

# Parity in Architectural Spaces

A novel Design Methodology in conceiving a  
Contemporary Art Museum in Frankfurt am Main

by

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# Introduction

For a large site in the east part of Frankfurt am Main in Germany, next to the planned, new headquarters of the ECB European Central Bank (designed by the renowned architectural firm Coop-Himmelblau), a new Museum of Contemporary Art is proposed. The major of Frankfurt am Main needs urgently to re-potentiate the forgotten east part of the city preferably with a public area and cultural building. Then, the project would have a unique cultural environment also a considerable socio-economic and tangible scale impact in the immediate urban context. In addition to this, the cultural building should work together with the iconic ECB building as reconciliation devices between the city centre and riverside, where are concentrated the most visited cultural, public places and events in Frankfurt am Main.

The city of Frankfurt am Main is not only long well known for being one of the most important financial capitals in Europe, but also for having the most agglomeration of museums in the Hessen Region in Germany. A visitor can easily find a total of 39 museums spread throughout the city centre, riverside and surrenders. Unprecedentedly, there are museums for every single interest, for instance there are museums for: electronic music, world heritage, caricature, architecture, communication, archaeology, film, science, contemporary- modern arts, and even there is a museum specially organized for blind people. From the architectural perspective, one of the most iconographic buildings in the city is the Museum of Applied Arts designed by the American architect Richard Meier and also the museum of contemporary art by the Austrian architect Hans Hollein. These exhibition buildings were planned and conceived around 1985 and 1990 respectively and represent within their features, traces of the late modernism in Architecture.

With an increasing market of contemporary Art worldwide, especially visible in Europe where a solid increasing of art visitors has a constant tendency. In the last years, German museums are looking to extend their exhibition's areas also for preserving Art. For instance, in 2010 the Städel Museum, one of the most important Art museums in the region, with an own collection of ca. 3100 Paintings, has extended 3000 m<sup>2</sup> more area (before had 4000 m<sup>2</sup>), almost has double its exhibition area. This extension is exclusively for a new collection of 230 works of Paintings, sculptures, installations, films and large- format photography and others type of art. The new contemporary Art collection is composed from 170 well-known artists such as Baselitz, Giacometti, Warhol, Bacon, Glöckner, are now exhibited. This new extension project, short described, proposes elegantly a doubly-curved roof slab with circulars roof lights. Aesthetically, manifest itself, from outside and inside, as deformable roof surface, a marvellous proposal which was conceived purely with computational tools, marking and envisioning drastically a shift in the architectural design process.



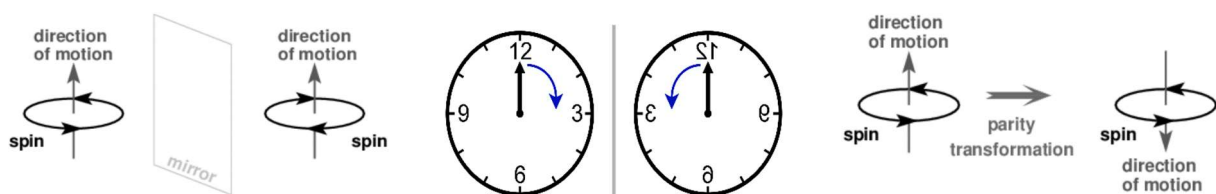
# Research questions

The main investigative stream in the project was to interrogates the spatial implication of the visitor in direct relation with the piece of art. *How conceivable is that the visitor becomes also a piece of art? and therefore being also exhibitable. How plausible is to invert these roles inside an Art museum? How can be recreated multiple spatial inversions, associated with the museum's program? How the piece of art interacts with the scale of the visitor?* These premises impact both on the spatial programmatic formulation of architecture and also on the differentiated geometry of the project.

For Physics and mathematicians, the inversion of space is in a direct relation with the inversion of time and also with the transformation of the spatial symmetry "Parity". This operator affects directly the projection of the space, its spatial coordinate and negativizes their values.

$$\mathbf{P} : \begin{pmatrix} x \\ y \\ z \end{pmatrix} \mapsto \begin{pmatrix} -x \\ -y \\ -z \end{pmatrix}$$

Consequently, the transition of a particle or a vector would have an opposite directionality. This phenomena could be simple exemplified by visualizing an object reflected on a planar mirror. When translating tangentially an object on a circumference as a path, could be seen how virtually two objects circumscribe an empty space with opposite directions. These circumferences have a Z-Axis. It is to assume the rotational transition as a clock system. A clock brings information of 24 hours on a two-dimensional circular plane, then the question, *if this clock spiralizes into a real three-dimensional space?*



The abstraction of the concept to reverse or negativize transitions, propose already to speculate about a rough primary spatiality. However, to develop the previous concept further, it would need an element, which tectonic induce a spiral organization. The selected element would work as an initial geometry. *Do a fibre have this geometrical potential?* Fibres have a defined geometry and structural organization. I assume, that the geometrical unit of a textile could be digitally reproduce an informed with parameters. For instance, it could be clockwise constrained with an exclusive angularity for each hour. But, parallel to this, it is needed to investigate theoretically a wide range of concepts dealing deeply with the concept of transitions, voids, geometry and space.



# Methodology

The Design Research methodology proposed for this project is a qualitative data exploration with the aim to derive in a unique architectural building verifiable through plan floors and sections and a three-dimensional model. This method is categorized principally in two sections:

## A Systematic Process:

With critical observations, analysis and interpretations of the information's subject, mainly identifying weak points or problematics in Art Exhibitions. Also, how to rethink or transform them into potential conceptual possibilities in planning a new Art Museum. In this case, I would describe and identify certain failures and mistakes in the most of Art Museums in the city. To begin with this process, was visited entirely the universe of art Museums and Galleries in the city. Analysing mainly the spatial organization, the disposition of the piece of art and the behavioural phenomena of the visitor on direct relation with the piece of Art. From a collection of problems, with a critical thinking, could be disseminated the most relevant issues, those are:

Firstly, in the most of the art museums the museography is disposed into a rectangular disposition, could be assumed that, this arrangement derives from the orthogonality of walls. Academically, the curatorial discourse is intensively trained to classified art, in order to demonstrate some hypotheses. Then exhibitions are divided in common features or periods. Also, the exhibitions are planned into rectangular cuboids or boxes with a considerable height. The difficult with this, is the fact that the exhibited art needs to be encapsulated into a large number of boxes. In most circumstances, this division truncate the spatiality of the whole exhibition, abbreviating it into sub-spaces which are no longer interconnected. As a consequence, visitors do not reach an overview of the entire exhibition, they just can value a fragmented group of art pieces, without a chance to compare them or, in between, to refer it with another artwork.

Secondly, from the upper point, is derived the problematic of perceptual comfortability. Generally speaking, it is important to have a proper space between each works. Also, visitors do not have enough area and depth distance to perceive properly an Artwork. Precisely in Paintings, contemporary art demands bigger formats of Canvas than before. Apparently, the initial reaction of the visitor is to move some meters back with an angular arc of 60 grad respect of a piece, for a proper appreciation of a canvas up to 2 x 3 meters it is recommended to have about 9- 11 meters distance. Unfortunately, the lack of this distance affect and distort the appreciation also by the spectator. In addition to this this perceptual space is also affected who other spectators who walk through.

And the third issue is related with the fluency of visitors through the museum. it is very notorious, when passing from one area to another one. In most of the case there is a narrow place of transiting, that makes quite uncomfortable and deaccelerate the interest in visiting art. In fact, some visitors manage to see about the 75 % of the entire exhibition.



## A Digital Process

In the revolutionary time of digital era, the usage of digital tools is becoming fundamental in planning and linking the knowledge in interdisciplinary fields. In the future construction technologies digitalization, virtual reality visualization and even 3d printing concrete are envisioned as a standards tools in the short- term future in the AEC Industry (between Architecture, Engineering and Construction). Under the assumption, the future of conceiving a building is completely digital, the research focuses in working with digital tools in the conception of complex, innovative and informed building. The research agrees in developing a new Process fundamentally between architectural Design and Computation.

The digital workflow used in the project can be seen as a novel computational methodology in architectural Design. In early stages, focusing in conceiving form generation with a non-standard/ orthogonal geometry, following by a collection and dissemination of data.

The computational capacities offer in the methodology a clear understanding in the development of geometry. The advance analytical models that are produced are performative models, capable to deploy several geometrical results. These models are calibrated through heterogeneous information that the programmatic space in the building needs.

Within the Research was work on a digital framework mainly based on Nurbs-Curves, - Surfaces (*Non-Uniform Rational B-Spline*) due to its flexibility and precision. I work with the powerful tools in modelling and animation of 3D Max such motion routes, bones, rigging, skinning, strings, particles and others dynamic systems and modifiers. In addition to this texture and transparency aspects were helping a lot of understanding the intentionality of the geometry, obtaining outstanding results. With these features, renders were helping as speculative representations allow me to speculate further about architectural space. Those were really helpful to initiate set up geometry them the geometry was implemented, parametrized and animated. Simulations are crucial in representing the evolution of the geometry. At different stages are the evidence of an infinite diversification of geometrical varieties. It is important to apply a discrete selection prioritizing the geometry that emphasizes positively a gesture in the project. To help in this procedure, was an enormous understanding working with timeframe, camera sections and cinematics effects. In fact, from the multiple scenes was set up Time-based diagrams exploring its variations of how the geometry performs at different times.

This digital process could be seen as an emerging technology capable to transfer descriptions onto three-dimensional models. Obtaining experimental data collected from these trained models is a long process but represent an unknown bur exquisite output just visible through computational capabilities.

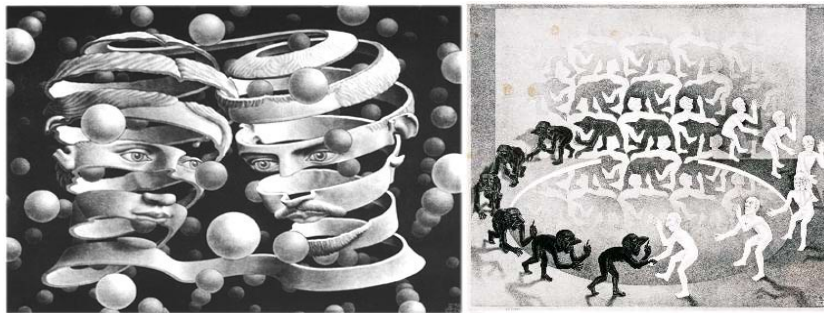


# Theoretical Analysis

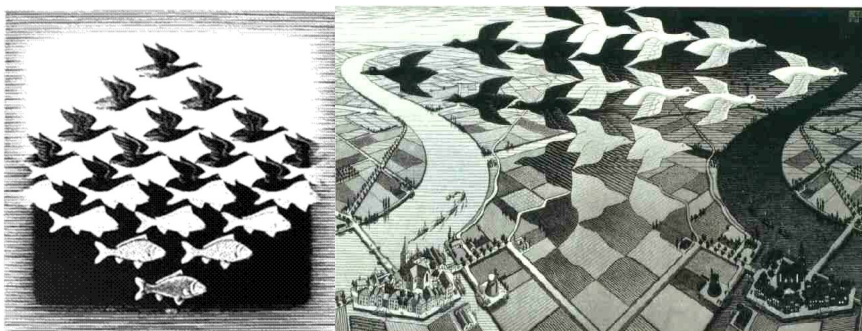
The Design Research undoubtedly include a theoretical part. This explore deeply through paintings, drawings, installation, and sculptures, which have the potential to translate purely a unique vision of a conceptualization of hypothesis.

## **The infinity geometrical time of Escher:**

The mathematical art of the dutch graphic artist Maurits Cornelis Escher, show us impossible geometry constructions without an End. Through his deeply exploration in the field of tessellations, this means regular patterns that divides perfectly a plane. This system with regular units turns into a high complexity sometimes showing a constant concentrically inversion till an infinity time. *without end at the Spirals?*



For Escher the transition, is a mathematical process of passing from one state or place to the next. This process means share of properties in both sides with a variable axis. Supporting this using also some chromatics strategies between the foreground and background, the inversion of some parts of the same draw consequently both sides are linked perceptually necessary to develop the effect of the transition.



The sense of infinitive was deeply present at each work of Esher the fluency of a path of walking is always the same, but something attracts to round in these infinitive ways. In some of his illustrations is dealing with the infinity in circular patters or in a mobius band.

The interesting on his works is that he elegantly disappears the symmetry by disaggregating its properties. Then distribute these into every single element on the two parallel realities.



## **Anish Kapoor: The Turbine Hall, London**

*Entrance , entranceway , entryway , entry , entree  
Something that provides access (entry or exit);*

The *Turbine Hall* at the Tate Modern Museum in London Installation by Anish Kapoor. The large-scale sculpture, works over 150 meters long, mainly composed of three steel rings with a PVC membrane stretched between them. The Artist focus on the negative space or non-space.



Formally, the fluency form of the installation, suggest gradually a main cylindrical entrance, when spectator is there, the space reacts to become into a scenario. The geometry is smooth and variate constantly from different radios. Perceptually the velocity of the inner space transfers the spectator inside its spatiality till an infinite. The installation investigates the void space as an element, from where a variety of flexibles scenarios around the sculpture are developed. At the same time, the flexible geometry disturbs and transform the immediate rigid context.

## **Nox architects: Blowout Toilette, Netherlands**

*Erupt in an uncontrolled manner, melt, break, or become otherwise unusable*



Nox architects emphasizes on the relation between subject and object also between matter and information. Projects are designed to explores into a notion of cognitive architecture. Moreover, investigate the concept that visitors unique perform upon what Nox calls “a reactive” architecture. The perception of space is complemented through movement. In their design spaces, rich of aesthetic properties, the architectural logic adapts to the user.

Nox architects lights up specially on structure a materiality. It is also interesting the usage of generative and experimentations models for form finding geometry.



## **Christo and Jeanne-Claude:**

### **The Gates, Central Park, New York City, 2005**

*A door-like movable barrier in a fence or wall.*

*A computer circuit with several inputs, but only one output that can be activated by particular combinations of inputs.*

*Passageway (as in an air terminal), where passengers can embark or disembark.*



The installation took place between 12 of February and 11 March of 2005 at the Central park in New York. This was a proposal from the artists Christo and Jeanne- Claude. This installation was inspired of reminding the gates that used to have the park, when this was surrounded by a stone wall about one hundred fifty-one years ago. In the previous years the park was intentioned to be close for security reasons, but finally this decision was declined.

Interesting in this landscape installation is first, the arrangement and directionality of the gates or frames. The scale of the frames plays a fundamental role, as same as in the work of Anish Kapoor, it suggests a unique space but also transform the immediate context. Secondly, the dynamic of the textile constantly moving at every frame. This movement give a sense of plasticity in transition. Moreover, the deformation at every frame produce a completely diverse environment or experience at every frame. The time in every space frame is moulded by the orange fabric. Also crucial is to perceive how is the relation between the visitor and the gates and the fabrics when walking through. But, theoretically gates are entrances, the concept implies a diverse of definitions, from a noun: *ingress*, *access* verb *entering*, *irruption*, *incoming*, *intrusion*, or *incursion*. or an adjective an also the enormous variety of synonyms, *admission*; *admittance* *registration*; *enrolment*; *enrolment*. *Entrée*.

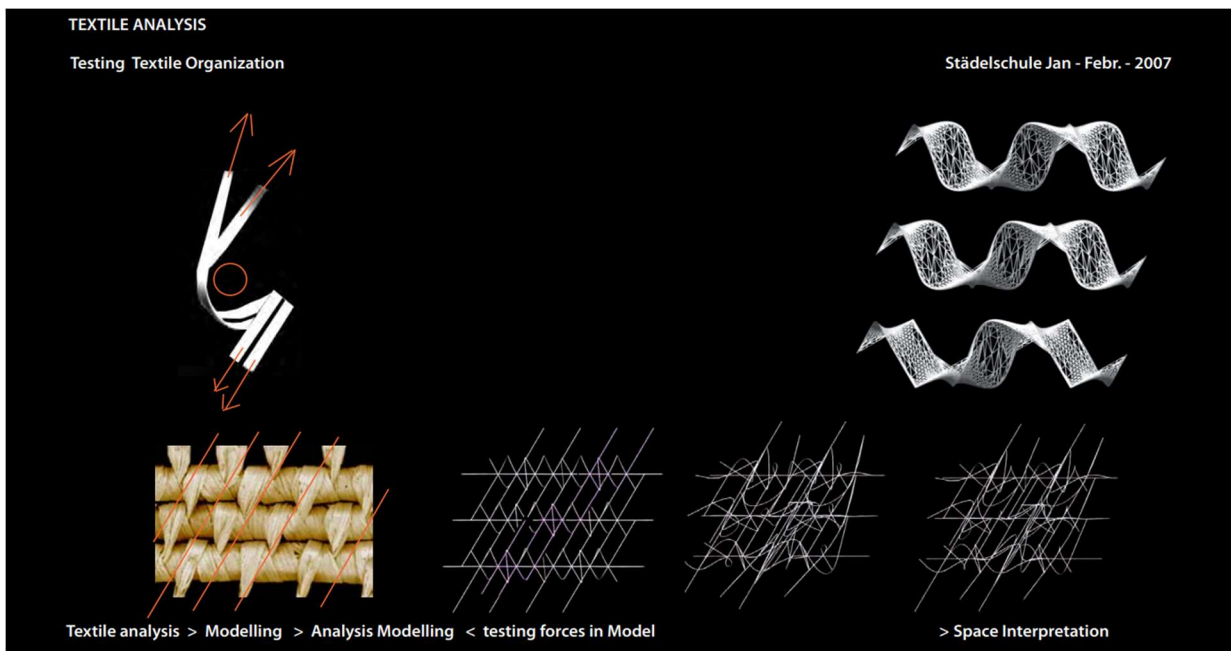
The Abstract idea of transition from a simple or multiple entrance could be an aggregate feature in the spatial planning. Further I will see how these conceptual ideas are transformed digitally. Entrances would transform in different forces which deform a spatiality. The idea of having a central void, from where, the architectural program derives from. The idea of merge the line of symmetry between the four exhibition spirals. The accented spatial relation between the visitor and the piece of art,





# Textile analysis

A textile is a complex geometrical system consisting of natural or man-made fibres, fibres are also composed of inner wrapping fibres. In macro view, fibres are usually long and thin but, in a micro view, the microscopic inner structure are composed of multiple spaces in between. These residual spaces are the reason why fibres are so flexible. On textile fibres follows a precise arrangement, then they are usually connected following a geometrical pattern. Physically, textile is an anisotropic system, which means that has different mechanical properties depending on the direction or cross section where is analysed. The Textile offering a strong structural capacity.



The flux of the visitors is intended to be a common parameter between two neighbour units

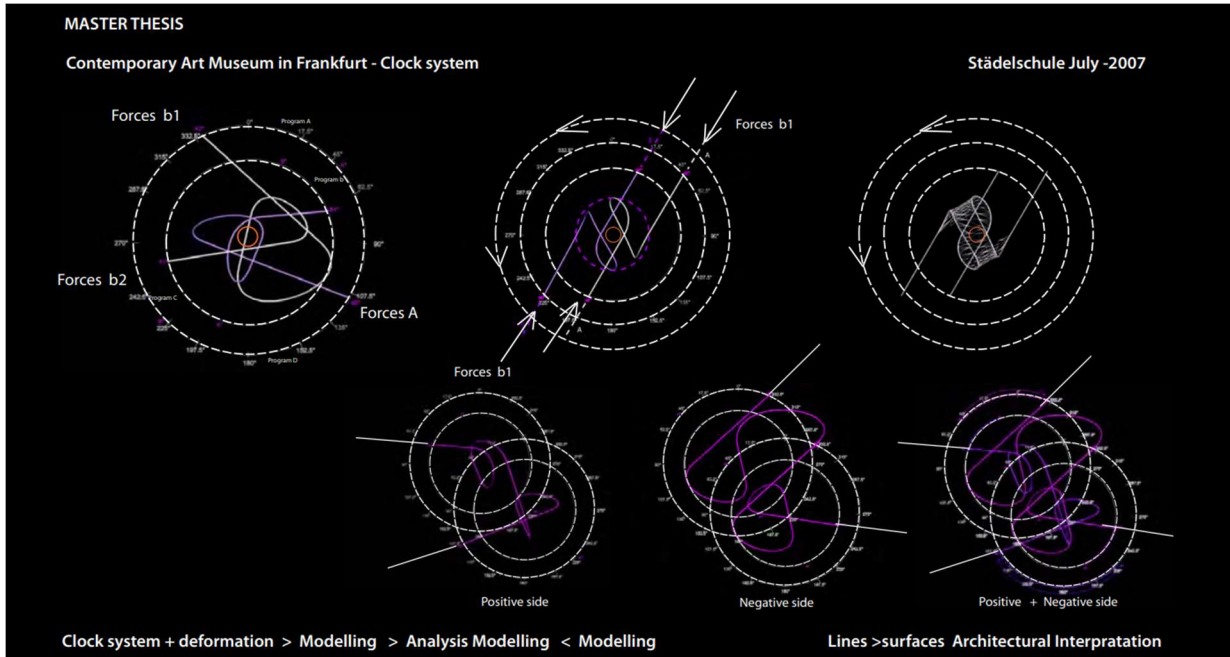
The digital model of the unit consists of two fibres, which parallelly wrap a transversal element, with an exact angularity of 45 degrees. Immediately after wrapping fibres bifurcate in order to wrap the next element, therefore form each of them the next units. After a repetitive process, a portion of a textile organization is digitally simulated. Here, the method of digital population of units have been related. Framing the digital system, reveals that structurally, forces runs diagonally throughout the textile system. However conventional stresses such a tension or pressure would not deform qualities and properties of the material compositions. In order to modify geometrically a unit, should be apply forces, which deforms diagonally its structure.

Constrains are applied to the four ending of every unit. Those endings are constrained to a set of circulars paths with different radios. When rotating fibres, interesting spatial dislocations appear. Hence, this alteration is more evident with an angularity more than 45 degrees. Further on, these radios would represent the amplitude of the exhibition area. Meaning that every circle is parametrized to fulfils a required area of every single architectural program. In this manner the entire program is represented in a system with many circles enclosing different areas. Each of these units are communicated and performs simultaneously an alteration, the result of this,



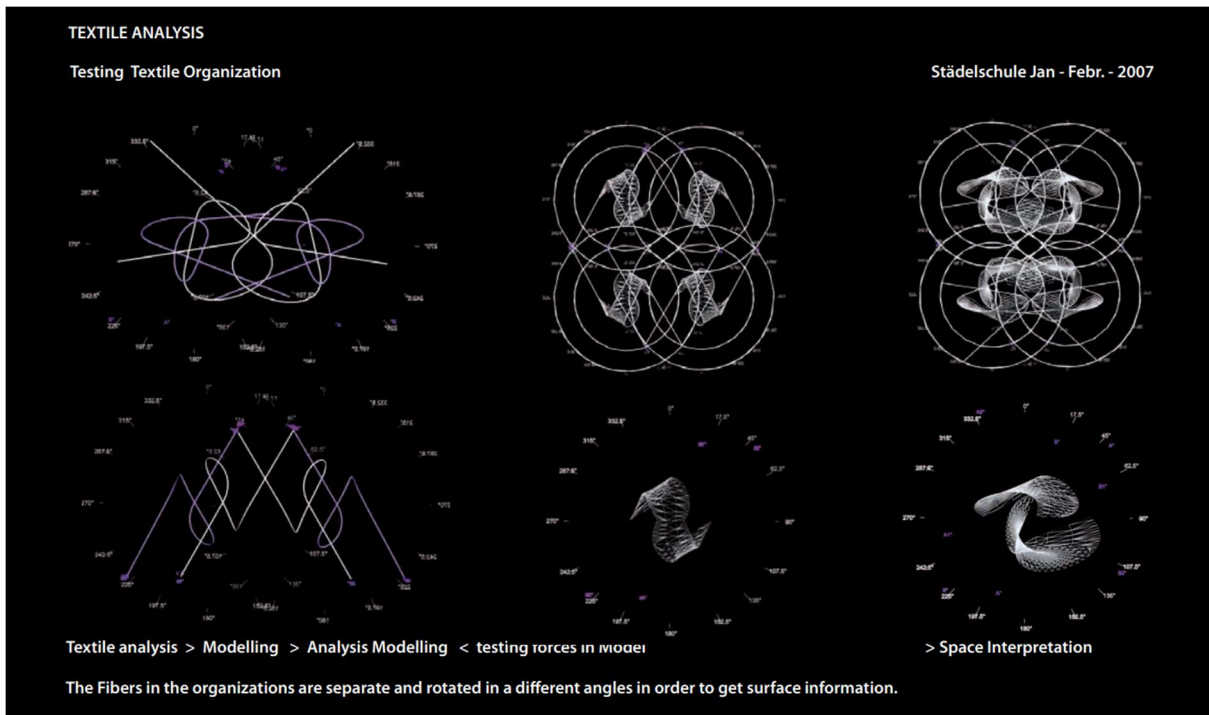
there is a unique geometry configuration, that could be assembled with the succeeding one. With the purpose of generating topological condition for architecture.

The textile unit is tested digitally by forces. This performs a variety of behaviours depending of the intensity, orientation, directionality and angularity of applied forces even a gravity force is applied. This deformation depends on the material system and geometrical condition of textile.



The flux of the visitors is intended to be a common parameter between two neighbour units

While transformative forces stretching the textiles organization, fibres in the inner structures are frictionating and bending. Digitally the result of this is a series inner deformed space.

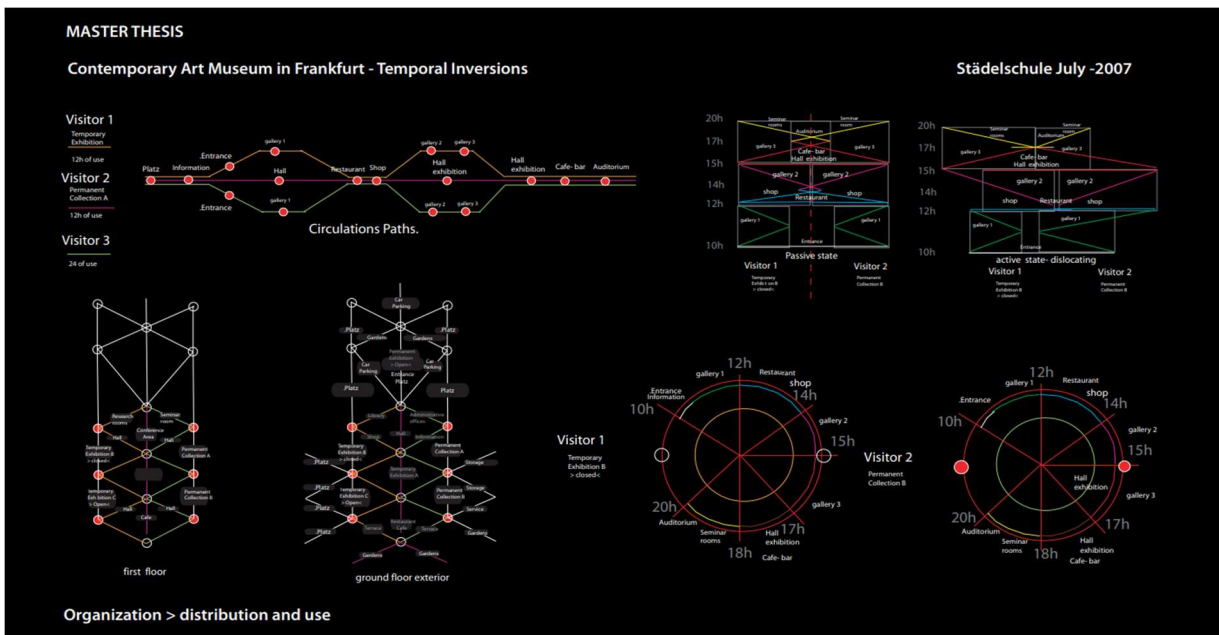


Deformation of the units, rotational forces are applied

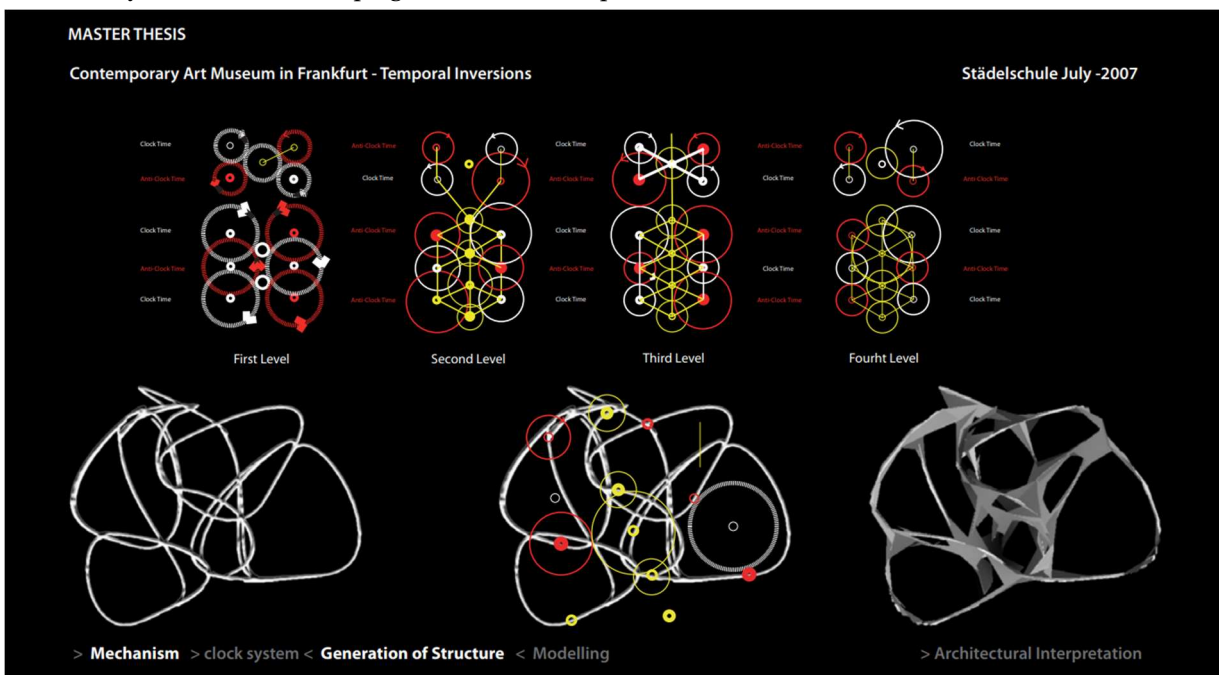


# Architectural programme

From the art curation responsible for selecting, exhibiting, housing and storage the art collection strongly recommends to prioritize two main programs at the museum of contemporary Art, those are the Permanent exhibition and the Temporal exhibitions area. In addition to these, there are a variety of programmatic spaces complementing and interconnecting both, such a multi- purpose spaces, Auditorium, Collection Storage, Museum offices, Administration, Library, Research area, seminar rooms, Gift- and Bookstore, café restaurant, Facilities support and visitor services. Outside the building parking exhibitions gardens, outside atrium and other smalls exhibitions area.



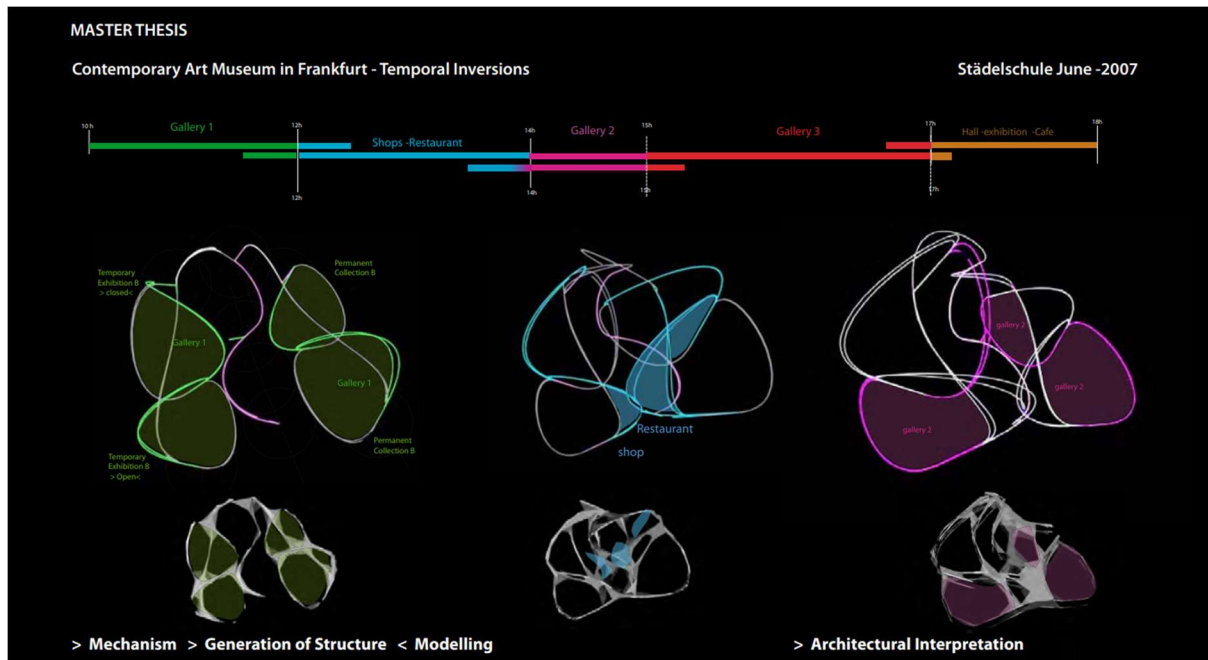
Connectivity of the architectural program. Clockwise disposition.



Generation of Architectural Structure

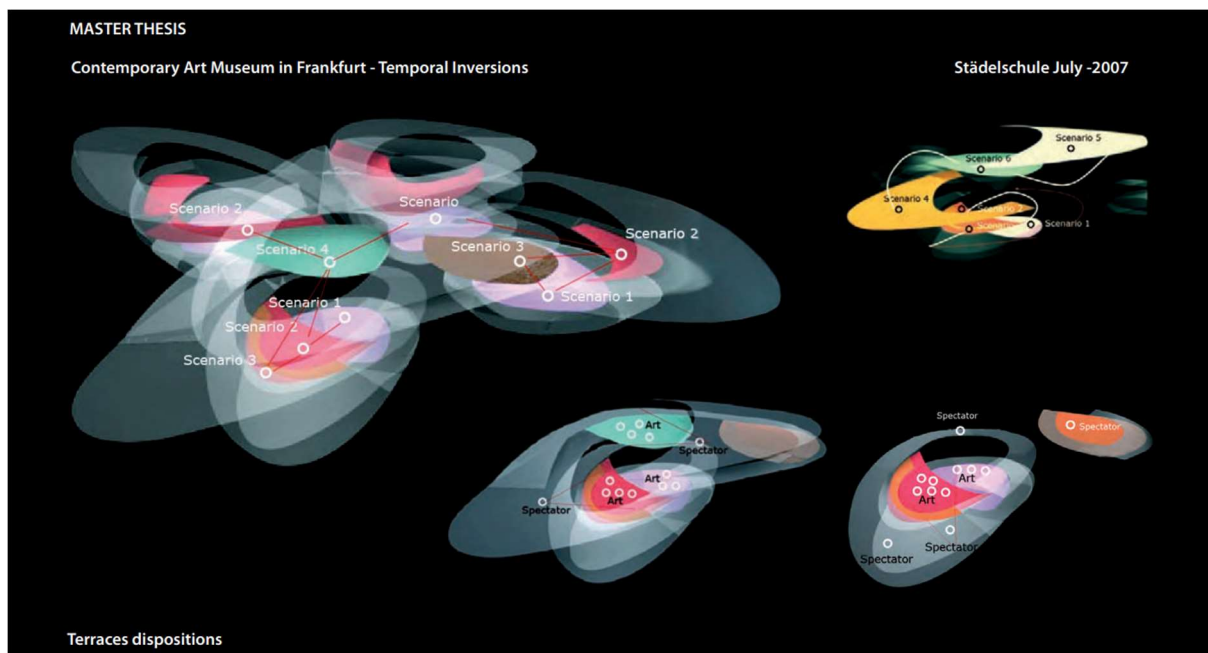


The fluent spiral organization enable to interconnect the program organization dynamically. Every collection is connected each other at the interlocking parts of the spirals, where new spaces appeared. In these intersections' knots, appears facilities such a conference and research rooms. Also, in these interlocking platforms are kind of transitional spaces where parallel exhibitions associated with the narrative of the main exhibition are presented.



Architectural Interpretation in the generation of Structure.

So, at the same spirals have a duality to generate multi or solo environments. In this transition It is also expected that visitors could navigate between the exhibitions and the rest of the program intuitively.



Disposition of terraces: Spatial relation between the piece of art and the spectator



# The Contemporary Art Museum

The museum is spatially composed of four intersecting spirals that unfold in a sequence of programmatic spaces such as extensive exhibition and performance spaces. The four spirals allow for dividing the exhibition programme into deferent categories. Furthermore, the intersections between the spirals accommodate general and shared amenities, such as cafés and restaurants, museum-, gift- and bookshops.

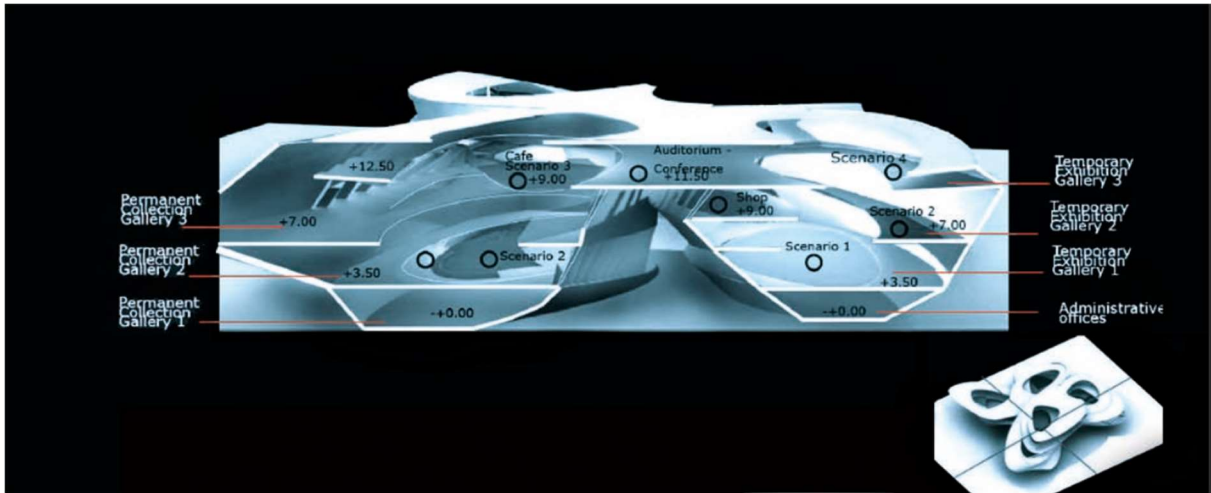


The new museum of contemporary Art in Frankfurt am Main, perspective view

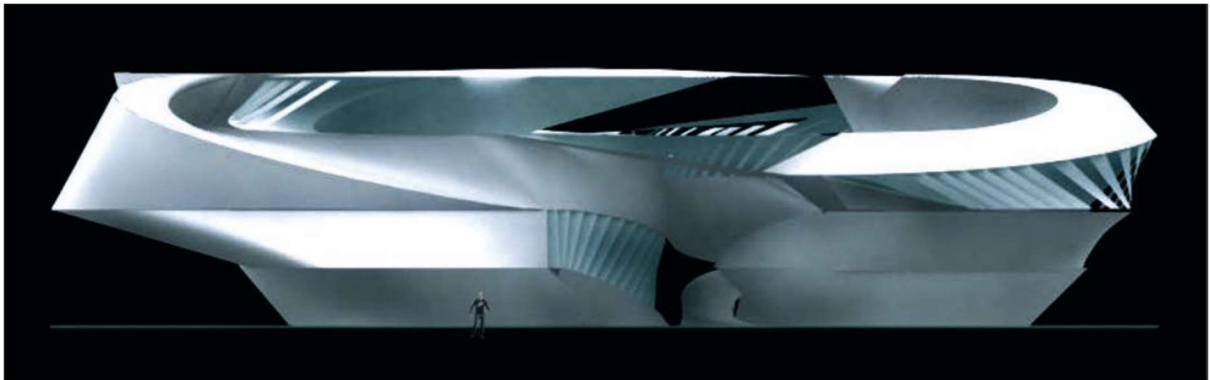
The new Museum of Contemporary Art in Frankfurt am Main organise itself as an open three-dimensional field, where the traditional gallery spaces are transformed into a series of terraces. In sectional terms, the terraces are set back from another and produce a theatre wherein the visitors become part of the art spectacle. From an upper terrace, one can look down on other visitors moving through the lower exhibition areas. In this manner, the proposal conceptually attempts to stage art in a new fashion where relation between the viewer and the object is transformed through intervention of other visitors.

The proposal embraces the design of the whole site. That's means a part of the museum we have some outside services that work 24/7 such a Parking area, Parking facilities, bus and metro station, Public Platz, pedestrian walkways and cycle paths, Gardens and landscape areas and open air -exhibitions platforms that are as well part of the public filter area between the museum and the immediate urban context.

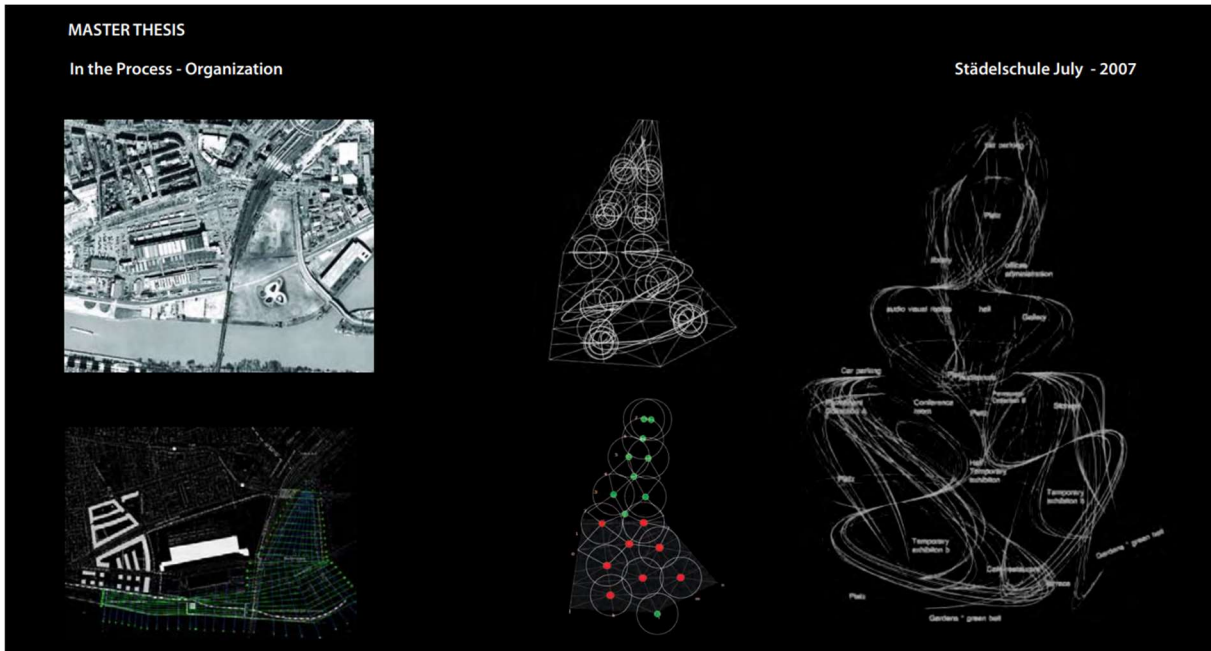




Analytical 3D Section: showing the interlocking spaces.



Main Elevation



Grid System on Site

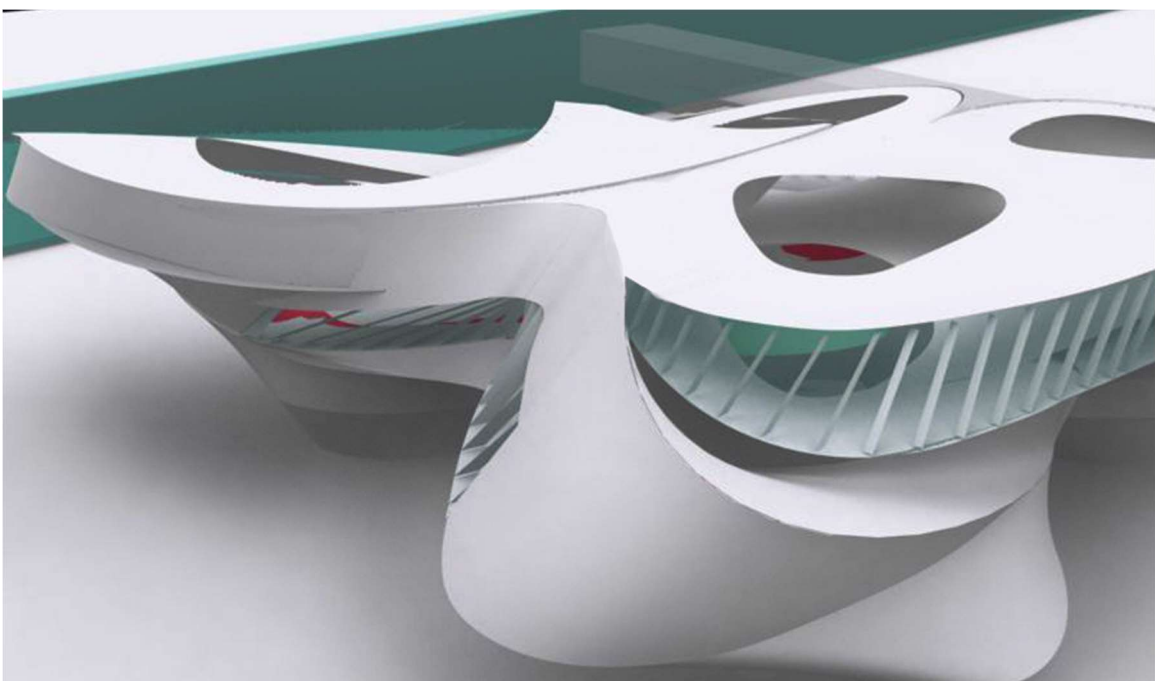
For this purpose, the entire area was gridded. On this, the mechanisms would re configures the grow of new units. This grid allows to extend and coordinate the system. Then the production of geometry fit on the entire site. The resulted geometry proposes from the system are compatible and have the same tectonically value as the Building.



Another feature in the Project are the central roofs from each spiral. Those are thought to be a lightweight structural system with curved semi- and transparent glass pieces. The design investigation of the roof is mainly inspired by the experimental research of membranes led by the German engineer Frei Otto. Consequently, the curvature of the system should follow the geometry projection of the last top edges till the gravity point of the openings. From this Point the most suitable subdivision, for acquiring the void form, is a polygonal triangulation. Progressively the structure extends through this arrangement.

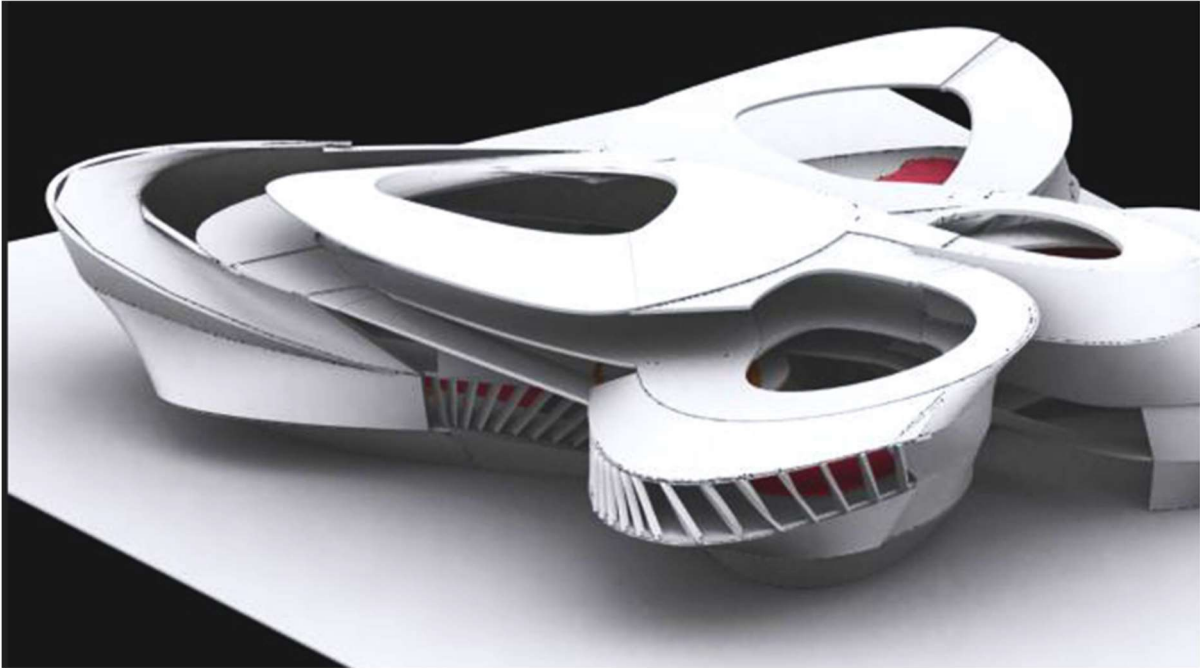


About the materiality, the intricate form of the external wall surface on the façade, could be materialize with a reinforce printed concrete in an additive manufacturing process, this is a construction technology which will mark a shift in the construction industry in a near future. Further, is how the facade is integrated or derive from the complexity of the architecture form.



The new museum of contemporary Art in Frankfurt am Main, west perspective view





The new museum of contemporary Art in Frankfurt am Main, est perspective view

**OBJECT ANALYSIS**

Paths -Interior Spaces generation Städelschule April-May 2006

Object analysis > Observation >< Concept > Analysis Modelling < Hand system > generation of space > Architectural Interpretation

Traces of the element we use when writing, for instance a pencil, the movement is following a determinated pattern, each of these intances carry information of directionality and time, we can with this data-information speculate about a generation of a space .

Generation of geometry through informed models.



Previous digital models.







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