Mushroom Furniture

Joseph Dahmen, Amber Frid-Jimenez

University of British Columbia

VOL 500

June 07, 2016

UBC Social Ecological Economic Development Studies (SEEDS) Report

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Overview

This UBC SEEDS (Social Ecological Economic Development Studies) project activated a space on the UBC campus through the design and fabrication of a architectural seating installation using sustainable biocomposite materials derived from mycelium (mushrooms) and cellulosic byproducts of the BC forestry industry. The aesthetic and structural potential of these materials were explored using laboratory testing and design-based research methodologies. The result was playful and inviting seating for the UBC campus. The installation explored concepts and modes that communicate the values of sustainability in a visceral way through innovative forms on which people can sit and relax.

Biocomposites are sustainable, high-performance materials with the potential to replace the engineered woods and other structural materials now on the market. Mycelium-based biocomposites refer to materials in which loose cellulosic materials are inoculated with mycelium spores, which act as binders to produce solid objects. Typical strength is comparable to that of expanded polystyrene (XPS) foams in wide use in the North American construction industry as thermal insulation. Once the desired amount of strength has been achieved, growth is checked through the application of modest amounts of heat. The finished materials are natural, renewable, biodegradable, and fully compostable at project end.

The project contributed to sustainability at UBC in three primary ways:

1. Laboratory testing of an emergent sustainable material
2. Design exploration with students of a leading edge sustainable material
3. Development of an architectural seating installation on campus using biocomposites that provided the UBC community an opportunity to experience the exploration viscerally, through direct contact with them.

The project contributed innovative interdisciplinary research at the intersection of materials, building technology, mycology and sustainable architecture, bringing the research out of the laboratory so that it could be directly experienced by a wide segment of the UBC community. Project participants included Joseph Dahmen at the UBC School of Architecture and Landscape Architecture (PI), Amber Frid-Jimenez, Canada Research Chair of Design and Technology at Emily Carr University of Art and Design, as well as student research assistants at both institutions, Scott Henderson, a Vancouver-based mycologist, Collin Varner, UBC Horticulturalist, and the president and technical staff of All Seasons Mushrooms, a commercial mushroom farm located in Langley, BC.

Project Description

This UBC SEEDS (Social Ecological Economic Development Studies) project created an architectural installation that activated a central space on the UBC campus with public seating fabricated with mycelium biocomposites. The installation drew upon interdisciplinary research conducted at UBC on mycelium biocomposites derived from local mushrooms and by-products of the forestry industry. The installation utilized design-based research methodology to explore the aesthetic and structural potentials of these cutting edge sustainable material in the form of playful, elegant and inviting seating for the UBC campus. The installation communicated the value of interdisciplinary research and sustainability to a broad public in a visceral way through innovative furniture on which people can sit and relax.

Biocomposites are high-performance sustainable materials with the potential to replace engineered woods and other structural materials in wide use within architecture and construction. Mycelium-based biocomposites refer to materials in which loose granular materials are held together by mycelium, or the roots of mushrooms. The sterilized growth

medium is inoculated with mycelium spores, which grow throughout the interstitial spaces of the substrate to produce a cross-linked three-dimensional matrix of structural polysaccharides. Once fully colonized with mycelium, the substrate is then ground up and moulded into shapes. The shapes can be removed from their moulds after several days, at which point they are typically subjected high temperatures to dry them and check the further growth of mycelium.

The finished material develops the approximate strength of polystyrene foams (e.g. Styrofoam), making it a possible substitute for these environmentally toxic architectural materials currently in wide use in building construction. Mycelium biocomposites can be combined with durable natural coatings to produce objects that are renewable, biodegradable, and fully compostable. Research at conducted UBC has proven the feasibility of producing mycelium biocomposite blocks using pleurotus ostreatus (commonly known as oyster mushroom) mushroom spores native to the region in a growth medium of sterilized sawdust.

The project was divided into two primary phases as follows:

1. **Phase I (Sept 2014-June 2015): Research**
   Material research and design exploration, in which samples of mycelium biocomposites were be created and tested in a range of conditions. Different fabrication methods (molding, CNC routing, hand shaping) were tested and different coatings and other finishing options were investigated (bio-epoxies, conventional polyester resins, and poly urea-based elastomeric coatings). An iterative design methodology was pursued to incorporate knowledge gained into Phase I prototypes.
2. **Phase II (August 2015- April 2016): Fabrication**
   Farbrication of architectural seating installation. During Phase II the knowledge gained during Phase I was be applied to produce a temporary seating installation on campus open to the UBC community. The results of Phase II can be found in Appendices B,C, and D

Research during Phase I of the project was carried out at the Lasserre Building. The results of Phase I research can be found in Appendix A. During Phase II, research and growth experiments were carried out in a 1,500 square foot greenhouse at the south end of the UBC Campus, which UBC Facilities granted the use of from August 2015 to May 2016.

The architectural installation was installed on April 12, 2016 at Raymond and Money M.C. Lee Square, a new public square at the intersection of University and East Mall roads, where remained for two months. The installation was commissioned by UBC Campus and Community Planning and approved as a part of the UBC Centennial Initiative in the area of sustainability. Funding was provided by UBC SEEDS (Social Ecological Economic Development Studies) and UBC Campus and Community Planning. Funds from the Peter Wall Arts Based Initiative helped cover installation materials, fabrication expenses, and graduate research assistants working on the project to see it through to completion. Additional funding received from the Alma Mater Society (AMS) was used to organize outreach activities among the student population at UBC. These included a moulding demonstration, in which students and other members of the UBC community had the opportunity to try moulding the mycelium, and a social event at the opening of the installation on campus.

In addition to the installation at UBC, the research public exhibition at the Museum of Vancouver. This installation, entitled *Mycelium Mockup*, was held in August 2015. Visual documentation of the installation can be found in Appendix B, which was the basis for a peer reviewed conference poster documenting the research that was presented at 2016 annual

meeting of the Association of Collegiate Schools of Architecture. The installation and related themes are further explored in “Soft Matters,” an invited peer-reviewed 2,500 word article by Joseph Dahmen published in the *Journal of Technoetic Arts*, a transdisciplinary journal that focuses upon the juncture between art, technology and the mind. The article is included in Appendix D. The architectural furniture installation will be the subject of peer reviewed journal publications in the future, in addition to a technical article documenting the production of mycelium biocomposites. An illustrated write-up of the installation will also be submitted to online sources documenting sustainable architecture and the project submitted for sustainability awards within the architecture and product design fields.

Discussion

The relentless cycle of consumption characteristic of contemporary architecture highlights the need to rethink its constituent materials. Mycelium biocomposites are visionary materials that suggest a future in which dynamic architectural components are grown rather than manufactured, provoking new approaches to architectural production. Mycelium biocomposites, which refer to materials in which granular materials are held together the roots of mushrooms, suggest a future in which dynamic architectural components are grown rather than manufactured, adding to local ecosystems and serving needs that are simultaneously structural, aesthetic, and visceral. The finished materials develop strength comparable to that of polystyrene foams (e.g. Styrofoam), making them a possible substitute for these environmentally toxic architectural materials currently in wide use in building construction. Mycelium biocomposites can be combined with durable natural coatings to produce objects that are renewable, biodegradable, and fully compostable. The SEEDS research at UBC demonstrates the feasibility of producing mycelium biocomposite blocks using local materials and mushroom strains.

Mycelium biocomposites offer the prospect of autopoesis, in which silently growing buildings replace the shrieking saws and clanging hammers of carbon-intensive construction methods. During the life of a building, the flexible living materials are capable of adapting to change and serving needs that are simultaneously structural, aesthetic, and visceral. When buildings are decommissioned at the end of their useful life, the mycelium blocks, which encode dormant organic decay into their basic structure, add valuable material to local ecosystems by breaking down other assemblies and making nutrients bio-available to other organisms. A response to unceasing cycle of demolition and rebuilding in contemporary free market cities, the mycelium biocomposite furniture installation suggests an alternate future in which the materiality of architecture engages with sustainability and temporality in new and productive ways.

Conclusion

This UBC SEEDS project activated a space on the UBC campus through the design and fabrication of a architectural seating installation using emergent sustainable biocomposite materials derived from mycelium and cellulosic byproducts of the BC forestry industry. Biocomposites are sustainable, high-performance materials with the potential to replace the engineered woods and other structural materials now on the market. The finished materials are natural, renewable, biodegradable, and fully compostable at project end.

The project contributed to sustainability at UBC in three primary ways:

1. Laboratory testing of an emergent sustainable material
2. Design exploration of a leading edge sustainable material
3. Development of an architectural seating installation on campus using biocomposites that provided the UBC community an opportunity to experience the exploration viscerally, through direct contact with them.

The project showed that durable mycelium biocomposite materials can be grown from regional sources of fungus and byproducts of the regional forestry industry. The project contributed to innovative interdisciplinary research at the intersection of materials, building technology, mycology and sustainable architecture, bringing the research out of the laboratory so that it can be directly experienced by a wide segment of the UBC community. The project demonstrates that there is substantial potential for developing these emergent materials further for use in Canada.

Mushrooms hold potential for sustainable building materials

Media Release | April 19, 2016

UBC School of Architecture and Landscape Architecture professor Joe Dahmen.

We slice them on pizza, toss them in salad and sauté them in stirfry. But have you ever thought about using mushrooms as furniture? According to the work of a team of researchers, the humble fungus is ready to leave the kitchen and take up a role as a building material.

In an innovative design project, six new stylish benches have been installed outside the UBC Bookstore. Assembled from light-coloured honeycomb-shaped bricks under a top of clear acrylic, the seats are more than an eye-catching spot where students can relax—they're also very much alive, grown from a blend of oyster mushroom spores and alder sawdust packed into moulds.

The roots of the project stretch back to 2014, when assistant professor at UBC School of Architecture and Landscape Architecture Joe Dahmen and his partner in work and life, Amber Frid-Jimenez, Canada Research Chair in Design and Technology at Emily Carr University of Art and Design, were expecting their second child. They had been working on an architectural installation fabricated of recycled polystyrene blocks—not exactly the most benign material —when they decided to explore more eco-friendly options.

"Amber couldn't get near the thing because it was so toxic," Dahmen recalled, touring the greenhouse where the benches were grown. "It got me thinking that there must be a more natural material that would still enable a similar range of expression."

In their search for an alternative, Dahmen and Frid-Jimenez discovered the world of mycelium biocomposites, an emerging field in which mushroom roots, or mycelium, grow in loose cellulosic material such as sawdust. The results are durable materials with attributes similar to that of polystyrene foams. Although a U.S. company recently signed a contract to provide Ikea with mycelium-based packaging, the method had yet to be done in Canada.

Through UBC's social ecological economic development studies (SEEDS) sustainability program (https://sustain.ubc.ca/courses-teaching/seeds) , Dahmen and Frid-Jimenez worked with university students and staff to develop a scalable method of producing mycelium biocomposites using two local materials: oyster mushroom spores and alder sawdust.

To address the size limitation of the material—mycelium biocomposites risk contamination by mould and bacteria if they exceed a half-metre in thickness—Dahmen developed a new process that drew inspiration from a wasps' nest discovered in the empty greenhouse that would house the project.

"I was really amazed at the honeycomb structure, because it's a highly efficient way of occupying space," he said, holding a piece of wasps' nest to display its dense grid of hexagonal chambers. "It's scalable, it can go in any direction, and it's extremely spatially efficient."

Putting a hole in the centre of each block of mycelium biocomposite not only allowed Dahmen to grow larger objects, it also provides a place in the benches for the mushroom to fruit. “That way, it’s contained, so people can see it but they won’t worry about getting it on their clothes when they sit down,” he notes. The fact that oyster mushroom fruit are “delicious”, said Dahmen, was a consolation whenever the growing process went awry.

Perhaps the greatest potential of mycelium biocomposites is as an alternative insulation material for buildings. “Their biggest application in the long run is in architecture and construction,” said Dahmen. “The average age of commercial buildings in North America is under 40 years. If we could imagine construction materials that add positive value to ecosystems as they break down, we have a whole new paradigm for the way we approach buildings, at a time when we’re demolishing most buildings long before they wear out.”

Dahmen also foresees mycelium biocomposites as a replacement for many other roles played by polystyrene, from packaging to building insulation. “Styrofoam is a material that functions for a short amount of time as packaging, and then spends hundreds, if not thousands, of years in a landfill,” he observed. Not only does mycelium biocomposite require much less energy to create, it also completely decomposes when composted, and helps break down other materials in the waste stream, making them available to other organisms.

Photo gallery:

Background: The five-step bench creation process

1. Alder sawdust was sterilized, blended with nutrients, and inoculated with the spores of Pleurotus ostreatus (oyster mushroom) at a local mushroom farm.
2. The mycelium (mushroom roots) were left to grow in the sawdust for two weeks and then transferred to a greenhouse at UBC
3. The sawdust and mycelium mix was shredded in a wood chipper, and then packed into moulds.
4. After five days, the moulds were removed and the blocks of mycelium biocomposite were wrapped in Saran wrap to encourage the growth of chitin (a strong polysaccharide similar to lobster shells) on their exterior.
5. After drying, the blocks were ready to be assembled into benches, and covered with clear acrylic.

UBC’s SEEDS sustainability program (https://sustain.ubc.ca/courses-teaching/seeds) advances campus sustainability by creating partnerships between students, faculty and staff that deliver innovative and impactful research projects.

Find other stories about: Amber Frid-Jimenez (http://news.ubc.ca/tag/amber-frid-jimenez/), Joe Dahmen (http://news.ubc.ca/tag/joe-dahmen/), Mushrooms (http://news.ubc.ca/tag/mushrooms/), Pleurotus ostreatus (http://news.ubc.ca/tag/pleurotus-ostreatus/), Sustainable building materials (http://news.ubc.ca/tag/sustainable-building-materials/), UBC Bookstore (http://news.ubc.ca/tag/ubc-bookstore/), UBC School of Architecture and Landscape Architecture (http://news.ubc.ca/tag/ubc-school-of-architecture-and-landscape-architecture/), UBC SEEDS sustainability program (http://news.ubc.ca/tag/ubc-seeds-sustainability-program/)

Contact

Lou Corpuz-Bosshart
UBC Public Affairs
Tel: 604.822.2048
Cell: 604.999.0473
lou.bosshart@ubc.ca (mailto:lou.bosshart@ubc.ca)

Media Resources

- Media Contacts (http://news.ubc.ca/media-contacts/)
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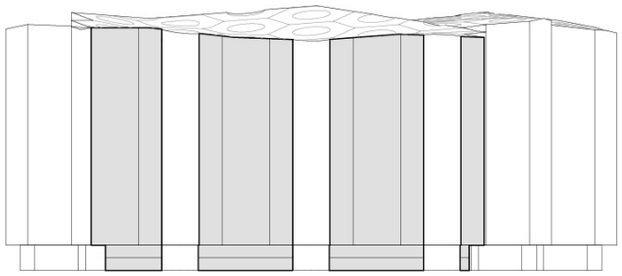
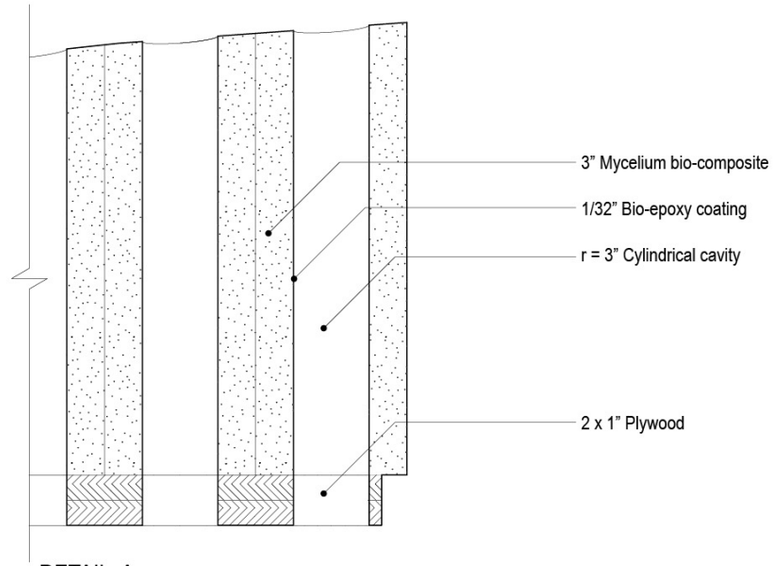
- TV and Radio Studios (http://news.ubc.ca/media-resources/tv-and-radio-studios/)
- UBC's Okanagan Campus Newsroom (http://news.ubc.ca/ubc-okanagan-news-room/)

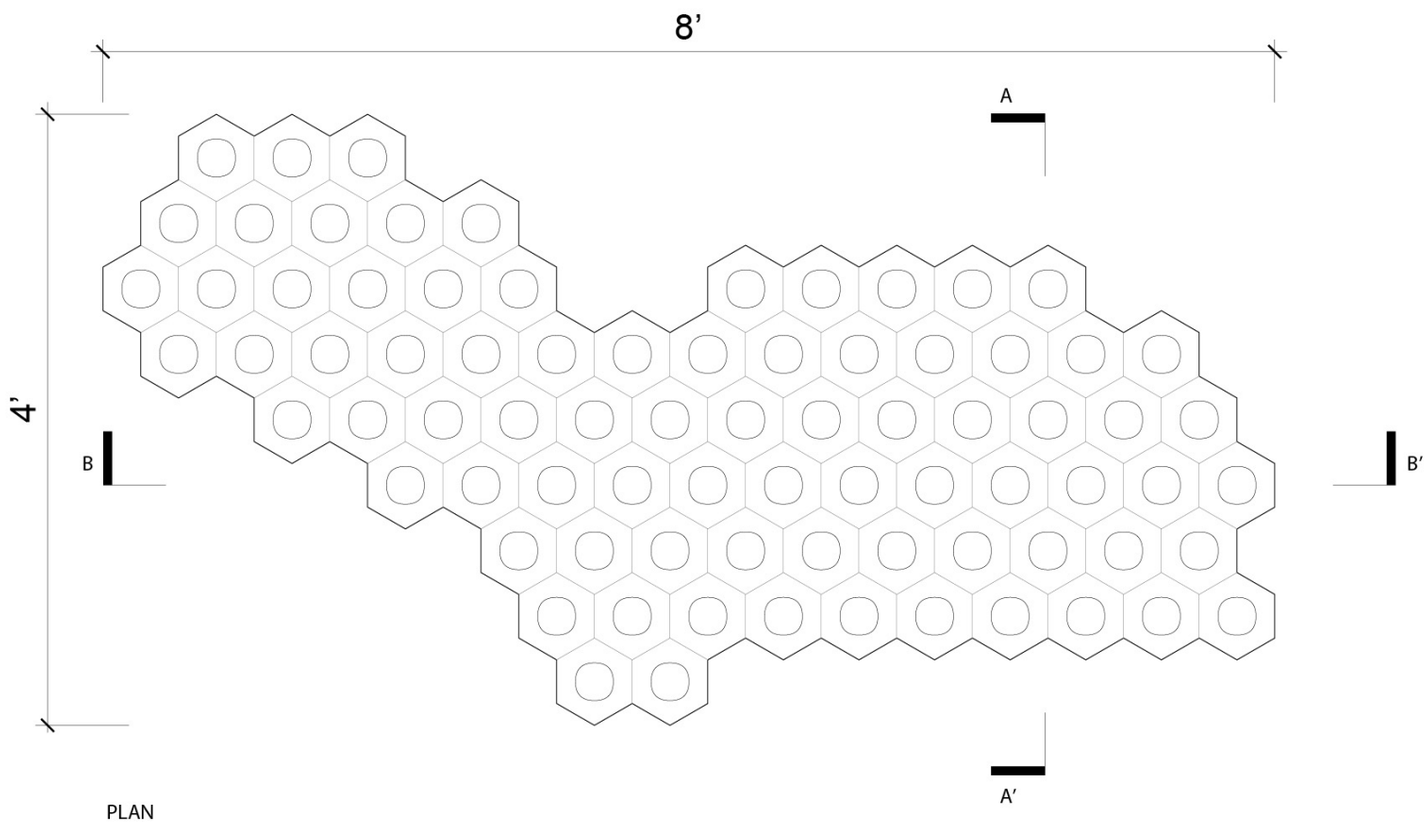


SECTION A - A'
1:10

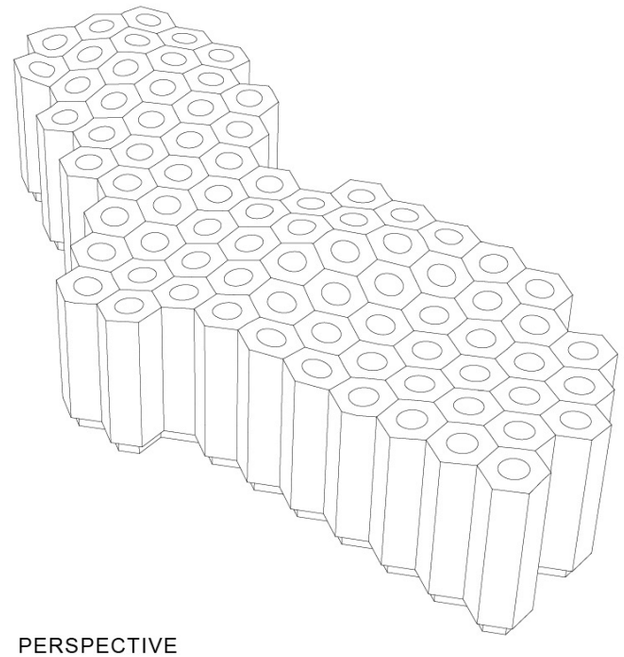
SECTION B - B'
1:10



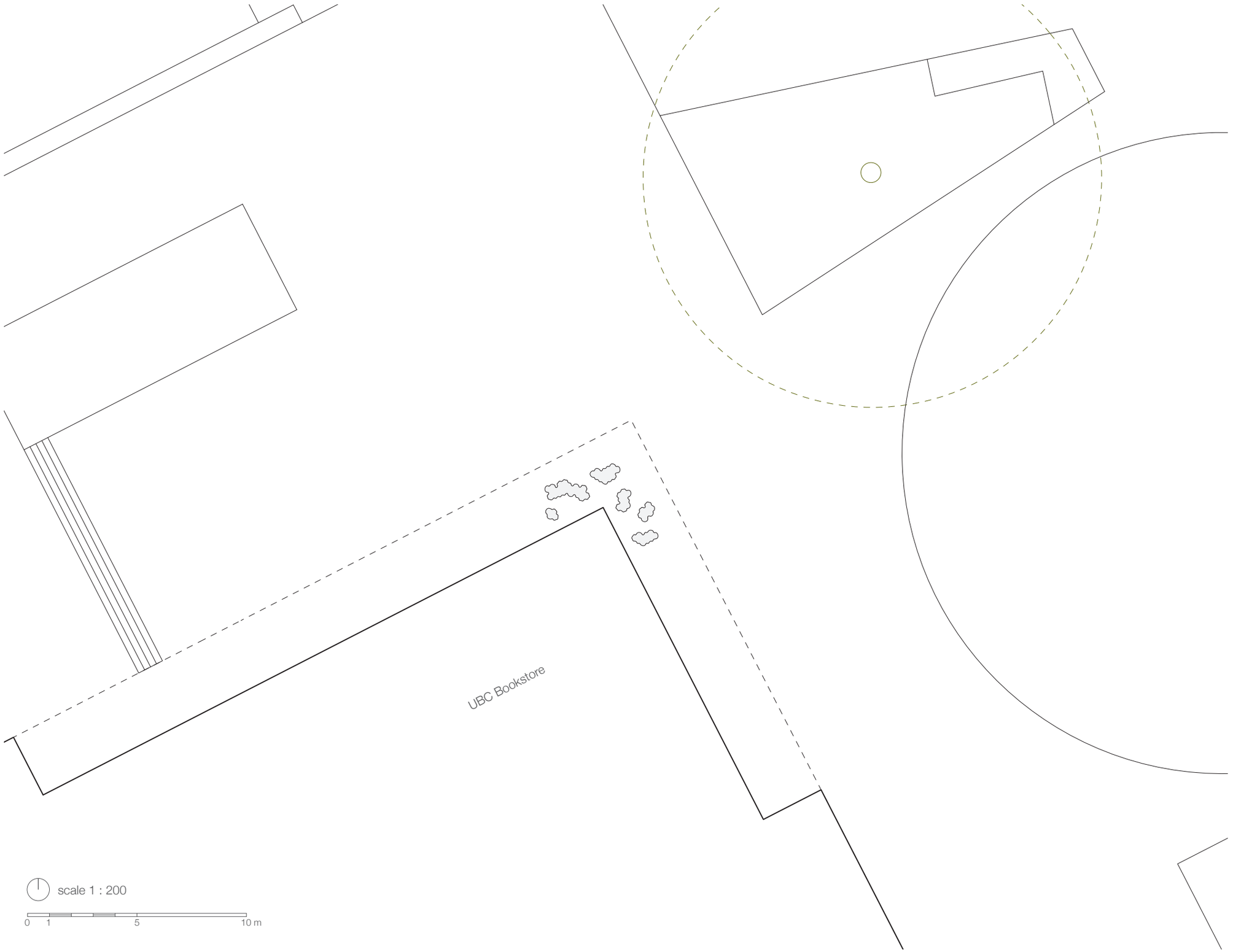
DETAIL A
1:5



PLAN
1:10



PERSPECTIVE


UBC Bookstore
scale 1 : 200
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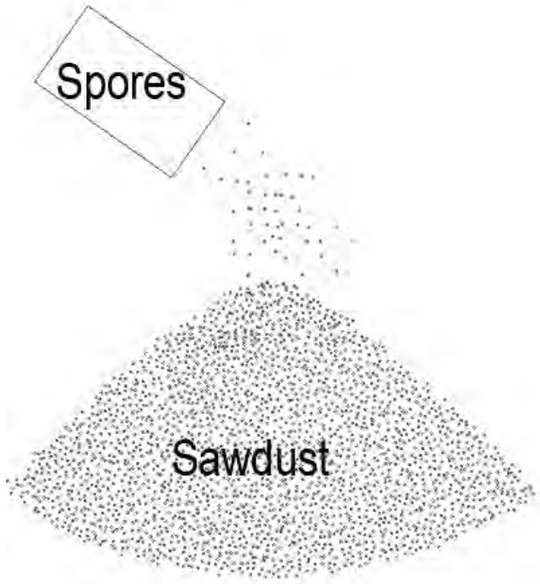
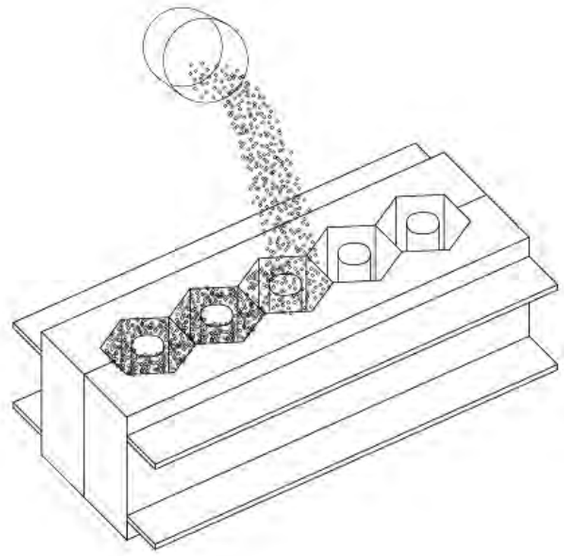
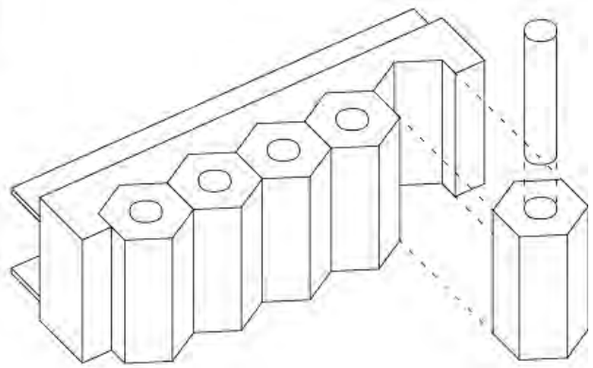


1. Sterilized sawdust and nutrient medium is innoculated with mushroom spores

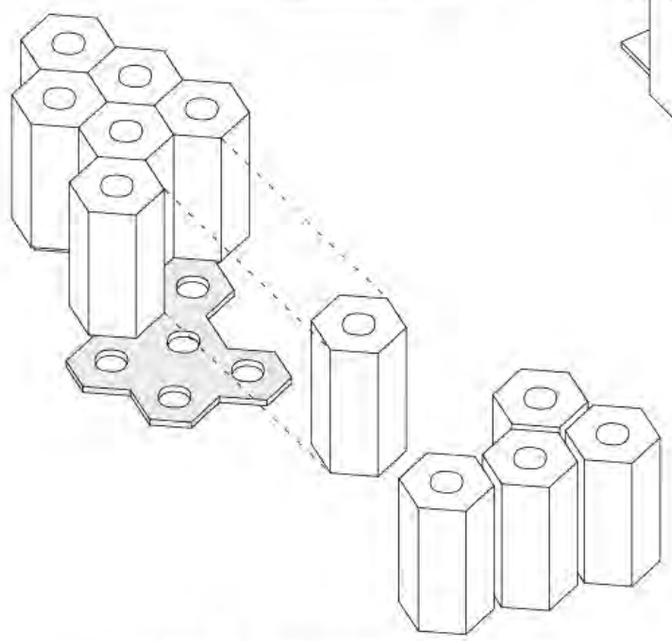
2. Innoculated medium is incubated under controlled conditions for 14 days



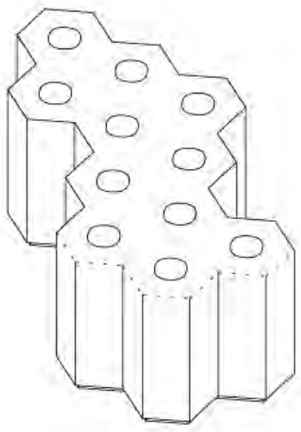
3. bags are molded into hexagonal units



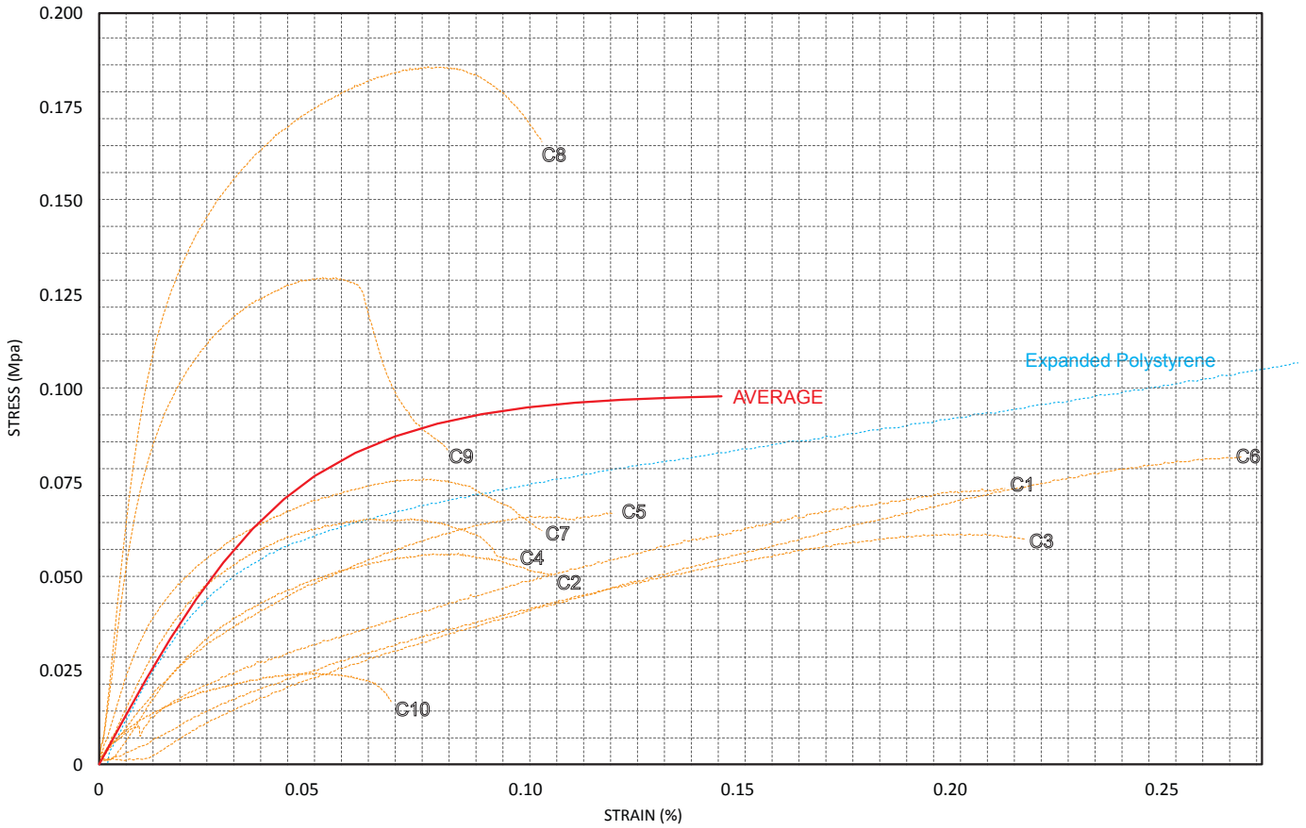
4. demoulding



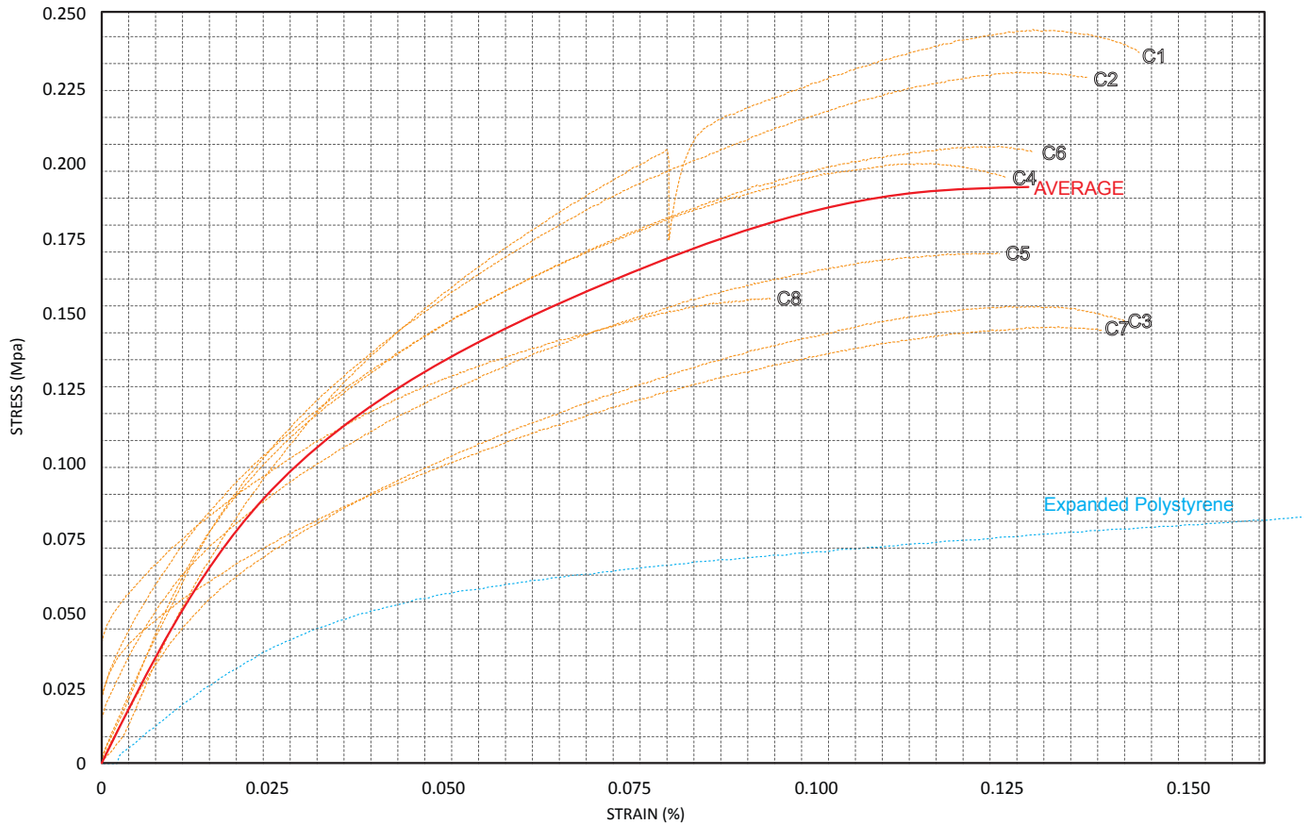
5. Units are assembled onto plywood base



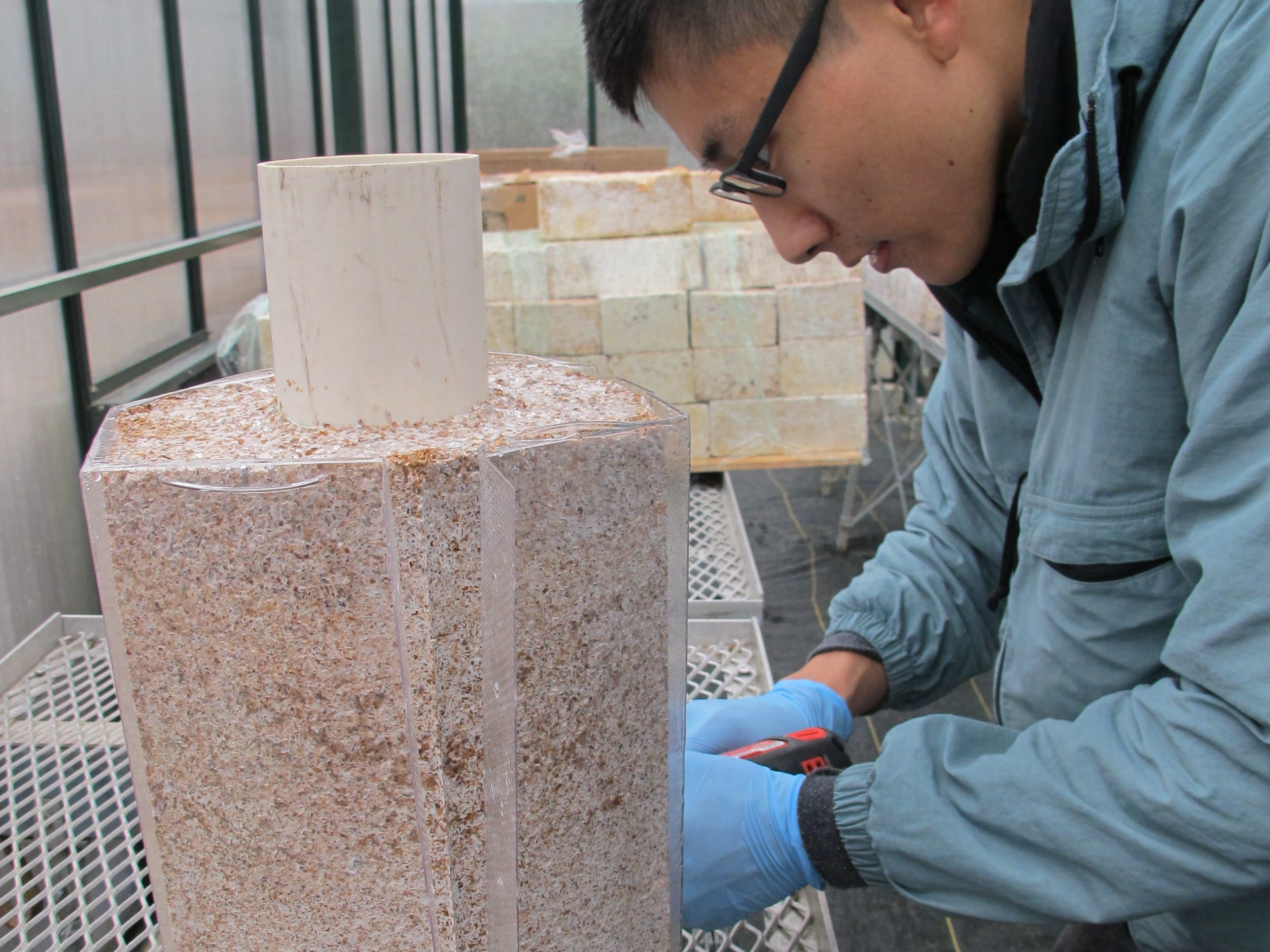
6. Chitin fuses units into monolithic whole



Unconfined Compression Test 01



Unconfined Compression Test 02



MUSHROOM MOULDING PARTY

EVENT:

AN AFTERNOON OF MUSHROOM MOULDING, GETTING A FIRST HAND LOOK AT RESEARCH AT UBC SALA THAT GROWS FULLY BIODEGRADABLE FURNITURE BY COMBINING CELLULOSIC WOOD WASTE AND MYCELIUM
1-4PM

LOCATION:

UBC PLANT OPERATIONS NURSERY 6029 NURSERIES ROAD V6T 1W5
FROM SW MARINE DRIVE TURN NORTH ONTO WESBROOK MALL. NURSERIES RD IS THE FIRST RIGHT. UBC NURSERY IS ON THE LEFT. 200M BEFORE ENVIRONMENTAL SERVICES FACILITY AT THE END OF THE ROAD.

OR TAKE 41 FROM THE BUS LOOP AND GET OFF AT TRIUMF CENTRE AND WALK 300M

BROUGHT TO YOU BY AMS, SEEDS, AND UBC CENTENNIAL INITIATIVE

MUSHROOM MOULDING PARTY

An afternoon of mushroom moulding, getting a first hand look at research at UBC SALA that grows fully biodegradable furniture by combining cellulosic wood waste and mycelium

LOCATION

UBC PLANT OPERATIONS NURSERY
6029 NURSERIES RD. V6T 1W5

DATE TIME

MONDAY
FEB. 8TH 1-4PM

BROUGHT TO YOU BY
AMS, SEEDS,
UBC CENTENNIAL INITIATIVE

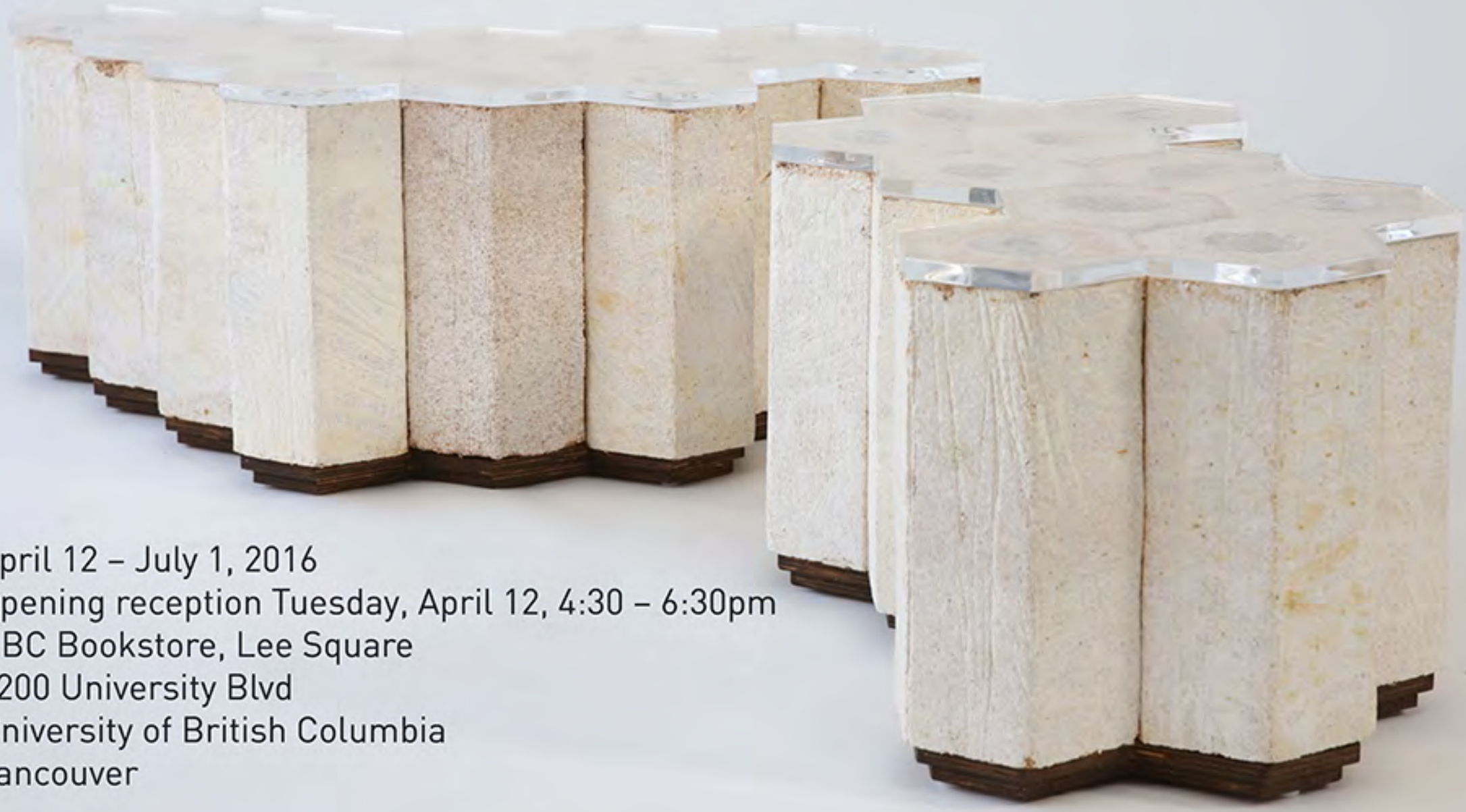
FOOD AND DRINKS!

From SW Marine Drive turn North onto Wesbrook Mall. Nurseries Rd is the first right. UBC Nursery is on the left -200m before Environmental Services facility at the end of the road. The greenhouses are visible from the road.
or take 41 from the bus loop and get off at Tirumf centre and walk 300m


U-HAUL
molded 12/30
5
5

They grow without us

Mushroom Furniture
AFJD



April 12 – July 1, 2016
Opening reception Tuesday, April 12, 4:30 – 6:30pm
UBC Bookstore, Lee Square
6200 University Blvd
University of British Columbia
Vancouver

The installation has been made possible through generous support from the University of British Columbia SEEDS, UBC Campus and Community Planning, Peter Wall Institute for Advanced Studies, UBC Alma Mater Society, UBC School of Architecture & Landscape Architecture, and the Emily Carr University Studio for Extensive Aesthetics.


They grow
without us
Mushroom Furniture
by AT.ID
Project Credits


Amber Frid-Jimenez
Research Assistants
Yan Luo
Joe O'Brien
Joomi Seo
Lianne Zanniver
Daichi Yamashita
PingFei Du
Lārinc Vass
Sponsors
UBC Centennial Initiatives Fund
UBC SEEDS (Social Ecological Economic Studies) Sustainability Program
UBC Campus and Community Planning
Peter Wall Institute for Advanced Studies
UBC Alma Mater Society
UBC School of Architecture & Landscape Architecture
Emily Carr University Studio for Extensive Aesthetics


They grow
without us


Think green
without us

They grow without us

Mushroom Furniture
by AFJD

The honeycomb shaped public furniture behind you is grown from mushrooms. A blend of mushroom spores and sawdust are grown in moulds to produce unique sustainable materials called mycelium biocomposites. While in the mould, the roots of the fungus, called mycelia, propagate in the spaces in the cellulosic material, producing solid objects. The honeycomb design of the seating reflects a fabrication process in which individually moulded hexagonal blocks are grown together to produce larger forms.

The mushroom furniture suggests a future in which biodegradable architectural components are grown rather than manufactured, adding valuable material to local ecosystems at the end of their life. In contrast to the relentless cycle of consumption characteristic of contemporary construction, mycelium biocomposites offer the prospect that conventional carbon-intensive construction methods could be replaced one day with silently growing buildings. The project builds upon innovative interdisciplinary research at the intersection of [illegible] technology, [illegible] and sustainable architecture.

The project is led by Joe Dahmen, Assistant Professor at UBC School of Architecture and Landscape Architecture, who worked with his partner, Amber Frid-Jimenez, Canada Research Chair in Design and Technology at Emily Carr University of Art + Design. Together they run AFJD, a transdisciplinary design firm based in Vancouver that designed the furniture.

The furniture installation was funded in part by the UBC Centennial Initiative and was developed as a UBC SEEDS (Social Ecological Economic Development Studies) Project. Project funding also provided UBC Campus and Community Planning, the UBC Alma Mater Society, and the Peter Wall Institute for Advanced Studies.

Project Credits

Design Firm
AFJD Studio
http://afjdstudio.net

Lead Designers
Joe Dahmen
Amber Frid-Jimenez

Research Assistants
Yan Luo
Joe O'Brien
Jiayin Sun
Liliane Zander
Daichi Yamashita
Pengfei Du
Lorenc Hoti

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UBC Campus and Community Planning
Peter Wall Institute for Advanced Studies
UBC Alma Mater Society
UBC School of Architecture & Landscape Architecture
Emily Carr University Studio for Extreme Aesthetics

Grow your furniture: Innovators use mushroom spores to make benches at UBC

CTV National News: Fungus as a plastic substitute?

A B.C. design team hopes its curious concept will replace non-organic material like plastic. Melanie Nagy reports on fungus furniture.