Alga(e)zebo

by mam
# Project Details

<table>
<thead>
<tr>
<th>Practice:</th>
<th>mam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designers:</td>
<td>Marjan Colletti and Marcos Cruz</td>
</tr>
<tr>
<td>Colletti and Cruz contributed equally to this project through their collaborative practice, mam architects.</td>
<td></td>
</tr>
<tr>
<td>Title:</td>
<td>Alga(e)zebo</td>
</tr>
<tr>
<td>Output type:</td>
<td>Design</td>
</tr>
<tr>
<td>Function:</td>
<td>Public architectural installation</td>
</tr>
<tr>
<td>Location:</td>
<td>Euston Square Gardens at Euston Station, London</td>
</tr>
<tr>
<td>Client:</td>
<td>Mayor of London, Greater London Authority</td>
</tr>
<tr>
<td>Practical completion:</td>
<td>July 2012</td>
</tr>
<tr>
<td>Dates:</td>
<td>25 July – 12 September 2012</td>
</tr>
<tr>
<td>Budget:</td>
<td>£120,000</td>
</tr>
<tr>
<td>Size:</td>
<td>Three columns of cold-formed welded 8mm steel plates, 7.80m × 5m × 3.35m</td>
</tr>
<tr>
<td>Engineering:</td>
<td>Bollinger-Grohmann-Schneider engineers, Vienna, Austria</td>
</tr>
<tr>
<td>Manufacturing:</td>
<td>Formstaal GmbH &amp; Co. KG, Stralsund, Germany</td>
</tr>
<tr>
<td>Consultants:</td>
<td>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</td>
</tr>
</tbody>
</table>
1

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


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.
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]
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]
4
Inverted tree silhouette perforations
Photograph Virgilio Ferreira

5
Algae photo-bioreactors

6
Detail of bark quality of steel canopy panels
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]
Alga(e)zebo
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]
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
35 & 36
Different algae strains
and preparation
of electronics for
photovoltaic panels
Pouring in of agar growth medium and insertion of algae

Carbon impregnated SLS model inserted in agar growth medium with exposure to light
Carbon impregnated SLS model with algae growth
Algae tubes inserted into Alga(e)zebo on-site

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]
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).
‘London 2012 Olympics: streets of capital to be lined with banners and bunting for Games’, The Telegraph (8 Jun 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

p. 32

p. 33

pp. 34–36

pp. 37–39
Bartlett Design Research Folios

Founding Editor:
Yeoryia Manolopoulou

Editors:
Yeoryia Manolopoulou,
Peg Rawes, Luis Rego

Content © the authors

Graphic Design:
objectif

Typesetting:
Axel Feldmann, Siaron Hughes,
Alan Hayward

Proofreading:
Wendy Toole
Bloom
by Alisa Andrasek
and José Sanchez

House of Flags
by AY Architects

Montpellier Community Nursery
by AY Architects

Design for London
by Peter Bishop

2EmmaToc / Writtle Calling
by Matthew Butcher
and Melissa Appleton

River Douglas Bridge
by DKFS Architects

Open Cinema
by Colin Fournier
and Marysia Lewandowska

The ActiveHouse
by Stephen Gage

Déjà vu
by Penelope Haralambidou

Urban Collage
by Christine Hawley

Hakka Cultural Park
by Christine Hawley, Abigail Ashton, Andrew Porter and Moyang Yang

House Refurbishment in Carmena
by Izaskun Chinchilla Architects

Refurbishment of Garcimuñoz Castle
by Izaskun Chinchilla Architects

Gorchakov’s Wish
by Kreider + O’Leary

Video Shakkei
by Kreider + O’Leary

Megaframe
by Dirk Krolikowski
(Rogers Stirk Harbour + Partners)

Seasons Through the Looking Glass
by CJ Lim

Agropolis
by mam

Alga(e)zebo
by mam

Chong Qing Nan Lu Towers
by mam

ProtoRobotic FOAMing
by mam, Grymsdyke Farm
and REXLAB

Banyoles Old Town Refurbishment
by Mías Architects

Torre Baró Apartment Building
by Mías Architects

Alzheimer’s Respite Centre
by Níall McLaughlin Architects

Bishop Edward King Chapel
by Níall McLaughlin Architects

Block N15 Façade, Olympic Village
by Níall McLaughlin Architects

Regeneration of Birzeit Historic Centre
by Palestine Regeneration Team

PerFORM
by Protoarchitecture Lab

55/02
by sixteen*(makers)

Envirographic and Techno Natures
by Smout Allen

Hydrological Infrastructures
by Smout Allen

Lunar Wood
by Smout Allen

Universal Tea Machine
by Smout Allen

British Exploratory Land Archive
by Smout Allen
and Geoff Manaugh

101 Spinning Wardrobe
by Storp Weber Architects

Blind Spot House
by Storp Weber Architects

Green Belt Movement Teaching and Learning Pavilion
by Patrick Weber

Modulating Light and Views
by Patrick Weber