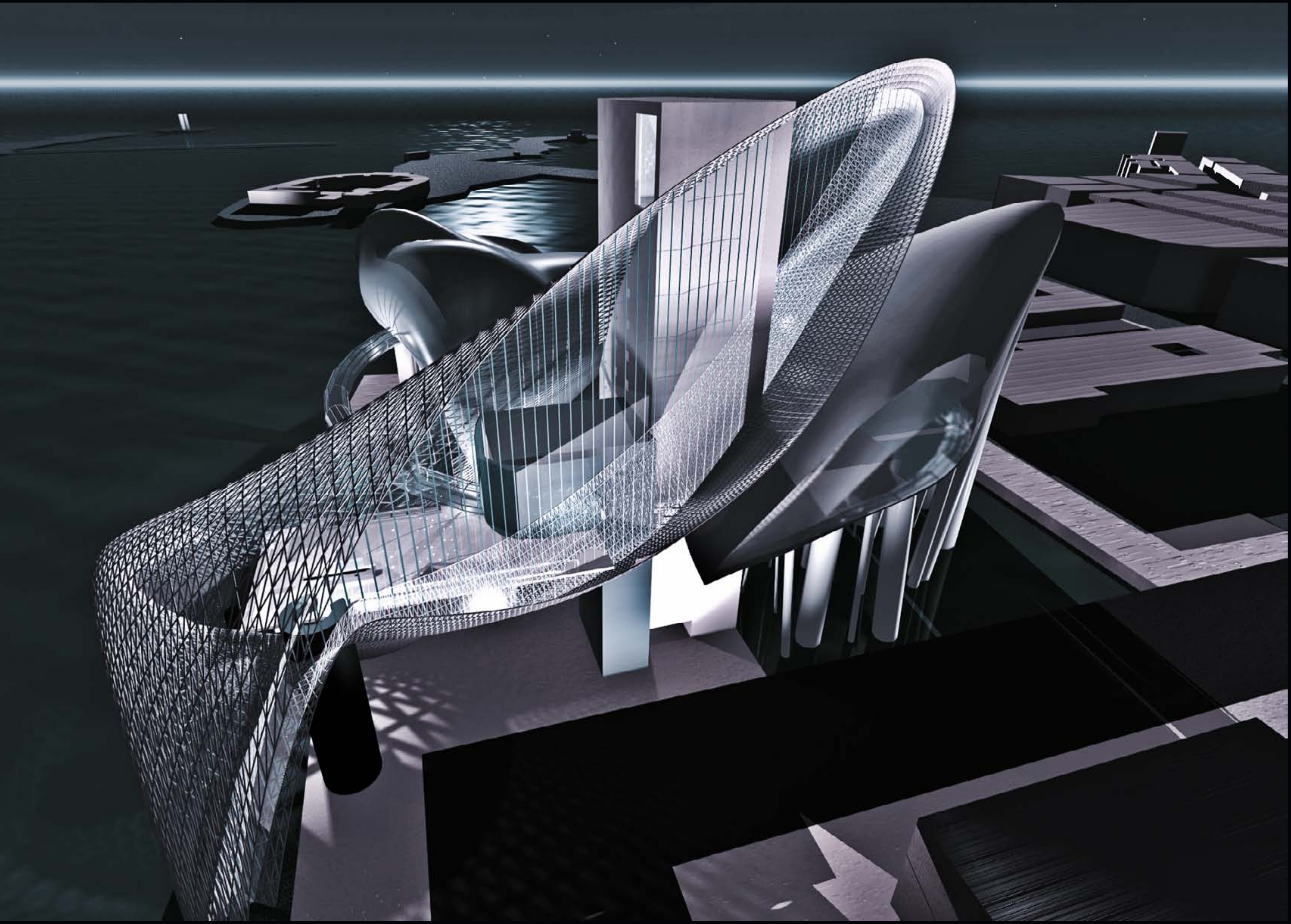


LET THERE BE MORE LIGHT

Aquarium in Trapani
March 2002

Contents and Functions

An aquarium is fundamentally a house for fish. If the house cares for its marine inhabitants it will probably also be a good piece of architecture. Such a presupposition is realised in the idea of building tanks, analogous in dimension and shape to the natural habitat, thus becoming pretexts for the elaboration of fluid cavities, modelled by means of curves and NURBS surfaces, a mathematical representation that accurately defines solids and surfaces with free or organic shape. Suspended on the water, denouncing their form to external space, they are moulded, cave-like, for the benefit of the little fishermen's boats. Aiming to be as discreet and respectful as possible to aquatic ecosystems, the visitor experiences the aquarium through a tubular pressurised gallery developing along a circumference. With a diameter of 200 metres and an extension of 800 metres, this creates a continuous walk which crosses the architectural complex from the light and ample Foyer to the fleeting and mysterious aquatic cavities. This system of visitor experience reverses the conventional hierarchy of single tanks and paths, the result of a vision of biological life rigidly subdivided by classes and sectors. Therefore the fishes' aquaria consist of two thirds of the building and man's experience is reduced to a single circular path, relatively small in proportion to the other parts. With the intention of sparking a synergy between experience within marine ecosystems and the outside world where the aquarium is sited, moreover, in the pauses between the principal tanks, the glass walls of the gallery suspended over the Mediterranean at a height of about 20 metres, give ample and luminous views over the archipelago of islets that fade away into the sunset until they condense on the three crusts of the Egadi islands on the horizon. In the circular path beginning and end coincide and so find their raison d'etre on the ground floor of the Foyer. Rising 20 metres over the sea, rational and irrational entities are revealed in a closed dialectic.

on preceding pages:
Night-time aerial view; Geodesic Cupola by B. Fuller in Montreal

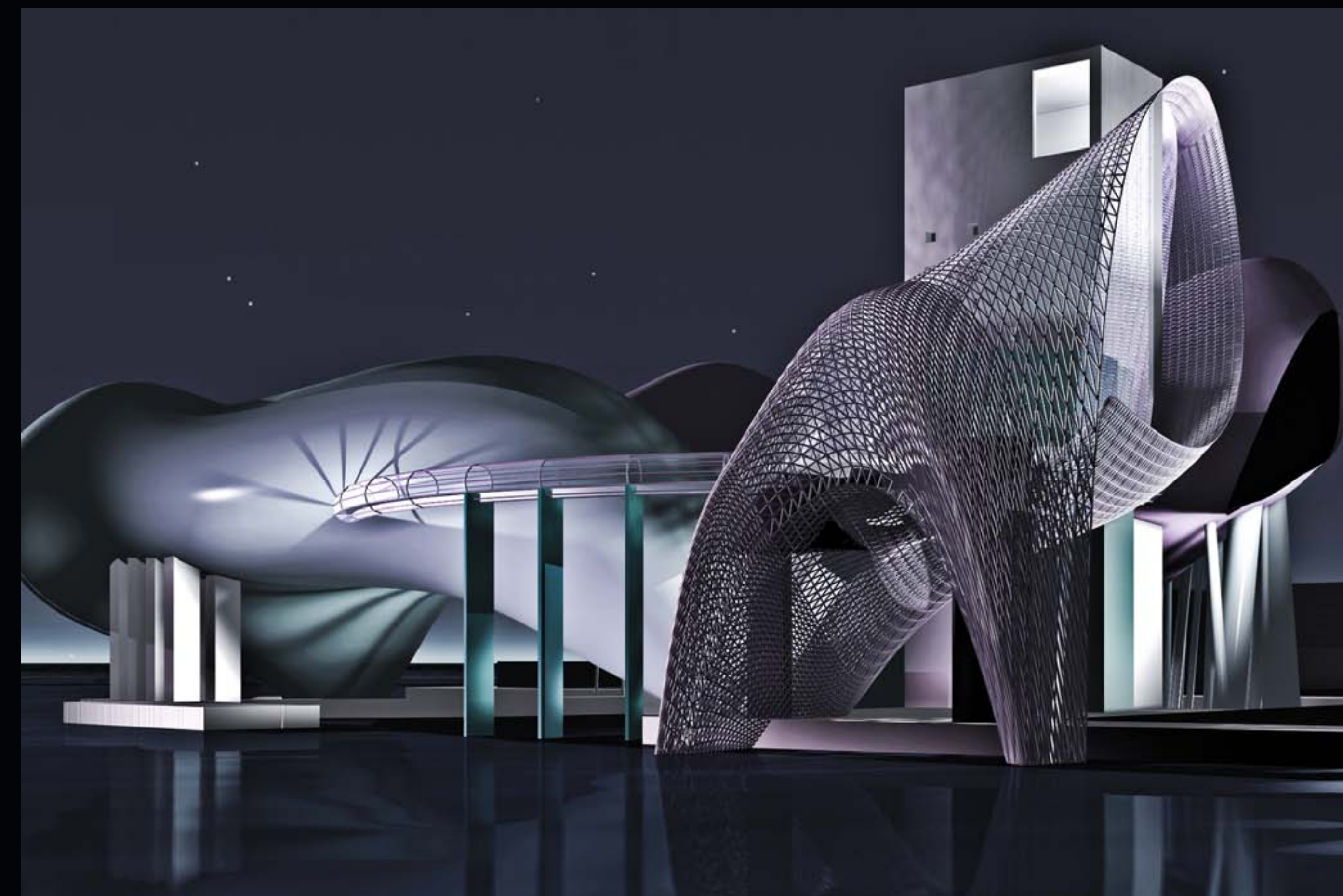
facing:
View of Foyer and Tower from Viale Regina Elena

above:
"Nassa" fishing net common in the Trapani area with double-hyperboloid grid structure

above:
"Trapano" by Joseph Roux, *Receuil des princi-paux plans, des ports et rades de la Mer Medi-terranie*, Plate 43, Marseille 1764

below:
Urban plan of the site

The concept which subtends the composition can be seen as deriving from the American Pavilion by Buckminster Fuller built for the 1967 Montréal Expo: a collection of open buildings enclosed in a geodesic grid structure. It is diverse in its method of shaping and recounting space and therefore in language. Here Fuller's platonic structure is substituted for an indefinable veil extending between the White Tower of the Department of Marine Biology and the sea. Condensed formally and structurally by a system of metal shafts looking like a rigid shell, it envelops the space in an extension of concaves and convexes. Inside there is an almost neoplastic dance of elementary objects. Their presence in the space does not imply a hierarchy, but an invisible network of resonances which make up the architecture. Some of them find their raison d'etre in recalling the functions of the Foyer: reception, lounge, galleries, shuttle lifts and stairs. Others,

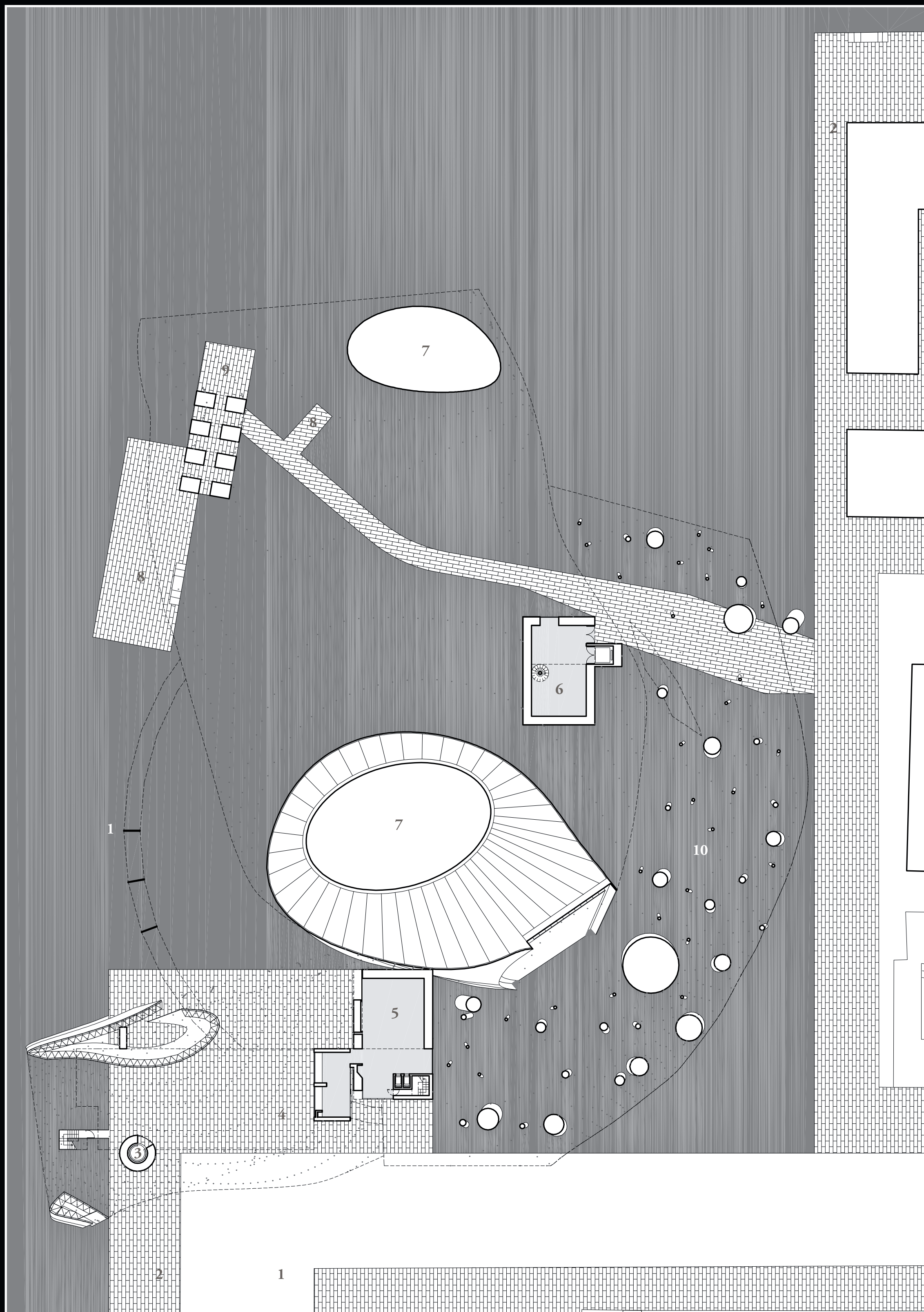


like in a vertical village, are true buildings within the building which, in strict succession, present themselves vertiginously on the platform of the Foyer. A recurving surface of green tunnelling envelops the interior of the Cafeteria and Bookshop, extended on two levels and accessible by a small staircase from the Foyer. Lastly, the spaces assigned to scientific study inside the White Tower integrate both entertainment and research.

Space. Private or public?

"Cadastre" is the main instrument on which Italian property legislation is founded. It originated from the urban culture of the 19th century and is by its nature two-dimensional. Contempora-

above:
View of complex from the sea, from left the lower tank with cave-like landing stage below, the glass tunnel on pylons, the glass grid structure with the Foyer platforms inside dominated by the laboratory tower and lastly close up view of the upper tank

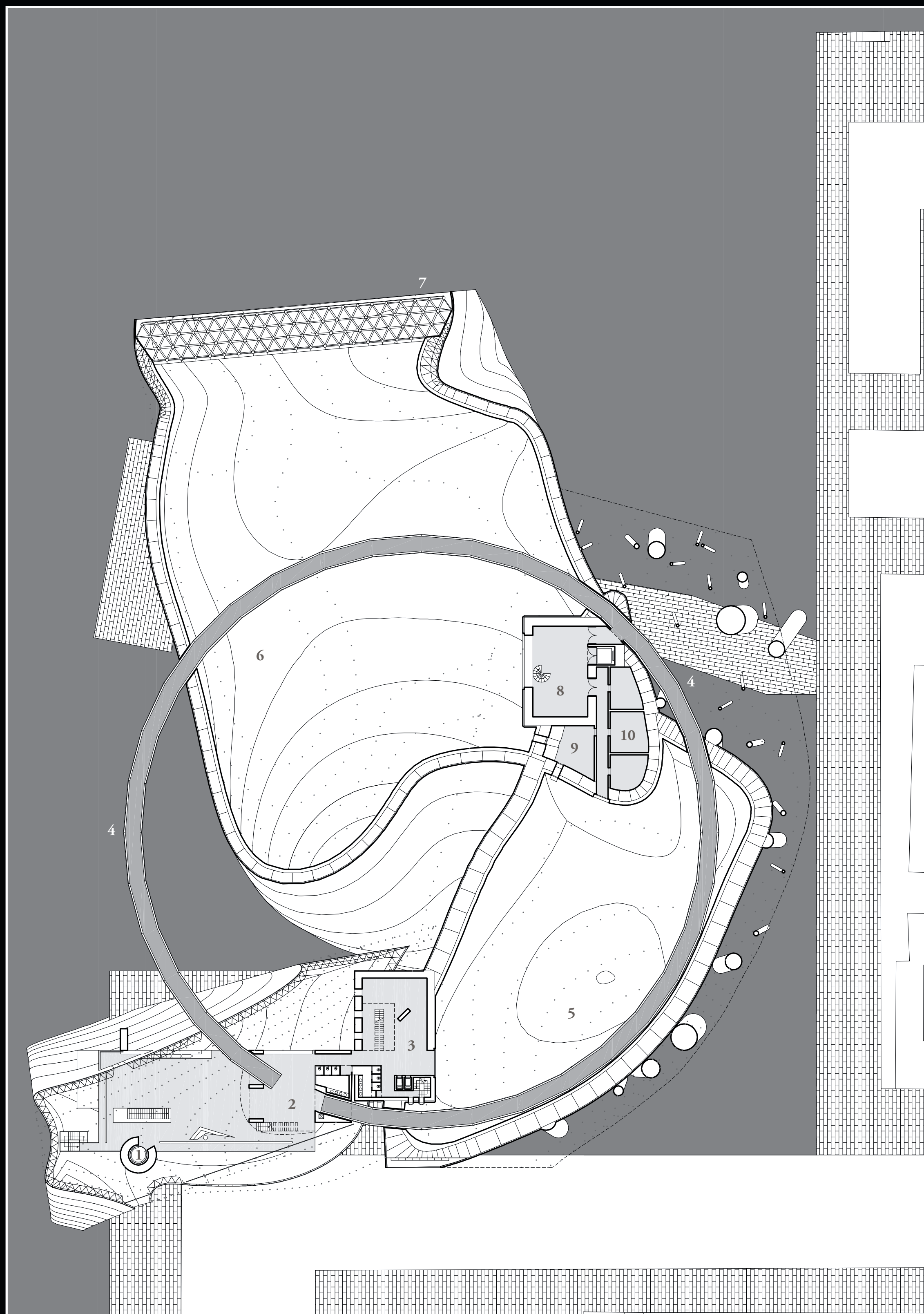


ry and modern architecture, following a now consolidated tradition that has it origins in the modern movement, tends to break up the building into parts to then reconnect the piece in three-dimensional space. As well as for reasons of distributive efficiency, this has psychological, visual and anthropological motives; but even in its legitimacy very often it clashes with current legislation. An example that has been built is the Kaufmann House by Frank Lloyd Wright, where the planimetric superimposition of a private area on State spaces is evident. The living space and the contiguous terraces giving freely onto a limpid brook determine one of the most embarrassing "abuses" in the history of modern architecture. But, even more than in nature, it is in urban space that the relationships between public and private are rendered closed and ambiguous. Turning back the clock of history we find various examples like the Rialto Bridge in Venice and the Ponte Vecchio in Florence, true buildings on public waters, up to the bridges between the buildings over the roads of Medieval, Renaissance and Baroque cities. These commonsense practices were thrown out by 19th-century building culture, and today are being reapplied, without producing, at a legislative level, a critical re-elaboration. And yet there is an ever more pressing need for emancipation from the spatial rigidity of the current regulations. What follows is a list of analogous situations, potential causes of conflict, present in the project:

1. In the Foyer area, at street level, the "covered" piazza underneath (the end of the sea walkway) is the property of the Aquarium. Alternatively we could consider this a public space, whose enjoyment is not limited by the Foyer overhead, but is instead strengthened, visually and functionally. A configuration of adjoining private space is not necessarily harmful to public interests; it is hoped it might rather promote an osmosis, an inquiry, in the design, ultimately benefiting both parties.
2. Public access to the Foyer is gained by means of a large panoramic lift, inside the cavity of a structural pylon. Placed on the wharf of the port it obstructs the public space. This feature, a continuation of the walkway but higher up, a sort of vertical shuttle, gives the opportunity to perceive the surrounding space from new viewpoints, stimulating the spatial knowledge of the place.
3. And again: apart from brief areas of structural contact with the submarine foundations, the tanks are suspended and define

facing:
Sectional plan of the complex showing urban access routes. *Contents and Functions:*

1. Viale Regina Elena
2. Wharf
3. Lift for access to foyer
4. Covered piazza from mantle of foyer
5. Laboratory tower
6. Equipment area
7. Lower tank structure (Yel's Cave)
8. Embarkation dock
9. Kiosk bar on the sea
10. Upper tank structure (Pink's Cave)



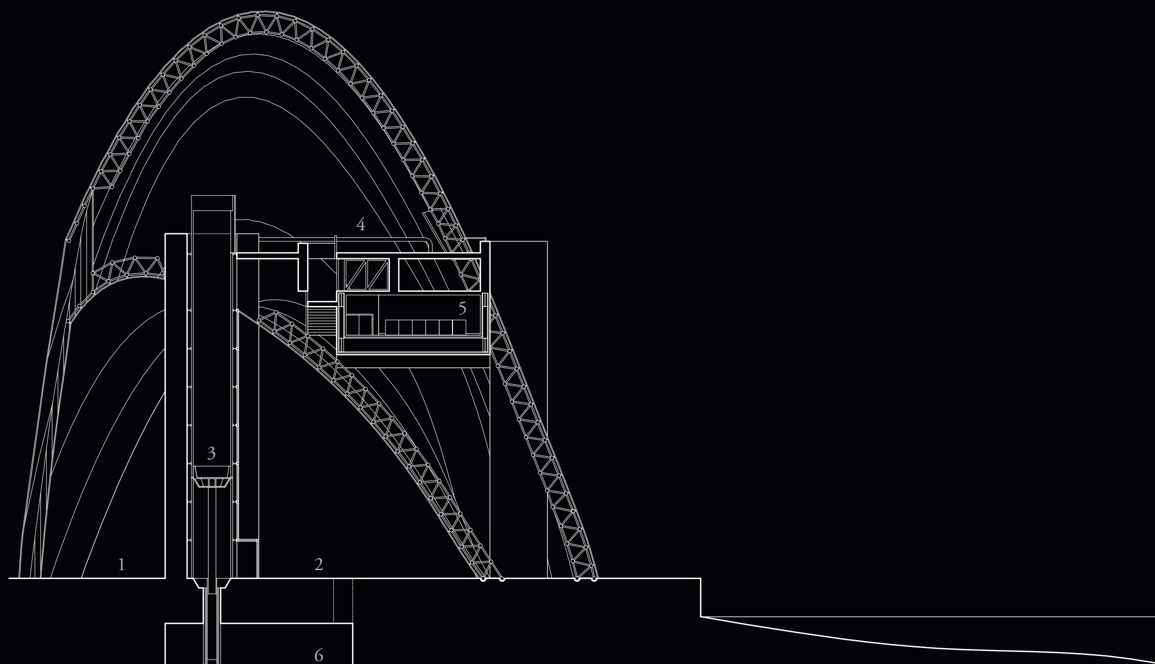
navigable aquatic fields underneath. Therefore, even though the space above is private, the waters continue to remain State property, rendering them navigable for small boats.

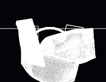
Pathways

It is through these paths that we can understand the structure of the building and the reason for the architectonic language. In aiming to regenerate the site, the design tries to spark, through a branching circulation in the three-dimensional space, a process of appropriation and knowledge. In the normal view from the road or from the sea, the small group of rocks to the west of the door, the salt reservoirs and the soft shapes of the Egadi islands in the background are seen as a series of low profiles, parallel and in receding serried perspective towards the sunset. It is difficult to discern the geometric relationships of the shape of the land and its distances. Thus the building forms a three-dimensional observatory of the marine landscape. For this reason the Foyer extends 20 metres over the surface of the sea, inside a glass creation which, enveloping it, condenses the internal cavities without making a rift in the landscape. Usually, in buildings, the shape of the walkways and thus the spaces is determined by walls. In many aquaria, for example, the exhibition route is the geometric result of the space between the tanks. In traditional building the shape of the walkway coincides with that of the space. This project experiments with the deconstruction and the independence of these two entities. The floors do not coincide with the spatial limits of the surroundings, be they walls or glass surfaces. In the Foyer the fluid and aerodynamic shape of the glass shell has at its heart a rectangular platform. Here, the terms “floor”, “ceiling” and “walls” are thrown into disarray. The perimeter glass surface develops within the slabs of the floor, transfigured from urban piazza to magic carpet apparently suspended in mid air. The only meeting points between the two entities are at the opposite corners of the rectangle: triangles of floor jut out from the glass shell, defining two galleries, one looking north-east towards the city, dominated by the vertiginous and vibrant glass walls articulated by a steep series of uprights; the other looking south-west towards the Egadi islands, touched by the descending undulation of the shell outside. These are the only two segments of contact, in which the external mantle, in-

facing:
Sectional plan of the complex at foyer floor level and of the ring path, circa 21 metres. *Contents and Functions:*

1. Lift to wharf
2. Foyer floor
3. Laboratory tower
4. Pressurised glass ring for public viewing of tanks
5. Upper tank (Pink’s Cave)
6. Lower tank (Yel’s Cave)
7. Glass wall holding back water
8. Equipment area
9. Water monitoring
10. Stores





tersecting with the rectangular floor, becomes a wall. But the event is very brief and is deliberately disproportionate to the zones of non-contact, which suggest a state of fluctuating suspension. Only in these small areas is it possible to “touch” the glass shell. The rest rotates inside, in space, elusive.

Discretizing

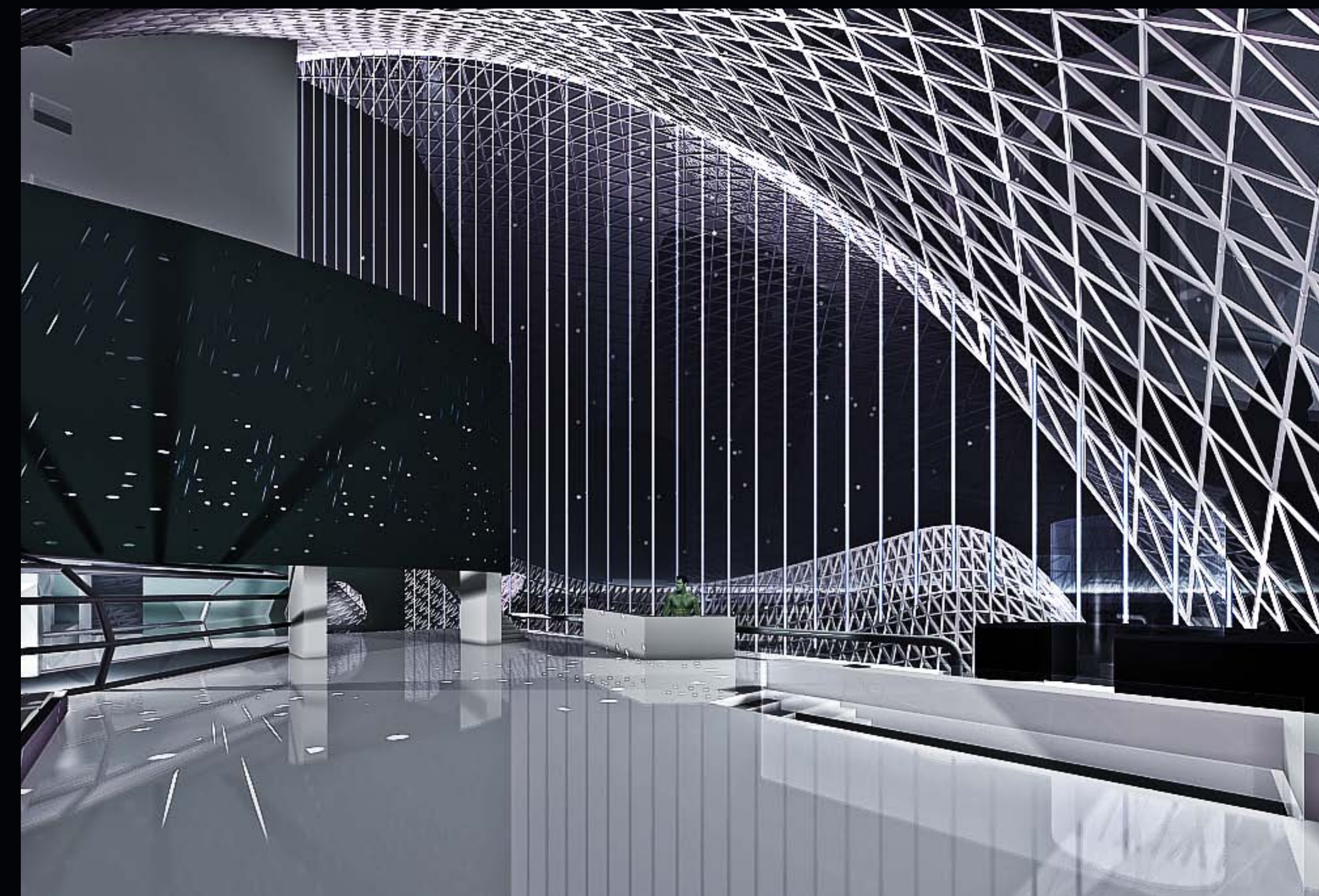
The details of the project presented here reproduce the shape of the tanks through a system of contours, resulting from a succession of sections every three metres through the organism of the building. The following table shows some data relating to the modelling of the tanks:

	SURFACE	VOLUME	X	Y	Z	DISCRETISATION	POLYGONS
UPPER TANK	9.869 m2	43.375 m3	95	61	34	Spaziale passo 5	3.636
LOWER TANK	12.758 m2	51.735 m3	161	136	44	Spaziale passo 7	9.831

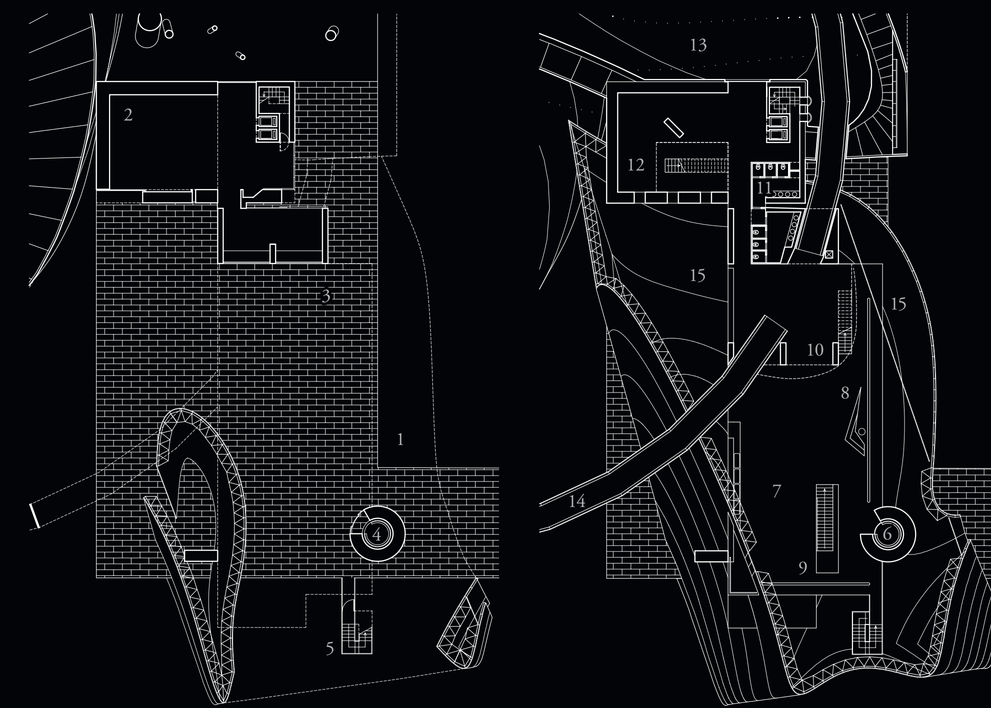
The surface area considered is that of the exterior. This determines the volume, including the containing walls. The values x, y and z give the extension of the bodies in metres through a Car-

above:
Section of foyer. *Contents and Functions:*

1. Viale Regina Elena
2. Covered piazza
3. Lift for access to foyer
4. Projection room
5. Lift equipment area



above, in order:
Night-time view of foyer with large flat window at rear open on Viale Regina Elena; Front view of Foyer by day with Blue Box of the Projection Room in foreground



tesian system parallel to the sea-walk. “Type of discretisation” means the method used by the calculator to reduce the NURBS surfaces to a finite number of triangular polygons, which by their nature are continuous. The number of polygons, then, relates to the external surface.

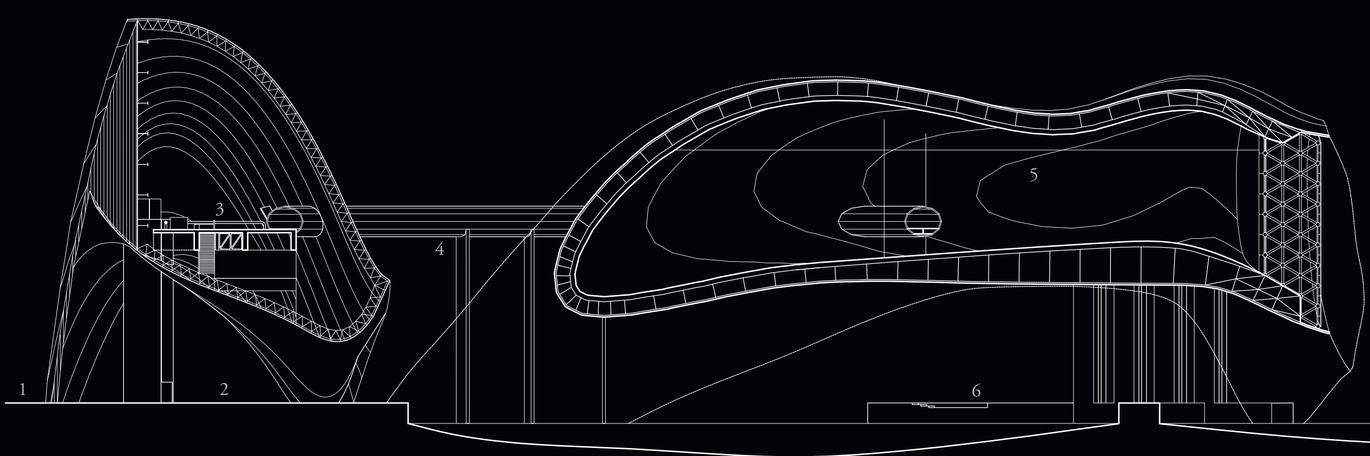
Structure and Technology
The structural problems arising from the free shapes of the aquaria are analogous with those of fuel tanks suspended on bases built around their perimeter. The structural walls encircle the liquid content creating an enveloping continuity. In the same way as veined floors, they are constructed with a double row of slabs joined by right-angle uprights. The distance between the two rows varies in proportion to the amount of bending to be absorbed, determined, in the central area of the tanks, by the enormous loads created by the water. Such a dimension limits the internal arm of the pair capable of absorbing the tensions caused by the arc in the outer and inner rows. Two cables make up the system: the one above compressed by the weight load and the mass of the liquid; the other at the bottom compressed by the

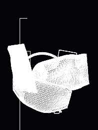
facing:
Views of the interior of the foyer, looking south and looking north

above, from left:
Sectional plans of the foyer from street level and at a height of 21 metres. *Contents and Functions:*

1. Viale Regina Elena
2. Laboratory reception
3. Covered piazza
4. Aquarium lift
5. Stairs

6. Lift to wharf - street
7. Foyer level
8. Reception
9. Stairs to projection room
10. Pilotis and bookshop stairs
11. Toilets
12. Bar
13. Pink’s Cave
14. Pressurised glass ring for public viewing of tanks
15. Void



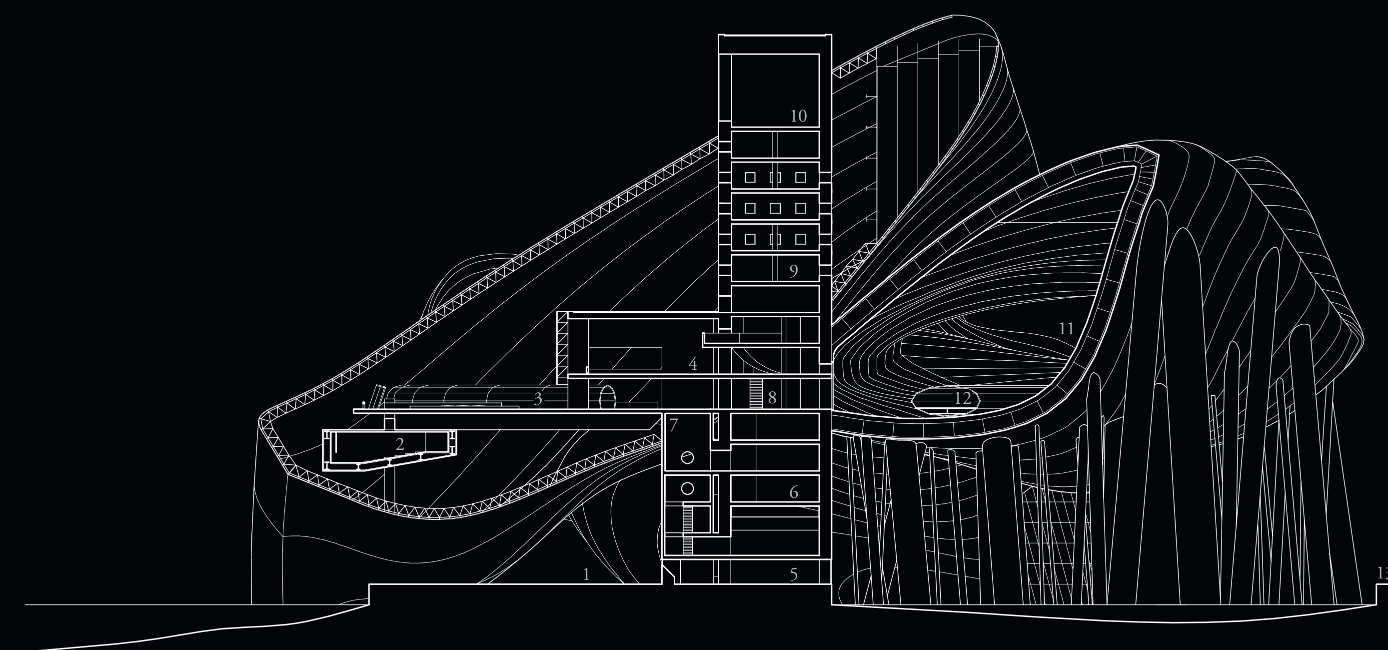


on preceding pages:
View of foyer from threshold of lift

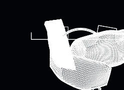
above:
Transverse section I, relationship between foyer and lower tank (Yel's Cave).
Contents and Functions:

1. Viale Regina Elena
2. Covered piazza
3. Foyer Level
4. Pressurised glass ring for public viewing of tanks
5. Lower tank (Yel's Cave)
6. Landing stage

weight of atmospheric agents. This last, furthermore, absorbs even the residual states of traction transmitted by the adjoining lower cable, balancing the opposing states of tension. The lower tank (Yel's Cave) discharges its weight load into the foundations by means of its own shape, which when forced to compress behaves like an arc. Two macro-objects, as well as making up the architectonic complex, absorb further loads: a narrow matrix of parallelepipeds at the south west and a tower for equipment, goods lifts and emergency stairs at the north. The upper tank (Pink's Cave) is partially anchored to the White Tower of the Department and intersects with the lower tank, appearing within its own internal space, with the intention of making the structures react one with another. The cavity formed by the intersection between the two tanks, accessible from the Equipment Tower, contains a station for monitoring the water with decompression chambers for access and immersion. The tank is also supported along its perimeter by a scattered series of cylindrical pillars, where the opposing states of tension of the cables are cancelled out. Diverse in inclination and diameter, these pointed structures carry the load thanks to their slenderness, through the combined

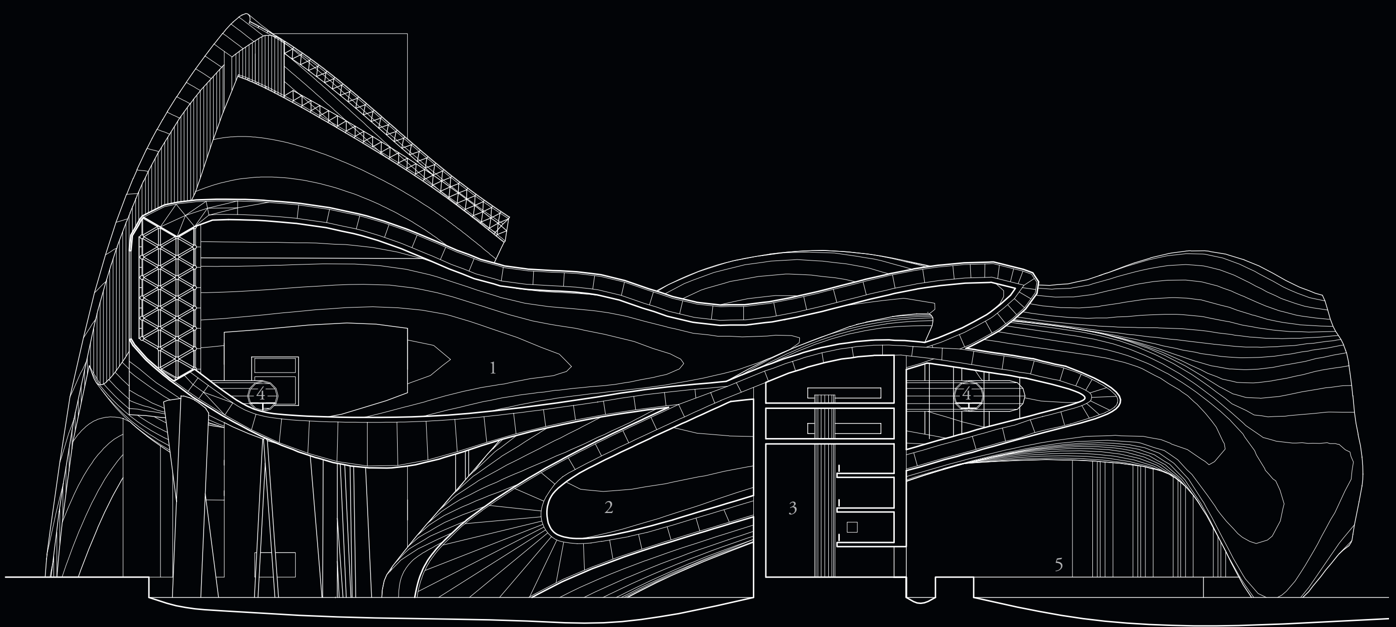


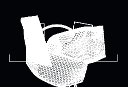
action of an inclination of five degrees from the vertical and different relative centres of rotation, thus giving a wide distribution of force. A hypothetical composition of the strata of the thickness of the walls of the tanks could be as follows: external coating in waterproof coloured ecological rubber, sprayed on the outside surface; steel slab (outer row); empty interspace, holding the vertical slabs screwed to the row by L-section joints; steel slab (inner row); isolator in laminated wood; layer of concrete; heavy duty eco-compatible waterproof sheath. Two structural models reacting alternately make up the Foyer:
1. A three-dimensional grid system curved in the space covers the surface of the glass mantle. A complex of inner and outer interconnected rows reproduces geometrically, in the single units, tetrahedrons of alternating orientation. Spherical junctions create hinges from which depart, towards the outside, points of support for triangle-covered plates in synthetic glass acting to condense the space, protecting it at the same time from the atmosphere. The synthetic glass reduces the loads on the structure and also offers greater elasticity in flexing. In the Foyer any excess heat generated by the warming effect is dispersed by a



above:
Longitudinal section, relationship between foyer and upper tank (Pink's Cave).
Contents and Functions:

1. Covered piazza
2. Projection room
3. Foyer level
4. Bookshop
5. Laboratory reception / schools
6. Laboratories
7. Equipment / stores
8. Bar
9. Classrooms
10. Conference room
11. Upper tank (Pink's Cave)
12. Pressurised glass ring for public viewing of tanks
13. Wharf

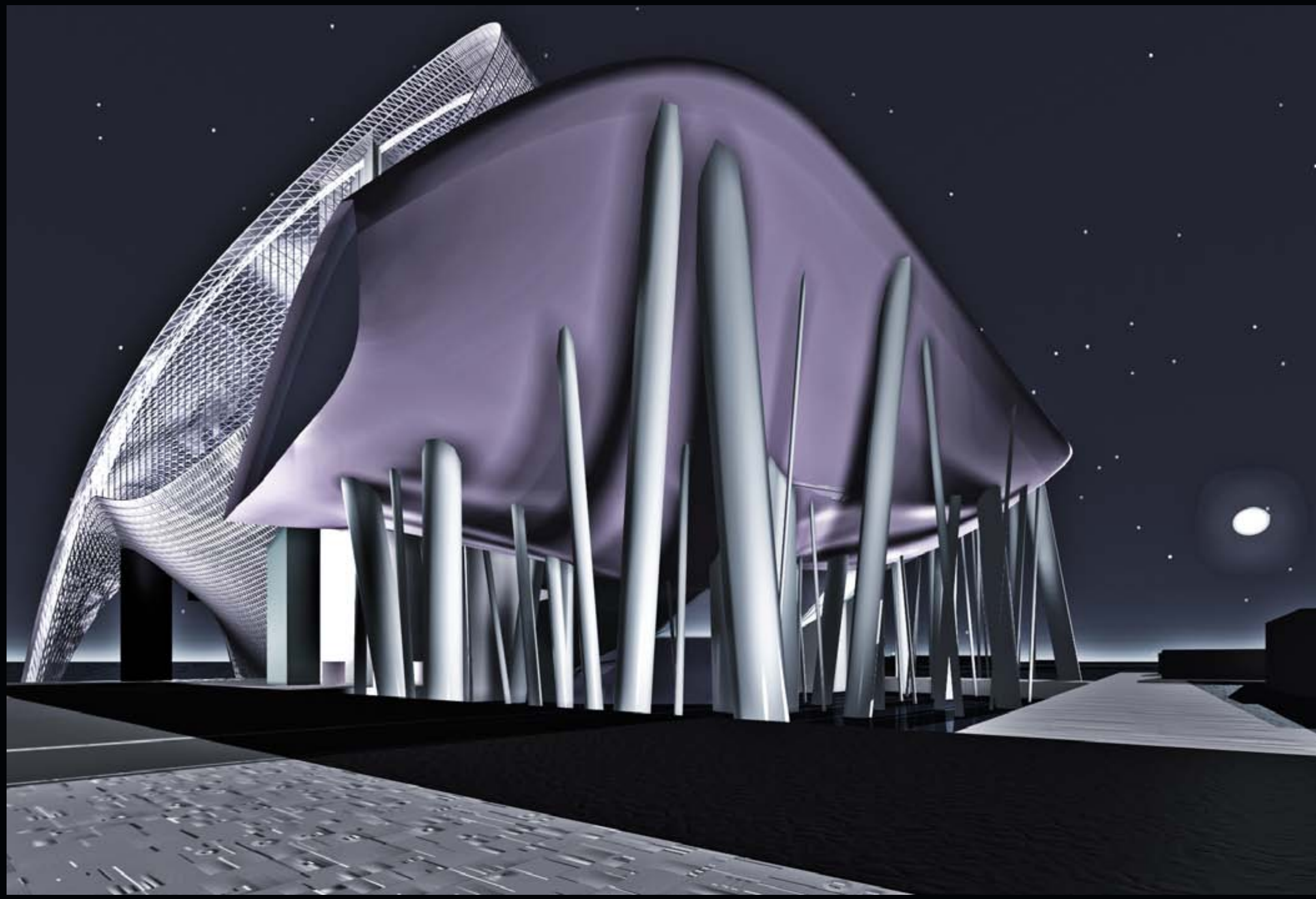


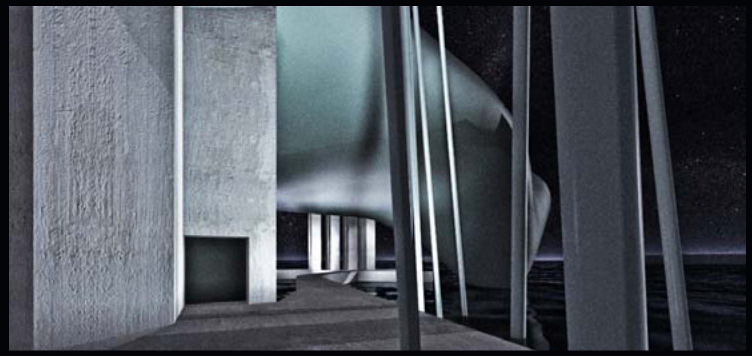


convection motor cooling the internal temperature with strategic vents near the water and in the highest recesses of the large glass covering, structurally carrying itself southwards with its curved shape and suspended to the north on the White Tower. A dense series of vertical steel pillars, joined at the edges to points on grid structure of the shell, hold the great flat glass surface that looks east towards the city. It is allowed to flex, counter-balanced by systems of vertical cables grafted onto the pillars.
2. The platform of the Foyer, along with the structures set upon it, is made possible thanks to the potential of constructing in reinforced concrete. Crossed by high longitudinal girders, its ceiling rests on a gigantic support whose components are the following structures: to the south, one of the pylons closes the cavity of the shuttle lift; to the north a small Green Tower, juxtaposed with the larger one of the Department, from the floor of the Foyer the semi-elipsoidal volume of the Libreria - Cafeteria mutates. Partially extending onto the floor of the Foyer, it is joined to the high longitudinal rib girders underneath by means of the three slabs of the colonnade. Opposing states of tension balance the system: there is present in the slabs both the compression

above:
Transverse section II, relationship between upper tank (Pink's Cave) and lower tank (Yel's Cave). *Contents and Functions:*

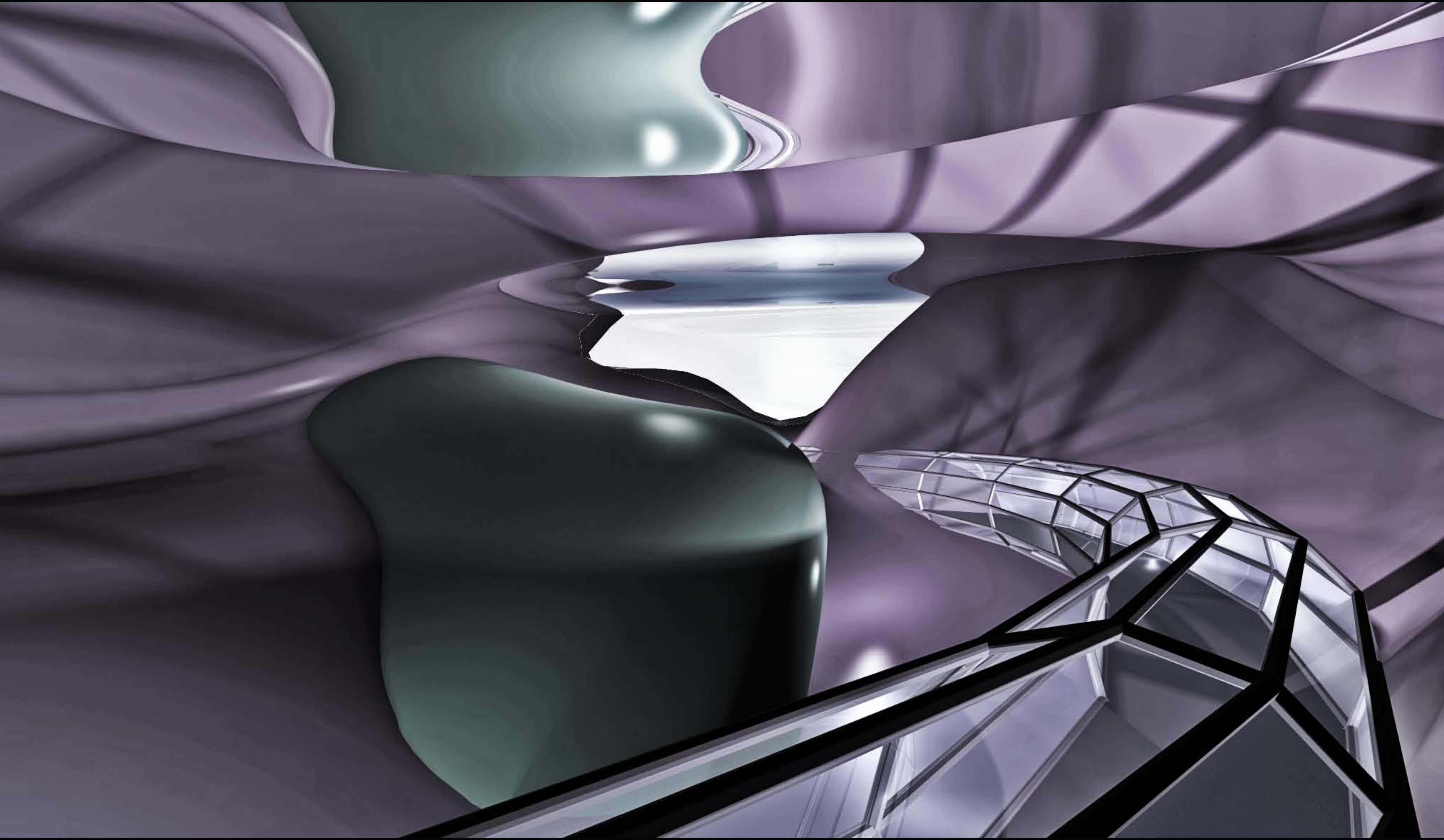
1. Upper tank (Pink's Cave)
2. Lower tank (Yel's Cave)
3. Equipment tower
4. Pressurised glass ring for public viewing of tanks
5. Wharf

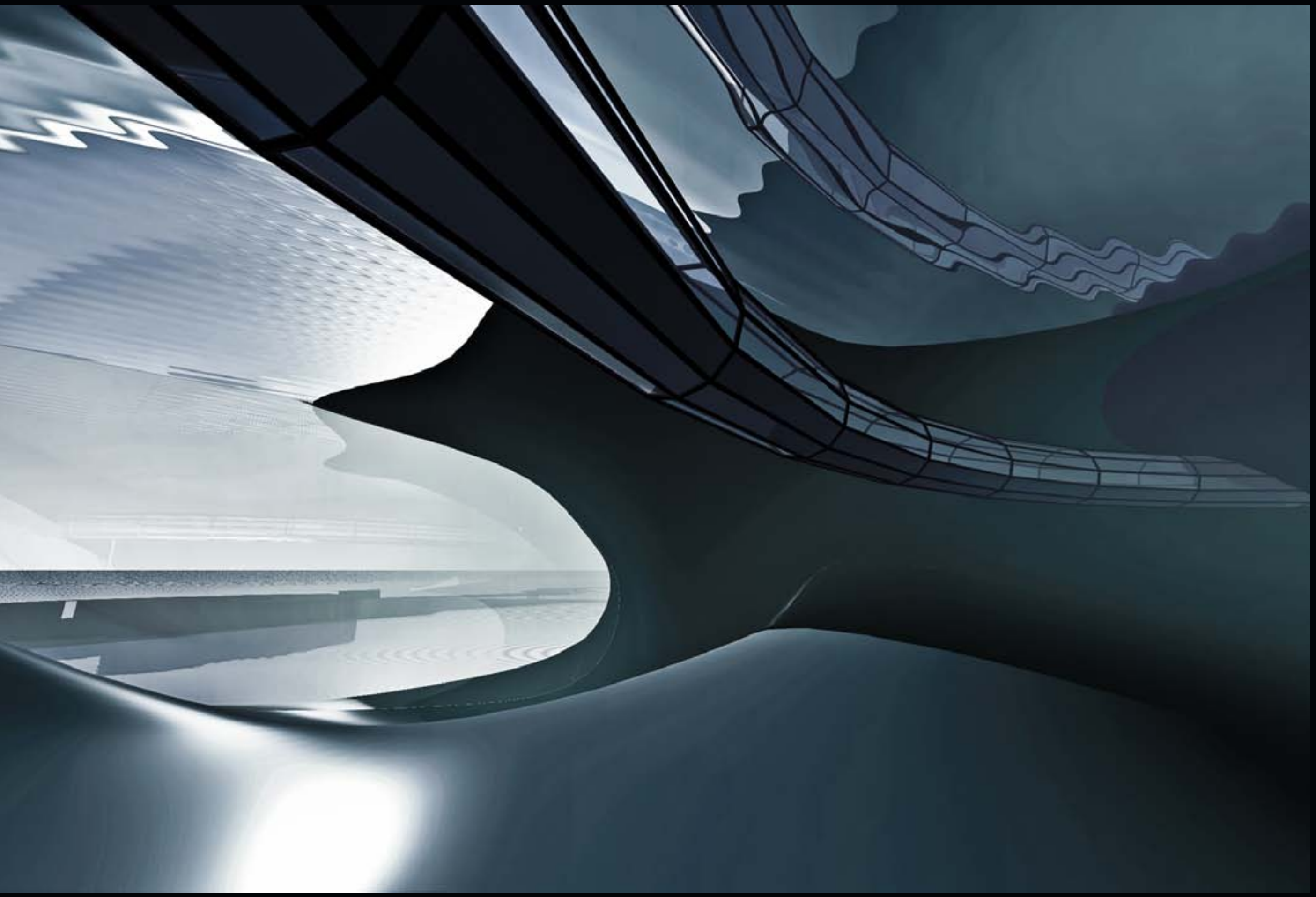


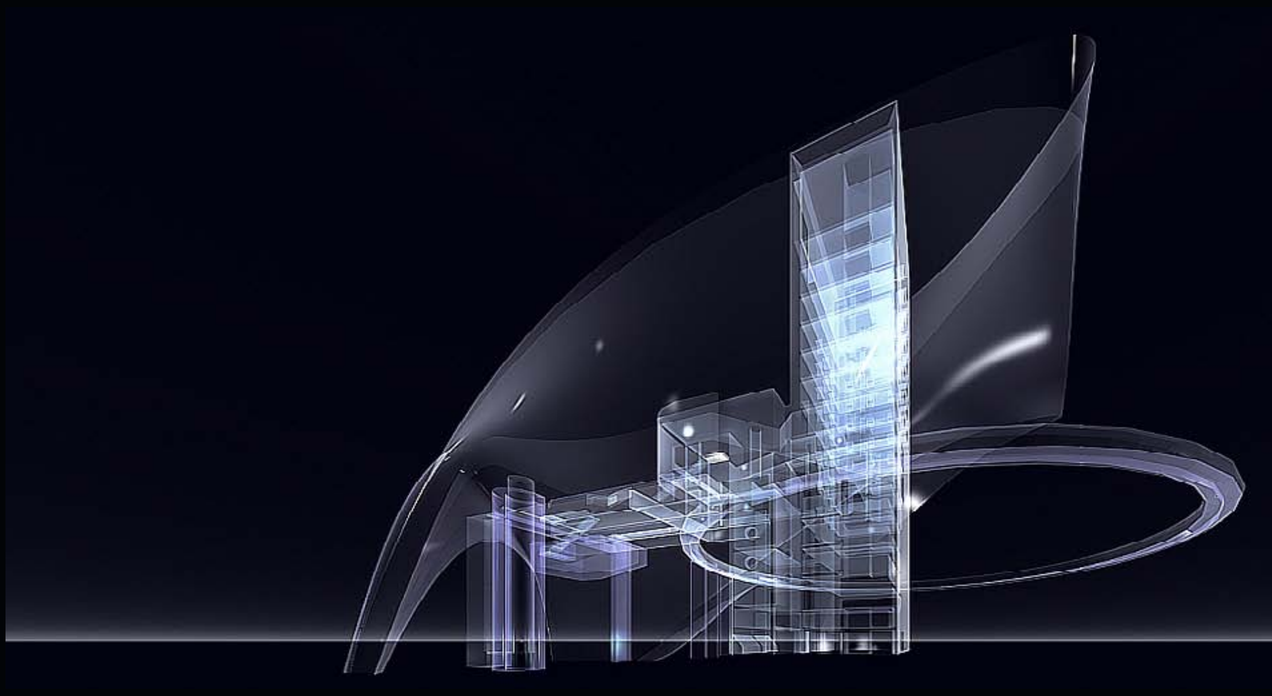


above, in order:
View of the Upper tank (Pink's Cave) from the street with the forest of structural vanes, in the middle ground, on the left the glass mantle of the Foyer and on the right long view of the wharf;
View of the cavity defined by the tanks with the equipment tower in the foreground and the wharf - street beyond

on following pages:
Internal view of the upper tank (Pink's Cave) with the glass walkway below, the grey mass at the intersection of the two tanks encloses the area for monitoring the waters





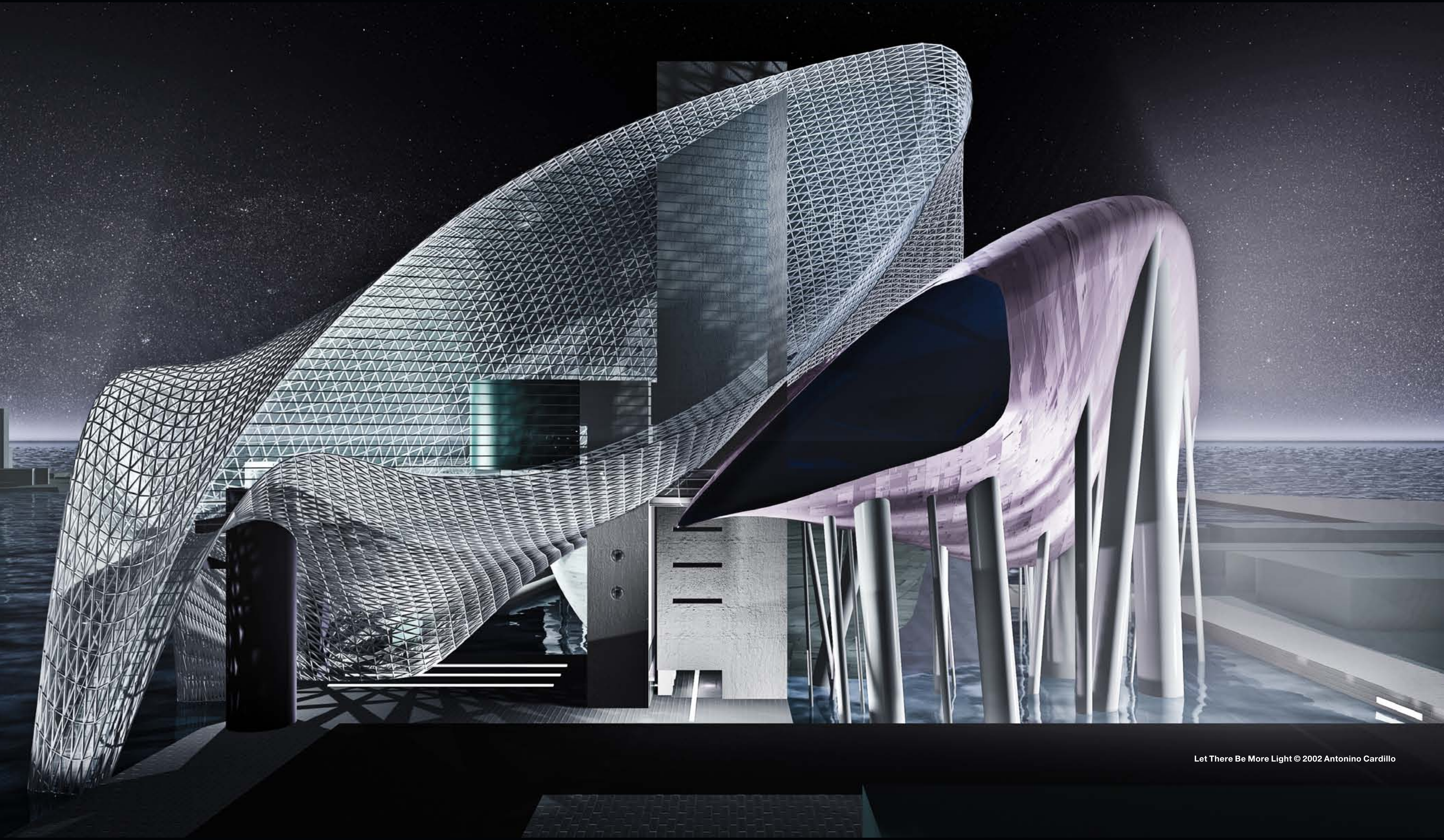


generated by the loads of the floors of the cafeteria and the traction of the drop in span of the floor of the platform. This strategy, reproducing a Vierendel joist, ensures the highest rigidity at the span of the support, virtually reducing an extension in length. A gap in the tapered floor of the reinforced concrete paving leads to the Blue Box of the Projection Room. Suspended from the ceiling of the platform of the Foyer, its floor inclined to make the screen visible, it is supported by a steel frame hidden from the perimeter walls, whose thin walls serve the sole function of isolating the interior acoustically and thermically. Lastly the high White Tower of the Department is constructed on 14 connected floors with a thick perimeter wall of reinforced concrete, dotted with small square windows. Because they are sparsely scattered the structural power of the perimeter wall is not reduced, so, behaving statically like a giant pillar of hollow rectangular section, it is capable of absorbing the loads and abnormal pressures of the tanks and of the glass covering of the Foyer on the walling. On the ground floor, the Reception is built in a double-height space illuminated from the west by a narrow gap in the wall. Above there are three floors for technical and office use, adjoining those of the Green Tower. From the Foyer level, the triple height of the Cafeteria cuts through the intermediary floors, in an internal space widening organically in the green office cavity on the platform. A trio of pillars alternates in the subsequent floors relieving the loads across the adjacent reinforced platforms that contribute to freeing the cafeteria and the succeeding laboratory floors from obstacles in the centre. Lastly the attic floor, as previously mentioned, contains a vast conference hall. Outside, in the street, the low horizontal entrance, dug out of the cornerstone of the White Tower, looks onto a small piazza moulded by the two juxtaposed towers and by the jutting Pink's Cave.

above:
Internal view of the lower tank (Yel's Cave) with the glass walkway of the pressurised ring above and the background open to natural light

above:
View of the building in transparency

on following pages:
View of the whole complex, background of the sea walkway Viale Regina Elena



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