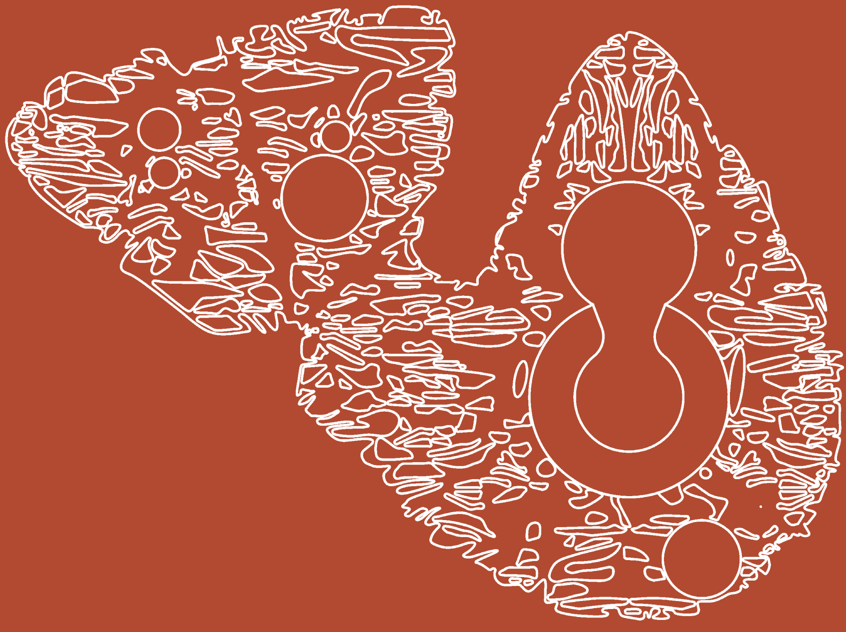
Bartlett Design Research Folios

Alga(e)zebo



by mam

Project Details

Practice:	mam
Designers:	Marjan Colletti and Marcos Cruz
	Colletti and Cruz contributed equally to this project through their collaborative practice, mam architects.
Title:	Alga(e)zebo
Output type:	Design
Function:	Public architectural installation
Location:	Euston Square Gardens at Euston Station, London
Client:	Mayor of London, Greater London Authority
Practical completion:	July 2012
Dates:	25 July – 12 September 2012
Budget:	£120,000
Size:	Three columns of cold-formed welded 8mm steel plates, 7.80m × 5m × 3.35m
Engineering:	Bollinger-Grohmann-Schneider engineers, Vienna, Austria
Manufacturing:	Formstaal GmbH & Co. KG, Stralsund, Germany
Consultants:	Richard Becket, UCL; UCL Algal Research Group: Lamya A Haj, Marco Lizzul, Saul Purton, Laura Stoffels; the Culture Collection of Algae and Protozoa, Scottish Marine Institute: Joanne Field, Joanna Szaub

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View of Alga(e)zebo in Euston Square Gardens
Photograph Virgilio Ferreira

Statement about the Research Content and Process

Description

This ‘gazebo’ was commissioned as part of the Greater London Authority’s Wonder series of architectural installations for the 2012 London Olympic celebrations. Sited at Euston Square Gardens, it consists of a large decorative canopy structure and biotechnological apparatus. It intertwines human artifice with natural surroundings in three ways: vertical columns which incorporate photo-bioreactors containing algae; an ornamental pergola that emulates an inverted tree silhouette; and an irregular outline which allows the local environment to occupy the structure, as well as functioning as a communal seating facility.

Questions

1. How can integrated design and manufacturing processes enable an interdisciplinary, international team of designers, researchers and fabricators to collaborate on complex biotechnological architecture throughout design and use?
2. What is the best means of digitally designing, modelling and testing the gazebo’s innovative geometry and double-curved structural steel panels?
3. How should the interrelationship between biological and steel structures be achieved?
4. How can the gazebo be designed to encourage interaction in the public realm, reinvigorating an underused green space through an educational resource and offering new opportunities to learn about biological processes?

Methods

1. **Conceptual design iterations which responded to the gazebo garden tradition.**
2. **Digital engineering tests developed with Bollinger-Grohmann-Schnieder's bespoke algorithmic and parametric scripting programmes.**
3. **Precision CNC manufacturing of the gazebo's double-curved panels by collaborating fabricators, CSI.**
4. **Biological research of algae growth, in collaboration with UCL's Algal Research Group.**
5. **Installation and occupation of the project.**

Dissemination

Published in the national and architectural press, including *Detail Daily, Architects' Journal, Building Design, Glass Magazine, Telegraph* and *Time Out London*. Presented in lectures in Madrid, Guimarães, London, Edinburgh, Taichung and Barcelos, Portugal.

Statement of Significance

One of the winners of the Greater London Authority's Wonder competition for architectural installations to celebrate the London 2012 Olympics and Paralympics.

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View of Alga(e)zebo at night
Photograph Virgilio Ferreira

Introduction

Located at Euston Square Gardens, London, this installation consists of a large decorative canopy structure and biotechnological apparatus – an Alga(e) zebo. It intertwines human artifice with natural surroundings in three distinct ways which grow in scale and effect. The vertical columns incorporate photo-bioreactors containing algae that grows and mutates when invaded by local species. The ornamental multifaceted patterns emulate an inverted tree silhouette, acting as a scaffold or pergola for smaller vegetation to grow into, and creating dynamic effects of light and shadows. The irregular outline of the gazebo allows for trees or taller bushes to grow in between the structure and functions as a communal seating facility for visitors to gather in and view the environment. [fig. 1]

Aims and Objectives

The project aims to incorporate fundamental structural attributes of biological systems into a complex steel construction. Alga(e)zebo innovates with its structurally sound double-curved geometry, allowing for deep cantilevered spans manufactured from cold-formed, perforated and welded 8mm recycled Carten steel panels. Realising the project required close developmental collaboration with international teams of structural engineers and fabricators and experimental research scientists. The structure was designed through a sustained process of testing and remodelling up to and beyond production using bespoke software, digital and analogue manufacturing processes, and the reshaping of its tectonic form by organic biological processes over the course of its two-month installation.

Alga(e)zebo therefore aimed to redefine the structural possibility of complex steel constructions through advanced technological tools, biological research and educational interaction.

Questions

1. How can integrated design and manufacturing processes enable an interdisciplinary, international team of designers, researchers and fabricators to collaborate on complex biotechnological architecture throughout design and use?
2. What is the best means of digitally designing, modelling and testing the gazebo's innovative geometry and double-curved structural steel panels?
3. How should the interrelationship between biological and steel structures be designed?
4. How can the gazebo be designed to encourage interaction in the public realm, reinvigorating an underused green space through an educational resource and offering new opportunities to learn about biological processes? [fig. 2 & 3]


3a


3b

3
Opening ceremony in July 2012

Context

Public installation

Alga(e)zebo was one of five installations designed by the Bartlett School of Architecture and built for London's 2012 Olympics celebrations. It was commissioned by the Mayor of London following a call for proposals for the Greater London Authority's 'City Dressing' programme and the Mayor's 'Wonder' series of 'incredible installations', which aimed to celebrate the capital's design talent by showcasing cutting-edge architectural projects throughout London. Between 25 July and 12 September 2012, it brought innovative design production closer to the public, transforming one of the capital's underused green spaces.

Biotechnological design

The aim to intertwine human artifice with natural surroundings reflects the complex boundary negotiations that take place between architecture and nature in contemporary cities. There is an aspiration to intermingle and merge these conditions in contemporary design; for example, when architecture behaves and looks more like biological constructs, and when nature is manipulated via human interference.

Architects have recently been attracted to the study of algae but have only integrated it superficially in application to façades. By embedding algae within the tectonic form of the architecture itself, this project offers a new proposal for architecture's engagement with algae. This integration of algae requires a different conceptual complexity.

Structural innovation

The manufacturing company Centraalstaal International (CSI) has pioneered the use of cold-formed steel structures in sculptures such as Anish Kapoor's Arcelor-Mittal Orbit, Future System's Media Centre at Lord's Cricket Ground and Wilkinson Eyre's Emirates Cable Car. This project required an unprecedented combination of digital and analogue bending and cutting, to allow for complex perforated curved plate cantilevers. [fig. 4 & 5]

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4
Inverted tree silhouette perforations
Photograph Virgilio Ferreira

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Algae photo-bioreactors

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Detail of bark quality of steel canopy panels

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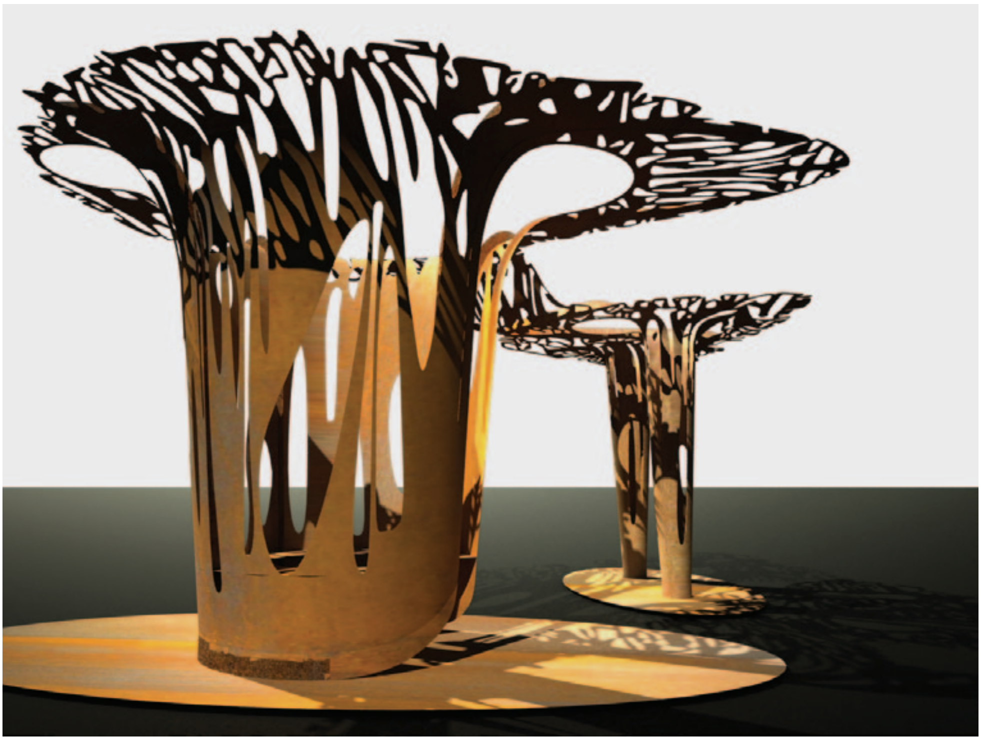

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7 & 8
Preliminary computer model of structure with growing algae

Methods

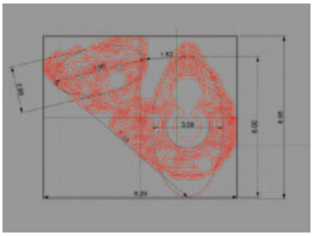
The installation makes use of state-of-the-art technology along with interdisciplinary work methodologies linking design and manufacturing processes to simulate complex geometries and to manufacture precise components that required exact assembly specifications in order to maintain structural strength. This was achieved through five stages: 1. Conceptual design; 2. Digital engineering tests; 3. Precision manufacturing; 4. Biological research; 5. Installation and occupation.

Conceptual design

The name Alga(e)zebo draws from the structure's programmatic side, following a British tradition of ornate filigree gazebos, creating a small gathering or viewing point that in turn organises the natural setting around it.

The project's siting in Euston Square Gardens triggered an inherently contextual design using sophisticated digital media processes. From outside, the gazebo's permeable boundaries subtly punctuate the gardens – disappearing and reappearing among mature trees. From within, its perspectival point of orientation allows for an endless play of framed vistas through and between.

The structure makes specific reference to the geometry and structural capacity of the garden's neighbouring ash trees characterised by their unique bark with pronounced vertical ridges and striking browning autumn leaves. Alga(e)zebo's hollow columns take the inverted form of a tree, and its rusted steel panels feature vertical lines that provide critical structural stability without recourse to additional structural reinforcements. The perforated steel filigree casts a silhouette of leaf patterns in shadow play, fitting in the tradition of exposed metal paraphernalia – gates, fences, fountains, pipe work – which distinguishes and enriches London's public realm. [fig. 6–8]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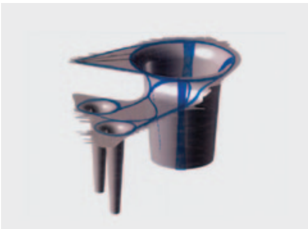
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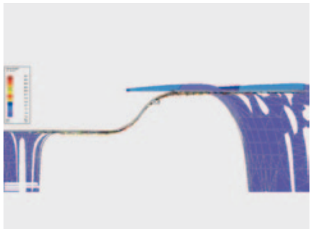
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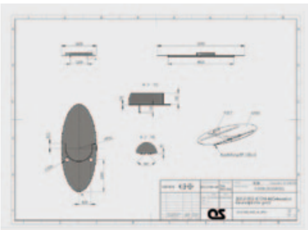
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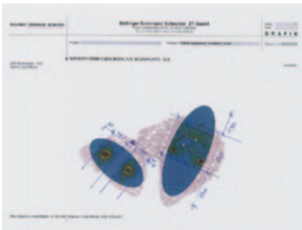
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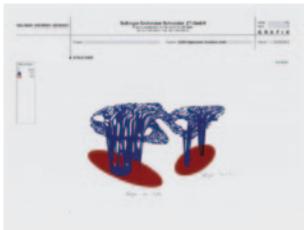
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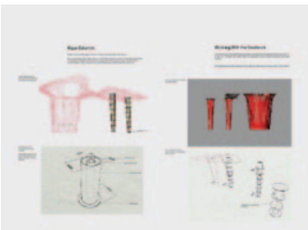
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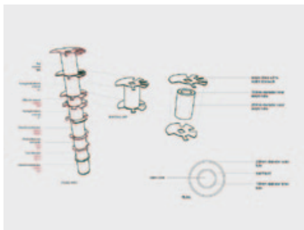
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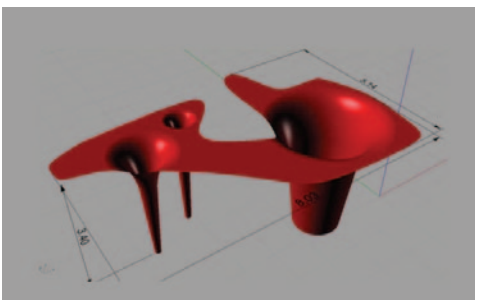
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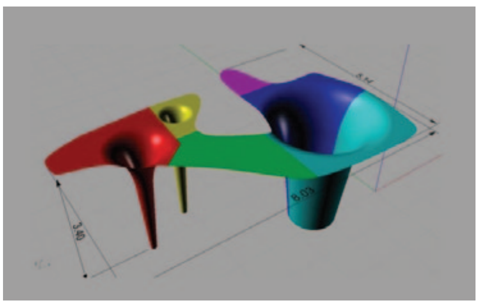
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Digital engineering tests

Bespoke algorithmic and parametric scripting programs by the renowned engineering practice Bollinger-Grohmann-Schneider enable the maximisation of design efficiency in two-dimensional processes (e.g. nesting scripting) and the production of structural integrity in three dimensions (e.g. topological projections).

The purpose-built NUPAS-CADMATIC shell plate software provides sophisticated analyses to calculate the distribution of forces in the structure's complex geometry. This software takes into account the weakened structural capability of the perforated motif design but also lightens overall mass, enabling deep cantilevers. The software allowed for continuous testing of structural design possibilities, in close collaboration with engineers and manufacturers, to create double-curved shell plates, including precisely defining 'edge data' and marking lines for assembling. [fig. 9–22]

9
Script of pattern projected onto canopy plan and preliminary 3D models with main structural areas

10–12
Computer studies of structural branches within canopy

13 & 14
Structural studies by engineers with calculations of curvature between cones

15–17
Foundation studies with points of stresses

18–20
Dimensionalising of algae tubes with details of fitted brackets between algae tubes and steel construction

21 & 22
Preliminary volumetric study with subdivision in main components

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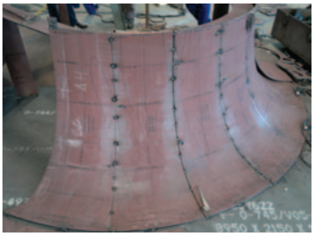

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Precision manufacturing

The world-leading manufacturing company Centraalstaal International (CSI) constructed double-curved welded panels from 8mm pre-rusted recycled Carten steel. The distinct geometry of each panel could not have been manufactured using traditional heat moulding as it is too imprecise due to cooling variations. CSI used cold-bending technology that combines bending templates and elongation information in advanced production data to ensure a high quality and exact fit. The resulting shell plates are laser-cut by CNC (computer-numerically controlled) machines as well as by analogue methods. [fig. 23–34]

Biological research

Consultants from the Algal Research Group at UCL were responsible for testing, growing and monitoring the photo-bioreactor technology in algae tubes. A series of algae growth tests choreographed how algae grow. These used *Chlorella sorokiniana* with differing strength of agar medium around SLS growth scaffolds coated in bicarbonate. Algae columns were fabricated from sections of extruded acrylic tubing in a doughnut configuration with laser-cut acrylic joints containing Scottish bioluminescent algae produced in vitro and coordinated on-site. [fig. 35–41]

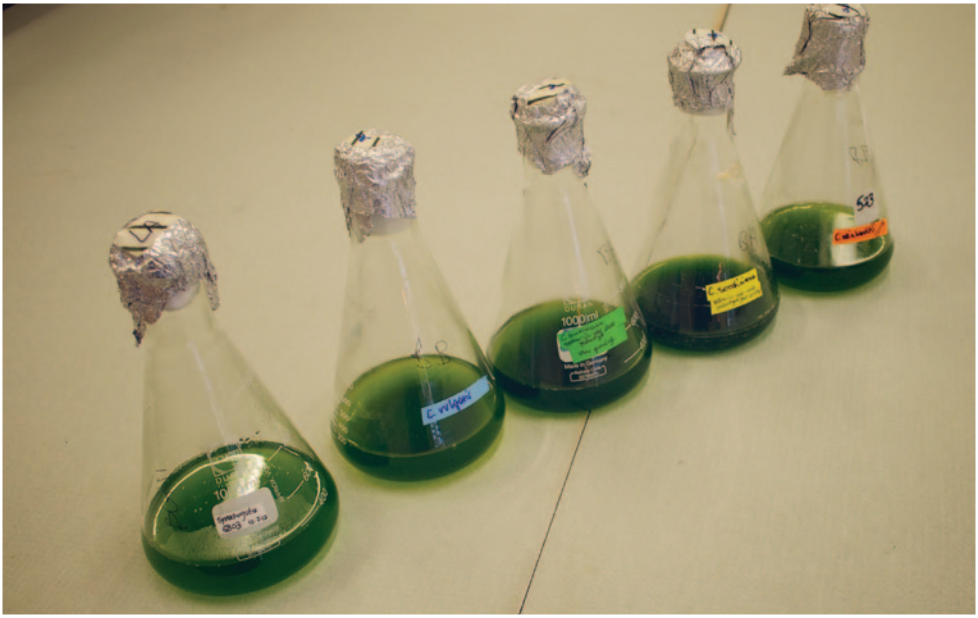
23–25
Initial fabrication process involving cold-bending of steel plates

26 & 27
Assembling of double steel curvature plates and laser-cut flat steel panels

28 & 29
Smaller cones welded and sanded with perforation process done by hand

30–32
Overall view of fabrication processes

33 & 34
Fabrication process after bending, sanding and welding, including integrated seating as a structural component to give resistance to main cone



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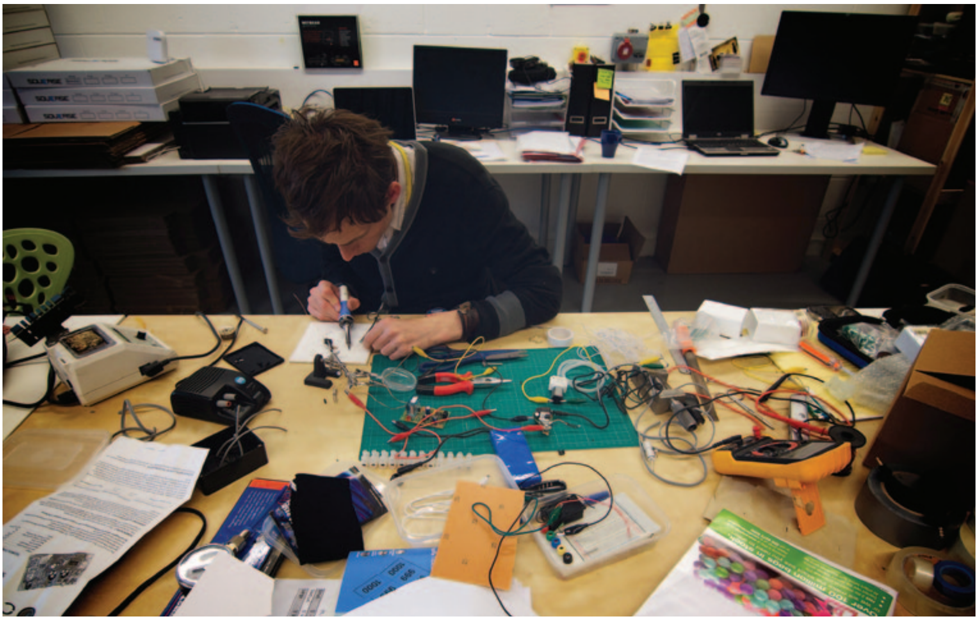

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35 & 36
Different algae strains and preparation of electronics for photovoltaic panels

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37
Pouring in of agar growth medium and insertion of algae

38
Carbon impregnated SLS model inserted in agar growth medium with exposure to light

39
Carbon impregnated SLS model with algae growth


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40 *(previous page)* Algae tubes inserted into Alga(e)zebo on-site

41 *(previous page)* View of carbon impregnated SLS model infused with algae in agar growth medium and the evolution of algae growth after two months of installation

Installation and occupation

The steel construction was produced in six parts with bolted connections and shipped in containers from Germany to the construction site in Euston Square Gardens. Camden Council prohibited any use of foundations given the sensitive requirements of the site above major London Underground lines. This was circumvented by triangulating the three legs in each trunk and anchoring the columns to wide bases of the concrete plate footprint.

The algae cylinders were prepared in isolation and attached to form the interlocked column of vertical acrylic tubes, inserted into the voids of steel columns and affixed to the steelwork using CNC horizontal acrylic discs to prevent lateral movement. Local algae were encouraged into the cylinders using ventilation tubes for spores in the air to infect and pollinate, mutating its form. [fig. 42 & 43]


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42
Installed Alga(e)zebo among canopies of surrounding trees

43
View of carbon-impregnated SLS model infused with algae in agar growth medium and the evolution of algae growth after two months of installation

Dissemination

The work has been published in national, international and architectural press:

'"London's getting ready for a summer like no other," says Mayor', *Greater London Authority* (8 Jun 2012).
Merlin Fulcher, 'In pictures: Architecture schools' Olympic installations revealed', *Architects' Journal* (8 Jun 2012).
Mark Wilding, 'Architecture students' Olympic designs to decorate London', *BD Online* (8 Jun 2012).
'London 2012 Olympics: streets of capital to be lined with banners and bunting for Games', *The Telegraph* (8 Jun 2012).
'The Bartlett installations for London 2012', *Time Out London* (19 Jun 2012).
'Bartlett Architectural Installations Unveiled', *Glass Magazine* (24 Jul 2012).
'Alga(e)zebo, by marcosandmarjan architects, The Bartlett, UCL, London', *Detail Daily* (20 Aug 2012).

It has also been presented in national and international keynote presentations and invited guest lectures at:

Keynotes

Parametric Thinking and Making on Architecture and Urbanism conference, Tunghai University, Taichung, Taiwan (2012)

Invited lectures

Universidad CEU San Pablo, Madrid, Spain (2012)
Contemporary Modes of Production symposium, Architectural Association and Universidade do Minho, Guimarães, Portugal (2012)
Edinburgh Science Festival, Edinburgh, UK (2013)
Feng Chia University, Taichung, Taiwan (2013)

Presentations

TEDx Barcelos, Barcelos, Portugal (2012)
TEDx UCL, London, UK (2012)

Related writings by others

pp. 30–31
‘“London’s getting ready for a summer like no other,” says Mayor’, *Greater London Authority* (8 Jun 2012): www.london.gov.uk/media/mayor-press-releases/2012/06/london-s-getting-ready-for-summer-like-no-other-says-mayor

p. 32
Merlin Fulcher, ‘In pictures: Architecture schools’ Olympic installations revealed’, *Architects’ Journal* (8 Jun 2012): www.architectsjournal.co.uk/news/daily-news/in-pictures-architecture-schools-olympic-installations-revealed/8631419.article

p. 33
Marlies Walther, ‘Skulptur für die Olympischen Spiele’, *Ostsee Zeitung OZ Lokal Hansestadt Stralsund* (7 Aug 2012): 1.

pp. 34–36
‘Alga(e)zebo’, *Suckerpunch* (15 Aug 2012): www.suckerpunchdaily.com/2012/08/15/algaezebo

pp. 37–39
‘Alga(e)zebo, by marcosandmarjan architects, The Bartlett, UCL, London’, *Detail Daily* (20 Aug 2012): www.detail-online.com/daily/algaezeboby-marcosandmarjan-architects-the-bartlettucl-london-6110/

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Blind Spot House
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