Hy-Fi (New York, 2014)

Commissioned by the Museum of Modern Art and MoMA PS1
Hy-Fi offers a captivating physical environment and a new paradigm for sustainable architecture. In 2014, we tested and refined a new low-energy building material, manufactured 10,000 compostable bricks, constructed a 13-meter-tall tower, hosted public cultural events for three months, disassembled the structure, composted the bricks, and returned the resulting soil to local community gardens. This successful experiment offers many possibilities for future construction.
RE-USED GROWING TRAYS FROM BRICK MANUFACTURING

COMPOSTABLE MYCELIUM BRICKS

SUSTAINABLE MORTAR

HEMP-CRETE FOUNDATION BRICKS

STEEL DIAPHRAGM FOR HURRICANE TIE-DOWNS

RECLAIMED TIMBER (NYC SCAFFOLDING BOARDS)

REUSABLE GROUND SCREWS FOR FOUNDATION
We designed a new type of brick through an innovative combination of corn stalk waste and living mushrooms with root-like growth. The bricks are lightweight, low cost, and extremely sustainable. We then created the world's first large-scale outdoor construction out of this material. We used biological, physical, and computational technologies to test the material's durability, structure, and thermal performance, and to design a robust and viable temporary building.
**BIOLOGICAL**
Growth of mycelium, the root-like element of mushrooms

**PHYSICAL**
Accelerated aging testing reveals no loss of stiffness

**COMPUTATIONAL**
Algorithm arranging bricks with complex geometry + proper bearing

Anisotropic properties of grown bricks

Algorithm arranging mirrored molds for maximum reflected sunlight

Brick types to fill any course length without cutting bricks

Structural testing reveals sufficient strength and bonding

Finite element analysis to calculate maximum displacement

Accelerated aging testing reveals no loss of stiffness

Thermal imaging reveals very low thermal diffusivity

Consultation with Ecovative

Consultation with Lars Dietrich Lab of Columbia

Consultation with Arup

Consultation with Columbia Engineering
Carlton Strength of Materials Lab

Consultation with Forrest Meggers and CHAOS Lab

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This new construction material grows out of living materials and returns to the earth through composting at the end of the structure's lifecycle. The manufacturing process engages bio-technology, agriculture, and industrial manufacturing. The composting process engages the municipal solid waste stream. In contrast to typical short-sighted architecture, our project is designed to disappear as much as it is designed to appear.

MANUFACTURING (BEGINNING OF LIFECYCLE): A GROWN BRICK

1. Laboratory (cultivate mycelium)  2. Agriculture (collect waste)  3. Manufacturing (combine in mold)  4. Industry (grow at scale)  5. Construction (lay bricks on site)

COMPOSTING (END OF LIFECYCLE): A BIODEGRADABLE BUILDING MATERIAL

1. Deconstruction (remove bricks)  2. Processing (break apart bricks)  3. Composting (add food waste)  4. Renewal (harvest soil)  5. Growth (soil used for new planting)
DESIGNED TO DISAPPEAR

BEGINNING WEEK 01 WEEK 02 WEEK 03 WEEK 04 WEEK 05 WEEK 06 WEEK 07
Construction waste accounts for over 30% of landfill volume. Our project offers an alternative to this wasteful linear economy. We use low-value raw materials rather than high-value ones, we use almost no energy to create building blocks rather than using massive energy, and we return demolition material to the earth in 60 days rather than burying it in landfills for hundreds of years. This approach is related to the Circular Economy, and according to the World Economic Forum, it has the potential to decouple economic growth—and also construction—from resource consumption.
This project involves a multi-faceted engagement with people. It offers a direct relationship to regional agriculture and innovation culture, municipal artists and non-profits, and local community gardens. People working on the project included local artists, local trade school interns, international graduate students, construction professionals, engineering professionals, and non-profit organizations. All people involved were meaningfully engaged and fairly paid. The project also engaged a diverse public through its high-profile installation.
**DESIGNING**
Onsite integrated design studio during construction

**BUILDING**
NYC brick masons and Columbia graduate students

**PLAYING**
Kids building alternate structures with our bricks

**MANUFACTURING**
Mass production of bricks in upstate New York Factory

**COLLABORATING**
Multifaceted team teaching and learning from one another

**SOCIALIZING**
Summer social events in Museum courtyard

**TRAINING**
On-the-job training for community interns

**EDUCATING**
Our team explaining the project and new material to visitors

**PARTYING**
Weekly music performances with 5,000 people
Hy-Fi offers a familiar-yet-completely-new building in the context of the glass towers and typical brick construction of New York City. The building creates mesmerizing light effects on its interior walls through reflected caustic patterns. The building frames the natural environment with a forward-looking perspective. The building plays with light, shadow, pattern, texture, and unique atmosphere. Both the architectural community and the general public have been enthusiastic about this design and this new vision for design and manufacturing. Overall, the building is full of wonder and optimism.

**SOCIAL MEDIA**
Public interaction with the project

**PRINT MEDIA**
Professional and popular interaction with the project

**ENVIRONMENT**
Environmental interaction with the project

**CULTURAL INSTITUTION**
Cultural interaction with the project (a parallel installation in lobby of the MoMA, we explored alternate form and organic dye)
“Hy-Fi might be the first built example of one of the [icons] of computer-assisted design: interlocking, curving columns... It is also one of the most fully realized bio-buildings ever constructed. As such, its form is a proof-of-concept both formally and environmentally.”

AARON BETSKY
Curator and Dean of the Frank Lloyd Wright School of Architecture

“The [designers] could have hired masters degree candidates at a volunteer basis, but they instead chose to engage Brooklyn Tech Triangle college students and working professionals in need of jobs at a competitive hourly salary, bolstering their confidence and providing them with fair wages.”

TORYL HANNA
Employment Coordinator, Brooklyn Navy Yard Development Corporation

“Hy-Fi reinvents the most basic component of architecture—the brick—as both a material of the future and a classic trigger for open-ended design possibilities... This material could become a staple for building in places where resources are very limited. It could be transformative.”

PEDRO GADANHO
Architecture Curator, Museum of Modern Art

“In terms of technology and sustainability, the idea of using agricultural waste in this brilliant, ingenious way—and drawing on the technologies of biology instead of the technologies of physics—is very impressive. And the method of bricklaying is very sophisticated.”

KENNETH FRAMPTON
Professor of Architecture at Columbia Graduate School of Architecture, Planning and Preservation

“The construction and deconstruction demonstrate the lifecycle and the circular economy of these sustainable and renewable materials. Fittingly, one of the plants growing in the courtyard is corn, making a kind of symbolic closed-loop for this material.”

ANDREW DENT
Vice President of Library and Materials Research at Material Connexion

“As a sustainable building material, this is exceptional. Unlike traditional biomass, this is not dependent on the sun for growth, decoupling it from the limitations of providing solar insolation and facilitating efficient production around a marvelous energy source—our organic waste.”

FORREST MEGGERS
Assistant Professor at Princeton School of Architecture

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