BETHLEHEM

from *exploitation* to *ecosystemservice*

'revitalizing a former sugercane plantation into a public park that cultivates building materials to stimulate a transition towards a sustainable domestic (self)building culture'

RESEARCH BOOKLET

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INTRODUCTION

Originally I started the MSc Building Technology. After two semesters of Building Technology and one semester abroad in Norway, I decided to change to the MSc Architecture; Architectural Engineering. My interpretation of Architectural Engineering is that it considers the social position of the architect to be an overarching principle. I felt like I was missing this in my previous education. In the studio one also critically reflects on the position of the architect. At Architectural Engineering, you often start with defining the relevance of the work you plan to do, before you do that work. To me it is very important that I am given the time to think about the relevance of my work in connection to societal issues, and to formulate my position as architect in relation to the project.

From the desire to contribute to the mitigation of societal issues I chose to graduate on Sint Maarten, initially for the apparent demand for resilience in the built environment. The need for appropriate solutions there seemed high, especially since the strength and duration of the reoccurring hurricanes will increase due to climate change in the coming decades. My focus has always been on helping the lower social classes of Sint Maarten, to which my graduation project is dedicated.

This booklet supports my graduation project and contains the thematic research I conducted, a position paper and a reflection, I hope you enjoy reading it.

THEMATIC RESEARCH - THE VERNACULAR AS EXAMPLE

HOW CAN TRADITIONAL VERNACULAR ARCHITECTURAL PRINCIPLES IMPROVE THE BUILDING CULTURE OF SINT MAARTEN?

ABSTRACT

Sint Maarten's building culture is highly dependent on foreign expertise and imported building materials due to its colonial history, and is generally unsustainable, particularly in relation to the reoccurring hurricanes and earthquakes. In the quest for revitalizing Sint Maarten's building culture, the author is drawn towards traditional vernacular architecture. Four sustainable traditional vernacular principles are defined; material appropriateness, climate responsiveness, socio-economic advantages and adaptability. Of the first three aspects, case studies are conducted. The same three aspects of the current building culture of Sint Maarten are analyzed. They are compared and discussed. It was found that Sint Maarten's modern vernacular can be improved by incorporating traditional vernacular architectural principles. However, the current environmental, economic, political and social situation should not be disregarded. The ATUMICS model could be an adequate theoretical model for merging tradition with modernity.

1. INTRODUCTION

Modernism and concurrent globalization have globally introduced alien and non-climate-specific architectural typologies that expel originality and the use of local, natural materials. Imagination, inventiveness, creativity and ornamentation are often replaced by concrete blocks and corrugated iron (Piesik, 2017). Sint Maarten has encountered a similar situation, and was introduced to foreign building methods and materials even before the advent of the Industrial Revolution. In search for overseas territories the Dutch occupied the island in 1631, bringing building materials and expertise with them. Initially, the Dutch brought bricks as building material. Later, local hewn stone was used to build, bonded by a lime mortar, in combination with imported North-American wood (Hartog, 1964, Andel, 1985). According to Fathy (1973), new materials and building methods also necessitate the intrusion of the professional architect, a specialist who has been taught the science of working in these materials.

This paper claims that due to Sint Maarten's historical context, the current building culture is highly dependent on foreign expertise and imported materials, and is generally confused and unsustainable. Particularly in relation to the climate with its reoccurring hurricanes and earthquakes, the current building customs seem to be in need of a sustainability and resilience-course, maybe best visible by the high percentage of destruction of the built environment of the latest hurricane (510, 2017), and the high CO2 per capita of Sint Maarten (Worldbank, 2014). The main problem stated in this paper is a lack of appropriate building knowledge, divided in

three subjects; climate responsiveness, material appropriateness and transmission or dissemination of building knowledge and skills. The paper is part of a graduation project that aims to revitalize the current building culture of Sint Maarten, with an emphasis on finding solutions to the problems mentioned above.

In the quest for revitalizing Sint Maarten's building culture, the author is drawn towards vernacular architecture. Building traditions embody conclusions of many generations' experimentation with the same problem (Rudofsky, 1965, Fathy, 1973, Oliver, 1997), rendering vernacular architecture the practical embodiment of centuries of wisdom and experience (Piesik, 2017). The body of vernacular research defines four main sustainability principles of vernacular traditions; climate responsiveness, the idea that indigenous vernacular dwellings and settlements are, by virtue of their forms and materials, responsive to (changing) climate conditions, material and site appropriateness, the notion that materials are used in a way that secures their constant renewal and supply, while appropriately fitting in and relating to the surrounding environment;, socio-economic advantages, the notion that traditional community building processes foster social bonds and lower building costs; and adaptability, the idea that these dwellings are flexible, expandable or portable (Lee and AlSayyad, 2011).

The sustainable vernacular principles most closely related to the beforementioned problem statement are the basis for defining the main and sub questions of this paper: How can traditional vernacular architectural principles improve the current building culture of Sint Maarten? Of which sub-questions are; 1. How can vernacular architectural principles improve the climate responsiveness of the current building culture of Sint Maarten? 2. How can vernacular architectural principles improve the material appropriateness of the current building culture of Sint Maarten? 3. How can vernacular architectural principles improve the building knowledge and skill transferability of the current building culture of Sint Maarten? To understand how findings could be applied to Sint Maarten, a fourth sub-question is added: 4. How can traditional architectural principles be applied to a modern building culture?

1.2 A definition of Vernacular Architecture

A definition of vernacular architecture is a necessity in order to research it. Coming across several potential definitions of the vernacular (Rapoport, 1969, ICOMOS, 1999), Oliver (1997) notes that a number of attempts have been made to find an overall definition of vernacular architecture and that it is not surprising that attempts have been unsuccessful for the term is used to embrace an immense range of building types, forms, traditions, uses and contexts. He continues to give his own definition of the vernacular anyway; '*Vernacular architecture comprises the dwellings and all other buildings of the people. Related to their environmental contexts and available resources, they are customarily owner or community-built, utilizing traditional*

technologies. All forms of vernacular architecture are built to meet specific needs, accommodating the values, economies and ways of living of the cultures that produce them.' Agreeing with this definition, but building up on it, it is considered here a definition of traditional vernacular architecture. During fieldwork, an architecture that can be described similarly was observed, though without using traditional technologies. When one leaves out the 'utilizing traditional technologies' of Oliver's definition, one has a definition of modern vernacular architecture.

2. METHODOLOGY

The methodology of this research is mainly qualitative and descriptive. The above mentioned concept of a traditional vernacular and a modern vernacular will be set forth throughout this paper. Traditional vernacular architectural research is conducted by literature research (case studies, chapter III). The modern vernacular architecture (i.e. the current building culture) is researched in-situ and conducted by (un)structured interviews, structured and recorded surveys, observation and fieldwork (chapter IV). The traditional vernacular and the modern vernacular are compared and discussed in the conclusion.

Considering the traditional vernacular, the case studies are selected according to the respective sub-topics mentioned in the introduction. Cases are also selected on geographic location, using a world map of natural hazards in combination with a Köppen-Geiger map (Munich, 2011, Piesik, 2017). If possible, a case is selected that is climatically similar to Sint Maarten, both in a (sub)tropical and a hurricane, cyclone or typhoon region. However, the available literature with an architectural emphasis on vernacular architecture is broad and mostly typological or aesthetical, but often not in depth in relation to the research focus of this paper. Therefore, cases are also selected on information quality and availability.

3. THE TRADITIONAL VERNACULAR; THREE CASES

3.1 Climate responsiveness: hurricane resilient measures of Ryukyu's vernacular

Edgar Hume, an American military engineer, documented the passing of typhoon Gloria over Okinawa, the largest of the Ryukyu islands, in July 1949. The typhoon reached wind speeds up to 270 kilometers per hour, nearly as intense as Sint Maarten's Irma in September 2017. He observed that the difference in the effect of the typhoon on the domestic huts of the Okinawans and on the military structures was remarkable (Hume, 1950). According to Hume (1950), the native houses certainly withstood the typhoon better than the military structures. In some cases, it could be explained by the location of the houses. Okinawans were already familiar with the reoccurring typhoons and situated their houses in tactical places, as sheltered nooks

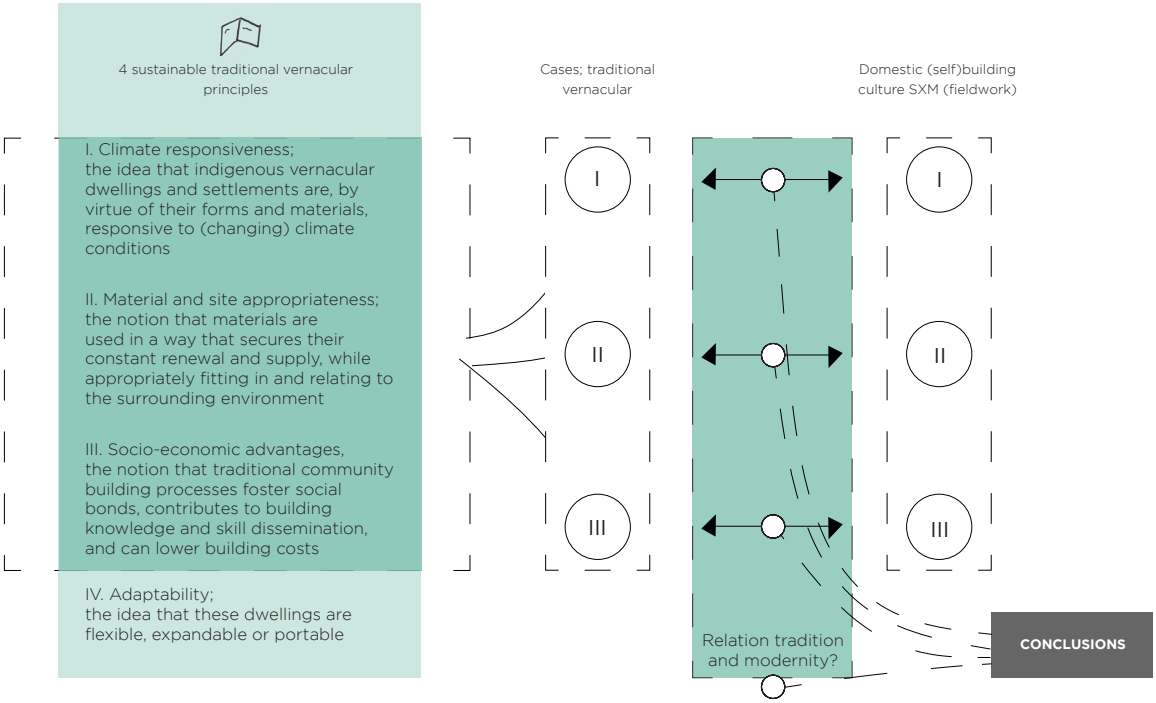


Figure 1: Overview research methododology. Own illustration

and the lee of the hills, where the wind would strike less severely. But even where Okinawan huts and American metal buildings stood side by side, it was usually the American buildings that suffered most damage. The local explanation was that the buildings of the Okinawans would let wind pass through. The tightly closed metal buildings were impervious. Wind could not enter their walls but did pass under the floors, pushing them up violently with an explosive effect, creating one of the largest hazards during Gloria; razor-sharp flying pieces of metal.

Not just the well thought geo-topographic relation and the permeability of the Ryukyu's vernacular results in its typhoon resiliency. On the Ryukyu Islands, local residents long followed a tradition of planting thick-leafed evergreen trees around their houses, known as Fukugi. Combined with a coral stone wall that is around 1.5 meters in height and 0.7 meter thick and carefully stacked, they create a streetscape unique to the Ryukyu islands. In addition to creating shade, the Fukugi and coral stone wall form a typhoon-barrier, protecting the houses from the horizontal gales, particularly protecting the roofs and eaves. Since the trees' trunks do not have thick foliage at their bases, the lower parts of the buildings are protected by the coral stone walls. The residents cannot completely surround their houses with walls; they need an opening to enter or leave their premises. To prevent winds from blowing in through this opening, a short additional wall, the Hinpun, is built behind it. A specific variation on Tonaki island shows ground levels of houses approximately 0.4 meters lower than street level. As many Ryukyu islands, Tonaki's subsoil is made up of coral reefs. Rainwater drains away quickly through the soil, making lowering the ground level of the house possible. The eaves of the roof are often made the same height or lower than the height of the surrounding stone and coral wall. With a height of the

Image 1 (left): Streetscape of the Ryukyu islands; a typhoon barrier of coral stone walls and trees (Okubo, 2016). Image 2 (right): Visible are the coral stone walls, the Hinpun and the red rooftiles bonded with plaster (Okubo, 2016).

wall on Tonaki island being approximately 1,6 meters and the lowering of the ground level of 0.4 meters, the eaves are usually around 2,0 meters high (Park, 2012, Okubo, 2016).

Next to the barrier that should break the wind and redirect it over the eaves, other hurricane resilient measures are the distinctive red rooftiles that are bonded by a plaster, preventing separate roof tiles from blowing off. Furthermore, in the Ryukyu islands, large-scale houses are considered disadvantageous since they would catch more wind. Often the houses comprise of one or several small buildings. The form of the house is simple and close to square. Structurally, it has thick pillars, a low ridge, and a well-established frame (Park, 2012). Under the eaves, the open space characteristics of the house result in natural ventilation and allows wind to go through the house, making the uplift of the house due to strong winds virtually impossible (figure 2 - 3).

3.2. Material appropriateness: the renewable materials of Caribbean's pre-Columbian vernacular

The Caribbean islands were already colonized about 6000 years ago. When Europeans arrived, they found the Caribbean to be densely inhabited by diverse indigenous groups, and in their observation concluded the Caribbean of having two kinds of people, the Taino's (or Arawaks) and the Caribs, while in fact there were many different ethnic groups that all descended from the Saladoids that migrated around 500 – 0 B.C (Wilson, 1997). In the study of the vernacular architecture of the pre-Columbus Caribbean, similar domestic architectural typologies seem to have emerged (Samson et al., 2015). In the available literature, several types are defined, amongst them the maloca, the caney and the bohio. They differ in size and form, but are often constructional and materially alike, though the materials used for construction seems dependent on local availability.

The archeological study of Samson (2010) discusses Oviedo's encounter with the domestic architecture of the indigenes during the Spanish colonialization of the Caribbean and serves as a good material and construction description of the structures, of which a summary is provided here;

They come in two forms, both built according to the preferences of the builder. Many posts of good, round wood, each an appropriate thickness, four or five paces between each post, are set in a circle. On top of these, after being fixed in the ground at head height, a ring beam is placed. On top of these tie beams are placed, which take the tension of the roof. Radial rafters are placed with the thinnest parts uppermost around the ring beam, so that they come together in a point, like a military tent. Over the rafters crosswise canes are put, or laths, a palm's distance (21cm) from each other, single or two by two, and on top of this a covering of long thin straw. Others

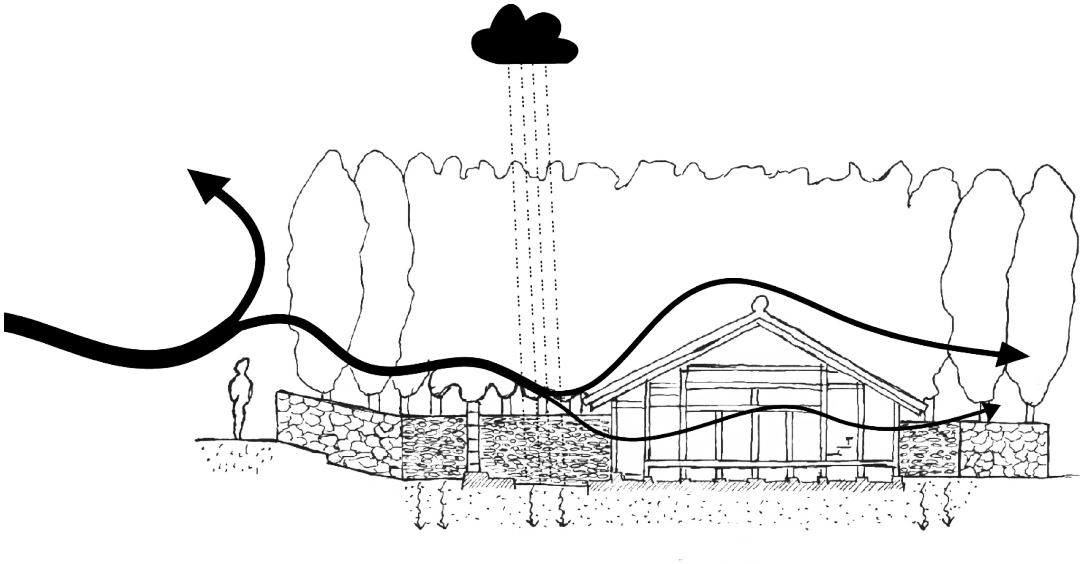
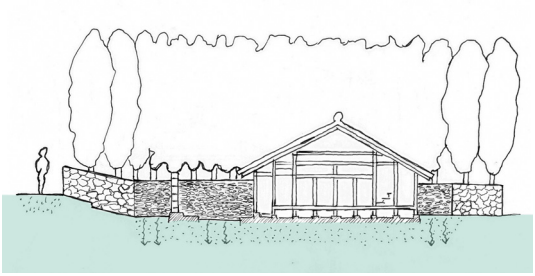
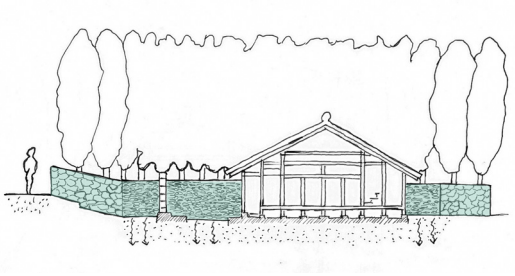


Figure 2: Section sketch of the behavior of one of Ryukyu's islands (Tonaki) vernacular in a typhoon with concurrent rainfall. Park (2012) describes that using the Fukugi-coral-stone wind break can reduce the typhoon force on the structure up to 50%. Own illustration after Okubo (2016).



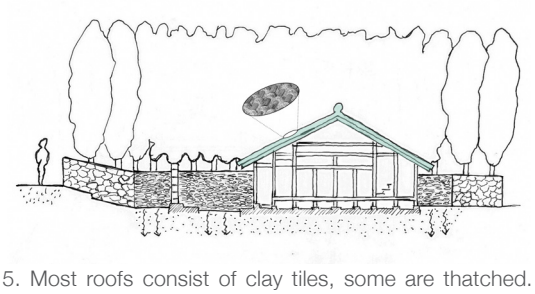
1. The subsoil of coral allows for adequate drainage during excessive rainfall. Therefore, the ground level can be lower than the street level, reducing typhoon impact on the building.



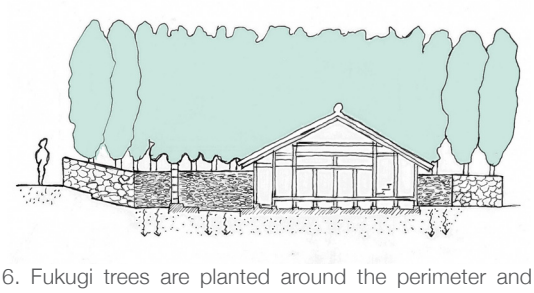
2. Coral stone walls are built along the perimeter of the plot, usually 1,5 meters high and 0,7 meters thick, functioning as a windbreak.

3. The coral stone windbreak cannot be continuous since one has to be able to enter the house. Therefore, the Hinpun is added (also for spiritual reasons).

4. The structure is made of local wood. It has thick pillars, a low ridge, and a well established frame. Wind is allowed to go trough the structure.



5. Most roofs consist of clay tiles, some are thatched. In order for the tiles not to blow off in the advent of a typhoon, they are bonded with a plaster.



6. Fukugi trees are planted around the perimeter and form the windbreak together with the coral stone wall.

Figure 3: Hurricane proof elements of Tonaki's vernacular, own illustrations after Okubo (2016).

are covered with bihao leaves, bunches of cane or palm leaves, and others with other materials. Where the wall is, from the ring beam to the ground and between the posts, canes are put shallowly fixed into the ground between the posts, and as close together as fingers on a hand. Joined on to the other they make a wall. They are tied together very closely with bexucos, which are vines or round cords which grow around trees like bindweed. The bexucos are very good ties, because they are flexible and easy to cut, and they don't perish. They act to fix and bind instead of ropes and nails to attach one piece of wood to another, and to attach canes the same way. The house made in such a fashion is called a caney. In order that it is made strong and the structure and everything properly built, it has to have a center post or mast in the middle, which is fixed in the ground four or five palms deep and which reaches the highest point of the house, to which all the points of the roof rafters are attached.

The cross-disciplinary study of Samson et al. (2015) researches the resilience of pre-Columbian house building in relation to the climate and makes no typological subdivision, referring to pre-Columbian architecture as 'the Caribbean architectural mode.' In their discussion of the Caribbean architectural mode, they describe the larger poles of the structures to be of a tropical hardwood, such as mahogany or sapodilla. Samson (2010) and Ramcharan (2014) also name guayacan (lingum vitae) to be a wood used for the poles. Archeological remains show that posts were sometimes directly put into holes in the limestone bed rock. The postholes must have been made with great skill using shell picks or chisels. In El Cabo, where 30 circular house plans were archeologically analyzed, 90% of the postholes were less than 26cm across. Slender hardwood posts could support considerable loads (Samson et al., 2015). Furthermore, a remarkable feature of the indigenous vernacular of the Caribbean that Samson et al. (2015) describe is that many structures appeared to have endured a considerable length of time trough either rebuilding or the replacement of parts. Site occupation typically spanned several centuries. Foundations were secure in high winds and earth tremors, in part because long, dense hardwoods are heavy enough to resist uplift. Making postholes in the bedrock would have facilitated house dismantlement at the approach of extreme events, kept intact the most valuable and labor-intensive parts of the construction and allowed rapid repair and reuse after storm impact. Ease and speed of dismantlement could have played a role in favoring smaller over larger houses, and choice of smaller and thus more numerous dwellings may have increased building survivorship ratios. Houses thus incorporated and shared a sacrificial principle by virtue of their combination of robust and replaceable lightweight elements providing an effective recovery system.

Another interesting feature of the archeological research in El Cabo is that despite the fact that postholes in the bedrock offered the possibility of infinite re-use, inhabitants periodically built new foundations, possibly as part of coordinated periods of community renewal (Samson et al., 2015) (figure 4 - 6).

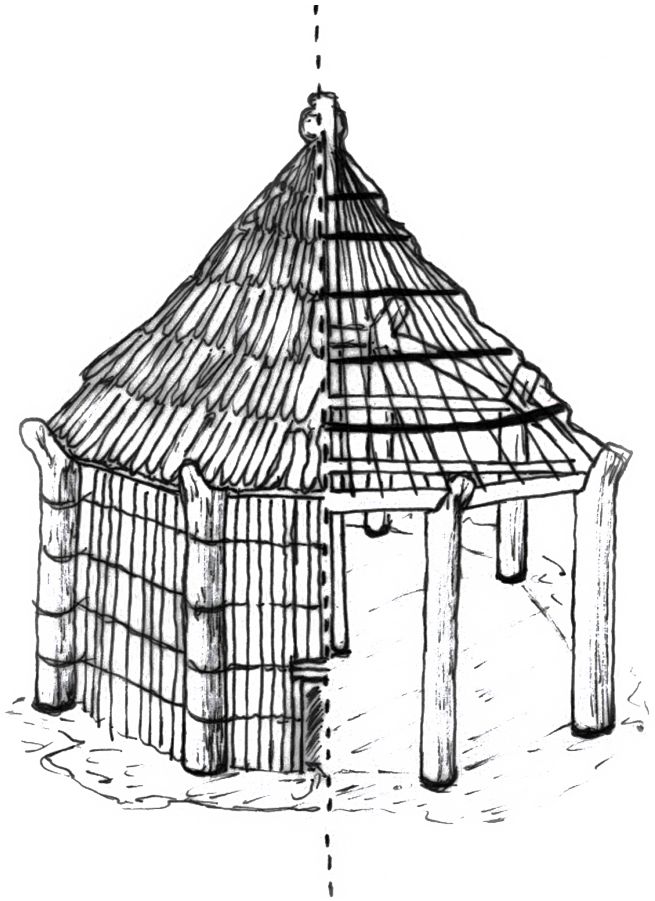


Figure 6: The Caney, own illustration after Fernandez de Oviedo y Valdes (1851) and Samson (2010).

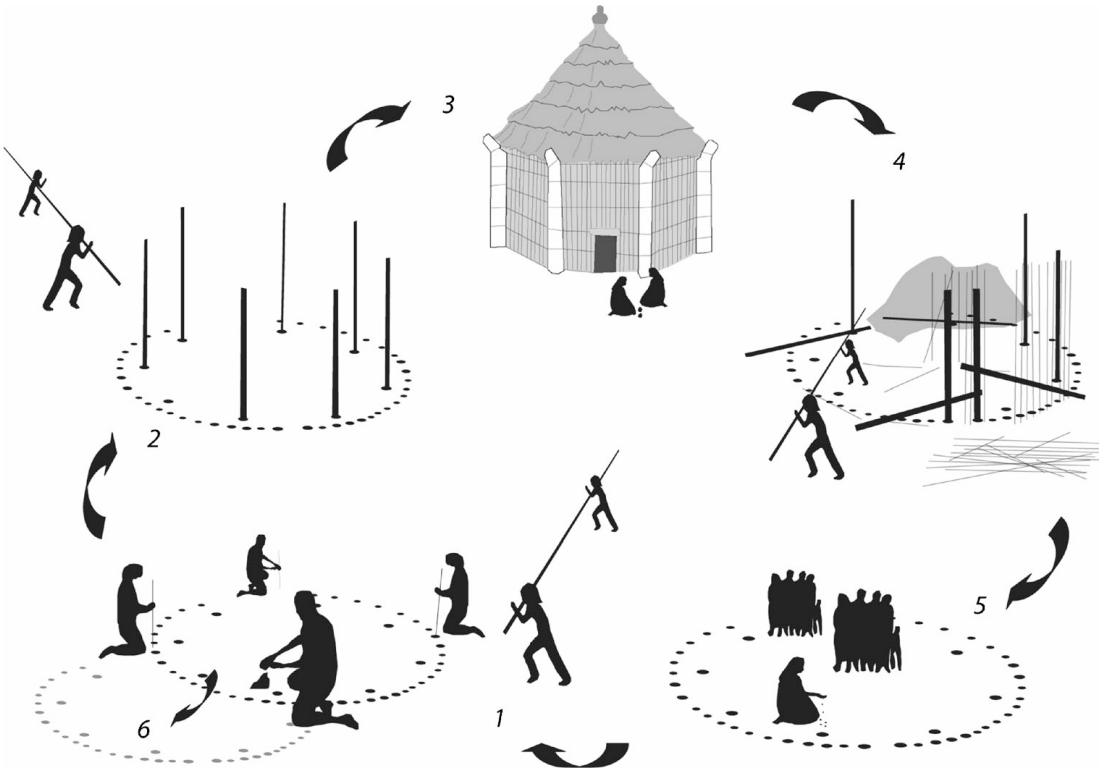
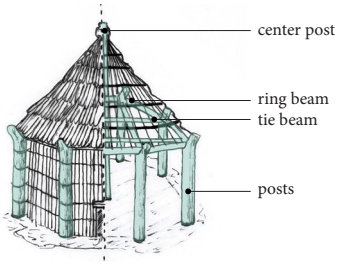
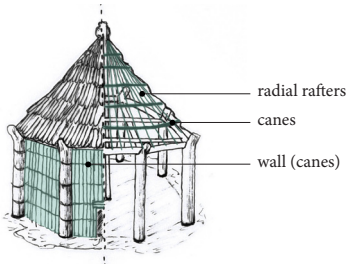


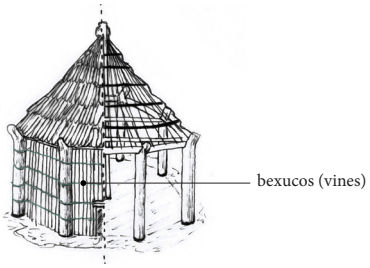
Figure 4: Repair and rebuilding in the lifecycle of a Caney. 1: digging foundations, 2: construction, 3: habitation and cycles of repair, 4: abandonment and reuse of parts, 5: ritual closing, 6: starting anew. (Samson, 2010)



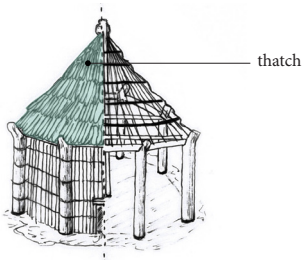
Materials of center post, ring beam, tie beam, posts;
Locally available hardwood (sapadilla, mahogany, guayacan). These durable elements can be disassembled in the advent of a hurricane and can be easily reused in other structures.



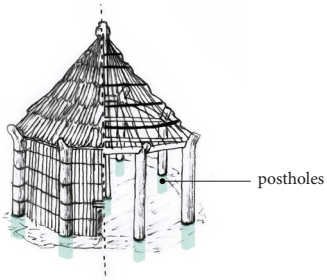
Materials of walls, radial rafters, laths;
Locally available canes. These elements were potentially less durable, but their availability was abundant and renewable.



Connection material;
Locally available 'bexucos;' vines. Similar to lianas. Flexible and easy to cut, does not perish. Acts to fix and bind instead of rope or nails. The avialability of these bexucos was abundant and renewable.



Roofing material;
Thatch could be different kinds of materials; straw, canes, bijao leaves, palm leaves, other materials. Material used for the roof was dependent on the preferences of the builder and on local availability.



Postholes in limestone;
Often the hardwood posts were connected to the ground by excavating a hole in the limestone bedrock. This way, posts could be removed after the lifecycle of the caney and reused in other structures.

Figure 5: The Caney's elements and materials, own illustration.

3.3. Socio-economic advantages: The Ise Shrine, transmitting traditional building knowledge and skills through rebuilding

Japan's Ise Shrine is famous for its thirteen-hundred-year-old reconstruction tradition, the Shikinen Sengu. In the shrine, two alternately used enclosures stand side by side. In an empty enclosure a new group of buildings is made in the image of the existing ones. This renewal process takes place every twenty years and is particularly remarkable for two reasons. First, it has preserved an ancient architectural style in a material that is susceptible to rot. Second, it has also preserved the ancient construction technologies needed to build it. The latter seems to be the most important aspect of the Sengu; the transmission of the tradition to the next generation, with an emphasis on preserving construction technologies (Tange et al., 1965, Adams, 1998).

In her research, Adams (1998) investigates the construction procedures used in the most recent reconstruction cycle and describes the procedures as subdivided in materials, labor, methods, management and rituals. Considering the materials used, they are simple, traditional and locally available, similar to the materials that have been in use since ancient times. Amongst them are hinoki (Japanese cypress) for the buildings, kaya (a reed) for the roof thatch and white pebbles for the ground cover (Adams, 1998).

Ise's labor force is constructed similar to other construction projects; each worker is skilled in working with a specific material and works as part of a group of people having the skills needed to complete the task at hand. Craftsmen represented are sawyers, carpenters, laborers and thatchers. The main group consists of carpenters and are ranked according to experience level. The youngest and least experienced begin by working on the Uji Bridge, which is completed earlier than other construction work and functions to improve skills and experience. They work in small teams called zoebu, each headed by a more experienced carpenter. A group containing the most experienced people work on more complex aspects of the project and advises the lesser experienced groups. Architects are also involved in the reconstruction, but their work is more management than design related. Also, a traditional carpenter learns design skills in his training too, so a greater number of people are trained to participate in design decision making. A unique aspect of the construction is the participation of several hundred thousand unskilled worshipers to perform two ritualized construction tasks; the transport of logs from the forest to the work site and the placing of the pebbles on the ground around the completed buildings (ibid).

Planning of the construction procedures commence sixteen years in advance of the climactic Sengyo ceremony. Trees are harvested and processed into building elements. The selection of the trees is done by the head carpenter, who at this stage already knows which tree will be which building element. Logs are transported to work yards and laid to season, which can take several years. In the milling shed, sawyers cut

them into rough planks. The wood rests until it is time for finishing. In a fabrication shed, carpenters plane the wood to final size and cut the joints. Simultaneously, another team is busy constructing a temporary shed over the building site. Electric tools and gas-powered engines are not allowed on the sacred building site, rendering all finishing tasks manual labor. The wooden structure is installed and the thatchers lay the roof. The temporary shed is disassembled and moved to the next building location, after which the pebbles are ceremonially placed on the ground around the new buildings. Six months after the Sengyo the old buildings are disassembled. The wood is saved for reuse (ibid).

On-site construction work is overseen by the zoecho, consisting of about forty carpenters managed by a team of five men, all of whom are overseen by a general construction manager. A number of subgroups are responsible for various parts of construction, including the beforementioned zoebu. As stated before, the most important aspect of the entire management process is the transmission of skills and technologies to the next generation. The carpenters at Ise do not make elaborate drawings of their work, most of their knowledge is passed on orally. Records consist of written descriptions of overall building dimensions, lists of wood members and their sizes, a rough site plan and a few detailed drawings of decorations. Besides de zoecho, the construction of Ise includes another management group; the zojingu. This organization oversees and regulates the ritual conditions within which the construction takes place (ibid).

What differentiates Ise of other traditional building practices are the rituals that mark more than thirty steps in the construction process. The rituals can be divided in roughly four groups; rituals that marks activities that disturb the natural environment such as harvesting trees, rituals that mark completion of particular phases of work, rituals held when particularly sacred building elements are installed and rituals in which the construction activity has become sacralized, for instance the collective white pebble placement (ibid) (figure 7).

Image 1 (left): using a hand-operated winch for lifting heavy wooden members into place (Adams, 1998). Image 2 (right): trolley for moving materials from the work yard to the sacred building site (Adams, 1998).

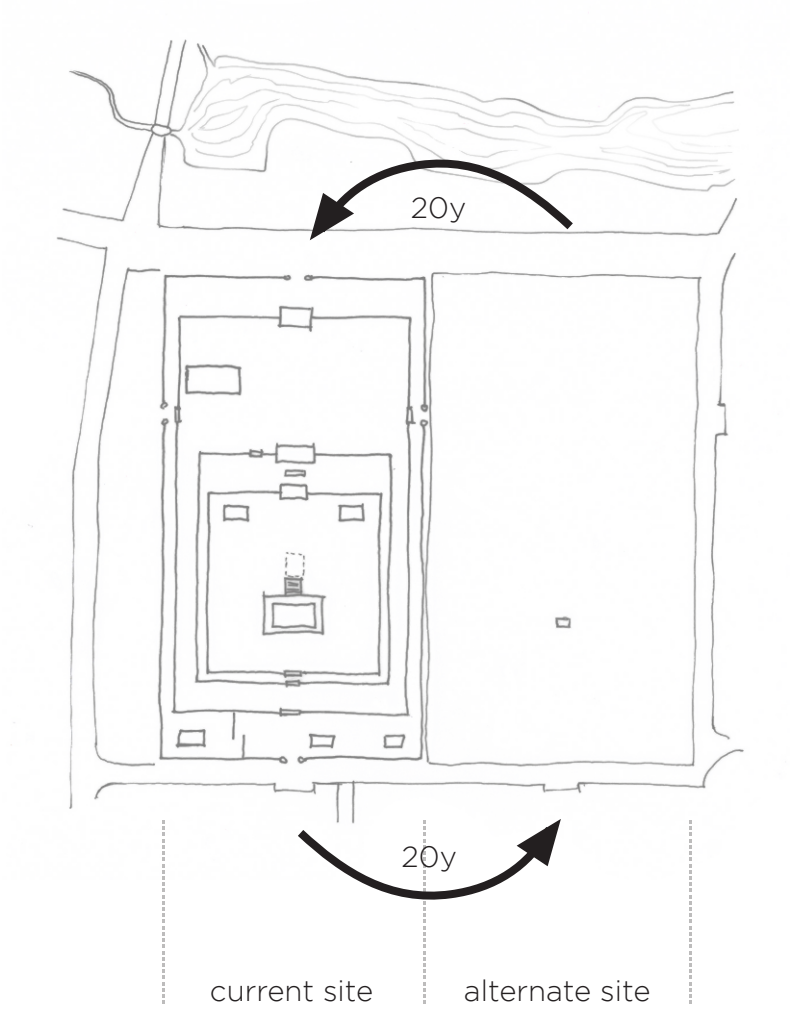


Figure 7: Socio-economic advantage of the Ise Shrine rebuilding tradition; transferring building tradition and techniques every twenty years. Own illustration after (Tange et al., 1965).

4. THE MODERN VERNACULAR OF SINT MAARTEN

From observation during fieldwork, wherein 22 houses were visited, it was concluded that generally there are three domestic modern vernacular types. These are; buildings with a concrete foundation, a wooden structure and a wooden roof; buildings with a concrete foundation, concrete walls and a wooden roof and buildings with a concrete foundation, concrete walls and a concrete flat roof (figure 8). In this chapter, the climate responsiveness, material appropriateness and building knowledge and skill transfer in relation to these types are briefly discussed.

4.1 Climate responsiveness: Sint Maarten

The domestic modern vernacular of Sint Maarten embeds some hurricane proof elements. The more aerodynamic hipped roof with short to no overhang is a characteristic of the modern vernacular dating back to the limestone wood houses described by van Andel (1985). Also, the proper bracing of wooden walls and roof are hurricane proof elements that are observable. Some houses have a verandah, which are meant to not be attached to the main roof structure since the overhang could 'catch wind' and rip of the complete roof. Windows are of a special type, that allow for cross ventilation and can be closed in the advent of a hurricane. Furthermore, especially the buildings that have concrete walls seem to be rather impervious to the characteristic eastern breeze present on the island. From conversation and

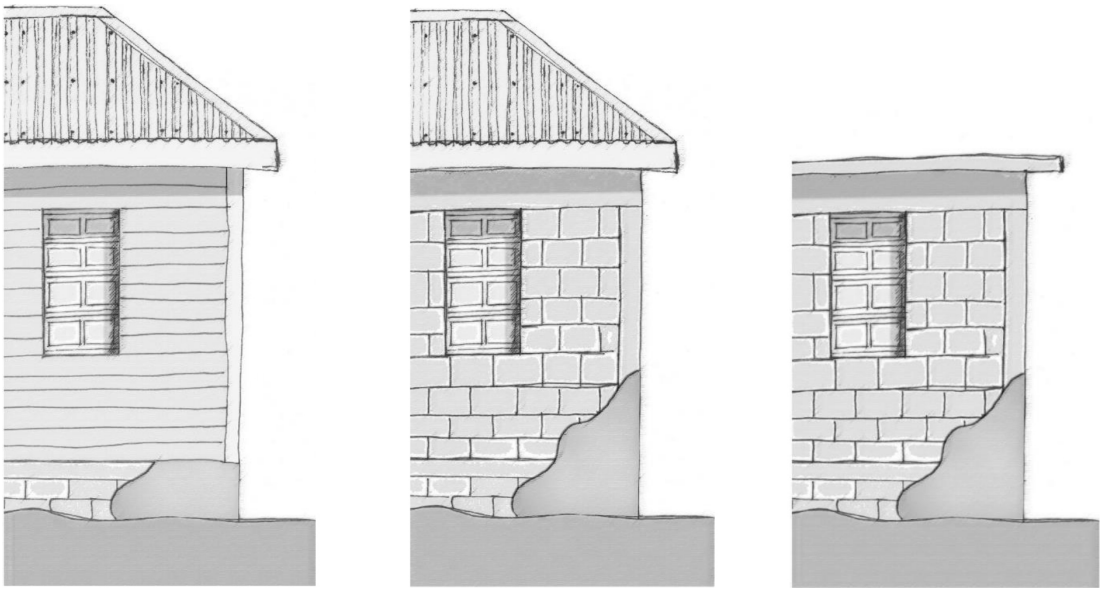


Figure 8: Sketch of the three domestic vernacular types, from left to right; 1. concrete foundation, wood walls, wood roof; 2. concrete foundation, concrete walls, wood roof; 3. concrete foundation, concrete walls, concrete flat roof (own illustrations).

observation, it became clear that building practices focus on the resistance towards hurricanes (and not to earthquakes), resulting in a preference of the concrete foundation, concrete walls and concrete roof-type over the other types.

4.2 Material appropriateness: Sint Maarten

Considering material appropriateness, the use of renewable materials is marginal. Also, all building materials are imported, providing serious logistic issues after hurricane impact. As described above, there seems to be an increasing preference over the full concrete type house due to its seemingly hurricane-resistant capacity, though hurricane-resistance highly depends on the quality of building (specifically of the anchoring, bracings and connections) and not on the material (Vaes, 2019). The Red Cross does not help with constructing concrete roofs for a clear reason; though it is not the most present threat, Sint Maarten is also prone to earthquakes. However infrequent, having a concrete roof could be disastrous in the advent of one.

4.2 Building knowledge and skill transfer in Sint Maarten

Self-building practices are not possible without having certain building skills and knowledge. It is likely that the knowledge and skill is also transferred within Sint Maarten's communities, though conversations with builders showed that often experience was developed during a job in construction on another Caribbean island. There is some skill to build, however, the knowledge on how to build hurricane and earthquake proof or resilient seems to be little and divergent. The lack of appropriate building knowledge is also observable by the low quality of the self-built buildings. Sint Maarten has a vocational school (NIPA), but schooled builders usually find their way to repairing hotels or other buildings for financial reasons (Vaes, 2019). The Red Cross teaches residents of Sint Maarten in need of a job to repair roofs with the Red Cross construction team (Gatóo, 2019). In doing so, the Red Cross is the only party on the island working on getting adequate building knowledge back into the communities and decreasing their dependency on expertise.

5. TRADITION AND MODERNITY

In architectural literature, traditional vernacular architecture is easily adopted as sustainable by definition. In response, Lee and AlSayyad (2011) suggest that it is important to think of the concept of a traditional vernacular in relation to the notion of time, resulting in the question; when is traditional vernacular architecture sustainable? The sustainability principles of the traditional vernacular are often inapplicable in today's context. A deeper reflection is needed about present-day environmental, economic, political and social issues in relation to sustainability and the traditional vernacular. Furthermore, in trying to recover the sustainable aspects of the vernacular, one should be careful not to adopt a copy-paste attitude. Solutions from the past often no longer meet current social aspirations, and put out of context

could be alienating and even ignorant of local climatic characteristics (Piesik, 2017). Piesik (2017) also advocates that countries need to establish a new paradigm for the expansion of their built environment; one that is based on the adaption of their past and the sensitive use of local resources, as well as meeting modern needs and aspirations.

4.2 ATUMICS, connecting tradition with modernity

Similarly, according to Walker et al. (2017) traditions have to change and adapt in order to stay relevant. Transforming tradition means connecting it with modernity. They propose a theoretical model with a product design emphasis, which has potential for architectural projects (figure 9). Practically, one can use the model as a guide in the process of designing a new object (or architecture). When designing something based on tradition, the method can be used to inform the designer which factors should be considered, which aspects of tradition or contemporaneousness could be used, and how to combine traditional with contemporary elements. Artifacts (or architectures) are classified according to six fundamental elements; the technique, utility, material, icon, concept and shape. Technique suggests a production process. Utility refers to the functionality and usability of a product or building. Material refers to the physical matter from which the artefact or architecture can be made. Icon suggests any form of local imagery that emerges from nature, color, myth, people

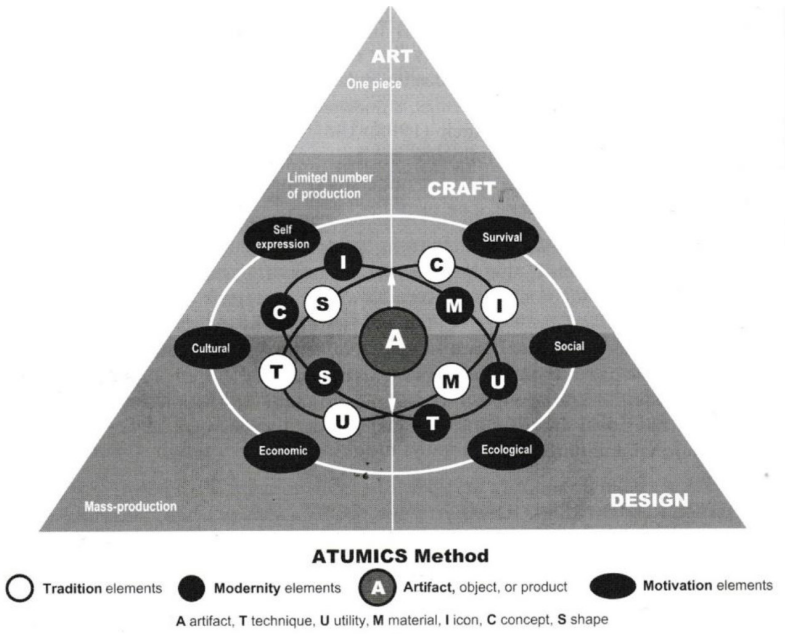


Figure 9: ATUMICS, a theoretical model for merging tradition with modernity (Walker et al., 2017).

or artifacts. Concept refers to hidden factors that exist beyond objects and forms and shape suggests the form or the visual and physical properties of an object. Furthermore, the method helps to clarify the designers motivation, and whether his design would aim at being a one-off project, or a mass produced project (Walker et al., 2017).

To understand this method better it will be used to analyze the work of Hiroto Kobayashi, who borrows knowledge from vernacular solutions in the region and combines this with an efficient modern structural system (Piesik, 2017). Particularly here, a project in Myanmar will be analyzed, the Manawhari learning center, which was constructed in the aftermath of a typhoon and a concurrent flood. The motivation for his work is both social and ecological. Kobayashi aims at restoring the connection between people and the built environment, and believes that people should become involved in the process of construction (Kobayashi, 2019). He uses this method for just several of his works across the world, making his work a craft rather than mass-produced. The project in Myanmar combines a self-built veneer construction with an infill of local woven bamboo mats. Thus, the technique in this project is both modern and traditional. Considering the utility, the function of the building inspired on the vernacular typology of the region is not domestic but public. The utility is thus modern. The material is again a combination of traditional and modern elements. The stilts are now concrete, the structure is veneer, but the infills are the locally traditional woven mats. Considering the icon and concept, they are hard to read from this project. The icon could be the local pattern of bamboo weave for example. The shape is inspired on tradition, since it follows the typology of the regions domestic vernacular (figure 10).

6. CONCLUSIONS

Ryukyu's traditional vernacular takes into account the geo-topographic relation before choosing a site to build upon, and lets wind pass through, therefore making uplift due to wind virtually impossible. Other elements are the use of a coral stone and tree windbreak around the perimeter, a qualitative construction, and a heavy solid roof. Also, houses often consist of one or several smaller buildings, large structures are considered to be less advantageous since they would catch more wind. Sint Maarten's modern vernacular could adopt site strategies, however there is generally a lack of space to build upon, and site motivation is often financial. Accepting wind to pass through a structure could be an interesting design implementation, as well as adding vegetation and other windbreaks along the perimeters of the plots to reduce hurricane impact. Since Sint Maarten's subsoil is not similar to the Ryukyu islands, lowering the foundation level of the building could be problematic in relation to the hurricane's concurrent rainfall. Creating several smaller structures rather than one large structure is advisable.

Figure 10: ATUMICS, applied to the work of Hiroto Kobayashi, who's motivation for merging tradition with modernity is socio-ecological, and his work is not a one-off but also not mass produced, hence a craft. He merges modern and traditional techniques and materials, therewith creating a new architecture, embodying traditional and modern elements (Kobayashi, 2019).

The pre-Columbian architectural mode consisted fully of locally available materials. Structural elements were made out of hardwoods, the walls and roof structure of canes, and the roof material was often thatched with palm, bijao leaves or other materials at hand. As connecting element, vines were used. Postholes were sometimes carved into the limestone bedrock. This mode incorporated a material disaster resiliency; robust materials would survive and could be reused, lightweight elements were allowed to be destroyed for they could be replaced easily. During colonization, this simple technology was misinterpreted as expedient and insubstantial. Sint Maarten's modern vernacular uses natural materials marginally, and is fully dependent on import, but has a rich colonial cultivation history (plantations). Reintroducing means of cultivation (of building materials), this time for local use, could be an interesting design implementation. Also, the sacrificial principle of light weight biodegradable elements could be incorporated in the design of the modern vernacular, as well as more durable and reusable structural members.

The Ise Shrine in Japan is unique for its continuous cycle of rebuilding. This is done primarily for the preservation of traditional building knowledge and skills and shows that, above all, vernacular architecture exists in the minds and skills of the people who create it. Considering the organization of the labor force, the zoucho work on highly skilled projects under supervision of the master carpenter. The younger and less experienced zoubu work under supervision of the zoucho and start with easier projects in order to gain experience. Unskilled, heavy work is done collectively by worshippers. Sint Maarten's modern vernacular building knowledge and skills are considered limited and generally inadequate in relation to the reoccurring hurricanes and earthquakes. Also, if there is expertise, it tends to dissolve into financially attractive projects. The general public could do well with a model for disseminating building knowledge and skills based on practice. In the educational structure of community building, the idea of building renewal in order to learn could be implemented. This could go hand in hand with the relatively high maintenance needs due to the island's harsh environmental conditions. The organizational structure of the labor force could be similar to Ise, divided in unskilled, skilled and highly skilled work, with the appropriate supervision.

Sint Maarten has deviated from the Caribbean architectural mode due to external reasons. Other mode's have emerged and disappeared. Certain elements seem to have survived since colonialism, as the wooden hipped roof and the verandah. The current architectural mode seems to develop in a way loose of any tradition. In attempting to incorporate traditional vernacular elements in Sint Maarten's current building culture, one has to be thoughtful and rethink the principles in relation to the current environmental, economic, political and social situation. Also, traditional vernacular principles have to change and adapt in order to stay relevant. Transforming tradition means connecting it with modernity, for which the ATUMICS model could be a theoretical framework.

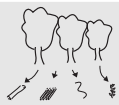
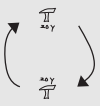
Climate responsiveness		Potential for SXM *low* *high*	*Notes*
1. Consider geo-topographic relation to reduce wind impact			*General lack of space*
2. Allowing wind to pass through structure reduces chances of roof-uplifting			*Consider what happens to interior*
3. Vegetation and other objects around perimeter of plot can reduce wind impact (windbreak)			*Consider tree species, uprooting. Consider workload of stone wals*
4. Lowering ground level in relation to street level can reduce wind impact (soil should be porous)			*Soil in SXM is not porous. Drainage could be made, but might clog easily*
5. Qualitative construction with special attention to anchorings, bracings and connections			*Educate people how to do this*
6. A heavy roof could resist uplift			*Is disadvantageous in earthquakes*
7. Avoid large structures (catch more wind), rather make several smaller structures			*Possible, but lack of space could be problematic*
Material appropriateness			
1. Material availability; try to use local (regional) renewable building materials			*Consider cultivation potentials, consider regional renewable materials, consider durability / preservation*
2. Consider sacraficial, easily replacable elements. Consider more durable, reusable structural members.			*Consider what happens to interior if elements are sacrificial. Consider what happens to these sacrificial elements*
3. Consider a process of communal rebuilding (or repairing).			*Could go hand in hand with maintanance needs*
Socio-economic advantages			
1. Consider the perpertual rebuilding of structures			*Could be way of disseminating knowledge and skills*
2. Consider a division in work related to task-importance and difficulty			*Could be communal strategy*
3. Create a stategic setup to advice less experienced how to build (mostly based on practice, not theory).			*Consider who would be specialists, and how they would relate to other builders*

Figure 11: Conclusions (own illustration)

REFLECTION

The methodical line of inquiry of the studio can be defined by extensive research, followed by design (figure 12). In the MSc3, the focus is mainly on both thematic and overall research. At the end of the MSc3, you have to present a concept-design. I experienced that in the extensivity of the research, the design can become of minor importance, while it is very good to already think of a design in an early stage. Nevertheless I have followed the methodical line of inquiry of Architectural Engineering.

I have conducted a clear thematic research, presented in a scientific paper, with the title; 'the vernacular as example' which described how traditional vernacular architectural principles can improve the building culture of Sint Maarten. Writing the paper, I discovered four sustainable vernacular principles; *material appropriateness, climate responsiveness, socio-economic advantages and adaptability*, of which I researched cases. The thematic research helped me enormously in defining a problem statement and an objective. It made me realize that the problems on Sint Maarten are more deeply rooted than just having to deal with hurricanes and earthquakes. I have never encountered such a complex historical and ethnographical situation as on Sint Maarten. I discovered that the building culture became dependent on import of skills and materials since 1631, when the Dutch occupied the island and brought their own bricks and masons to build with. I also discovered that the architecture of the then indigenous of the island was highly specialized in relation to the environment and embodied socio-economic advantages, but the colonists interpreted the architecture as inexpedient and insubstantial. Furthermore, remnants of the salt- and plantation history of the island are strongly visible in the ethnography; former slaves have settled on Sint Maarten, and though slavery was abolished in 1863 they still seem to have to deal with their history of suppression. Lately, local migration resulted in a mixture of various ethnographic groups on the island, who meet but do not mix.

During the fieldtrip I gained a good understanding of the local reality. What has especially formed the thesis project is the days spend together with the Red Cross, where I gained some insight in the living conditions and needs of the more vulnerable residents on Sint Maarten, and in a way confirmed the theoretical problem statement that I was defining in my thematic paper. The Red Cross days also gave me contacts that I could visit personally, and so I have conducted formal and informal interviews with residents, builders and a restaurant owner/farmer.

Furthermore, next to the thematic research, my overall research is manifold (figure 13 & 14). Generally, I enjoy doing research. The extensivity of the research can result in good arguments for design decisions, but I've also experienced that when the field of information increases, it becomes harder to connect the right ingredients to the right design. At some point the amount of information becomes confusing, rather than concluding.

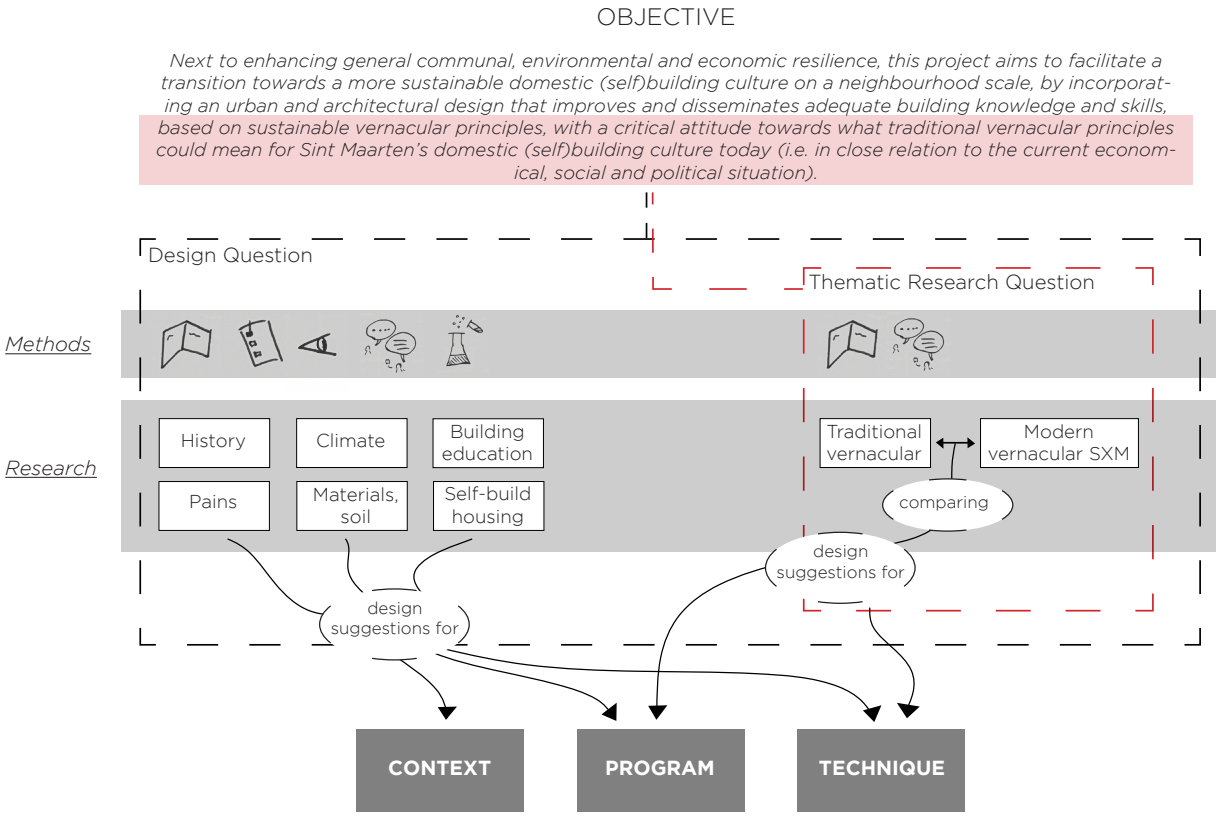


Figure 12: Initial methodology to arrive at the context, program and technique of the design (own illustration)

Motivated by the core sustainability aspects of traditional vernacular architecture that defined the objective of my design; *'how can an urban-architectural intervention stimulate a transition towards a more sustainable domestic (self)building culture?'* I initially came up with the idea to start a bamboo plantation on a former sugar plantation. The products that the production environment would produce could then be used for upgrading the surrounding slums. I took the timber network from Yoshiharu Tsukamoto & Momoyo Kaijima of atelier Bow Wow as main example. However, after a while I felt like I was too much focussed on production and logistics related aspects, thereby creating a new monoculture of bamboo instead of the previous sugarcane on the plantation. Also I was overseeing the multiplicity and variety of the people the intervention could relate to. I was quite confused for some time on how to integrate all aspects that I was researching and desiring. Mo Smit helped by steering me towards the sugarcane production ruins that are present on the plot, therewith showing aspects of the public production park on a smaller scale, and making it more comprehensible in this way.

In the end I have incorporated socio-economic and environmental sustainability in the Bethlehem park. The public park connects to both tourists and surrounding communities. A path connects the different clusters of program, and can grow in a similar way as a rhizome (root system of poaceae) grows. Material appropriateness is acquired by cultivating building materials, that acts as a carbon sink. Climate responsiveness is acquired by showcasing how the architecture in this location can be climate responsive. Socio-economic advantages are realized by incorporating cultivating and building education in the program, the main building that I have designed is a school were local workers and residents can learn how to build with the materials that are cultivated and harvested in the park. All in all it is a social network inside a heritage framework, that stimulates a transition towards a more sustainable domestic (self)building culture, and adds value to the surrounding neighbourhoods. What was once a place of exploitation, is now a place of ecosystem service, providing public space, education, social bonds, materials and economic diversification for the surrounding areas.

In relation to the themes of Architectural Engineering; make, flow and stock, I feel like I am mostly related to the make. The thesis project showcases a communal and low tech way of building, build from natural materials in a climate responsive way. I have found a resilient strategy to deal with the hurricanes, based on the idea of sacrificiality that I understood from the pre-Columbus architecture. I perceive this as a highly valuable solution, since the lower (or lowest) social classes often do not have the financial means to build in a completely resistant way.

Globally, having lost a local building language that is adequate in terms of material use and climate response and having socio-economic advantages, is a problem that many countries that dealt with colonialism (and later modernism in the advent of the industrial revolution) encounter. This makes the results of the graduation perfectly transferable in the scientific field, though one will have to take into account the genius loci of the location of the intended design. In relation to the current climate crisis, interventions similar to bethlehem can stimulate a transition towards a more sustainable building culture in terms of material use, climate response and socio-economic networks. I believe a lot of ground is to be gained here, especially in the developing countries that often perceive modernism as an ideal to strive towards, while overseeing the potential of their (ancestors) local and often specialized building cultures.

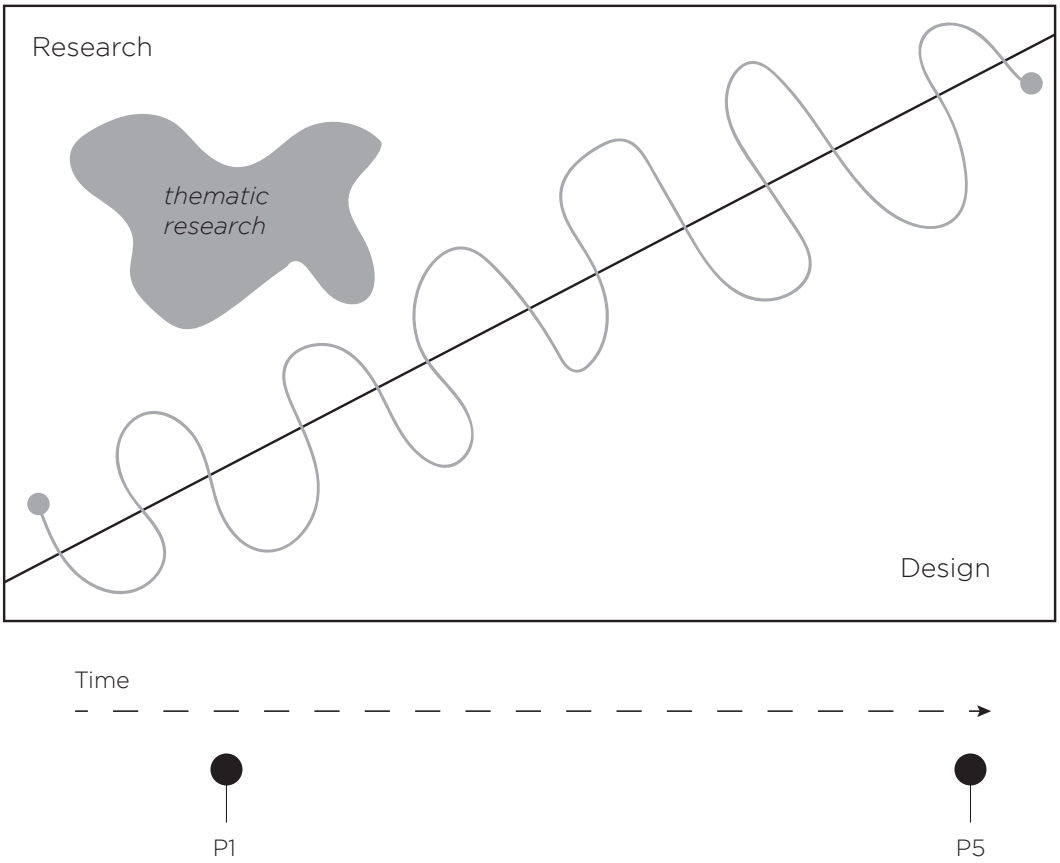


Figure 13: Methodical line of inquiry AE; Msc3 = focus on research and less on design (thematic research as an island within all the research), Msc4 = focus on design and less on research. There is always a relation between the two.

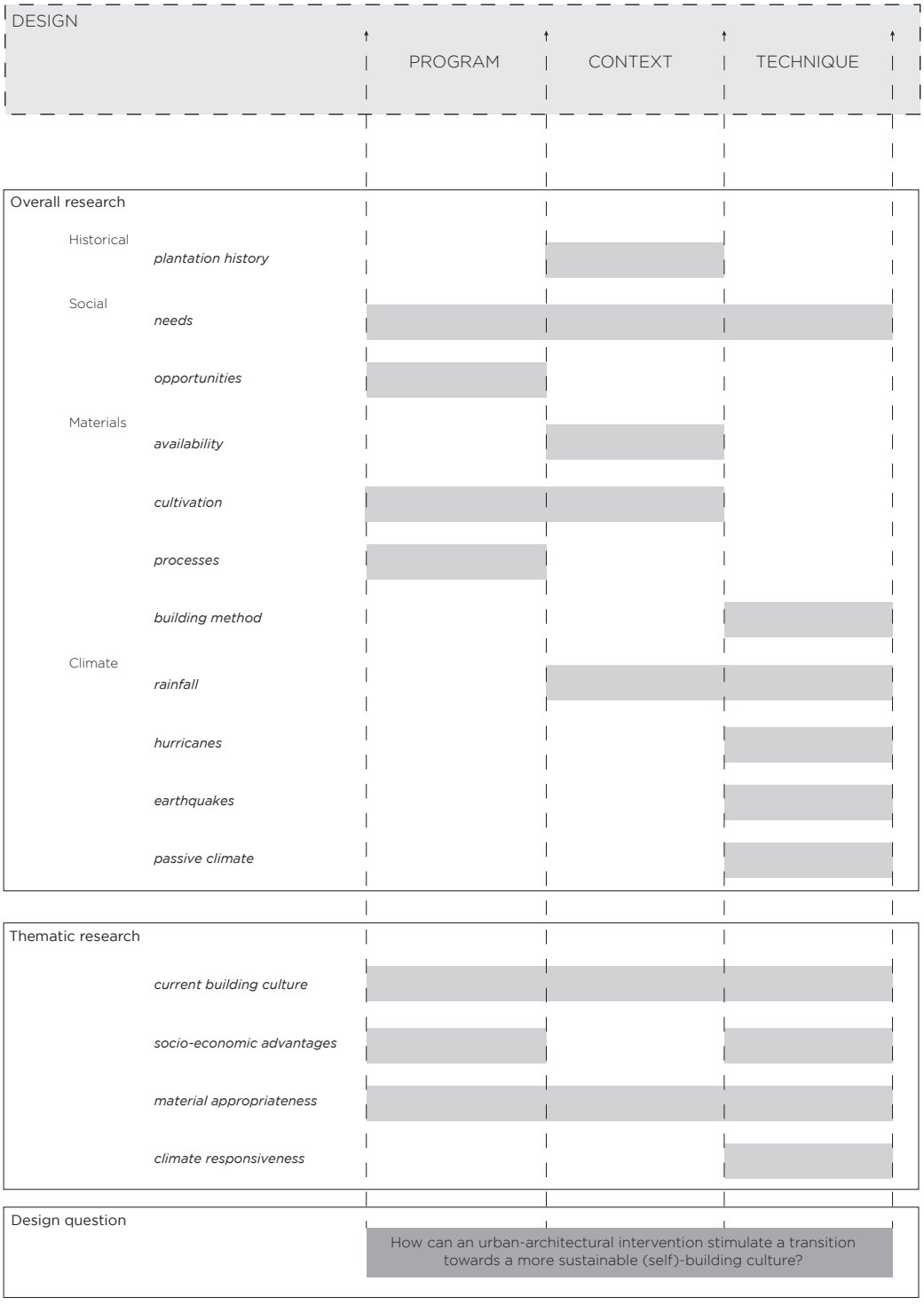


Figure 14: The layers of the research in retrospect. From design question to design. Filled in which research aspects influenced program, context, technique respectively. Read from bottom to top.

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