

ROOT BRIDGE GENERATION

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DESCRIPTION
Living root bridge communities are common in the Northeastern State of Meghalaya, India. For millennia, these suspension bridges have been handmade from the aerial roots of Indian rubber fig trees by native Khasi and Jaintia tribes, the elaborate process and tradition passed along generations. Historically, these bridges served to facilitate withstanding monsoons in their flood-prone state, and unlike man-made structures, they last for centuries at a time, unaffected by rough storms or material decay — epitomizing symbiosis between humans and nature. With the turn of the 21st century, increased tourism at the Meghalaya root bridges has inspired green architecture endeavors across the world.

PROCESS
The traditional process of creating a root tree bridge spans over 10-30 years and starts from a single rubber fig tree planted on one bank of the river. After the tree develops aerial roots, they are wound onto a supporting bamboo structure that stretches to the other side where the roots will eventually take hold. Over time, daughter roots grow, which are then wound by multiple generations of people, that further strengthen the bridge and enable people to cross. This is possible by inosulation, when two tree limbs merge and grow together when bound tightly together.

INSPIRATION
While we were first forming our groups, we were drawn to the processes involved in creating and maintaining the bridge as well as the possibilities for green architecture in the future. As we researched more about this community, we found there was more to it than just a bridge — it had influences relating to tourism, preservation, and economic development.



SECOND ORDER

GLOBAL SUSTAINABLE FUTURE

IMPROVED INDUSTRIAL CLIMATE
ENVIRONMENTAL IMPACT IN CITIES

SUSTAINABLE ARCHITECTURE

As knowledge from observers transfers to greater scale, ethical responsibilities are applied towards second order cybernetics

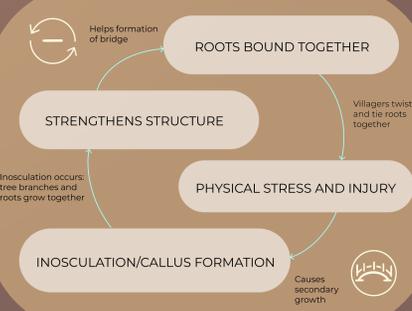
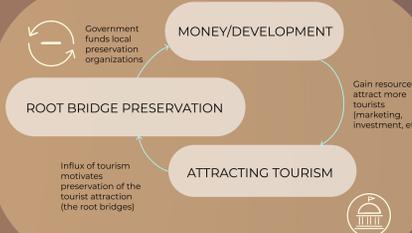
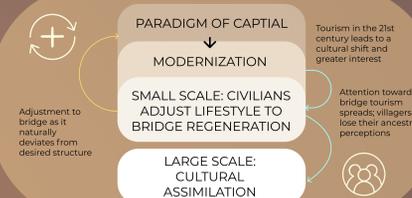
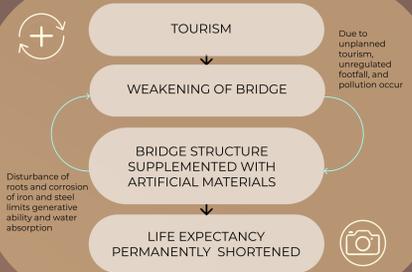
TOURISTS

Regenerative root bridges act as first order feedback loops

ROOT BRIDGE GENERATION

Tourists act as observer participants of the first order

FEEDBACK LOOPS



ARTIFICIAL REINFORCEMENT

CULTURAL PRIVATIZATION

TOURIST DEVELOPMENT

PRESERVATION CHALLENGES

BRIDGE FORMATION

GOVERNMENT

CAPITAL DEVELOPMENT
The Meghalaya government promotes the use of inappropriate building materials, like reinforced cement concrete, burnt bricks, galvanized iron and steel, in order to maintain a steady flow of tourism, bringing money into the economy.

TOURING
"Self-named 'God's own garden,' Mawlynnong is known as the cleanest village in India, while the bridges attract streams of visitors, bolstering the tourism industry. Prime Minister Narendra Modi recognized the community as a model for the country.

CULTURAL INFLUENCES
Government occasionally consults with representatives of the Khasia and Jaintia tribal groups, representing their villages distinct cultural beliefs.

PRESERVATION FOR CONSTITUENTS & VISITORS
Parts of the roots are either cut, damaged or overlaid with concrete, destroying the living structure.

DEVELOPMENT
Concrete bridges which may not endure the adversity of the terrain and climate have also replaced some of these bridges.

BRIDGE
FINANCIAL CAPITAL (MONEY)

ORGANIZATIONS

EMPATHETIC PRESERVATION
Private organizations are goal-oriented, centralized around the improvement of the bridges rather than profit.

Living Bridge Foundation
"People were like, 'We get money, but the bridge sacrifices for us.' These communities didn't understand, sustainable tourism. That's what inspired me to start this initiative to protect them." Morningstar Khongthav, 23, started the Living Bridge Foundation (LBF).

Meghalaya Base and Development Authority
The MBDA works with three organizations: the Meghalaya Institute of Entrepreneurship, the Meghalaya Institute of Cultural Organization, and the Institute of Natural Resources.

United Nations
Many villagers and organizations are advocating for sites to be legally protected by the United Nations Educational, Scientific and Cultural Organization, inscribed on the World Heritage List in order to be protected for future generations.

BRIDGE
The Living Bridge Foundation is dedicated to the preservation of the cultural heritage of the living root bridges, focusing on repairing living root bridges.

INCREASING AWARENESS
The Technical University of Munich has supported LBF's initiative, funding good quality photographs.

FOSTERING COMMUNITIES BETWEEN VILLAGERS
Yearly, within villages in the Khasi hills, the home of the 'War community', the locals host a clearing drive, located on their ancient trails which were once key sources of connectivity. Everyone in the village participates in these drives and does maintenance work for the bridges.

VILLAGERS KHASIA & JAINTIA NATIVES

PRE-COLONIAL/ PRE-CAPITALISM/ PRE-GLOBALIZATION
MAINTAINING TRADITIONS AND COMMUNAL RESOURCES
These bridges have been maintained by families, and village communities, who prune and tie the roots in certain ways that have been passed down.

POST-CAPITALISM/ POST-GLOBALIZATION
Concepts of ownership, public, private, village
Attempting to balance short and long term tourist gains alongside bridge preservation
Transitioning to a service economy led to infrastructure and utility developments

HARMING
Changes in the land use patterns of many of the villages for agricultural purposes
Large swathes of jungle are being cleared to make way for a type of grass used to make brooms
As the jungle disappears, the slopes it once occupied become less capable of retaining water, due to the fact that the root systems of the grasses are much shallower than those of the jungle vegetation. This results in landslides and stronger flash-floods than the area has ever seen before.

GENERATIONAL RELATIONSHIPS
Mixing dead wood from jackfruit trees with a layer of soil as nutrients for roots
Planting area nut trees on top to prevent root damage from boattail.

INTERVILLAGE RELATIONSHIPS
Founded from sharing bridges between villages

BRIDGE
MONEY
All 74 bridges were used by villagers to cross the monsoon filled rivers to reach other villages, or markets.

TOURISTS

HAWKINS MODEL (MODIFIED)
Many tourists visiting these areas are drawn to the beauty and dream of a new relation to nature. Their role as one of the leading introducers of money into the local economies has drastically influenced the development of communities.

CROWDING AND ALIENATION
As tourism increases and exceeds the acceptable carrying capacity, attitudes and related perceptions become more negative over time.
"In some villages, the bridge receives a foothill of more than a thousand people per day." — Mr. Sanjeev Shankar, an architect and researcher of the living root bridges

NATURAL DETERIORATION
The bulk of tourism is unplanned which leads to unregulated foothill as well as pollution of the surrounding ecosystem, deteriorating the flora and fauna in addition to the bridges structural integrity.

TOURIST-RESIDENT RELATIONSHIP
Perceptions and Relations

CARRYING CAPACITY MANAGEMENT
The influx of tourists who visit these renowned structures has resulted in increased load on the bridges, outweighing what they were initially built for, compromising subsurface roots.

MODERNIZATION
The Double-Decker bridge is currently an important tourist attraction in Meghalaya. The goal of adding a third bridge is to attract even more tourists to the village, which will hopefully raise awareness of the Khasi people's inventive practices, maintaining the bridges for centuries to come.

ENVIRONMENT

RUBBER TREE PLANT
The Indian rubber tree plant is native to the Meghalaya region. They can grow up to 30-40 meters tall, and they naturally develop aerial and buttressing roots.
The bridge building technique takes advantage of the tree's aerial roots and their ability to anatomize to form mechanically stable and strong structures through inosulations.

STRUCTURAL CREATIVITY
The malleability of the rubber tree plant allows for bridges to have handrails, second decks, and arches.
NATURAL ENDURANCE
The trees regularly withstand flash flooding and storm surges — providing a low-cost and sustainable way to connect remote villages scattered throughout the steep terrain.

CLIMATE EFFECTING CULTURE
India's monsoon season brings heavy storms and floods causing man-made bridges to rot and decay. The state of Meghalaya is home to the two towns with the highest annual rainfall on Earth. The village of Mawlynnong has 467 inches, or nearly 39 feet, of rain per year. This has shaped their culture (created bridges).

SUSTAINABLE ARCHITECTURE

FOREIGN TOURIST PERSPECTIVES
"The living root bridges are the most abundant form of living architecture in the world and studying them can help us learn how to protect these unique structures." — Wilfrid Mollath, Green Technologies in Landscape Architecture, Technical University of Munich, Germany

"The technique of using aerial roots of (Indian rubber tree) to form bridges is a unique example of botanical architecture grown without the tools of modern engineering design. Living root bridges provide the only known example of repeated, predictable use of tree growth for structural purposes." — Scientists led by Dr. Ferdinand Ludwig at TUH

GREEN CITIES
These bridge structures could be applicable to building cooler cities to combat global warming, integrated with their buildings.

BAUBOTANIK
Baubotanik is an emerging research area in green architecture that focuses on a building method where architectural structures are created through the interaction of joints and plant growth.
This contrasts with the mainstream way of greening buildings, which is adding plants on top of a built structure. Implementing baubotanik methods, structures are able to regenerate and withstand external forces.

Saving Money
"Stone, concrete and asphalt heat up readily at high ambient temperatures, so that heat stress is particularly relevant in cities. Plants provide cooling and mitigate the climate in the city," remarks Dr. Ludwig. This would effectively reduce cooling costs in the summer, using less electricity.

Durability
In Mumbai, 4 bridges have collapsed in the past 6 years, leading to 28 deaths. Despite the use of reinforcing materials, poor quality of construction and lack of maintenance lead to similar catastrophes. However, the root bridges, which are as old as 250 years, still remain standing.

TIMELINE

PRE-INDUSTRIAL
Bridges serve functional use to connect villages to resources. Modern non-organic building materials such as concrete and steel were not available, so villagers utilized the natural resiliency of rubber trees to combat the monsoon season.

DOCUMENTATION

The earliest written record of Schra's (Cherapuri's) living root bridges is by Lieutenant Henry Yule, who expressed astonishment about them in the 1844 Journal of the Asiatic Society of Bengal.

GROWTH/DEVELOPMENT

In 2004, media started documenting the bridges (photomontages, photos, blogs, etc) This caused world wide interest, which brought tourism.

SUCCESS

An influx of tourists enter and start stimulating the economy. They cause strain on the environment and on the bridges.

PROBLEM/STAGNATION

Increased tourism causes bridge to weaken. This causes the government to reduce tourism to increase the longevity of the bridges. Additionally, harmful structures are built around the bridge for tourists.

REJUVINATION/DECLINE

Reduced tourism effects popularity overall and causes the spot to be less known over time.