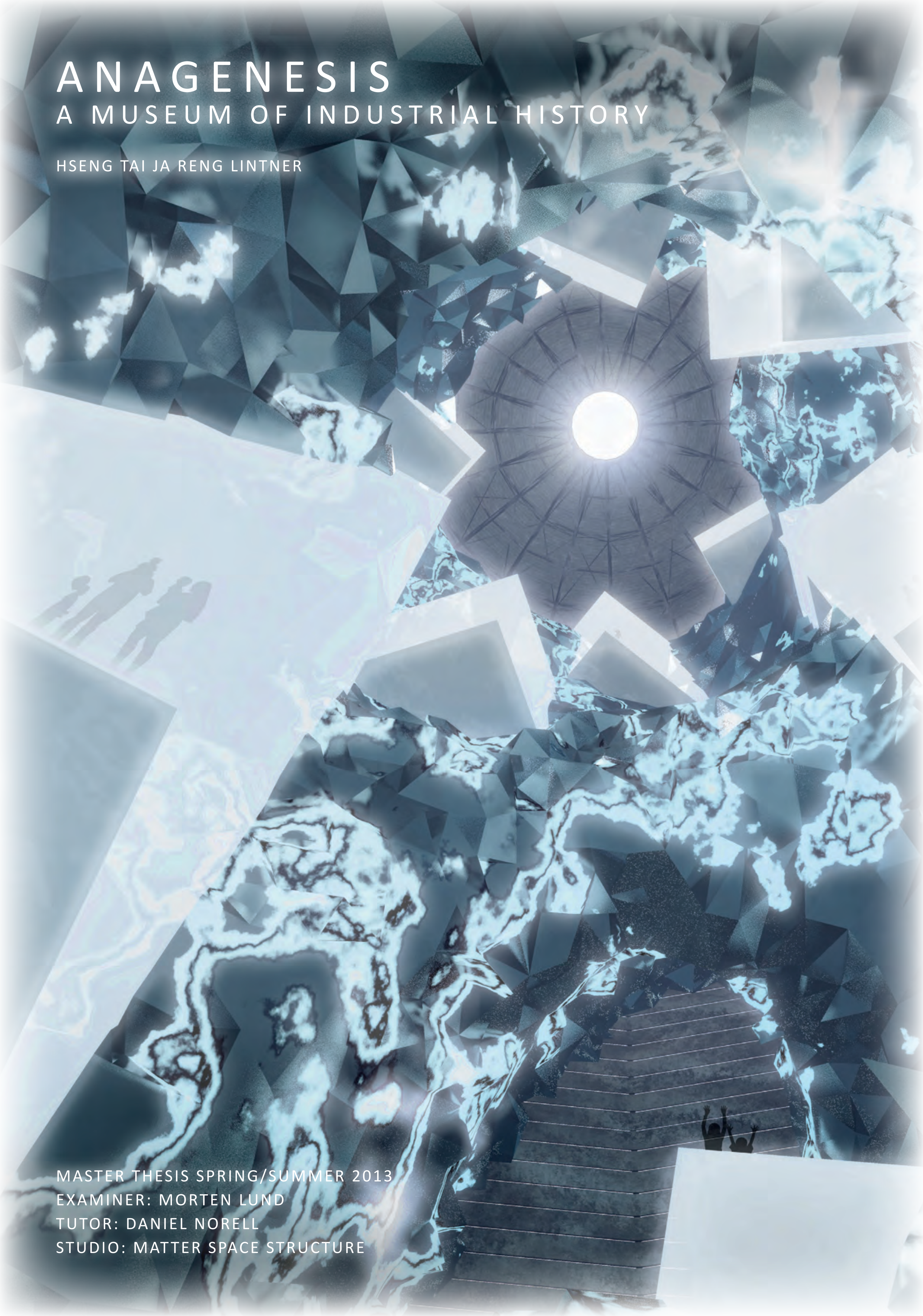

ANAGENESIS
A MUSEUM OF INDUSTRIAL HISTORY

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STUDIO: MATTER SPACE STRUCTURE

Anagenesis: When a species gradually changes over time to the extent that it becomes a ‘new’ species

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ABSTRACT

PROPOSAL

A museum exhibiting the achievements of the industrial world housed in a building envelope that optimistically reflects the dawn of a new era of post-industrialism.

DESCRIPTION

Industrial society typically sees man as an opponent of nature, one that uses his ingenuity to overcome nature and set himself apart from it – a strive that is perhaps manifest most obviously in the built environment. Post-industrialism on the other hand is a shift in paradigm where we start to consider natural phenomena as a productive force.

Through the integration of natural phenomena in the building envelope, this project explores the interrelationship between the natural and the manufactured. The proposal incorporates self powering, renewable organic light sources that produce ambient lighting for interior spaces through a process called bioluminescence.

The design of this has been supported by a dialogue between digital and analogue mediums that has throughout the process informed performative systems and spatial relationships. Explorations involved emulating the experience of geological formations through architectural language which was rationalized using a series of sketch models and computational physics.

As a way of bringing the project full circle, and creating a narrative contrast between program and building envelope, the proposed program is a new museum of industrial history housed in a post-industrial installation in the old gasometer at Gullbergsvass in Gothenburg.

PART ONE: PREPATORY RESEARCH

"The ability to digitally generate and analyse the design information and then use it directly to manufacture and construct buildings, is fundamentally redefining the relationships between conception and production - it provides for an informational continuum from design to construction... Communication among various parties increasingly involves the direct digital exchange of information."

Now that we are able to manufacture high precision building components for complex geometries at a relatively fast pace, the use of direct outputs from digital models is becoming increasingly formalised and decreasingly challenging.

One key aspect to consider in the next development within this disciplinary field is of course the role of materiality. Chemical advancements in the production and application of materials provide a potential platform for many interesting possibilities for the built environment. With matter, one can not only address environmental issues but one can also begin to incorporate alternative processes as a means of achieving even greater complexity outside what is already possible in terms of digital fabrication and allow for a certain element of planned randomness.

ENTROPIC PROCESSES

In terms of fabrication, there are several ways to approach this. The following examples take into consideration the effect of climate and time within a given context on particular materials, some of which are spawned out of the environment itself. In these examples, entropic processes are a fundamental part of the final design outcome.

In the project, *Things Which Necrose* (fig. 1-3), R&Sie(n) architects emphasized the ambiguity of the paradox between biodegradable and sustainable. The questioning of this politically correct dogma of ecology was brought to life by the development of a biodegradable pavilion that decomposed gradually throughout the timespan of the exhibition at which it was displayed, Green Architecture for the future, Louisiana Museum of Modern Art (Denmark).

Fig. 1, "Things Which Necrose", a limited time span & biodegradable pavilion + prototype, R&Sie(n) architects

Fig. 2, "Things Which Necrose", a limited time span & biodegradable pavilion + prototype, R&Sie(n) architects

Fig. 3, "Things Which Necrose", a limited time span & biodegradable pavilion + prototype, test pieces, R&Sie(n) architects

Fig. 4, "Dusty Relief", electrostatic carbon monoxide collection facade system, R&Sie(n) architects

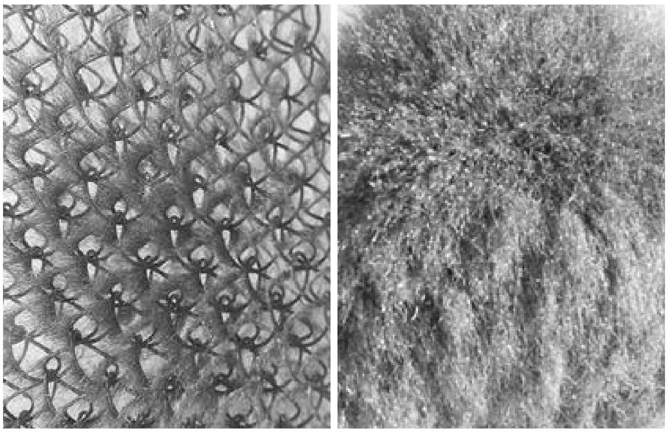


Fig. 5, "Dusty Relief", electrostatic carbon monoxide collection facade system, prototype, R&Sie(n) architects

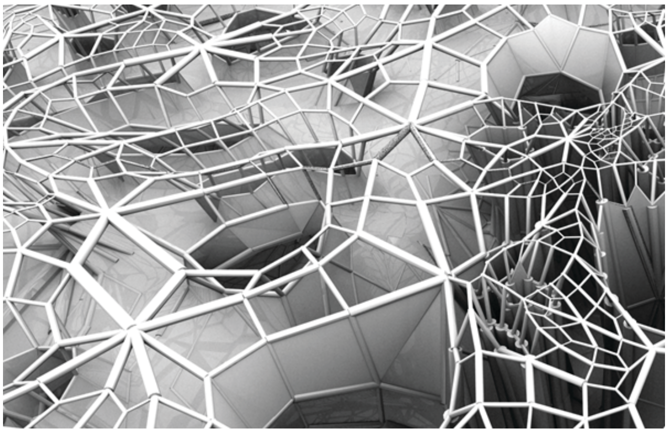


Fig. 6, "GEOtube", vertical salt deposit building skin, Faulders Studio

Its degradation was manually controlled by the degree of humidity in the atmosphere and the program, asking for a temporary building, was thus considered literal here, as long as its own death is included in its protocol of life. The pavilion, or prototype, is composed of a bio-plastic consisting of hydro-soluble polymers from agriculture that are injection moulded into a 5 axis CNC milled mould.

Another project by R&Sie(n) architects which also addresses the local environment is *Dusty Relief* (fig. 4-5), a proposal for a contemporary art museum in Bangkok. The building envelope collects dust and particles of carbon monoxide through an electrostatics system creating a monolithic grey topological geometry from afar and a hairy building skin from up close. Unlike *Things Which Necrose*, where a pavilion was already constructed and put in an environment where it would decay, the envelope of *Dusty Relief*, responds and actually builds itself from the environment.

Faulder's studio's *GEOtube* (fig. 6-7) is also an example of a building envelope that builds itself from the local environment. The project is a proposal for a salt deposit building skin in Dubai which consists of an armature that is gravity sprayed with adjacent Persian Gulf waters. In this way the building skin is entirely grown rather than constructed. As the water evaporates and salt deposits aggregate over time, the tower's appearance transforms from transparent to white solid and the result is an accessible surface for the harvesting of crystal salt and a specialised habitat for wildlife.

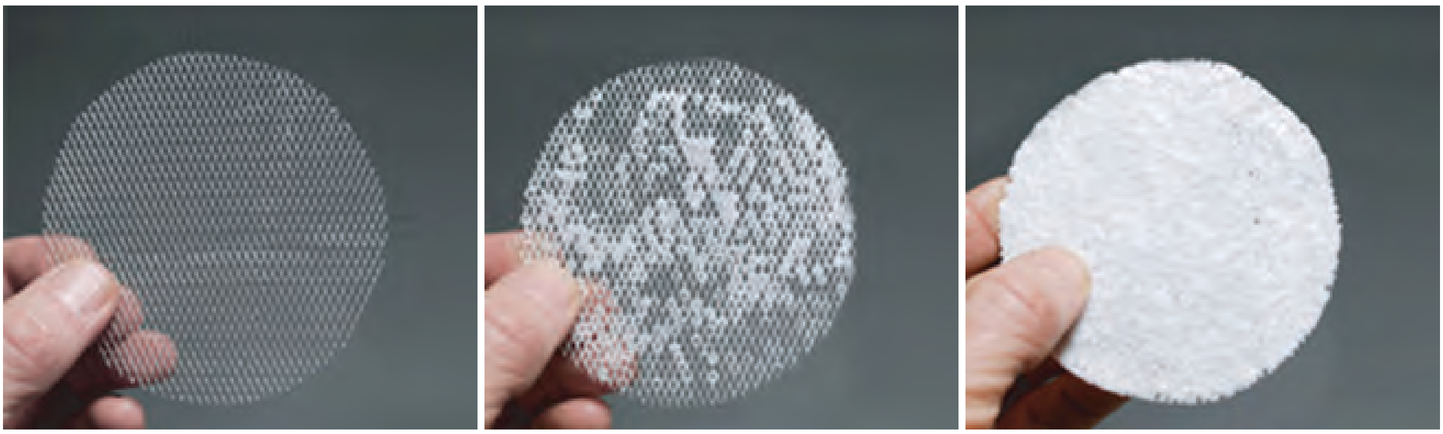


Fig. 7, "GEOtube", vertical salt deposit building skin, crystallisation tests, Faulders Studio

CASTING

Another approach to fabrication that has the potential to incorporate a greater level of complexity is through the reinvention of a multi-step process such a casting. Casting through the use of concrete is an age old tradition that dates back to ancient Rome (fig. 23) and a certain level of complex geometry is achievable through the use of a textile mould. However when combined with digital processes, a greater level of planing and control can be achieved, as can be seen in Andrew Kudless' P_Wall investigation (fig. 8) and in some small scale projects undertaken by students from the Architectural Association's Design Research Laboratory course, Matter as Computation (fig. 9-10). Stitch marks, creases and weave patterns from the textile imprint themselves onto the surface of the cast forms resulting in an almost microscopic level of detail.

To take these techniques even further we can perhaps start to look deeper into the actual matter that is being cast. Traditionally a casted object originates from a homogenous solution or mixture which solidifies over time. However, advances in material sciences not only mean that we can find new materials to cast with that will yield alternative solutions to materiality, as in the project *Things which Necrose*, but because casting begins with a fluid form, we can now form heterogeneous compounds with distinct sensibilities. We can control the interaction of different materials with each other as they set, or the mould itself could be coated with something that would react to the fluid - these are but just a couple of fabrication techniques that could bring on a whole new dimension to the design process.

Fig. 8, "P_Wall", installation at the San Francisco Museum of Modern Art, Andrew Kudless

Fig. 9, "Grompies", liquid plaster set in stitched lycra mould, structural design investigation, Brendon Carlin

Fig. 10, "Grompies", liquid plaster set in stitched lycra mould, structural design investigation, Brendon Carlin

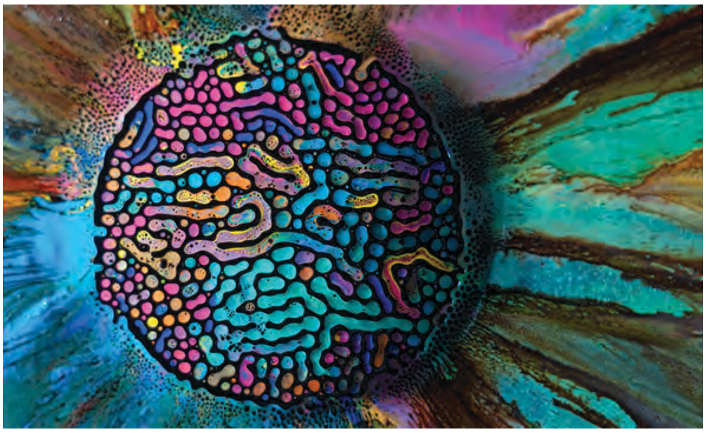


Fig. 11, "Millefiori", mixed ferro-fluid with water colours in a magnetic field, Fabian Oefner

Fig. 12, “Cumulus”, cast plaster and soap with aerogel, test piece, Karin Hedlund, Jakub Jilek, Marcus Abrahamsson, Hseng Tai Ja Reng Lintner

Fig. 13, “Cumulus”, cast plaster and soap with aerogel, test piece, Karin Hedlund, Jakub Jilek, Marcus Abrahamsson, Hseng Tai Ja Reng Lintner

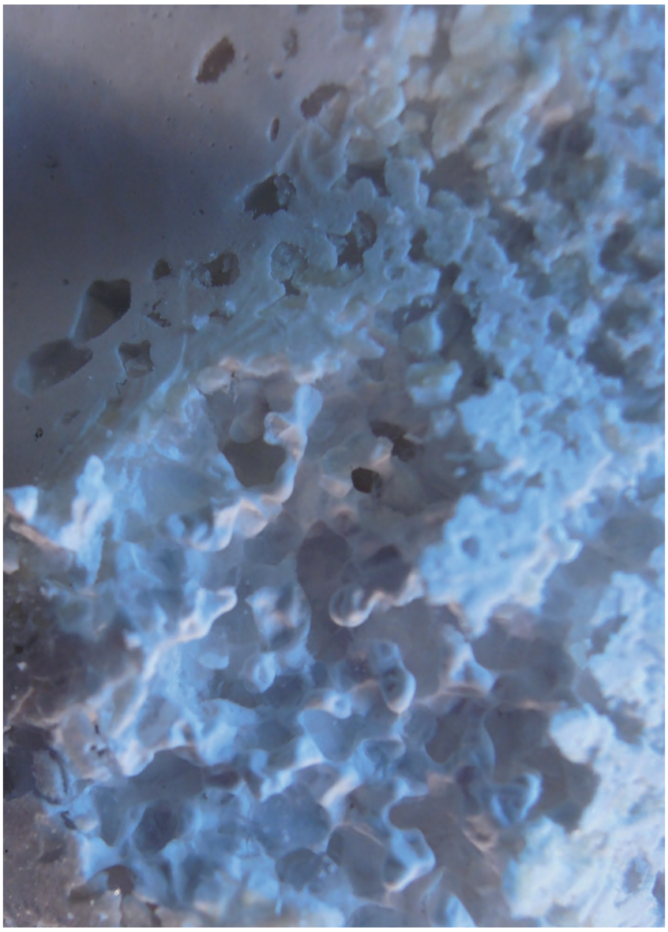


Fig. 14, “Cumulus”, cast plaster and soap with aerogel, test piece, Karin Hedlund, Jakub Jilek, Marcus Abrahamsson, Hseng Tai Ja Reng Lintner

Unfortunately, there is little precedent for this approach to fluid matter within the disciplinary context of architecture but in other disciplines such as fine art there are numerous examples of such applications, such as Fabian Oefner’s Millefiori series (fig. 11), which uses ferro-fluids in a magnetic field in order to mix colours. Although the Millefiori series does not deal with casting, it does however incorporate layered processes in working with fluid matter and similar principles can be applied to casting processes.

In a course which I have recently completed at Chalmers Institute of Technology called Design and Communication Tools: Matter at Work, students were asked to “unlock the live material agency of casted matter by digitally altering the linear process of casting. This will involve transforming the mold as well as the casting material with the aim of balancing geometric control with erratic material behavior”. The architectural potential of our new found casting methods was finalised in the format of a mobile gallery. In terms of surface articulation, the group I worked in focused on creating ‘eroded’ openings (for displaying objects) in plaster through the use of hydrophobic aerogel (fig. 12-14). This was then interlocked with a transparent material to create a weatherproof vitrine space.

MASS

When working with casting as a fabrication process one aspect that one is likely to deal with is mass in the form of both positive and negative space.

Rachel Whiteread, an English artist who is best known for her casted sculptures which explore the absence of an object by giving that absence a physical presence. Her works include Ghost, which is a large plaster cast of the inside of a room in a Victorian mansion (fig. 15) and Library, a plaster cast of an inverted bookshelf (fig. 16). This use of negative space as a means of re-thinking the familiar and leaving traced memory spatially addresses the past and the present.

Similarly, in the project, *Gue(ho)st House* (fig. 17-19), French architecture firm Berdaguer and Péjus, have used mass to “ghost” over an existing recognisable building typology, the pitched roof house. The building, which has undergone several transformations from prison, to school and to funeral home, is located in the grounds of the Synagogue de Delme contemporary art centre in Delme, France. Blocks of high density polystyrene covered with resin and a layer of white paint create the white veil that drips onto the surrounding landscape, resulting in a moving form that contains elements of past and present. The name Gue(ho)st House, is reference to Marcel Duchamp’s phrase, “A GUEST + A HOST = A GHOST”. According to Berdaguer and Péjus “Duchamp’s wordplay ended up being a trigger, a base line for drawing up the project... Guest is the common denominator, the sharing space that we imagined. Ghost is a metaphor, a phantasmagoria.”

Fig. 15, “Ghost”, plaster cast of the inside of a room in a Victorian mansion, Rachel Whiteread

Fig. 16, “Untitled (Library)”, plaster cast of an inverted bookshelf, Rachel Whiteread

Fig. 17, “Gue(ho)st House”, Synagogue de Delme contemporary art centre, polystyrene covered in resin and paint, Berdaguer and Péjus

Fig. 18, “Gue(ho)st House”, Synagogue de Delme contemporary art centre, polystyrene covered in resin and paint, Berdaguer and Péjus

Fig. 19, “Gue(ho)st House”, Synagogue de Delme contemporary art centre, polystyrene covered in resin and paint, Berdaguer and Péjus

Fig. 20, “Liquid Glacial”, CNC-milled hand-polished clear acrylic tables, Zaha Hadid Architects

Fig. 21, “Liquid Glacial”, CNC-milled hand-polished clear acrylic tables, leg vortex detail, Zaha Hadid Architects

Fig. 22, “Liquid Glacial”, CNC-milled hand-polished clear acrylic tables, re-fractional caustic surface detail, Zaha Hadid Architects

A more literal and perhaps less poetic geometric approach is the use of real world dynamics such as fluid motion. Such an exploration has been explored by Zaha Hahid Architechs in their *Liquid Glacial* tables (fig. 20-22) which embed refraction and causticity through the use of transparent CNC-milled hand-polished acrylic. The underside of the flat table tops capture a frozen moment of fluid in motion through a series of vortexes that form the surface ripples and legs of the tables.

This way of dealing with mass as a digital design tool for the generation of geometric language can be taken in numerous directions. One way is to use simulations of real world dynamics such as fluids, cracking, inflation, overgrowth etc.

Whatever the final concept, the aim of the eventual exploration is to enhance it through entropic, biotic or material processes, thus creating a multi-layered interdependent relationship between the digital and the analogue.

BUILDING STRATEGIES

The examples in this section portray various structural and construction solutions appropriate for dealing with cast structures and mass.

Reiser & Umemoto's *O-14* tower in Dubai (fig. 23-24) houses 21 storeys of office spaces whose layouts can be customised without the barriers of conventional internal load bearing walls and columns, a result of the building's external reinforced concrete structural shell. According to the firm, "the openings on the shell are modulated depending on structural requirements, views, sun exposure, and luminosity." The building also uses an offset between the perforated shell and the internal facade to cool the surface of the glass windows by means of a chimney effect whereby hot air has room to rise, thus cooling the glass facade behind the shell. O-14's external shell is cast completely on site using traditional concrete reinforcements and form-work.

Alternatively, 3deluxe's *Cocoon Club* concrete wall (fig. 25-27) in Frankfurt is cast totally off site. The 80 x 80 cm panels come in several geometric varieties that tessellate seamlessly - giving the impression of a "non-repeating" pattern. They are made of self-compacting high performance concrete reinforced with steel fibres, making them extremely resistant to abrasion, frost, and de-icing salt. The stability of the material means that even the most intricate details and edges can be made fracture resistant and the high surface density results in a surface that absorbs almost no dirt.

The *Shin Yatsushiro Monument* in Tokyo by Kumiko Inui (fig. 28-30) is an example of both off site and on site casting. As a means of reducing the construction time, the walls were prefabricated and the roof was cast on site. The openings were produced using plywood and expended polystyrol blocks in the form work and the "thinness" of the structure was achieved by adding glass fibre to the liquid concrete before the casting process creating perforated load bearing concrete walls that are just 7cm thick.

These building strategies, along with the chosen material properties will inform the final construction methodology and the breakdown of the final geometric scheme.

Fig. 23, "O-14", office tower in Dubai, external reinforced concrete structure, Reiser & Umemoto

Fig. 24, "O-14", office tower in Dubai, external reinforced concrete structure, construction, Reiser & Umemoto

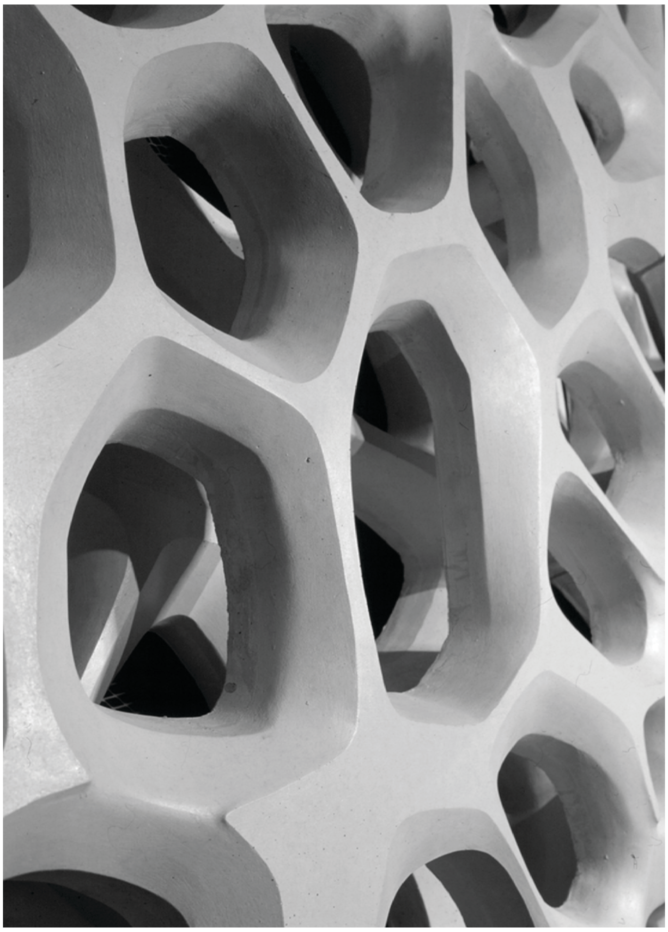


Fig. 25, "Cocoon Club", panellised concrete wall, design by 3deluxe, development of concrete elements by Villa Rocca

Fig. 28, "Shin Yatsushiro Monument", pre-cast walls and cast in place roof, 7cm thick glass fibre-reinforced concrete, Kumiko Inui

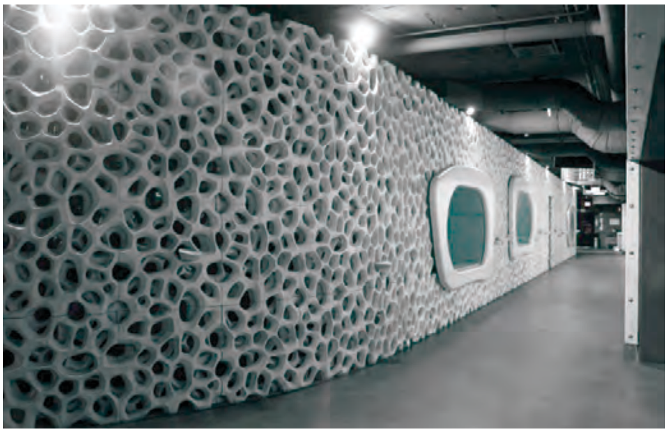


Fig. 26, "Cocoon Club", panellised concrete wall, design by 3deluxe, development of concrete elements by Villa Rocca

Fig. 29, "Shin Yatsushiro Monument", pre-cast walls and cast in place roof, 7cm thick glass fibre-reinforced concrete, Kumiko Inui

Fig. 27, "Cocoon Club", panellised concrete wall, prefabrication process, design by 3deluxe, development of concrete elements by Villa Rocca

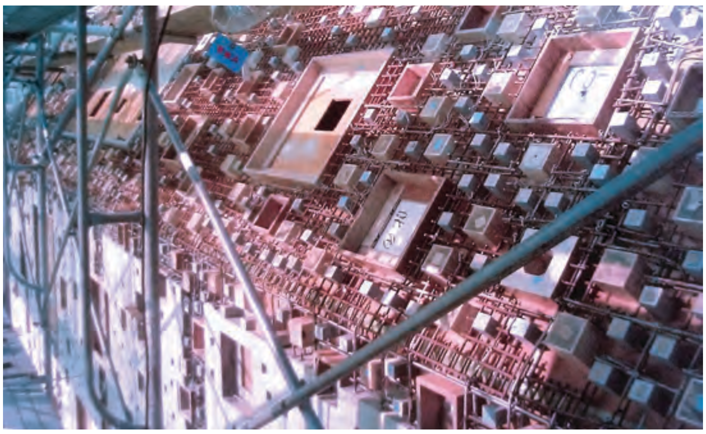


Fig. 30, "Shin Yatsushiro Monument", pre-cast walls and cast in place roof, 7cm thick glass fibre-reinforced concrete, roof casting process, Kumiko Inui

INITIAL ANALOGUE TESTS

Entropy:
Figures 43-44 demonstrate the possibilities of using crystallisation of abundant and renewable minerals, such as oceanic salt, as a self building matter that can change over time. The crystals used for the real life 1:1 output will be decided upon further research into crystallisation processes, minerals and properties.

Casting:
Figures 31-42 demonstrate various methodologies of casting transparent and opaque heterogeneous material solutions that integrate multiple material logics in a controlled environment. These tests were carried out in order to develop a greater understanding of these specific material logics so that they can be harnessed and extrapolated when applied to eventual test geometries. For the purpose of model making, these have been carried out using various combinations of polymer/mineral oil mixtures and soap, however, the actual 1:1 output will employ the use of various bio-plastics or similar.

ANALOGUE TESTS ON DIGITAL OUTPUTS

The next step is to investigate the relationship between controlled geometry (the digital output) and uncontrolled material behaviour (the cast).

Scale dependent spatial experiences will be addressed through a series of models that scale from 1:1 material tests, to 1:10 models of spatial interventions such as display cases and suchlike to a model scale that encompasses the entire building.

Casting:
These experiments will explore the relationship between the mould geometry and the fluid cast material. The aim is to investigate how different geometries in combination with different casting methodologies can direct the flow of the cast material.

Entropy:
These experiments will explore the relationship between geometry, substrate material, salt water flow and subsequent crystal growth. The aim is to

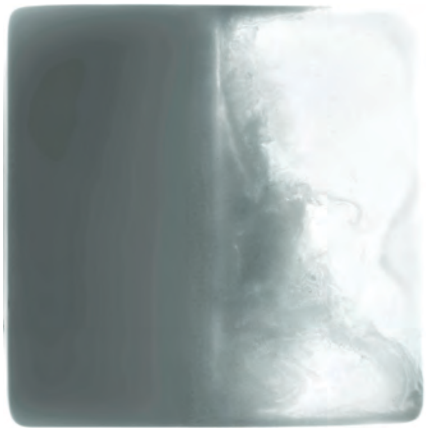


Fig. 31, Cast transparent and white soap, 2 halves in a heated mould

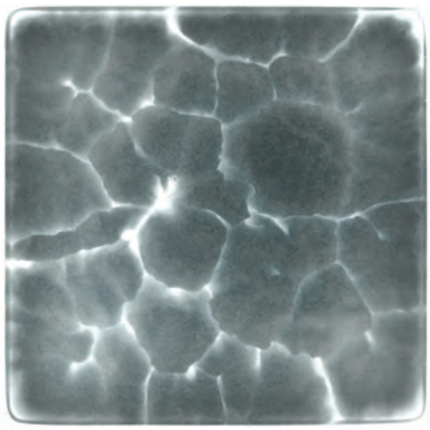


Fig. 33, Cast transparent and white soap, 7 minutes between pouring

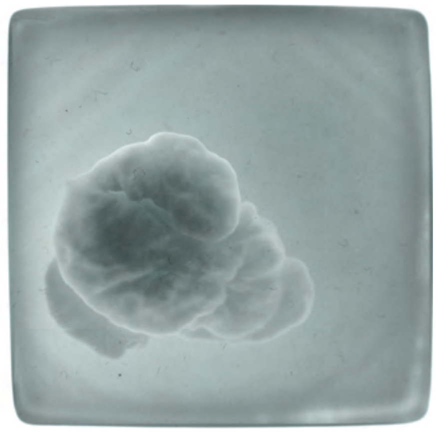


Fig. 35, Cast transparent and white soap, 10 minutes between pouring

Fig.32, Cast transparent and white soap, 2 halves in a heated mould

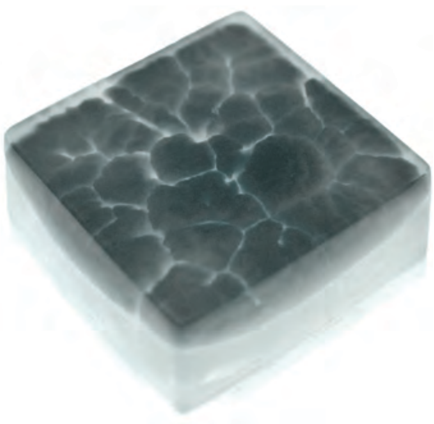


Fig. 34, Cast transparent and white soap, 7 minutes between pouring

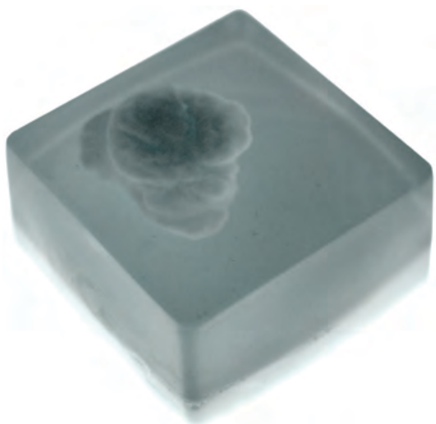


Fig. 36, Cast transparent and white soap, 10 minutes between pouring investigate how different geometries in combination with substrates and water flow can determine the regions of crystallisation.

They will also explore the interrelationship between materiality and climate with regard to the material life-cycle verses the building life-cycle (refer to the section *Versatility, Flexibility, Interactivity* in the chapter "Program").

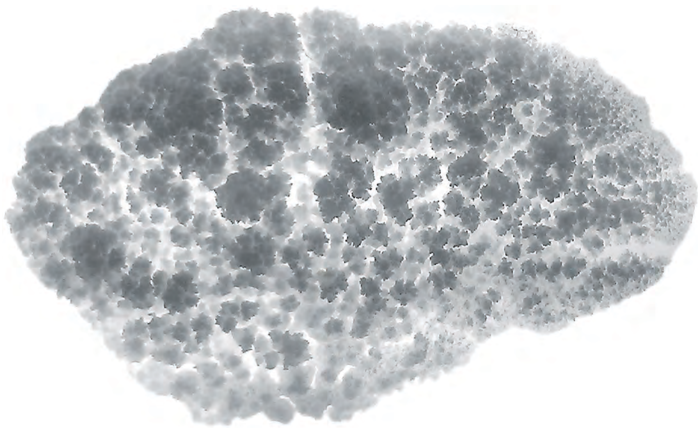


Fig. 43, Salt crystallisation test on felt substrate, growth span: 1 week

FINAL OUTPUT

The entropic, material and biotic processes discussed in the chapter "Matter" will be a means of propagating controlled change to or within the building envelope and the tests conducted will inform this design process.

Fig. 44, Salt crystallisation test on felt substrate, growth span: 1 week, close up shot

Fig. 37, Cast gel and white soap, 2 halves in a heated mould

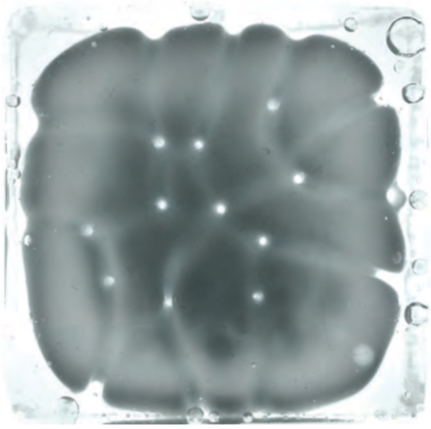


Fig. 39, Cast gel and white soap, 7 minutes between pouring

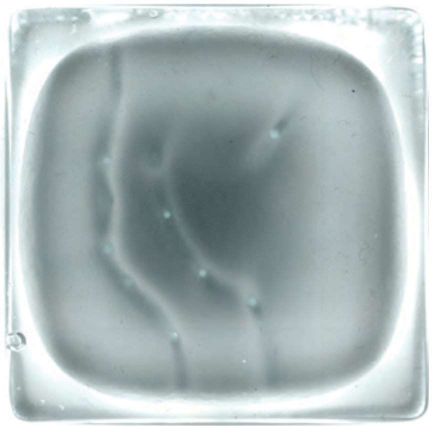


Fig. 41, Cast gel and white soap, 10 minutes between pouring

Fig. 38, Cast gel and white soap, 2 halves in a heated mould

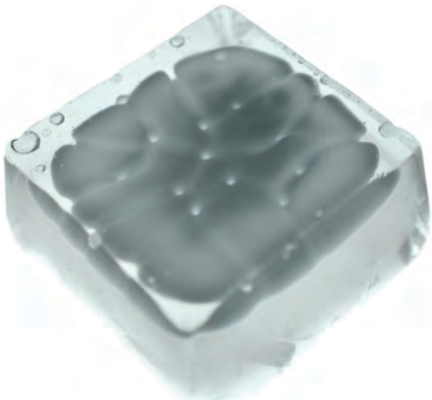


Fig. 40, Cast gel and white soap, 7 minutes between pouring

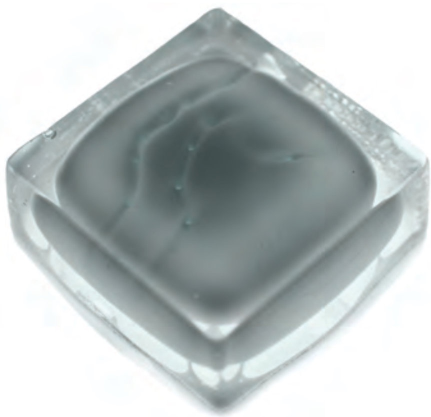


Fig. 42, Cast gel and white soap, 10 minutes between pouring

DIGITAL STRATEGIES

Figures 45-57 are various digital explorations of geometric strategies that will inform the design process. These explorations are as yet scaless, with figures 52-53 suggesting human scale, whilst figures 48-51 and 54-55 portray definite spatial qualities. The various scales at which a building is perceived will be informed through more tests along with parallel analogue explorations.

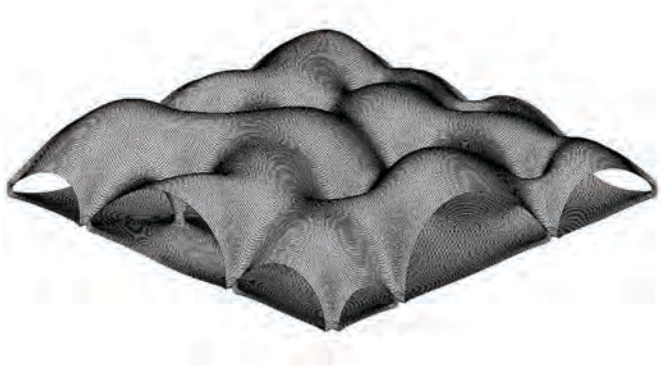


Fig. 45, Kangaroo springs + unary force + anchor points, catenary model generated through Kangaroo (Grasshopper plug-in, Rhino)

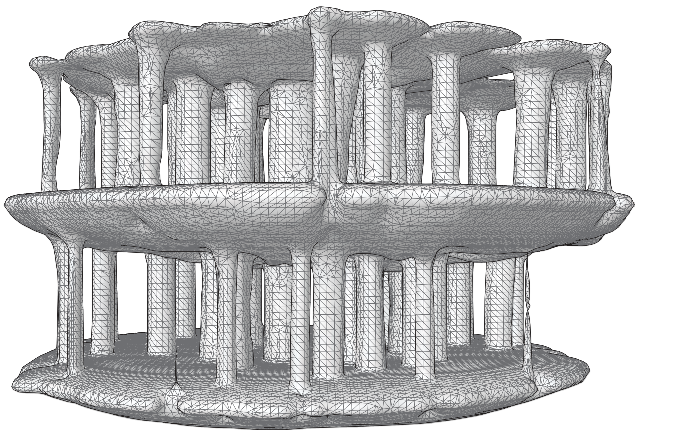


Fig. 48, Perforated meshes + Maya fluid simulation, pillar hall (Maya Dynamics)

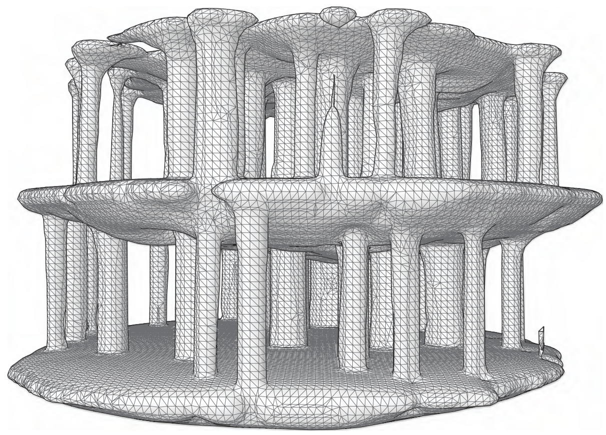


Fig. 49, Perforated meshes + Maya fluid simulation, pillar hall (Maya Dynamics)

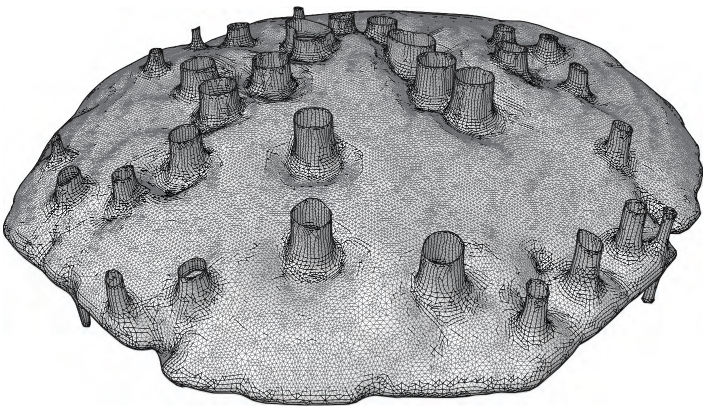


Fig. 52, Perforated meshes + Maya fluid simulation, cropped, possible surface articulation (Maya Dynamics)

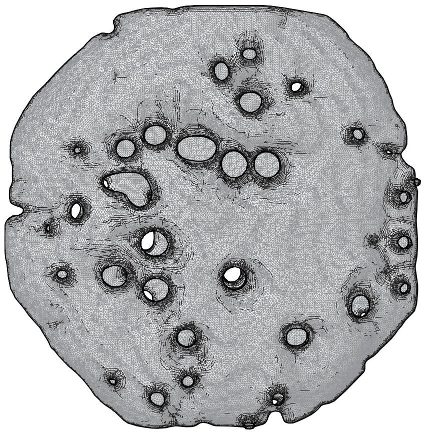


Fig. 53, Perforated meshes + Maya fluid simulation, cropped, possible surface articulation (Maya Dynamics)

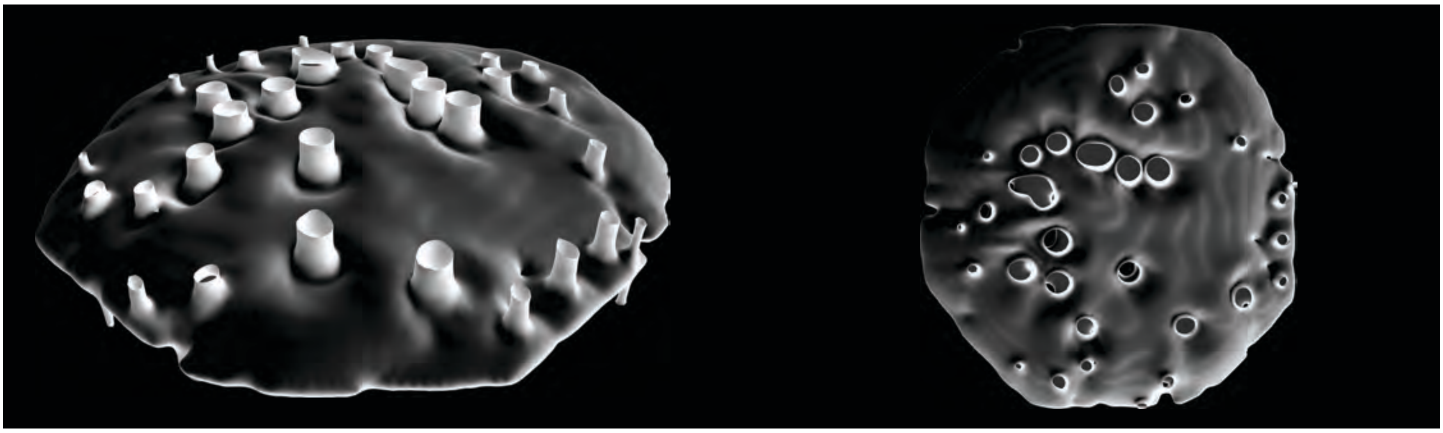


Fig. 56, Perforated meshes + Maya fluid simulation, cropped, possible surface articulation (Maya Dynamics)

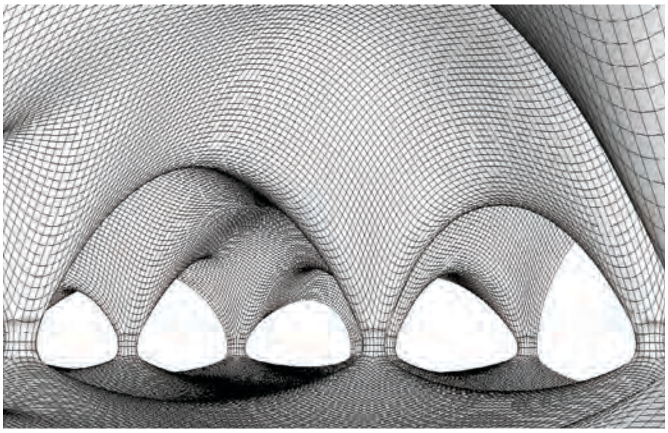


Fig. 46, Kangaroo springs + unary force + anchor points, catenary model generated through Kangaroo (Grasshopper plug-in, Rhino)

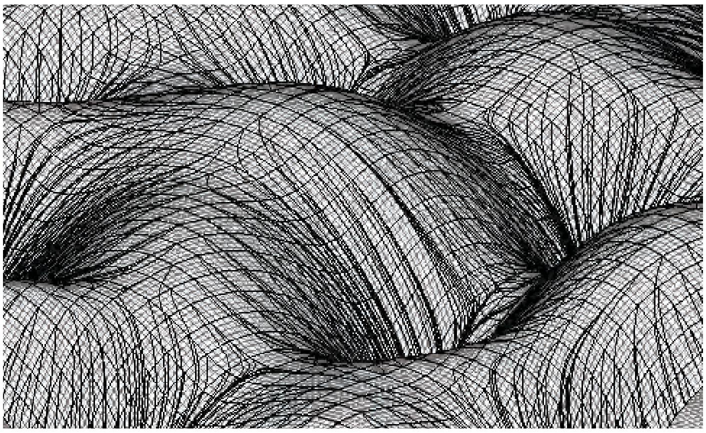


Fig. 47, Points + unary force + collision, gravitational point flow trails on surface, rainwater flow concentration (Grasshopper plug-in, Rhino)

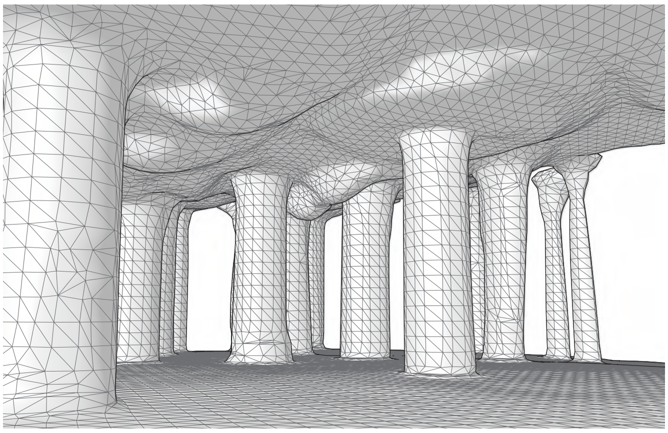


Fig. 50, Perforated meshes + Maya fluid simulation, pillar hall, interior view (Maya Dynamics)

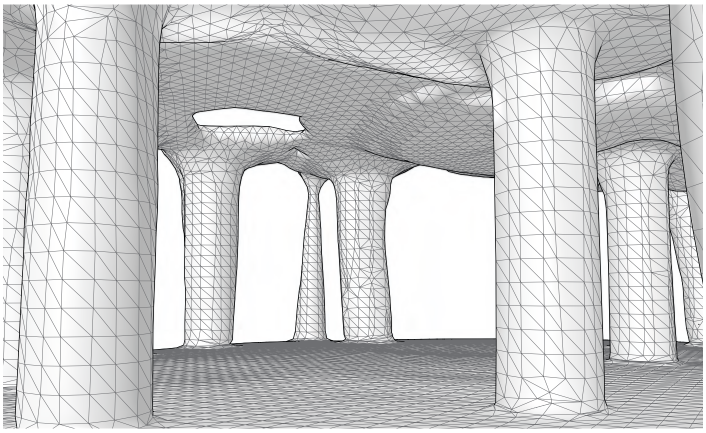


Fig. 51, Perforated meshes + Maya fluid simulation, pillar hall, interior view (Maya Dynamics)

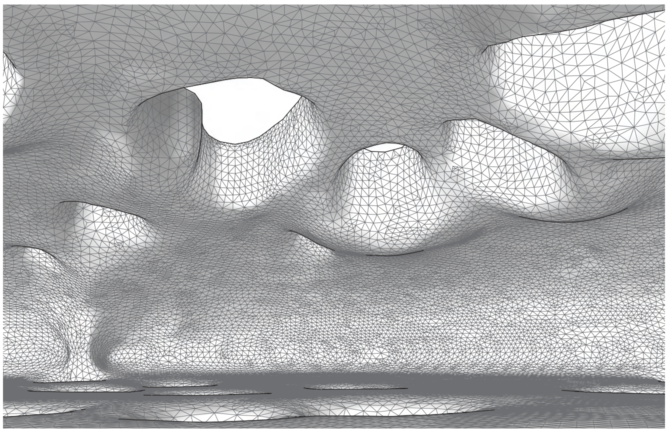


Fig. 54, Perforated meshes + Maya fluid simulation, cropped, interior, view (Maya Dynamics)

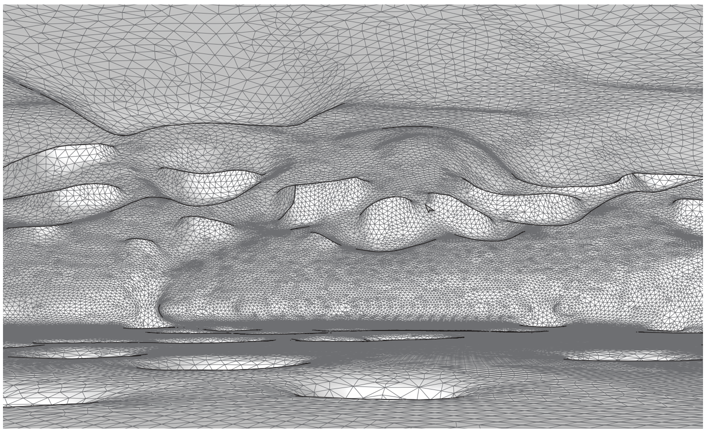


Fig. 55, Perforated meshes + Maya fluid simulation, cropped, interior view (Maya Dynamics)

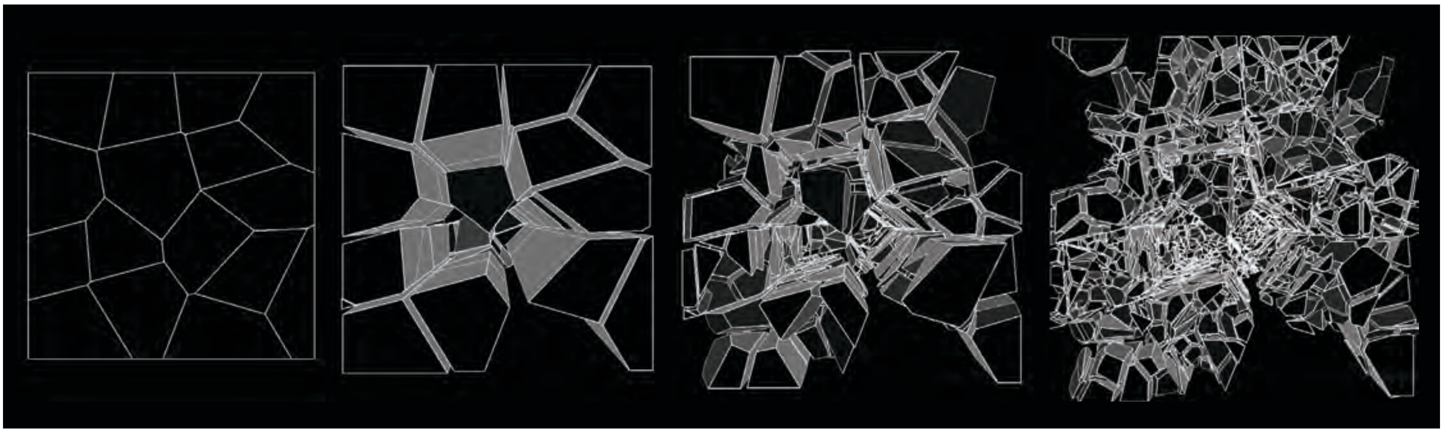


Fig. 57, Points + voronoi 3D surface offset, shatter simulation (Grasshopper plug-in, Rhino)

VERSATILITY FLEXIBILITY INTERACTIVITY

The usage of the museum in a contemporary fast pace technologically advancing society demands an unprecedented level of versatility, flexibility and in some cases interactivity. Exhibition spaces and media rooms require constant updating, resulting in vast amounts of re-building and interior reconfigurations which in turn result in a large turnover of building materials.

In order to respond to this need for change it is important to rethink the notion of permanence within the built environment. Instead of envisioning the traditional building which is built to last, can we instead envision a building which is built to change or even decay during an anticipated time period?

There are two main directions in which this can be applied:

1. Both the envelope and the interior have the same level of permanence with a predetermined “use by” date i.e a disposable or recyclable building
2. The envelope has a higher level of permanence whilst the interior has a lower level of permanence meaning that their changes happen at different rates i.e a semi permanent shell with a disposable or recyclable interior

The entropic, material and biotic processes discussed in the chapter “Matter” will be a means of propagating controlled change to or within the building envelope thus actually minimising energy input, construction waste and transportation both during its lifespan and at its “death”.

Change as a spatial and material strategy in itself can be addressed a number of ways:

1. Change by addition
2. Change by subtraction
3. Change by metamorphosis

The choice of change-strategy will affect the subsequent exhibition cycle and can be planned in advance (for more information regarding exhibition life-cycles, refer to the next section, “Programmatic Studies”).

REQUIREMENTS FOR A FULL FLEDGED LOCAL SCIENCE CENTRE

GALLERIES & FACILITIES	REQUIRED AREA
Energy and Environment Electric power Fossil fuels Renewable energy Nuclear energy Steam engines The history of energy	500 m²
Communication & IT The computer Photo and film Recording sound Paper and printing Radio and Television The telephone The telegraph	200 m²
Space Life in space Moon cameras Space research Ssc ferries Sweden in space Sweden’s first astronaut Various space projects	500 m²
Technological & industrial history Inside a factory Industrial heritage Historical time-line of technology The history of metal The history of plastic The history of the textile industry The history of housing and construction	700 m²
Vehicles & Transportation Boats Cars Bicycles Flight Motorcycles Roads Traffic	1000 m²
Research Temporary exhibitions concerning a current development	500 m²
Library / Archive Books and journals Documents and photographs that describe how industry and technology, particularly in Sweden, have evolved through time	200 m²
4D cinema	400 m²
Administration office	100 m²
Conference areas	500 m²
Café/restaurant	100 m²
WC	200 m²
Utility area	100 m²
Circulation space (nett area + 30%)	1500 m²
TOTAL	6500 m²

Fig. 58, List of required facilities for a full fledged science museum adapted for the local context

REQUIREMENTS FOR A LOCAL MUSEUM OF INDUSTRIAL HISTORY

GALLERIES & FACILITIES	REQUIRED AREA
Gallery 1: The History of Energy Coal and steam Oil Electric power	100 m^2
Gallery 2: Communication & IT Photo and film Recording sound Paper and printing Radio and television The telephone The telegraph	100 m^2
Gallery 3: The History of Materials Metal Plastic Textiles Housing and construction	100 m^2
Gallery 4: The History of the Factory Inside a factory Industrial heritage Historical time-line of technology	100 m^2
Gallery 5: Vehicles & Transportation Boats Cars Bicycles Flight Motorcycles Roads Traffic	500 m^2
4D cinema / conference area	400 m^2
Administration office	100 m^2
Café / restaurant	50 m^2
WC	50 m^2
Utility area	50 m^2
Circulation space (nett area + 30%)	465 m^2
TOTAL	2015 m^2

Fig. 59, List of required facilities and example galleries for the first life cycle for a museum of industrial history adapted for the local context

PROGRAMMATIC STUDY: THE SCIENCE MUSEUM

Figures 60-62 are studies of different science centres and their spatial configurations. These studies will manifest in the final project as organisational and spatial hierarchy models.

Figure 58 is a hypothetical list of required facilities and museum galleries required for a full fledged science museum, whose scale is adapted for the local context (Gothenburg).

For the purposes of the thesis however, the program will be reduced to cover galleries exhibiting industrial history (fig. 59) within a global context. This smaller scale will provide a more suitable platform for spatial and material experimentation within the given the time frame. The example galleries could either be showcased simultaneously in separate galleries or successively in one or two galleries.

In much of the science centres around the globe, collections for exhibitions are often rotated and in some cases, collections that are not currently on display are placed in nearby storage facilities, as is the case in The Science Museum in London. As a means of generating a greater global museum dialogue in Gothenburg, the industrial history museum will collaborate with other science museums around the globe and will display their collections on a rotating and interchanging basis.

Collections will of course fall under various categories which will be represented through different galleries. The program requirements specified in figure 62 depicts 5 galleries each with their own specified theme. However, since the contents of the exhibition space will undergo continual change, these suggested galleries and their spatial requirements can be treated as the first exhibition life cycle.

Each exhibition cycle will in turn be reflected in the material life span of or within the museum itself.

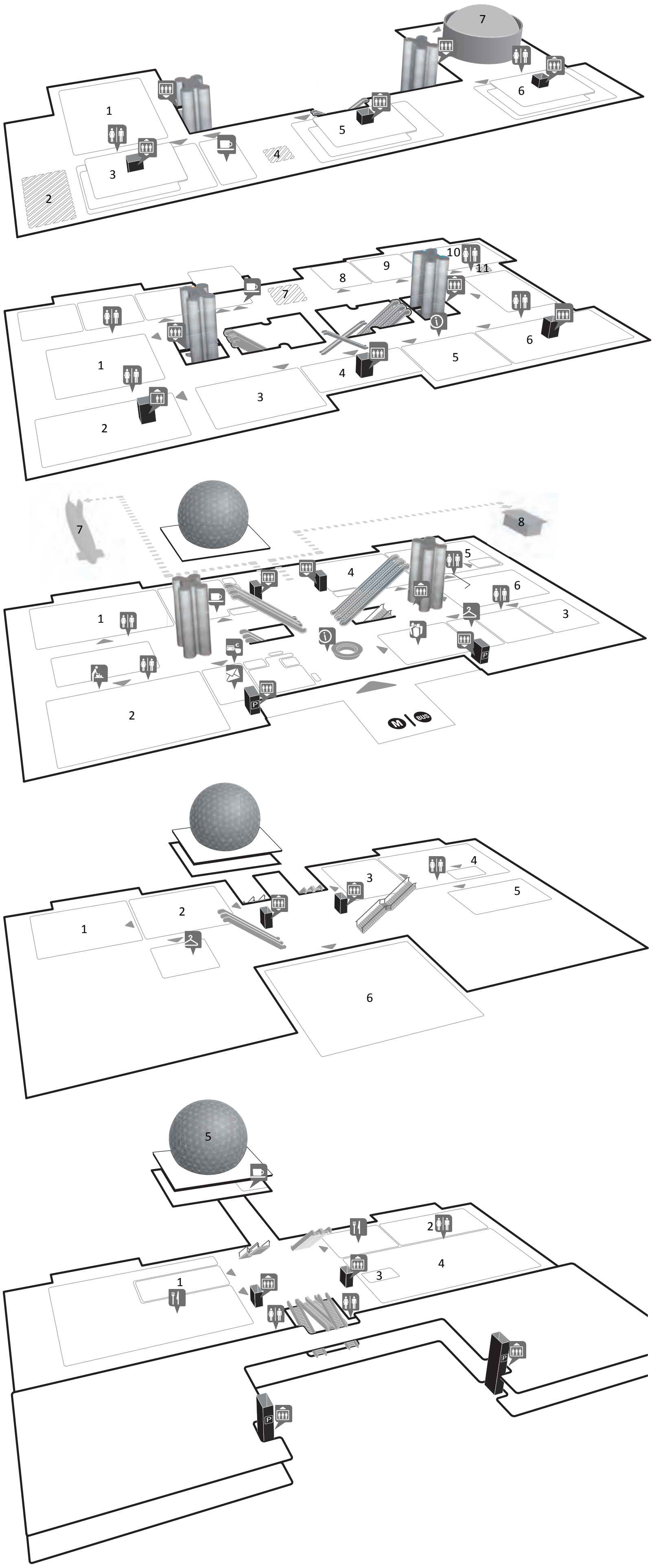


Fig. 60, Cité des Sciences et de l'Industrie, Parc de la Villette, Paris, France. 1986

LEVEL 2

1. Temporary exhibition space
Ongoing theme: food

2. Géolabo: Animation point

3. Light games
Interactive light room - visions and illusions

4. Room of lights: Animation point

5. Temporary exhibition space
Ongoing theme: health

6. The Universe
An invitation to travel 13.7 billion years

7. The planetarium
Large immersive shows devoted to the science of the universe

LEVEL 1

1. Temporary exhibition space

2. Imagery
Manipulation on images

3. Genetics
Evolution and heredity and bioethics

4. Temporary exhibition space

5. Sound
The sound phenomenon: physical, speech, hearing and diversity

6. Mathematics

7. Forum: Animation point

8. Temporary exhibition space

9. The observatory
Innovations for sustainable development and human security

10. Objective Earth
The observation of earth and space

11. Astrolabo: Animation point

LEVEL 0

1. The city of children, 5-12 years
More than a hundred activities divided into six universes: the body, communication, the garden, the TV studio, water games and the factory

2. The city children, 2-7 years
5 themes of exploration: I discovered I can do, I mark, all together, I experimented

3. Louis-Lumière cinema
2 films ongoing, 9-12 sessions per day

4. Temporary exhibition space

5. Les Shadoks cinema
Films for children

6. The auditorium
Debates, conferences and projections

7. French submarine Argonaute
A 1958 flagship submarine

8. The Cinaxe
4D cinema

LEVEL -1

1. History of Science
Contemporary history, philosophy, sociology, educational science and museology and science from the 16th to 19th century

2. Digital Crossroads
Cyberbase initiation and development of information and communications technolgy (ICT)

3. The city of health
Professional health information and consultation documentation

4. Life and Environment
Collection of nature, the universe, earth sciences, biotechnology and environmental risks

5. Louis Braille room
Equipped for the blind and partially sighted

6. De la Villette congress centre
Restricted access

LEVEL -2

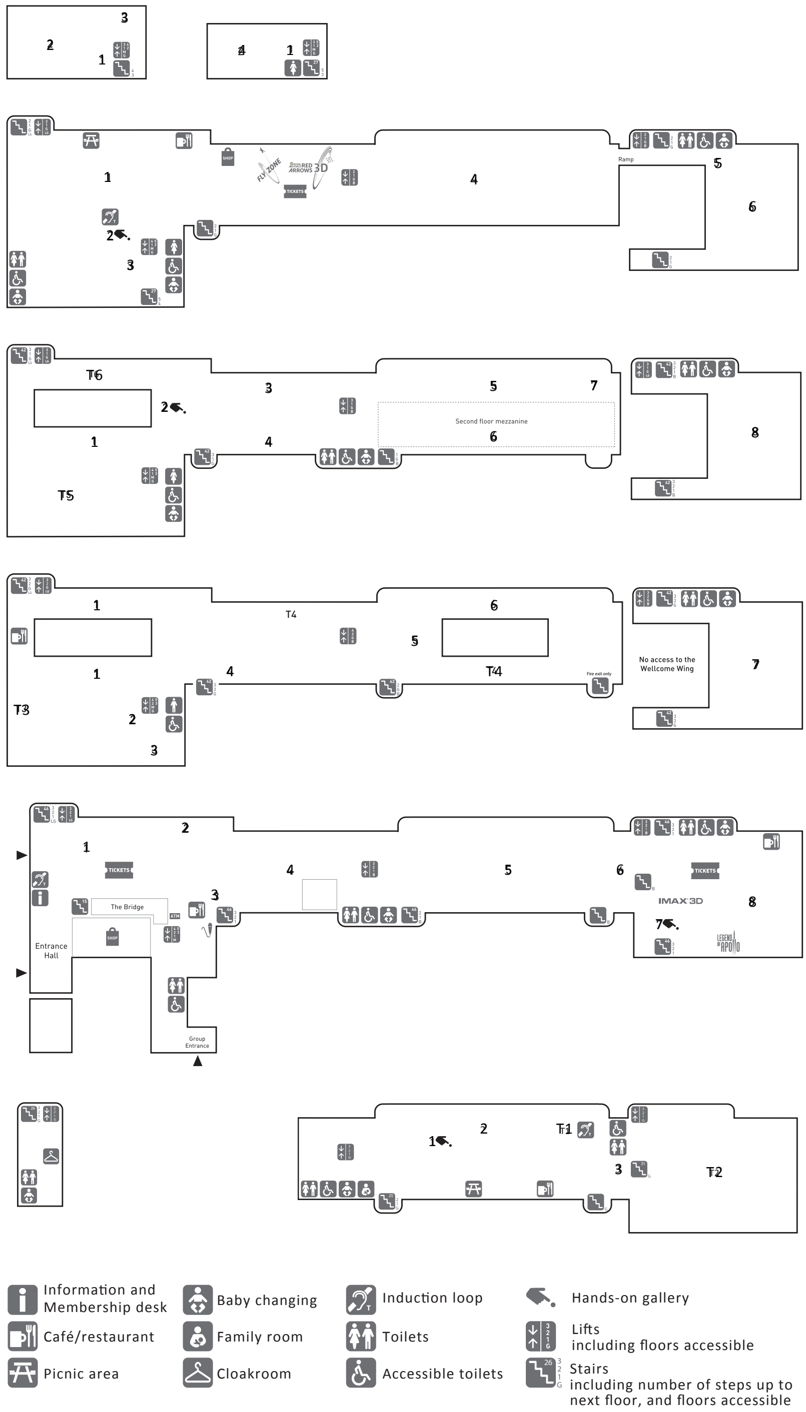
1. The aquarium
More than 200 species of the Mediterranean coast

2. Science and Society
Social, philosophical and political developments related to science

3. Jean Painlevé films
Projection and discussion room

4. Sciences industries
Collection of basic sciences and their applications in industry

5. Geode Hemispherical cinema
IMAX ® 3D



LEVEL 4 - 5

1. The Wellcome Museum of the History of Medicine
2. The Science and Art of Medicine
3. Veterinary History
5. Glimpses of Medical History

LEVEL 3

1. Science in the 18th Century
2. Launchpad
3. Health Matters
4. Flight
5. Welcome Wing
6. In Future

LEVEL 2

1. Public History: Oramics to Electronica
2. Energy: fuelling the future
3. Computing
4. Mathematics
5. 6. 7. Closed for redevelopment
8. Atmosphere: Exploring climate science
T5. Temporary exhibition space
T6. Temporary exhibition space: Signs, Symbols, Secrets

LEVEL 1

1. Challenge of Materials
2. Contemporary Arts: Listening Post by Mark Hansen and Ben Rubin
3. Telecommunications
4. Agriculture
5. Cosmos & Culture
6. Measuring Time
7. Who am I?
T3. Temporary exhibition space
T4. Temporary exhibition space

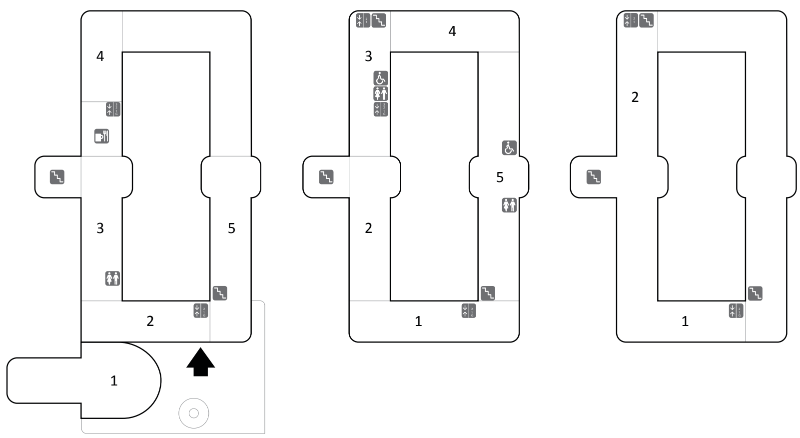
LEVEL 0

1. Energy Hall
2. James Watt and Our World
3. Foucault's Pendulum
4. Exploring Space
5. Making the Modern World
6. Wellcome Wing
7. Pattern Pod
8. Antenna – science news

LEVEL -1

1. The Garden
2. The Secret Life of the Home
3. Wellcome Wing
T1. Temporary exhibition space: Things
T2. Temporary exhibition space

Fig. 61, The Science Museum, London, UK. 1919.



LEVEL 0

1. Chapel
2. Entrance hall
3. Transport
4. Conference room
5. Temporary exhibition space

LEVEL 1

1. Energy
2. Mechanics
3. Archive
4. Construction
5. Communication

LEVEL 2

1. Scientific instruments
2. Material

Fig. 62, Musée des Arts et Métiers, Paris, France, 1794. Repository for the preservation of scientific instruments and inventions

PROGRAMMATIC STUDY: KUNSTHALLE

Traditionally, a kunsthalle is a term in Germam-speaking regions for a facility that houses art exhibitions on a temporary basis. Its function is similar to a kunstmuseum (literally "art museum") but whereas a kunstmuseum has its own permanent collection, a kunsthalle does not and is often a medium scale development. Today the two terms are interchangeable but for the purpose of clarity, these studies are primarily meant to encompass museums of a certain scale (a scale similar to that of this thesis project) that do not house permanent collections.

The first example, shown in figure 64, is a floor plan of the *Temporäre Kunsthalle Berlin* by Adolf Krischanitz. The building was a 1125m^2 temporary kunsthalle which was situated on Schloßplatz in Berlin between 2008-2010. During a total of 467 exhibition days, more than 212,500 visitors viewed the contributions of more than 800 artists. The building underwent several exhibition cycles and façade projects throughout the building's existence.

A less traditional example of the kunsthalle is *PLATOON KUNSTHALLE* in Seoul by Graft Architects (fig. 65-68). The facility provides showcases of "underground artists" and a selection of performances and features a 272m^2 lounge, a shop, a bar/cafe/restaurant, exhibition spaces, multi-purpose/conference rooms, 4 artist residences and studios.

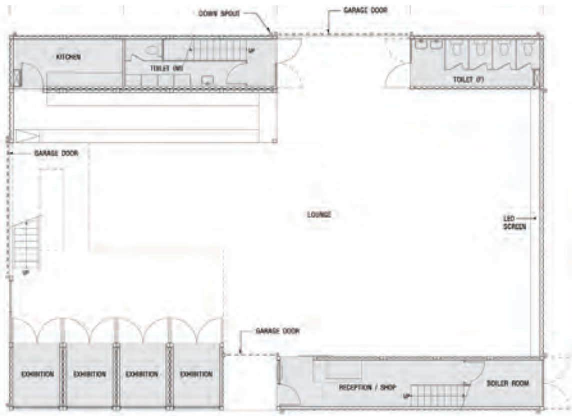


Fig. 65, "PLATOON KUNSTHALLE", exhibition space, meeting place and artists studios/residences, level 1, Graft Architects

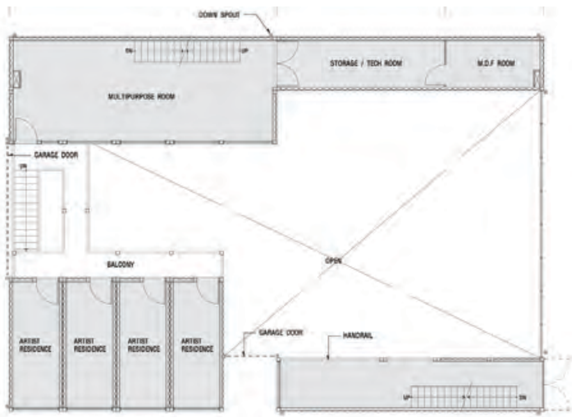


Fig. 66, "PLATOON KUNSTHALLE", exhibition space, meeting place and artists studios/residences, level 2, Graft Architects

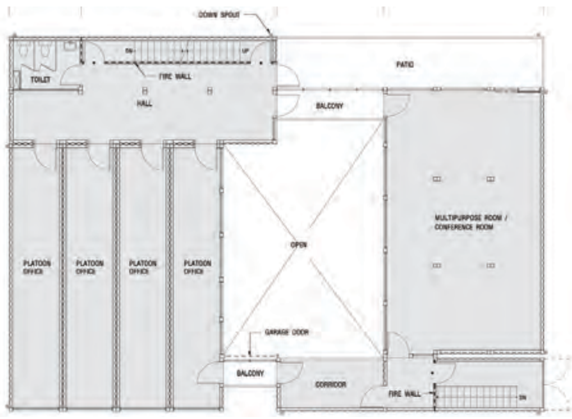


Fig. 67, "PLATOON KUNSTHALLE", exhibition space, meeting place and artists studios/residences, level 3, Graft Architects

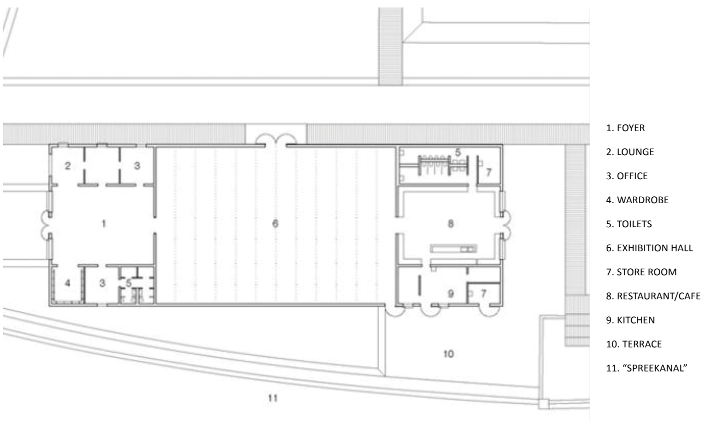


Fig. 64, "Temporäre Kunsthalle Berlin", temporary art gallery, Adolf Krischanitz

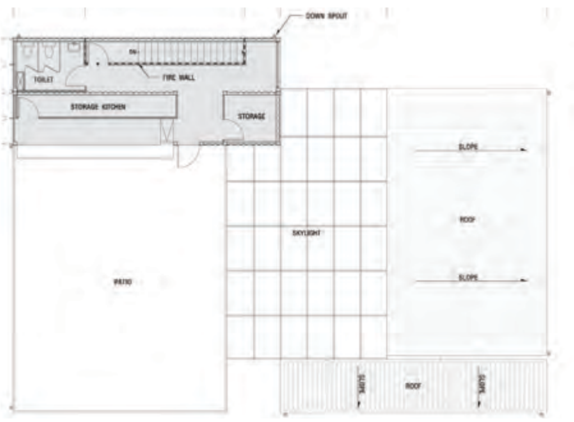


Fig. 68, "PLATOON KUNSTHALLE", exhibition space, meeting place and artists studios/residences, level 4, Graft Architects

PEDESTRIAN PUBLIC & GALLERY VISITOR INTERACTION

Another aspect to consider is the role of a museum in society. They are no longer merely places that exhibit but they also hold an important social function as meeting places for both official gallery visitors and the general public.

The distinction between the public realm and the exhibition space is becoming increasingly blurred as museums seek to reach out to an ever-expanding audience.

The successful merging of these two sectors is evident in such gallery spaces like Herzog & de Meuron's Turbine Hall in the Tate Modern gallery in London amongst others. Gallery visitors and casual passers by enter directly into what has become a public living room (fig. 71) which regularly features various art installations known as the Unilever Series (fig. 69-70).

The ambiguity between exhibition space and public space will play a large role in the eventual schematic program layout of the project. However, the intention is not only to create a place for exhibitions and a hub for meetings but hopefully, the bridge between the two will result in a more socially accessible and inviting museum space and provide a platform for public dialogue.

Fig. 69, "The Weather Project", art installation by Olafur Eliasson at the Tate Modern's Turbine Hall, Herzog & de Meuron.

Fig. 70, "Sunflower Seeds", art installation by Ai Weiwei at the Tate Modern's Turbine Hall, Herzog & de Meuron.

Fig. 71, Regular day (no installation) at the Tate Modern's Turbine Hall, Herzog & de Meuron.

GASKLOCKAN

Gullbergsvass, Gothenburg, SWEDEN

For the purposes of the proposed program, it is perhaps most appropriate to work with an existing industrial structure that chronicles the city's industrial heritage. The old gas holder at Gullbergsvass in Gothenburg was completed in 1933 and is a local landmark that has been the subject of much debate since its decommissioning in 1993, from whence it has stood empty.

Göteborg Energi, the current site owners, have applied for demolition on numerous occasions, all of which have been turned down by the local cultural administration on the grounds that the building has been an important landmark for 80 years, is part of the skyline and its size makes it a powerful symbol of the industrial city of Gothenburg. Additionally, one could also argue that its proximity to the central station, city centre and the riverbank also makes it a strategic player in the activation of the area as well as a gateway building for Gothenburg.

Developments for the area have been explored in an international workshop that took place in 2011 called RiverCity. More specific proposals for the building itself have also been discussed by many parties. These include Coca-cola's proposal to turn the tower into a large representation of a coke can as part of their advertising campaign during the IAAF World Championships in Athletics in 1996, as well as proposals to replace the building with a residential tower or a hotel with a new building of the same shape.

Alternatively, this project will not be replacing the building but rather restoring it whilst introducing a new function. Its connection to the city's past as well as its domination of the city's skyline makes it an ideal candidate for this homage to the city's recent history.

GENERAL DIMENSIONS

Internal diameter: 44.75m
Height: 75 meters to the eaves - a total of 81 meters
Area: 1572.81 square meters
Volume: Approximately 100,000 cubic meters

Fig. 72, "Gasklockan", areal view

Fig. 73, "Gasklockan", the gasometre as seen from Mårten Krakowgatan

Fig. 74, "Gasklockan", the gasometre as seen from ground level

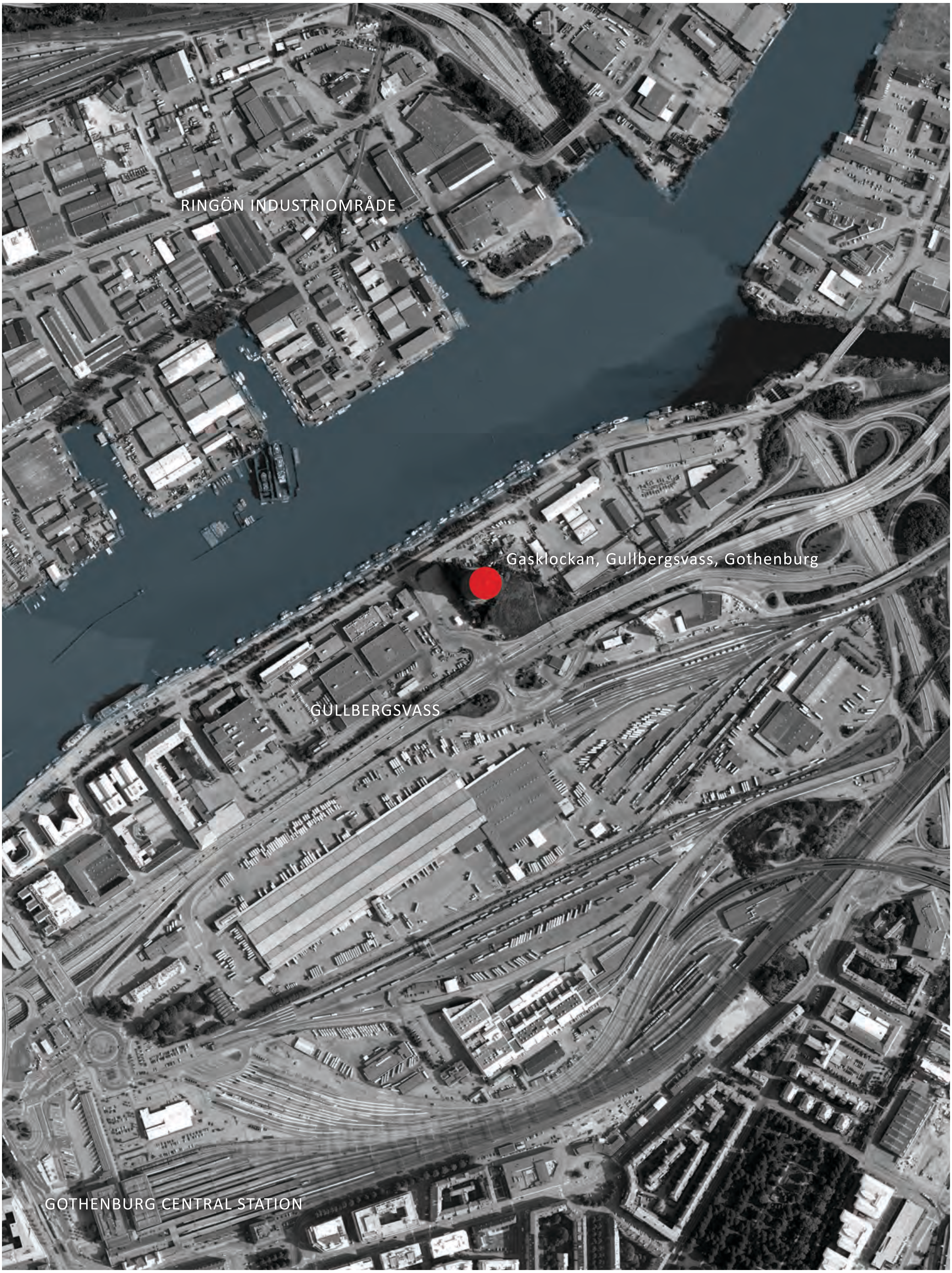


Fig. 75, satellite image of the gasometer and nearby areas

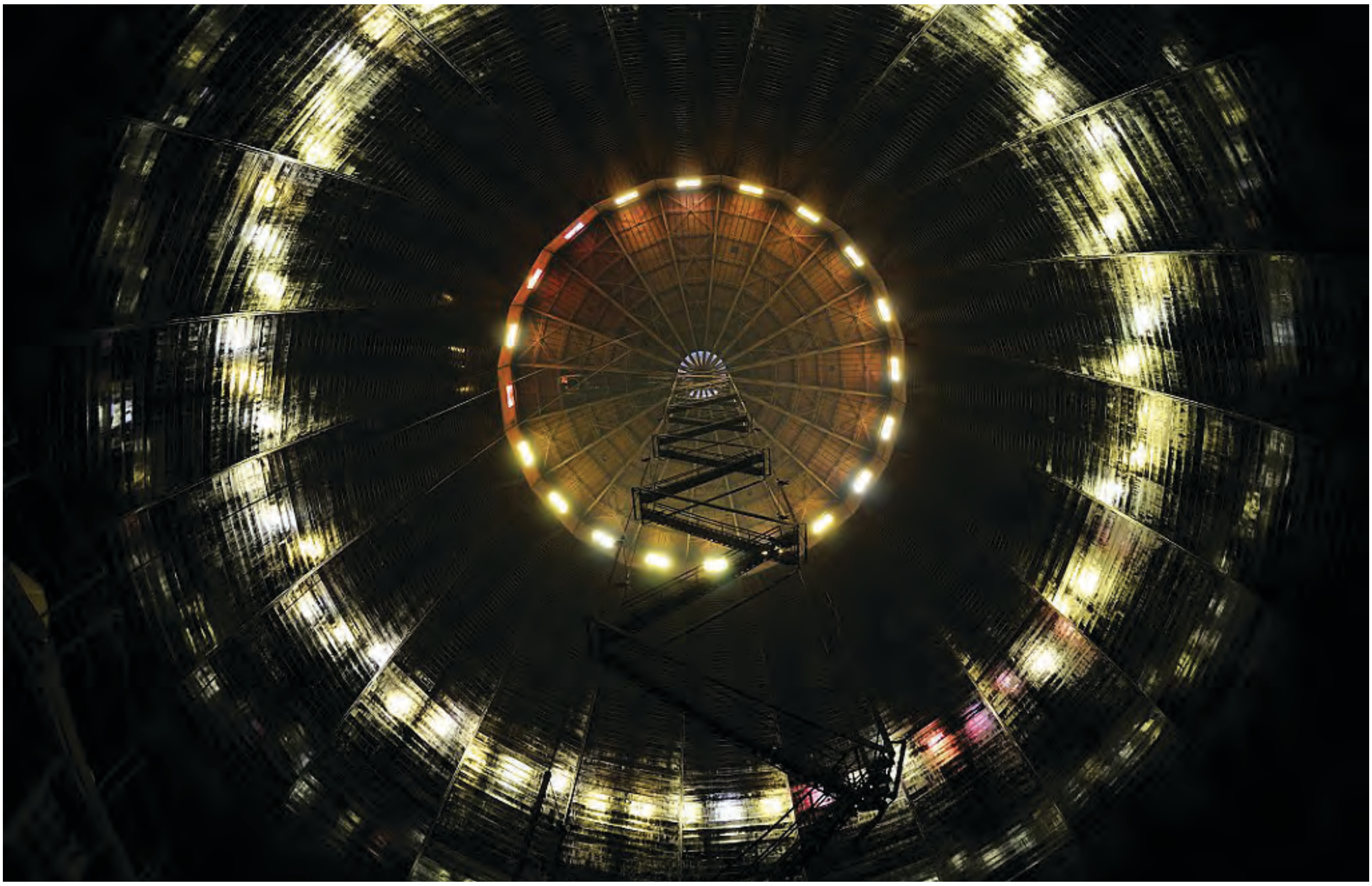


Fig. 76, an interior view of the near identical gasometer in Stockholm

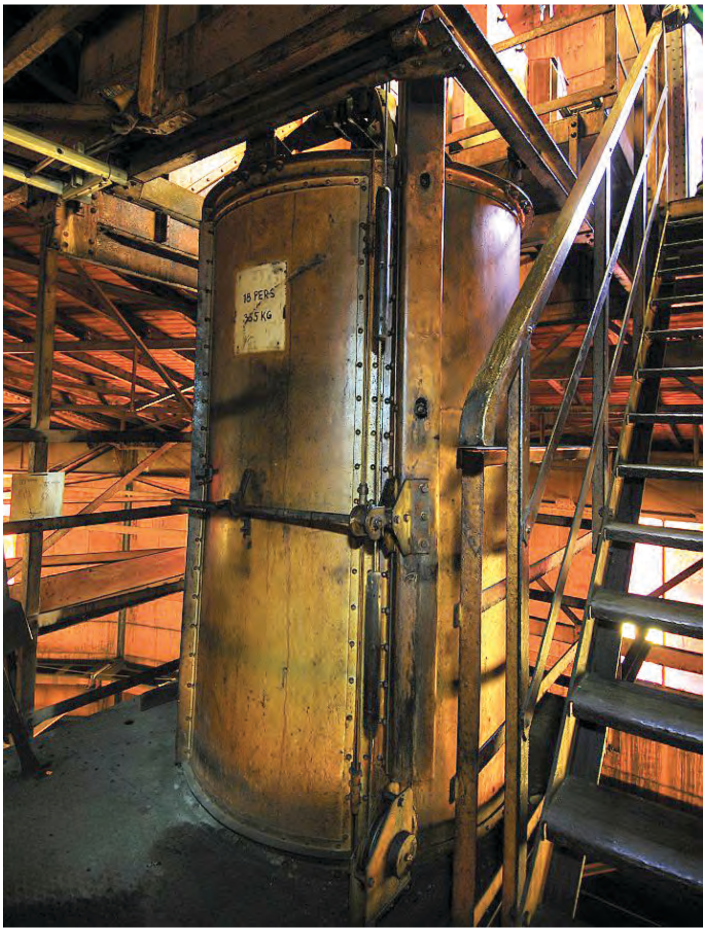


Fig. 77, the elevator in the near identical gasometer in Stockholm

Fig. 78, an interior view of the near identical gasometer in Stockholm

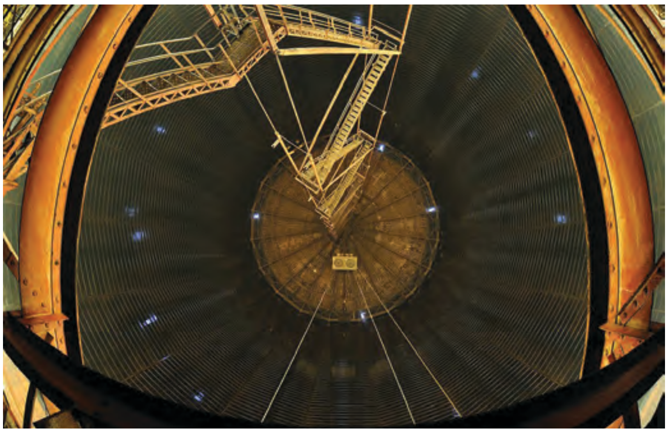


Fig. 79, an interior view of the near identical gasometer in Stockholm

ANALYSIS: TEMPERATURE, PRECIPITATION AND SUNLIGHT

Fig. 80, Average temperature ranges

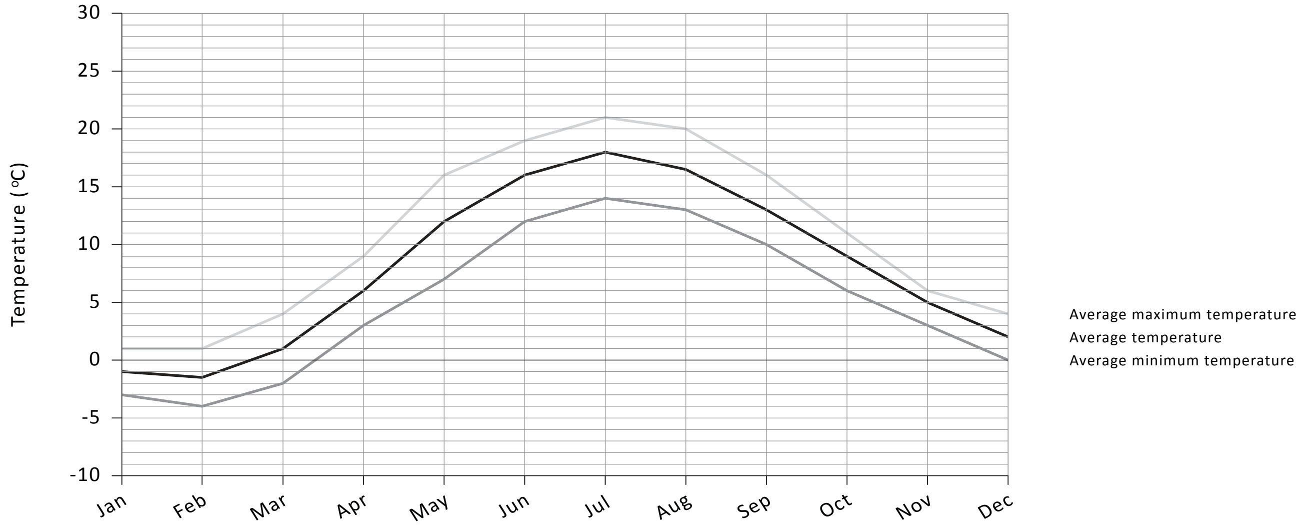


Fig. 81, Precipitation and humidity

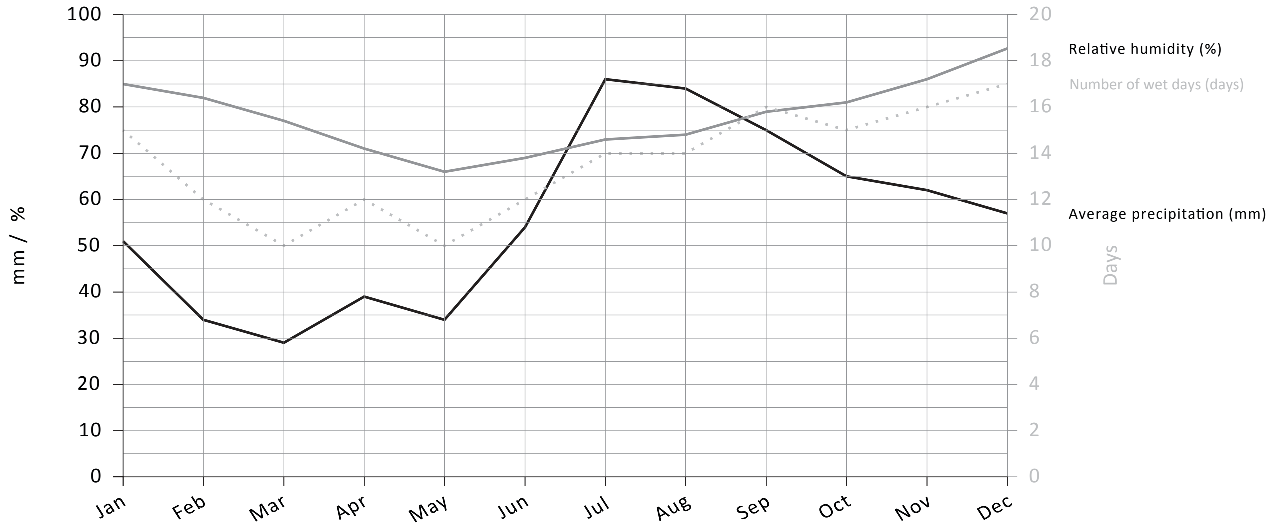
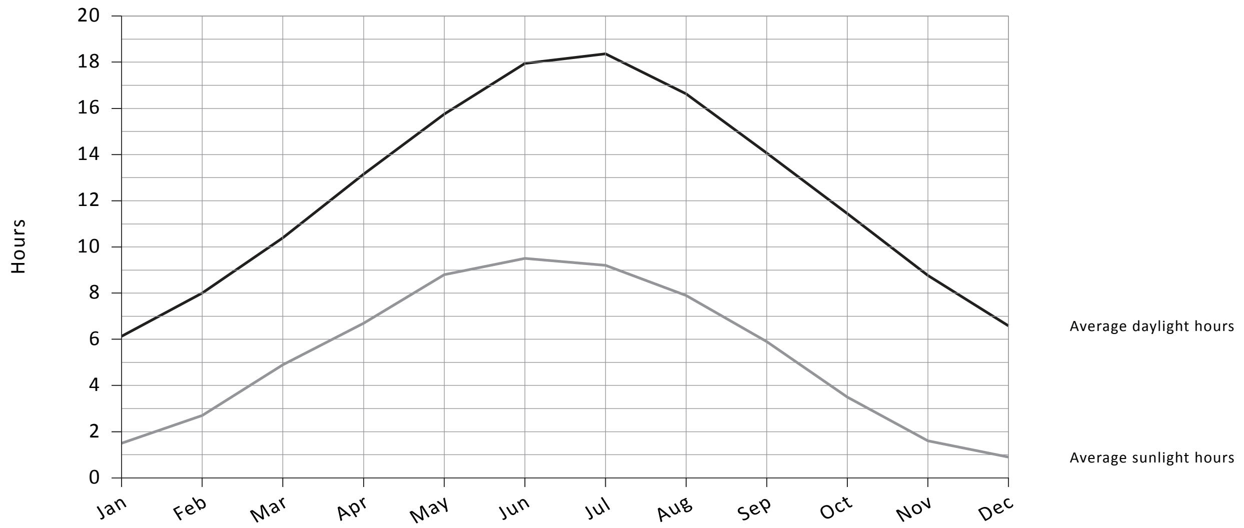
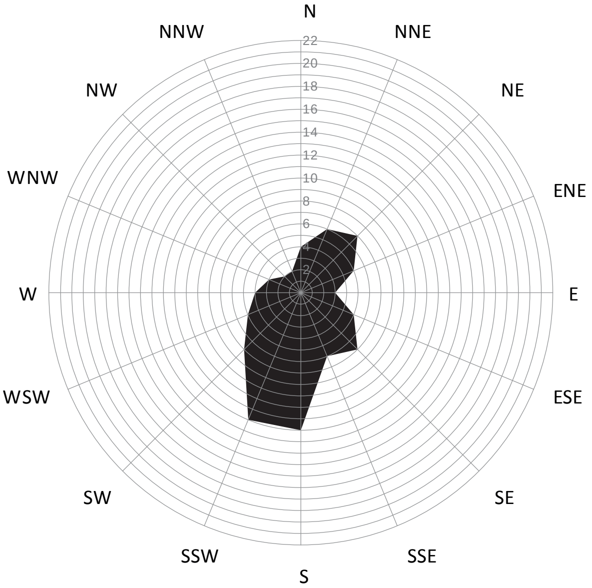


Fig. 82, Average daylight and sunshine hours

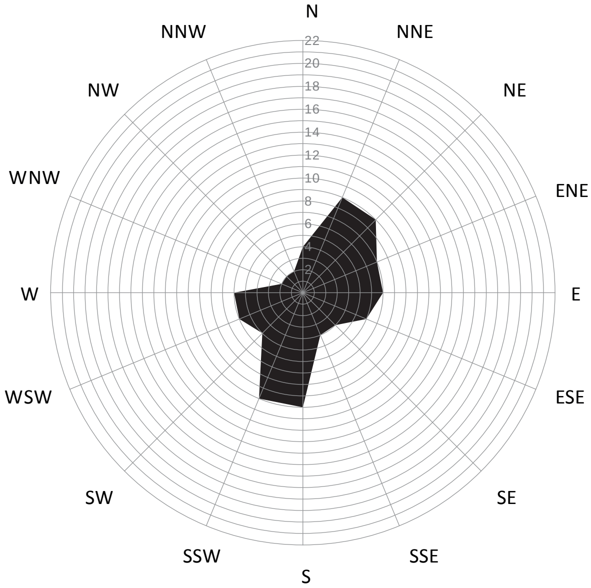


ANALYSIS: WIND DIRECTION & SPEED (KNOTS)

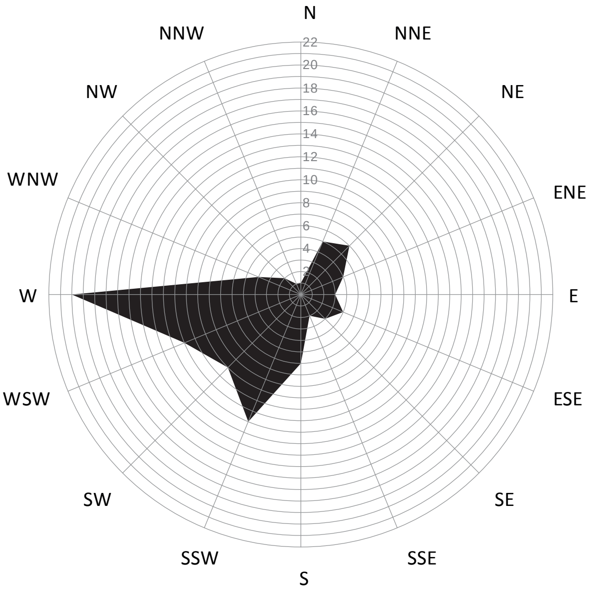
January



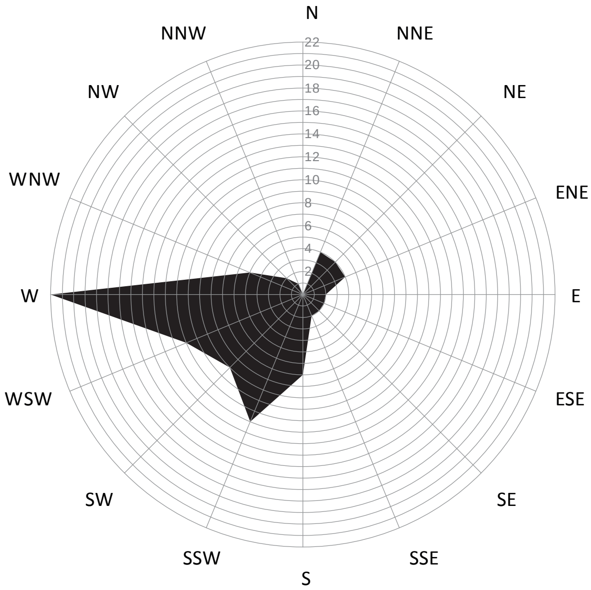
February



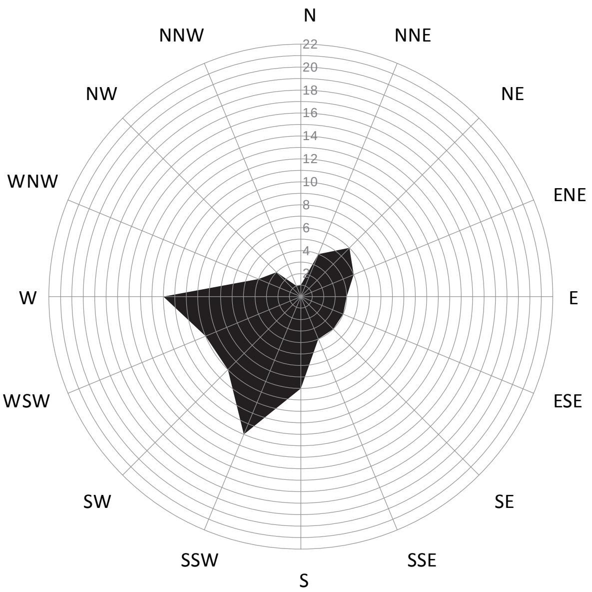
May



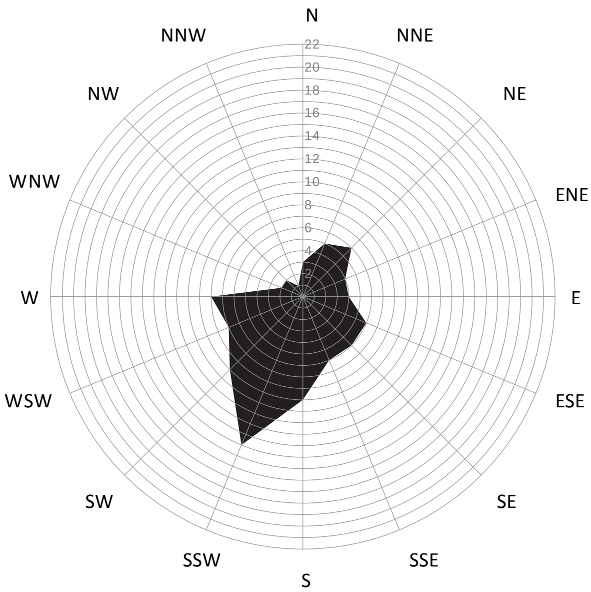
June

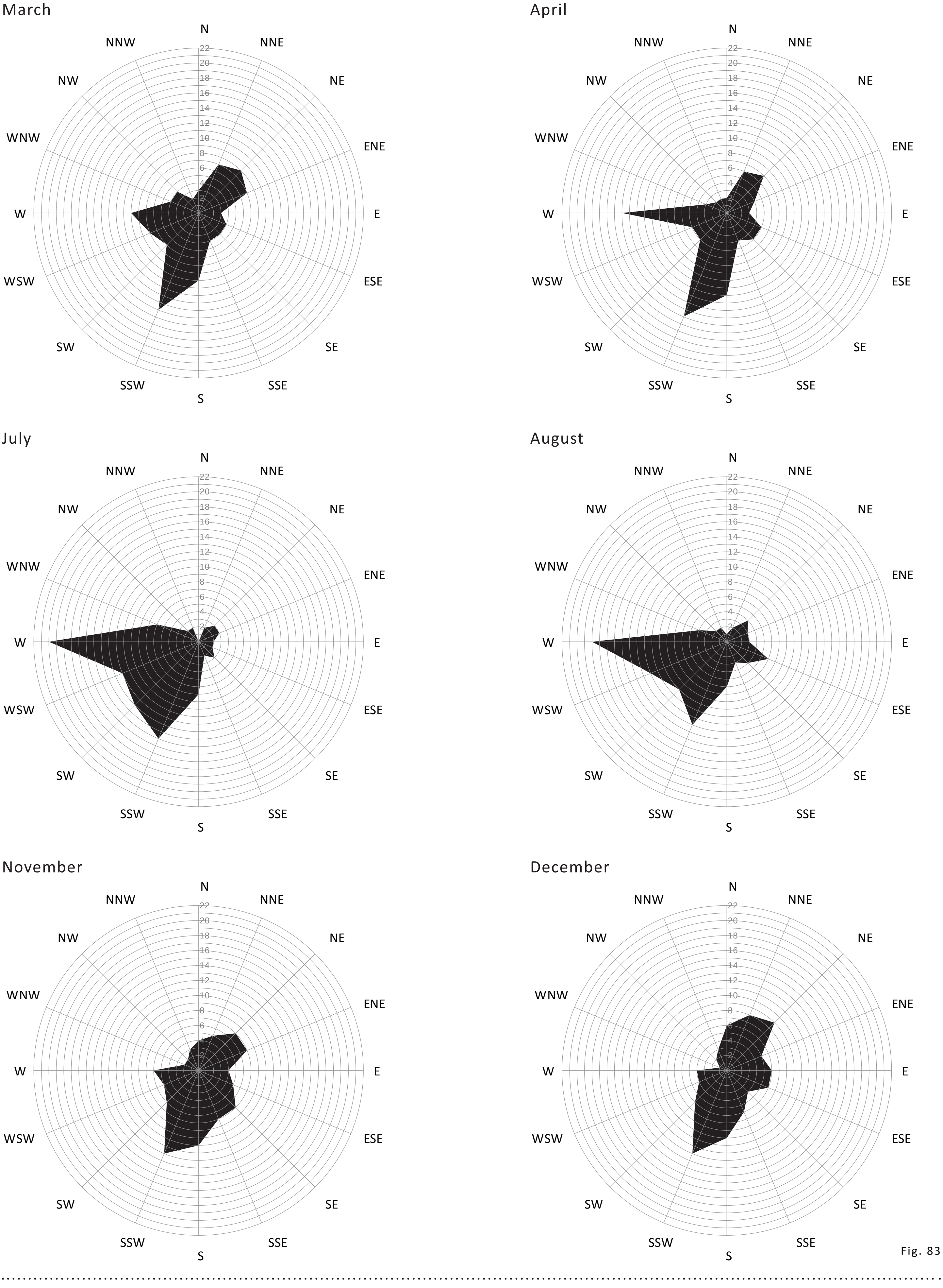


September



October





March
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Fig. 83

JANUARY

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	
	1	2	3	4	5	6	W1
7	8 **PREPARATORY FINALISATION**	9 Complete preparatory research booklet	10 Complete preparatory research booklet	11 Complete preparatory research booklet	12 Complete preparatory research booklet	13 (reserved time for uncompleted tasks)	W2
14 **CONSULTATION** Brief, production plan, pin up draft, collaborators	15 Contact city planning office and land owners regarding site	16 Sketch layout $4m^2$ Compilation of material for MT launch	17 Make digital site + gas tower outline model	18 Make digital site + gas tower outline model	19 Make digital site + gas tower outline model	20 (reserved time for uncompleted tasks)	W3
21 **MT LAUNCH DAY**	22 Find drawings of gas tower Refine digital model in detail	23 Analyse existing space Diagram of historical usage	24 Structural analysis of existing tower conditions.	25 Spatial sequence: - layout strategy - atmospheric explorations	26 Spatial sequence: - layout strategy - atmospheric explorations	27 (reserved time for uncompleted tasks)	W4
28 Spatial sequence: - layout strategy - atmospheric explorations	29 Spatial sequence: - layout strategy - atmospheric explorations	30 Spatial sequence: - layout strategy - atmospheric explorations	31 Spatial sequence: - layout strategy - atmospheric explorations				W5

FEBRUARY

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	
				1 Digital exploration with attention to atmosphere/ concept	2 Digital exploration with attention to atmosphere/ concept	3 (reserved time for uncompleted tasks)	W5
4 Digital exploration with regard to atmosphere/ concept	5 Digital exploration with regard to atmosphere/ concept	6 Digital exploration with regard to atmosphere/ concept	7 Digital exploration with regard to atmosphere/ concept	8 CNC mill geometry Site model	9 Analogue tests on digital output	10 (reserved time for uncompleted tasks)	W6
11 **EARLY SEMINAR** 11-15 FEBRUARY	12 Spatial sequence - exploration of programmatic strategy	13 Spatial sequence - exploration of programmatic strategy	14 Digital exploration with regard to program	15 Digital exploration with regard to program	16 Digital exploration with regard to program	17 (reserved time for uncompleted tasks)	W7
18 Digital exploration with regard to program	19 Digital exploration with regard to program	20 Digital exploration with regard to program	21 Digital exploration with regard to program	22 Digital design iteration 1	23 Digital design iteration 1	24 (reserved time for uncompleted tasks)	W8
25 Digital design iteration 1	26 Digital design iteration 1	27 Digital design iteration 1	28 Digital design iteration 1				W9

MARCH

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
				1 Rationalise explorations in architectural terms	2 Rationalise explorations in architectural terms	3 W9 (reserved time for uncompleted tasks)
4 Systematise construction methodology	5 Digital exploration with regard to construction methodology	6 Digital exploration with regard to construction methodology	7 Digital exploration with regard to construction methodology	8 Digital exploration with regard to construction methodology	9 Digital exploration with regard to construction methodology	10 W10 Presentation prep
11 CNC mill geometry Partial building	12 Digital design iteration 2	13 Digital design iteration 2	14 Digital design iteration 2	15 Digital design iteration 2	16 Digital design iteration 2	17 W11 Presentation prep
18 **MID SEMINAR 18-22 MARCH**	19 Digital design iteration 3	20 Digital design iteration 3	21 Digital design iteration 3	22 Digital design iteration 3	23 Digital design iteration 3	24 W12 (reserved time for uncompleted tasks)
25 Digital design iteration 3	26 Digital design iteration 3	27 Digital design iteration 3	28 Digital design iteration 3	29 Digital design iteration 3	30 Digital design iteration 3	31 W13 (reserved time for uncompleted tasks)

APRIL

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
1 Physical detail drawings: construction / structure	2 Physical detail drawings: construction / structure	3 Physical detail model: construction / structure	4 Physical detail model: construction / structure	5 Physical detail model: construction / structure	6 Physical detail model: construction / structure	7 W14 (reserved time for uncompleted tasks)
8 Design model	9 Design model	10 Design model	11 Design model	12 Design model	13 Design model	14 W15 (reserved time for uncompleted tasks)
15 Sections 1:1 material samples	16 Elevations 1:1 material samples	17 Plans 1:1 material samples	18 Axos 1:1 material samples	19 Illustrative section / visual	20 Prepare and send/ order STL model	21 W16 (reserved time for uncompleted tasks)
22 Visuals	23 Visuals	24 Visuals	25 Visuals	26 Visuals	27 Visuals	28 W17 (reserved time for uncompleted tasks)
29 Diagram: concept Diagram: life cycle + matter	30 Diagram: building layout Diagram: construction					W18

MAY

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	
		1 Finalising/refining presentation of boards + models + booklets + slides	2 Finalising/refining presentation of boards + models + booklets + slides	3 Finalising/refining presentation of boards + models + booklets + slides	4 Finalising/refining presentation of boards + models + booklets + slides	5 Finalising/refining presentation of boards + models + booklets + slides	W18
6 Finalising/refining presentation of boards + models + booklets + slides	7 Finalising/refining presentation of boards + models + booklets + slides	8 Finalising/refining presentation of boards + models + booklets + slides	9 Finalising/refining presentation of boards + models + booklets + slides	10 Finalising/refining presentation of boards + models + booklets + slides	11 Finalising/refining presentation of boards + models + booklets + slides	12 Finalising/refining presentation of boards + models + booklets + slides	W19
13 **FINAL CRITIQUE 13-17 MAY**	14 Final additions and modifications	15 Final additions and modifications	16 Final additions and modifications	17 Final additions and modifications	18 Final additions and modifications	19 Final additions and modifications	W20
20 Final additions and modifications	21 Final additions and modifications	23 Final additions and modifications	24 Final additions and modifications	25 Final additions and modifications	26 Final additions and modifications	27 Final additions and modifications	W21
28	29 **PUBLIC PRESENTATION 29-31 MAY**	30	31				W22

PRODUCTION CHECKLIST

ANALOGUE MODELS
- Site model + intervention 1:400
- Design models - partial interior 1:50
- Surface demonstration model 1:50
- Analogue tests / sketch models of varying scales
- CNC milled geometry
- Casting forms / vacuum forms

DRAWINGS
- Situation plan 1:1000
- Elevations / Plans / Axos 1:400
- Sections 1:200
- Detail drawings 1:50
- Illustrative section (large visual)

DIAGRAMS
- Building parts
- Programmatic layout
- Performative layers
- Integrated systems
- Construction methodology

VISUALS
- Entrance
- Galleries
- Exterior / Situation

PRESENTATION
- 4-5 A0 / 4-5m² boards (minimum)
- Model display with light table
- Portfolio
- Slide show

IMPORTANT DATES:
- 14 January: Registration
- 21 January: Master thesis kick off
- 11-15 February: Early seminar
- 18-22 March: Mid seminar
- 13-17 May: Final critique
- 29-31 May: Public presentation

PART TWO: THESIS THEMES

MAN AND NATURE

In much of architectural history, not least in the context of post-industrialism, one of the main roles of the built environment has been to provide a desirable vicinity that not only protects against the elements but endeavours to keep them out all together. Industrial society typically sees man as an opponent of nature, one that uses his ingenuity to overcome nature and set himself apart from it – a strive that is perhaps manifest most obviously in the built environment.

Post-industrialism on the other hand is a shift in paradigm where we start to consider natural phenomena as a productive force. What was once condemned as undesirable weathering or build up (of mould, bacteria, algae, dust, salt crystallisation, etc.) is now being purposely “built into” our structures in a variety of au courant projects from the designed weathering of Matys’ P_Wall to the more practical energy producing algae of Arup’s bioreactor façade of the BIQ building in Hamburg.

THE RE-APPROPRIATION OF REDUNDANT INDUSTRIAL STRUCTURES

With technological advances and the purpose built buildings that support them, our industrial structures of yesteryear are being rendered redundant in increasing numbers. What we chose to do with them should utilize the last breath of life they have to offer and give remembrance to a past era.

MASS-CUSTOMISATION

Current developments in digital fabrication technologies means that we can now generate highly complex and customisable building components that may rival their mass-produced counterparts. The ability to digitally generate and analyse the design information and then use it directly to manufacture and construct buildings has fundamentally redefined the relationship between conception and production creating a design continuum from design to construction.

The proposal incorporates self powering, renewable organic light sources that produce ambient lighting for the museum spaces through a process called bioluminescence.

Bioluminescence is the production and emission of light by a living organism. It is a naturally occurring form of chemiluminescence where energy is released by a chemical reaction in the form of light emission.

Fireflies, anglerfish, and other creatures produce the chemicals luciferin (a pigment) and luciferase (an enzyme). The luciferin reacts with oxygen to create light. Organisms that produce luminescence produce it as a result of a symbiotic relationship to various microbes. These microbes also occur without a host, sometimes in large colonies that light up entire coastlines.

One particular species of bioluminescent bacteria that would be appropriate for incorporation into the design is Aliivibrio fischeri. Planktonic Aliivibrio fischeri are a bioluminescent strain of bacteria that are found in very low quantities (almost undetectable) in almost all oceans of the world, preferentially in temperate and subtropical waters making them endemic to Gothenburg.

These free-living Aliivibrio fischeri subsist on organics within the water. They can be cultivated and grown in artificial climates and survive on a nutrient medium consisting of sea water, peptone, yeast extract and glycerol. This species requires dark growing conditions with optimal growing temperatures ranging from 4 to 25 degrees.

Fig. 84, dinoflagellate phytoplankton disturbed by oxygen, Raa Atoll islands, Maldives

Fig. 85, various strains of bioluminescent bacteria grown in Petri-dishes in a lab

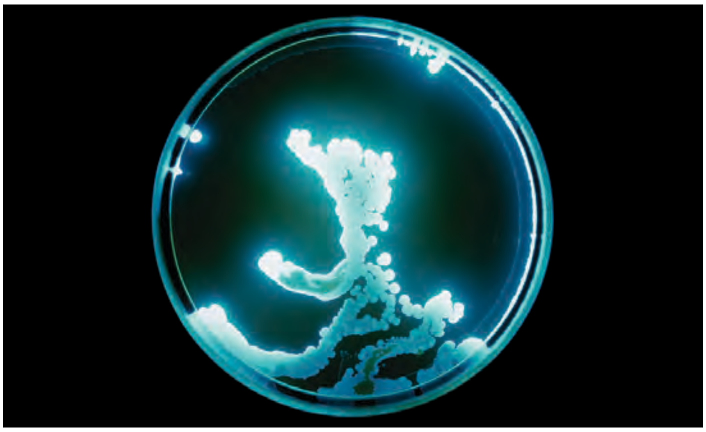


Fig. 86, Aliivibrio fischeri colony grown in a Petri-dish

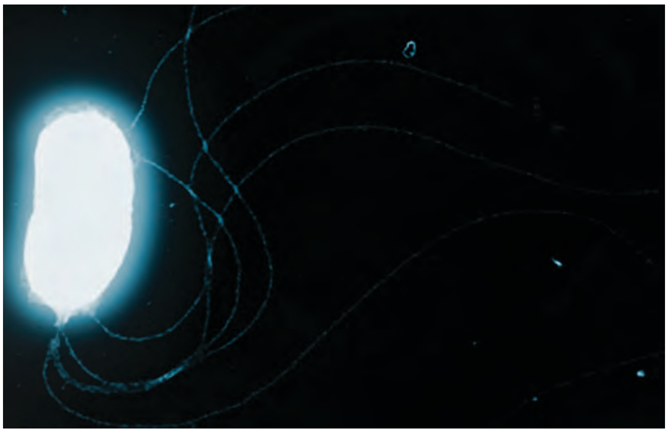


Fig. 87, close up of an Aliivibrio fischeri bacteria cell

Samples can be either cultivated directly from the ocean and concentrated, or ordered through the Centre of Culture Collection at the department of Clinical Bacteriology.

Figures 89-90 show some of the samples that were ordered from the lab at the Centre of Culture Collection. Several strains of bacteria were tested and grown on a variety of different mediums, the most successful medium being a transparent seawater complete (SWC) agar medium.

Fig. 88, Aliivibrio fischeri grown in a liquid medium

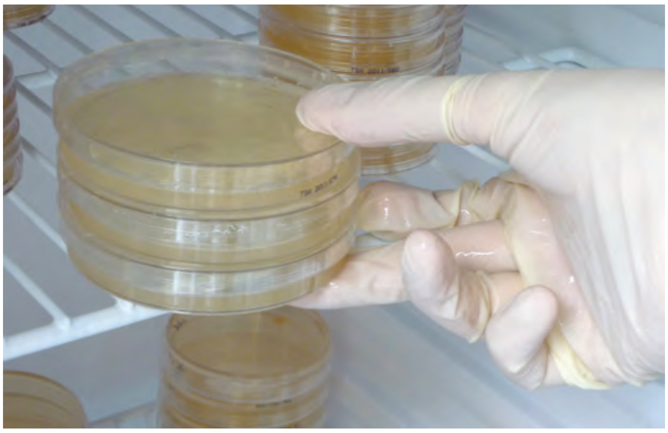


Fig. 89, Incubation of bacterial strains, Department of Clinical Bacteriology, Gothenburg University.

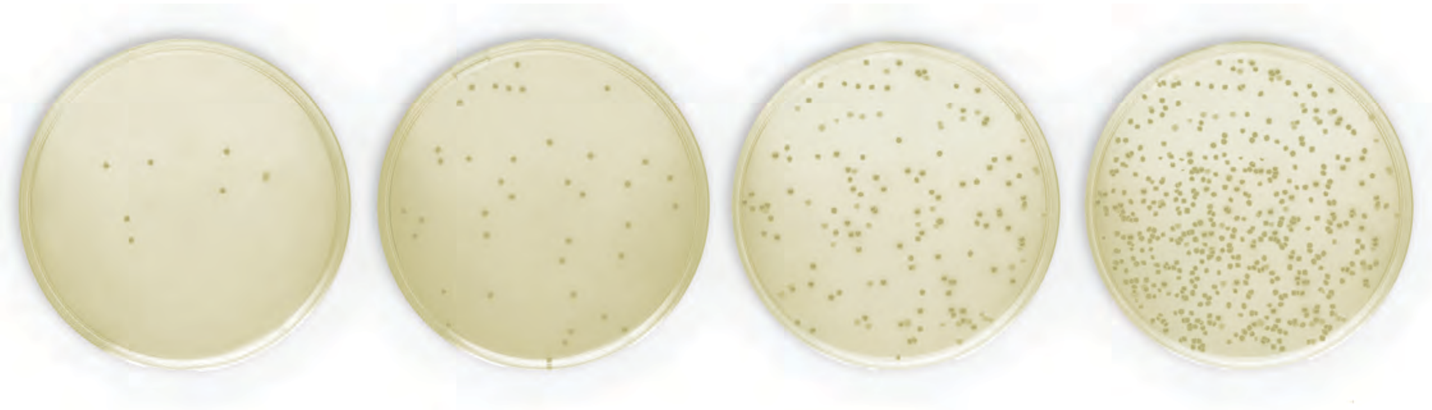


Fig. 90, Aliivibrio fischeri grown in various nutrient agar mediums 48 hours after incubation, Department of Clinical Bacteriology, Gothenburg University

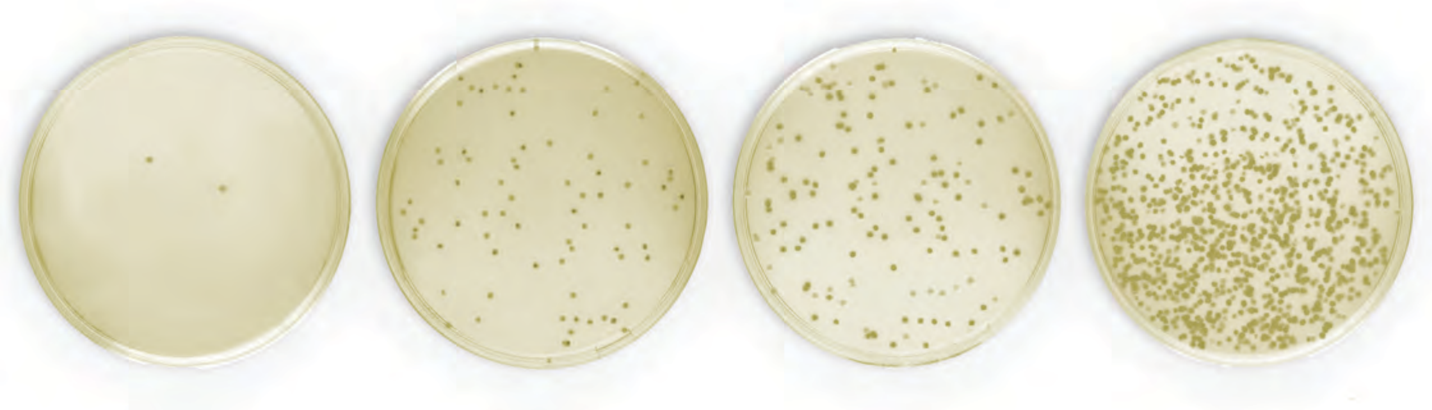


Fig. 91, Vibrio harveyi grown in various nutrient agar mediums 48 hours after incubation, Department of Clinical Bacteriology, Gothenburg University

PART THREE: ARCHITECTURE AND PROCESS

Fig. 92, mold: form + clay | matter: wax

Fig. 93, mold: form + clay | matter: wax

As a result of the discrepancy between the volumetric requirements of the program and the volume of the existing structure, an appropriate strategy for design was the introduction of a vast open air atrium space which would showcase the natural phenomena and provide an “external” vertical communication and public platform for entering the galleries. It would also minimize the volume of required for climatised spaces.

The design of the atrium was first conducted through a series of cast models that explored the interrelationship between positive and negative spaces, the positive space being programmed space and the negative space being atrium space. Atmospherically, the atrium tries to emulate the experience of geological formations through architectural language.

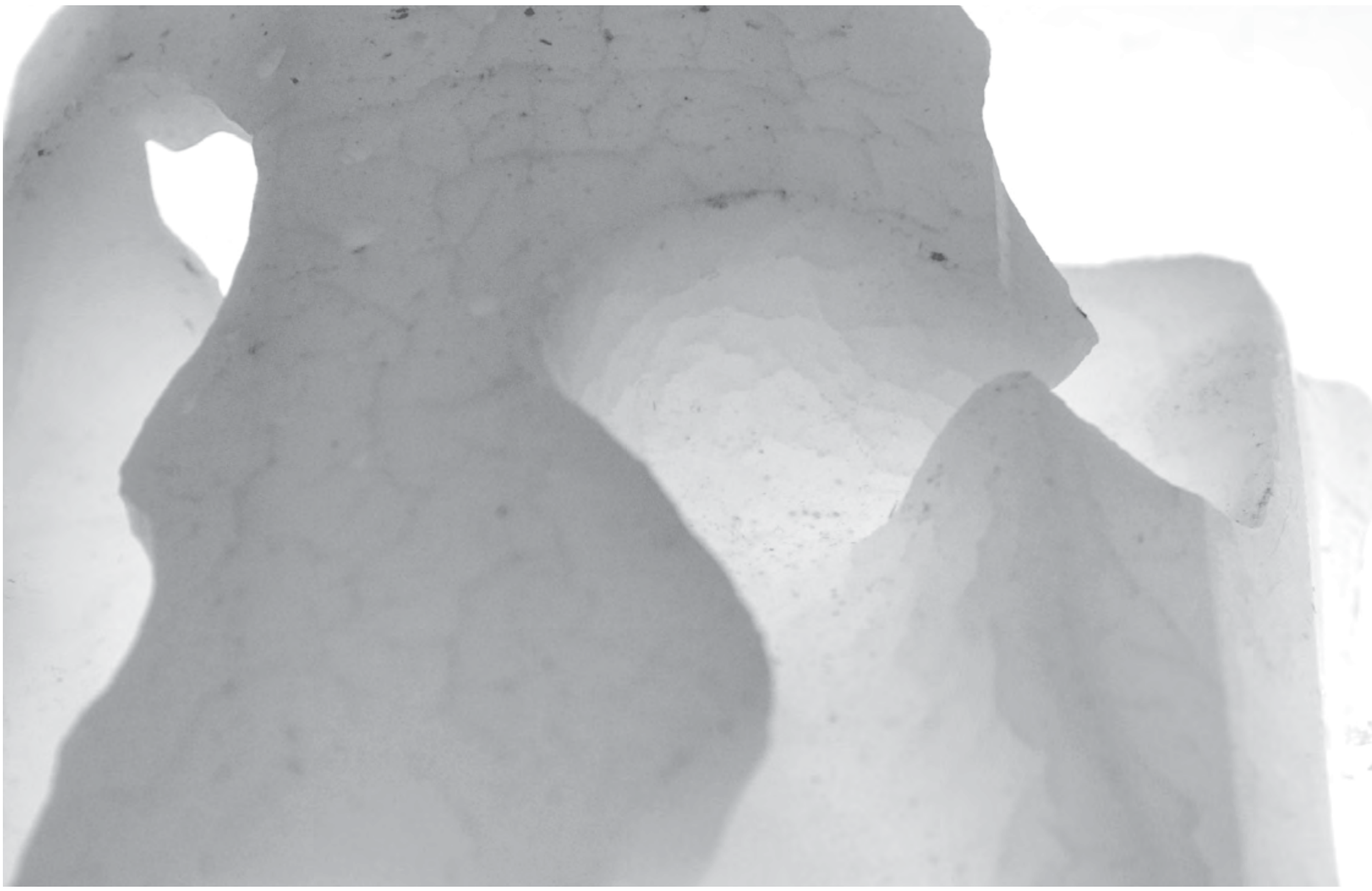


Fig. 94, mold: form + clay | matter: wax

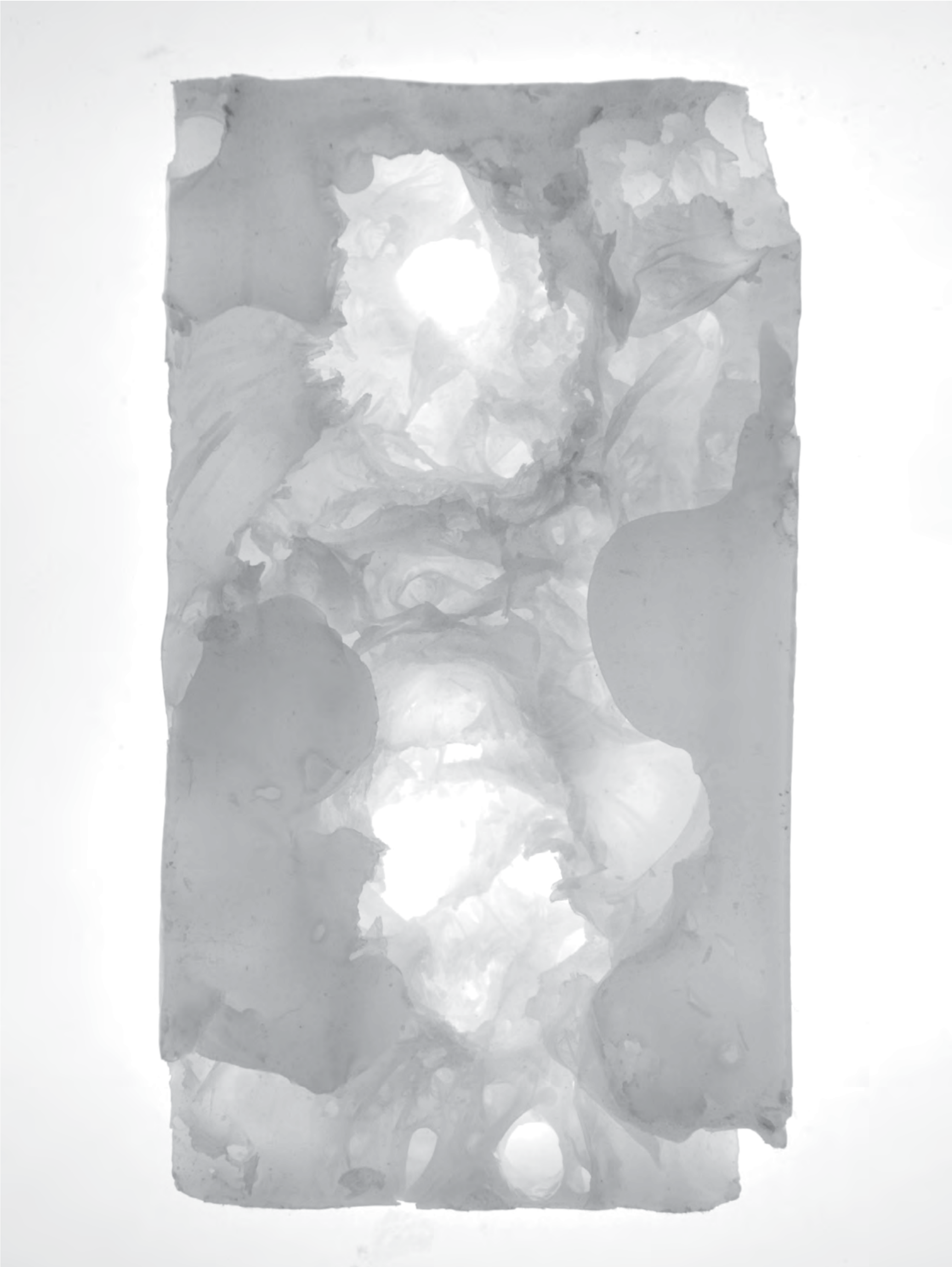


Fig. 95, mold: form + water 50ºC | matter: wax


Fig. 96, mold: form + water 50ºC | matter: wax


Fig. 97, mold: form + water 50ºC | matter: wax

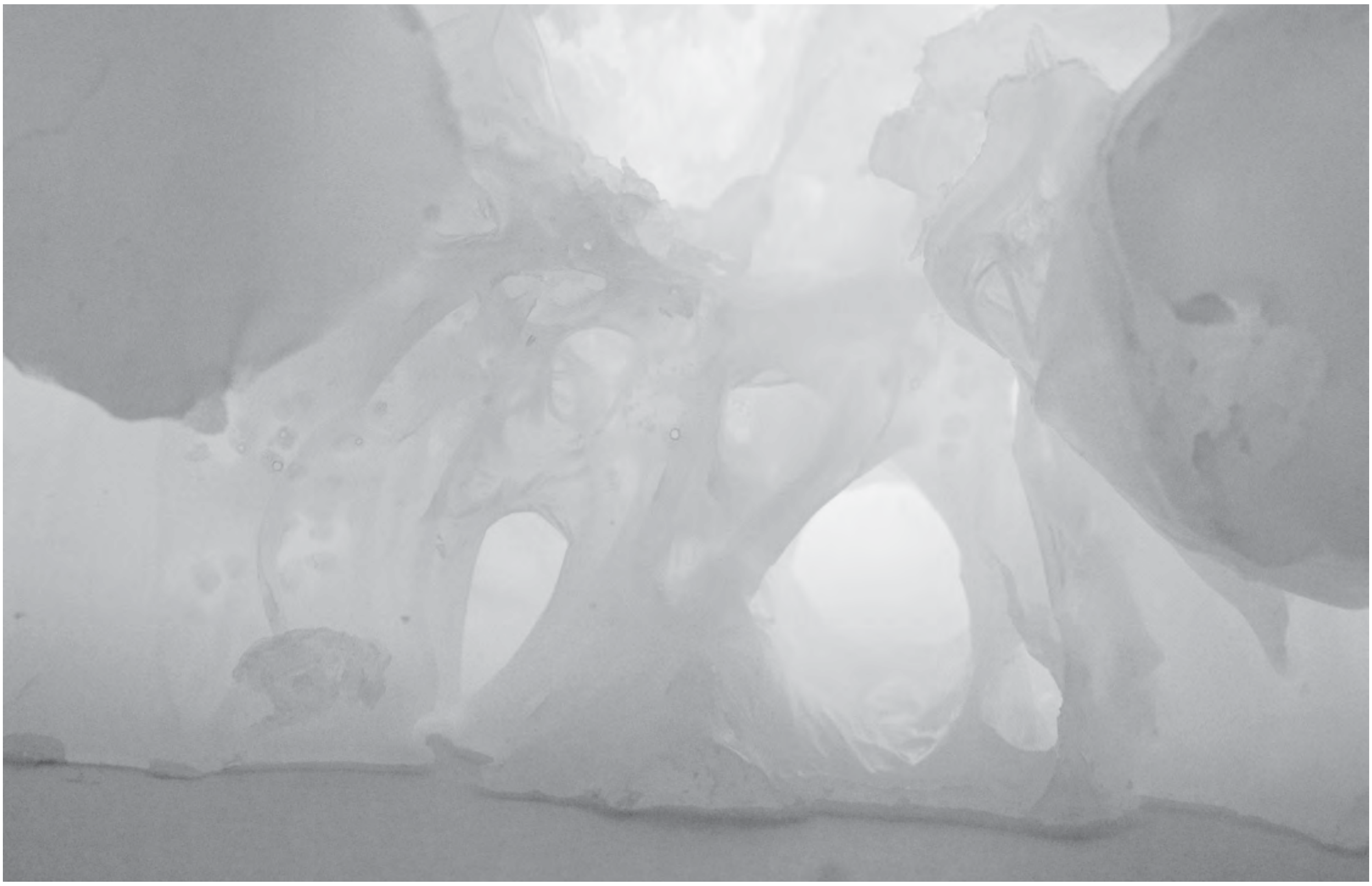


Fig. 98, mold: form + water 50ºC | matter: wax

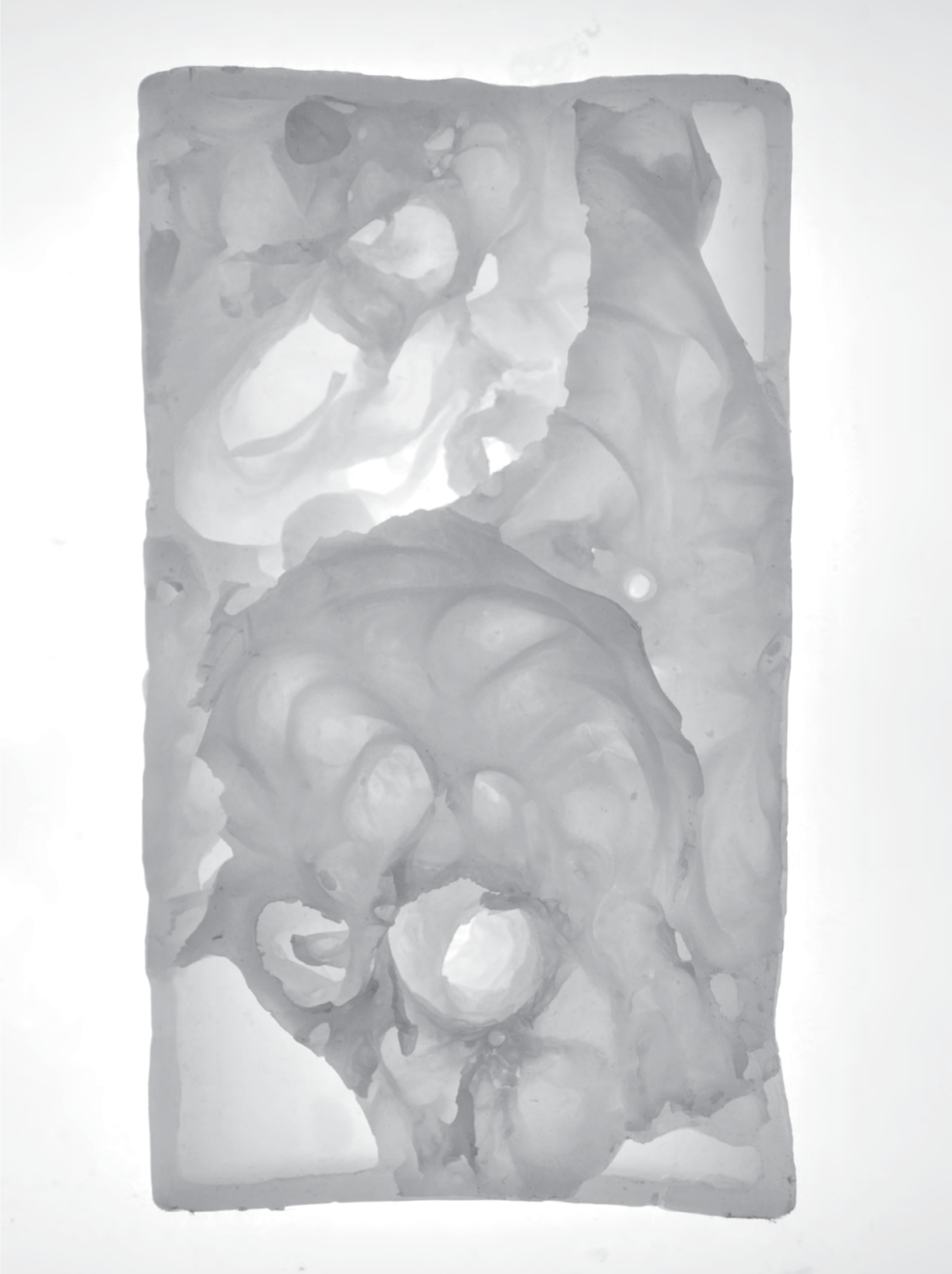


Fig. 99, mold: form + water 5°C | matter: wax

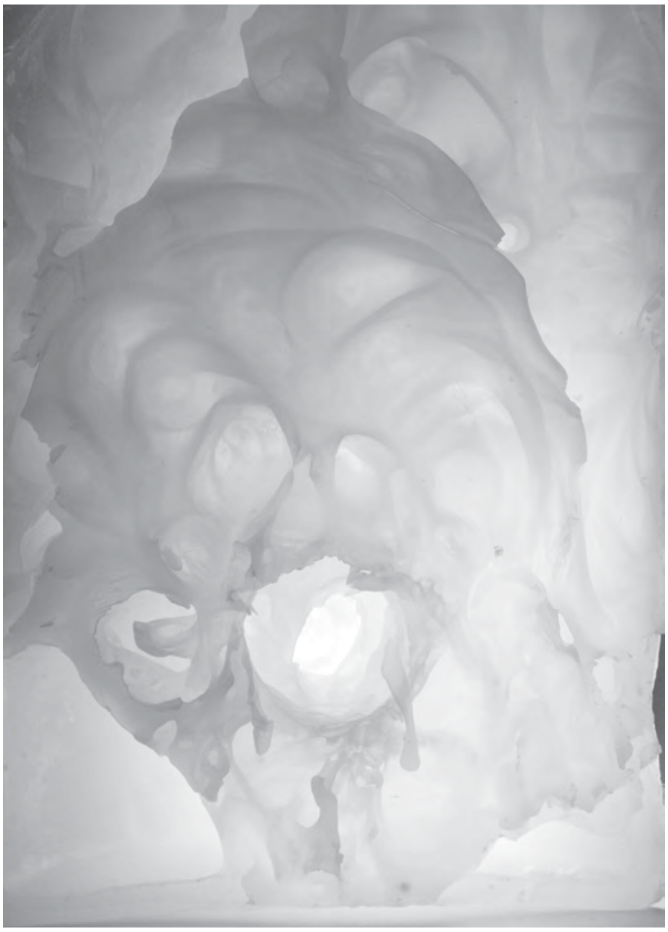


Fig. 100, mold: form + water 5°C | matter: wax

Fig. 101, mold: form + water 5°C | matter: wax

Fig. 102, mold: form + water 5°C | matter: wax

Fig. 103, mold: form + foil | matter: wax


Fig. 104, mold: form + foil | matter: wax


Fig. 105, mold: form + foil | matter: wax

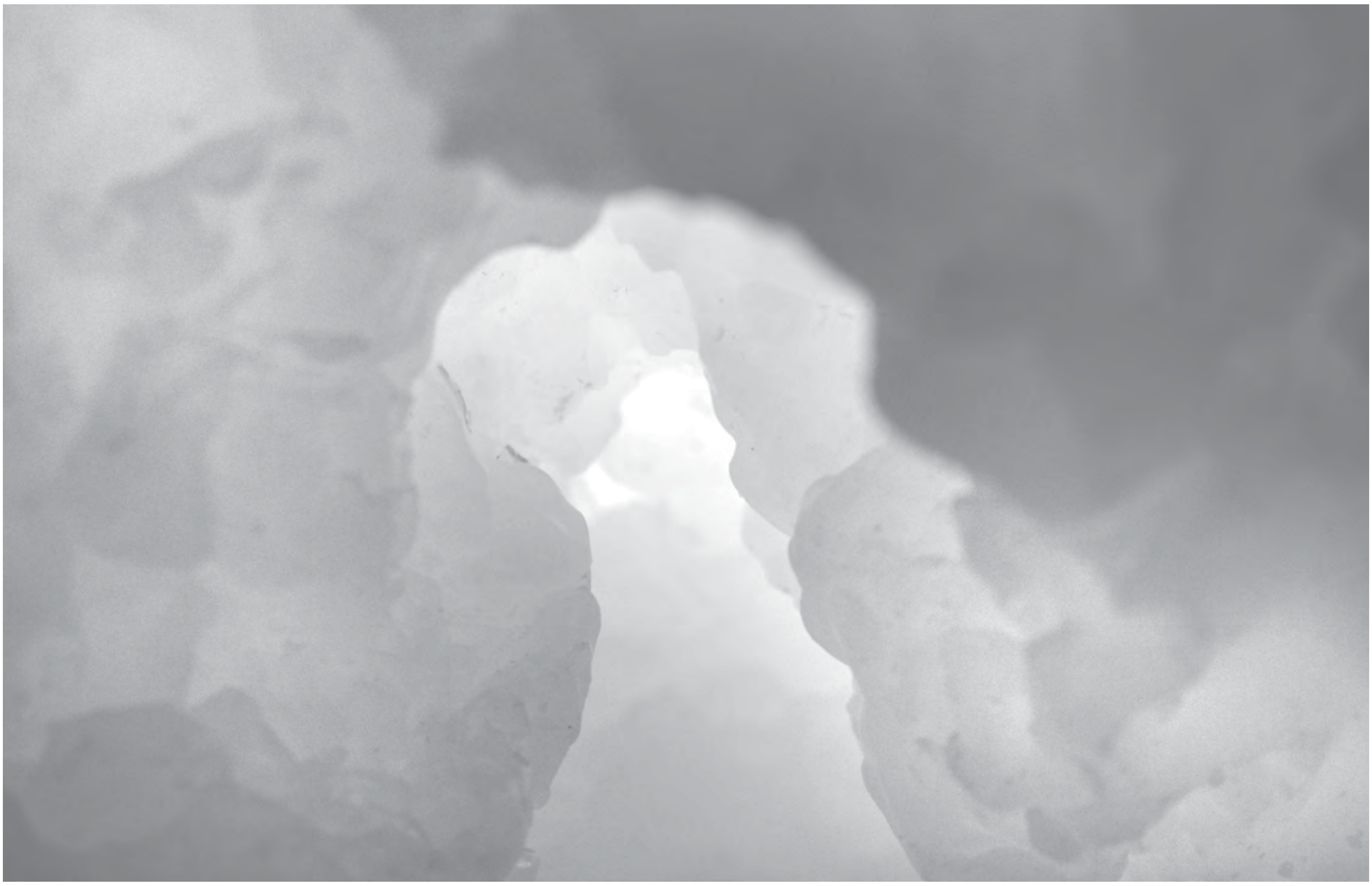


Fig. 106, mold: form + foil | matter: wax

Fig. 107, mold: form + paper | matter: wax + paper

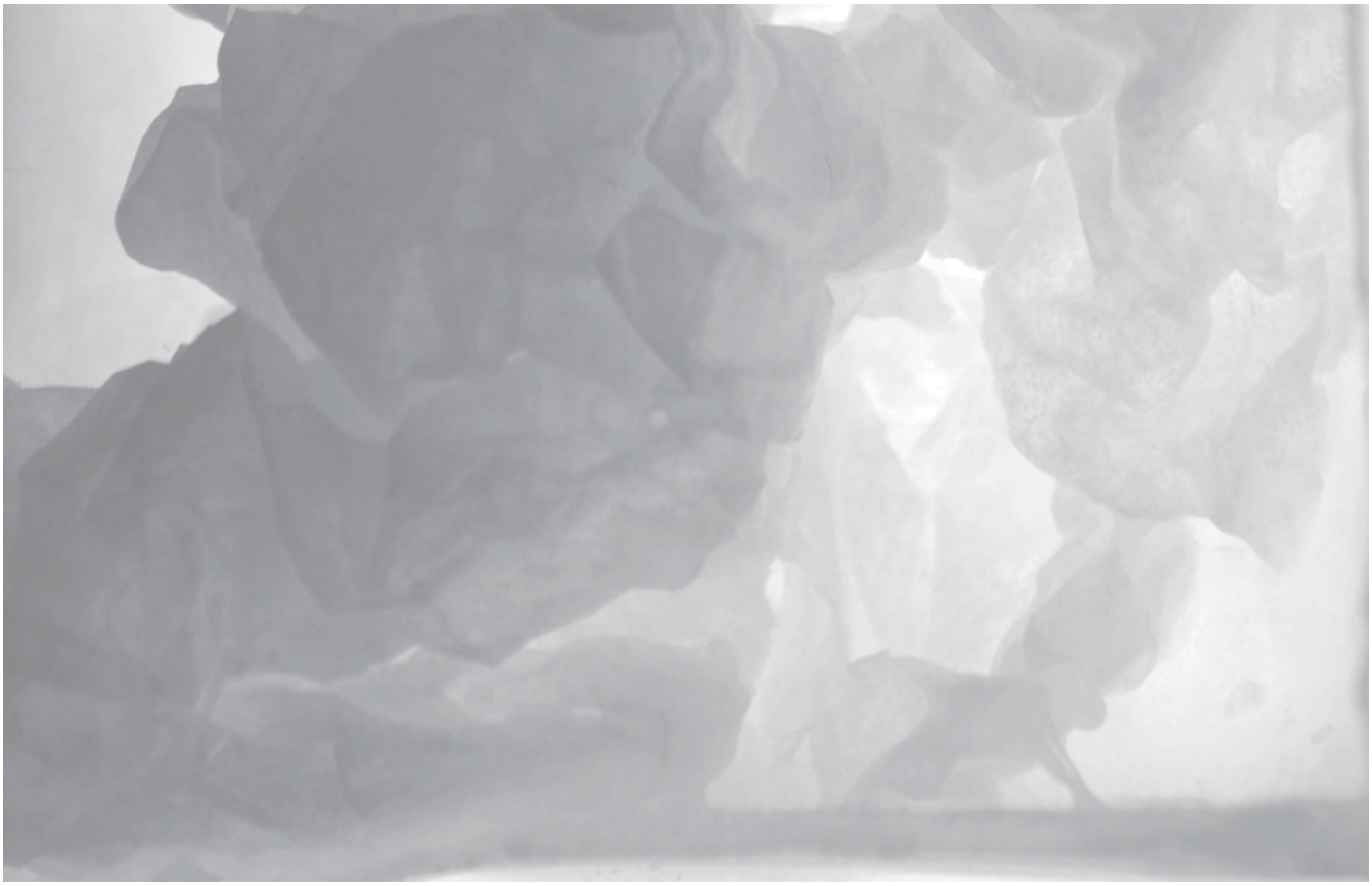


Fig. 108, mold: form + paper | matter: wax + paper

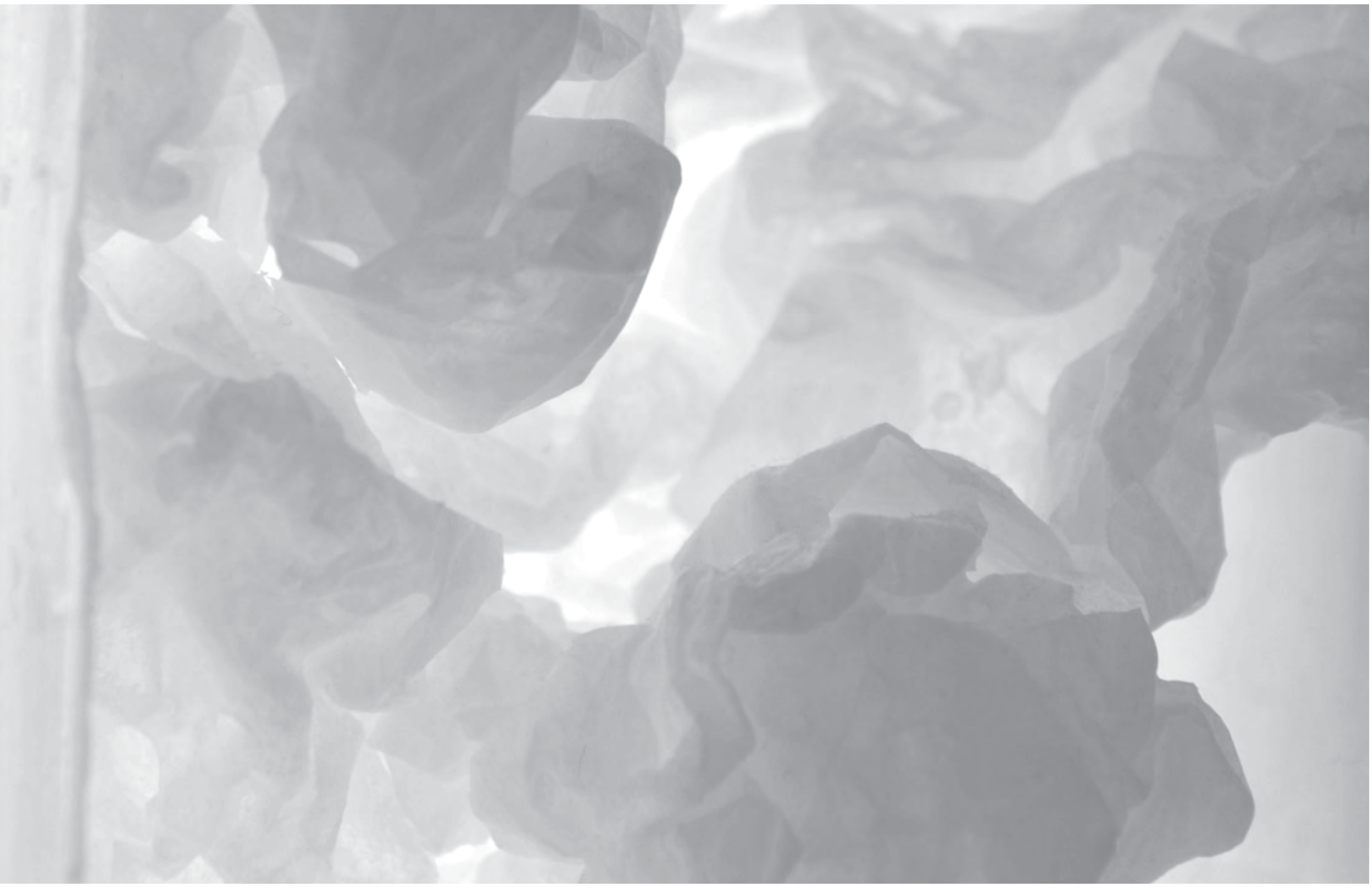


Fig. 109, mold: form + paper | matter: wax + paper

Fig. 110, mold: form + paper | matter: wax + paper


Fig. 111, mold: form + paper | matter: wax + paper


Fig. 112, mold: form + paper | matter: wax + paper

Fig. 113, rationalisation of geological surface: tessellation strategy for surface crumpling. Model: Laser cut polyester triangles on adhesive film

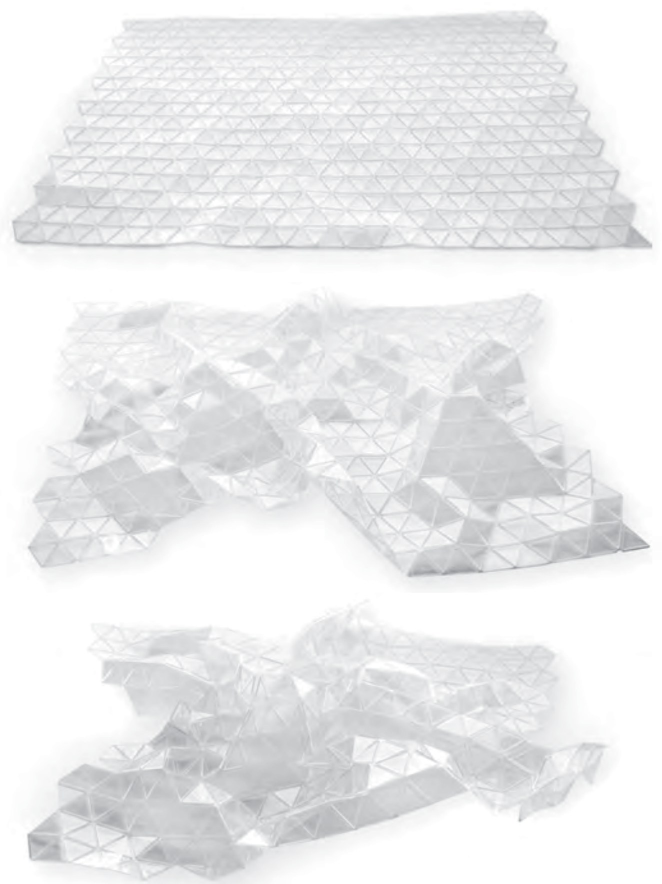


Fig. 114, crumpled surface generation through from flat sheet. Model: Laser cut polyester triangles on adhesive film

SURFACE CRUMPLING

The types of surfaces generated by the most successful casts (fig. 106-101) were rationalized through larger scale models and digital processes. Figures 112-113 are scale models that are made up of pre-cut equilateral triangles that are attached to a fabric or plastic film which can then be manipulated through a series of fixed control points in order to form the surface crumpling effect explicit in the cast models.

INTERRUPTIONS

Additionally, straight edged elements were introduced not only as a means of breaking the monotony of the crumpled surface, but they would also serve various architectural roles such as stair cases, viewing platforms, gallery entrances and windows. Intersections between the crumpled surface and the straight edged elements result in moments of contrast between the two surface typologies – creating a relationship between geology and architecture (fig. 115-119).

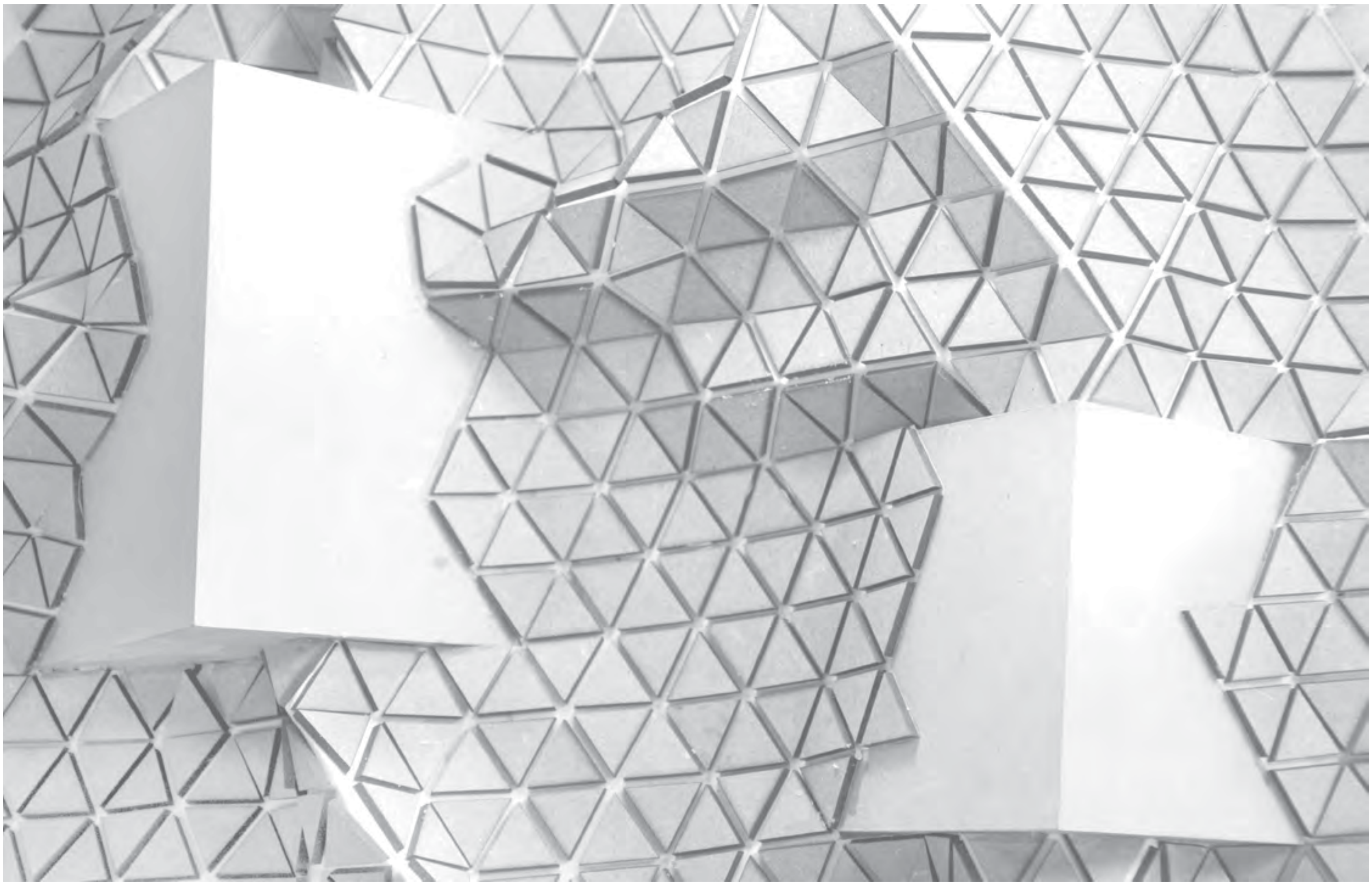


Fig. 115, introduction of interruptions in the crumpled surface that will serve architectural roles (windows, viewing platforms, lobbies, etc...)

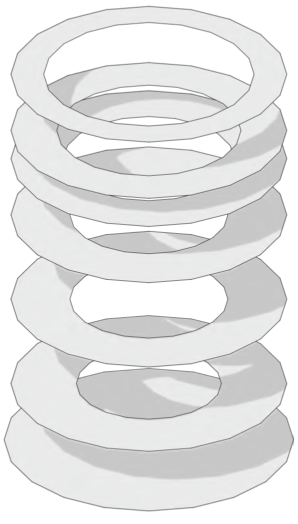
Fig. 116, final design iteration combining the surface and strait edge elements. Model: 3D print in polyamide 2200 and transparent acrylic

Fig. 117, final design iteration combining the surface and strait edge elements. Model: 3D print in polyamide 2200 and transparent acrylic

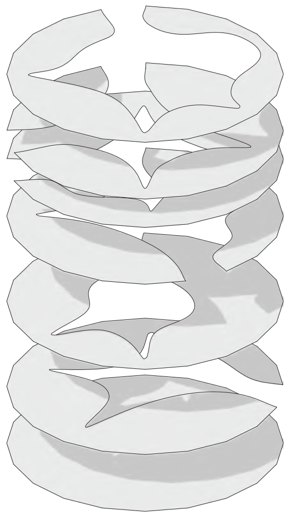
Fig. 118, final design iteration combining the surface and strait edge elements. Model: 3D print in polyamide 2200 and transparent acrylic

Fig. 119, final design iteration combining the surface and strait edge elements. Model: 3D print in polyamide 2200 and transparent acrylic

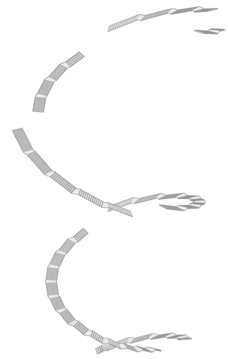
SPATIAL STRATEGIES



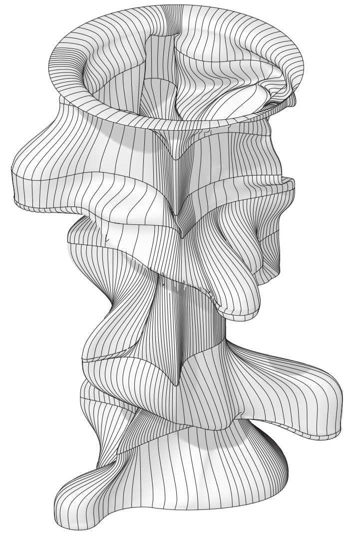
Floor plates according to program area and volume requirements



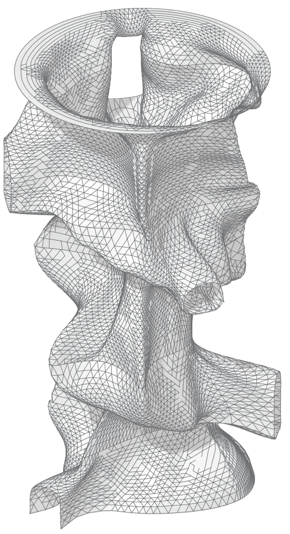
Subdivision of gallery spaces



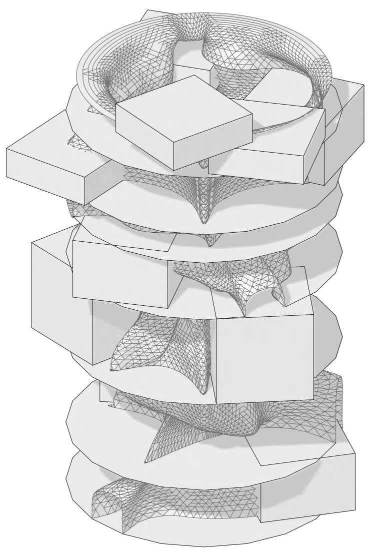
Vertical communication (atrium)



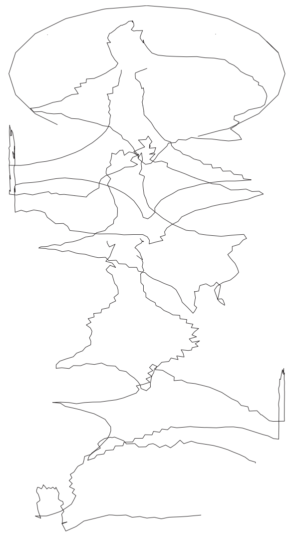
Atrium void surface based on floor plates and vertical communication



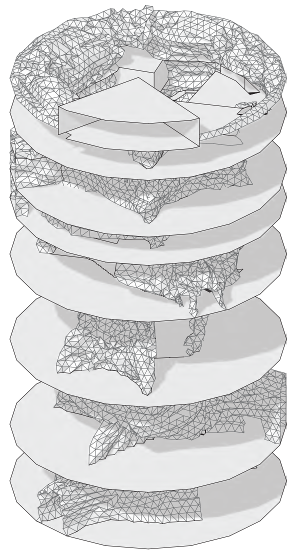
Triangular paneling of atrium void surface



Introduction of view cubes and lobby areas



Constrained areas for surface crumpling: Meetings with floor plates



Resulting crumpled surface, floor plates and view cubes/ lobby areas

Fig. 120, spatial organisation of atrium, gallery areas, gallery entrances, vertical communication, viewing platforms, atrium windows and lobbies

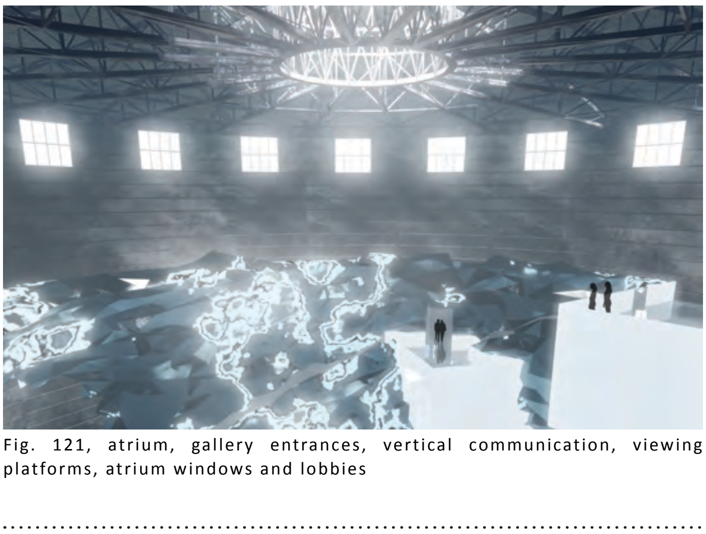


Fig. 121, atrium, gallery entrances, vertical communication, viewing platforms, atrium windows and lobbies

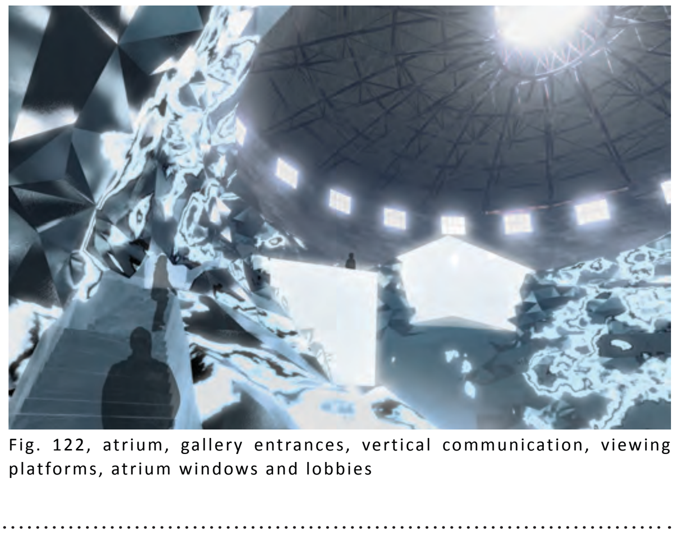
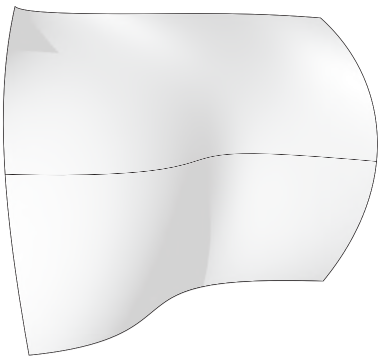
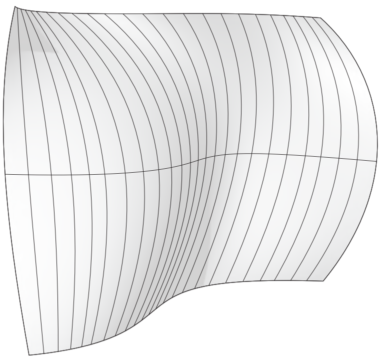


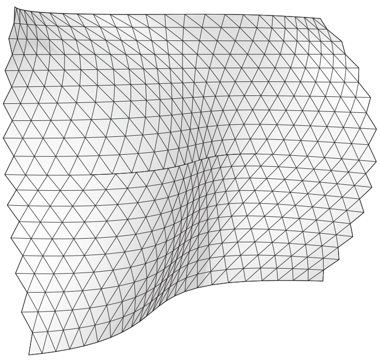
Fig. 122, atrium, gallery entrances, vertical communication, viewing platforms, atrium windows and lobbies



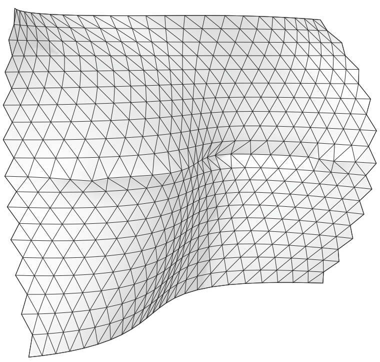
Initial Rhino surfaces. Diagram shows an area where two floors (two separate surfaces) meet each other



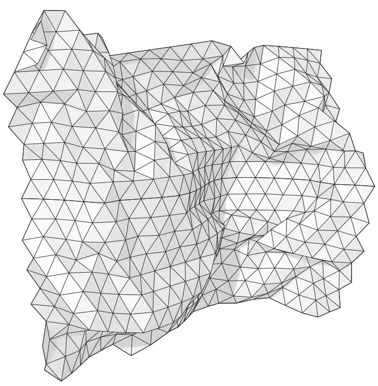
Rebuilt surface through extraction of iso-curves at predetermined densities. Density effects the amount of crumpling



Triangular paneling of rebuilt surface. Panel density is linked to surface iso-curve density



Constraint adjustment at meeting point between floors. Vertex repositioning based on eventual triangle edge length



Crumpling of surface based on panel equilateralisation using Kangaroo Physics. Force objects include gravity, springs and hinge angles. Anchor points are based on the meeting between floors

Fig. 123, step by step digital crumpling process

DIGITAL STRATEGIES

Using the Kangaroo Physics plug-in in Rhino's Grasshopper, an input surface was first subdivided into a triangulated mesh, then anchor points were selected at strategic locations, after which equilateral triangulation was applied in order to achieve the crumpled surface (fig. 120 and 123-125).

The concentration of the initial mesh subdivision pre-determines the amount of crumple. Using this logic, areas requiring more ambient light have been given more crumpling of the surface creating larger surface areas for bacterial growth. Furthermore, the global geometry of the crumpled surface was also used to subdivide the interior spaces, creating smaller pockets of space with appropriate dimensions for gallery spaces (see plans fig. 140-147).

Fig. 124, surface triangulation and anchor point selection in grasshopper

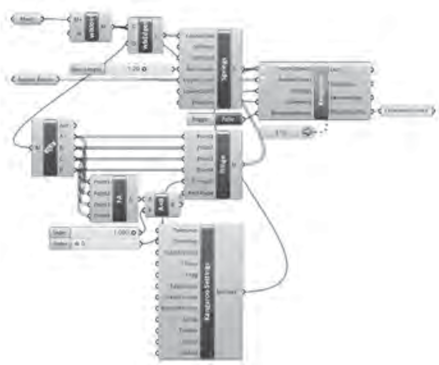


Fig. 125, triangle equalateralisation through the Kangaroo Springs and Hinge forces

PERFORMATIVE LAYERS

The surface is made up of several layers which perform in different ways. The outer walls are epidermic layers that keep the system closed and protect the bacteria from contamination. The structural lattice forms and holds together the geometry. The vascular pipe system distributes the nutrients to the bacteria. The textile acts as a substrate for the bacteria to latch onto (fig. 126-127).

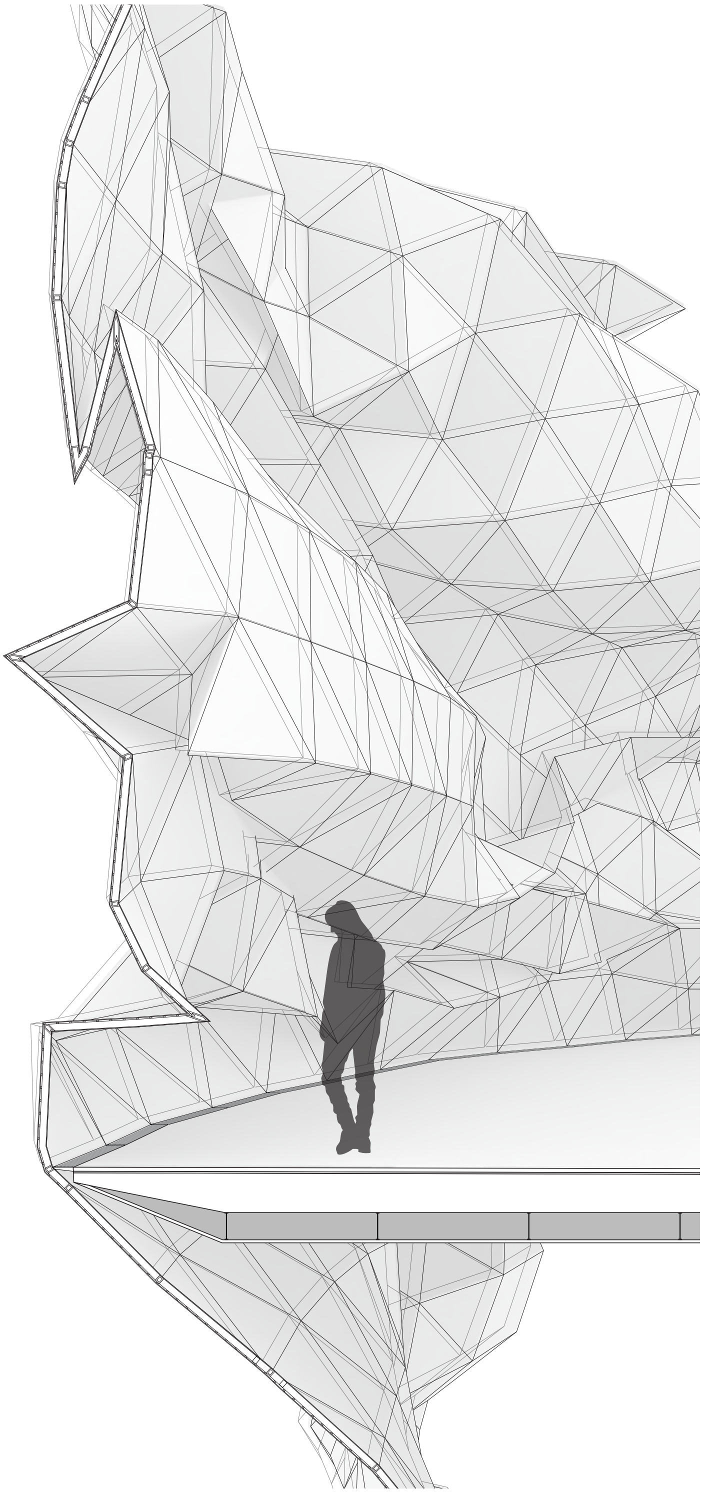


Fig. 126, section through layered surface

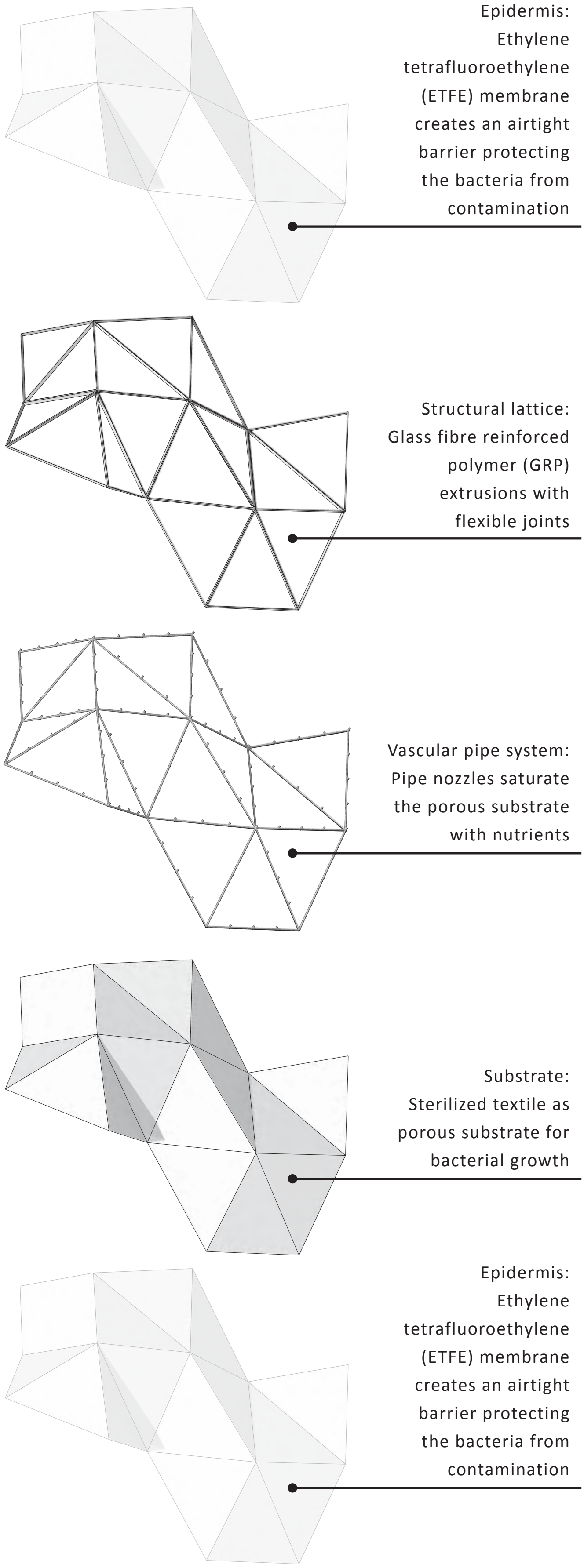


Fig. 127, surface performative layers

NUTRIENT DISTRIBUTION SYSTEM

Nutrients are produced and pumped from a tank on the lowest floor to a storage tank on the uppermost region of the system. From here the nutrient solution can flow through the vascular pipe distribution system through gravity feed and pipe nozzles from the vascular pipe system feed the bacteria (fig. 128)

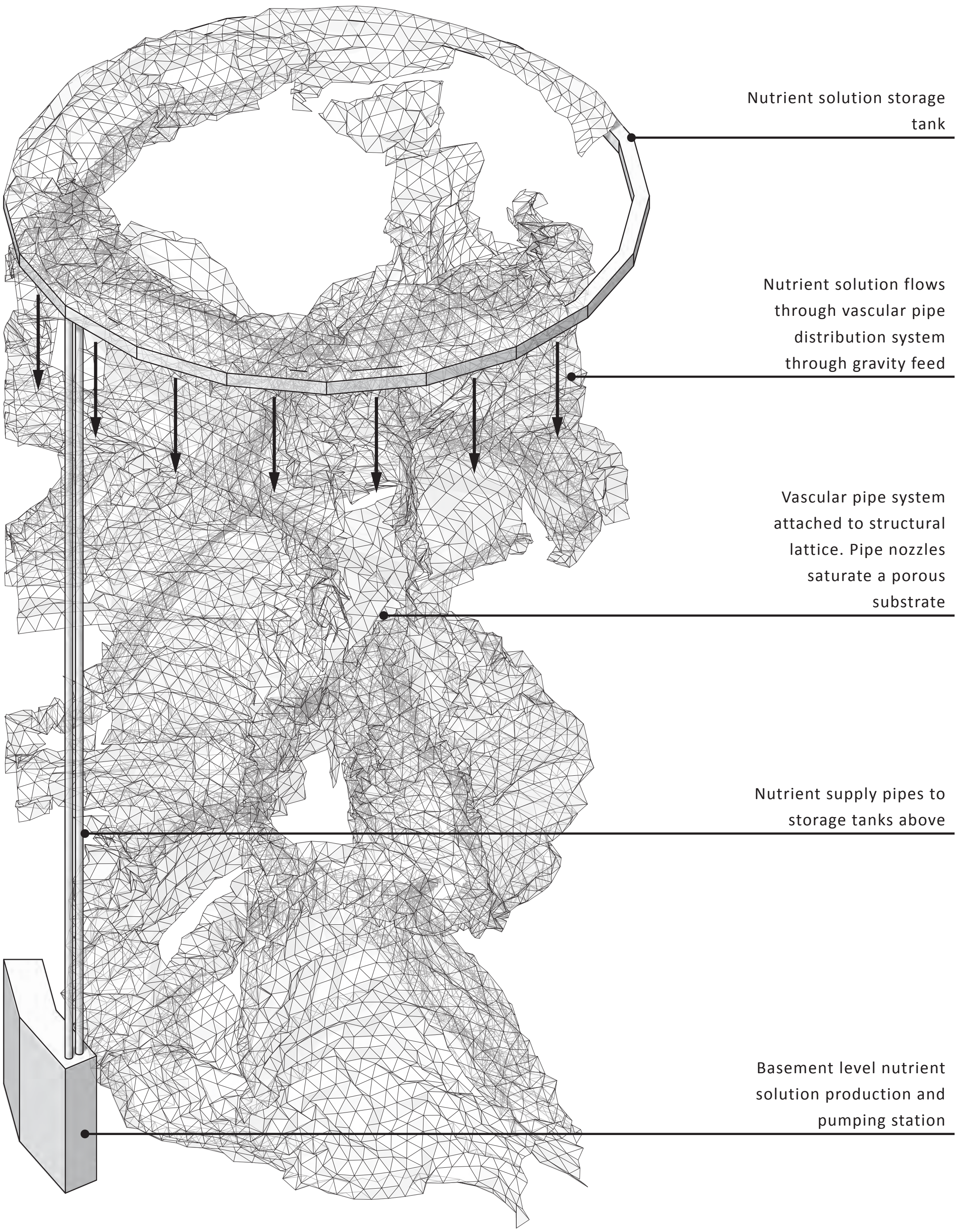


Fig. 128, nutrient distribution system

THE FLUID LANDSCAPE

Exterior design elements have been generated using fluid dynamics which as an architectural anecdote to the building’s former use. The exterior of the existing structure will remain seemingly untouched. A system of one way viewing perforations are incorporated into façade where visibility in or out will depend on the time of day (fig. 131-134). Daylight hours will allow gallery visitors to see out whereas the nighttime hours will vaguely reveal the overall geometry made by the perforations.

The landscaping which forms the new subterranean entrance and the new embankment across the road is the effect of a positive fluid geometry being subtracted from the ground (fig. 129-131).

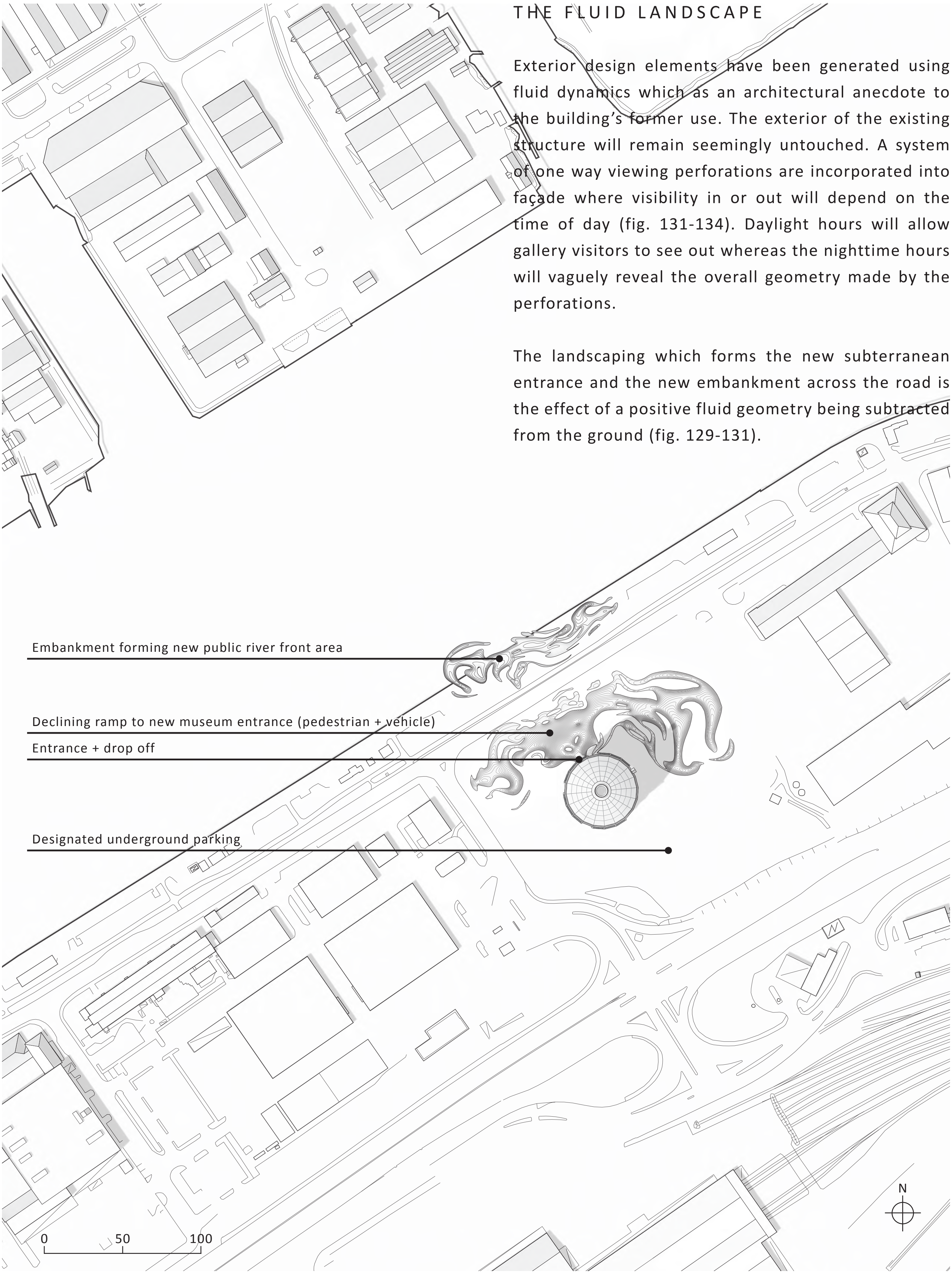


Fig. 129, situation plan

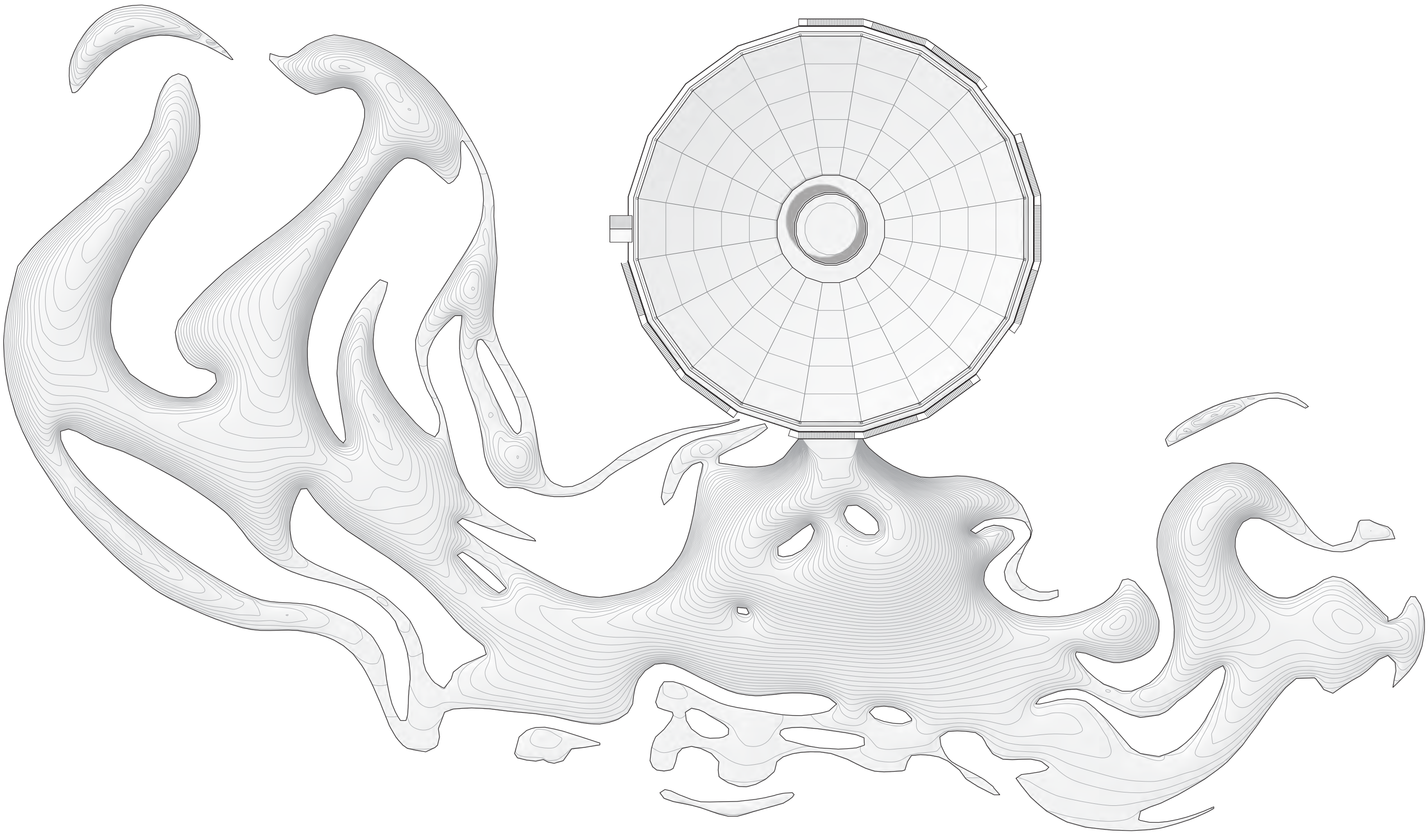


Fig. 130, plan of fluid landscape

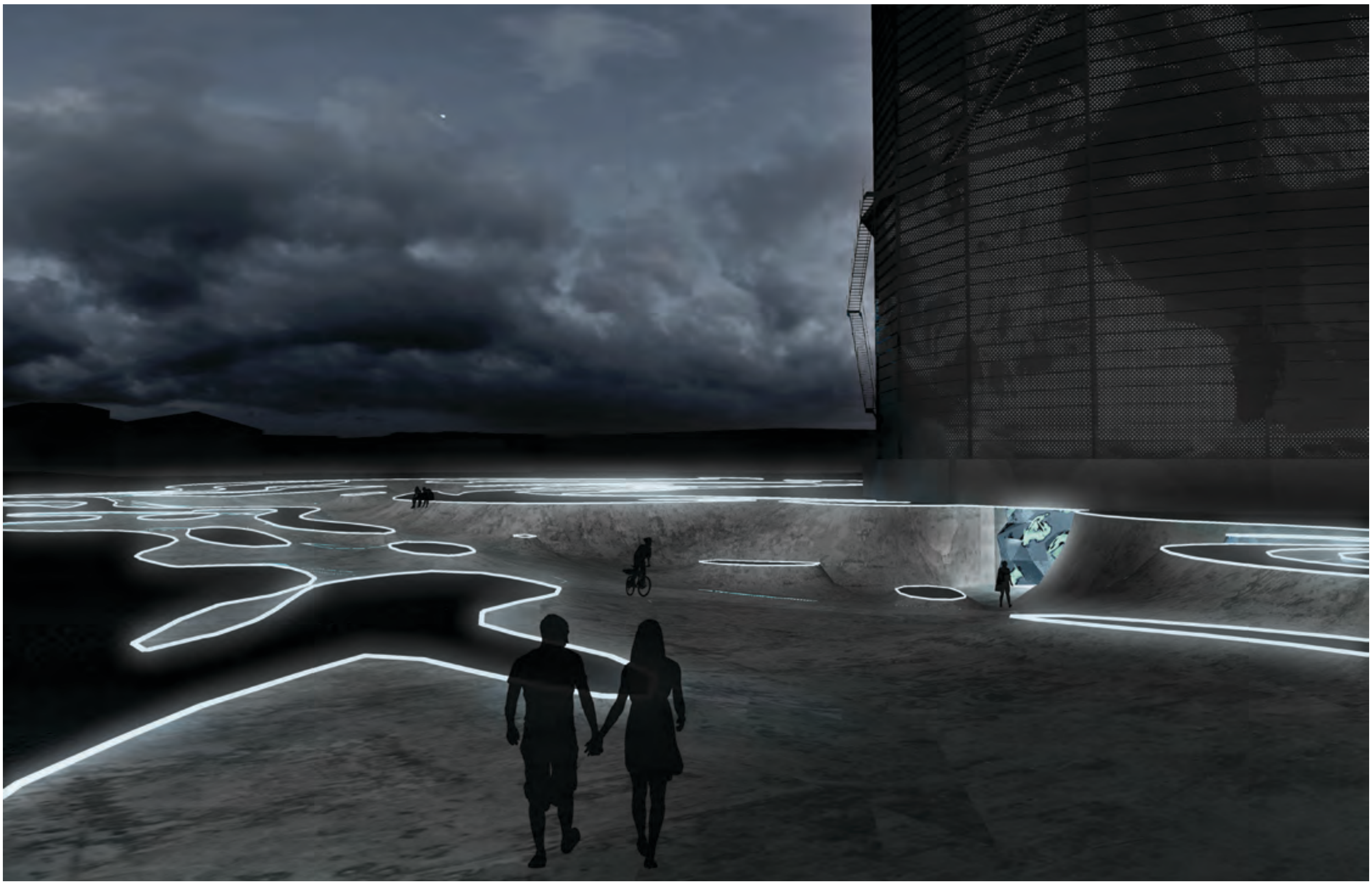


Fig. 131, declining ramp, new subterranean museum entrance through
fluid landscape and existing facade perforation

ONE WAY VIEWING PERFORATIONS

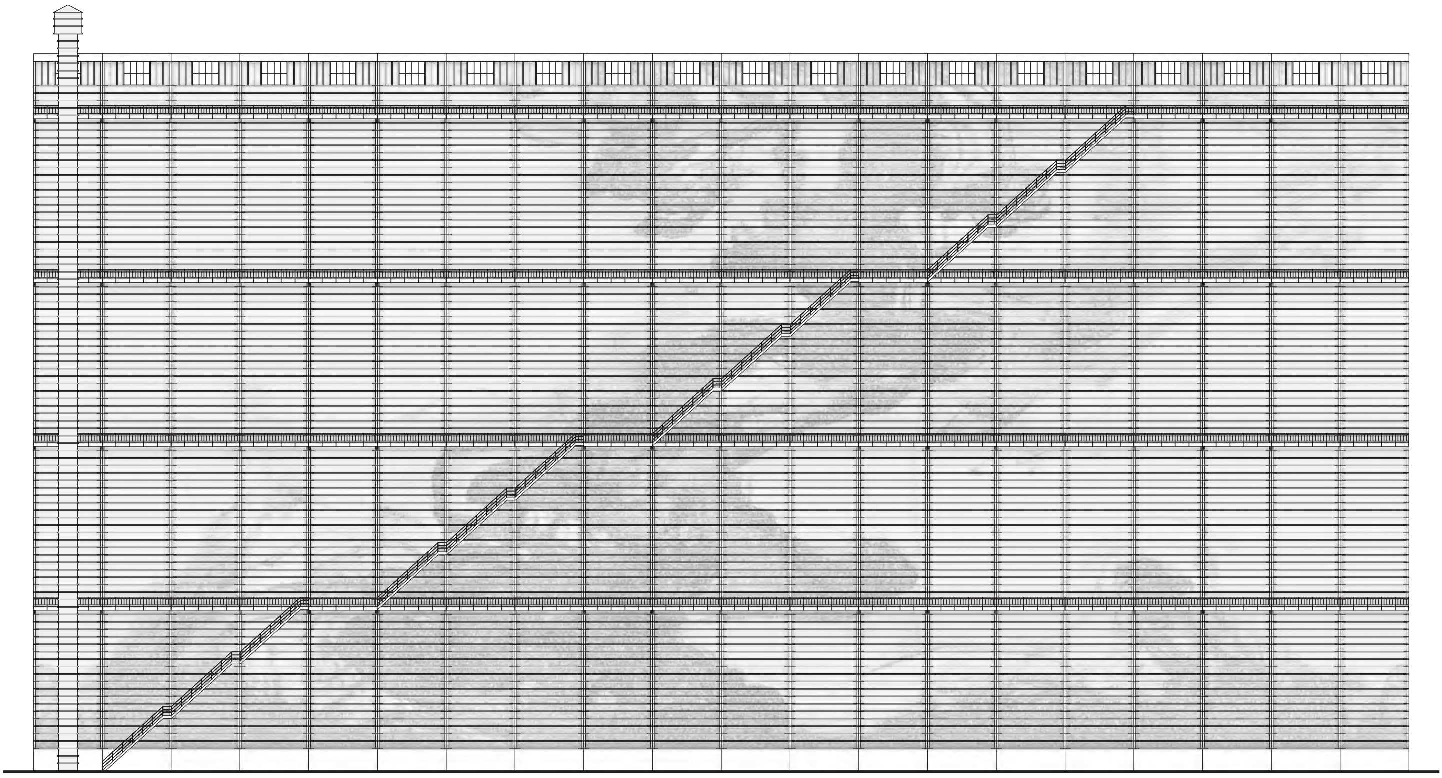


Fig. 132, perforation pattern on unrolled facade 1:800

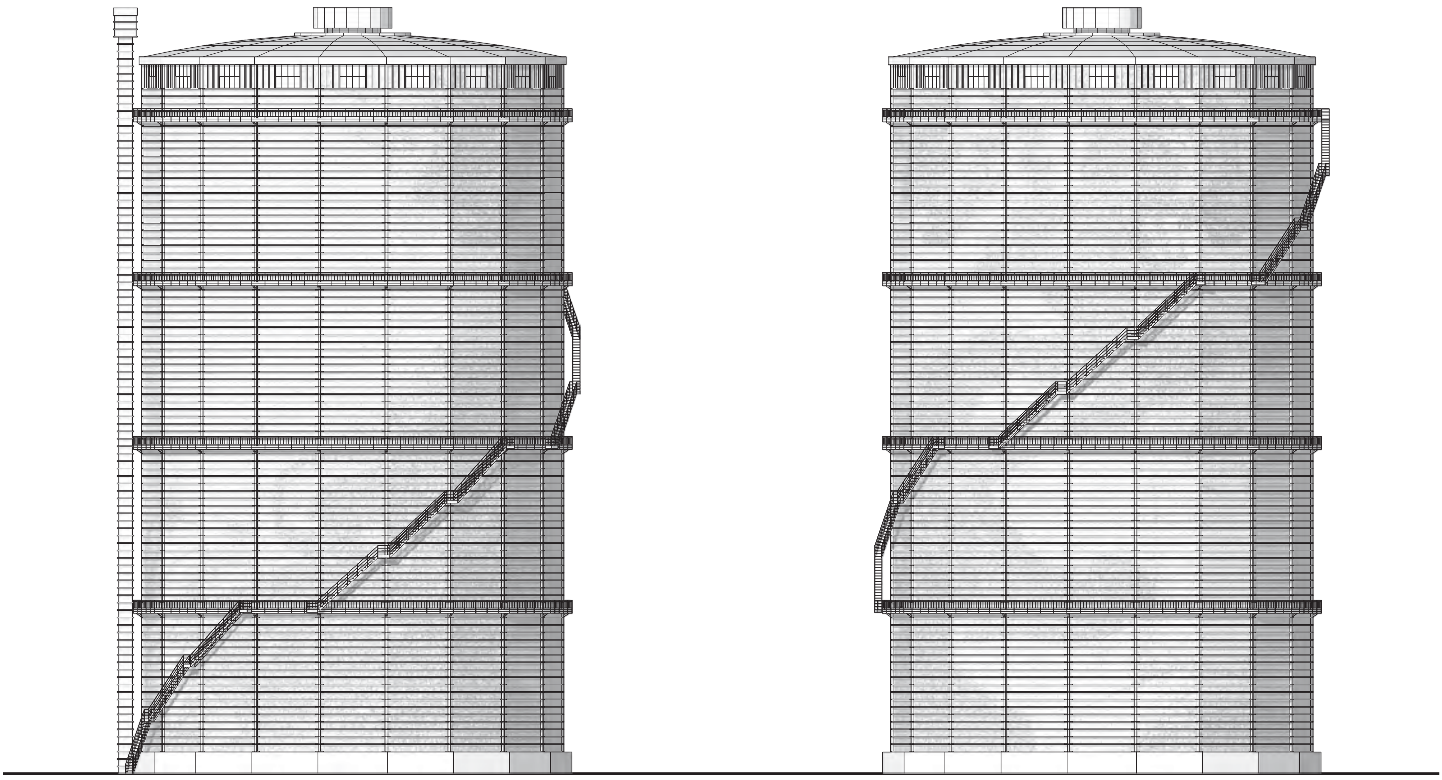


Fig. 133, elevations 1:800

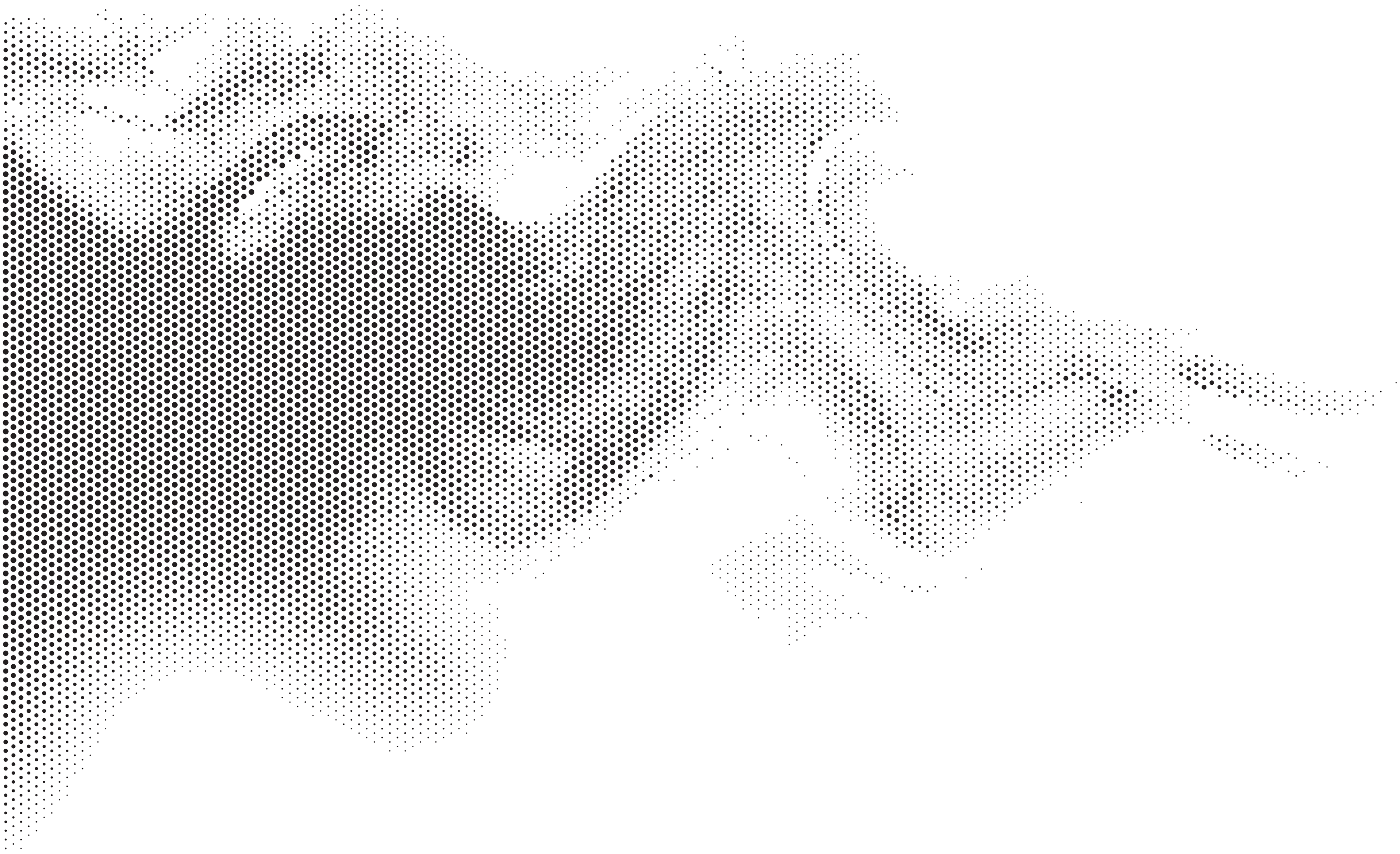
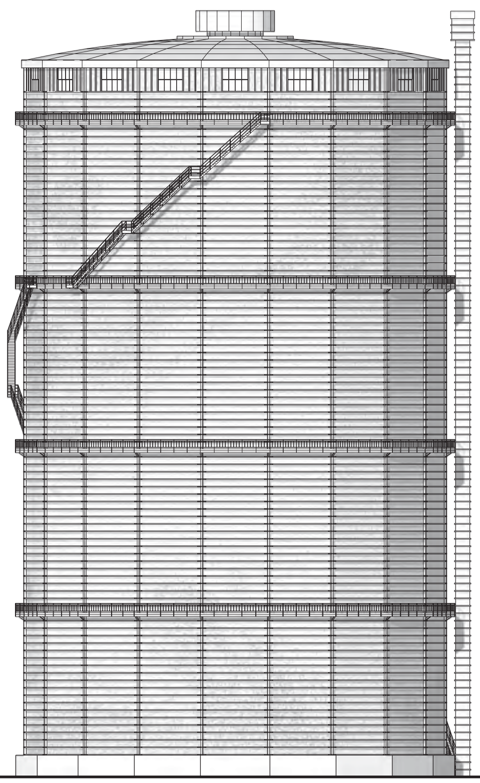
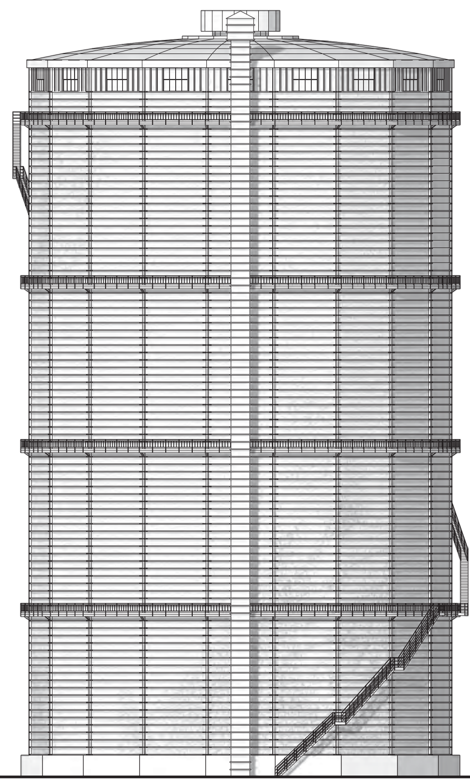


Fig. 134, detail of perforation pattern 1:2

Back



Left



CONTENT

This museum of industrial history and technological advancement will showcase the rise and fall of industrialism told from interrelated perspectives: Energy, transportation, the factory, materials, communication and technology.

- Gallery 1: The History of Energy
  Coal and steam | Oil | Electric power | Nuclear energy | Renewable energy
- Gallery 2: Vehicles & Transportation
  Boats | Cars | Bicycles | Flight | Motorcycles | Roads | Traffic
- Gallery 3: The History of the Factory
  Inside a factory | The assembly line | Industrial heritage | Historical time-line of technology
- Gallery 4: The History of Materials
  Metal | Plastics | Textiles | Building and construction
- Gallery 5: Communication & Technology
  Photo and film | Recording sound | Paper and printing | Radio and television | The telegraph and telephone | The computer | Household machines
- Gallery 6: Current Research
  Temporary exhibitions concerning current technological developments
- Library / Archive
  Books and journals | Documents and photographs that describe how industry and technology, particularly in Sweden, have evolved through time
- 4D cinema / conference area / lecture theatre
- Administration office
- Café / restaurant
- Storage

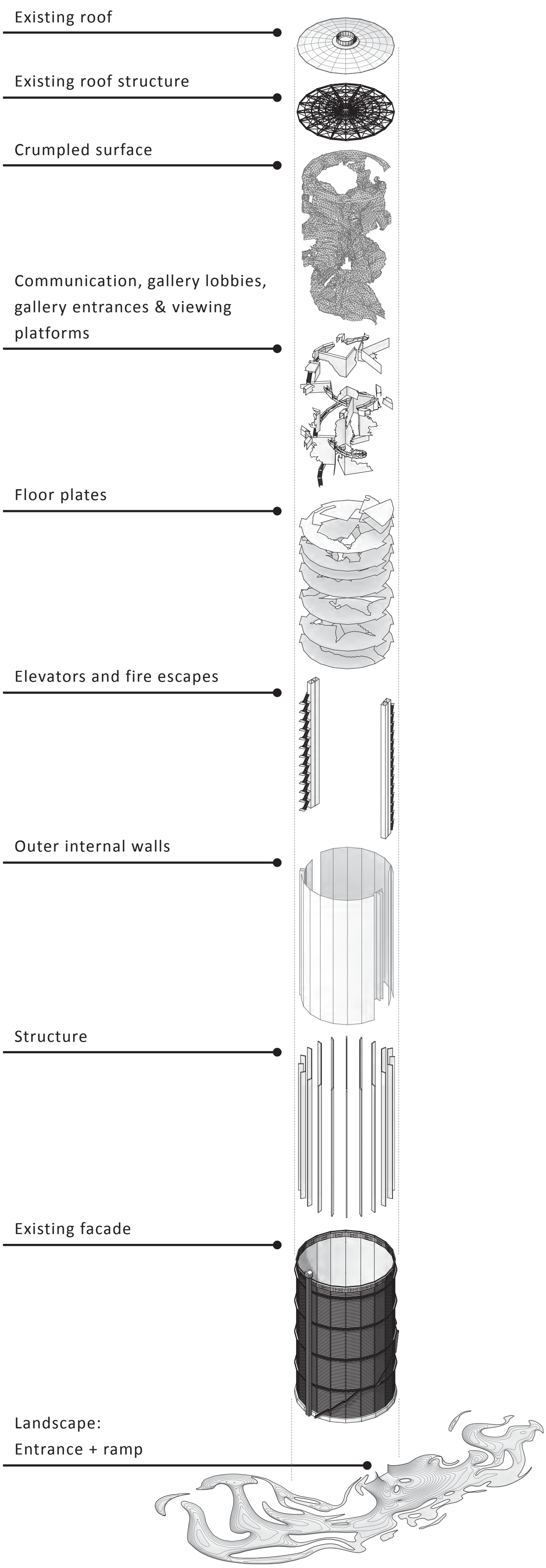


Fig. 135, building parts

SPATIAL ORGANISATION

Visitors enter into the atrium space on the lower ground floor from which they can either enter a reception area which leads to the museum shop or the elevators taking them to the galleries. Alternatively, visits can choose to use the atrium stair case to travel through the museum. Galleries containing larger objects are on the lower levels, whilst galleries containing smaller objects are on the upper floors

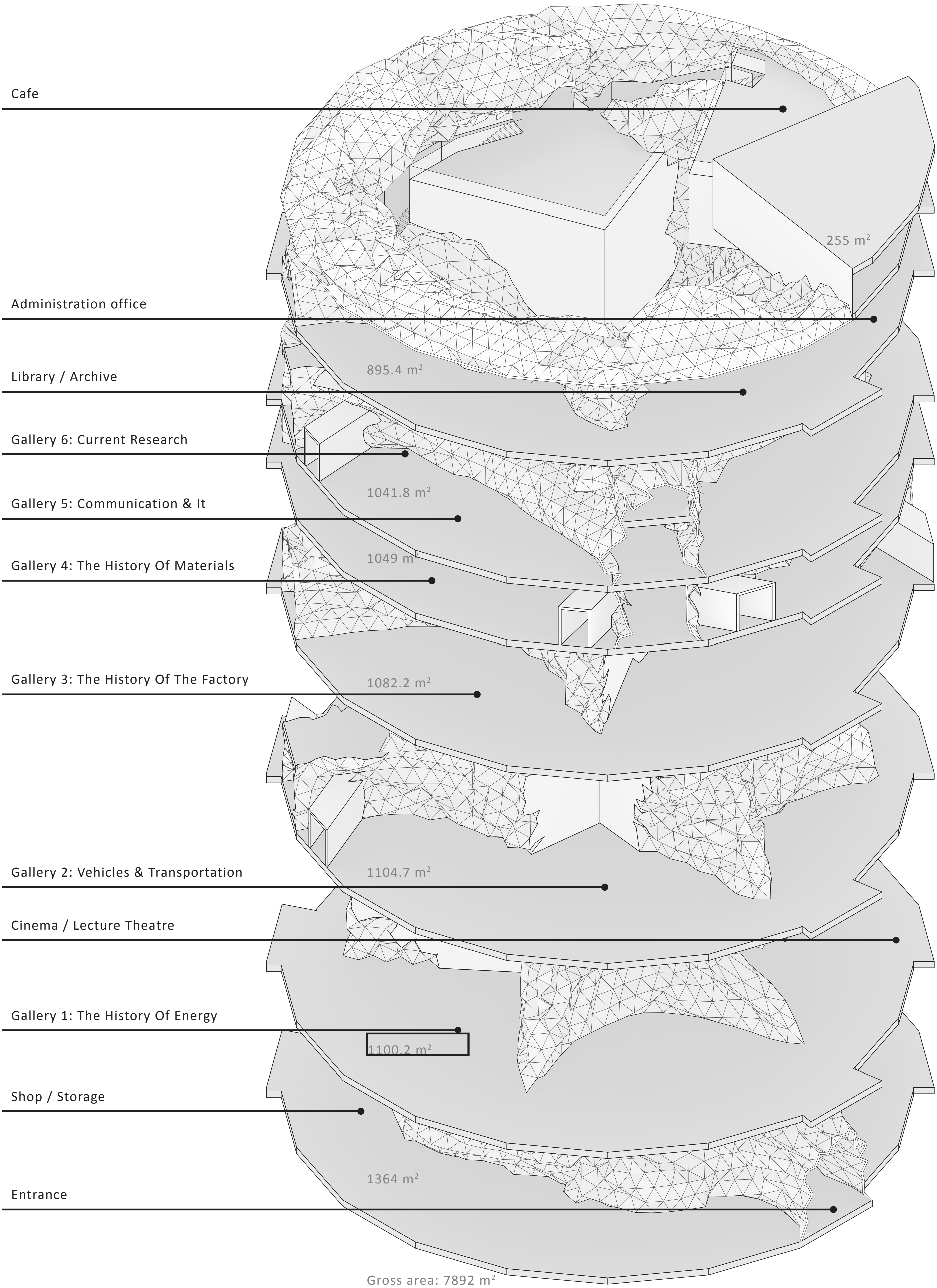


Fig. 136, programmatic configuration

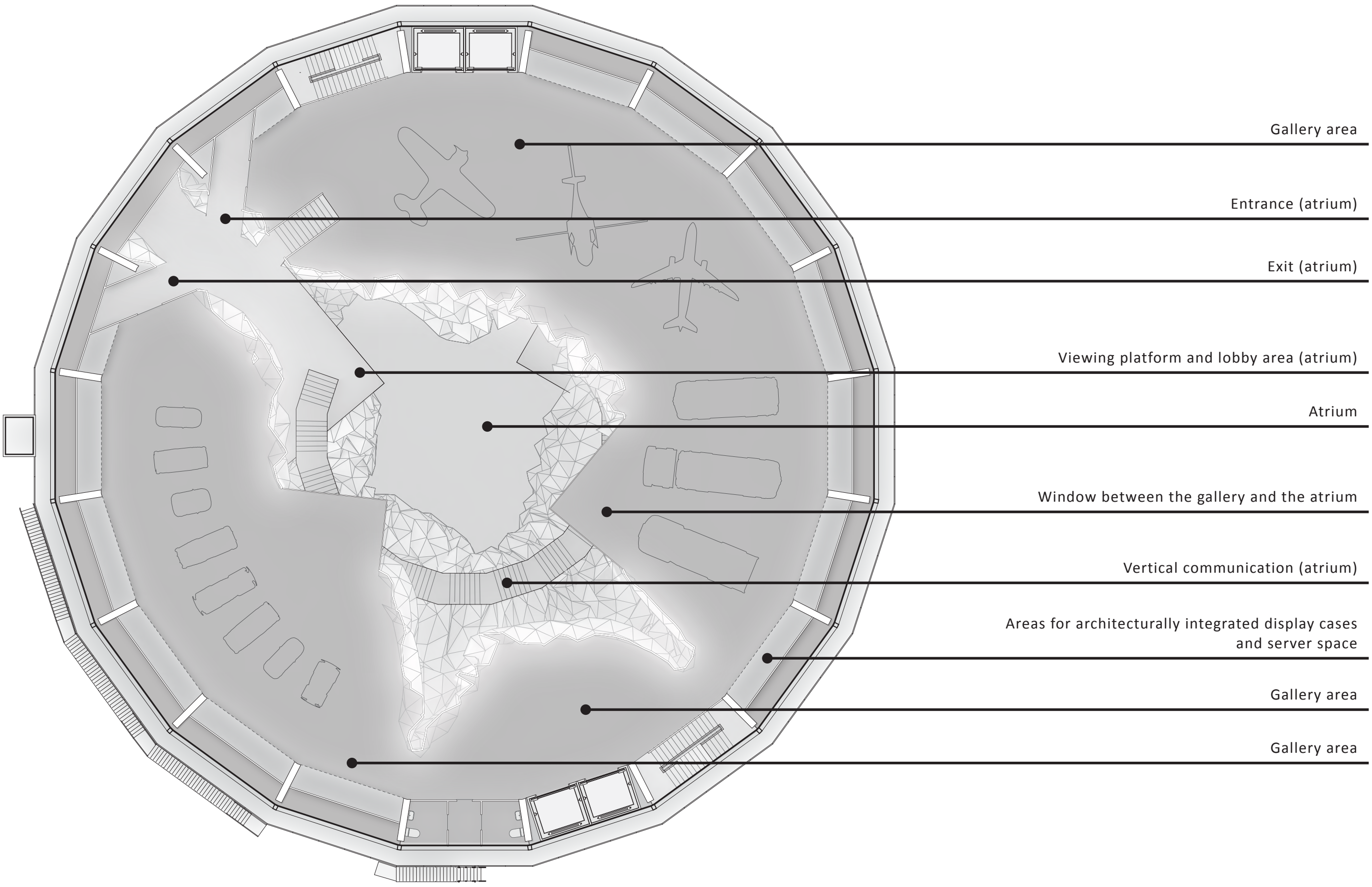


Fig. 137, sample gallery layout

Fig. 138, illuminated gallery area with the bacteria as ambient lighting and spotlights lighting museum objects

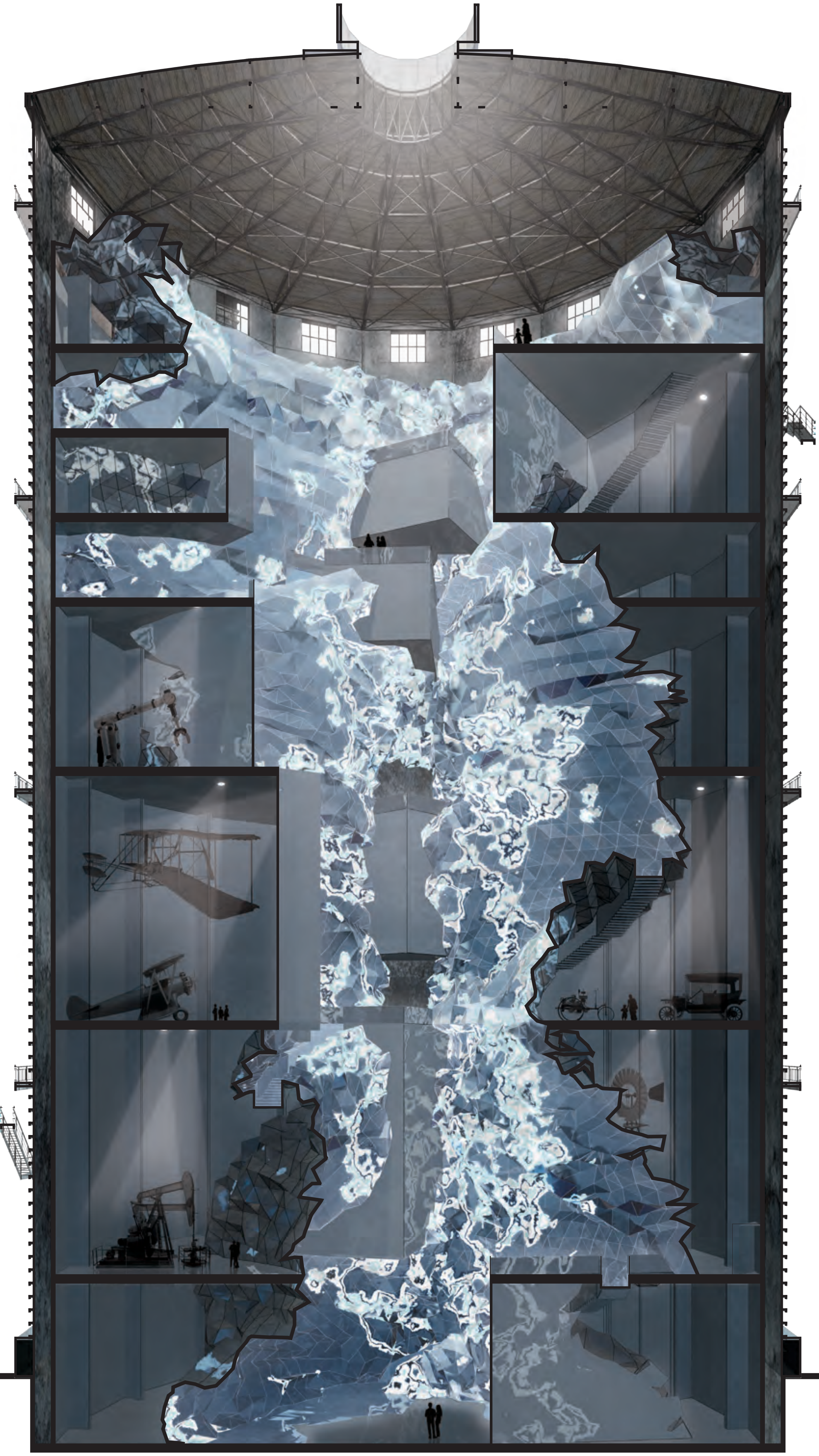


Fig. 139, atrium and gallery spaces

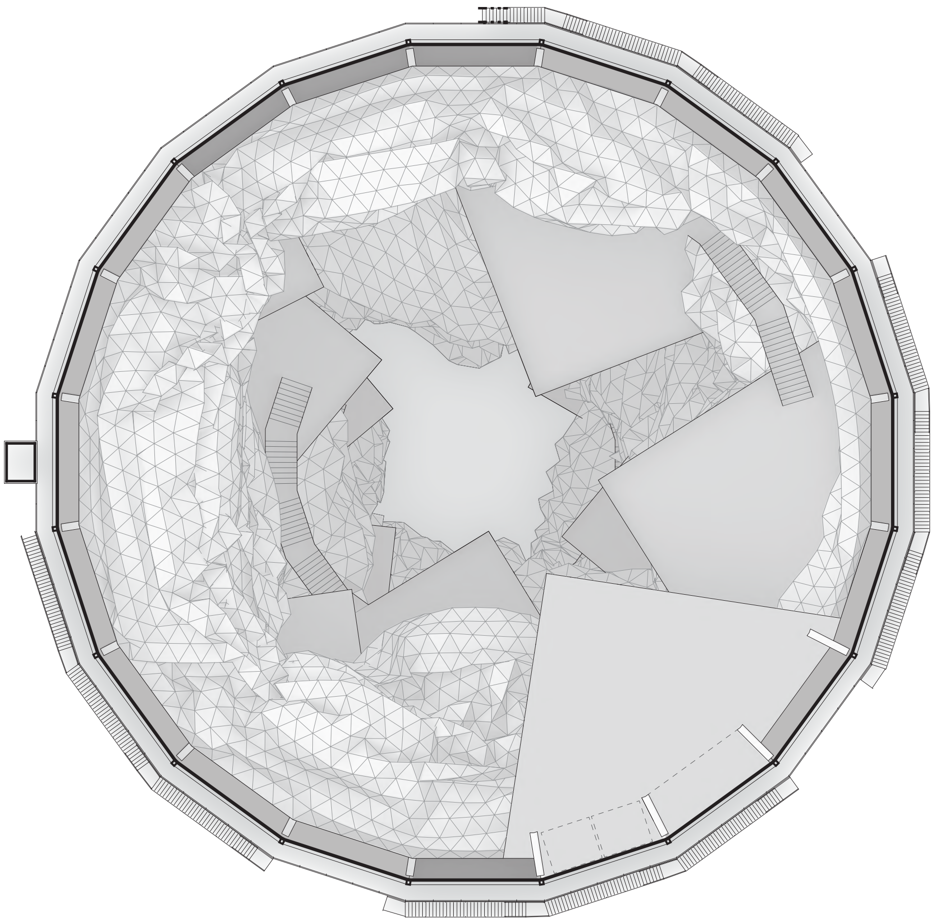


Fig. 140, level 7 1:400

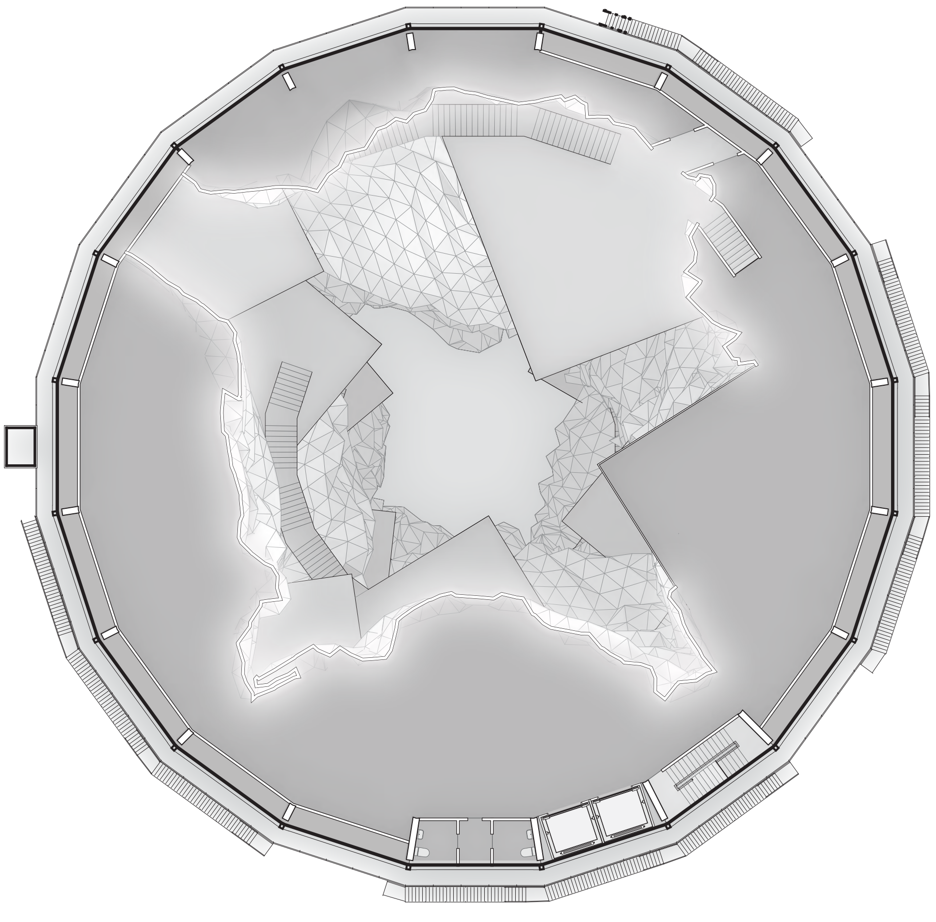


Fig. 141, level 6 1:400

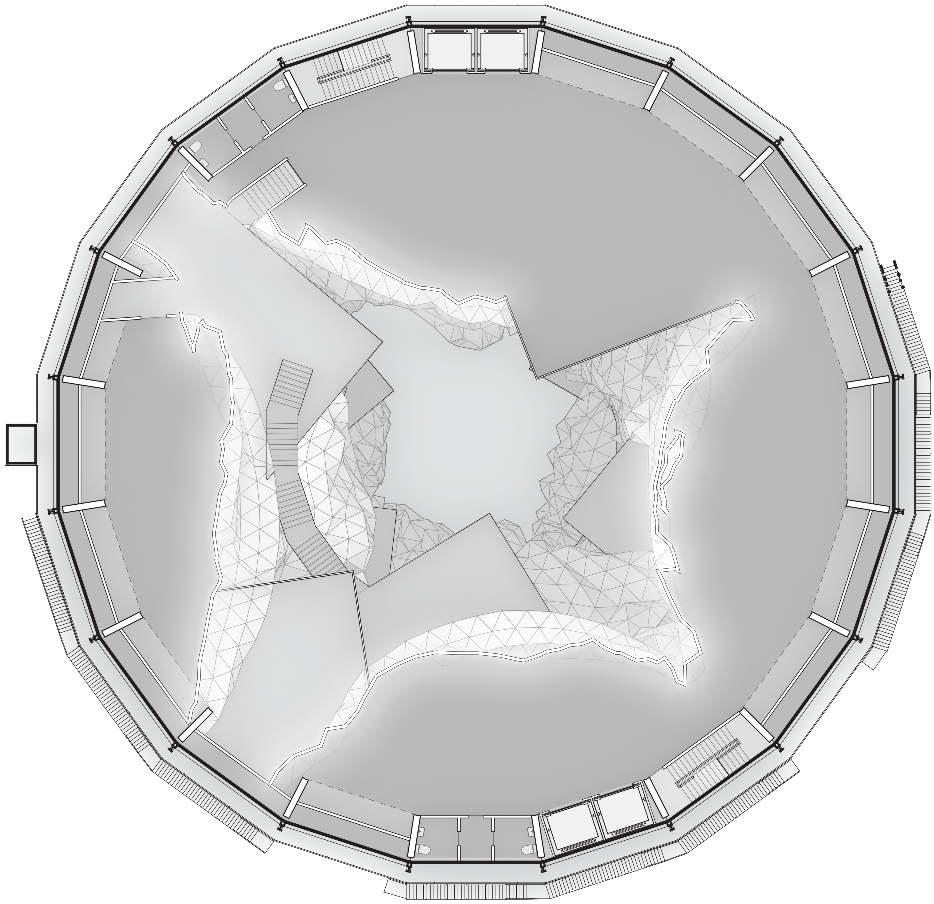


Fig. 142, level 5 1:400

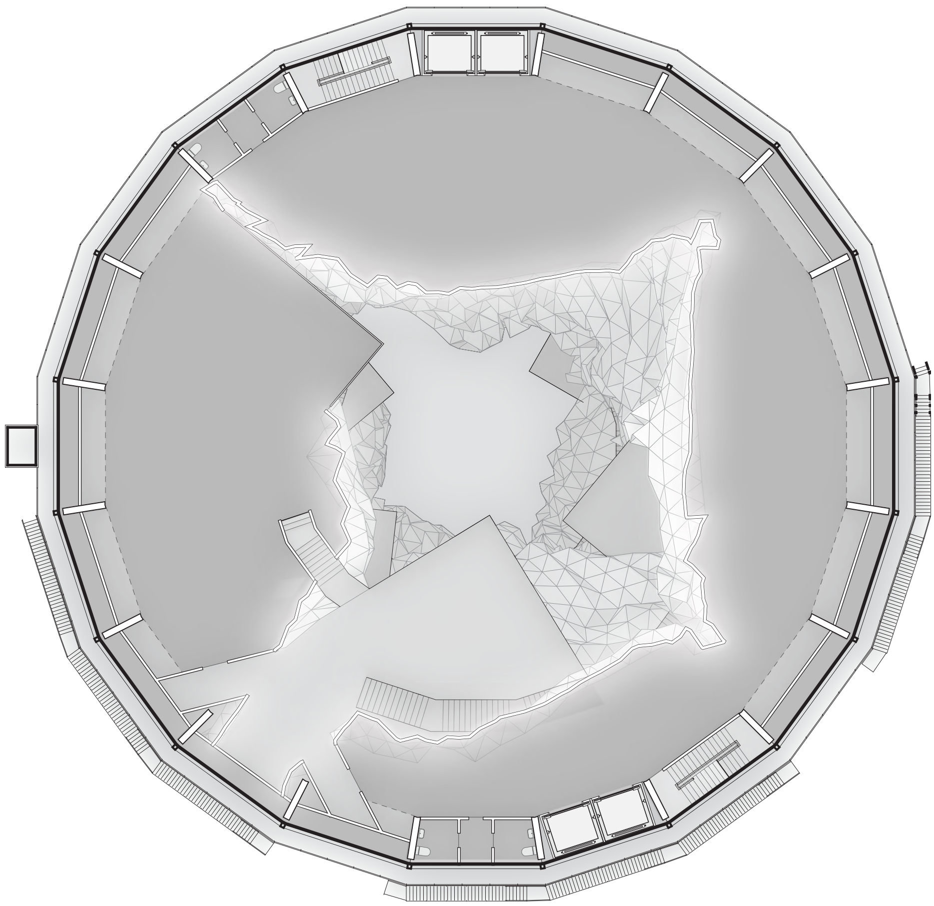


Fig. 143, level 4 1:400

Fig. 144, level 3 1:400

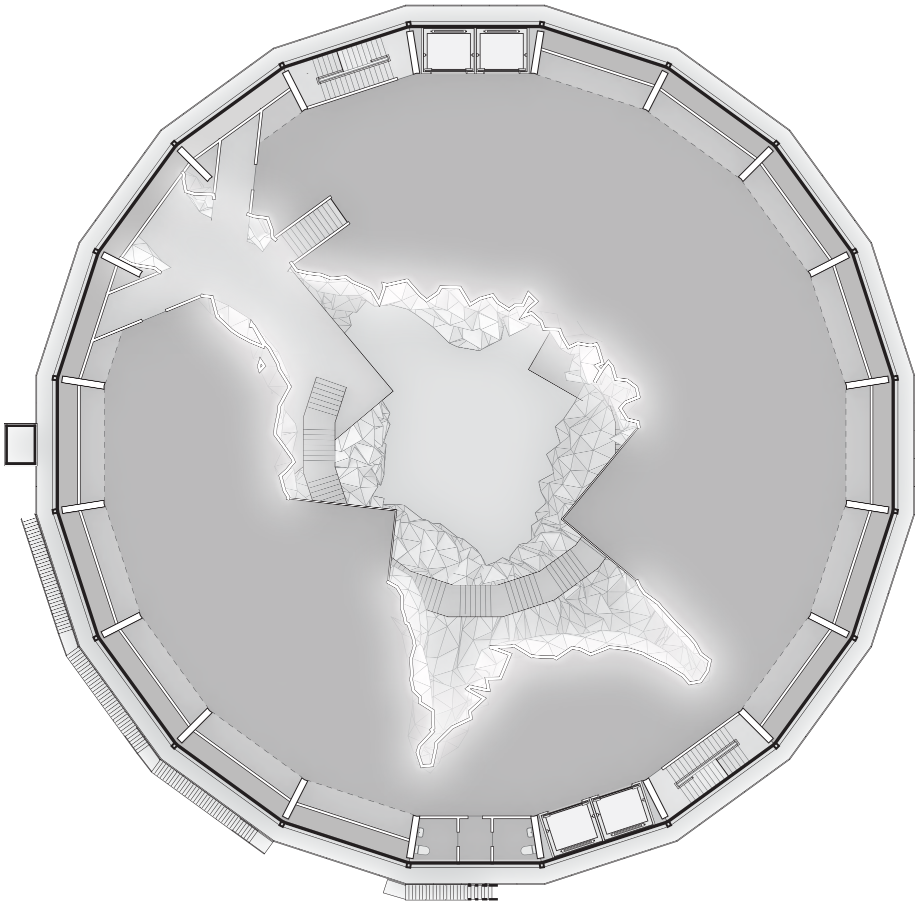


Fig. 145, level 2 1:400

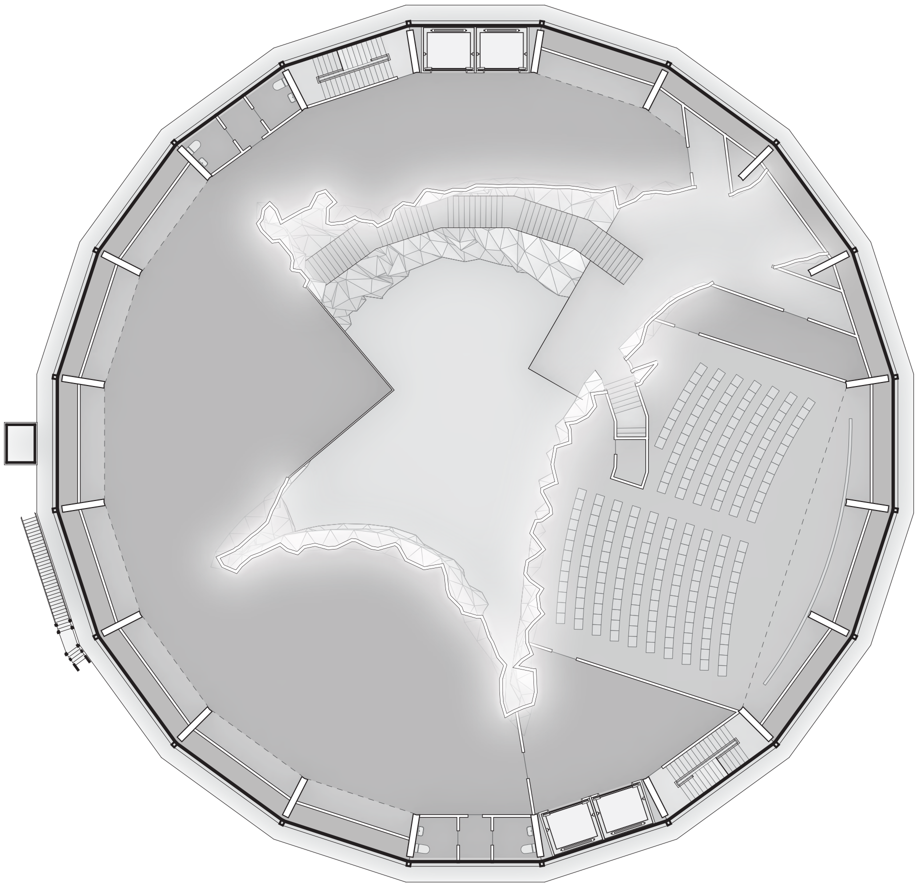
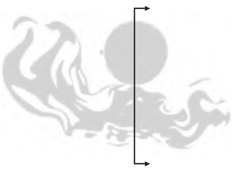


Fig. 146, level 1 1:400

Fig. 147, level 0 1:400



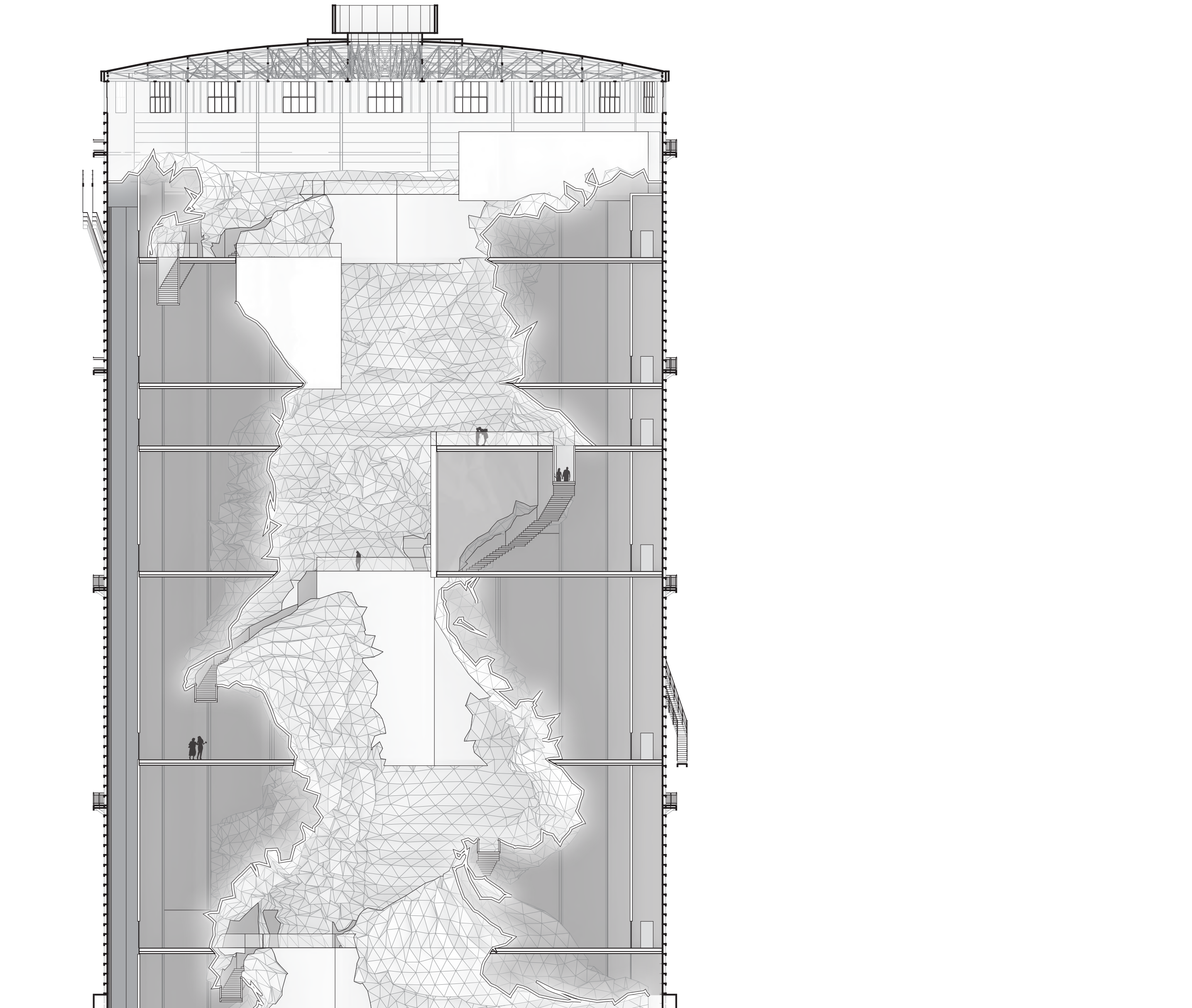
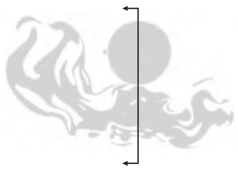


Fig. 148, section 1:500



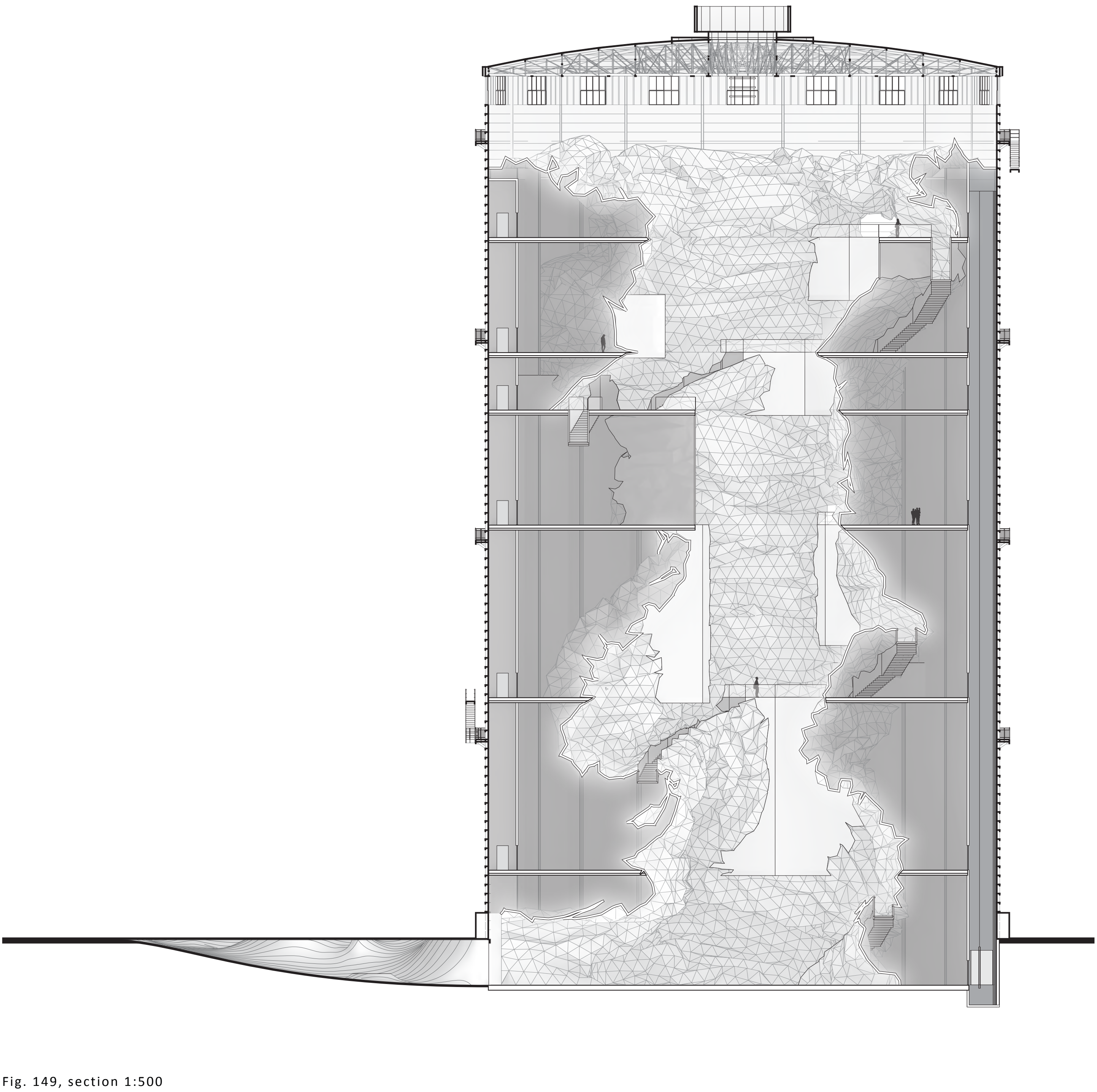
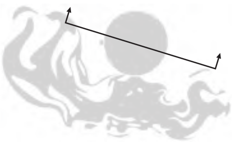


Fig. 149, section 1:500



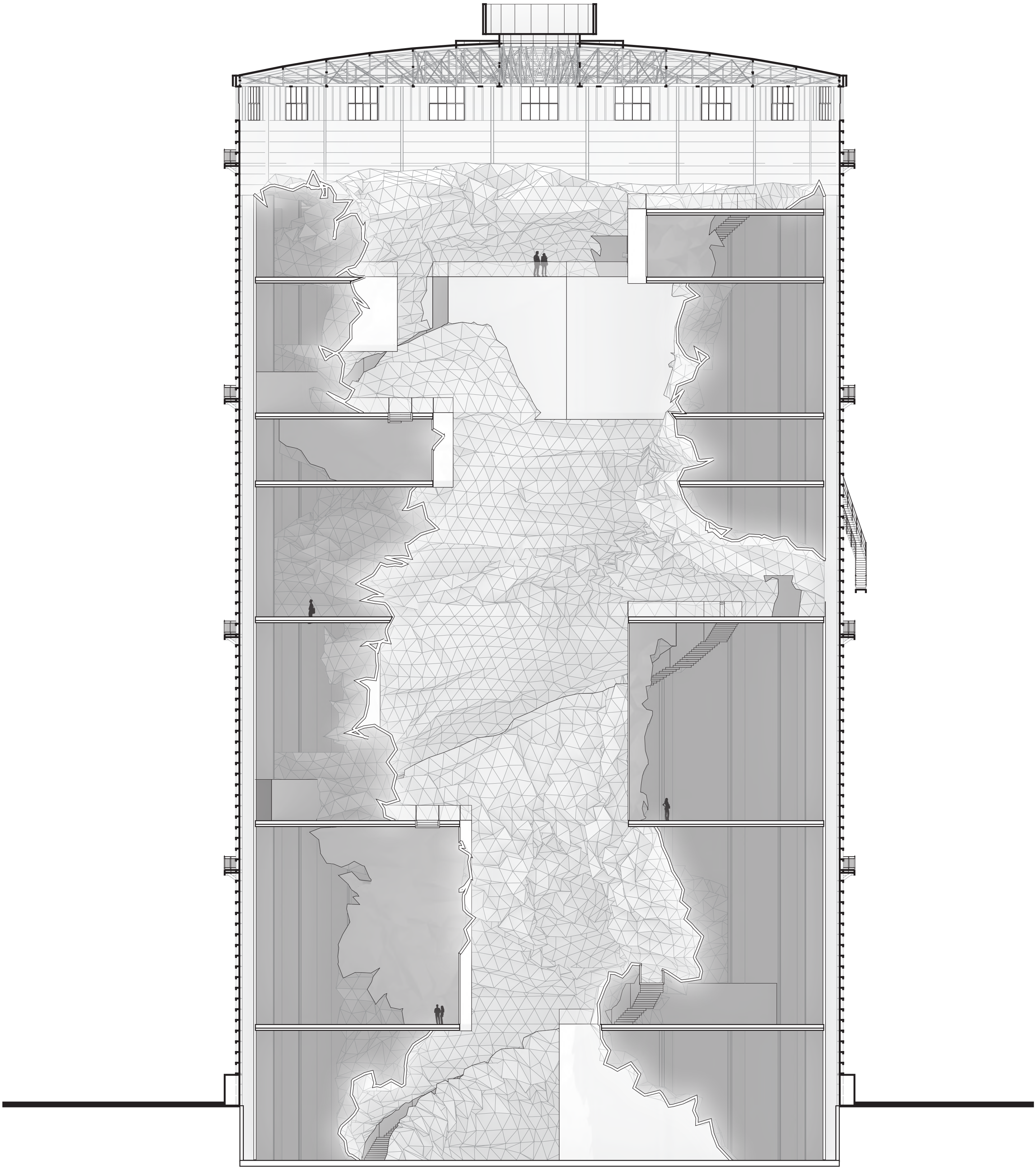
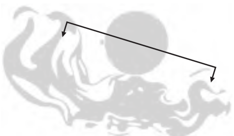


Fig. 150, section 1:400



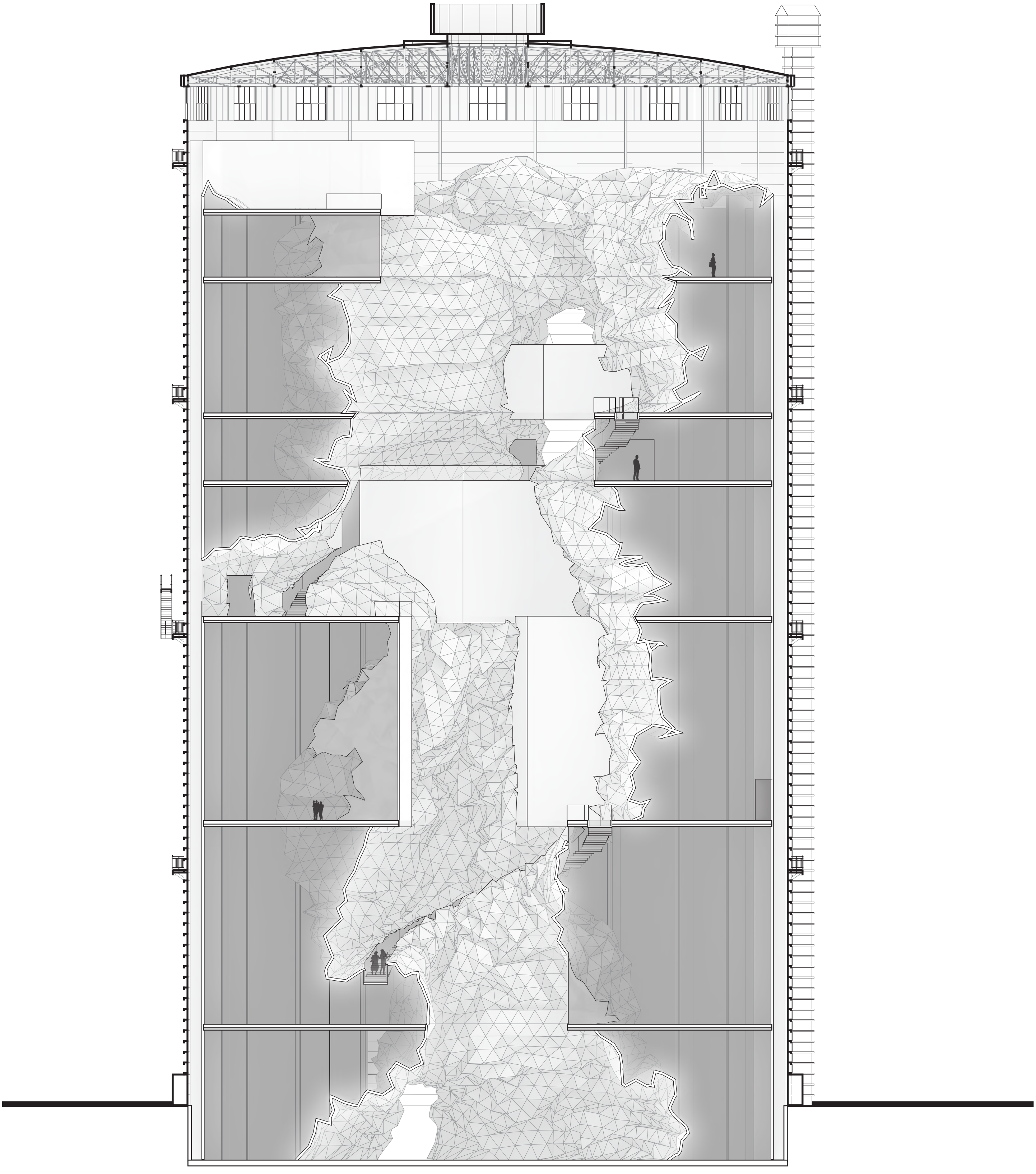
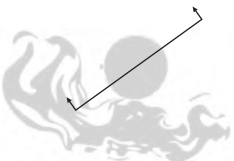


Fig. 151, section 1:400



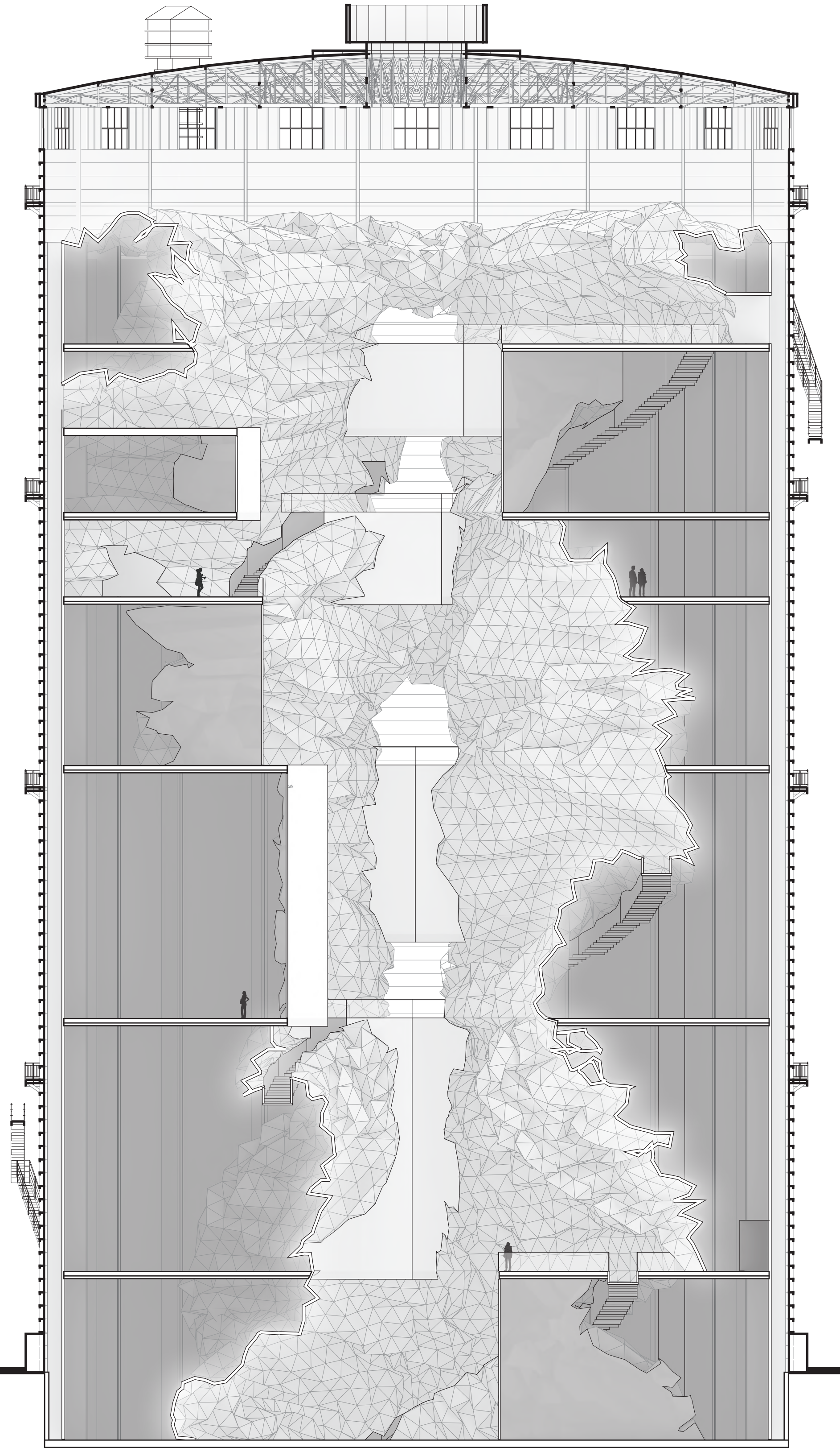


Fig. 152, section 1:400

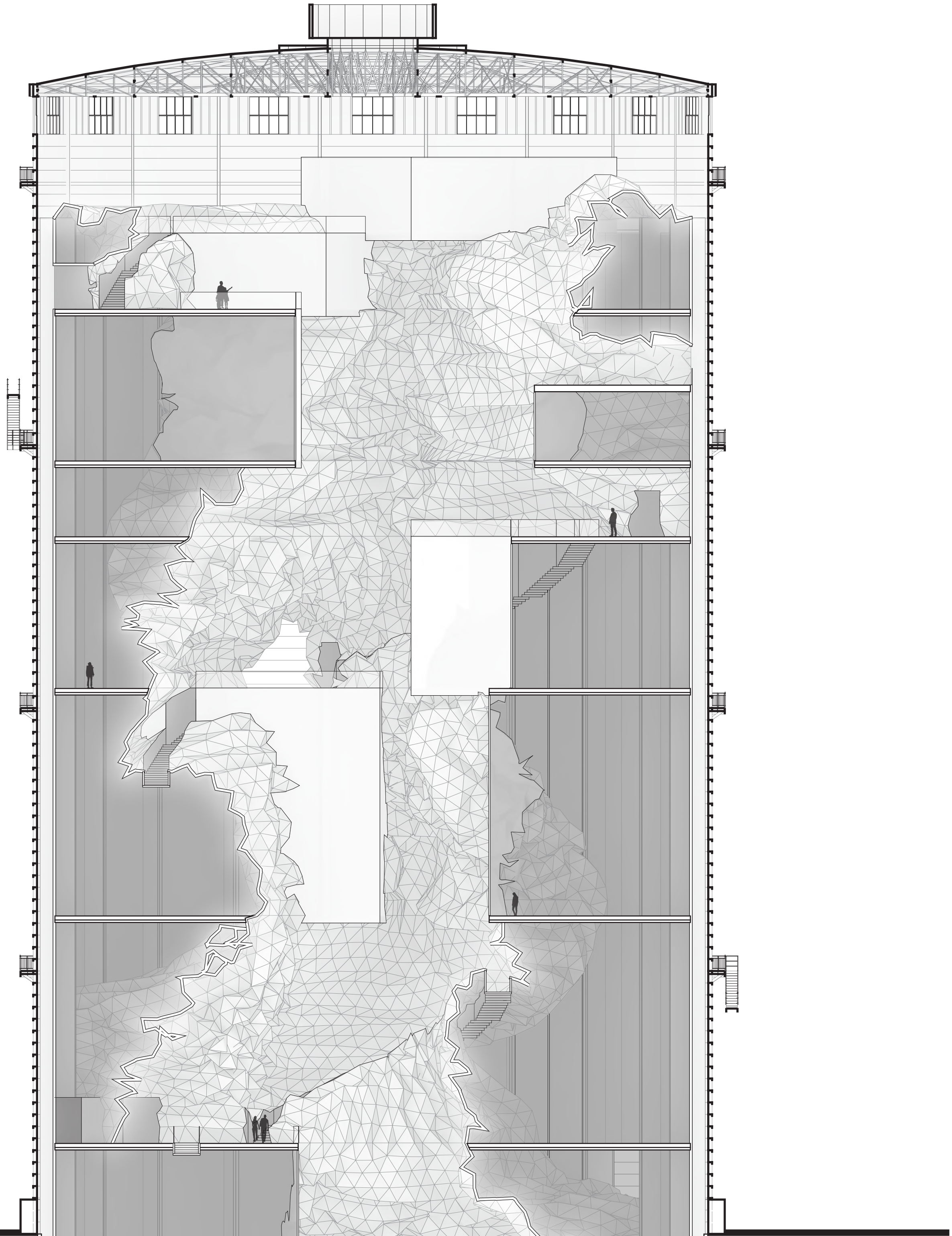


Fig. 153, section 1:400

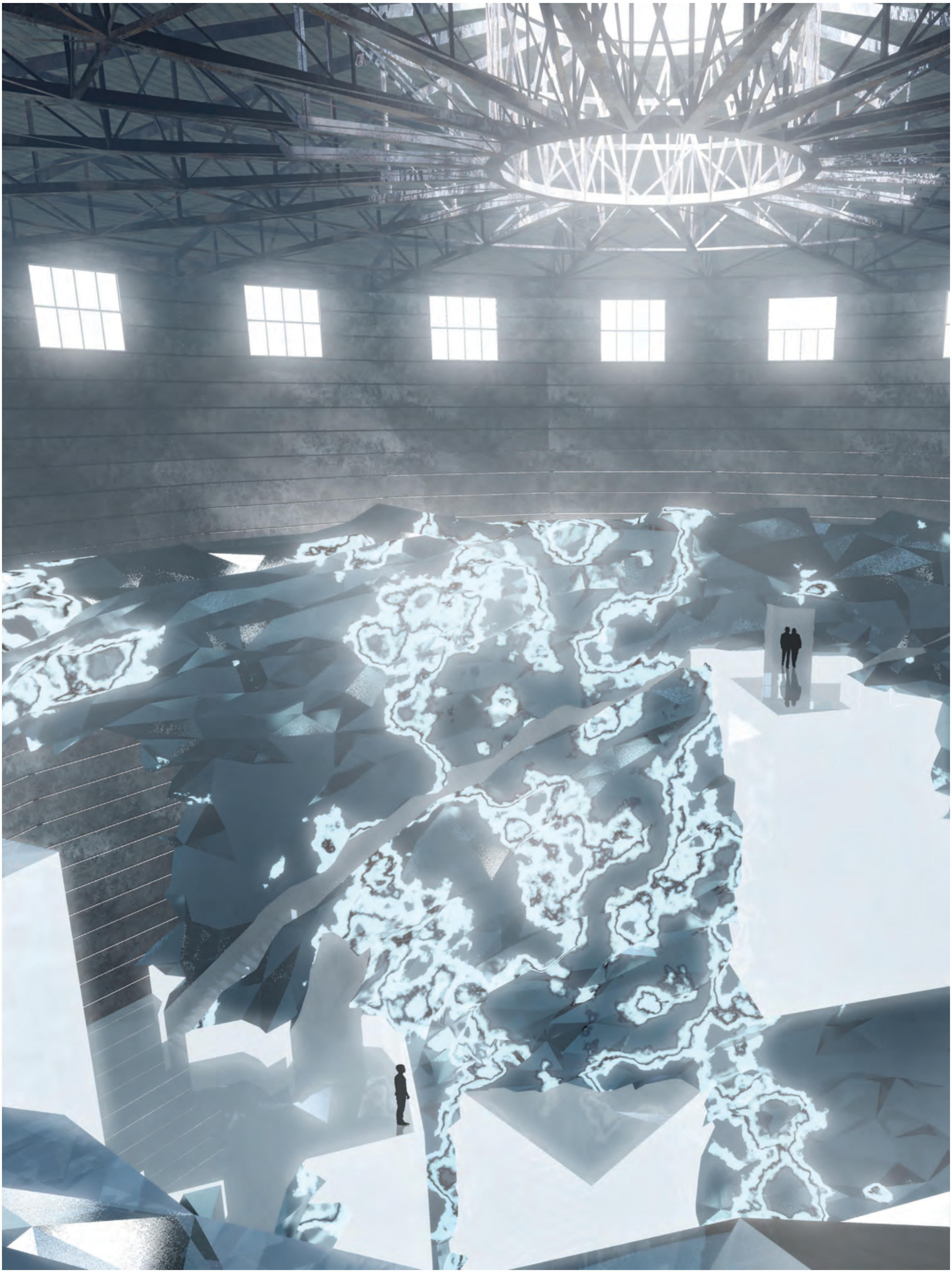


Fig. 154

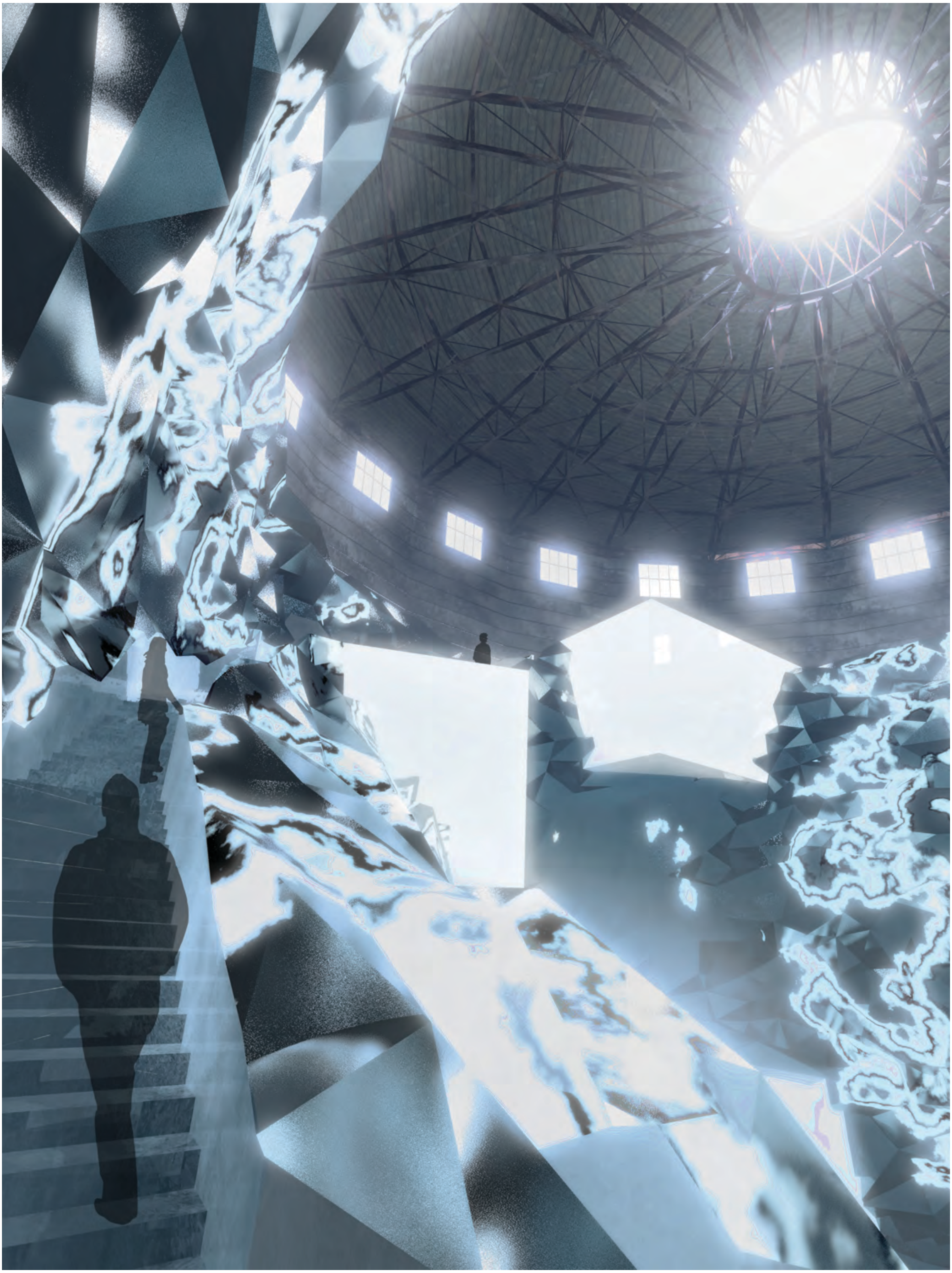


Fig. 155

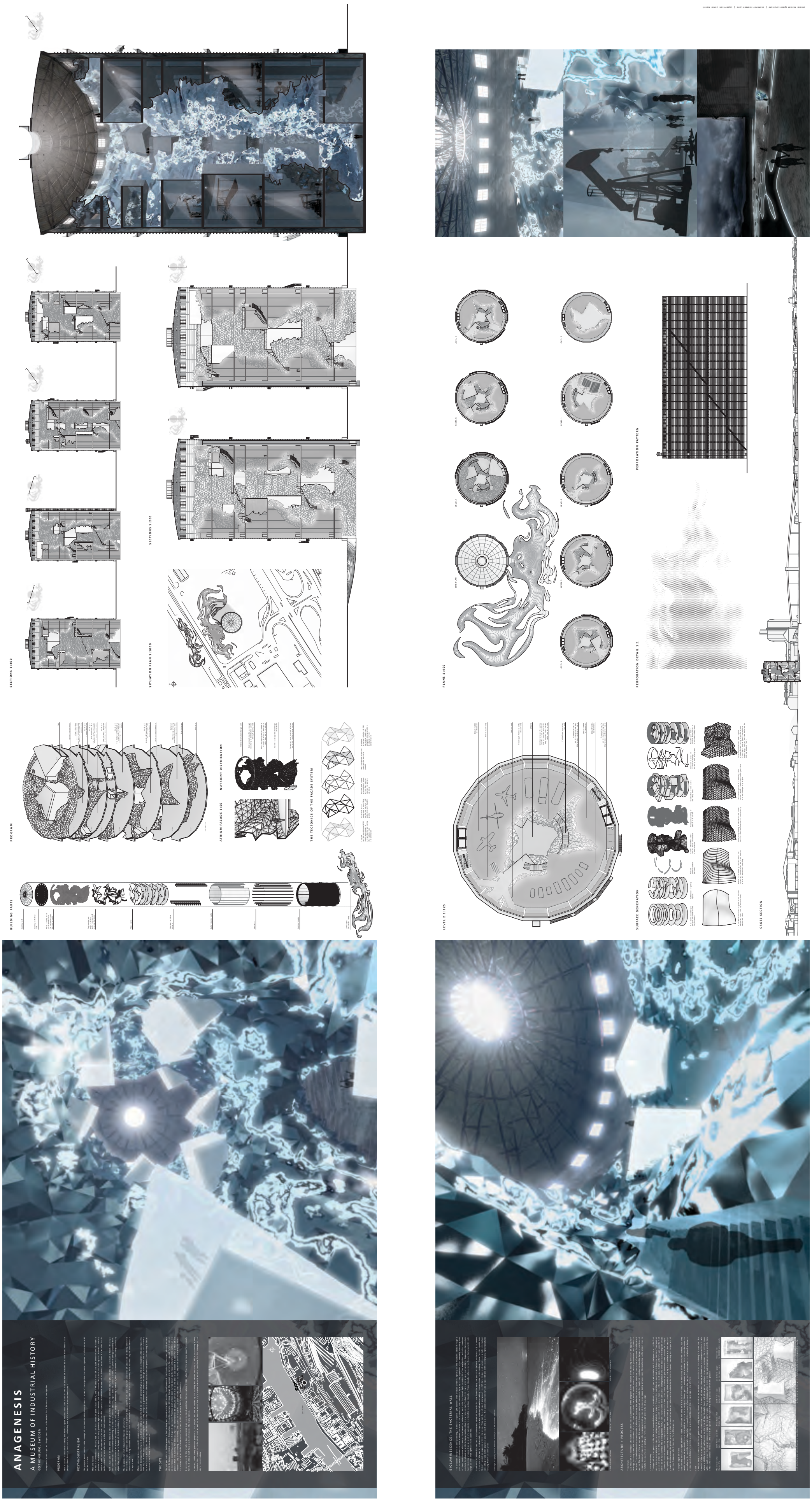


Fig. 156 Final presentation panels (2 panels). Single panel dimention: 841mm x 3365mm

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