ubiquitous planting and green bricks

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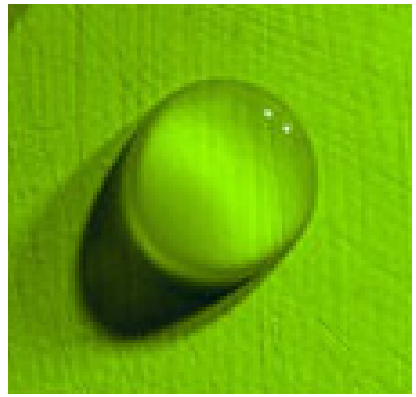
10 Great Ideas to change the world in Next 50 years
IIT Bombay

IDEA

To design a green "brick" which has specific native plants or seeds integrated with it

The design of the "plant tile or skin" would combine principles of biomimetics with the design and construction of the built environment. It would be an intelligent, modular and structural “living brick”, integrated with the built form; thereby trigerring diverse, edible greens within a city. These "bricks" would gradually transform the city's infrastructure into a productive, fertile, healthy, edible and playful green fabric.

Public participation in the design, production and management of these bricks is an important part of this vision.



BACKGROUND

"If radical changes are not made to how we produce and distribute our food, the world's people cannot be fed over the next half-century and we will be left with a world which nobody wants to inhabit. Business as usual, is not an option." (Robert Watson, director of Assessment of Agricultural Knowledge, Science and Technology for Development, 2008)

- By the end of 2008, half the world's population will be living in cities for the first time in history. (according to a UN report)

- Declining resources in many parts of the world has met a rising population. The result is starvation, drought and resource wars.

- Food crisis is further compounded by changing food habits, rapidly deteriorating soil quality and use of agricultural land to grow corn for ethanol.

First bloom, nagaland, India, 2005

Marble quarry, Italy, 1993

TRIGGERS

“Our present global crisis is more profound than any previous historical crises; hence our solutions must be equally drastic. I propose that we should adopt the plant as the organizational model for life in the 21st century, just as the computer seems to be the dominant mental/social model of the late twentieth century, and the steam engine was the guiding image of the nineteenth century.”
(McKenna, 1992)

The thrust of this idea is to use technology and advances in material science to explore the relation between architecture and ecology by redefining the quintessential building block: the brick.

Biology provides inspiration and functional biomimetics will inspire the overall product development which will be shaped by the following questions:

- how can we learn from nature to design more resilient, efficient and responsive systems ?

- how can we embed this 'brick' with living technologies to perform certain functions within the built environment ?

- how can every 'tile' perform as an insulated green house which accumulates solar energy to power the house ?

- could the constituent material of the brick act like a nutrient for the embedded plants ?

- could such a close and continuous spatial association with plants create a paradigm shift in our relationship with other species ?

BENEFITS OF USING NATIVE PLANTS

• The choice of native plants will be adapted to address pressing challenges within a city and engage its people. Public participation and awareness can create a green tipping point for our cities.

• These living bricks will become a source of nutrition, vitamins and herbal medicine.
(Leucas aspera cures bronchitis and asthma, Lia Indica cures ulcers, amaranthus is used by dentists)

• Each home will become an independent seed bank, a space for abundant biological exploration and a living, evolving bio-archive.

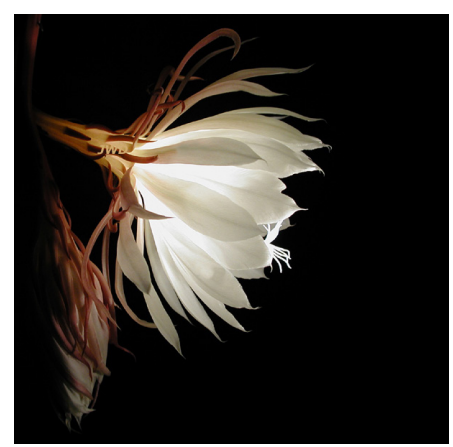
• The integral plants can pre-date on pests and act as repellents for termites (Lantana is a pest repellent)

• Creating a green cushion which acts as an acoustic buffer and generates fragrance.
(epiphyllum oxypetalum, commonly known as 'queen of the night')

• They would also perform as green filters creating healthy micro climates in urban realms

• Reduction of the urban heat island effect with these bricks is a positive side effect. At an urban scale the benefits are exponential.

Amaranthus



Epiphyllum oxypetalum

Leucas aspera

Illustration A- Green Brick concept

The intent is to design and produce a living brick or skin for mass use. People could buy the product off the shelf and use it as a substitute for conventional bricks or concrete blocks. This would be part structural and part biological and become an integral part of the building structure.

The illustration above is not representative of the final product

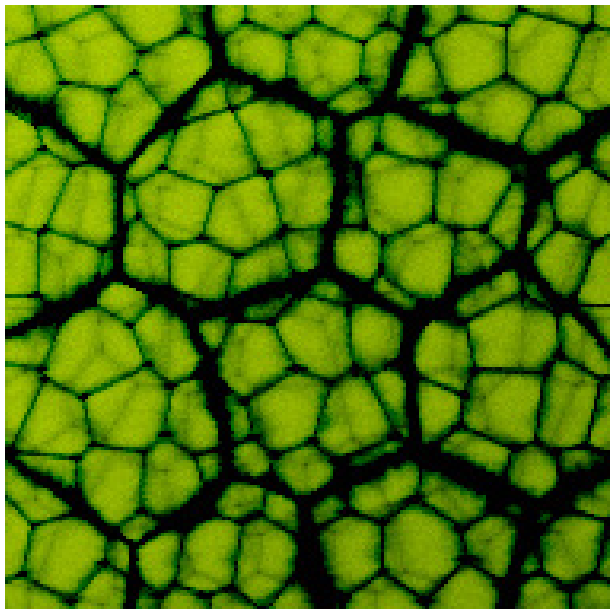
Illustration B- Green Brick concept inspired by seed balling

Possible materials for fabrication of the brick include ceramics, organic composites and recycled materials.

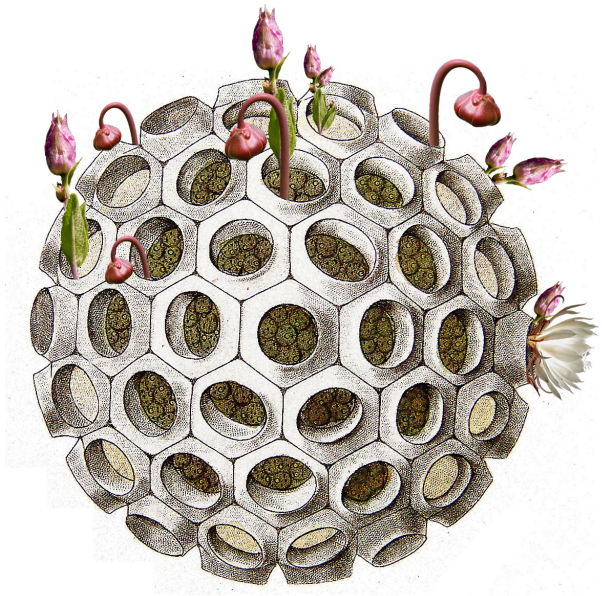
Research references: Biomimetics, plant science, emergent technologies, smart materials, permaculture, seed balling

The illustration above is not representative of the final product

Leaf texture detail



Physical manifestation



Assembly and connection

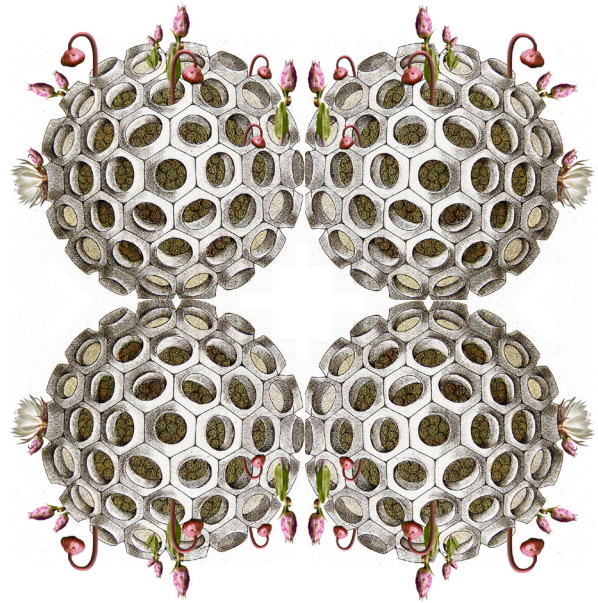
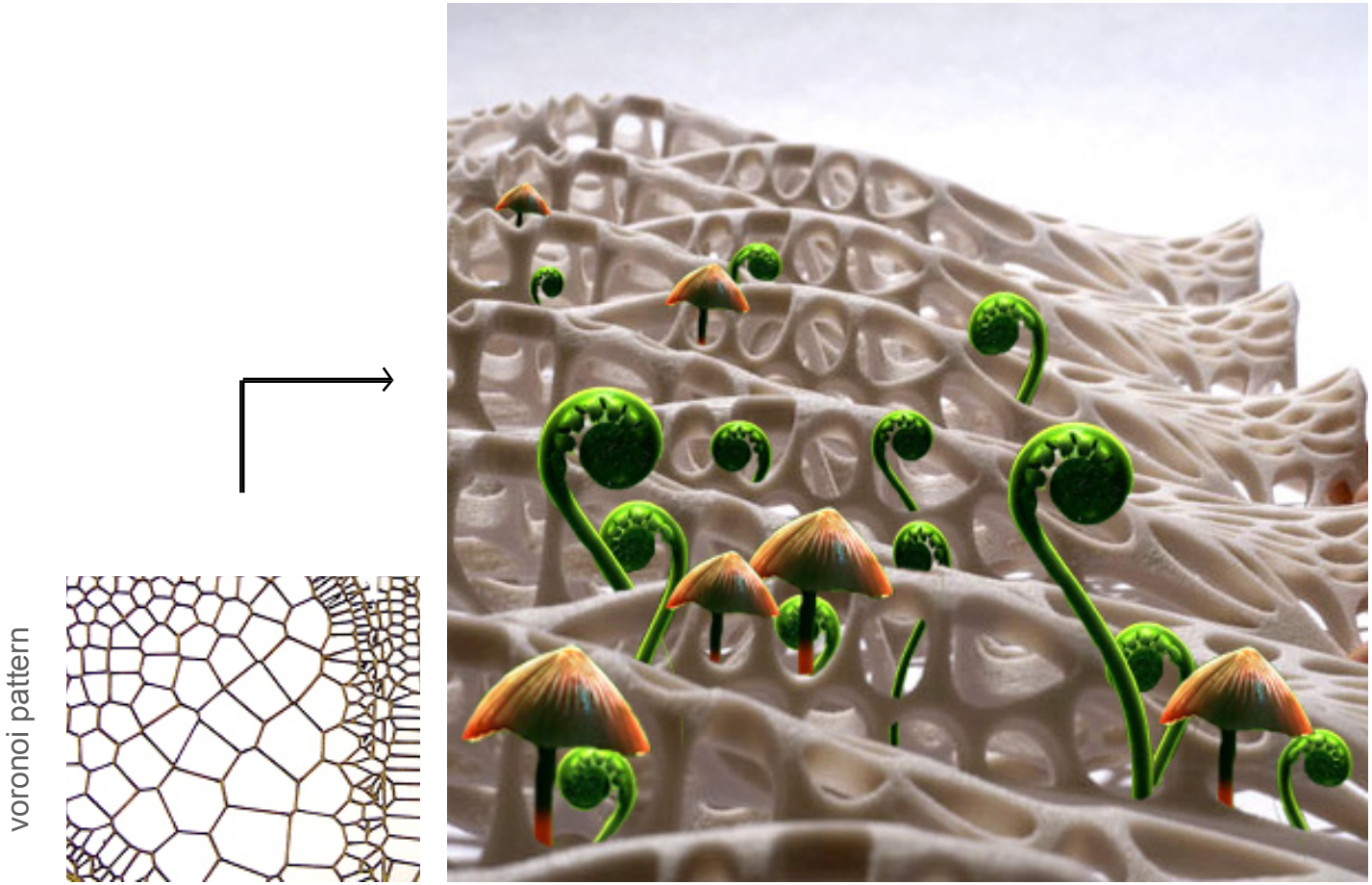


Illustration C- Pattern investigation for geometry, structure and assembly of the green brick

Analysing biological tissues to explore efficient material organization and appropriate geometry for the brick skin which is informed by structural load, performance criteria and environmental conditions.

Research references: growth patterns, material organization, evolutionary algorithms and self assembly

The illustrations above are not representative of the final structure. It suggests a method of analysis and abstraction from a natural system.



Skin developed by Neri Oxman

Illustration D- Form and pattern concept based on load bearing skins

The pattern and form here is inspired by single shell (monocoque) construction technique that could support structural load using the brick's external skin. Here, using a voronoi pattern, the notion of structural skin is demonstrated, the density of which corresponds to multi-scalar loading conditions. A continuous, multi-funtional structural skin also provides an opportunity to explore capillary action.

Research references: voronoi algorithmic patterns, architectural skins, parametric form finding

The illustration above is not representative of the final form

micro level development

macro level integration

Illustration E- From green brick to a green habitat

Research references: climatology, native plants, vernacular construction methods, design customization

The illustration above is not representative of the final product or architectural language

Urban Sprawl in our cities today → Green, edible, fertile vision

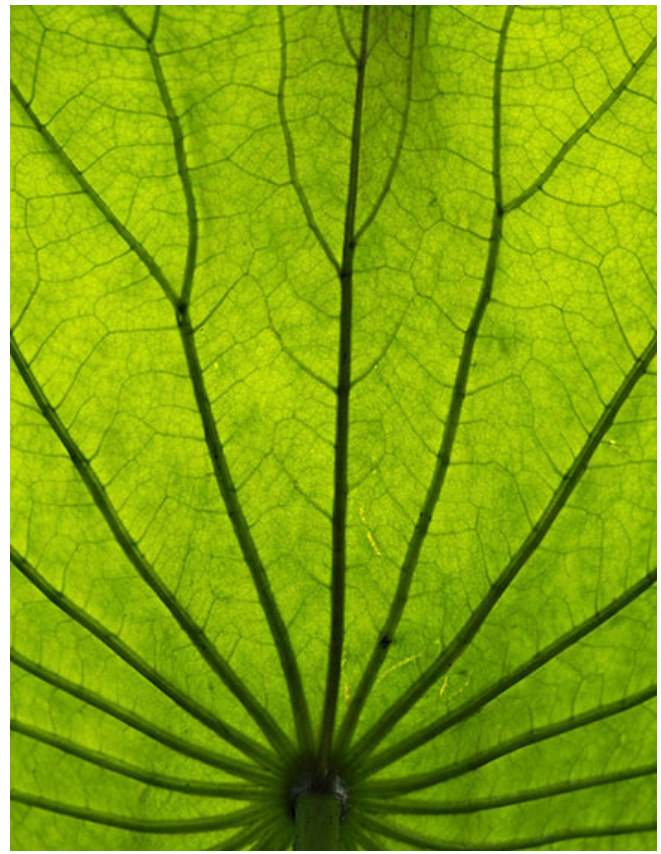


Illustration F- Vision : Impact of green bricks on our habitat

Proposing a radical architectural experience. 21st century architecture was about repetition, homogeneity and standardization. With effective macro-urban level integration, this idea could revitalise global infrastructure into a fluid, nourishing and evolving symbiotic experience. Local climatic conditions, constraints and vernacular construction methods could inform regional variations and act as important variables in the process.

Research references: sustainable design, responsive architecture, urban ecology, human plant interaction

green light

glowing tobacco plant

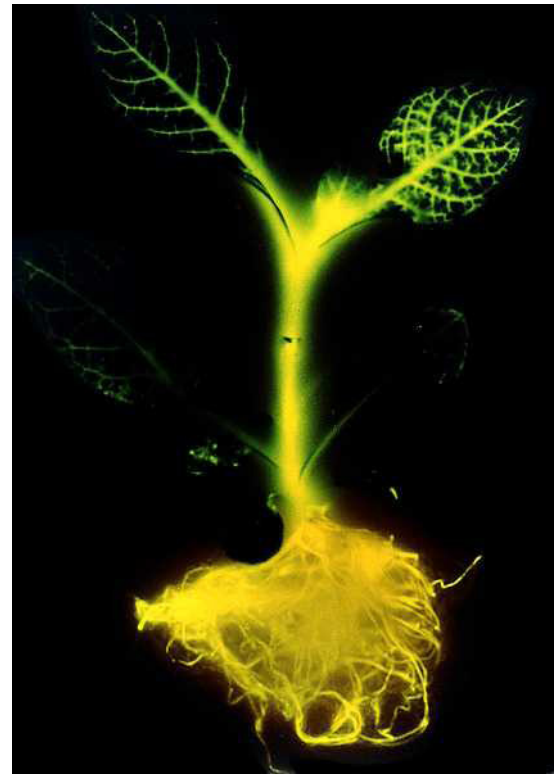


Illustration G- Possibility of green brick acting like a green house, a source of light and a solar battery

Research reference: solar energy, bioluminiscence, fungi mycelium growth

The illustration above is not representative of the final configuration of the light source and embedded plant

PRODUCT DEVELOPMENT STRATEGY

plant research

- epiphytes / air plants
- plant growth patterns and life span
- seed survival and temperature range

+

material research

- ceramics (slow curing bricks)

+

form and fabrication research

- porous structures which can be cast and accurately reproduced
- biodegradable formwork and on-site construction/growth using fungi-mycelium

Integration of "green brick" structure with nutrient supply for plants into a "single component"

- Investigating vertical gardening wall panels
- Investigating hydroponic vertical gardening
- Reference case studies:
    - vertical gardening by Patrick Blanck
    - hydroponic wall by R&Sie(n)
    - form found porous structures developed at Architectural Association, London
    - traditional mud construction methods

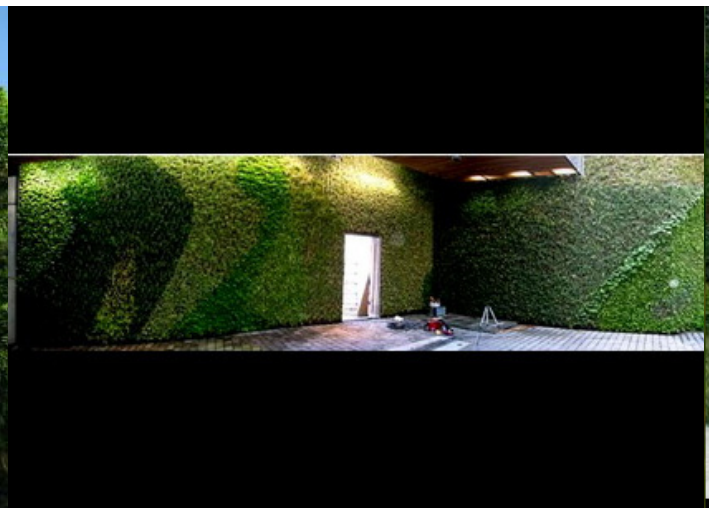
Further integration of green brick with the building envelope

- Developing range of green bricks which have either high structural capabilty or high biological capacity or both
- Making a full scale prototype of a habitat(3 metre x 3 metre) using these green bricks to see its performance over a long period

Case Study 1: Vertical Gardening by Patrick Blanck

- Use of tropical “understory” plants receiving minimal sunlight beneath the rainforest canopy.
- The Vertical Garden is composed of three parts: *a metal frame, a PVC layer and felt(high capillary action)*.
- Overall weight of structure is less than 30 kg per square meter.

Madrid - Caxia Forum



Seoul

Pont Max Juvenal, Aix en Provence

HYDROPONICS

Hydroponics is a method of growing plants using mineral nutrient solutions, in water, without soil. Terrestrial plants may be grown with their roots in the mineral nutrient solution only or in an inert medium, such as perlite, gravel, or mineral wool.

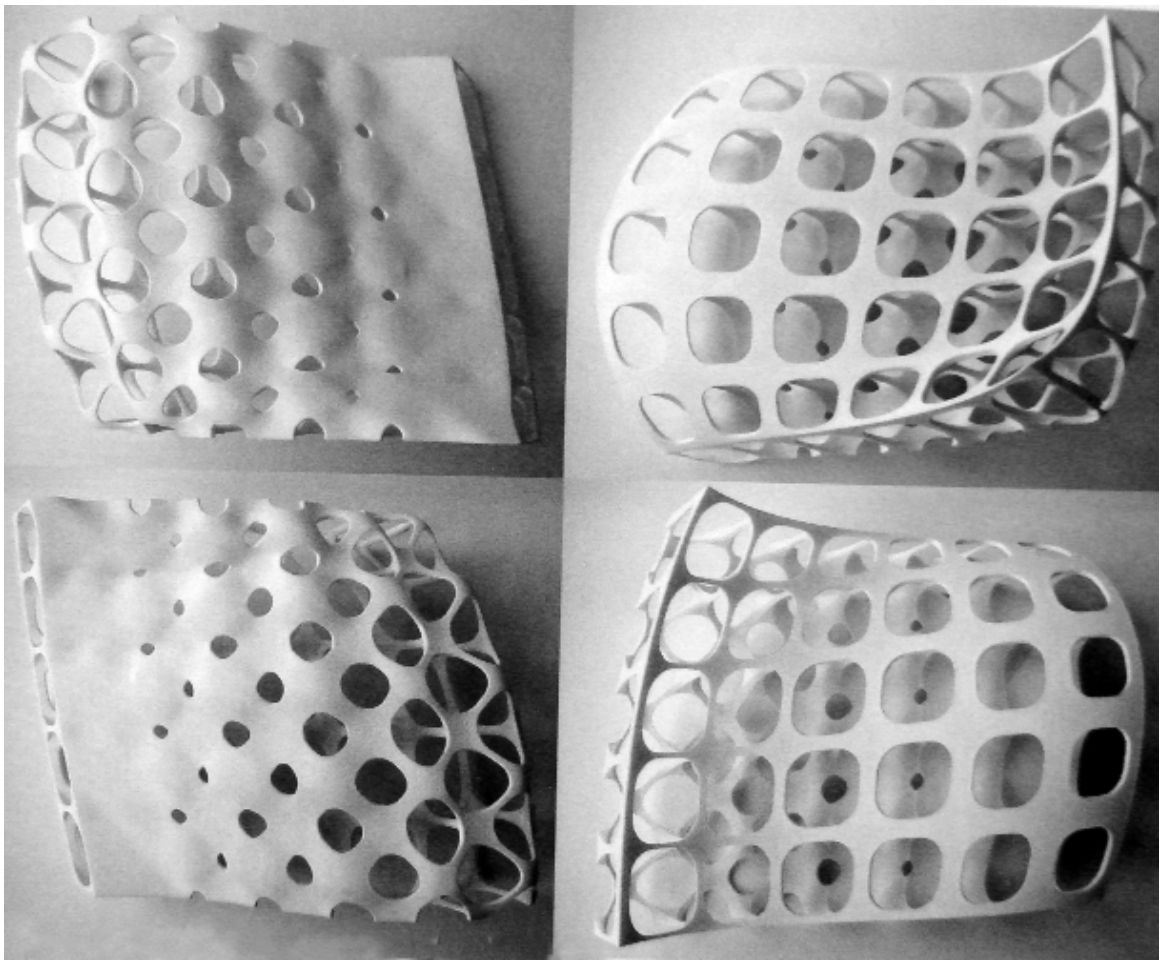
- Rockwool (mineral wool) is the most widely used medium in hydroponics. It is an inert fibrous medium accessible to capillary action and is not degraded by microbiological activity. Other materials include wood fibre, cocoa fiber, perlite and expanded clay pellets.

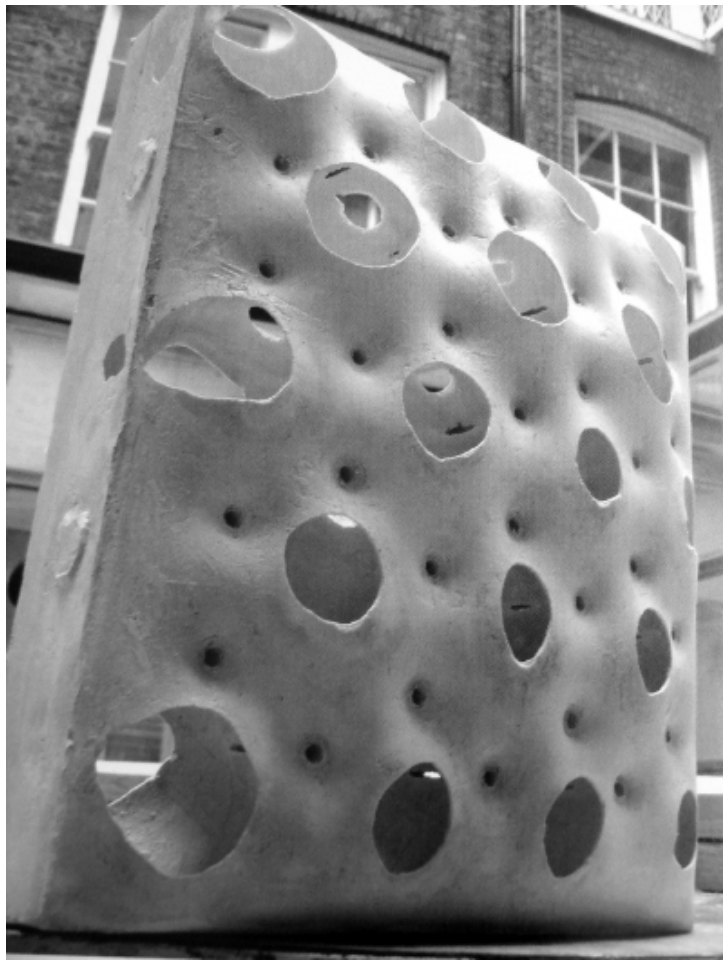
Case Study 2: Hydroponic vertical garden system, R&Sie(n), Paris, 2008

- 130 square metre wall consisting of 1200 hydroponic ferns(dryopteris filix-mas) and 300 hand blown glass beakers for bacterian production to feed the plants.
- Individual drop by drop system with nutritional adding is based on proportioning controls.
- Insulation carried out with high density PU foam by layers sprayed and covered by geo-textile.

Case Study 3: Material investigation : Ceramics

- Exploration of porous structures in concrete inherent to cast fabrication systems.
- This case study can inform fabrication of slow cured ceramic bricks within a range of "green bricks" with different structural and biological capabilities.

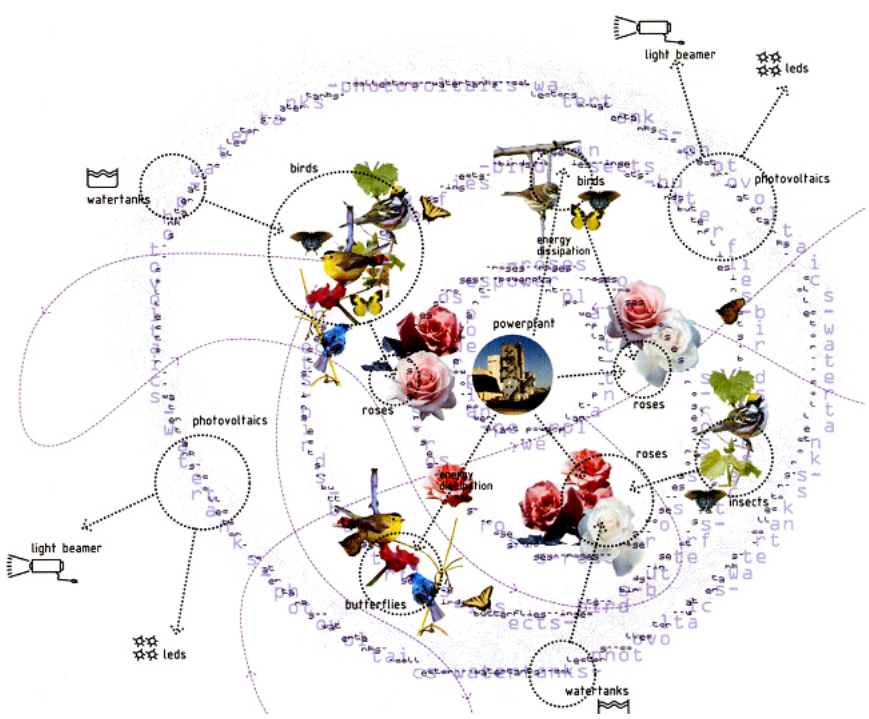




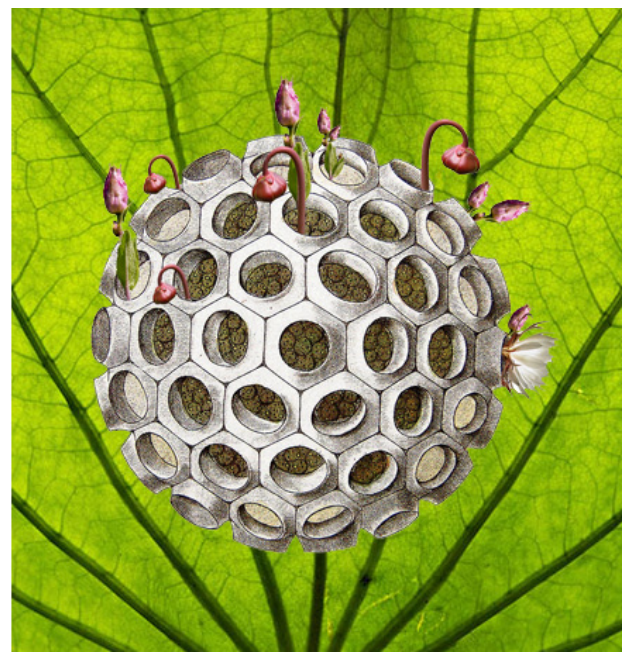
Prototype developed by Gabriel Sanchiz Garin at Architectural association exploring porous structures inherent to cast fabrication systems

Case Study 4: Living cladding project : proposal for an ecosystem akin to a biological network

- Transforms an existing power station into a living landscape within the city
- A membrane of roses fused with honeysuckle creepers
- Living matter on outer shell is planted in a grid of recycled polypropylene pallets(each measuring 1.5 mts x 3 mts by 3 inch thickness)
- Perimeter pathway behind the living membrane acts as an access link and maintenance corridor
- Membrane designed as an ecosystem to attract important butterfly species from northern US and turn the power station into a receptacle for bird nests : a resting ground for migratory birds



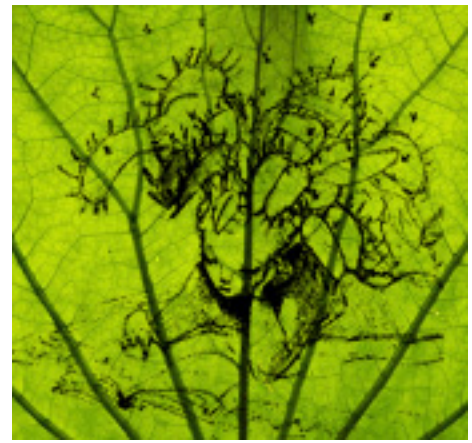
Living cladding project for a thermal power station by AMID, Iowa, 2002



A GREEN HOPE : human - plant symbiosis

The success of this idea will depend on collaborative research with plant scientists and ceramic scientists.

We would like to set up ***bio-labs*** in collaboration with botanical gardens in different regions of India and Europe to begin on-site prototyping. A dialogue with Kew gardens, London is being initiated towards this. Other interested partners could come from the fields of botany, computation, advanced ceramic fabrication, mud-architecture and biomimetics.



CREDITS

Gurukula Botanical Sanctuary, Wayanad, Kerala

Foundation of Revitalisation of Local Health Traditions, Bangalore

Tata Energy Research Institute, New Delhi

Industrial Design Centre, IIT Powai

Architectural Association, London

FoAM, Brussels