



BUILDING BIOMIMETICALLY

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A stylized, handwritten signature in black ink, appearing to read 'Kaitlyn Snider'.



EXTERIOR RENDERING

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THESIS INFORMATION

THE QUESTION

How can we utilize the tactics and lessons learned from nature to create more environmentally friendly everyday systems?

THE DIRECTIVE

- Create environmentally friendly buildings
- Reduce our reliance on fossil fuels
- Design a more sustainable heating and cooling system using Biomimicry
- Reduce energy consumption for current HVAC systems



STATEMENT

One of the organisms that has the potential to influence one of the most used everyday systems, heating and cooling, the termite species *Macrotermes natalensis*. The *M. natalensis* utilize their natural surroundings of clay, soil, and dung as well as termite saliva, to build mounds that create a self-regulating, passive heating and cooling system for its inhabitants.

ARGUMENT

While the world advances in technology and practices, termite mounds have remained the same in structure and purpose, not fighting against change but rather adapting and evolving. When it comes to the design of more sustainable practices in design, we can learn from such species as they have proven their methods of passive heating and cooling are successful and stand the test of time.



FRONTIERS SCIENCE/TERMITE MOUND DIAGRAM

THE RESEARCH

BIOMIMICRY

Noun. The design and production of materials, structures, and systems that are modeled on biological entities and processes (Oxford Dictionary)

○ ————— GATHER INFORMATION —————

TERMITES

M. natalensis

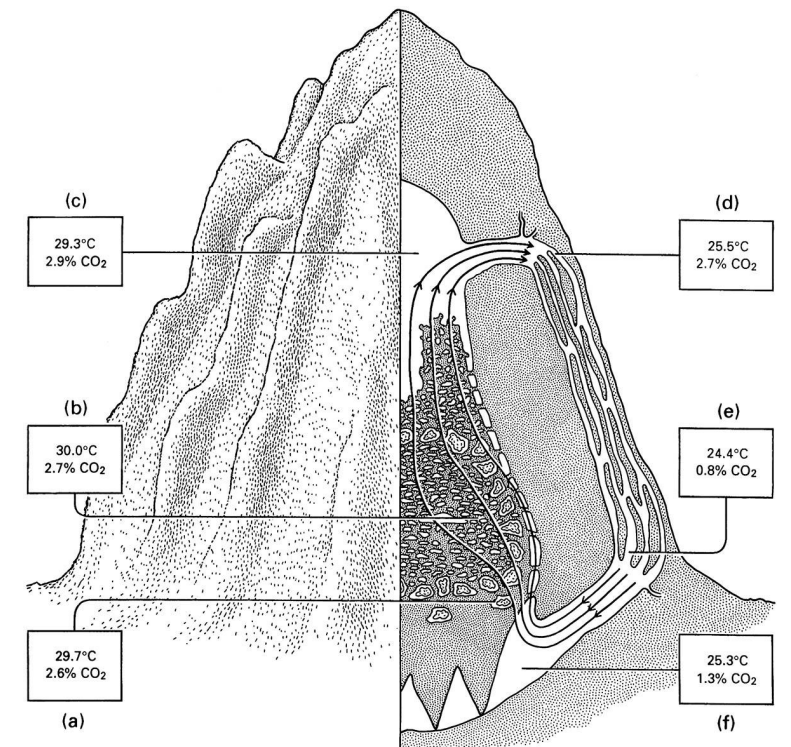
- Fungus-growing termite native to South Africa
- Use of natural grounds and surroundings to create mounds



SHUTTERSTOCK / TERMITES



SHUTTERSTOCK / TERMITE MOUND



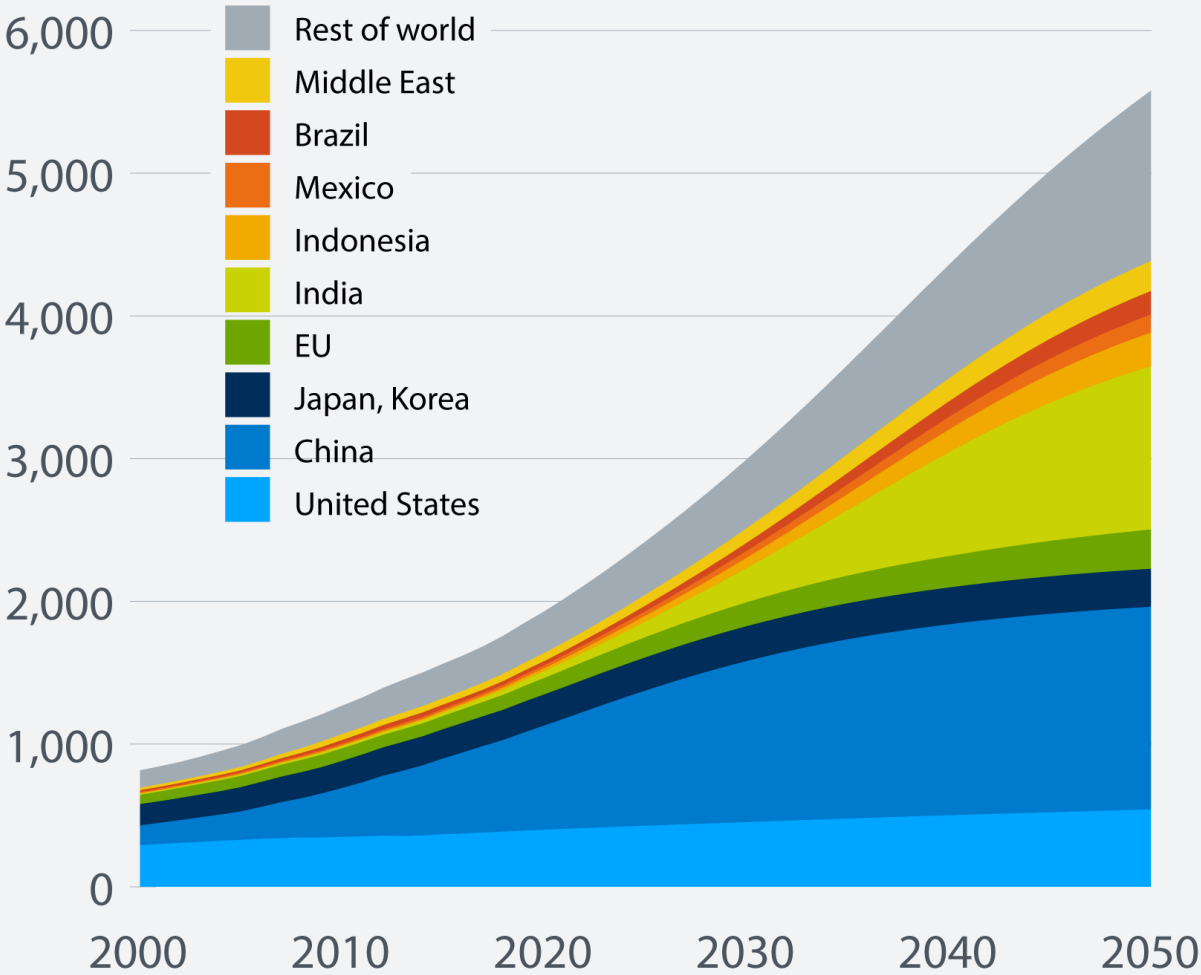
SCIENCE DIRECT / SECTION TERMITE MOUND



SHUTTERSTOCK / TERMITE MOUND

Growing global demand for cooling

Projected number of air conditioning units in use worldwide (in millions)



Source: International Energy Agency

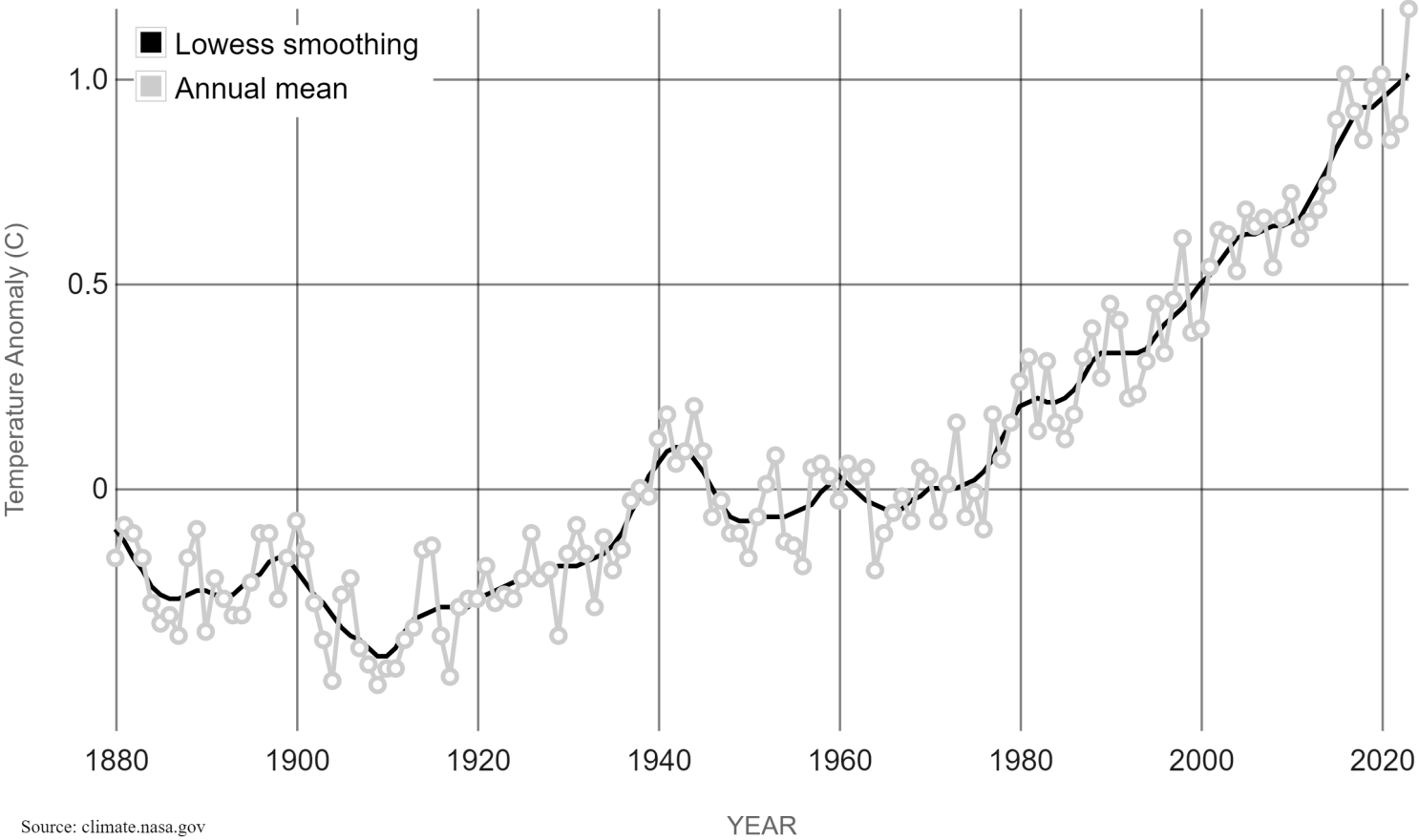
THE RESEARCH

HVAC AND CHANGING TEMPERATURES

- Cascading effect that ultimately ends in drastically changing temperatures on earth
- Heating, Ventilation, and Air Conditioning (HVAC) Account for 4% of global greenhouse gas emissions
- Twice the emissions from the aviation industry
- There is a need to adapt as temperatures become more drastic and HVAC use exponentially increases

(Washington Post)

GATHER INFORMATION



Source: climate.nasa.gov

YEAR

THE RESEARCH

PASSIVE HEATING AND COOLING

- Architectural technique used as early as the Egyptians
- Utilized primarily to promote natural ventilation within interiors by using the surrounding earth and strategically placed elements to direct wind

○ ————— GATHER INFORMATION ————— |

THE HISTORY

- Egyptian reed technique employed the use of evaporative cooling
- Middle Eastern wind catchers would direct air flow and use the principles of thermodynamics of cold air falling and hot air rising

THE TAKEAWAY

- Architects previous **implementation** of individual techniques as whole within one building rather than focused on a single aspect to be used universally
- Create a more universal system that can move passive architecture towards less of a design principle and more of a design system



SHUTTER STOCK / EGYPTIAN PASSIVE COOLING



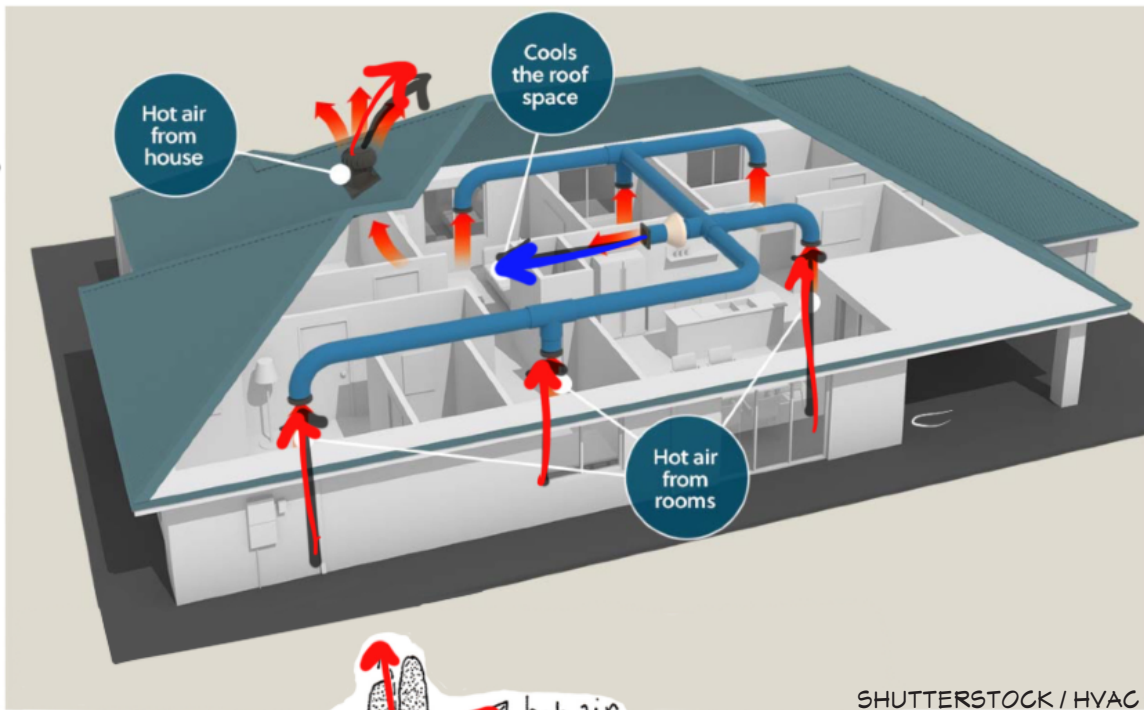
SHUTTERSTOCK / WIND-CATCHER

THE CRITIQUE

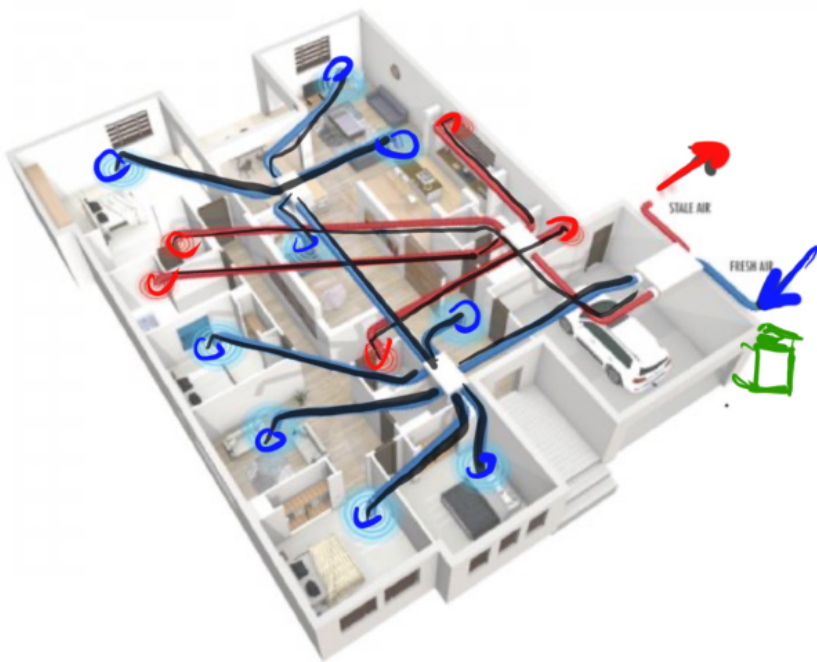
HVAC SYSTEMS

PROS:

- SEPERATES HOT/ COLD AIR
- DEPOSITS AIR INTO SPECIFIC AREAS
- USES INSULATING MATERIALS



SHUTTERSTOCK / HVAC



SHUTTERSTOCK / HVAC

TERMITE MOUNDS

PROS:

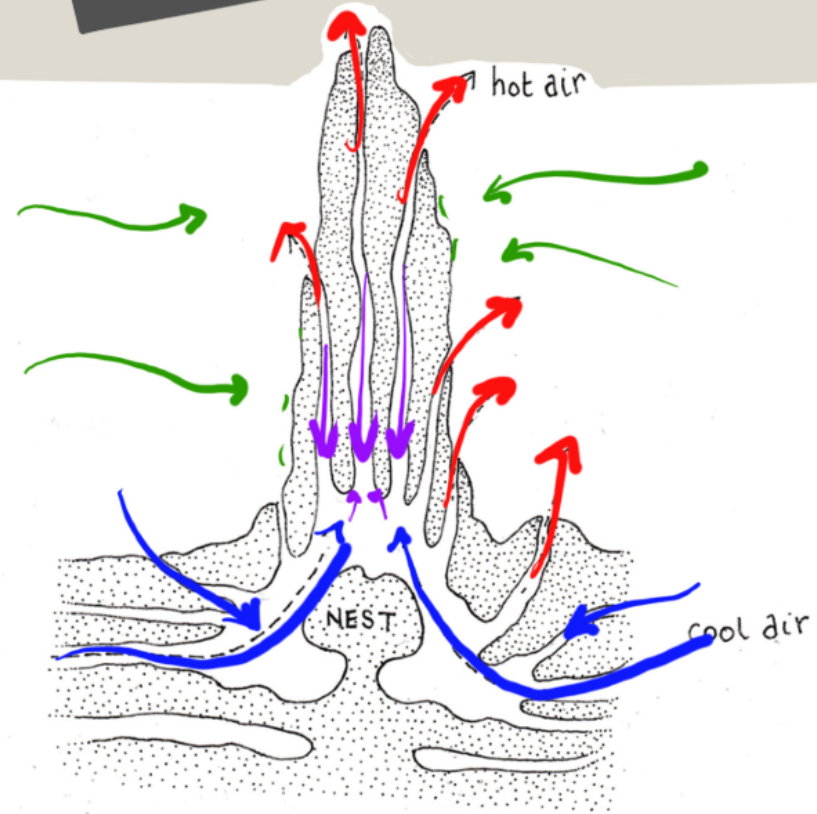
- VERTICAL CONSTRUCTION
- POROUS MATERIAL
- ADAPTABLE
- EVAPORATION TECHNIQUE WITHIN CENTRAL ROOM

CONS:

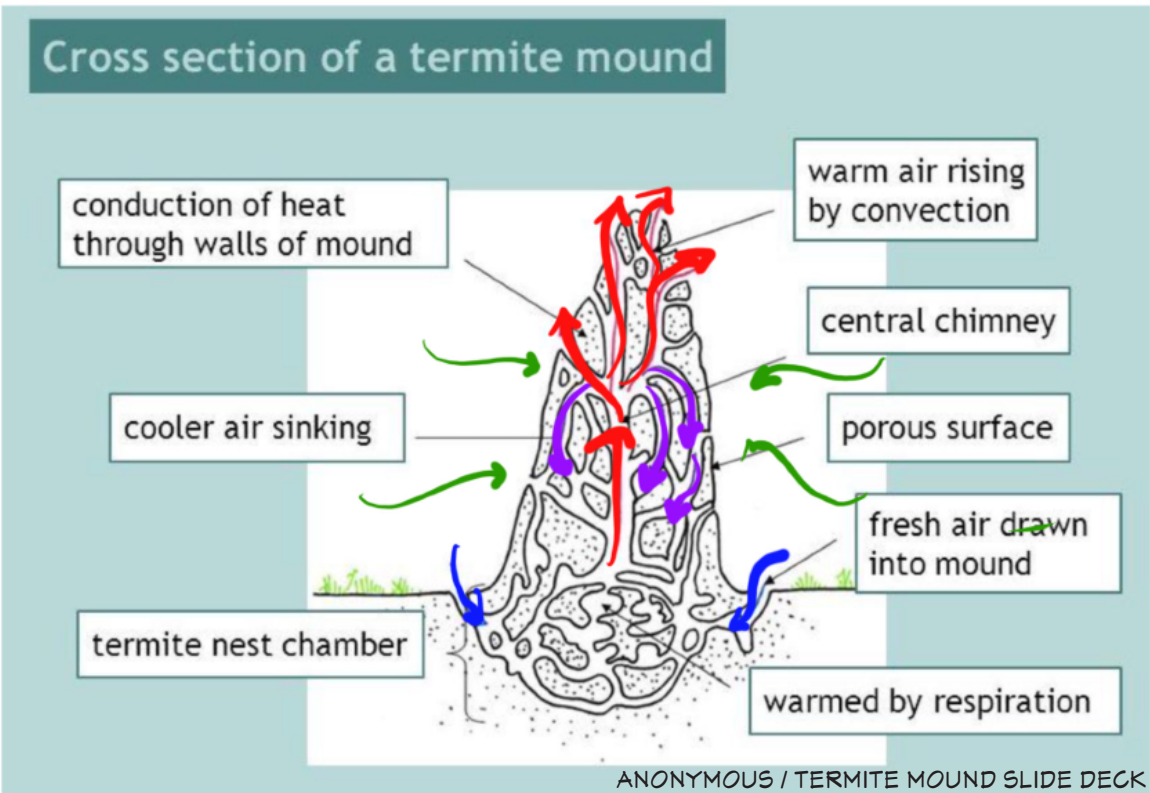
- MIXES HOT/COLD AIR
- CAN BREAK DOWN IN SEVERE WEATHER

CONS:

- HORIZONTAL DESIGN
- REQUIRES A COOLING AGENT



PBS / TERMITE MOUNDS



ANONYMOUS / TERMITE MOUND SLIDE DECK

SIMILARITIES:

- EXIT CHIMNEYS
- AIR DEPOSITS AND COMES FROM ABOVE
- COMPLEX PATHWAYS

THE PRECEDENTS

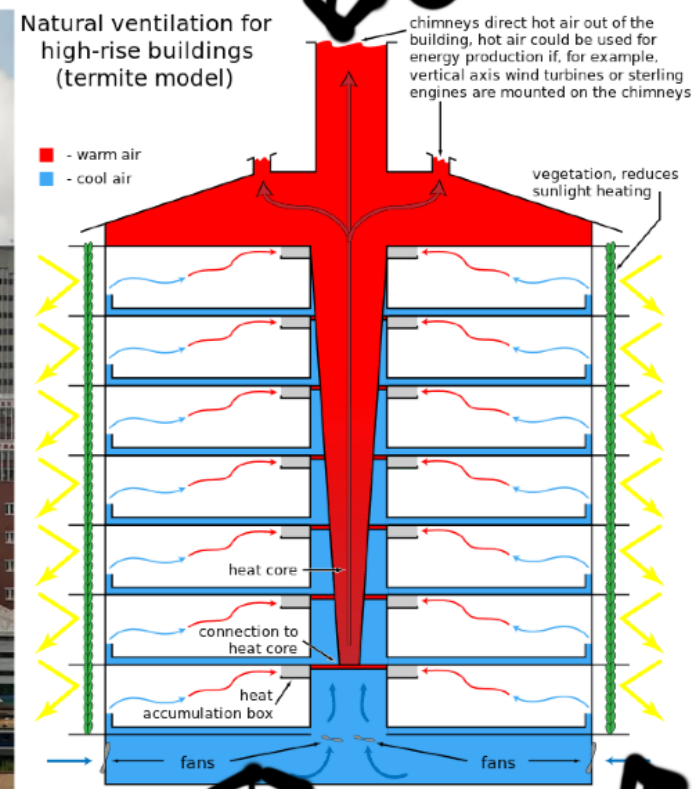
THE EAST GATE CENTRE

HARARE, ZIMBABWE // 1996

LOTS OF LARGE
WINDOWS

EXIT CHIMNEY

VERTICAL SYSTEM



HOT/ARID CLIMATE

AIR FLOWS IN
FROM BELOW

VEGETATION FOR
EVAPORATIVE
COOLING

PULLS AIR
FROM BELOW

THE PRECEDENTS

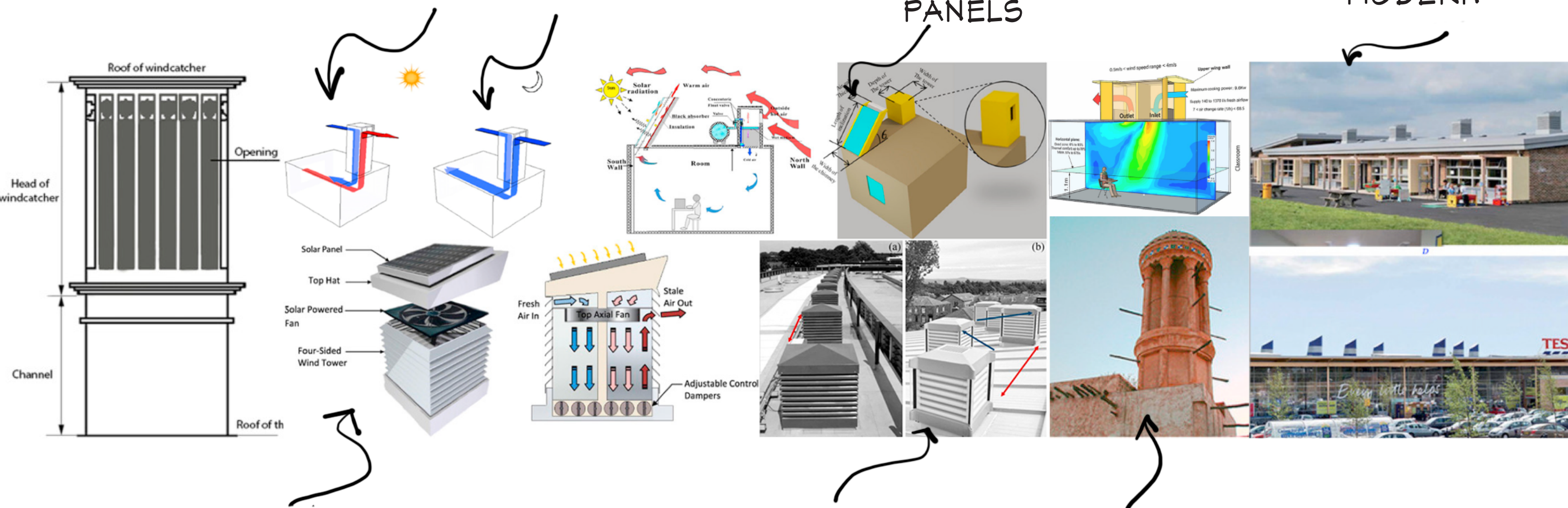
WINDCATCHERS
MIDDLE EAST // 14TH CENTURY

CIRCULAR
VENTILATION
DURING DAY

COOL AIR AT NIGHT

USE OF SOLAR
PANELS

MODERN

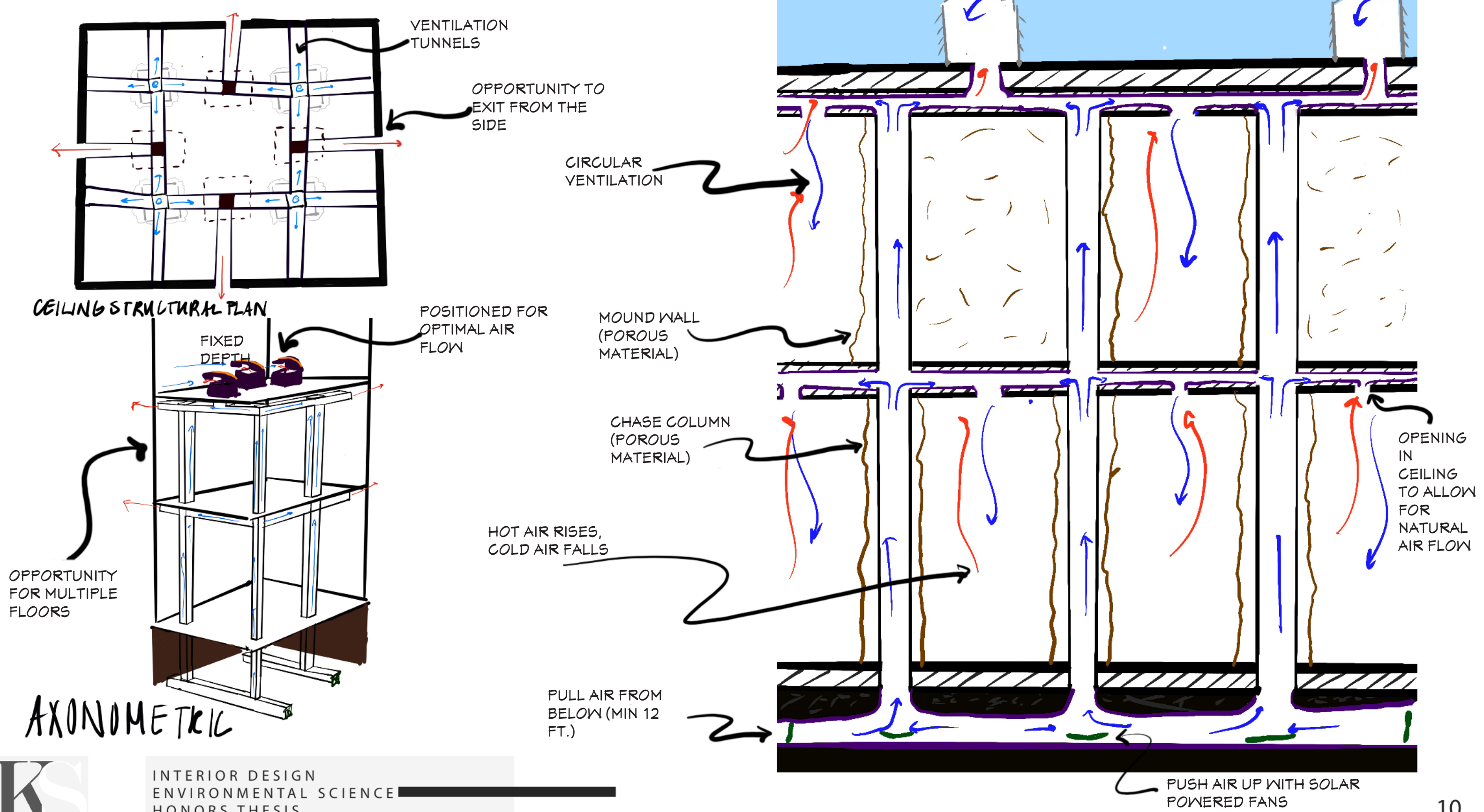


EVOLUTION TO INCORPORATE
FANS AND MOVE TO A MORE
MODERN LOOK

STAGGERED
FORMATION

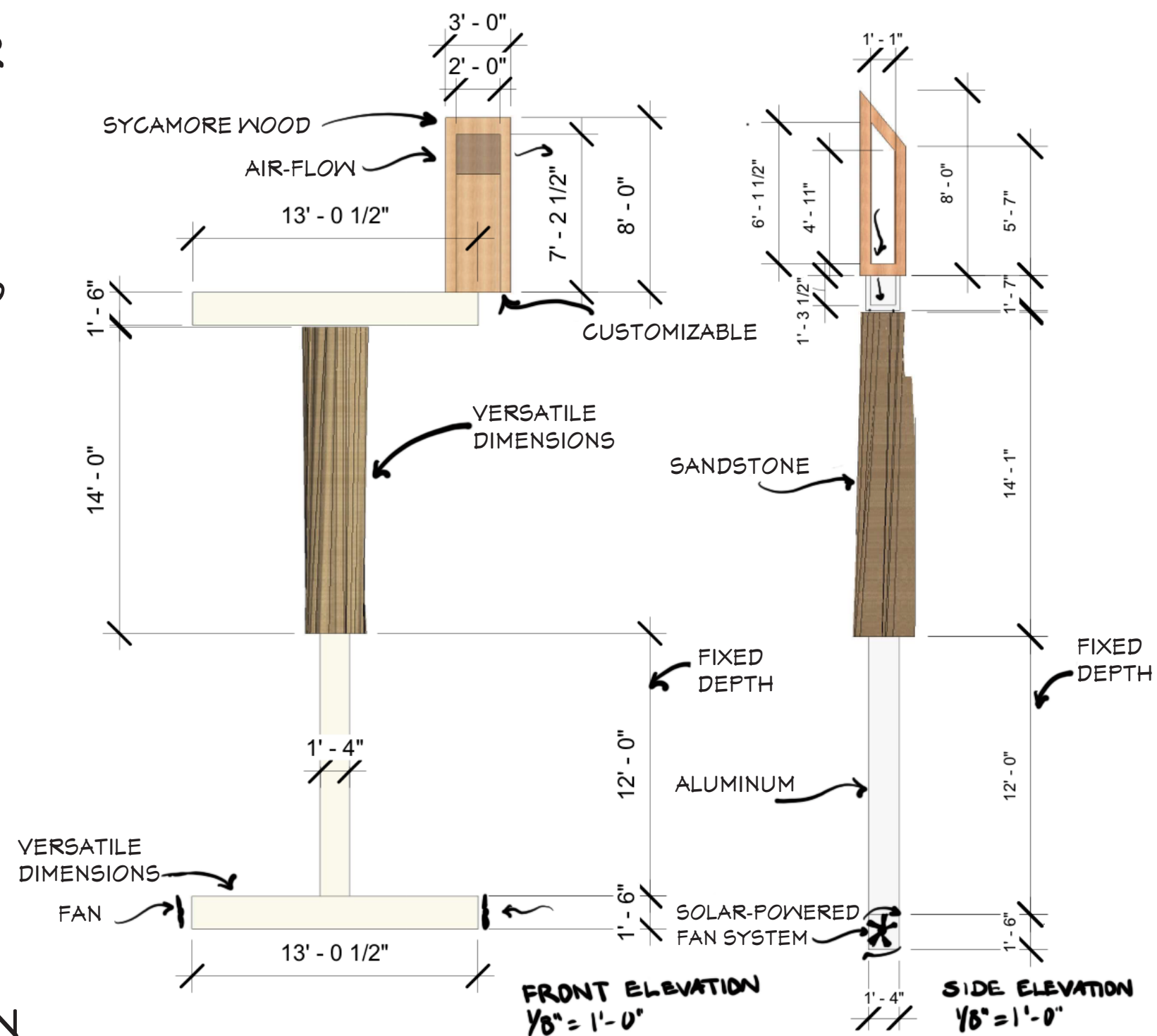
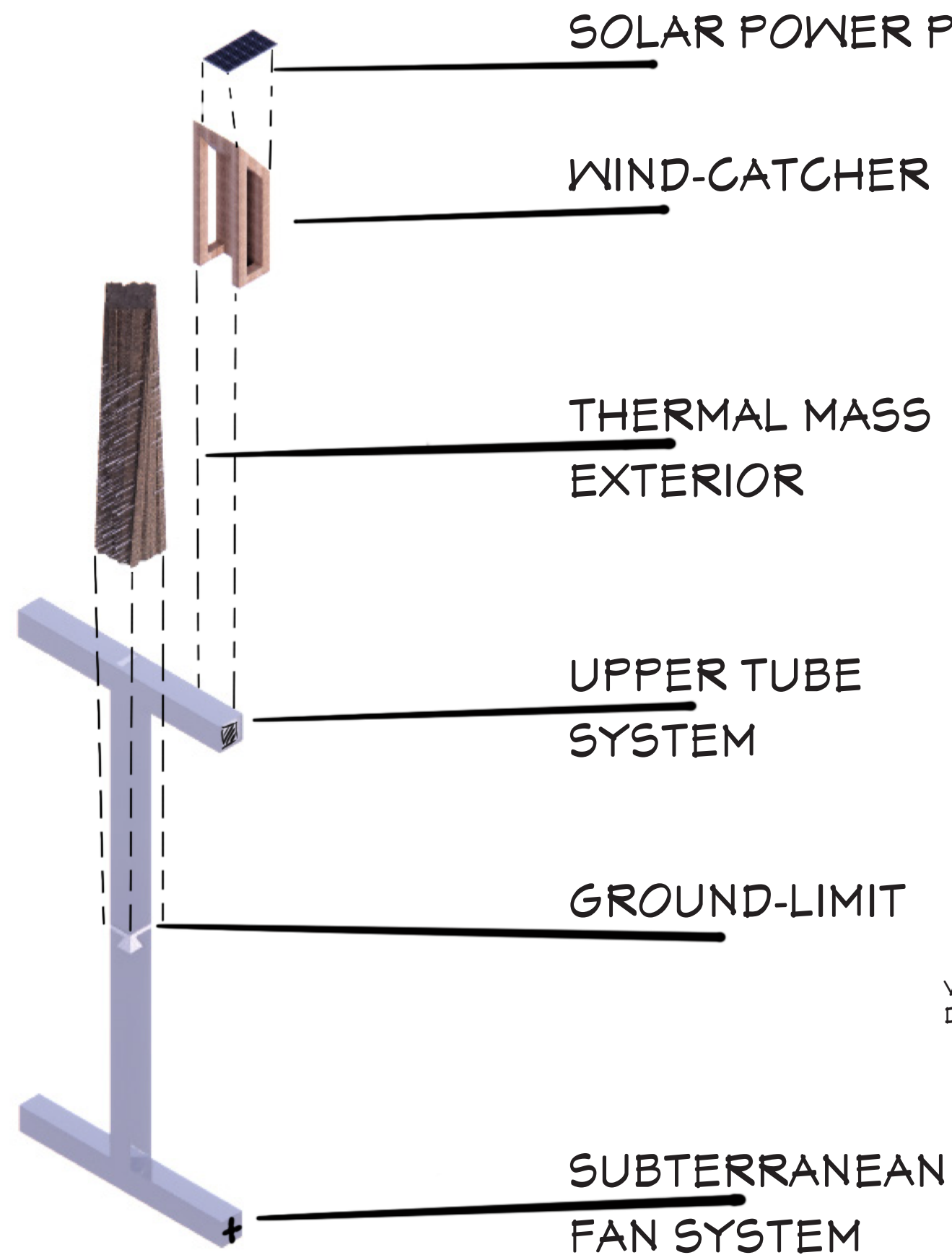
TRADITIONAL

THE DEVELOPMENT

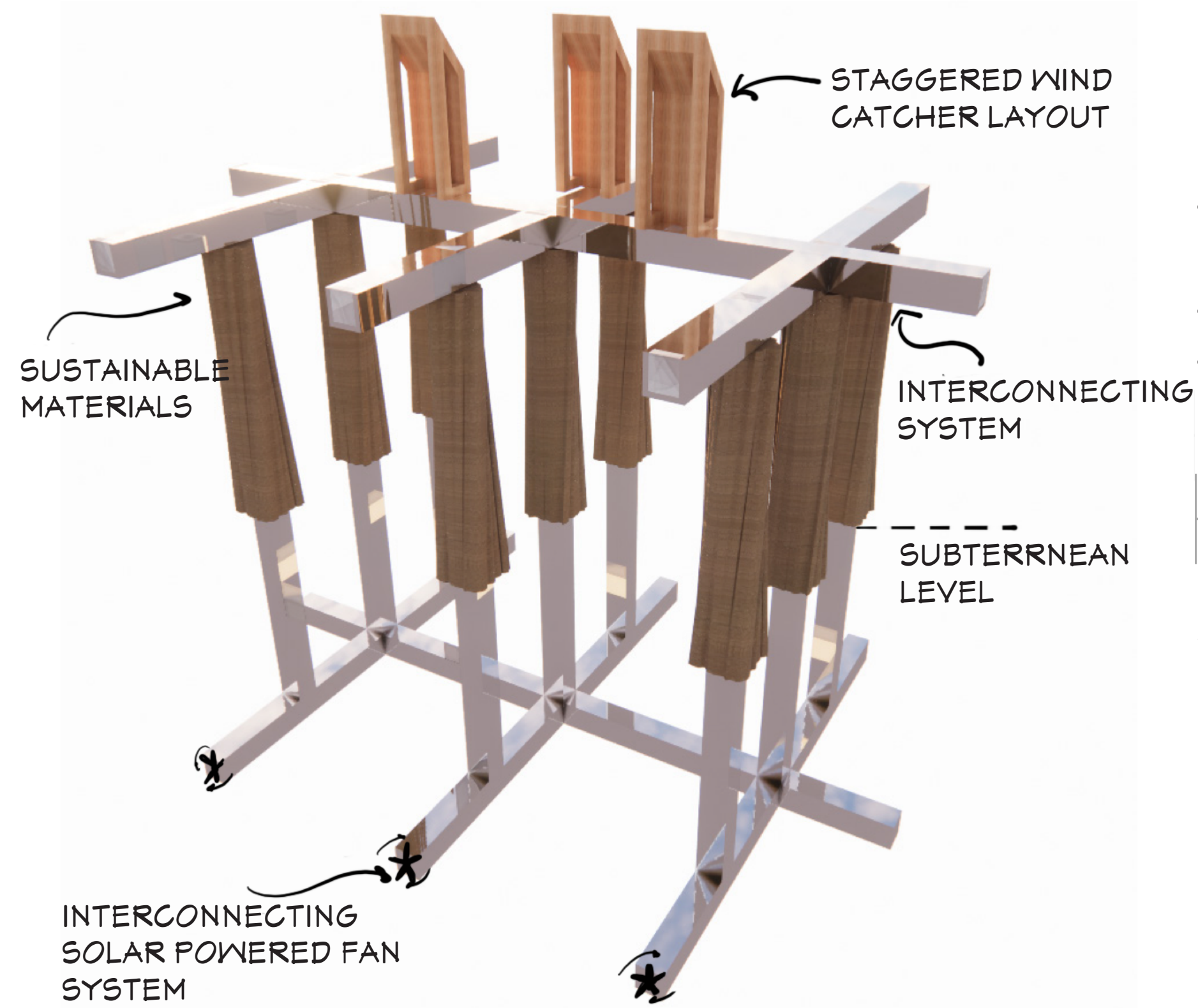


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THE SOLUTION



THE SOLUTION



THE NATURAL VENTILATION

- The goal: 90% naturally ventilated during the day; 100% naturally ventilated at night
 - Constant interior temperature of 80 degrees Fahrenheit
- Average ventilation cost cut from \$2,268 to roughly \$226.8 per year, by running
- the active system only 10% of the time (Self Inc.)

PROTOTYPE ANALYSIS

PASSIVE TECHNIQUES

- Natural Ventilation (termite mounds)
- Evaporation via vegetation
- Wind-catchers for wind tunneling/funneling
- Solar Panels to power the fans that push the air through the system
- Porous material to allow for air flow from all angles

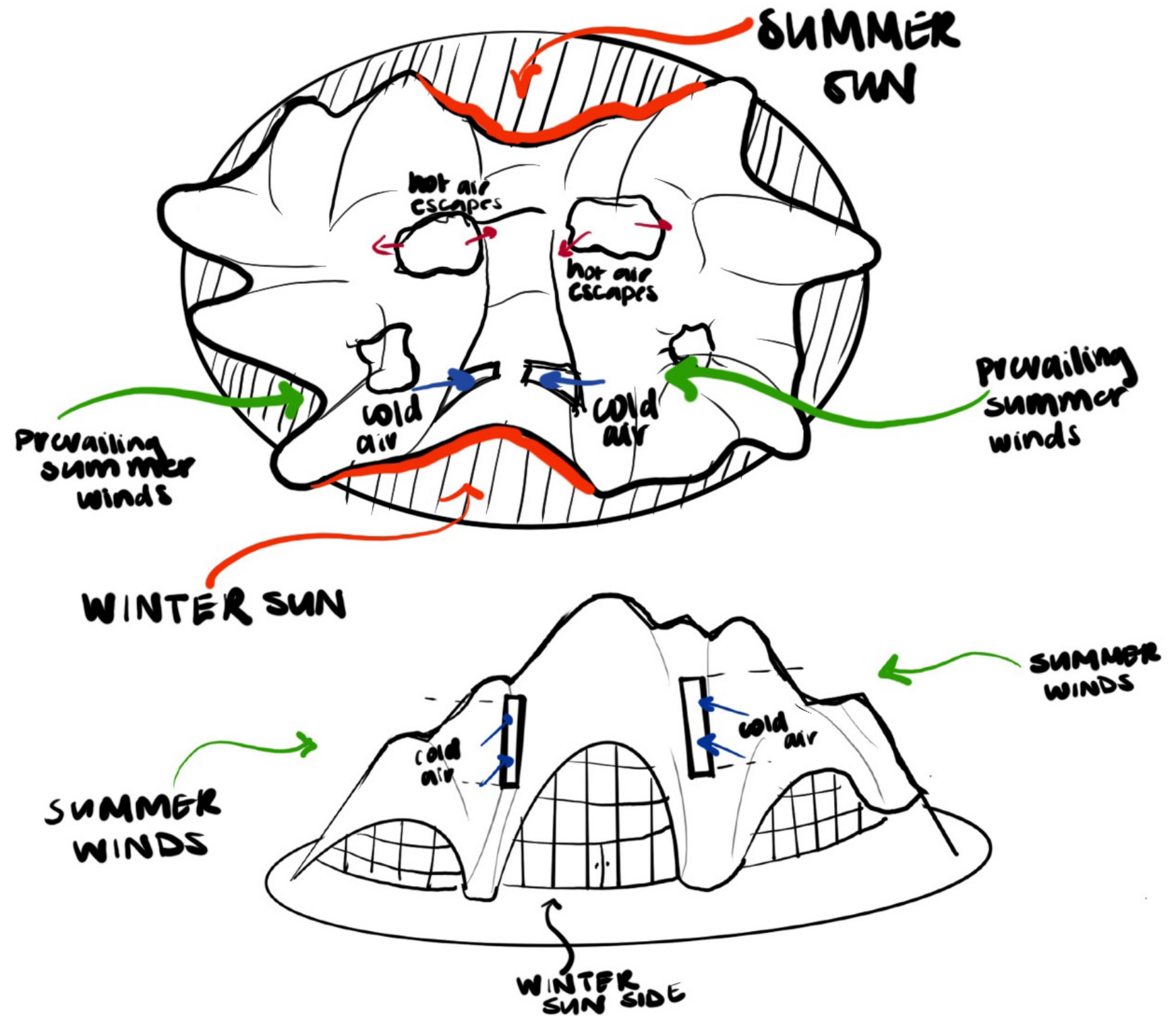
OUTDOOR PAVILION

- Common form of passive architecture
- Utilize shading for passive cooling
- Biophilic element

CONCEPTUALIZE

TEXAS CHRISTIAN UNIVERSITY

- Feature pavilion for environmental architecture
- Utilizes strategic placing for optimal airflow and shading from the sun
- The HVAC system will funnel winds through the wind-catcher, into the tubes as well as up from the ground, dispersing the cool air into the space below while also allowing hot air to escape
- Evaporation cooling within the fountain design and placing of vegetation
- Designed to look like the top of a termite mound
- Used for studying and learning as well as relaxing, inspires interdisciplinary thinking
- Greenhouse inspired



THE SITE

DALLAS // FORT WORTH, TEXAS

- South Central, USA Region
- Temperate Climate
- Resident's spend 48% of their electricity bill on ventilation costs
- Annual Temp High: 76.8 F
- Annual Temp Low: 56.5 F
- Mean Temp: 66.6 F
- 66% average relative humidity
- Prevailing winds: 70 degrees

(National Weather Service)

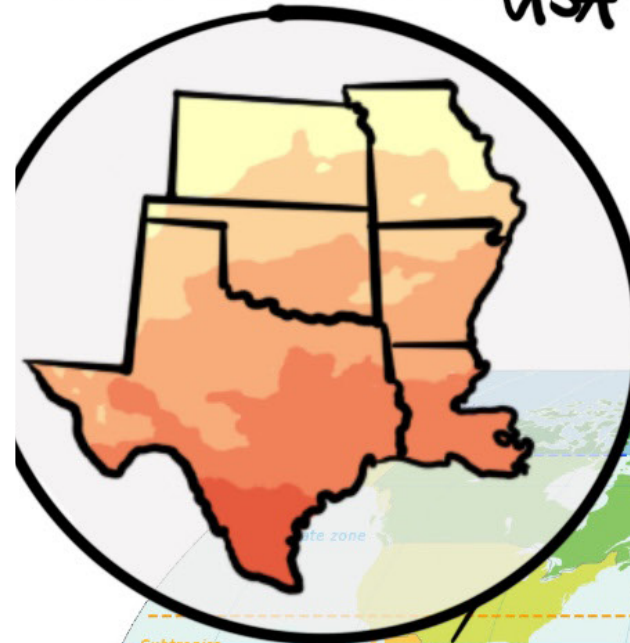
GATHER INFORMATION

SOUTH AFRICA ORIGIN

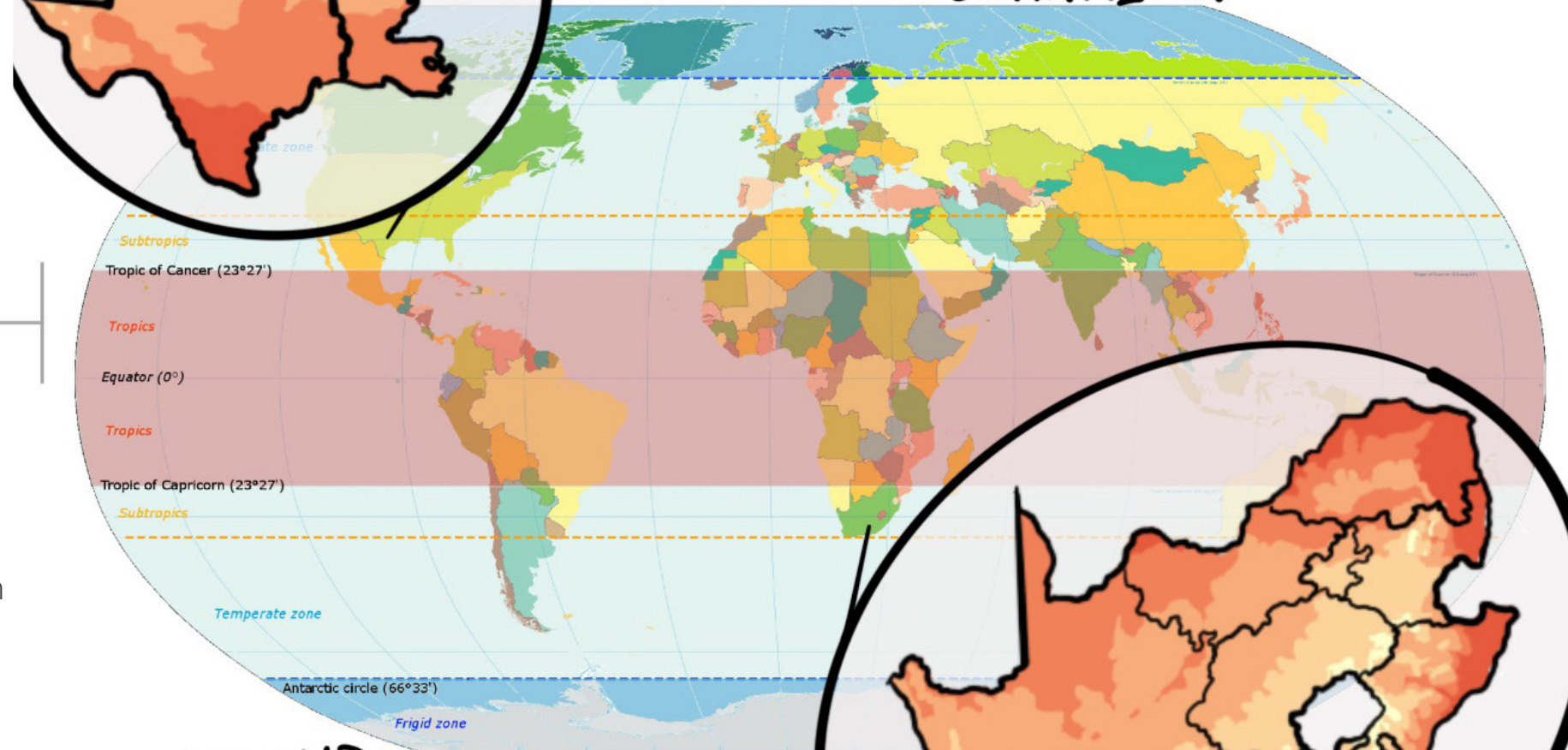
- The *M. natalensis* Termites are native to South Africa
- Temperate climate, same as the South Central Region
- This system proves it will be successful in Texas since it is already successful in South Africa
- Average Temp High: 78.8 F
- Average Temp Low: 51 F
- Mean Temp: 65 F
- 59.2% average relative humidity

(Climate Knowledge Portal)

SOUTH CENTRAL REGION, USA



ANNUAL TEMPERATURE COMPARISON



LEGEND

76°F - 80°F
24.4°C - 26.6°C

71°F - 75°F
21.6°C - 24°C

66°F - 70°F
19°C - 21°C



61°F - 65°F
16°C - 18°C



56°F - 60°F
13.3°C - 15.5°C



51°F - 55°F
10.3°C - 13°C

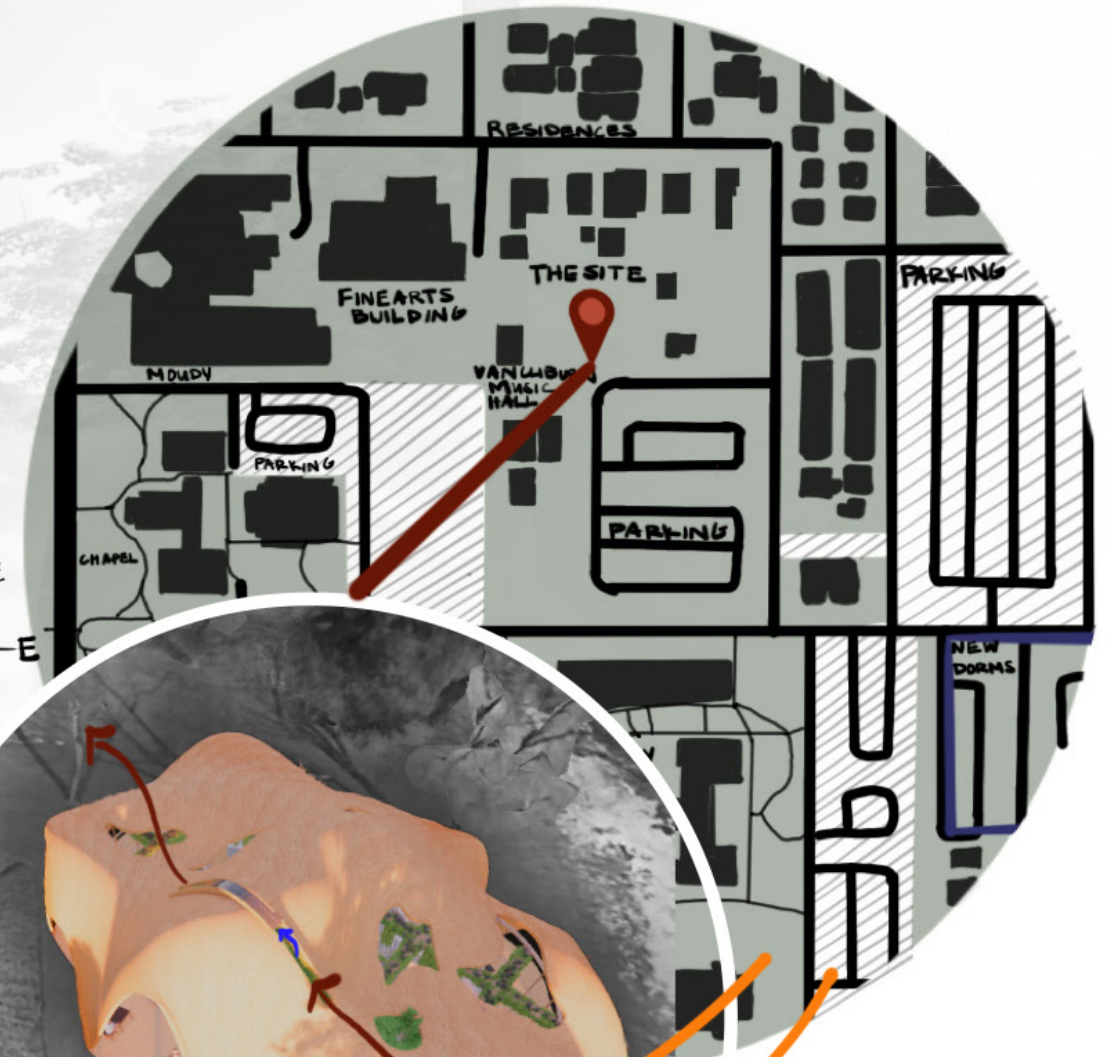


SOUTH AFRICA

NOAA / NATIONAL WEATHER SERVICE / CLIMATE CHANGE KNOWLEDGE PORTAL

THE SITE PLAN

TCU FINE ARTS CREATIVE COMMONS



WINTER
SUN

SUMMER
SUN

SSE → ANW

SUMMER WINDS

THE USER PROFILE

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FORT WORTH STAR TELEGRAM / STOCKYARDS



TCU / FROG FOUNTAIN

THE COMMUNITY

- DFW Community
- Residents and organizations that hope to reduce the financial impact of HVAC

GATHER INFORMATION

TEXAS CHRISTIAN UNIVERSITY

- The specific site for my implementation
- It will aid in the goal to create a wellness focused pavilion
- Provides a stress free environment while also portraying all the different passive ventilation techniques that the world will continue to rely on as global climate change continues to drastically change temperatures



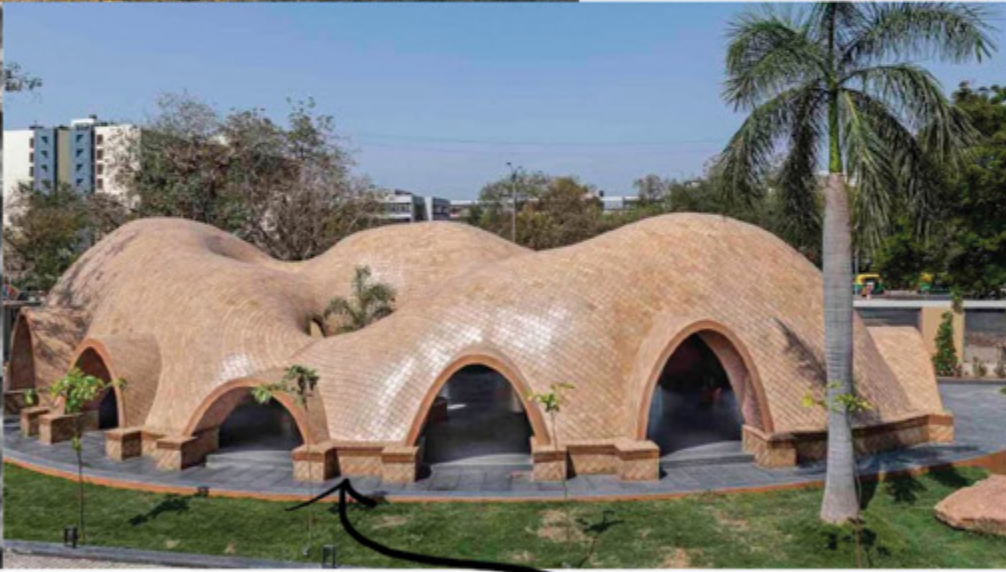
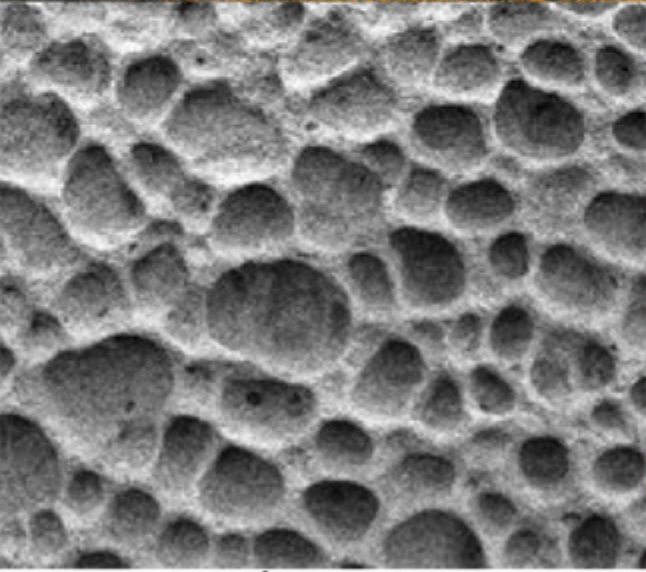
TCU FINE ARTS BUILDING

THE PRECEDENTS

VARIOUS VOID HEIGHTS

INTEGRATED WINDOWS & CURVED
FACADE FOR SHADING

TCU BUFF
BRICK
(COLOR



POROUS-LIKE
ORGANIC MATERIAL

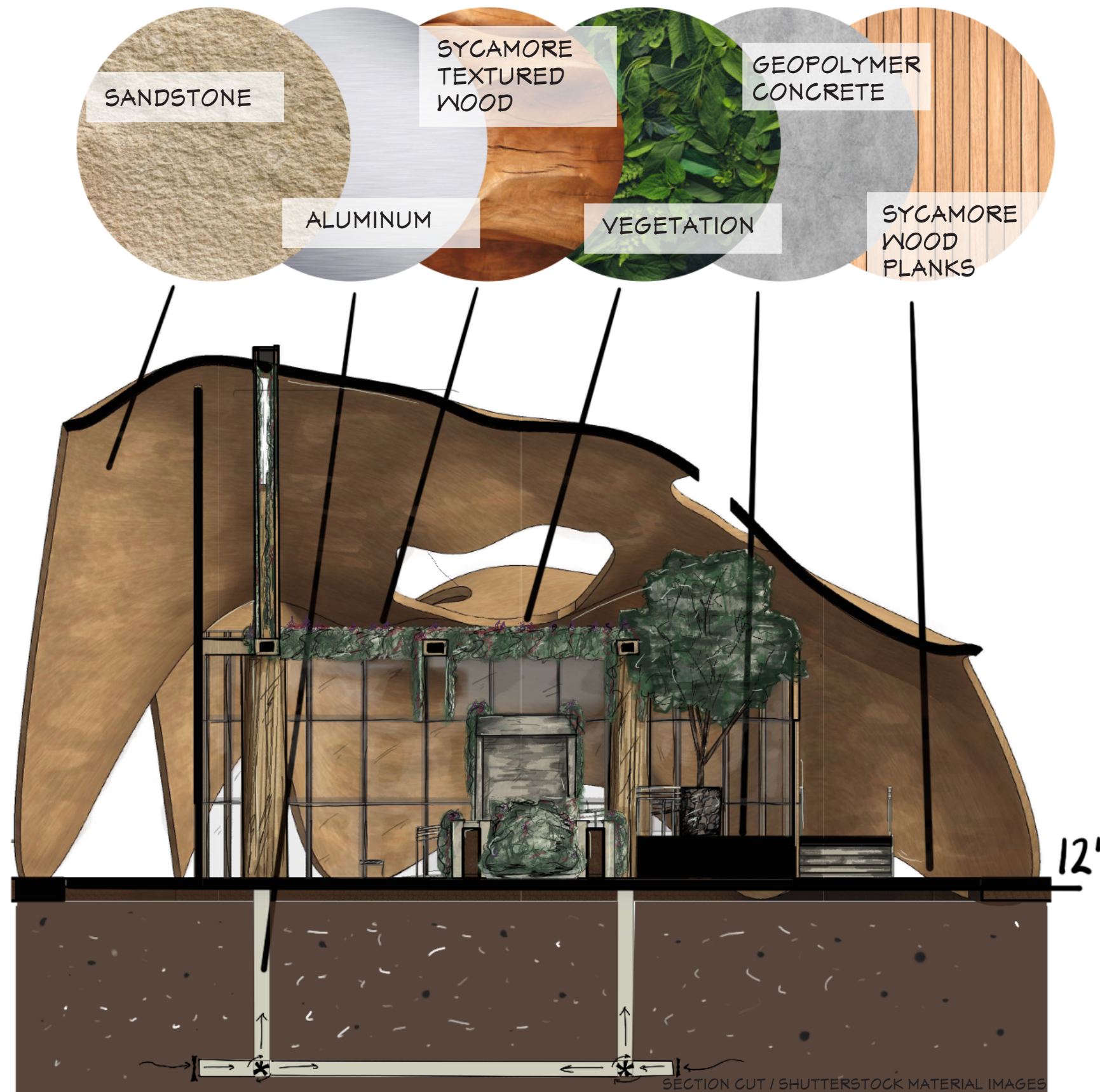
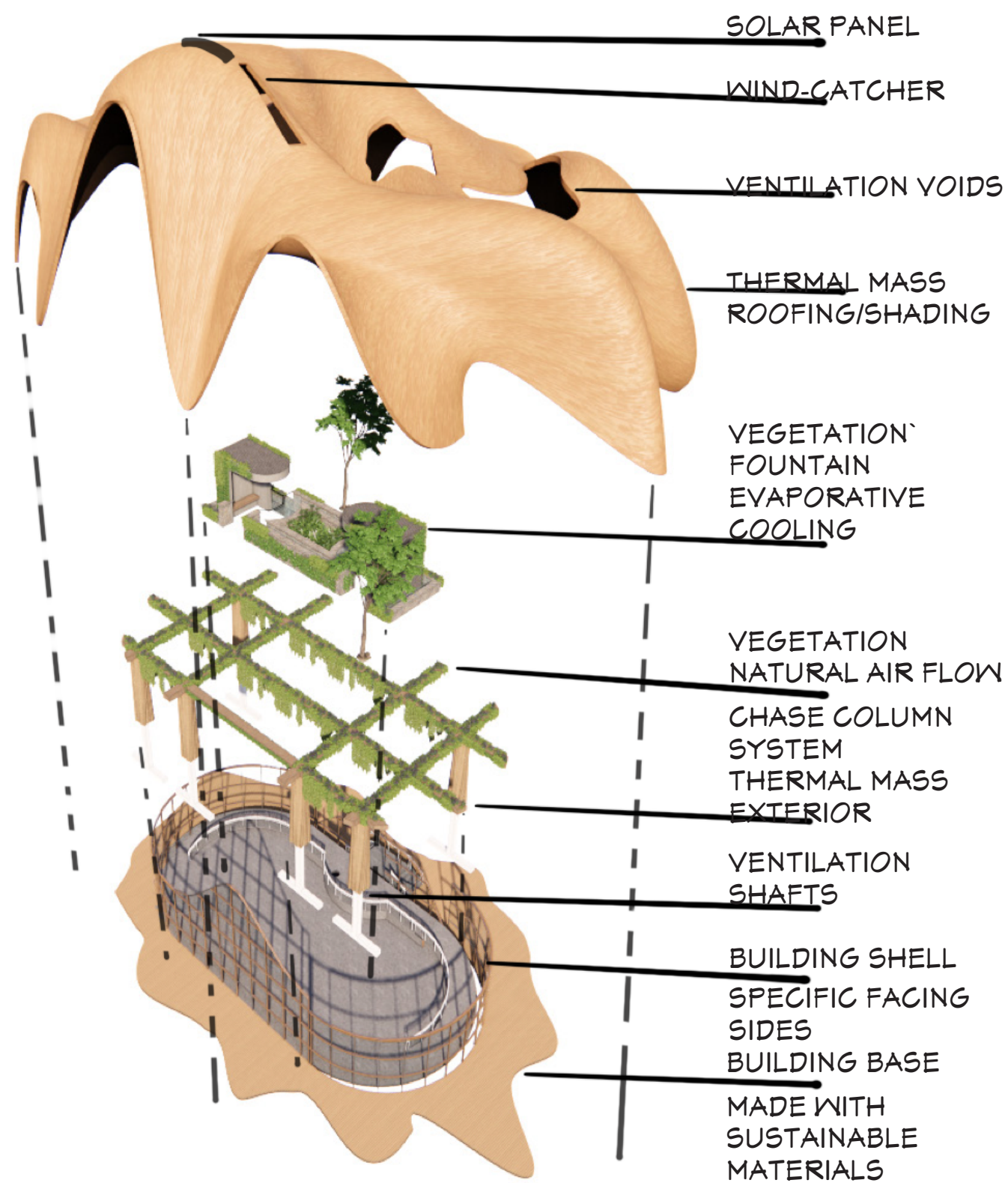
ROOF OPENINGS FOR
PLANTING & AIR-FLOW

TEMPERATURE
REGULATING
THERMAL MASS

INTERIOR
ORGANIC FORMS

THE PASSIVE TECHNIQUES

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ENVIRONMENTALLY

- Features all forms of natural systems, renewable energy, and sustainable practices in architecture
- Demonstrates how architecture can work and adapt with the environment

PROTOTYPE ANALYSIS

EDUCATIONALLY

- Designed and built using extensive research of natural systems
- Demonstrates the concept of Biomimicry
- Serves as a historical significance of past passive ventilation techniques
- Showcases of a combination of sustainable design techniques that will become an architectural foundation for buildings in the future
- Cultivates and inspires thinking in an interdisciplinary fashion



FORT WORTH BOTANICAL
GARDENS GREENHOUSE

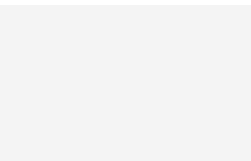
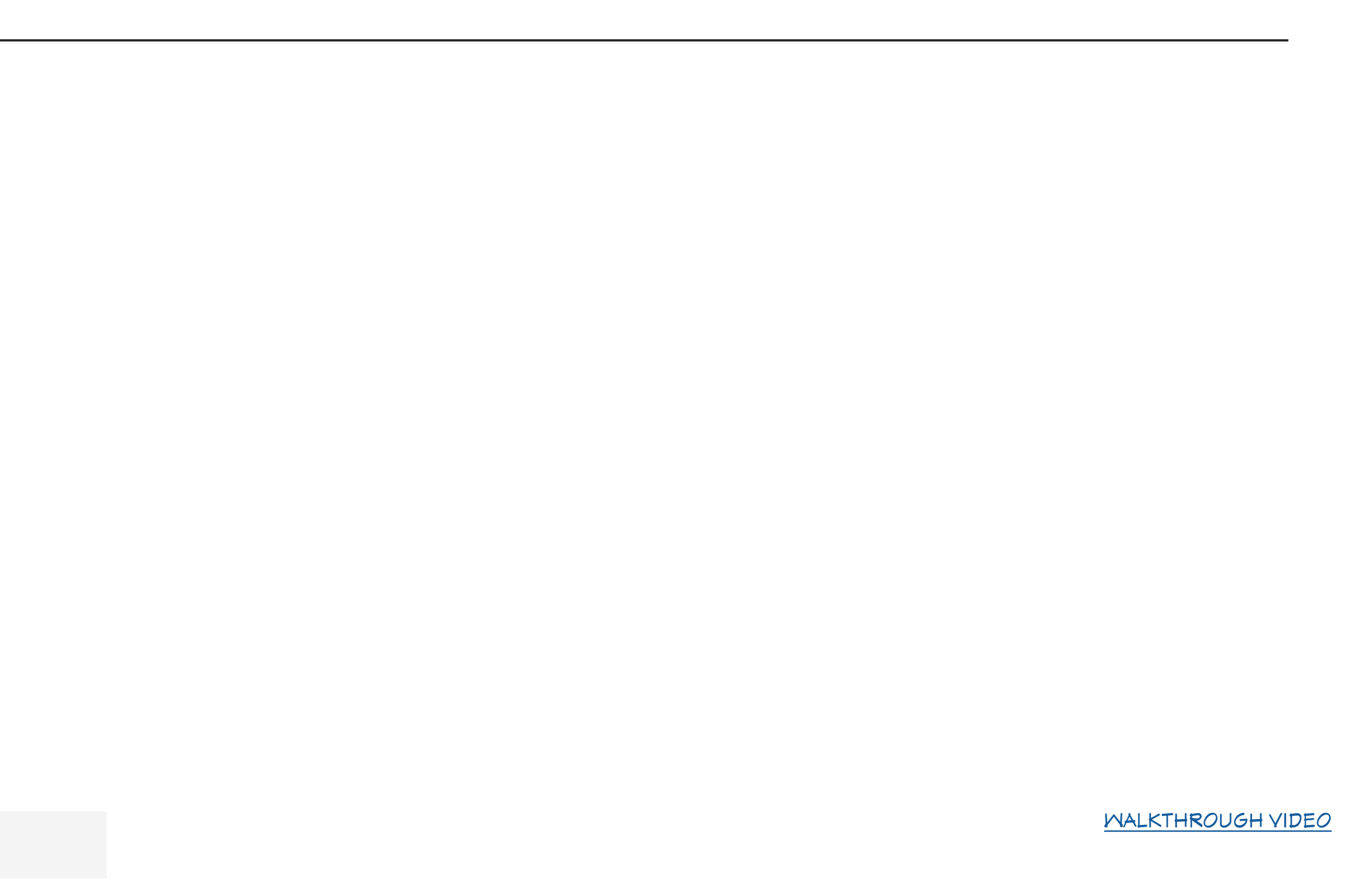
THE SIGNIFICANCE



SHUTTERSTOCK / GREENROOF



SHUTTERSTOCK / COMMUNITY GARDEN



THE CONCLUSION // FURTHER RESEARCH

CONCLUSION

The result of this system is a mainly naturally ventilated building. Creating a temperature controlled environment while using significantly less energy than current building, thus reducing costs for active heating and cooling systems.



FINALIZE & IMPROVE

FURTHER RESEARCH

- Research ways that the system could move closer to being 100% naturally ventilated instead of just 80% or 90%.
- How this system could continue to be adapted to become more universal and easily implemented into current buildings
- Research how this system could be adapted globally, into different countries as well as climates that may not be temperate and would need adjustments to adapt to said climate as well.





Thank You! ANY QUESTIONS?

KashB

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