2017

Tanzania Collaboratory 2014-2017

Thomas Fowler, IV
Kevin Dong

Tanzania Design Collaboratory

2014-2017

CAL POLY

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architecture
ARCHITECTURAL ENGINEERING

Thomas Fowler
Kevin Dong

2014 – 2017 Design Collaboratory

College of Architecture and Environmental Design
Cal Poly, San Luis Obispo, CA

Introduction

The work in this publication is a summary of ongoing work that started in 2014, when architecture and architectural engineering students starting developing the master plan for the proposed Polytechnic University in Samé, Tanzania, Africa, working directly with ARUP's David Lambert and the MBESESE Initiative. Since this time we have had 60 plus graduate and undergraduate students who have provided research and design input into the development of this project.

This work from 2014 – 2017 provides an update to the master plan and building designs for the Polytechnic University, along with proposed hotel designs have been developed for another location in Karatu, Tanzania the location of Ngorongoro, a World Heritage Site and popular tourist attraction for safari tours.

The Design Collaboratory is an award winning (NCARB Prize, Auto Desk Grant and national student design competition recognition), multi-disciplinary group of undergraduate and graduate students, and faculty (from architecture and architectural engineering, joined occasionally by planning, construction management and civil engineering), that work directly with industry partners in developing building design projects. Professsors Dong and Fowler have collaborated on these types of projects, which use interdisciplinary student groups, for more than 10 years. They bring more than 30 years of professional expereince which provides avenues for insightful research and innovative design proposals, and leverage approximately 40 years of teaching experience to mentor and enable students to create holistic design solutions.

Sincerely,

Professor Kevin Dong
Professor Thomas Fowler

Professor Thomas Fowler, DPACSA, NCARB, AIA

The Director of the Graduate Program of Architecture and a Professor of Architecture.
Thomas' teaching responsibilities include third and fourth year design and building technology courses, working with a range of four and fifth year independent study students and has been co-teaching as part of the Collaboratory Building Design Studio since 2007.

Prior to beginning his teaching career at Cal Poly, Thomas worked with a range of architecture firms in New York City and Washington, DC for over a 13 year period. His work was highly collaborative with a range of disciplines on small to large scaled building types.

Professor Kevin Dong, PhD, SE

The Associate Dean of Administration of the College of Architecture and Environmental Design and Professor of Architectural Engineering.

Kevin's teaching responsibilities range from 2nd year technology classes through graduate structural systems and seismic engineering courses, and has been co- teaching the Collaboratory Building Design Studio since 2007.

Prior to beginning his teaching career at Cal Poly, Kevin practiced holistic design with Ove Arup & Partners (ARUP) for 13 years, starting as an Arup Fellow in London and then moving to the San Francisco office. During his tenure with ARUP he worked on numerous projects nationally and internationally that required collaboration and integration of all disciplines from design inception through construction and occupancy.

Contents

2014/2015 Karatu Hotel

The site for the project is located in Karatu, Tanzania

folding savanna

team 01

Augustina Radziunaite
Huu Nguyen
Gina Kope

Augustina Radziunaite
Vilnius, Lithuania

Interdisciplinary team work was most definitely a new experience for me and I believe a valuable one. It provided me a chance to get out of the strongly restricted design process I have been following as a working professional during the past few years.

Huu Nguyen
Fresno, CA

The design process behind the graduate design studio helped me in bridging the gap between Architectural Engineering and Architecture by providing an opportunity to experience first-hand a development approach that challenges more than just technical ability.

Gina Kope
Arroyo Grande, CA

I have valued most the perception that I have gained when working alongside others in separate fields of study. Through interdisciplinary work and collaboration I have gained an insight that has allowed me to consider all aspects of building design. I have found this knowledge to be crucial in the development of an efficient, elegant design.

Folding Savanna

Roofscape of Textiles

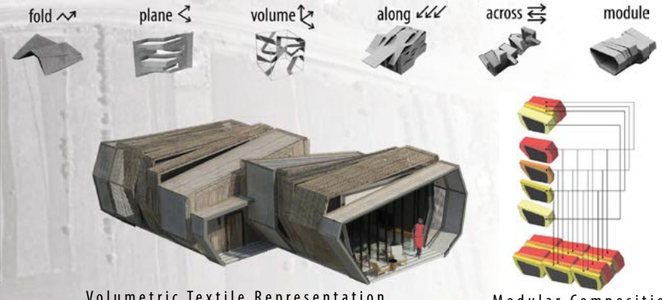
Main Hotel Resort Entrance

The team has developed a design proposal for a new Hotel Resort located just outside the town of Karatu in Tanzania, Africa. The program will consist of 30 private hotel bungalows on the south side of the site, providing both single and double unit options, in addition to the main hotel space, which includes the lobby/welcome center, functioning as the central communal hub for the site. The goal of the project is to provide a destination that will allow visitors to engage with the neighboring town and embrace the diverse culture of Tanzania. Utilizing the highly graded landscape, the geometry of the frames mirrors a folding motion, forming volumetric geometries for the roof-scape. Variable angles and widths provide dynamic interactions throughout the site while capitalizing on the existing surroundings, further enhancing the visitors' experience.

Karatu, Tanzania

5 km

Site Plan

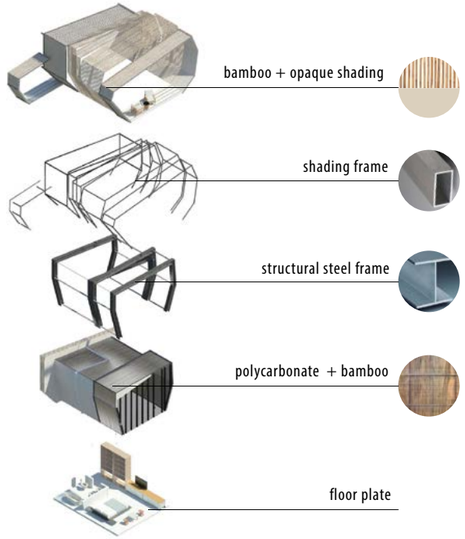


Volumetric Textile Representation

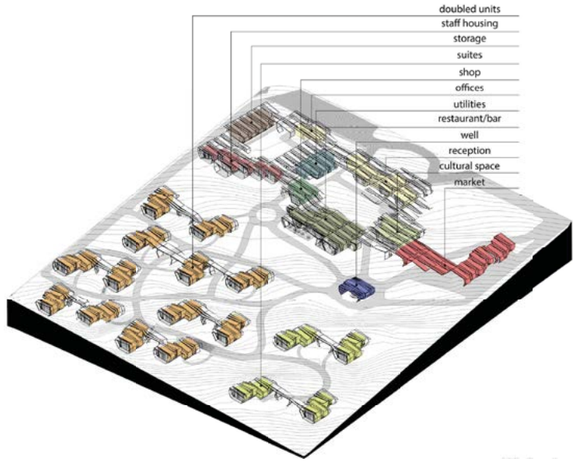
Modular Composition

Presentation Board 01

Daily Public Market



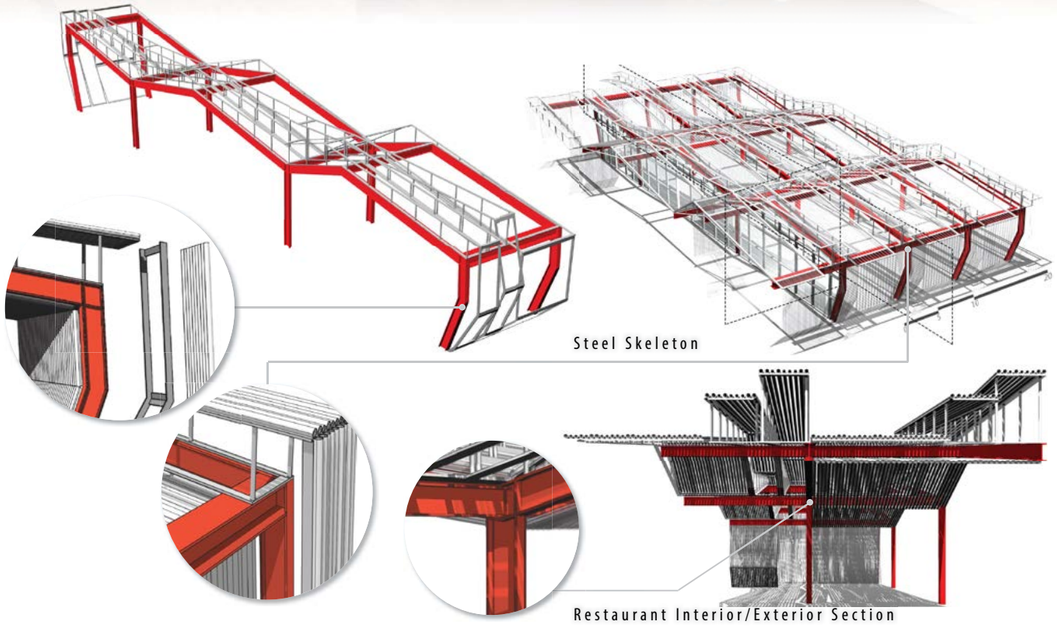
Building Components



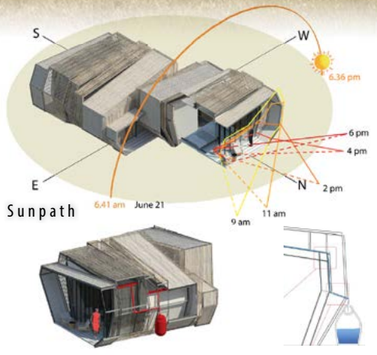
Programmatic Site Plan

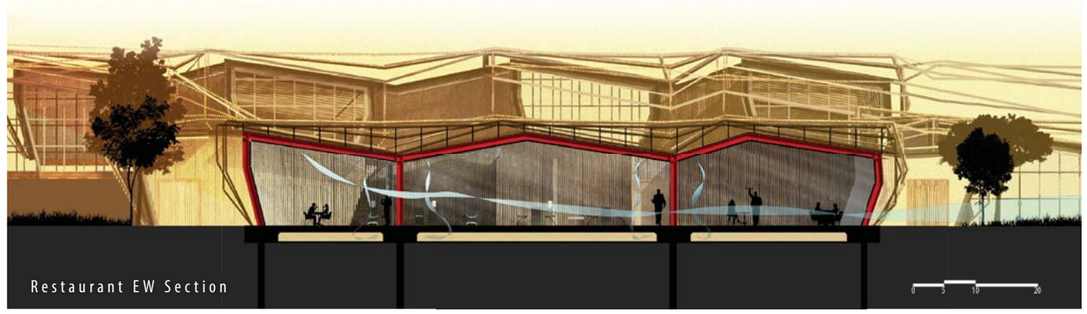
Site NS Section

Presentation Board 02



Presentation Board 03





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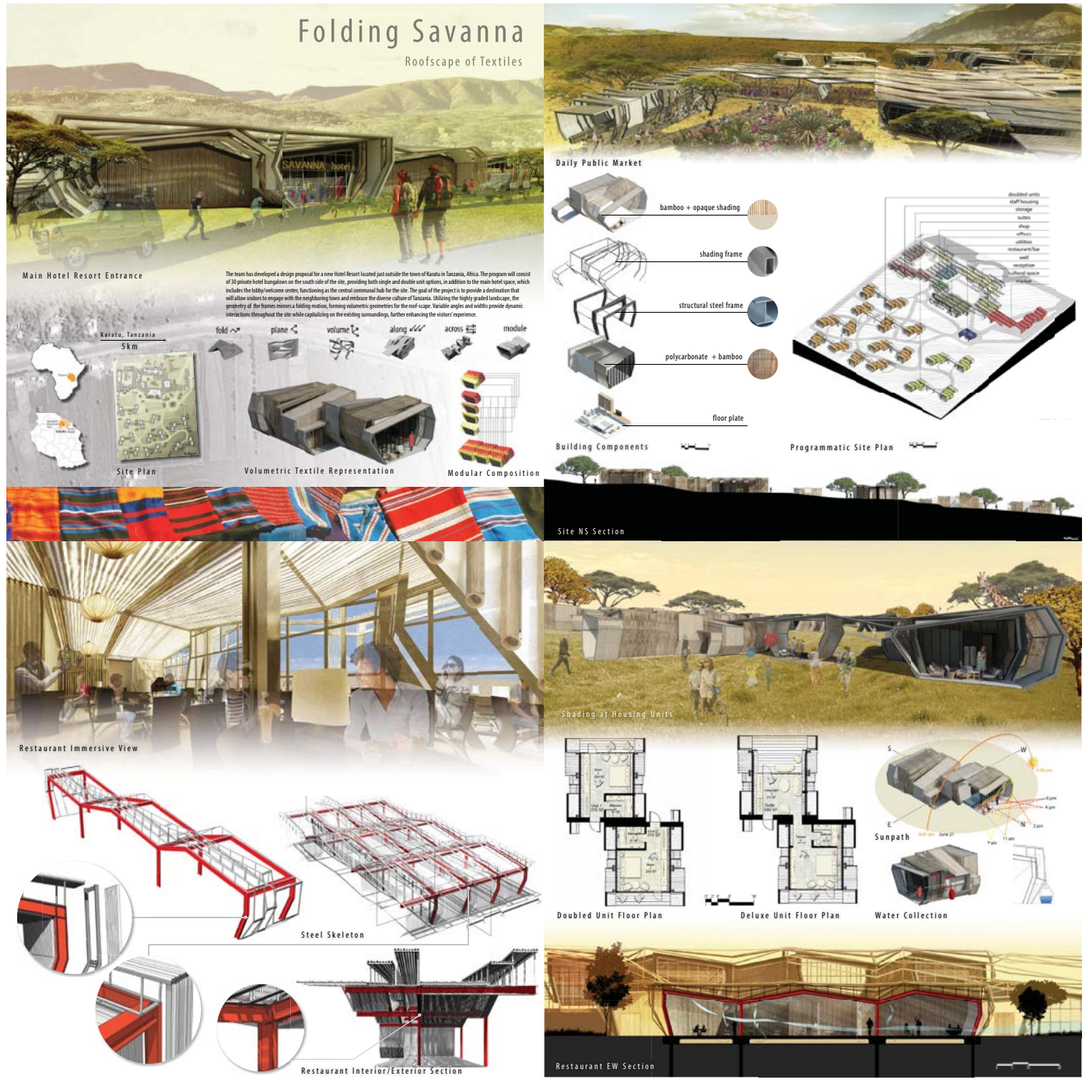


Presentation Board Summary

Folding Savanna

Roofscape of Textiles

A Hotel Resort proposal focuses on connecting locals and visitors through common activities in large shaded multipurpose areas. The conceptual module of the complex reminds of a striping pattern reflected in local fabrics. Building systems have strongly shaped design decisions and outcomes.

location: Tanzania, Arusha Region, Karatu

concept: The main intention was to house visitors and cultural activities while providing enough of indoor and outdoor shaded spaces. An initial "folding" design approach was developed into four main external and one internal shapes to create a vibrant exterior shading structure while maintaining unified and functional interior space.

structure: The lateral forces are resolved through the frame action. Structural frame encloses a unified interior spaces. The exterior shading frame is patterned by four repetitive shapes and offset from the structural frame with perpendicular truss elements.

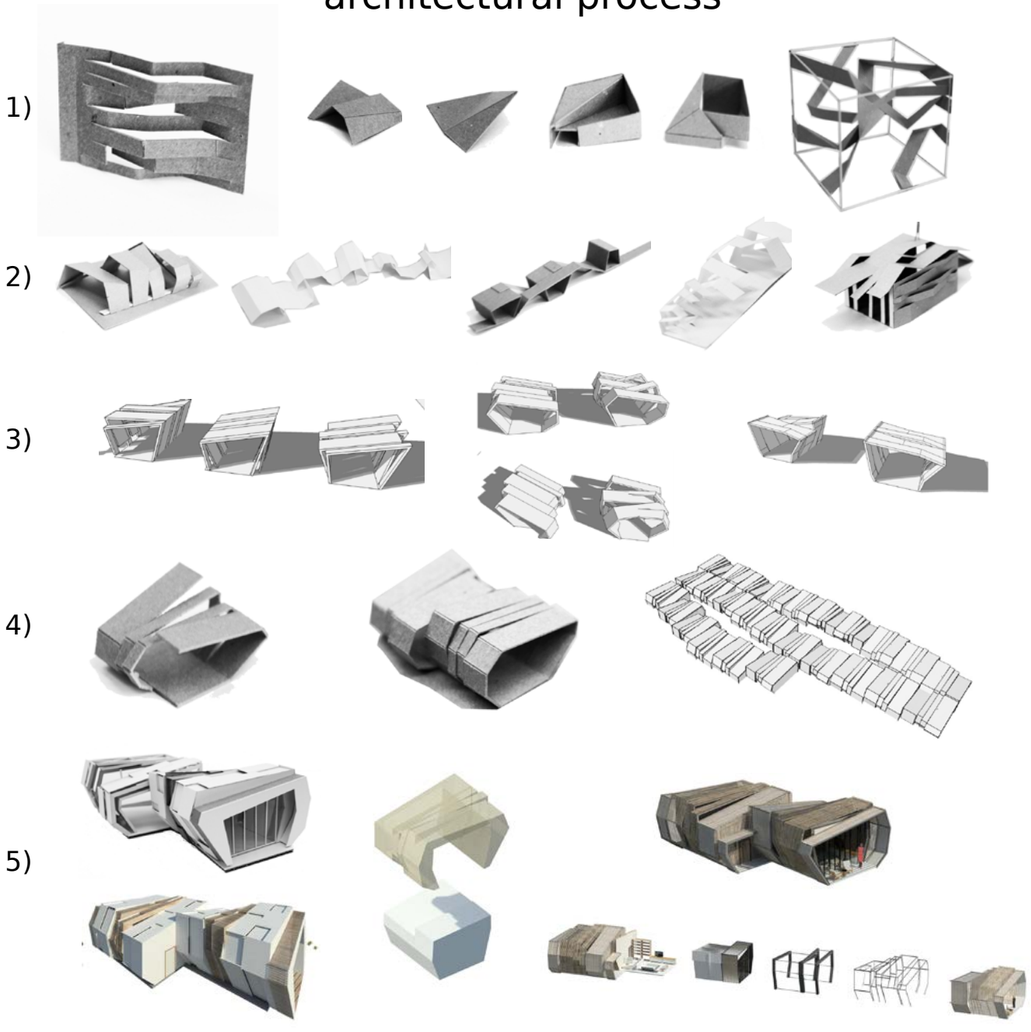
Main cladding materials are polycarbonate panels for the walls and corrugated translucent FRP panels for the roof layered with local clay plates and bamboo louvers to control the light (from completely opaque elements to filtered light areas depending on the functional and aesthetic need).

shading design: Multiple daylight control strategies included shading within the module itself (functional double layering), isolating light from east and west sides, creating additional shading for gathering on the exterior. Strategic placement of the trees and other greenery accumulates even more coolness crucial throughout the day.

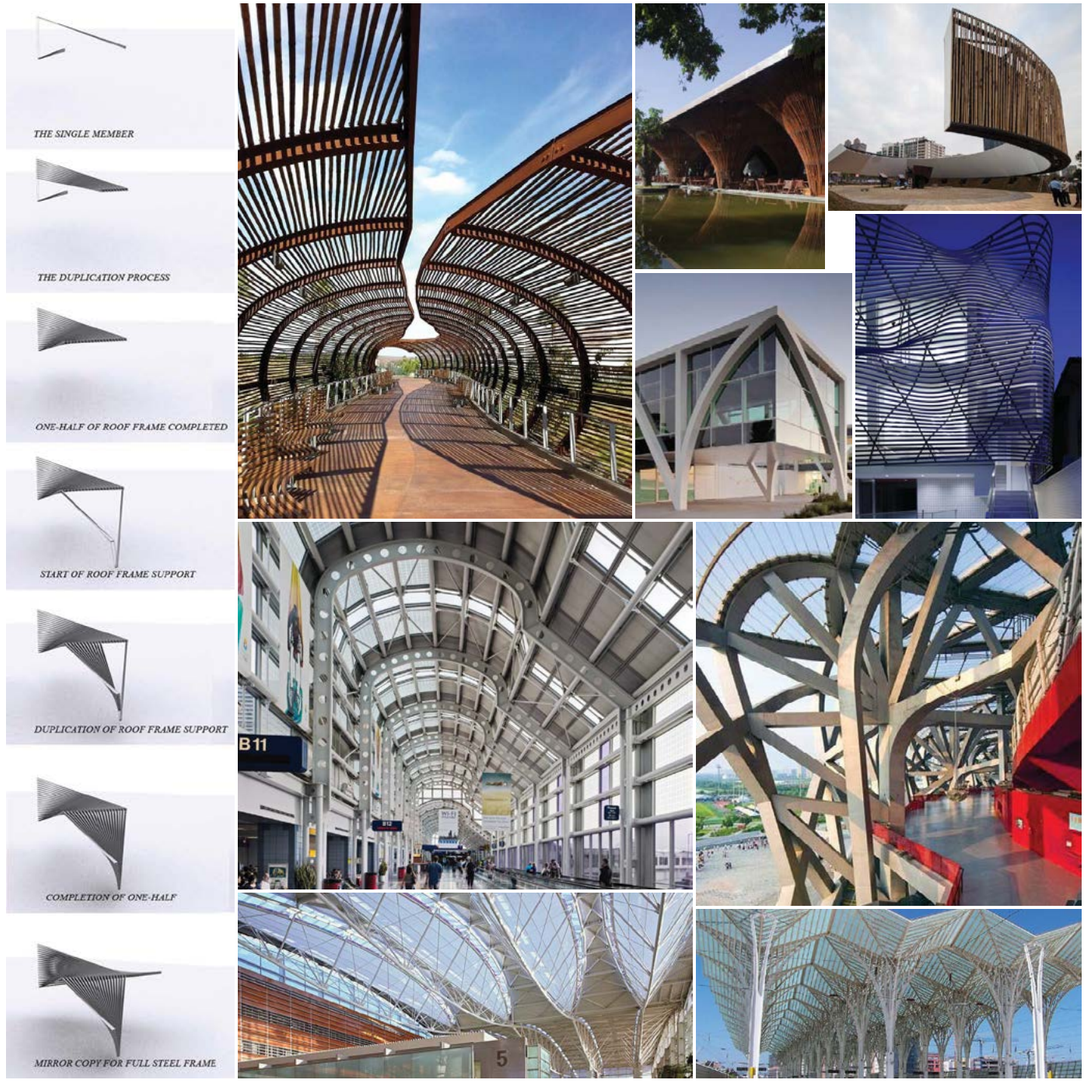
passive ventilation: Buildings were strategically placed to catch prevailing south eastern wind and use it for fresh air supply. In addition, natural difference of landscape grading was used to create cold air pocket under the building and move it vertically towards the heated roof. The air enters the building through louvered panels and operable openings.

water collection: Rain water collection was addressed through the roof slopes, duct system and landscape grading directed towards multiple water tanks. Moreover, several bio swells were incorporated in garden areas to facilitate agricultural activities.

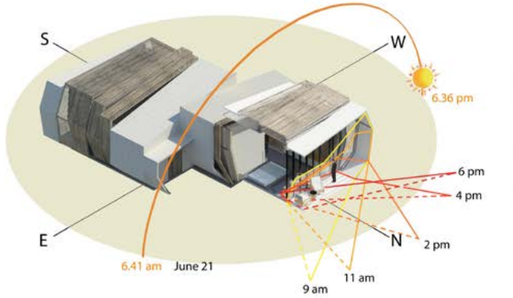
architectural process

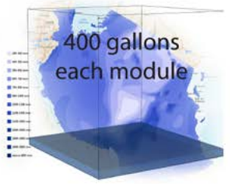


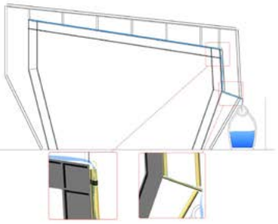
Architectural Design Process Summary

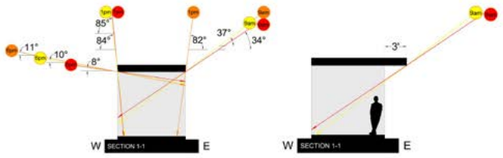


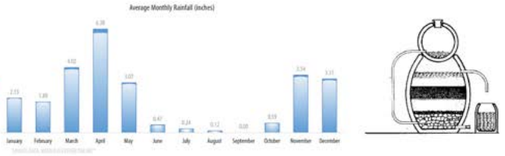
Structural Design Process Summary

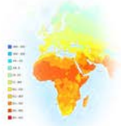


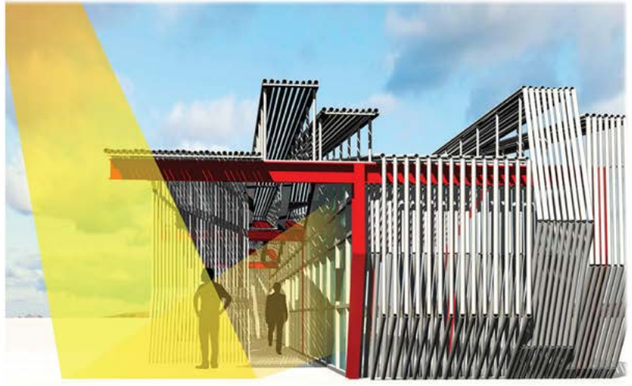


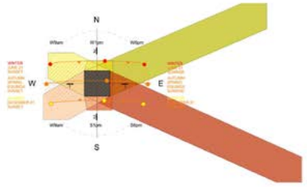


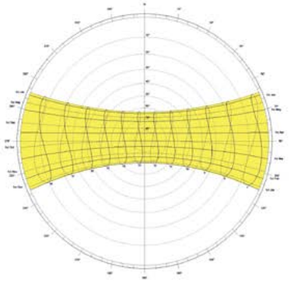




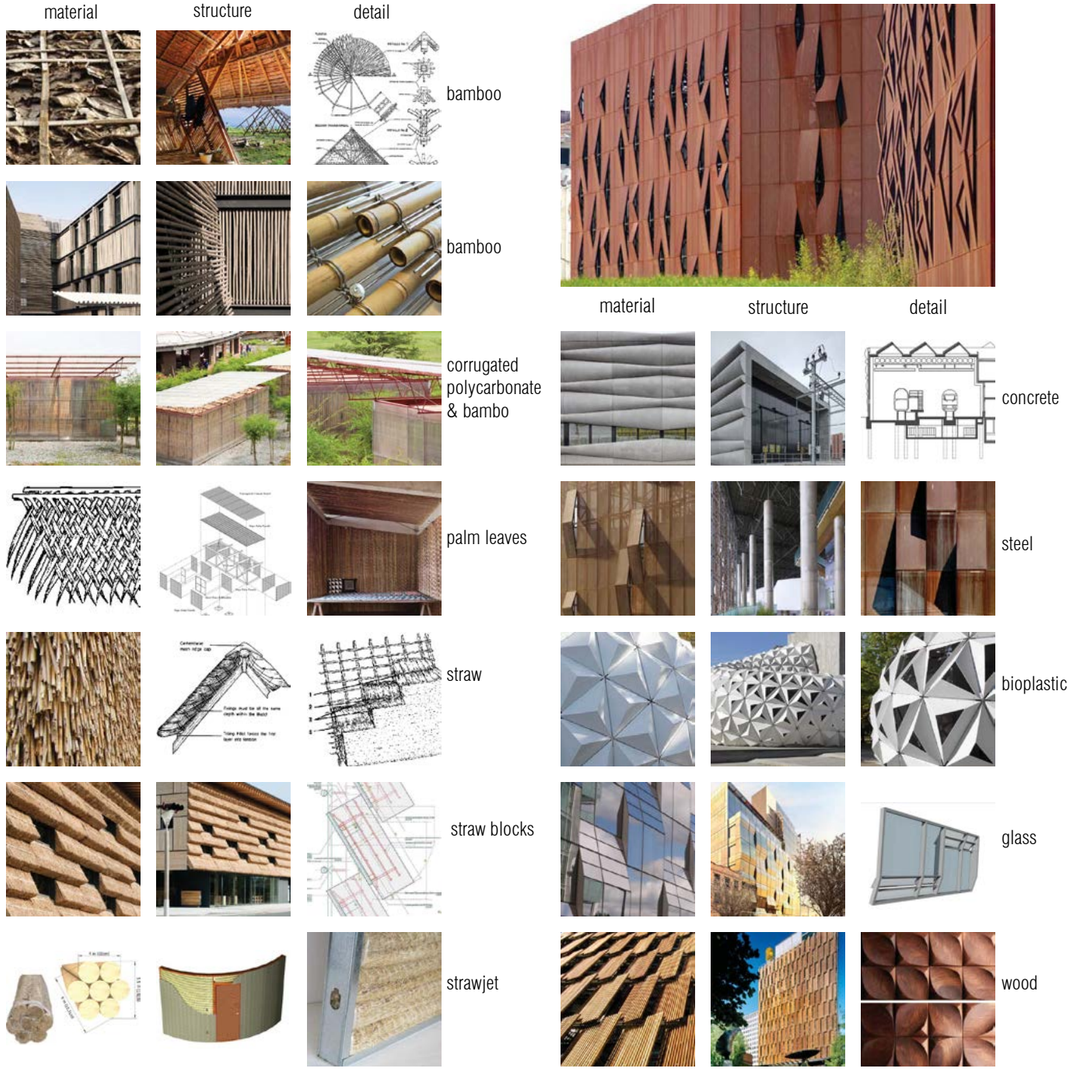








Environmental Precedents



Material Precedents

Project Models

Augustina Radziunaite

I learned: 1) Team work 2) Time management 3) Non contextual idea development
Huge work load as well as requirement to work as a team have definitely contributed to this learning. It was the first time in my life developing a totally unrelated idea with a hope that it may turn into something valuable.
The advantages of the interdisciplinary studio are:
I think I have a better understanding about engineer's work flow. As an architect I can definitely apply that to my structural thinking and incorporate some steps in an initial design.

Huu Nguyen

I learned to create project goals for myself instead of waiting for them to be given; I learned how to stand between two very opinionated minds and find common ground in the interest of forward progress; and I learned how to concisely present convoluted information. I think the open nature of the assignments contributed to my learning, though without proper encouragement (maybe there's a better word here) this kind of laissez-faire instruction can have the opposite effect. Maybe a focus on getting students to "think for themselves" early in studio would help in the later stages.
Being in an interdisciplinary team configuration helped me in conveying my ideas to someone without a similar background; it forced me to convey my thoughts in a way that anyone could understand.

Gina Kope

The top 3 things I learned from this studio experience:
(1) The design process is always adapting and changing and that the critique from the instructor and other students is meant to help with growth by addressing what is not working in the project. I have learned to develop a tough skin with criticism and organize the key take-away items from each meeting to further develop each stage of design.
(2) Working in groups takes patience and a strong voice. Communication is key in this setting and although your idea may not be the one that is agreed upon, it is valued as a part of moving forward in the design and is required for discussion on key issues that must be addressed.
(3) The structure of the course is not meant to frustrate you, it is meant to allow for freedom in design and not hinder creativity.

This interdisciplinary experience has exposed me to viewpoints and concerns that I would not be aware of had I been in a class with only engineers. This quarter I was able to work side by side with students that have been exposed to an entire undergraduate education in design and observe how they analyze a building and their concerns. This includes how individuals experience an indoor and outdoor space, how materials are chosen and how a space functions with certain layouts. I am now aware of how to manipulate a site in a way to address circulation, while highlighting important communal areas and distinguishing those for private use.

truncated icosohedron hotel

team 02

Angelo Freeman
Marketa Jelinkova
Charles Weir

During my time in the Arch 551 Studio, I learned firsthand experience working with students with a vast amount of knowledge regarding building structure. I learned the importance of developing a structural system alongside an architectural one, in order to create an integrated building system within a harsh environment.

Angelo Freeman
Linden, CA

I got better at making physical models and I learned to use my time more effectively while doing so. Also it was very helpful for realizing that a design process has many aspects to be aware of, such as ventilation, water collection, shading etc.

Marketa Jelinkova
Ceske Budejovice, Czech Rep.

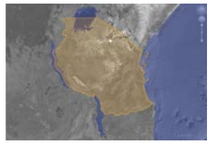
The building design process from this Tanzania Project has given me valuable experience in prioritizing my efforts during the process of developing ideas without any sign of completion on the horizon. The interdisciplinary experience has provided me with insight into aspects of the project deliverables that would have previously gone overlooked and unappreciated.

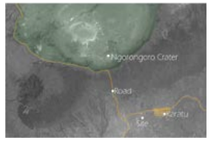
Charles Weir
San Mateo, CA

THE TRUNCATED ICOSAHEDRON HOTEL

A RESORT & LODGE - KARATU TANZENIA.

LOBBY APPROACH





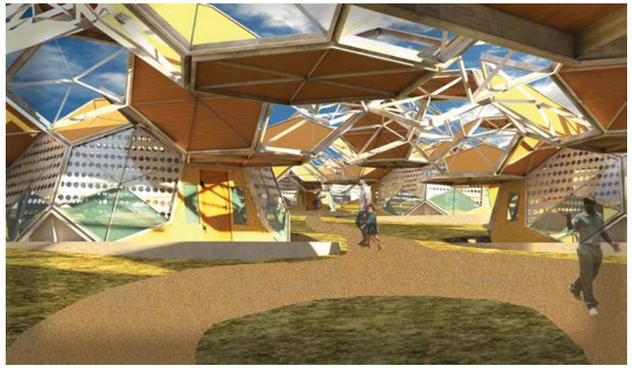
SITE LOCATION

Beginning as a study regarding the modularity of flattened steel rings, our project has finally culminated into the shape of a truncated icosahedron, as an evolutionary stepping stone between circular rings and rigid polygonal shapes. With the addition of structural rigidity, the shift into polygonal shapes aided us in the creation of a modular design, that repeats and completes itself throughout the site. Attaining our original goal of complete modularity, we have massaged our design to the point where our building's entire structural skeleton will be able to be built utilizing mass manufactured amounts of only 15 different individual pieces.

Born of both structural and architectural minds, our building's substructure has been designed both as a means of increasing our buildings rigidity, as well as opening the doors for endless architectural possibilities. Not just cladding as a means of cloaking the structure, our building exudes both heaviness and grace, as large steel members float above and shade residents of the hotel.

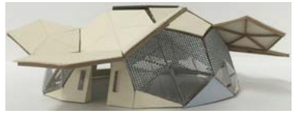
PROCESS MODELS

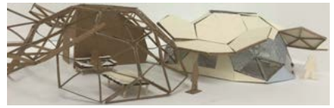
SOUTH EAST SITE VIEW



MOTEL CIRCULATION

Presentation Board 01





CLADDING AND COLUMNS

SOLAR PANEL

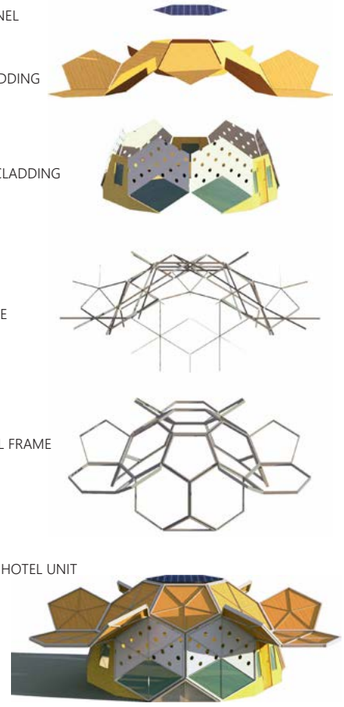
ROOF CLADDING (WOOD)

EXTERIOR CLADDING

SUB-FRAME

MAIN STEEL FRAME

COMPLETE HOTEL UNIT



SOLAR PANEL

ROOF CLADDING (WOOD)

MAIN ROOF FRAME

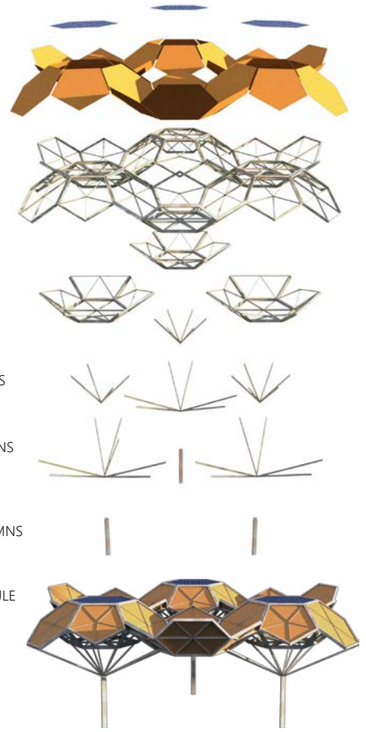
MIRRORED SUB-FRAME

STRUCTURAL COLUMNS

WATER COLLECTING COLUMNS

WATER STORAGE COLUMNS

COMPLETE LOBBY MODULE



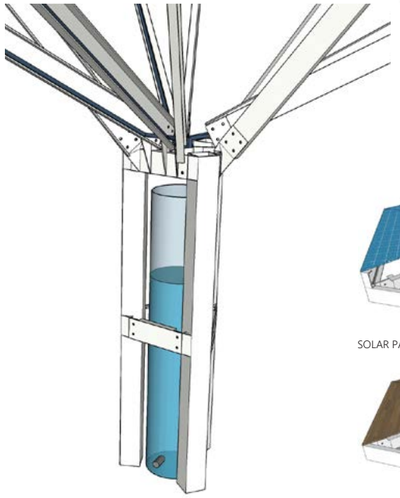
HOTEL UNIT (CLADD AND UNCLAD)

BACK OF HOUSE COLUMNS

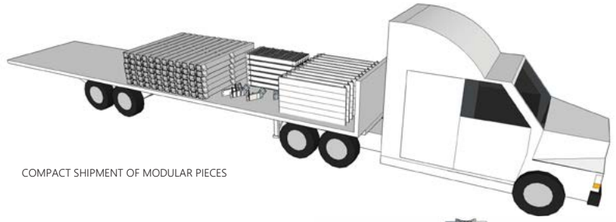
COLUMNS OF LOBBY

Presentation Board 02

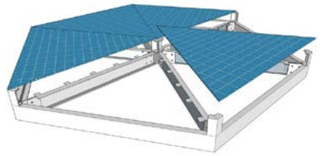
CLADDING AND CONNECTIONS



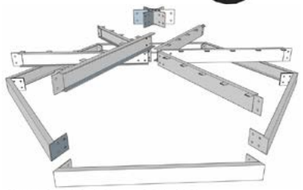
LOCALIZED WATER COLLECTION AT COLUMN INTERFACE



COMPACT SHIPMENT OF MODULAR PIECES



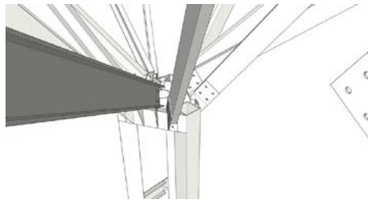
SOLAR PANEL CLADDING CONNECTION



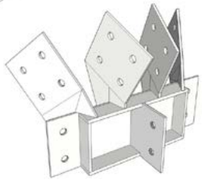
FRAMING AND SUB-FRAMING EXPLODED

WOOD PANEL CLADDING CONNECTION

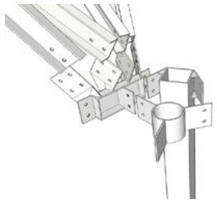
FRAMING AND SUB-FRAMING INTACT



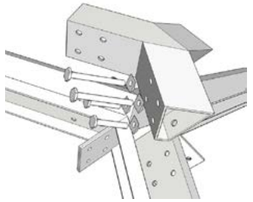
LOBBY COLUMN CONNECTION INTERFACE



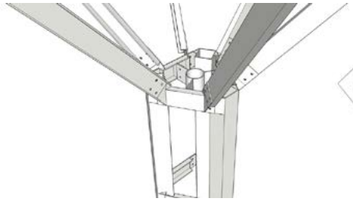
CONNECTION GUSSET PLATE



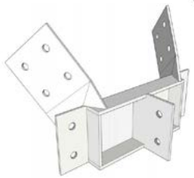
CONNECTION INTERFACE EXPLODED



STANDARD CORNER CONNECTOR EXPLODED



STANDARD COLUMN CONNECTION INTERFACE



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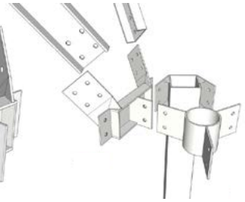
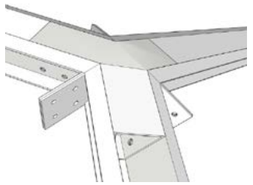


CONNECTION INTERFACE EXPLODED



STANDARD CORNER CONNECTOR INTACT

Presentation Board 03

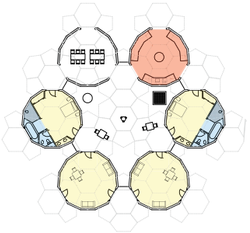
BUILDING PLANS AND SECTIONS

RESIDENTIAL UNIT SITE LOCATION

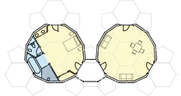
BACK OF HOUSE SITE LOCATION

MAIN HOUSE / LOBBY SITE LOCATION

- Residential
- Restrooms
- Kitchen
- Lobby / Store
- Bar / Restaurant
- Cultural Center
- Office
- Facilities



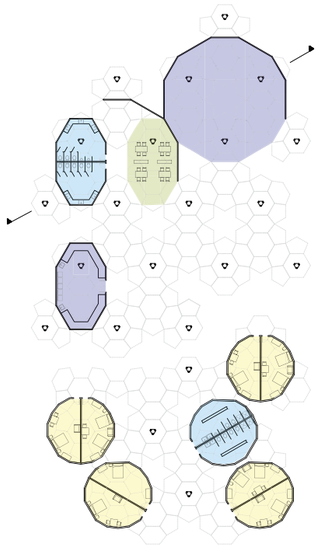
PENTHOUSE SUITE (1 unit)



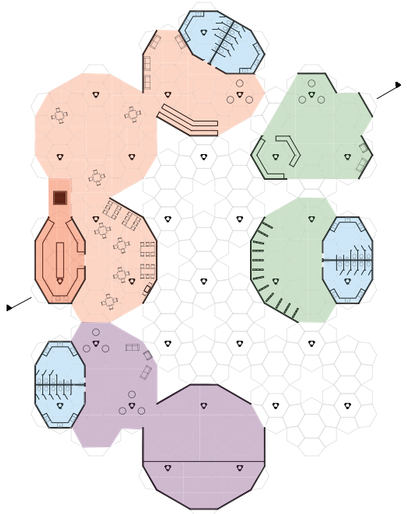
DUAL DOME SUITE (3 units)

SINGLE DOME SUITE (26 units)

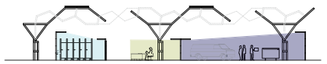
DOME SECTION



BACK OF HOUSE PLAN

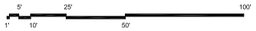


MAIN HOUSE / LOBBY PLAN



BACK OF HOUSE SECTION

MAIN HOUSE / LOBBY SECTION



Presentation Board 04

Presentation Board Summary

TRUNCATED ICOSAHEDRON HOTEL

Design Introduction

The truncated Icosahedron hotel is a hotel and landscape design which has been designed to integrate itself with the landscape. The hotel modules slope along with the landscape in order to preserve the integrity of the site and reduce the amount of infill and excavation. The undulating roofscape helps to organize the space by defining module location, as well as spacing between programs. Its modular design allows the entire site to be built using a kit of 15 parts in total that can be manufactured abroad where material is cheap, and constructed on site, where labor is cheap.

Design Process

Our group's design process included bringing individual developments to the group for advancement and evolution of each new iteration. Following each critique, the team would separate and try to explore their own personal goals. The team members would then discuss their diverse ideas the next day and choose a direction to proceed.

Influential Precedents

In the beginning, our hotel layout was inspired by the Ecork Hotel. We aimed to replicate the design of a shared centralized public space, with smaller individual private residences. Later, when our project's design shifted from rings to geodesic domes, we drew from the knowledge of Buckminster Fuller to help determine the ways in which our domes would interact with the ground. Lastly, following the creation of our undulating roof slab, we found inspiration in the design of the Stanstad Airport's structural columns as a means of elevating members without supporting domes.

Hotel Layout

In our attempt to replicate the style of the Ecork Hotel, we designed our hotel layout to wrap around the central gathering space that is the lobby. The hotel units formed a sort of C shape surrounding the West side of the lobby. This orientation was chosen so that the units would be able to receive the prevailing winds coming from the South¬East side of the site. In response to the sloped landscape, the hotels would climb along contour lines, overlapping certain roof tiles as they went. Individual hotel placement was determined by the undulating roof structure, with hierarchy between units being determined by the spacing between the units.

Structure

The structure is made up of modular members that are connected to form a complete panel. These complete panels are linked together to form the undulating structure that serves as both the building, as well as roof structure. The lobby and back of house spaces are unique in that the roof structure is elevated with structural columns. This branching column's branches contain tubes designed to collect water that collects on the roof. For more details on connections, refer to the structural design poster.

PROCESS & PRECEDENCE

SITE RENDERING & BACK OF HOUSE FLOOR PLAN

CLUSTER RENDERING & FLOOR PLAN

DESIGN PROCESS

The initial module study consisted of weaving steel rings of the same diameter to create a space enclosed by the resulting structure. The interlacing of equal sized circles created three equilateral polyhedrons: a tetrahedron, a cube and a dodecahedron. The hinged connections on the half dodecahedron shown were one exploration of alternative connections between members.

ITERATION 1

An explorations of module interaction created a spread of hemispherical huts. The precedence study of the **Ecork Hotel** influenced the repetitive layout of similar modules. Each module's pentagonal floor plan was split into three private and two communal spaces. This geometry forced angles that did not efficiently utilize space. The interaction between adjacent modules was undeveloped.

ITERATION 2

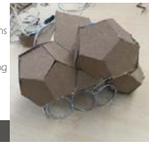
Further exploration of the connecting adjacent forms did not allow for smooth transitions. The sharing of the planar faces and edges intended to follow an orderly pattern; this order produced a seemingly random translation and rotation of each module adjacent module in all three axes. This study inspired the need to break the rule set by the sharing the pentagonal form.

ITERATION 3

Exploring connections of iteration 3 allowed for more options of module layout. New rules were established that disregarded face-to-face connections. Further development of the previous iteration's interior space attempted to address the height issues created by utilizing spheres as interior space. By bisecting the dodecahedron into two floors a more realistic story height was achieved.

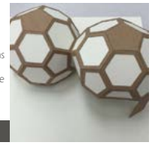
ITERATION 4

The rules of the dodecahedron rings restricted the options for exploration of module connectivity. This study focused on connections between circles and pentagonal planes of various sizes. The intersection of edges with faces created significant freedom in form finding but sacrificed the symmetrical order found in the previous forms. This study opened up options for connectivity to the ground.



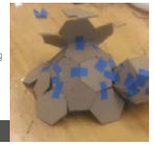
ITERATION 5

This iteration incorporated the use of rings and planes. The rings and planes were used in the development of the structural materials. A wooden truss frame allows for sandwiching thin planar surfaces. The planar surface options can incorporate a solid plane, glass, or any other similar option. Although larger and more symmetrical, this form still restricts the structure to close upon itself in a spherical pattern.



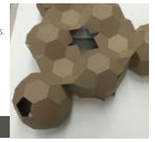
ITERATION 6

The next exploration attempted to utilize the interaction between planes developed in iteration 6 while avoiding this pattern's tendency to close in as a sphere. Connections between a different radius spheres and varying the direction of curves where investigated on one intersecting form. This represented a significant departure from the previous iterations...



ITERATION 7

Further investigation of previous forms built on the oscillating paterns in iteration 6. This created a patterned slab with undulating peaks. The incorporation of the previous sphere-like forms opened up many options built from the original form. This iteration closed exterior curves by continuing the peaks of the slab downwards to create dome structures on the exterior corners.



ITERATION 8

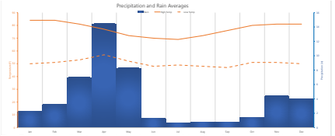
The latest iteration expands on iteration 8 to form various footprints for multiple uses. Exploration of structural systems taken from the **self study** allowed for further extension of the roof; shadding was developed by escaping the restrictions of the dome. The programing takes precedence from the **Ecork Hotel**. Lastly, offsetting adjacent roofs provides hierarchy of space.

ITERATION 9

INFLUENCE & PRECEDENCE

The Ecork Hotel blends the community and architecture through the layout and architectural form. The main building provides a grand common space juxtaposed next to the minimalistic modules that are grouped together in a simplistic grid layout. This segregated layout emphasizes the distinction between community and private space. This study heavily influenced **iterations 2 & 9**.

ECORK HOTEL



The Tanzanian climate requires a large consideration for shading of buildings and outdoor spaces. The moderate temperature allows for a blended interaction between the interior and exterior spaces. A structurally incorporated rain catch system was incorporated to **iteration 9** to provide water storage to the hotel and local residents.

PRECIPITATION & SUNLIGHT

Difficulties with the resolution of the form into the ground were constantly problematic. Exploration of two structures, Sendai Mediatheque by Toyo Ito and the Standsted Airport by Norman Foster, inspired the current design. These structures create space with few interuptions through the use of "mega-columns." This method was utilized in **iteration 9** to create an itegrated system.

RESEARCH & SELF STUDY

ARCH 551
FALL 2014
DONG & FOWLER

Willy Rosenbaum
Charlie Weir
Angelo Freeman
Marketa Jelinkova

Architectural Design Process Summary

STRUCTURE & THE DOME

Precedent Studies for Structure

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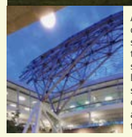
C.Weir - M.Jelinkova - A.Freeman

Dome Structures

Missouri Botanical Gardens Climatron, St. Louis MO

Large spanning dual layer hexagonal superstructure with a triangular substructure spanning between both layers.

ASM Headquarters, Materials Park OH



Another large spanning dual layer hexagonal superstructure with triangular substructure spanning between both layers. The two layers are spaced apart enough to create a truss slab that adds strength and depth to the geodesic dome.

Fullerene Molecule, Science and Space

Buckminsterfullerene, named after Buckminster Fuller, is a very stable carbon molecule (C60). The carbon atoms make up the vertices of a truncated icosahedron and the bonds are the edges. The molecules stack in a chrystal formation similar to a box of fruit.

Spaceship Earth, Orlando FL

This structure is a full geodesic sphere with a cladding system adding a visual representation of the structure to the surface.

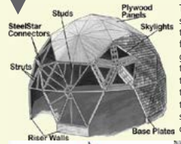
Micro Tilt-up Low Cost Dome, University of Vermont

This senior project attemps to create a low cost shelter that can be built quickly with the recycled materials of carpet and wire mesh and non-structural morter. This shelter illustrates the inherent strength of the truncated icosahedron form.

Buckminster Fuller Home, Carbondale IL

Buckminster Fuller's own home originally built in seven hours from 60 wooden triangle panels. The inventor resided with his wife for over a decade. Illustrates the simplicity of the structure and versatility of the space.

Timberline Geodesics, Berkeley CA: domehome.com



This company provides structural and architectural plans and kits for building residential geodesic dome structures. Although they typically support timber construction they did a custom steel dome for the set of Austin Powers 2.

Column Structures

Passerelle Simon-de-Beauvoir, Paris France

Each group of columns on this bridge taper down from the top level to a point on the bottom level. This elegant look provides a strong upper connection.

Sagrada Familia, Barcelona Spain

The columns branch out like a tree as they approach the ceiling they are supporting. The form of the branches are developed in line with the loads they are carrying so that every piece of the column is primarily loaded axialy.

London Stansted Airport, England

The mega-columns are spaced in every other square unit of this grid area. They taper from the wide area roof to a narrow footprint at the floor. This allows for maximum flow of the covered space while providing a repetive yet elegant support system.

Stuttgart Airport, Stuttgart Germany

These mega-columns also transfer the loads from a wide roof area to a narrow footprint. The branching form follows the naturally dispersing load path from the roof down to the base.

Structural Design Process Summary

Solar - Wind - Water

Technical Poster

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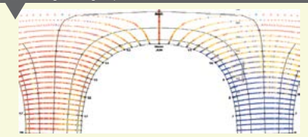
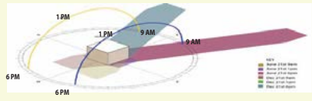
C.Weir - M.Jelinkova - A.Freeman

Daylighting Analysis

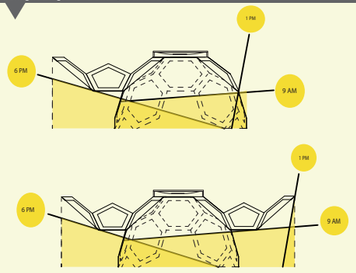
Determining Shading Requirements



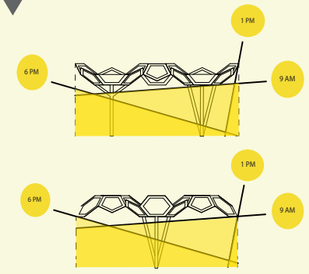
This sun path diagram displays the hours of the day in which heat from the sun is desired in order to maintain thermal comfort. From this, we can deduce that buildings in Tanzenia require constant shading from 10 AM until sunset.



Sunlight Diagram - Dome (Uncladded)

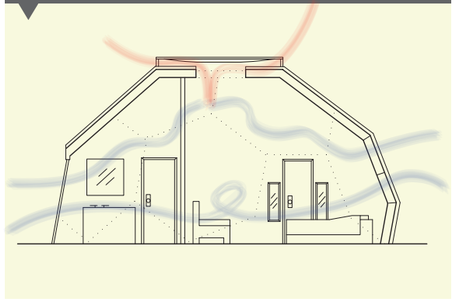


Sunlight Diagram - Lobby & Back of House (Uncladded)

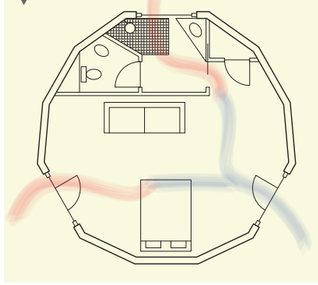


Ventilation

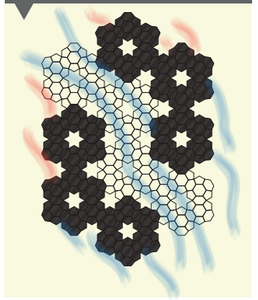
Sectional Cross Ventilation



Cross Ventilation - Plan

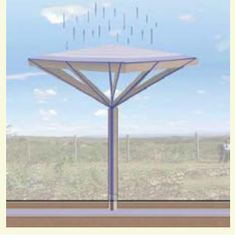


Cross Ventilation - Plan

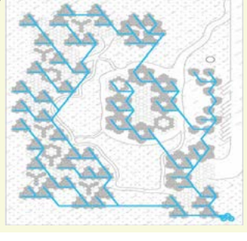


Water Collection

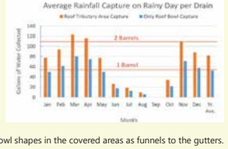
Bowl Collection Detail



Site Water Collection



Rainwater Collection Data



The water collection system utilizes the concave bowl shapes in the covered areas as funnels to the gutters.

The gutters transfer the water to piping that travels inside the cavities of the steel channels and columns.

The piping will be laid slightly under the grade with removable cover plates for maintenance.

The water travels downhill to the South-East corner to storage tanks. A well is located by the entrance.

Environmental Precedents

CLADDING

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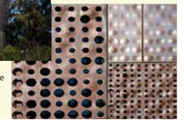
Choices of Materials

De Young Museum

De Young Museum in San Fracisco, CA utilizes perforated copper as cladding. Perforated structure allows for sunlight and gives the building a unique look. Oxidated copper echoes the surrounding trees.

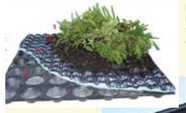


Cladding is supported by solid glass structure to keep the building weatherproof.

Water Cube

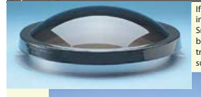
The Water Cube in Beijing, China's cladding system consists of so called ETFE (ethylene tetrafluoroethylene) panels. They are made of plastic membranes filled with air. They can be made transparent or opaque. Their advantages include corrsion resistance, insulating properties and lightness.

Vector Architects



Light green roof panels would help solve issues with water collecting, keep the inside significantly cooler and provide a natural aspect.

Bryant U Dome



If acrylic skylights were used as they were in the Bryant University Dome project in Smithfield, Rhode Island, they could be made in different levels of transparency. This would avoid too much sunlight going in.

XAN House

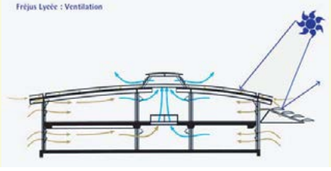
The Xan House in Xangrila, Brasil uses wooden poles as cladding. It provides a shading effect, while keeping the exterior walls see-through.

Oxford University

Windows and openings could utilize outside louvers to keep the sun out on hot sunny days.

Natural Ventilation & Lighting

Lycée Albert Camus



The Albert Camus Lyceum in Frejus, France, uses both shading devices and natural ventilation system, which could be used in our project.

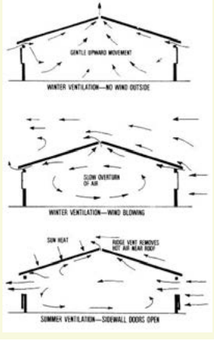
The shading devices consist of light, metal net attached to the building.

Natural ventilation is provided through the roof system, which consists of two layers.

A light metal layer rests on a concrete waved structure. The voids between the two layers encourage a flow of air inside the building.

If layering was used in our project, we would be using natural ventilation to cool down the interior of each unit. Air would flow in between the two layers, that keep the building weatherproof.

Natural Ventilation



Material Precedents

Demographics

Karatu & Ngorongoro Crater

ARCH 551.F.14 Dong-Fowler
W.Rosenblatt - C.Weir - M.Jelinkova - A.Freeman

Datoga Tribe

The Datoga tribe is most similar to Maasai in culture. Very isolated and most resistant to education and development. Only 5% speak Swahili which further harbors their isolation from other cultures. Mainly governed by group pressure with the occasional fine or curse imposed by a group elder.

Maasai Tribe

The Maasai are a Maa speaking nomadic tribe and the largest tribe in the Karatu area. Their culture extends throughout Kenya and Northern Tanzania. Maasai warriors are sometimes employed as trusted security throughout Tanzania.

Ngorongoro Crater Tourism

Hadzabe Tribe

The Hadzabe are a hunter gatherer tribe originating from Lake Eyasi (southwest of the Ngorongoro crater). They have been practicing sustainable hunting for centuries and typically do not respond well to government or religious influence. The tribe is currently struggling to maintain their cultural identity while acclimated to the reality of modern day society and medicine.

Iraqw Tribe

The Iraqw people are a Cushitic speaking farming tribe. They sell crafts and produce in the local markets in Karatu. They have been historic rivals of the Maasai people and remnents of this animosity still exist. Typically their houses were dug underground to protect from weather and thieves.

Culture and Infrastructure

Access to Water

Access to water has always been an issue for the Karatu region. In the past decade there have been discussions as to who will be responsible for financing the infrastructure improvements. Lack of access to clean water in some areas has led to increased rates of illness and child mortality. The infrastructure improvement for the Karatu area are currently supplying less than 25% of the demand but are intended to fully supply the area by April of 2015.
The more rural areas do not have the finances required to upgrade the water infrastructure. The residents are required to walk long distances to carry back potable water. Since availability of clean water is significantly lower the rural regions have a more health problems.

Local Markets

Local markets sell a variety of local products from food, meat, and crafts from the Karatu residents and various nearby tribes. Almost none of the money from the safari tourism reaches the local communities so the trade of products produced by the region makes up the bulk of the Karatu economy. Some of the native tribes are slowly acclimating to the financial need to communicate with other cultures.

Lifestyle and Economy

Many of the Karatu residents work in the agricultural and livestock industry. The fertile soild of the area provides great variety of fruits and vegetables, coffee, and grazing land for goats and cattle. Safari tourism does not provide a significant economic boost to the region and many of the residents can never afford to see the wildlife their region is known for. This dilema has created a more socially conscious tourism option where people can visit the city, stay with local residents and experience the rural lifestyle. This homestay experience provides travelers a unique outdoor, cultural and culinary experience while assisting the local residents and keeping money inside the community.

Many residents also are involved in brick making. The abundance of clay soil allows the region to easily produce a building material. These bricks are a much more sustainable and affordable building material for the region since minimal transportation is required. Some tourist will visit the site recieve an education on the brick making process. These tours also bring a boost to the local economy.

History and Government

Prior to 1950s

The area of Tanzania was uncolonized until the Portugese arived in the late 1400s

In the 1800s it was under German rule.

After World War I it was under British rule.

After World War II it was under given self rule by the United Nations.

Gaining Independence

In 1962 Julius Nyerere became the first president of Tanzania.

In 1964 Tanzania united with Zanzibar to form the United Republic of Tanganyika and Zanzibs.

Swahili was adopted as the national language in order to unite the nation without ostracizing tribal communities.

The Tanzania Ugandan War

In 1979 Tanzania Troops and Ugandan nationalists defended the Tanzanian land occupied by Idi Amin's troops forcing the dictator into exhile.

Current Struggle

The current government officials live a much more lavish life than the general populist adding to the disparity.

The need for added infrastructure such as transportation and clean water are needed most by areas without the finances to provide them.

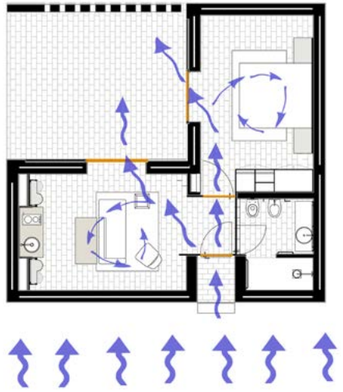
Corruption exists in aid and services providing support to impoverished areas and many times more money leaves than enters.

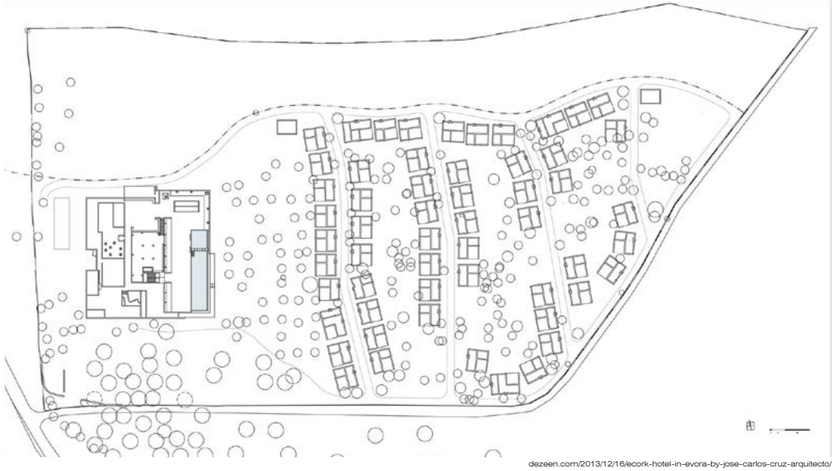
Some tribal residents are not accepting of the westernization of education and medicine and this further hurts the areas as the government tries to balance the slow transistion to progress

Cultural Precedents

ARCH 551 // Modular Precedence

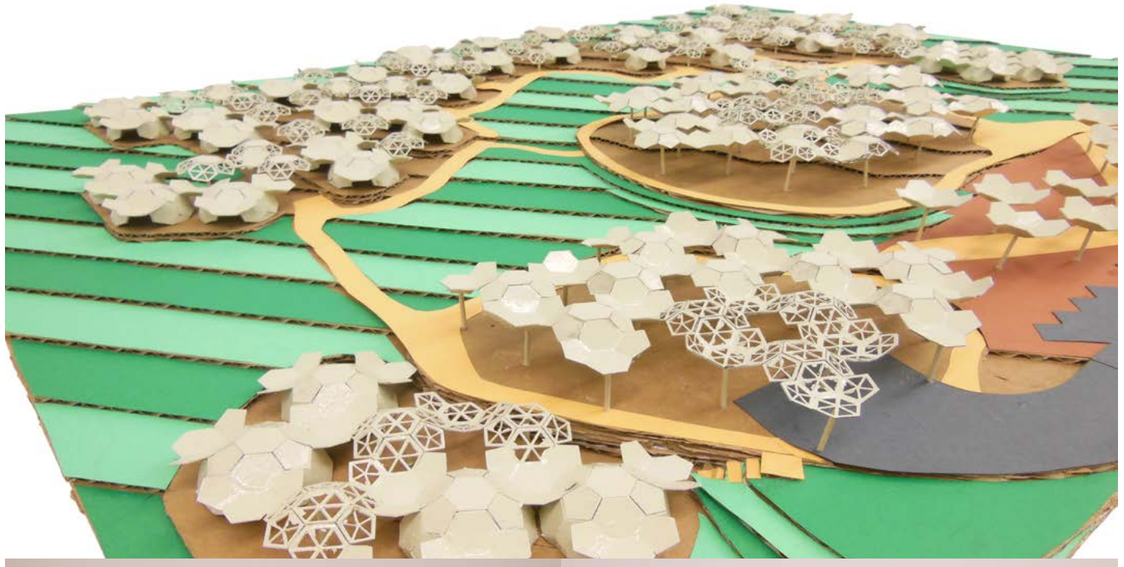
ecorkhotel // José Carlos Cruz

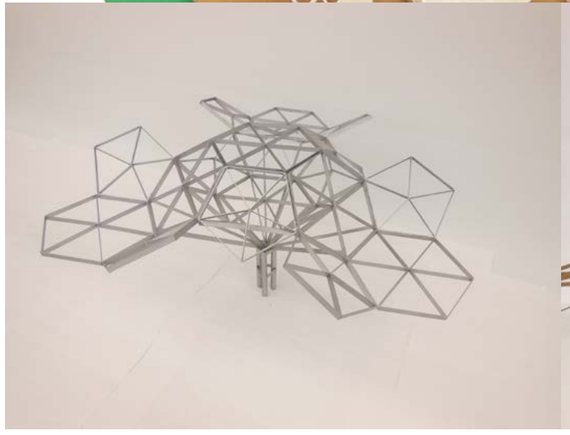




dezeen.com/2013/12/16/ecork-hotel-in-evora-by-jose-carlos-cruz-arquitecto/

Modular Precedents





Project Models

Reflections

Angelo Freeman

(1)Efficiency in site layout in regards to natural ventilation.
(2)How to generate a compelling story to argue your design's integrity.
(3)The ways in which architecture and structure can mesh.

The second point I think will have the most impact in my career as a designer. During our presentation at ARUP we didn't clearly communicate the specific reasons behind our design choices and this left the reviewers with a lot of questions. Later during our final review we had learned to hone our presentation into something that spoke for itself, rather than requiring us to explain the project in further detail.

During the Fall quarter I felt as though I relied on my group mates to answer any structural questions that may arise. However, by the end of the quarter I felt as though I was as knowledgeable as they were about our design. What I learned from spending two quarters with them was the importance of creating a structurally feasible design early on in the design process rather than having to retroactively generate a structural support system to some out of the box design that may end up ruining the entire project.

Marketa Jelinkova

This quarter in particular taught me how complex building design is, and how much there is to it. Before, I was mostly forced to think about the architectural, structural and managerial side of the design process, but the studio helped me develop a broader view of it and consider other aspects like ventilation, daylighting, and water collection. With time, I also realized more and more how important digital modeling is and how useful and resourceful computer programs are. Presenting our ideas is just as important as coming up with them and it will be helpful in the future to be aware of that and focus on the presentation. The first workshop we had in the studio helped us realize the importance of soft skills and presentation. I also learned that when designing the structural system, I cannot only rely on what I learned in class, books and codes, but it is most of all merely using logic and intuition.

It was a good experience as I realized the importance of being able to use computer programs I haven't used before and the architect on our team was very good and experienced in utilizing those to receive our digital models.

Charles Weir

1- I was expecting to learn specific design for the architectural requirements of a project. Although we touched on specifics for lighting and ventilation this quarter the majority of the efforts were spent improving the entire presentation each week. The bulk of my education was on the design process and the design requirements seemed to require independent education.

2- I was expecting to perform finalized design, detailing and calculations in support of our project presentation. This class had tasks and assignments that were always evolving which required most of our developing ideas and less of our time finalizing the product. This required many of the details to be easily changeable and the calculations to be rough but accurate. This hectic style was a new experience that will benefit me in life but I still look forward to learning the finalization process.

3- I was expecting to be given an overwhelming amount of criteria at the beginning of the quarter and learn how to incorporate all the needs of a project into a design. Instead we were fed some information here and there and the end product was not always what I wanted it to be. Of course this is the design process but one example is we accommodated our site to a slope as an afterthought as opposed to an initial design decision.

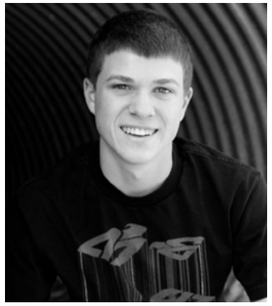
One thing I learned from the interdisciplinary aspect of this group project is that as engineers we need to provide our input to the design process. It is easier to wait for a task, complete it, and move on to the next one but when the structural efficiency is integrated into the design from the beginning it shows in the final product. It is nice to see the form and function integrated.

One of the biggest things I learned from the interdisciplinary aspects of this class is that I want to explore the design aspect of my career more. I have been focused on the technical analysis recently and miss the process of creation. Possibly a career change is required.

tesselate

team 03

Derek Avrit
Sarah Anderson
Sam Tooley
Brian Murillo



I learned through this process that there are many steps to creating a well-designed building. A huge number of variables can affect the final project, and the process never really feels like it has ended. When working in an interdisciplinary environment, listening to others' ideas was key to moving forward in a positive direction.

Derek Avrit
Murphys, CA

Working in this collaborative studio has shown me as an ARCE that there are major advantages to working alongside an architect at every step of the project. I understand the significance of an iterative process and how to progress from form finding to the creation of digital models and renderings, none of which I had experienced before.

Sarah Anderson
Aurora, CO

Working in this studio, I learned a tremendous amount about the design process. A huge takeaway for me is how to balance the economy of a structural system with the expression of an architectural form. In a collaborative environment, rather than with engineers filling a consultant's role, engineering and architecture work in harmony rather than in opposition.

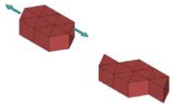
Sam Tooley
Fort Collins, CO

The inderdiscplinary aspect of the studio taught me to see the ARCE as a multi-faceted discipline, not only because they provided good insight on structural design, but also becasue they were able to adjust really well into architectural design, contributing great ideas and helping to progress the project.

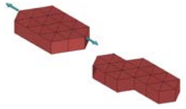
Brian Murillo
Las Vegas, NV

TESSELLATE

The project is a new hotel located in the Karatu District in Tanzania, Africa. It offers a public market and cultural demonstration center that allow for visitors to interact with local residents in a very informal manner, and to experience the Maasai lifestyle without ever leaving the hotel site. Tessellate is unique in its building forms, programmatic relationships, and cladding system. At its core, the hotel design stems from the fundamental concept of interconnected spaces, tied together by a series of common courtyard areas that encourage a communal atmosphere. It reflects the idea of grouping together components to form a coherent whole. The blending of culture, comfort, and community is articulated through its modular, triangular patterns. The triangular forms are translated from pattern to structure through the hotel's steel bracing, roofing, and cladding. The steel allows for the project to be easily assembled on site as a kit-of parts, reflecting the construction methods available in the area. Tesselate features 24 single units, arranged in pairs, and 6 deluxe units that provide varying levels of seclusion from the more public regions of the site.



living unit plan from triangular grid. slid to accomodate two units



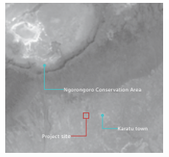
hotel plan slid to reflect living units, and to avoid a large depth

triangular module as hexagonal pyramids

roof derivation

reconfigured roof patterning

tanzania, africa



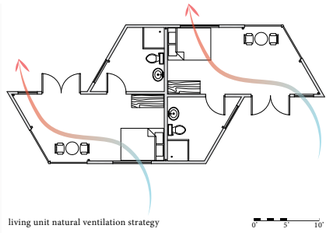
site and context. karatu, tanzania

site plan

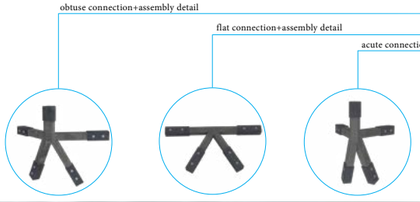
1 living unit clusters on site

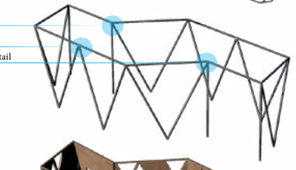
Presentation Board 01

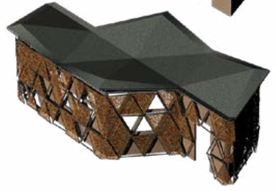
living unit interior



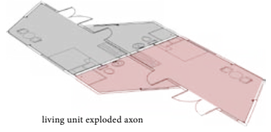
living unit natural ventilation strategy





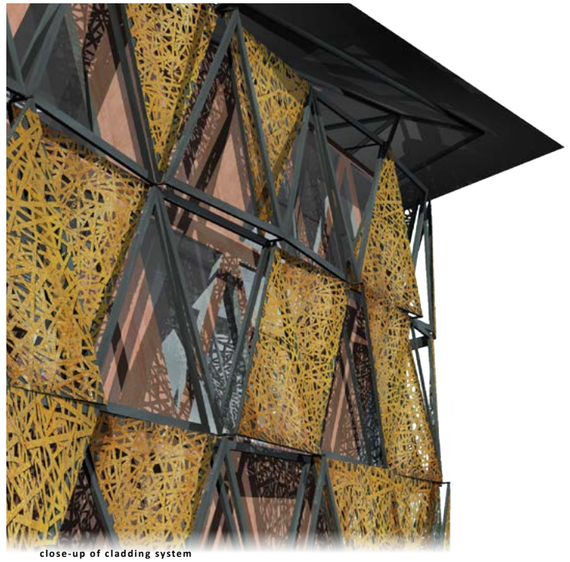


2 living units exterior

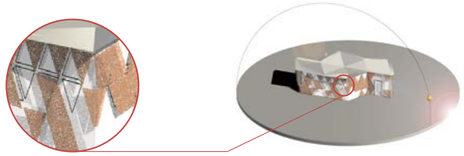


living unit exploded axon

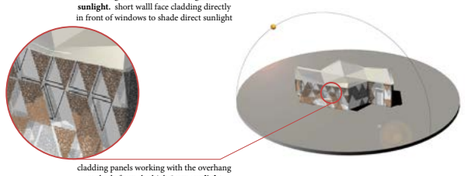
Presentation Board 02



close-up of cladding system

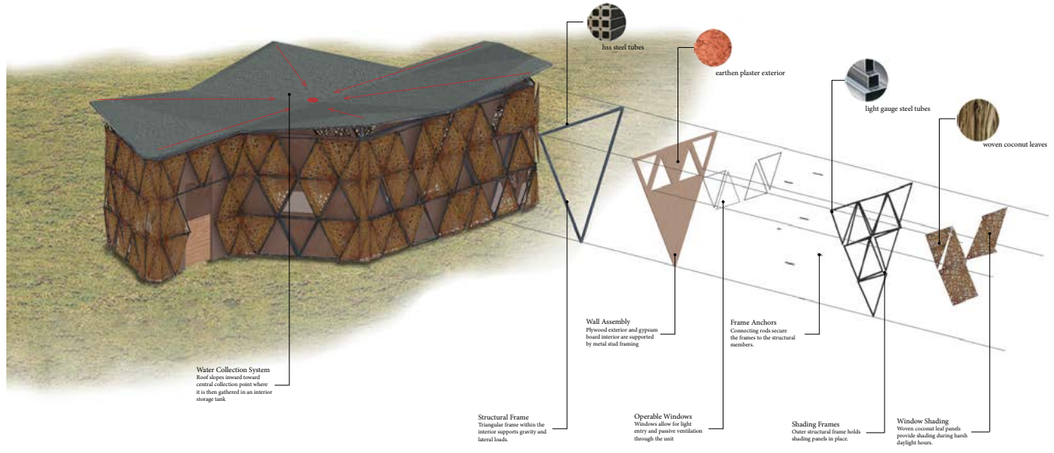


cladding panels shading the window voids on the long face from the low-angled **9 am sunlight.** short walll face cladding directly in front of windows to shade direct sunlight

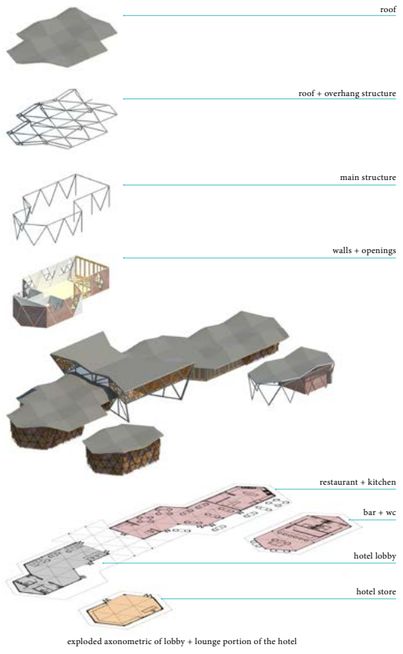


cladding panels working with the overhang to shade from the high **1 pm sunlight**

cladding panels shading the windows from the low-angled **5 pm sunlight.** trees aid cladding in shading large openings

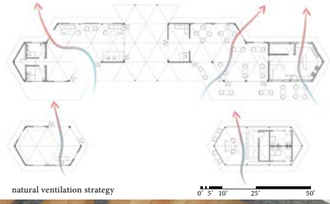


Presentation Board 03



exploded axonometric of lobby + lounge portion of the hotel

'hotel tesselate' location on site

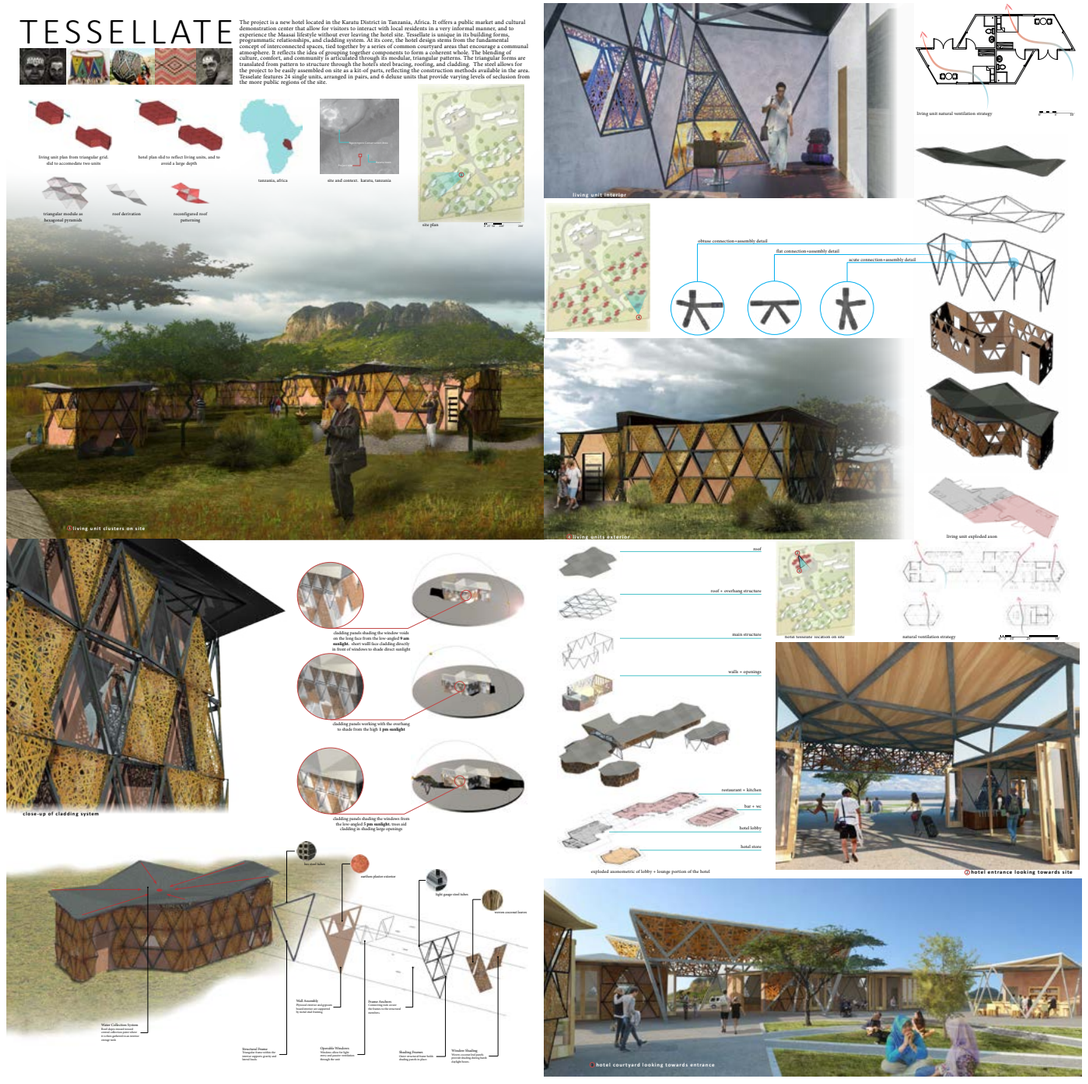


natural ventilation strategy

2 hotel entrance looking towards site

3 hotel courtyard looking towards entrance

Presentation Board 04



Presentation Board Summary

TESSELLATE

Creating pattern with tiled geometric shapes

SITE LOCATION

The site is located in the Karatu District in Tanzania, situated outside the town of Arusha and nearby both Serengeti National Park, Mt. Kilimanjaro National Park, the Ngorongoro Conservation Area.

CONCEPT DESCRIPTION

In an intense arid climate, Tanzania is one of the most bio-diverse and culturally vibrant environments in the World. TESSELLATE's form references the rhythm of the vibrant patterns and nimble tribal dances that beat the pulse of Tanzania. The pace of the site is articulated by repeating forms and screens manipulated to lend programmatic hierarchy and rationally applied to respond to the environment. This hotel project aims to create a sense of community through a balance of private bungalows, greenery, and public/retail space while speaking of Africa's intimate connection between people and the environment—blurring the division between elegant hospitality and cultural experience.

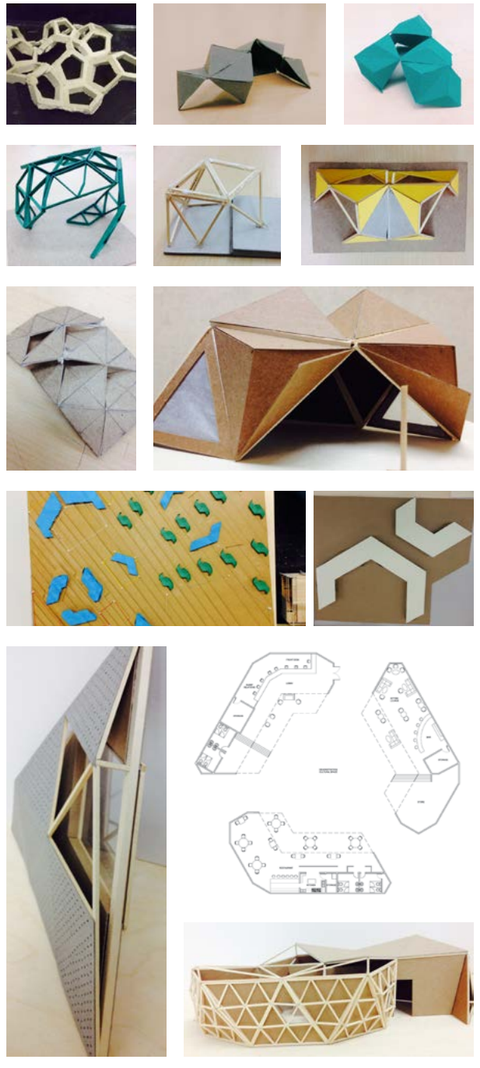
PROGRAM CONFIGURATION

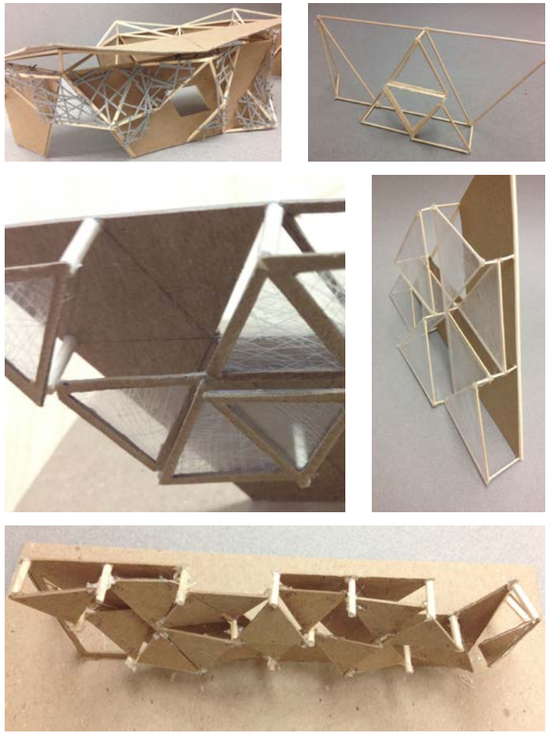
Guests experience the area's beauty and tranquility in an honest and authentic manner. In order to maintain and encourage the interactive flow of pedestrian traffic, the public market and cultural demonstration center trace the existing artery at the site boundary to invite hotel guests to interact with local residents. Tessellate is unique in it building forms, programmatic relationships, and cladding system. At its core, the hotel design stems from the fundamental concept of interconnected spaces, tied together by a series of common courtyard areas that encourage a communal atmosphere—creating a comfortable expression of the traditional East-African value of assembly on a veranda and reflecting the idea of grouping together components to form a coherent whole. The blending of culture, comfort, and community is articulated through its modular, triangular patterns. Tessellate features 24 single units, arranged in pairs, and 6 deluxe units that provide varying levels of seclusion from the more public regions of the site.

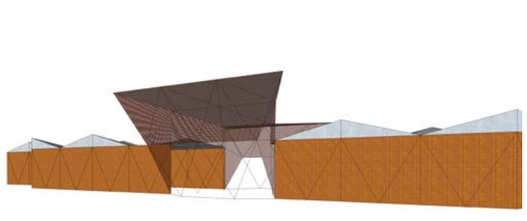
SKIN / STRUCTURE

Tessellate echos the bold geometric patterns found throughout Tanzania by creating a responsible repeatable economic module. As a kit-of-parts, only achieved by implementing steel, the structure elegantly resolves lateral forces with a three dimensional triangulated truss in three equilateral directions. Trusses achieve a strong redundant structure without relying on complex construction methods and appropriate to the availability of materials. Expressed woven panels are rationally applied as a secondary screen with a simple bolted system to light interior spaces without the associated thermal load.

ARCHITECTURAL PROCESS







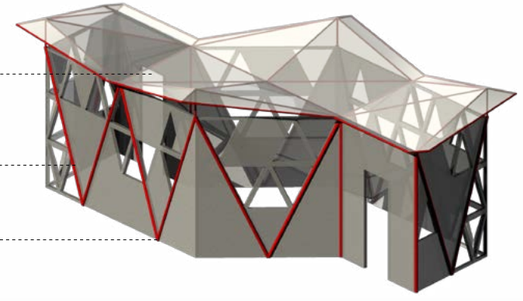
Architectural Design Process Summary

STRUCTURAL PROCESS

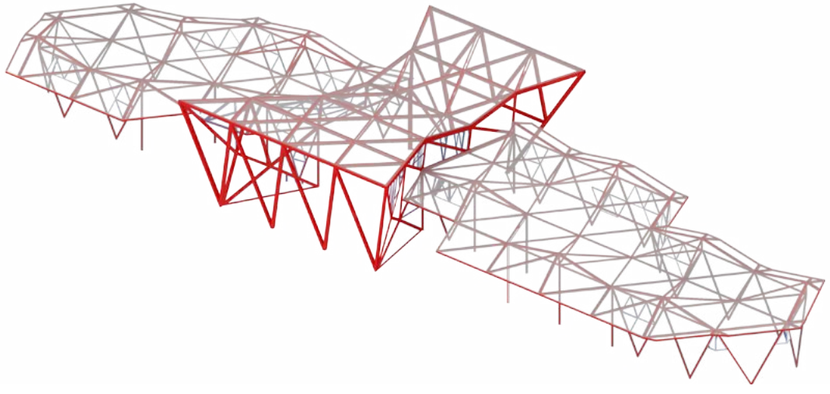
PRECEDENTS

STRUCTURAL SYSTEM

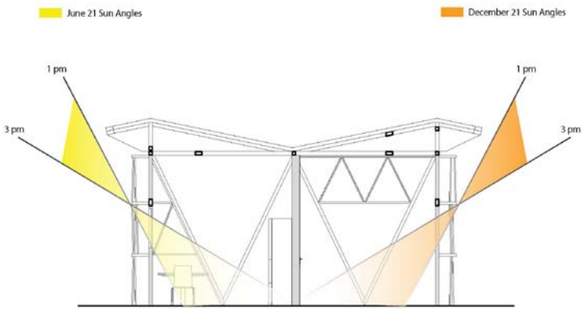
LIVING UNIT

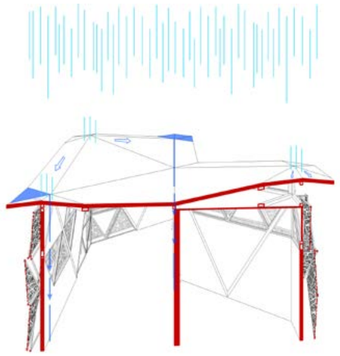


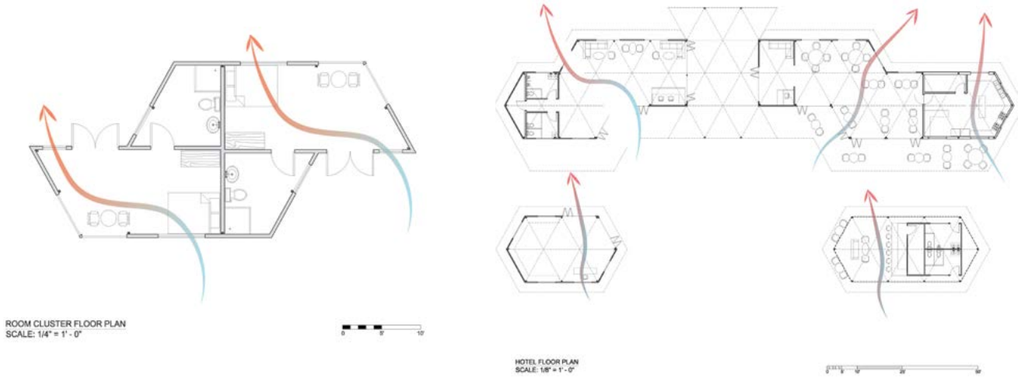
HOTEL LOBBY



Structural Design Process Summary

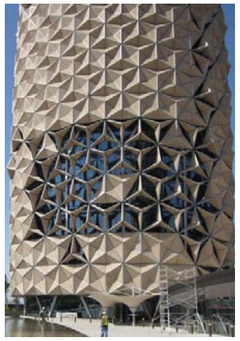




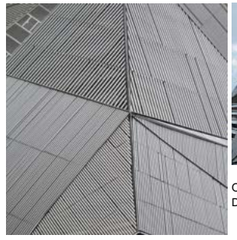


Environmental Precedents

Cladding Systems

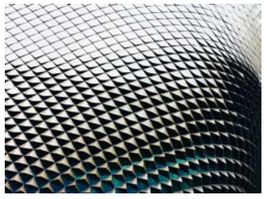


Al-Bahr Towers
Aedas

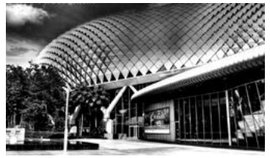


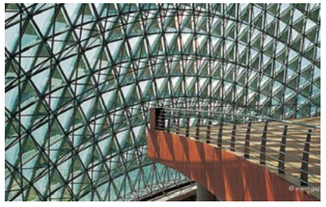
Orchard Central
DP Architects

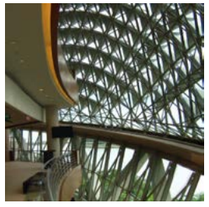
Bermondsey Bike Store
Sarah Wigglesworth Architects



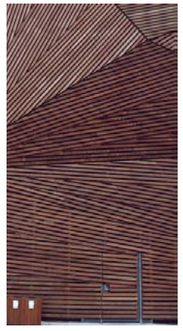
Esplanade Theatres
DP Architects







Canadian Pavilion
SNC-lavalin inc.



Material Precedents

DEMOGRAPHIC TYPOLOGIES

HISTORY

KARATU
Karatu was originally colonized by the Germans in the early 1930s, and the original native tribe in the area was the Barbaig. The Barbaig primarily used the land for livestock grazing, but the arrival of the now dominant Iraqw tribe - who converted much of the space to farms and houses - along with a growing population, caused the Barbaig to move out of the area. The Karatu land was at once threatened by an infestation of the deadly Tse-Tse fly, which was only restored when the Iraqw farmers cut down the bushes that covered Karatu. It became an Administrative District in 1997.

NGORONGORO CRATER
The original inhabitants of the Ngorongoro Crater area were the Datoga tribe, remaining there until the early 19th century. The dominant Maasai tribe eventually forced the Datoga out of the area, but small Datoga communities can still be found nearby. German explorers first discovered the crater in 1892 and built farms in the fertile crater land. In 1959, the Ngorongoro Conservation Area was separated from the Serengeti National Park and made into multi-purpose land for the Maasai tribe.

DEMOGRAPHICS

KARATU
Karatu is one of six districts in Arusha Region. Its current population is 178,434 with approximately equal proportions of men and women, growing at an annual rate of 3.2%. The average population density in the district is 52 persons/km^2 with higher density in areas with higher rainfall due to the primarily agrarian economy. The dominant native tribe in Karatu is the Iraqw, though other tribes such as the Bardaigs (pastoralists) and Hadzabe (hunger-gatherers) are also present in the area. Christianity and Islam are the commonly practiced religions in Karatu, though some traditional indigenous religions remain.

NGORONGORO CRATER
Since arriving about 200 years ago, the Maasai have colonized the Ngorongoro Conservation Area (NCA) and remained there in large numbers. They may bring their livestock to the Crater for water and grazing, but they are no longer permitted to settle or cultivate there.

The Ngorongoro Conservation Area attracts an average of 500,000 tourists each year, which has played a major role in the development of the Karatu District. Tourists can visit Maasai designated cultural bomas - homesteads containing huts made of sticks, mud, and cow dung - to take photographs and buy souvenirs.

CULTURAL

WATER ACCESS
Karatu depends on water supply from natural springs and rivers in the Ngorongoro Conservation Area, Marang Forest, and Northern Highland Forest Reserve. As of February 2013, about 60% of the Karatu District had access to clean tap water. The remaining residents were projected to get clean and safe water by the end of 2014. The number of water users in the Karatu Township tripled from 3,350 in 2013 to 20,920 in April 2014. There are a total of ten water projects targeting the Karatu District for the fiscal year 2013-2014.

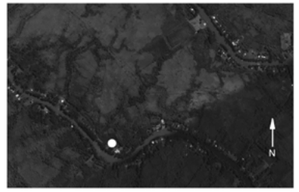
CRAFT MARKETS
The Maasai are known primarily for their beadwork, which may take the form of jewelry, shields, warrior's spears, and ceremonial headdresses and clothing, though they also sell masks and carvings. Pottery, solely the domain of Iraqw women, is their most common craft. However, they also make tools, reed mats, leather goods, musical instruments, and furniture.

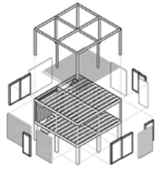
LIVELIHOOD
Despite the number of tourists visiting the Ngorongoro Conservation Area every year, the tourism industry is not providing benefits to the local communities. The Maasai population continues to grow while the livestock population has remained about the same as it was in the 1950s. Cultivation in the Crater has been banned for the Maasai multiple times throughout the area's history. The numerous lodges and other tourist attractions around the Crater rarely employ Maasai; instead, their employees tend to come from distant areas.

CLIMATE IMPACT
The climate in the Karatu district is influenced by nearby Lakes Manyara and Eyasi, especially during the end of the dry season when high winds dry up the landscape. Due to the many rain-fed farming practices, population density is very high in areas higher in rainfall. The climate has allowed for arable farming and pastoralism to be the primary land use, with crop and livestock production being the most important sectors (comprising 90% of the district's labor force). Unfortunately, agricultural productivity has decreased in recent years due to more erratic rainfall and poor soil fertility, which is forcing Karatu residents to intensity agricultural practices.

Cultural Precedents

Ecork Hotel
JOSÉ CARLOS CRUZ



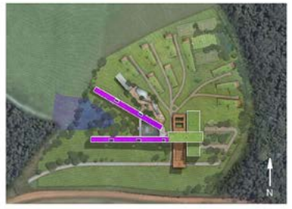


LOCATION: Argentinean River Delta

PURPOSE: Six-client vacation destination

MATERIALS: Steel Framing + Concrete Foundation

Hotel Aliah
HIPERSTUDIO + ARKIZ



LOCATION: Sao Paulo, Brazil

PURPOSE: World Cup Accommodations

MATERIALS: Steel Framing + Green Roof

Delta Cabin
ATOT ARCHITECTS

LOCATION: Evola, Portugal

PURPOSE: Luxury Resort + Spa

MATERIALS: Plaster Coating + Cork Facade

Motel Precedents

Project Models

Reflections

Derek Avrit

From this studio experience I learned that group collaboration is vital in a design project. Individual work is obvious when compared to a collaborative design, and often lacks the progress of the group piece. I also learned that the correct group configuration could be a refreshing experience compared to other issues that I have had in the past. I also learned that the design process is not about getting the correct answer as much as about constantly moving forward in a positive direction. Producing a large amount of work seemed to be the most useful way to tackle difficult decisions within the process.

I do not believe I would have appreciated the design process without an architecture student on our team. There were often times when we would lose sight of the purpose of certain activities, but the architect helped to acknowledge the significance of each step towards the final product.

Sarah Anderson

I discovered and appreciated the significance of form finding exercises prior to looking at a project in its entirity as this would introduce factors that could restrict the design process. I experienced the challenge of going through a desk critique without taking comments personally; I still need to work on seeing this as criticism of the product and not the people. I learned just how many factors must be analyzed and considered in order to develop a project proposal that is practical yet meaningful. I became increasingly aware during the process that there is an almost endless amount of time that I could put into each step along the way, and that each component of our final submittal could be developed further.

This interdisciplinary team configuration taught me that architects and ARCEs can actually approach a problem in much the same way. When placed together in a collaborative environment such as this, I think there is less potential for having conflicting ideas and struggling to agree on a solution. Having an architect on the team rather than all ARCEs is significant because it taught me more about craft and presentation than any number of ARCEs would be able to figure out. The architect on our team brought 5 years of experience in generating similar deliverables to that of our class, so he helped us raise the quality of our models (physical and digital) and drawings/posters.

Brian Murillo

The form finding technique was a new method for me to use when trying to find a design. The several exercises opened my eyes to the potential uses of the technique. Also, I learned that choosing a module helps a lot with restraining the design; or rather, keeping it from straying too far from the main intention/concept of the project. Lastly, I learned a lot about group dynamics. I am much more appreciative of the worth of good team members and how much better a project can be when the group works well.

Working in an interdisciplinary studio with the ARCE's made me more aware of the structural side of designing. I don't think any of my previous projects have considered structure as a tool for design as heavily as this one. I saw that we quickly became equals in terms of designers. Although the arce students looked to me for guidance in terms of architectural design, I did just as much of the same to them for many other things. The sharing of ideas was important for the different perspectives.

Sam Tooley

The overall success and efficiency of a project comes from the successful harmony of form and structure. In other project groups I've been involved with, form is one discussion, structure a second, and the modification of each to accommodate the other is a third and lengthy compromise. The entire design process of our project involved both the architecture and structural aspects in the same conversation. Compromises were made on the fly, and the final product was stronger for it. Architectural design is as much about responding to the environment as it is aesthetics. Our design, from the beginning, was an expression of the cultural values we learned about northern Tanzania. The modularized solution was born out of the constructability concerns surrounding the site and lack of skilled labor or heavy equipment. Nearly every other aspect was an application of the design aesthetic in a manner that addressed the environment. The overarching theme of our project, the triangular modules, and the environment were the only constants throughout each iteration.A drawing is an expression of an idea; a model is a test, demanding proof.

It's easy to see how this is directly applicable to my future as a structural engineer. An engineer creates a system that works integrally with the architecture of a space. When an architect and engineer communicate about a project, it is certainly in the project's best interest to have both parties in a similar understanding of the spatial implications of the structure. A structural engineer who can graphically illustrate choices available or the selection process undergone is certainly more valuable to an architect than the alternative.

tentzania

team 04

Amy Burruss
Joaquin Bermudez
Sebastiano Beretta
Andrew Stephens

Understanding and being open to the iterative design process by always moving forward instead of taking steps back is something Amy took away from the architectural design studio experience. She developed a better foundation for architectural design, which will be utilized in a structural design capacity.

Amy Burruss
Salt Lake City, UT

I learned about presenting information in an interesting way that perhaps other disciplines should try. This will be the most useful in my career.

Joaquin Bermudez
Live Oak, CA

From the Tanzania Project I learned how to pursue a more “naked” form of architecture,where space and structure are tentatively the same thing.

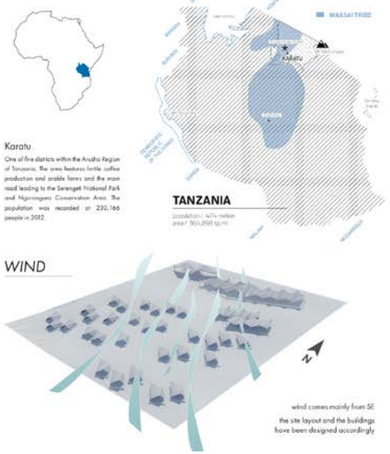
Sebastiano Beretta
Desio, Italy

By working on a project for Tanzania, it wasn’t what I learned most, it’s what I realized. I realized that structures reflect a lot on the location of the site.

Andrew Stephens
Trinity Center, CA

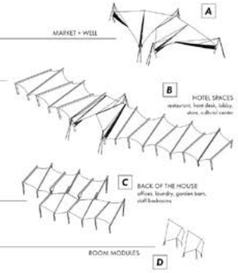
TENTZANIA

SITE



SITE PLAN

PROGRAM



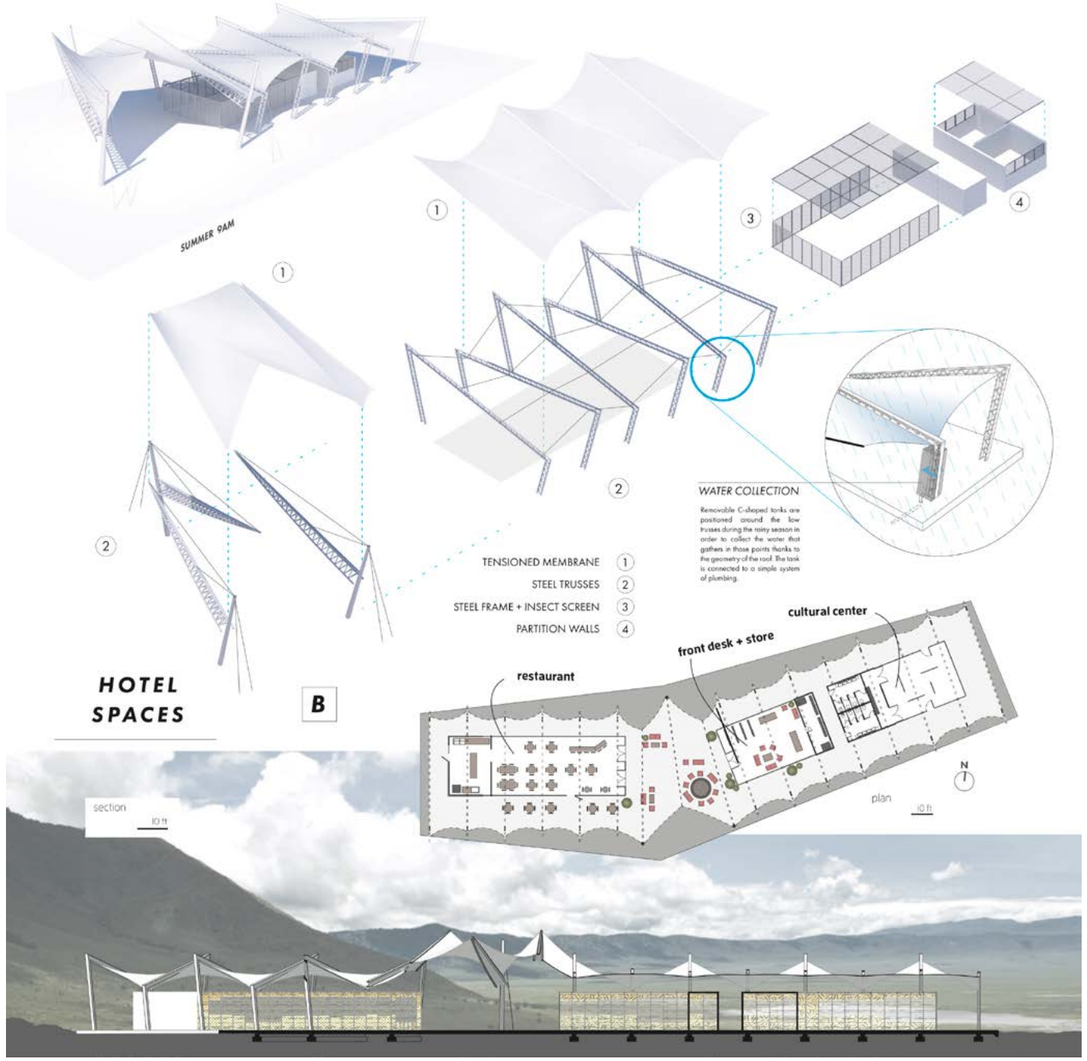
Tentzania offers an outdoor living experience. The community is more than a Safari camping ground. The broad tensile suface and light vertical framing lend themselve to the environment and local culture. Tenzania's design of public spaces as well as living units allow for passive ventilation, expansive shaded areas, and minimal wall cladding. The emphasis of Tentzania is the natural beauty of the region.

Design Process
Research into modular design started with creating forms out of tension, weaving and layering. Parabolic shapes were extruded to create continuous surfaces and eventually tensile structures.

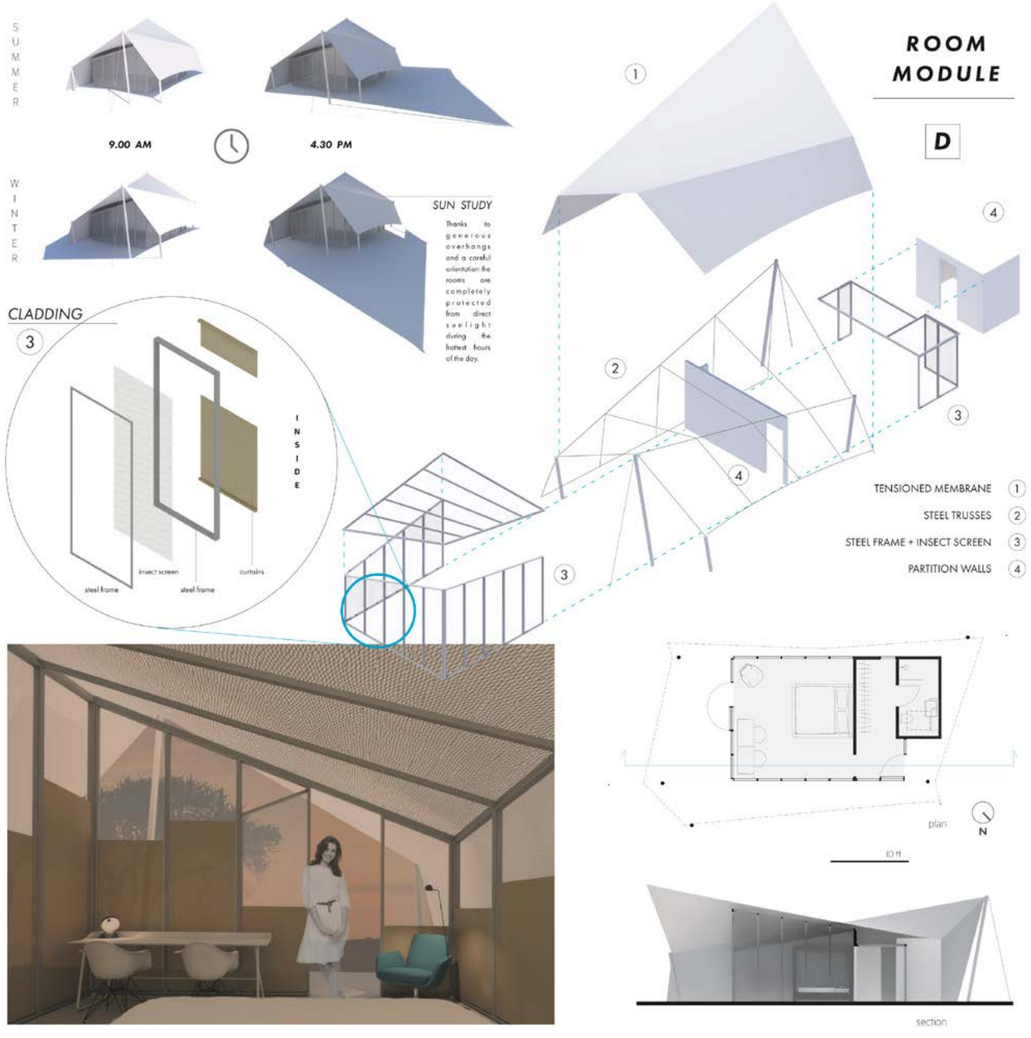
Program
Hotel living units (10,000 sf). Reception, public space (12,500 sf) Market, gardens (50,000 sf)

Structure
Steel open web truss frames / Steel posts and cables

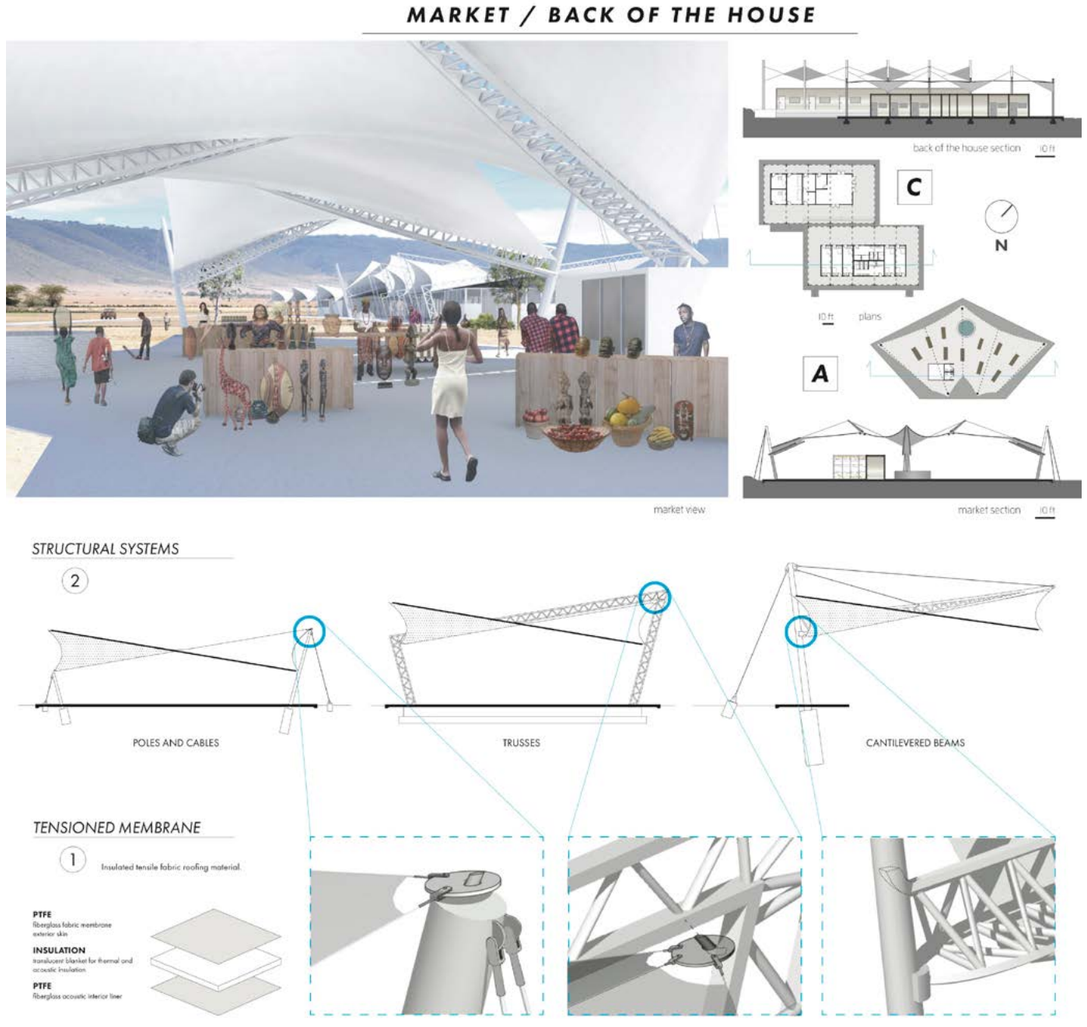
Presentation Board 01



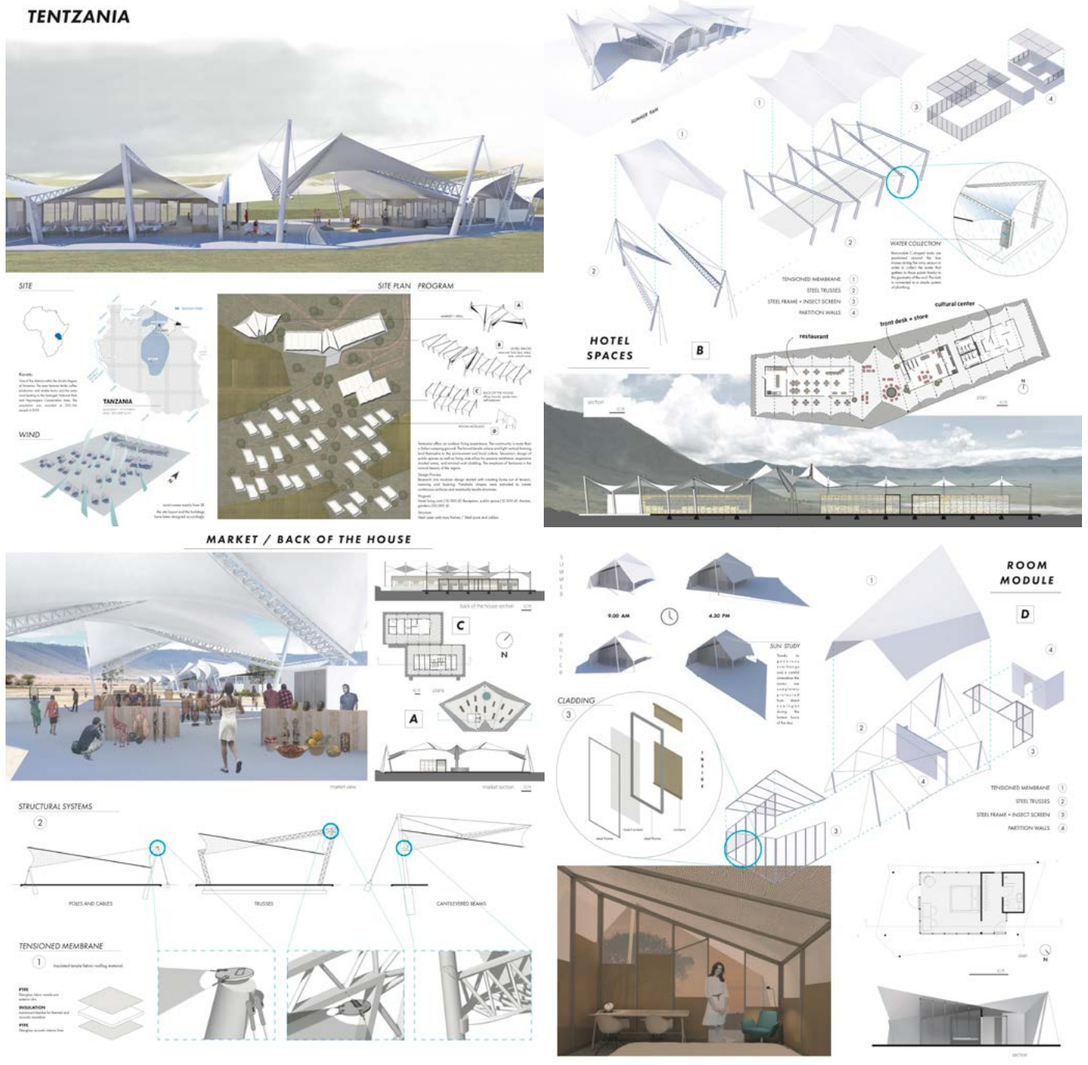
Presentation Board 02



Presentation Board 03



Presentation Board 04



Presentation Board Summary

TENTZANIA

CONCEPT:
Tentzania offers an outdoor living experience. The community is more than a Safari camping ground. The broad tensile surfaces and light vertical framing lend themselves to the environment and local culture. Tenzania's design of public spaces as well as living units allow for passive ventilation, expansive shaded areas, and minimal wall cladding. The concept of Tentzania is to enhance the visitor's sense of the African region through a luxurious camping experience.

FORM FINDING:
Investigation of tensile structures started with a woven string system. Undulating the ends of the strings allowed for a more dynamic weaving pattern taking the shape of a hyperbolic paraboloid. A more dense weaving system began to represent an enclosed shape created by tension. Studying the surfaces which created the enclosed tensile structures, also began the development of the structural systems used to support the surfaces. Scaling the size of the surfaces also meant scaling the size of the structural system.

CIRCULATION / PUBLIC AND PRIVATE AREAS
Buildings closest to the road are the visitor reception and spaces to interact with the community, while those that are furthest are private living units. The main buildings include an open air market, water distribution area, cultural center, restaurant, and hotel lobby. The use of larger tensile structures helps differentiate between public and private space. A central axis serves as guest circulation between these two areas. Certain areas of the site were used for agricultural purposes to allow for site sustainability.

SKIN / STRUCTURE:
The tensile enclosures are primarily formed by one of three structural systems. Larger structures incorporate open web steel trusses and steel frames while the individual room modules utilize steel columns and cables to create the same hyperbolic paraboloid. Lateral load transfer along the length of the public buildings is achieved by interconnecting the steel frames and tying them down with cables at the ends of the frame sequences.
The roof system is composed of PTFE tensile sheathing with a separate vertical cladding system beneath. The vertical cladding, both in the main buildings and living units, are composed of light gauge steel frames, insect screen, and shades.

PASSIVE VENTILATION / DAYLIGHTING:
Passive ventilation from prevailing northeast wind proved to be a significant design decision for the orientation of the buildings on the site and development of the cladding system. The shades within the wall systems can be raised and lowered to block sunlight and wind according to the occupants comfort levels. The large overhangs created by the tensile structures also keep out direct sunlight. They are found on both the north and south faces of all buildings, as the site's proximity to the equator produces a consistent sun path year round.

SITE AND CONTEXT STUDY 1

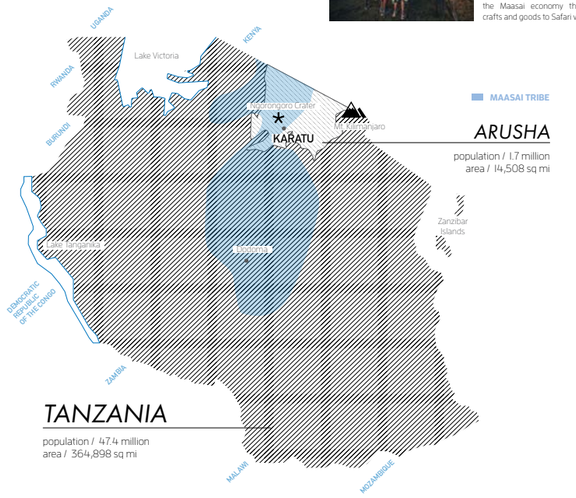
ARCH 551. F14. DONG|FOWLER
Amy Burruss Joaquin Bermudez Sebastiano Beretta Andrew Stephens

Ngorongoro Crater
Over 500,000 people per year visit the landmark. It is the world's largest inactive, intact, unfilled volcanic caldera making it one of seven natural wonders of Africa. The crater's grasslands inhabited by native African wildlife, desert plants as well as lush vegetation.

Maasai Tribe
Semi-nomadic people who live along Great Rift Valley and utilize land resources in a sustainable manner through Maasai Communal Land Management. Their economy and culture focus on herding cattle, goats, and sheep. Tourism helps the Maasai economy through selling crafts and goods to Safari visitors.

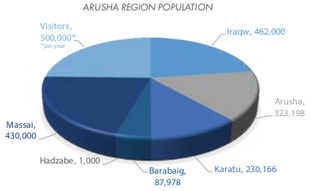
DEMOGRAPHICS

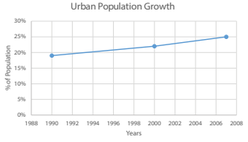
Karatu
One of five districts within the Arusha Region of Tanzania. The area features fertile coffee production and arable farms and the main road leading to the Serengeti National Park and Ngorongoro Conservation Area. The population was recorded at 230,166 people in 2012.



ARUSHA

population / 1.7 million
area / 14,508 sq mi



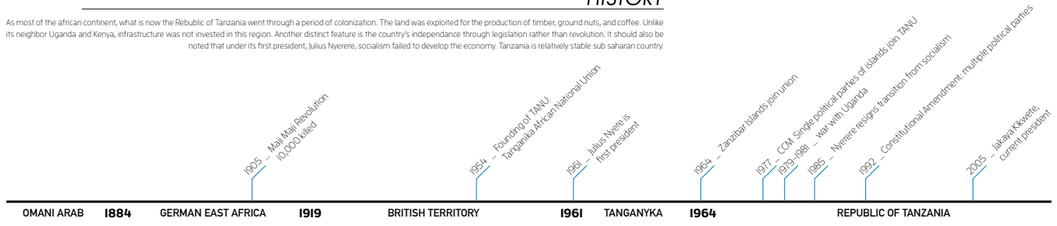


TANZANIA

population / 47.4 million
area / 364,898 sq mi

HISTORY

As most of the african continent, what is now the Rebublic of Tanzania went through a period of colonization. The land was exploited for the production of timber, ground nuts, and coffee. Unlike its neighbor Uganda and Kenya, infrastructure was not invested in this region. Another distinct feature is the country's independance through legislation rather than revolution. It should also be noted that under its first president, Julius Nyerere, socialism failed to develop the economy. Tanzania is relatively stable sub saharan country.



Site and Context Study

MAIN THEMES / GOALS

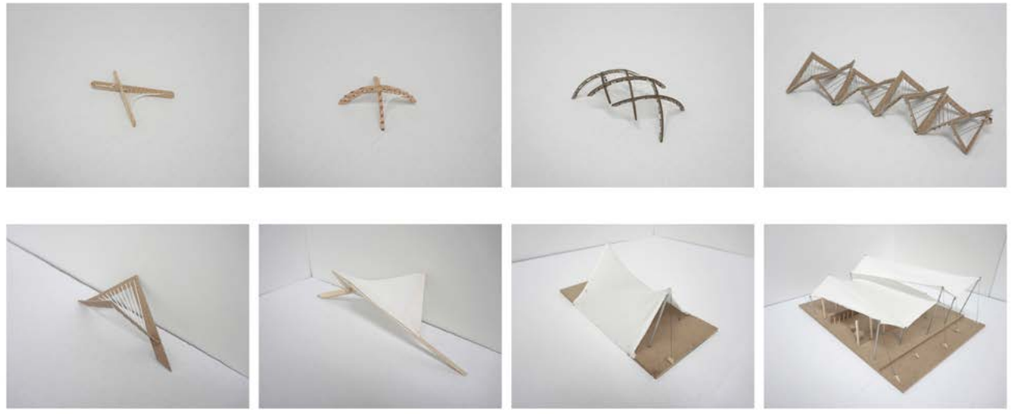
PRIVATE / PUBLIC
provide **balance** to public and private sectors within hotel spaces

SUN / WIND
due to the proximity to the **equator** there are no dramatic changes in the **sun angles**
winds come mainly from **SE**

LOCALS / TOURISTS
how to **engage** the tourists **with the locals** to allow for cross cultural experience for each

CAMPING / TENSION
provide an **updated camping** experience by exploring the possibilities of **tension structures**

FORM FINDING



Form Finding & Main Goals

Project Models

Amy Burruss
This studio experience put me greatly outside of my comfort zone. The three main things I learned from this studio is to listen and communicate well, understand that the design process is very iterative, and to be open to others ideas. The review sessions in class and form finding iterations helped in developing the understanding of these three ideas.

The interdisciplinary structure of the course forced people to come together and think for one common goal who individually think different from one another. From a structural side, I would focus more on the constructability and stability to a structure whereas from an architectural approach there is more focus on form, sustainability, and layout. The collaboration from each discipline forces each individual to consider the other group member's focus as well as their own. The entire project and each design step was collaboration between all the group members, which was achieved through bouncing ideas and approaches to the project from one another. If this was an individual effort my final project would look nothing like my group's final project does. This is not to say that I do not like our final project, but my process individually would have led me to a different end result than combining others ideas at different stages along the way. At each iteration point of our design someone would bring something new.

Joaquin Bermudez
I learned to trust other people when they choose to do only certain tasks for the group. Sometimes it is better to have specialists in the group that only do what they are best at. I learned more about modular design and how to move forward when a shape you are interested in doesn't really fit in as a module. There are different ways to express the same theme. I learned how to model in Rhino. This was not expected but I am glad I pushed myself to model in this software.

I learned more about presenting material. Our discipline is very technical and information is presented in a dull way. It is more effective to present something that is both useful and interesting.

Sebastiano Beretta
I learned how to deliver a good design with a solid presentation in a short period of time. Having to talk about our project to different people in more than one occasion really helped to come up with a cohesive story, with the good side effect of clearing our heads
about where we were heading.

As the only architect in the group I somehow needed to go back to basics in a good way: structure was part of the design process from the very first phase, and my teammates were naturally more aware of that than myself.

Andrew Stephens
The number one thing I learned from this studio is how to model build. I was the main contributor to building the physical models, so there was a large amount of time to practice this. The second would be how to take criticism better. I think this was a direct result of the large amount of critiques we had. I started the quarter off with not being able to do this as well because of the large amount of time that I spent on something and then just having it ripped apart (literally sometimes). The third most learned thing from this class that I learned would have to be how to work in collaboration with other engineers and architects. I know this is usually a challenge in our industry, but with all the interdisciplinary classes we experience here at Cal Poly, I feel it has better prepared me for this.

I learned a great deal about how to work with other engineers and architects, similar to what I expect it to be like in industry.

Barbed Wire Tied Back Around Wood Framing
note: In the full construction of the project, the barbed wire would be extended between courses of the adobe sheer walls, however these tie backs serve as a replacement in testing.

Barbed Wire Reinforced Wall Fully Assembled

Testing Apparatus Pushing on Barbed Wire Reinforced Wall

Structural Testing

Karatu Hotel Sandbag Study

The project takes advantage of the size of the site to create opportunities for both public discussion and private retreat. The front of house buildings are organized to create a town square style courtyard, allowing for visitors to sit out and watch dances by the local messai tribe, enjoy a drink at the bar, or peruse through trinkets in an open market shopping area. These buildings take advantage of extreme openness to blur the qualities of the indoors and the outdoors, creating a space that is not quite one or the other.

This open market area creates a primary axis for circulation, guiding tourists to their private bungalows down the gently sloping hill. The bungalows are organized and spread out such that small farming spaces and gardens form between them, taking advantage of heavy rains to allow for multiple stage water use. Passing the gardens becomes a very tranquil experience, relaxing guests after long days of travel.

Primary goals of the project became developing wall and roof systems that would be cheap and efficient to build in the harsh climate of Karatu. The many buildings of the site were equipped with extensive eves to shade the walls as well as a complex double skin roof system. The roof uses bouyant air flow to allow breezes to pass through the two layers, effectively creating a cooled air gap that stops the harsh sun from penetrating the building.

The wall system is equally unique. Sandbags layered with barbed wire create infill panels in between adobe sheer walls. These sandbag walls are tied back to a concrete bond beam, which paired with the barbed wire create connections that will resist out of plane loading on the infill wall.

Sandbag Wall, No Barbed Wire

Steps	Load (#)	Displacement (in)
1	0.000	0.000
10	479.916	1.703
20	615.829	2.394
30	642.394	2.986
36	653.786	3.347 max load
40	605.469	3.545
50	567.110	4.036
60	553.792	4.661
70	458.243	5.035
80	440.515	5.039
90	431.722	5.443
100	363.499	5.814 max stroke

It is easy to see from the data above that the barbed wire reinforcement in the sandbag construction was succesful. The maximum load reached before the wall failed in the test without barbed wire was only 600 pounds. The second test proved more interesting. A wooden plate was used in testing, in order to distribute the load throughout multiple sandbags, and it failed at around 1600 pounds of force. The wall continued to hold strong all the way through 1800 pounds of force. Whats equally interesting is that the displacement of the two wall systems were nearly equal at time of failure.

Nails in the reinforcing wood beams engage the outer layers of sandbags

Sandbag Wall, With Barbed Wire

Steps	Load (#)	Displacement (in)	
1	0	0	
10	434.74	0.503	
20	601.269	0.85	
30	813.569	1.2	
40	947.023	1.495	
50	1067.65	1.777	
60	1178.993	2.17	
70	1336.247	2.525	
80	1492.285	2.751	
90	1618.047	3.554	
100	1772.195	3.72	
101	1802.173	3.752	max load
110	1753.882	3.864	
120	1687.417	3.707	
130	1646.065	3.859	
140	1694.732	4.205	
150	1673.321	4.366	
160	1612.019	4.222	
170	1557.9	4.296	
180	1533.856	4.345	
190	1463.13	4.447	
195	1456.655	4.499	max stroke

Sandbag Wall - With and Without Barbed wire

Reflections

Charlie Crowe

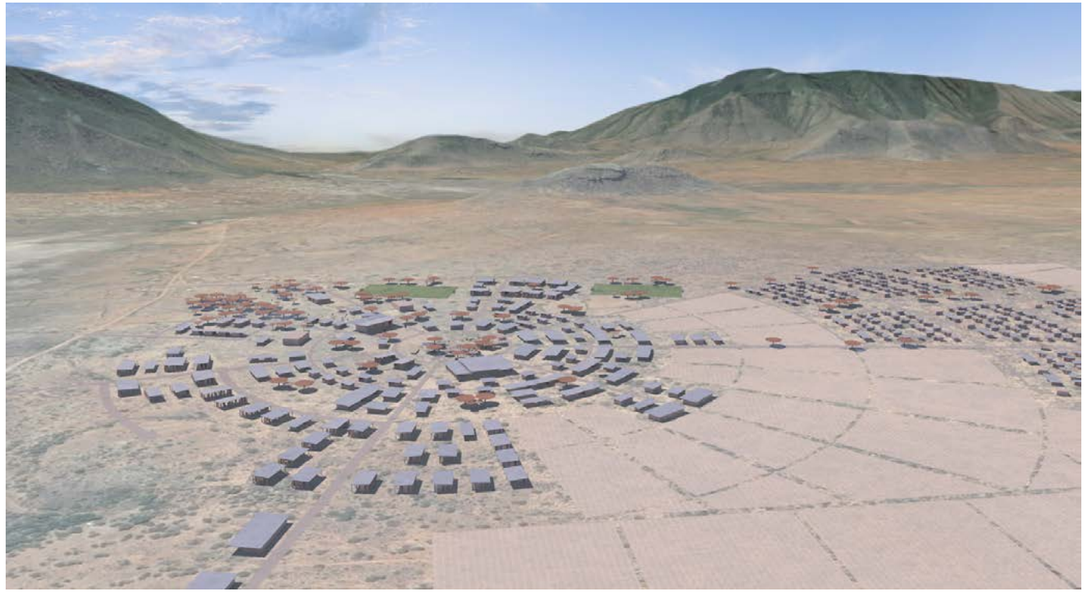
A building in Tanzania seemed like a very interesting challenge to me. It strayed from the normal college architecture project in that understanding the cost of the materials and systems at play in the project was as or more important than the design itself. The project revolved heavily around convincing the professors and outside advisors that the systems being researched were the best way to design a building in a hot humid climate. Understanding that long overhangs and lots of openings was key to the needs of the people inhabiting the project.
The most significant challenge to me was understanding how the connections inside of the project supported the structure. Working with a sandbag system required us to come up with something unique when it came to finding a way to make the wall systems act as a unit. Another serious challenge was understanding the climate. Most of the year is fairly dry, with torrential rainfall in certain significant months. Accomodating that rainfall and designing for rainfall is something that is rarely thought about in architecture school, even though it is heavily discussed.

Jesslca Fares

The three things I learned from this experience are how to communicate with architectural terminology, how wind/sun/environment affects a building, and how sandbags and adobe can be used structurally in moderate seismic zones. The type of project given contributed to this learning.
I learned about the architectural process and the constant iterations that they have to do.

Jesse Fowler

When I first heard about this class I was immediately intrigued. I hope to be able to help people in impoverished areas around the world with the skills I learn as an Architectural Engineer. I wanted to use this course to learn how we could use materials readily available to a region in the safest way possible. I was also glad to be a part of something that would benefit the local people of Karatu, Tanzania.
I had no idea how architecturally heavy this course would be. I did not understand the point of constantly going over the site plan from the beginning of last quarter to the end of this quarter we were asked to revisit the site plan on a weekly basis. I learned a lot about the architectural process and began to see a beautiful site plan develop from our team over time.
The greatest take away this course gave me was the invaluable advice given by the team at ARUP. They would review our projects and give us feedback that only a design professional in the thick of practice could give. There were professionals from all Architectural and Engineering disciplines in the construction process. They were short quick and shot from the hip. They pulled no punches and constantly asked why. There was a practicality to their wisdom, and for that I couldn't have asked for a better ARCE senior project.
I would have loved to go more into the engineering of the project but we never got to a point that we could fully engineer a wall without it needing to change the very next day. Hopefully, for the future, the classes will be able to use some of the studies we have done to push their engineering further than what we were able to accomplish.



2014/2015 Campus Master Plan

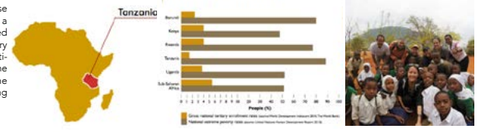
The site for the project is located in Same, Tanzania

LINKING MULTI-DISCIPLINARY LEARNING AND PRACTICE:

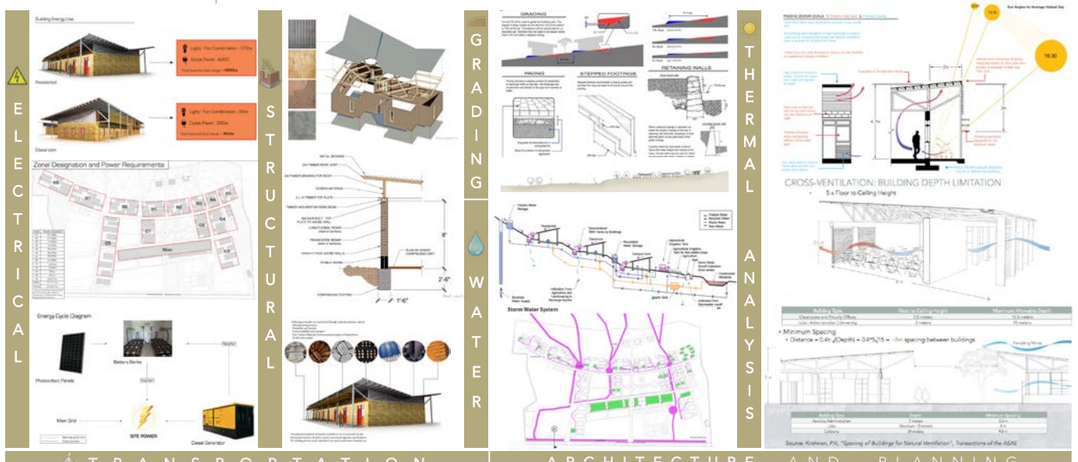
THE SAME' POLYTECHNIC COLLEGE MASTER PLAN AND SCHEMATIC DESIGN

ABSTRACT

Communities in East Africa are in need of supplemental and diversified tertiary educational opportunities to increase human capital and reduce the severe levels of poverty endemic in the region. The Same Polytechnic College is a proposed vocational training institution of higher learning to be established in the Kilimanjaro Region of the United Republic of Tanzania. The college is the pilot project of a US registered charitable organization whose primary purpose is to improve quality of life for rural communities in East Africa. The non-profit has partnered with a multi-disciplinary engineering firm and the students and faculty of the university to develop a framework around which the entire campus will grow. The idea is to strategize for the orderly and efficient growth of the campus anticipating the necessary programing, facility needs, planning principles and design goals for buildings and supporting infrastructure needed to support a projected enrollment of 1,200 students.



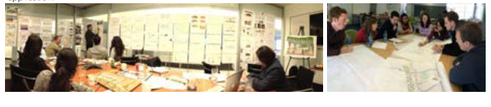
MULTIDISCIPLINARY DESIGN



Lines are drawn between residential pods and each individual school in order to show the expected movement of students and faculty throughout the day. This data is then combined with the projected schedules of each school in order to assign each line a thickness. The thickness of each line is based on the amount of people it describes with thicker lines representing larger amount of people than thinner lines.

COLLABORATION OF FACULTY, STUDENTS AND PROFESSIONAL ENGINEERS

Collaboration between over 16 students with engineering and architecture backgrounds along with the invaluable input from over 10 licensed architects, engineers and professors specializing in city and regional planning, architectural design, civil, structural, mechanical and electrical engineering resulted in the production of an all-encompassing master plan. The students had mentors who critically assessed their work and offered constructive feedback. In a typical two week cycle, students would investigate a design issue, analyze it, and then propose a solution. The students would create a graphical representation of the solution and then e-mail it with a short summary of their approach plus any questions that arose in the design process to the consulting engineering firm. Additionally, two-day workshops with the multi-disciplinary engineering firm provided a more intense forum for design integration and validation of engineering application.

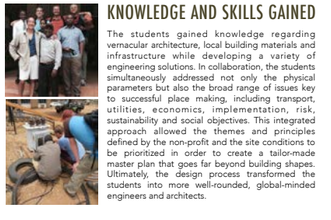


BENEFIT TO PUBLIC HEALTH, SAFETY, AND WELFARE

The Same Polytechnic College will:

- Provide students with a remarkable education, preparing them to enter their chosen profession and make immediate contributions to society.
- Serve as a resource for rural East African communities, providing students and faculty who can apply their expertise, energy, and enthusiasm to practical problems in order to produce civic, social, and cultural benefits.
- Supply the local public and private sector with a diverse pool of skilled and knowledgeable professionals.
- Provide East African nations with the professional infrastructure for stable economic development and support for essential social services such as education.

Furthermore, two basic principles embedded in the master plan include planning for sustainable, carbon-positive operations and respecting the tropical savanna environment.



KNOWLEDGE AND SKILLS GAINED

The students gained knowledge regarding vernacular architecture, local building materials and infrastructure while developing a variety of engineering solutions. In collaboration, the students simultaneously addressed not only the physical parameters but also the broad range of issues key to successful place making, including transport, utilities, economics, implementation, risk, sustainability and social objectives. This integrated approach allowed the themes and principles defined by the non-profit and the site conditions to be prioritized in order to create a tailor-made master plan that goes far beyond building shapes. Ultimately, the design process transformed the students into more well-rounded, global-minded engineers and architects.

Same, Tanzania Campus Master Plan Groundwork (2013/2014)

same polytechnic university

meet the team

Sebastiano Beretta
Angelo Freeman
Brian Murillo
Augustina Radziunaite

Sebastiano Beretta
Desio, Italy

Planning a Campus was something entirely new for me. So I learned how to deal with a large scale project. I also learned how to work in a short time frame, and how to deal with views about a whole compound rather than a single building. The workshop, the presentations and studying the precedents all helped to learn. I didn't really know what to expect from this quarter, so I cannot say what I was expecting to learn.

Angelo Freeman
Linden, CA

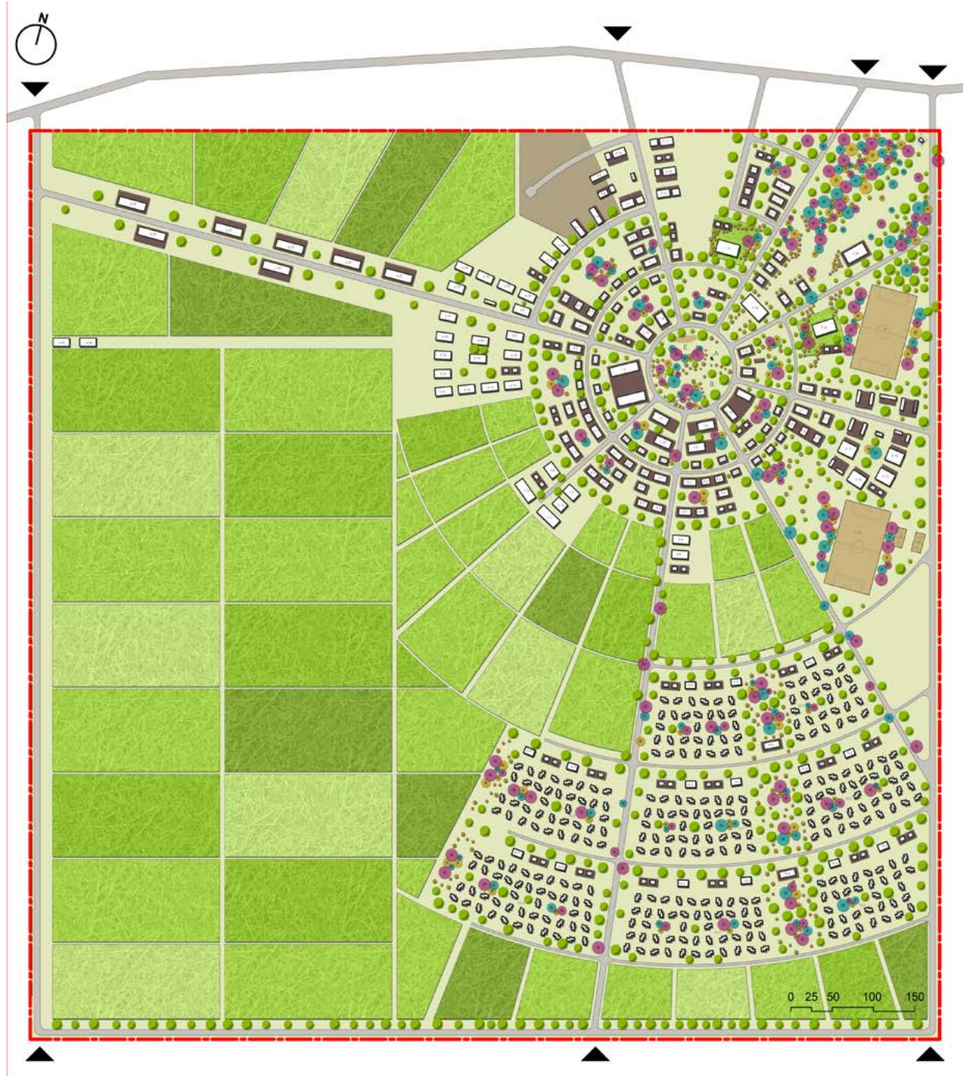
(1) Campus Design – There are so many factors to consider when designing a college campus that I never would have imagined prior to this course.
(2) Laser Cutting – I learned what materials worked well together as well as what materials lent themselves to laser cutting. For example, while our early cardboard buildings worked well for their initial purpose, our switch to mdf board made the buildings sturdier and more visually appealing.
(3) Presentation – The feedback we received from our multiple presentations showed me what elements of our project were most successful in conveying our ideas. For example, the color coding of the program seemed to really aid in the understanding of our audience.

Brian Murillo
Las Vegas, NV

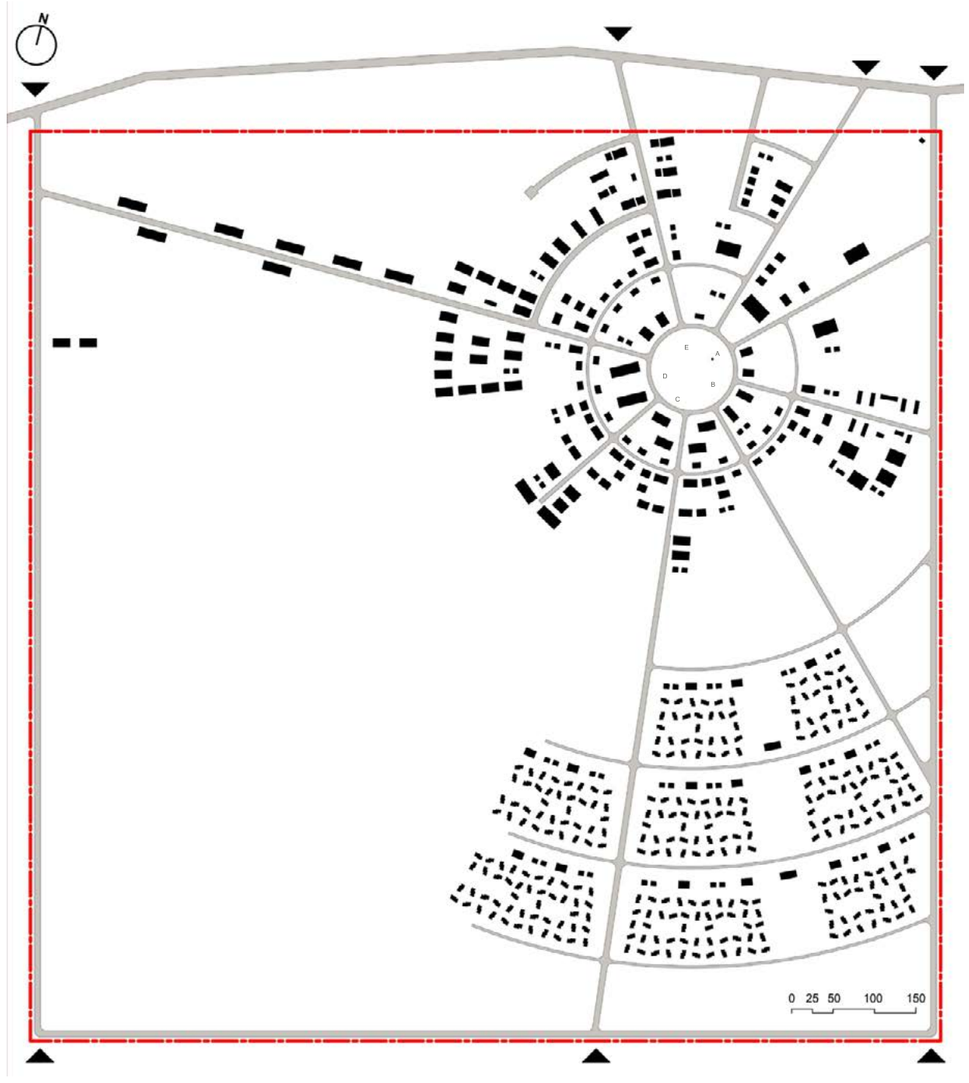
Having not ever worked on a master plan, it really helped that we were presented with research on the big things to consider for campus planning. It also helped we were asked to continue that research in the form of figure-ground drawings/analysis. I would also say that it was a fairly smooth transition from the "typical" architecture design to planning design. We started with core concepts and applied those to all of our decisions. I enjoyed working with other designers because the sharing of ideas went really well, and pushed the design further than if we worked individually. I guess the biggest thing I learned was how to translate my typical design process into a different type of project, one I never dealt with before. The same values apply.

Augustina Radziunaite
Vilnius, Lithuania

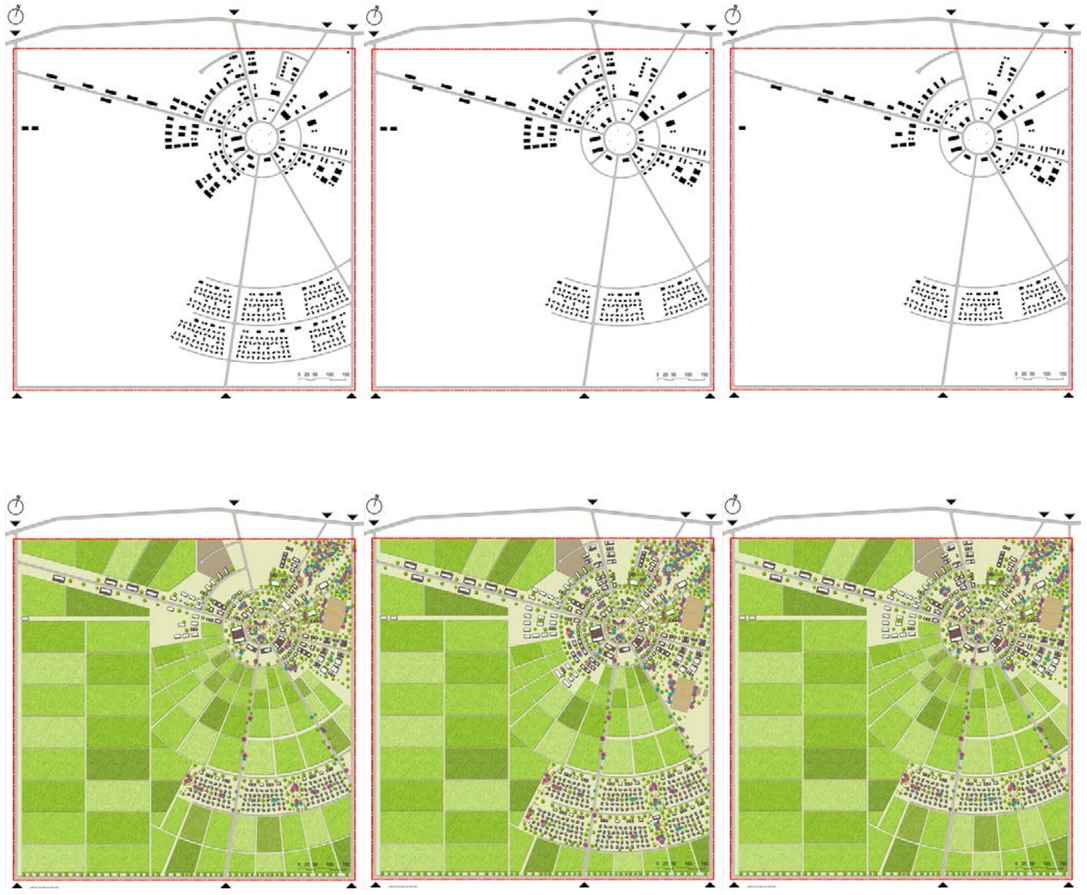
1) Presentation. Again, presentation for ARUP team placed a much heavier responsibility on us and I felt much more pressure to cover all the things as professionally as possible.
2) Urban planning practice. Up till this course my exposure to urban planning was very limited. I feel that this type of projects should be more often incorporated into curriculum.
3) Patience. Every person in a team had a different work style and approach. It took patience and understanding to manage work with three other people.



Final Campus Master Plan

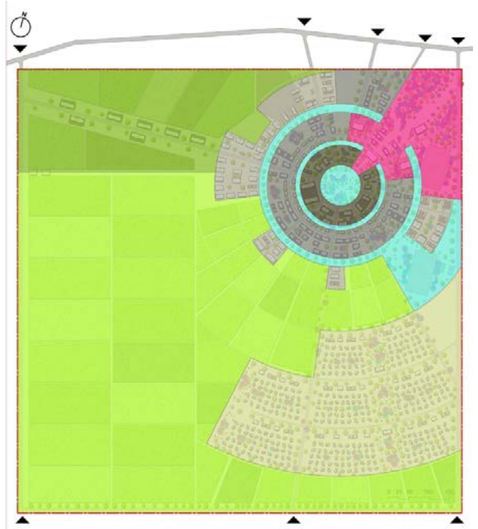


Figure/Ground Final Campus Master Plan

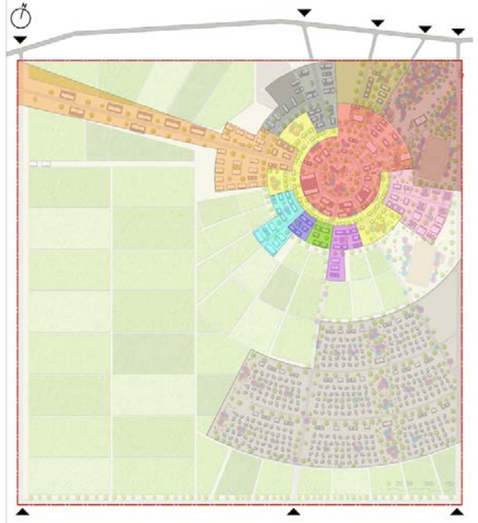


Master Plan Phasing

- Academic Core
- Public Area
- Faculty Offices and Classrooms
- Labs and Workshops
- Grazing Fields and Stables
- Agricultural Fields
- Student and Faculty Housing
- Recreational Stripes

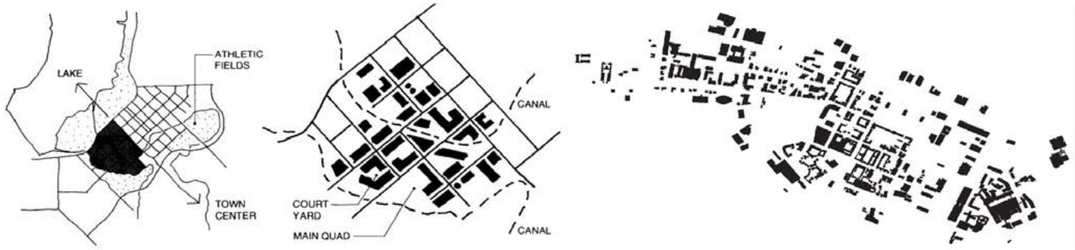


- Public zone
- Administration and Student Facilities
- Classrooms
- School of Automotive Mechanical Technology (SAMT)
- School of Agriculture, Food, And Environmental Sciences (SAFES)
- School of Building Sciences and Construction Technology (SBSCT)
- School of Business Managment (SBM)
- School of Tourism and Hospitality (STH)
- School of Social Sciences (SSS)
- School of Education (SE)
- Housing
- MISD
- Fields



Campus Master Plan Zoning Diagrams

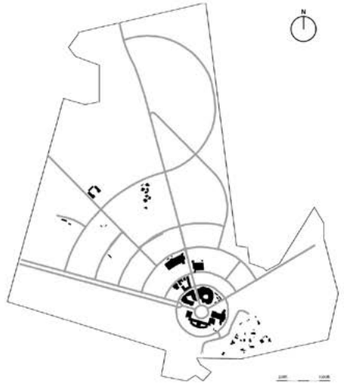
research: precedents: grid type (linear)



UC Merced

Yale University

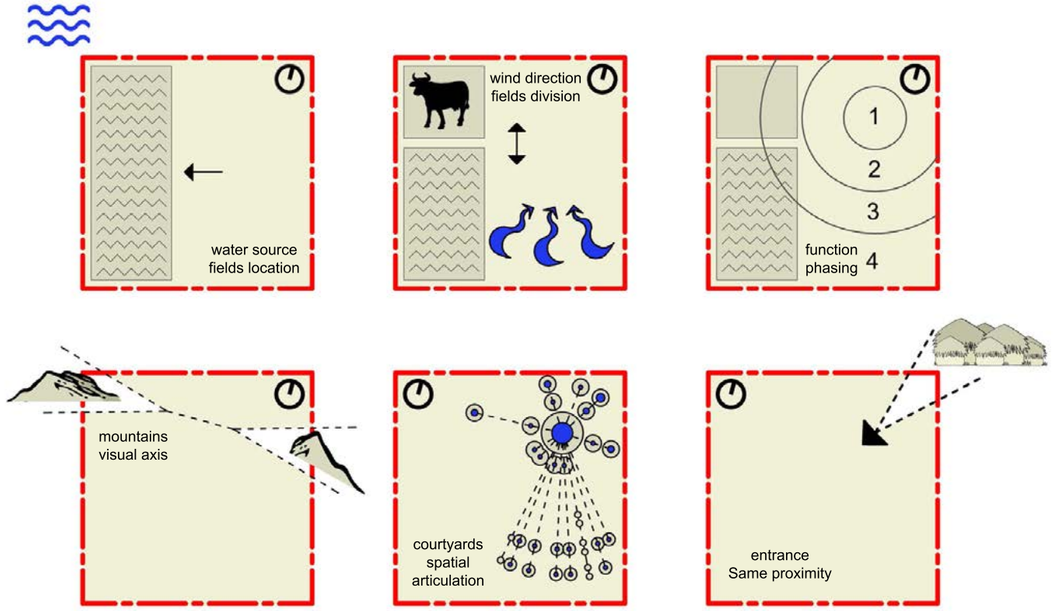
research: precedents: radial type



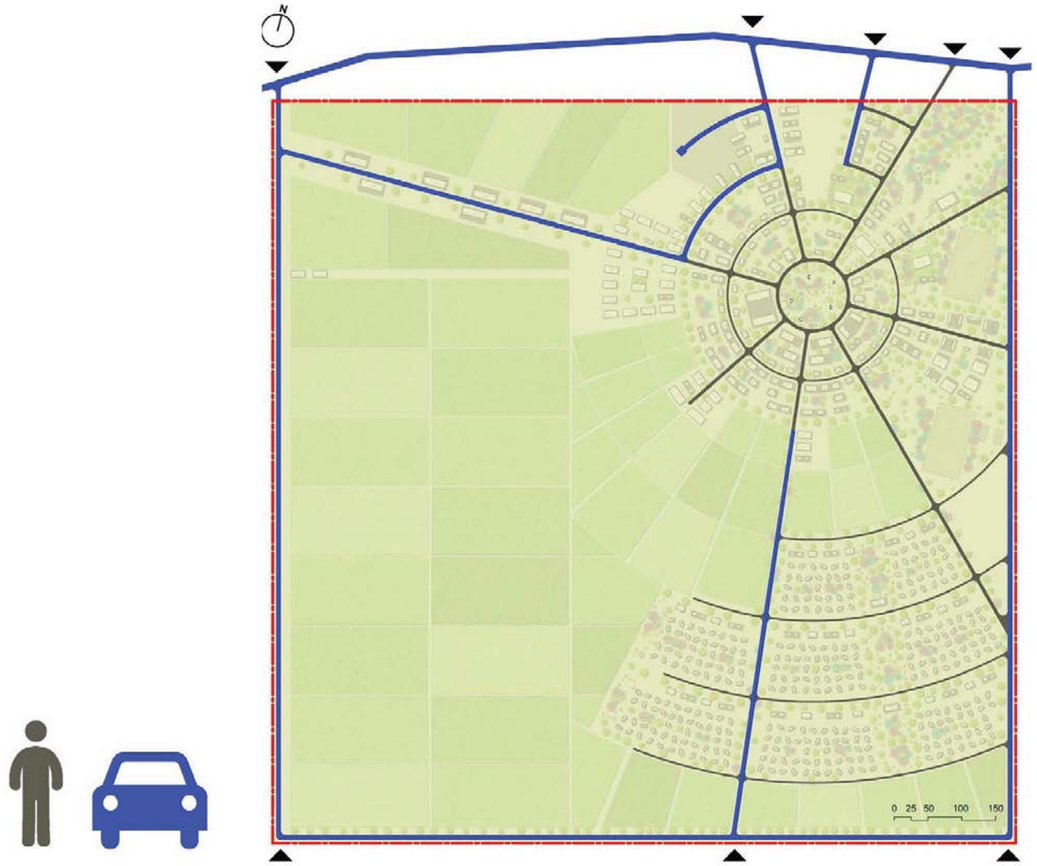
National University of Science and Technology Zimbabwe

Indian Institute of Technology

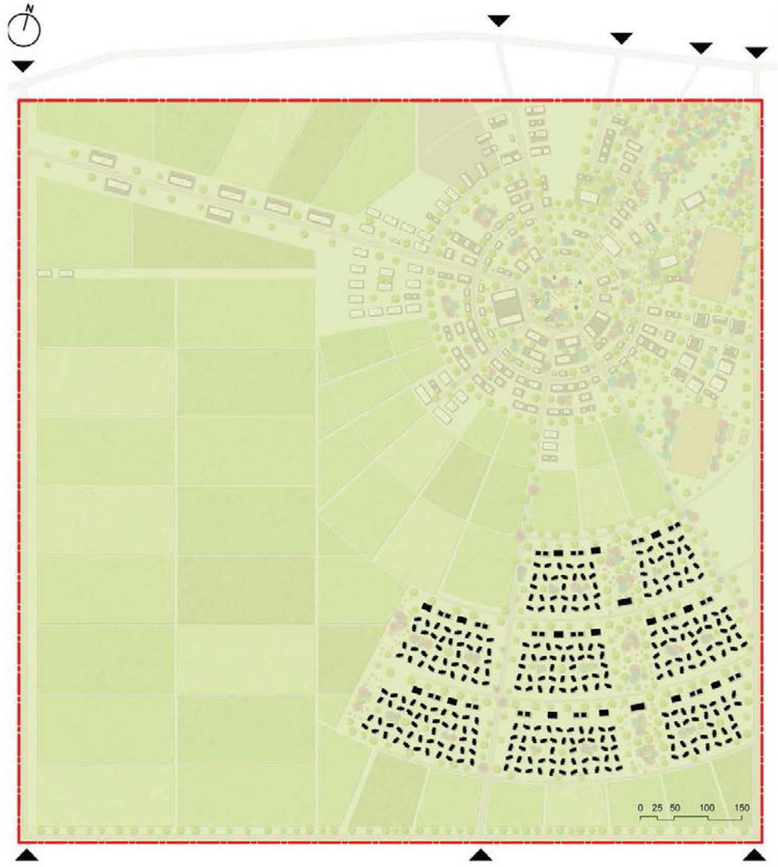
Campus Planning Types Research



Core Design Values

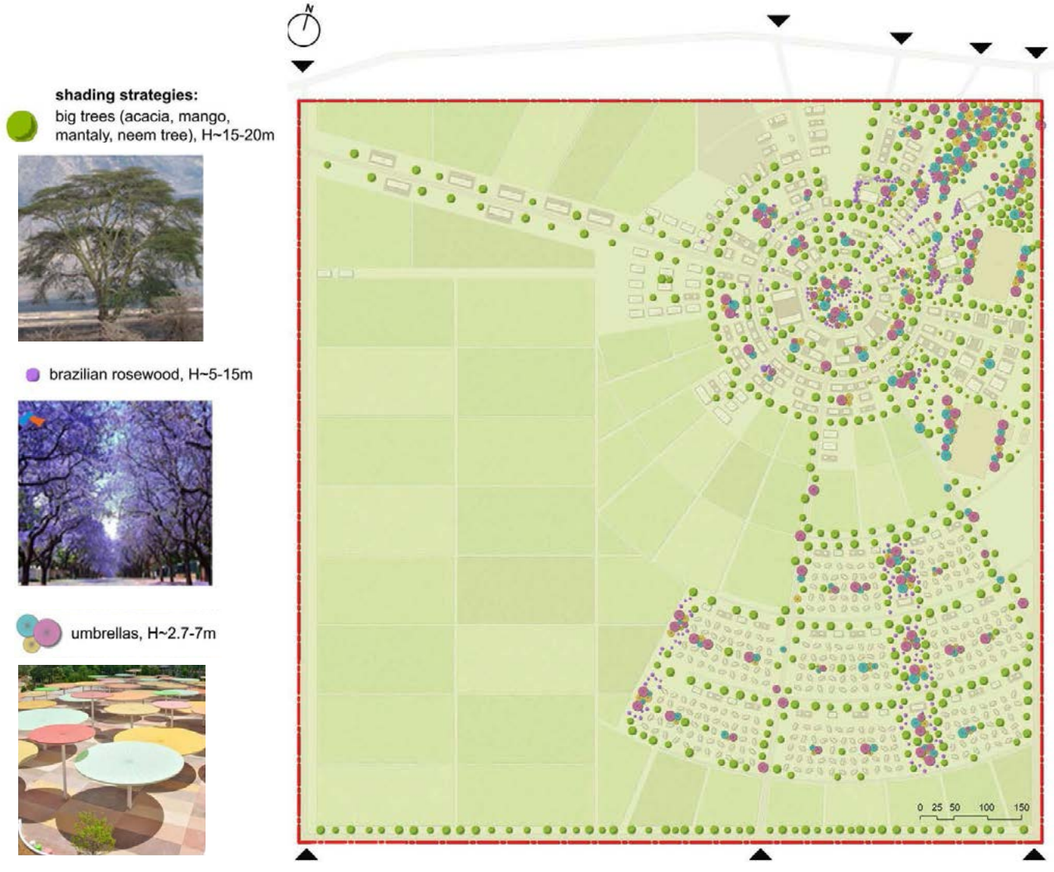


Campus Circulation: Pedestrian vs Vehicular

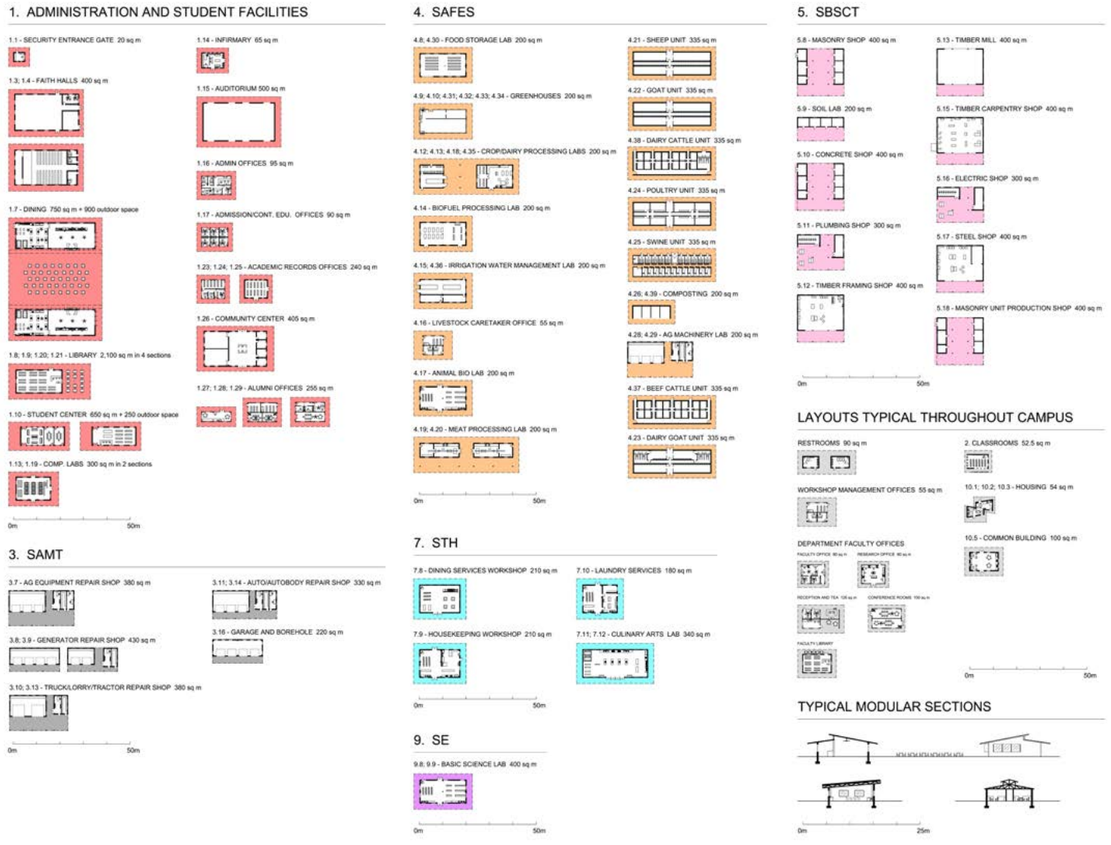


housing:	students		faculty	total
phase #1	78	+	38	116 (464 people)
phase #3	81	+	47	128 (512 people)
phase #4	56			56 (224 people)
total:	215	+	85	300 (1200 people)

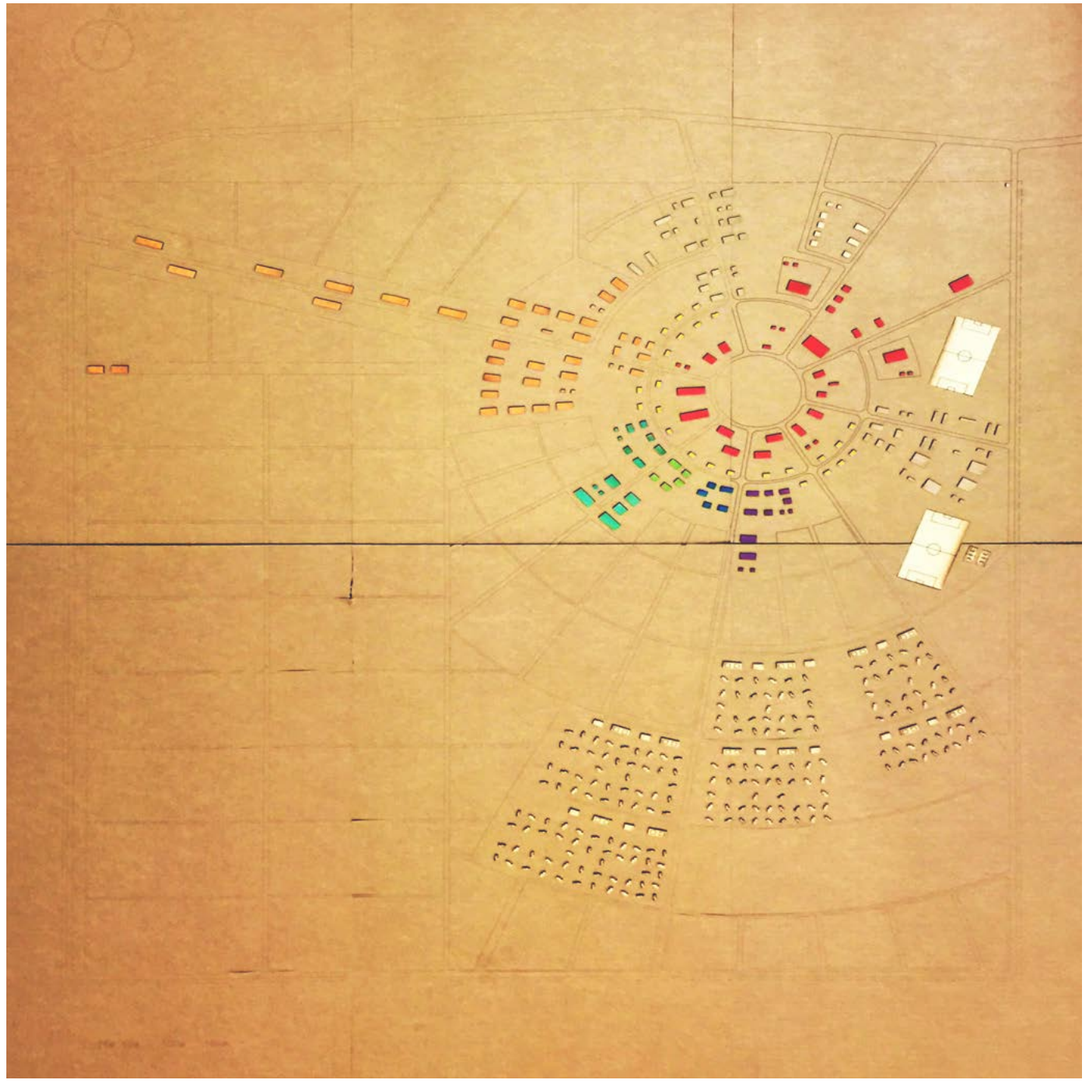
On Campus Housing



Campus Shading Strategies



Program Inventory: Plans and Sections



Project Models

This quarter we worked on the Same Polytechnic College Master Plan near Same in the Kilimajaro region of Tanzania. We started by researching general typologies and principles of university campus master planning, local contexts, and analyzing previous years iterations.

As we started the design process, we laid out some core values. We based the agriculture fileds near the water source located on the Northern West corner of the site. We separated grazing fields on the Northern West side to avoid the wind carrying smells across the campus. We focused on the various aspects of project phasing. We emphasized local natural features by developing a visual axis between two neighboring mountains. We subdivided spaces into primary and secondary cores with courtyard spaces, creating cozy enclosures for students and faculty. Lastly, we placed the main entrance to the campus on the Northern East side of the site to have the most direct access from Same to the campus.

The master plans starting as a grid type, with a boulevard to visually connect the mountains; and all the functions were distributed along it. We concurrently designed the radial type where every function would get a different spoke to develop from. As we became more confident with the size of the site, understanding walkability issues and the clustering of similar functions together, we came to the conclusion that the radial scheme was the better choice. It was the more flexible option for further campus development. It was convenient for separating circulation and noise levels, and it was an efficient way to fill the site without compromising functional connections or adding unnecessary infrastructure. The campus structure consists of an academic core, faculty offices and classrooms, then labs and workshops. The area between the academic core and the entrance to the campus is dedicated to the needs of the community, including a daily market, community center, and other administration facilities. On the southern end of the campus we placed the housing units, and the rest of the site is dedicated to the agricultural and grazing fields.

Programmatically, we started by working off of the program that was previously defined. To understand it better we broke it down building by building, and created an inventory. We went into more detail by correlating the buildings to our iteration's current spatial arrangements, and tweaking them according to the needs we thought the master plan lacked. Eventually we developed new plans for most of the campus buildings with characteristic sections.

Circulation was mainly oriented towards pedestrians and most of the campus paths are solely dedicated for them. Some roads can be accessed by vehicles, but are mainly for site maintenance needs.

The shading strategy was based on the differentiation between big trees, decorative trees and the umbrella structures. Their placement along the roads as well as above social gathering spaces was strategic. To have more shading options, we have incorporated umbrella structures that also can perform as water collection element, artificial outside lighting and power generator if it had the necessary solar battery system.

Geographically we had to be aware of the sun path due its path relative to the equator, as well as high humidity levels. Another big climatic concern for us was the wind, which flows mainly from the South with occasional fluctuations to the west and to the east. The last big concern relates to seismic activity due to the site's proximity to the East African Rift system. Due to these seismic factors every structural element has to be reinforced. The most common local wall structure is reinforced clay masonry. This was taken into account when choosing how the buildings would be constructed, and with what materials.

Final Renderings

Final Renderings

2016/2017 Campus Master Plan

The site for the project is located in Same, Tanzania

new same polytechnic university

meet the team

Sebastiano Beretta
Snehal Daliya

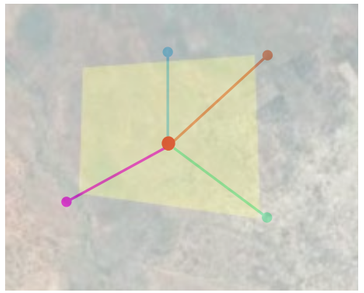
Sebastiano Beretta
Desio, Italy

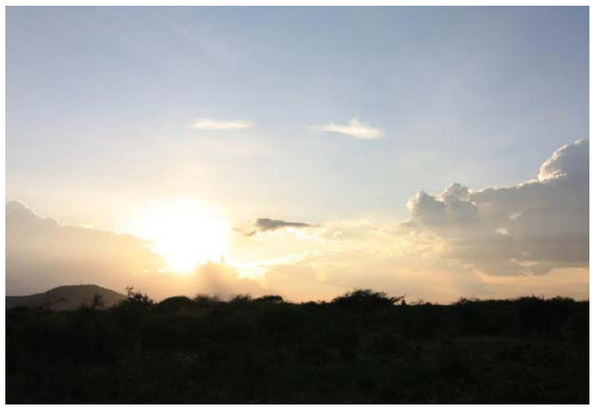
Planning a Campus was something entirely new for me. So I learned how to deal with a large scale project.
I also learned how to work in a short time frame, and how to deal with views about a whole compound rather than a single building. The workshop, the presentations and studying the precedents all helped to learn. I didn't really know what to expect from this quarter, so I cannot say what I was expecting to learn.

Snehal Daliya
India

There are so many factors to consider when designing a university campus that I never would have imagined prior to this project.

New Site (103.85 ACRES) is 1/3 rd of the size of Old Site (315 ACRES)





Site Photographs: Views from the Site

New Master Plan

ADMINISTRATION AND STUDENT FACILITIES
Library,Cafeteria,Admin,Student Services, Auditorium and Non Profit Buildings

SAFES
School of Agriculture, Food and Environmental Sciences

SBSCT
School of Building Science and Construction Technology

STH & SE
School of Tourism and Hospitality & School of Education

SBM
School of Buisness Management

SAMT
School of Automotive and Mechanical Technology

Common Facilities
Classroom, Faculty Offices, Housing, Restrooms

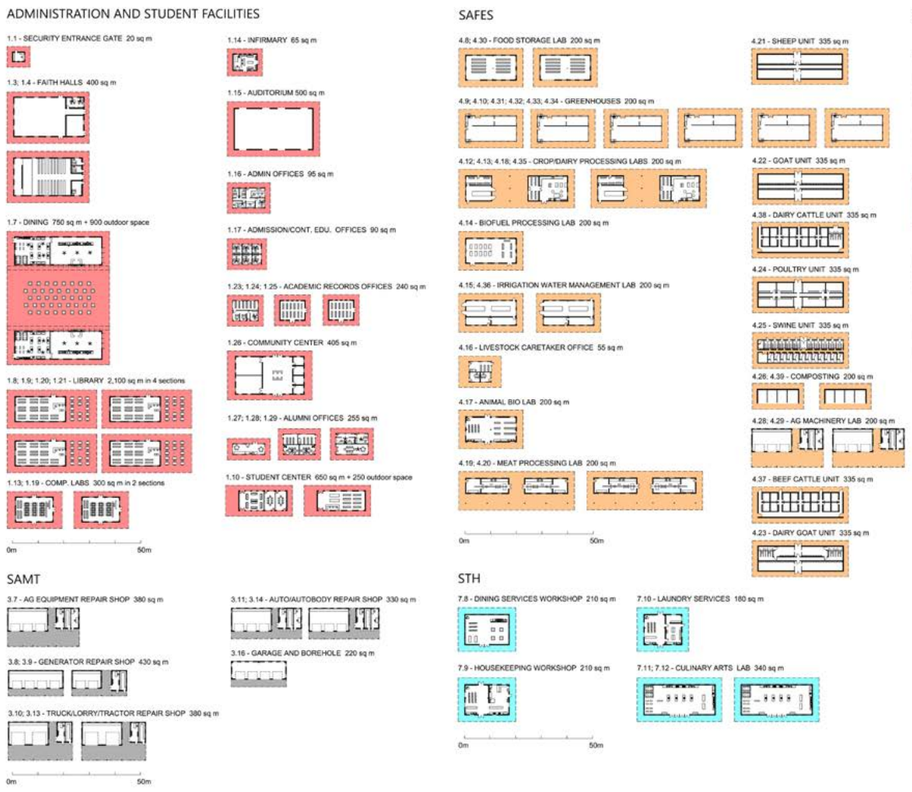
Agricultural Fields

Color Coding Legend

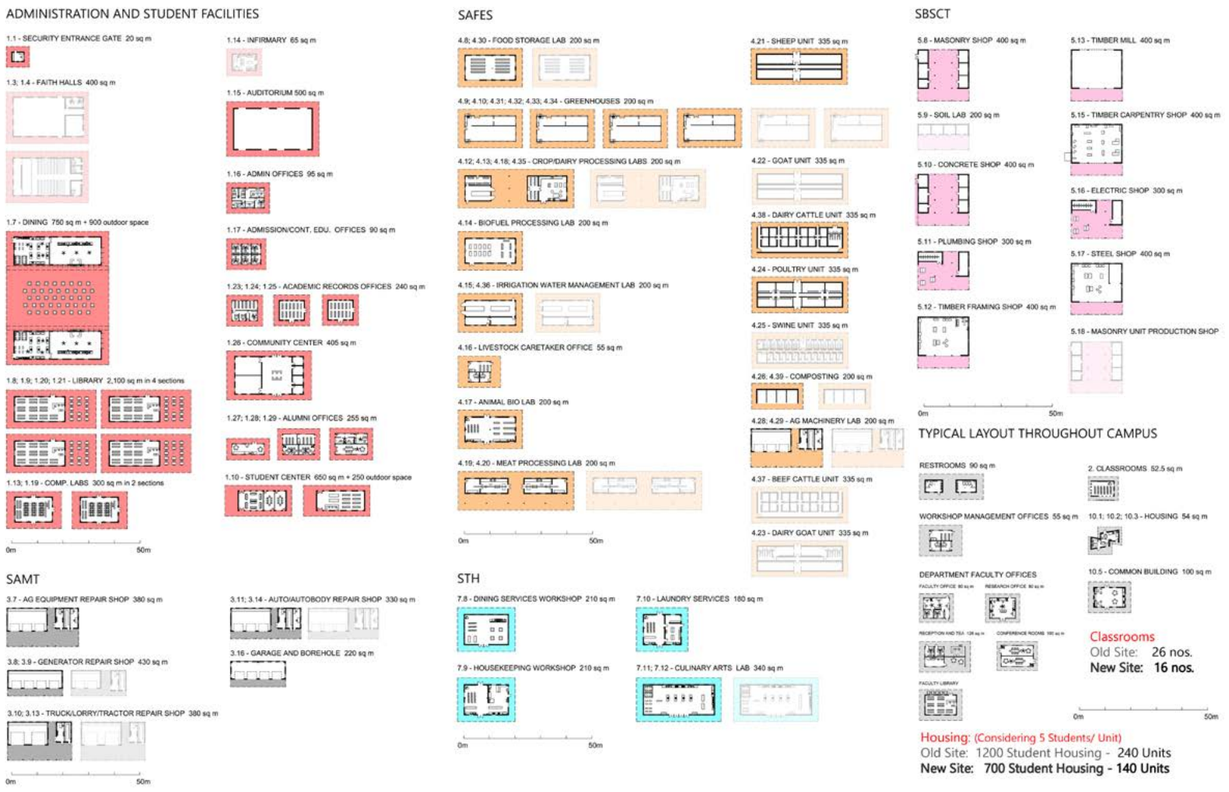
Phase 1

Phase 2

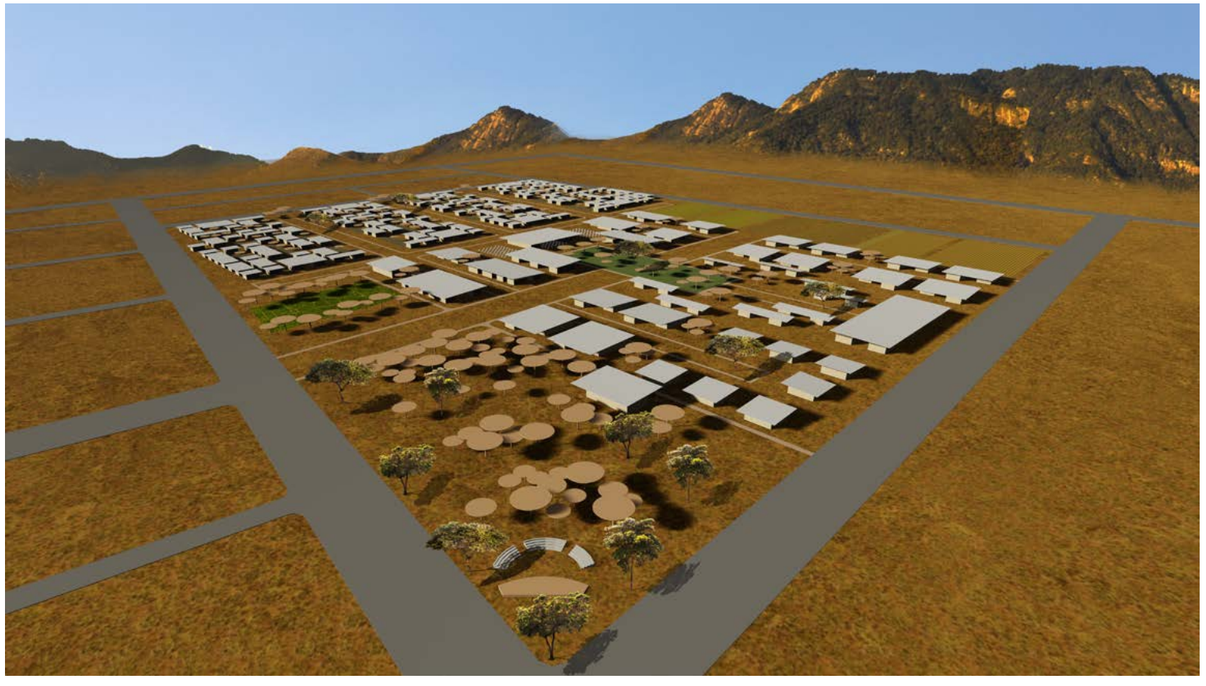
Phase 3



Building Layouts: Old Site



Building Layouts: New Site



Main Axis- Conceptual Rendering

Central Park- Conceptual Rendering