops of posts. Any fitting was done on the end that was to be below the ground by trimming and chipping with the stone adze.

Once the plate was in place the posts to support the ridge pole were raised. These posts (pouhana) had a special significance for the Hawaiians and were endowed with supernatural powers. The raising of the ridge pole seemed to mark the change from the house as an idea to a house as a reality.
There was nothing unusual about the assembling of the rest of the house frame except the absence of the diagonal brace corner to corner. Apple does indicate a partial brace across the rafters in a diagonal direction, but it does not run corner to corner as does the usual bracing. This lack of effective bracing caused the frame to sag out of shape, the lashings to become loosened, with the result that the house deteriorated much faster than it should have.

When the frame had been completed and lashed together, the entire exterior was covered with small sticks (afo) about 3/4-inch in diameter, placed horizontally and about one span (the distance between the extended thumb and forefinger tips) apart. It was to this framework of sticks that the thatch would be lashed.

Thatching materials included the leaves of ti, sugar cane, and hala, as well as several grasses. The material most preferred was pili grass because of its reddish color, the odor, the length of its flat-bladed leaf, and the fact that it was longer lasting than most of the other grasses.

According to Peter Buck, in his *Arts and Crafts of Hawaii*, clumps of pili grass up to 5 or 6 feet long, 6 inches wide and 4 inches thick would be lashed to this frame with sennit. Thatching started at the bottom and proceeded upward, much as shingling a house does today.

The thatching of the ridge required very expert craftsmanship to make this area rainproof. Sheaths of the banana plant were added to reinforce this sensitive part of the roof.

During the construction of the house care is taken not to trim the thatch over the doorway. When the house is finished and before the owner occupies it, the ceremony called "the cutting of the navel cord of the house" is performed.

A kahuna or priest, standing outside the house, with an adze in his hand and a block of wood under the untrimmed thatch, begins his chant, at the same time bringing down the adze in cadence with his words.

Following is a prayer used, according to Malo, on the island of Molokai:

"Severed is the piko of the house, the thatch that sheds the rain, that wards off the evil influence of the heavens.

The water spout of Haakula-manu oh! Cut now! Cut the piko of your house, O Mauli-ola! That the house-dweller may prosper That the guest that enters may have health,

That the chiefs may have long life. Grant these blessings to your house, O Mauli-ola! To live till one crawls hunched up. Till one becomes bleary-eyed, Till one lies on the mat, Till one has to be carried about in a net.

Amama. it is free."

If nothing has happened to disturb the peace of the ceremony, the house is ready to be occupied and the usual luau begins.
The above outline sketch of artist Webber's drawing of the village of Waimea, Kauai, at the time of Captain Cook's first landing in Hawaii in 1778, showing the shapes of roofs most popular then. The houses with curved rafters are numerous. It is from drawings by the artists on these early voyages that we form our views of many things. It should be remembered, however, that from these drawings made at the scene, the finished engravings were made and printed by other craftsmen. The chances for artistic license are great and the temptation to improve the picture by showing a variety of roof design cannot be discounted.
The most popular style of grass house is shown below left. There is only one post hole to be dug at each end; other posts end in the stone wall (without mortar). Rafter ends are covered with stones. There are no wall plates to fit.

These elegant designs below were made by bending two trees together at the ridge, as shown in the drawing below right, or by bending and holding fresh cut trees to one curve between stakes. The trick is to find two or more trees growing in the proper alignment to warrant attempting a design like this. This design is popular with artists and people who don't like to dig post holes.
The coming of the missionaries in 1820 with their clapboard house marked the beginning of the end of the grass house. The many ways in which the missionary house was superior to the grass house was immediately apparent to both King Kamehameha II and Regent Kaahamanu. Permission to erect the first clapboard house was delayed several years because it would be a house superior to that of the ruler of the islands.

Materials to build the first lumber houses had to be brought around the Horn, a voyage of several months. With the coming of the first sawmills, this type of construction was speeded up, and with the importation of highly skilled carpenters among the Oriental laborers, the work of the next hundred years developed a type of dwelling new to Hawaii. Gradually the grass house passed out of the picture.

The new house had walls of a single board in thickness serving to support the roof and to present a finished wall surface both interior and exterior. This required lumber of the highest grade, without knots. The inborn frugality of the Asian builder led to designs devoid of any semblance of beauty. Everything was done at the lowest cost. The result was the T&G VCV plantation house with bedrooms and bath on one side and kitchen and living room on the other. Everything was done to keep cost as low as possible.

The lumber found most economical was a 1" by 6" Oregon pine run to tongue and groove and V'd at the joint. For some unknown reason an extra V was run down the center of the board creating the most dismal interior imaginable.

But these houses were cheap. The expanding sugar industry required houses for imported laborers and the T&G VCV house was the ideal economical answer. A vast number were built and many are still in use in plantation camps.

This “godawful Gothic period” lasted well into the 1900s and the small house was neglected by Hawaii's few architects. Then the Halekulani Hotel gave the office of
C.W. Dickey, AIA, the commission to erect three small one-room cottages in the palm grove surrounding the hotel.

Roy Kelly, AIA, then a recent arrival to Hawaii and Dickey's office, was the project architect for the job. He took the double slope roof concept already in the works and modified its slope to the gentler, now familiar, configuration shown above.

This roof design, based on roofs of grass houses to which extra rooms or lanais had been added, was used with variations by other architects and has become part of our regional architecture—the so-called "Hawaiian roof" was inspired by that of the grass house.

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The use of the double slope roof on the small house spread throughout the architectural profession. The T&G VCV cottage was usually built with a roof slope of 6" in 12". Experiments with slopes as low as 4" in 12" were part of the trend toward low broad lines, assisted by wide 4-foot eaves on even the smallest houses. The growing use of sliding sash and doors, allowed wide open spaces and created deep cool interiors.

The structural details needed for the double-pitch roof with wide eaves required a lot of study and went through the usual phase of development to find the best combination of line and economy. The closer the point of change in the roof—i.e., knuckle—came to the exterior wall line the less attractive the roof became, but the easier it was to construct. The break in pitch is best made one half of the distance between the ridge and the outer edge of the roof.

The pleasing effect was achieved by using a 5" slope in the lower part of the roof and eaves with an 8" slope in the steeper part up to the ridge. Actual details of construction for such a roof are shown on page 20.

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These sketches show that the "Hawaiian roof" simply cannot be made to fit comfortably onto a two-story building. It would seem that the spirit of the grass house does not choose to inhabit any building that is so obviously an import by visitors.

However, on a large palatial residence, where the building sprawls all over the lot it can soften the whole picture in a most attractive way.

Building codes in Hawaii require that the lower story of a two-story building must be of stud wall construction. This is probably to assure adequate load-bearing capabilities in the design. However, it is interesting to examine this point.

An 8-foot-long stud wall presents, for load-bearing purposes:

5 pcs. 2" x 4" 1 1/2" x 3 1/2" = 5.25 x 5 = 26.25 sq. in. cross section bearing surface, O.P. while an 8-foot-long single 1 1/4" x 8" T&G V'd wall presents 95 x 1 = 95 sq. in. cross section bearing surface.

Lateral bending of single walls is prevented by outside girts and intersecting partitions and case work. Single walls, when properly braced, can provide three times the load-bearing capabilities of a stud wall.

To an architect who has been used to stud wall construction the single board wall at first glance appears flimsy and too casual for professional use. This attitude usually gives way to the realization that it is admirably suited to subtropical architecture and that with the proper attention to mill work quite acceptable houses can be built.

Because the walls are only one inch thick the window frames are built entirely on the exterior of the house, protruding about 4 inches. This is one of the conditions that single wall construction cannot avoid and one might as well accept it.

Of course, the lateral strength of the single board wall must be supported by longitudinal bracing.

However, all two-story frame buildings in Hawaii must have stud walls in the lower story.

The framing details shown here are the result of much experimentation to provide satisfactory solutions.
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The thread running through this collection of notes seems to be
"Hold onto that 'something' which comes down to us from the grass
house."

The grass house, in its early fragile form could not meet the
demands of today's living. It could not support the TV antenna and
there was no place for the car or the rubbish cans, not to mention a
bathroom. It had to go—but somehow we let it go reluctantly. The
duty of perpetuating any of its charm fell squarely on the shoul-
ders of Island architects.

The small house—and the typical grass house was small according to
Captain Cook—does not present many opportunities for architectur-
al embellishment. The roof design is about the only place where origi-
nality can be exercised without being obvious. The double pitch
roof was the result, inspired by the roof line when a lanai or other floor
area was added without raising the ridge height.

A construction detail is offered here to show how it has been
accomplished. There are many designs, but a profile resembling
this combination of slopes was very popular with homeowners.

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There are other touches, such as the generous use of dry wall masonry of lava rock, the shoji from Japan, and the jalousie from Australia. Hawaii is the gathering place. Our people have come from many places bringing their ways and customs with them. From these many cultures something new is emerging. In the case of architecture, the small dwelling has made the greatest strides, benefiting from the deep regard a man has for his own home as well as that of his host. In Hawaii we want to keep something of the grass house with us always, out of respect for those who first came to these islands and made it possible for us to come later, to enjoy their charm, part of which was, and still is, the image of the grass house.

Island people favor the one-story dwelling, even if the area is quite large. This seemingly automatic rejection of the two-story building as un-Hawaiian supports the idea that the grass house is still with us—in the form of the small single dwelling, unpretentious and comfortable, charming in its simplicity and grace of line, a fitting place for gracious people to live, a people who have given the whole world a word to add to its vocabularies—aloha.
As a young man Ray Morris was obsessed by two strong desires: (1) to escape from the New York area and to come to the Hawaiian Islands to live and work; and (2) to use his talents to help the man of modest means have a home of his own. Both of these dreams have come true. He has lived in Hawaii since 1926, and as an architect—ten years in the home building department of Lewers & Cooke, Ltd., and later in private practice—he has planned hundreds of the homes that dot the hills and valleys of Oahu. From the living room window of his own modest home in Kaimuki, each night at dusk he can look up the slopes of Wilhelmina Rise and St. Louis Heights and watch the lights go on in homes he planned and built.

Morris spent the World War I years building submarines in Bridgeport, Connecticut, then came West to San Francisco. There, as an employee of the Pacific Manufacturing Co., he was put in charge of the millwork for a certain home in Honolulu: La Pietra. In this connection he met F.D. Lowrey of Lewers & Cooke, Ltd., and confided his desire to come to the Islands.

Lowrey was not encouraging but Morris came anyway, arriving in Honolulu via the S.S. Ventura in May 1926 with $97 in his pocket. Of the ten jobs offered him during the first ten days after this arrival, he chose to help create a home building department for Lewers & Cooke, Ltd.

To this day he has not forgotten how Lowrey steered Lewers & Cooke through the years of the great depression of 1929 without letting go of a single employee.

He joined the local eight-member branch of the American Institute of Architects as an associate member and served many years as its secretary. In 1929 he received his Territorial Architectural License No. 188.

Morris opened his own office in 1936. One of the first executive orders of World War II forbade the sale of building materials to private individuals and this put a stop to home building. He spent the war years working with the Hawaii Housing Authority and when the war was over he went back into private practice.

Morris has always been interested in the Hawaiian grass house as a symbol of graceful simplicity and sought to incorporate in his own designs whatever lines and touches he could.

Because of this respect for and interest in grass houses, he was selected to plan and build the rather extensive Hawaiian Village in Hilo. The Village was wiped out shortly after its completion by the 1946 tidal wave. He was also "grass house architect" for the Ulu Mau Village built by the Honolulu Junior Chamber of Commerce.

When he volunteered to put an issue of Hawaii Architect together dealing with the development of the "Hawaiian House" we were excited and welcomed his work. Obviously, that work was considerable and well spent.

For many years Morris's cartoons, usually based on the humorous side of Island life, have amused Star-Bulletin readers. Some of that flair is seen on the preceding pages. He has also been active, as set designer and stage manager, in hundreds of amateur theatrical productions. He and his wife, playwright Aldyth Morris, have one son, Richard, a graduate of MIT who is with the Jet Propulsion Laboratories in Pasadena, California.
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