A VÁROSLIGETI LEPEL

1. AUTHOR'S VISION

Buda and Pest

The history of the City Park is marked by constant attention to its civic green space. Throughout the centuries, the evolution of the City Park has seen an ebb and flow of new construction paralleled by the enrichment of the surrounding recreational areas. This process has resulted in a dense yet constructed landscape that reflects the wide range of culture and the city's appreciation for lush, open greenspace. The etymology of Buda and Pest can be traced to their geo-morphologic bases: "Buda" refers to water and "Pest" means cave. Water is a central feature of public life in Budapest, with an abundance of thermal baths serving as social platforms. It is a giver of life and has the ability to shape and form materials it interacts with.

The caves and quarries of the surrounding region are symbols of the past. Throughout the centuries, the limestone quarries of the region have served as building blocks for neighboring countries and public buildings. Whether shaped by nature or quarried, the unique limestone strata is a record of time. Embedded with fossils, it has the ability to preserve layers of history. Much like the trees in the City Park, the caves and quarries represent a quiet and sheltering place and have the capacity to "shroud" or protect. In recent times, the Rákos limestone quarry in Fertőrákos has become a monument in its own right, being named a UNESCO World Heritage Site for its sculptural quality. The New National Gallery and Ludwig Museum will therefore represent both the geology and the culture of the country and its capital city. We envision our building as a merging of these two archetypical attributes, clad in a shroud we call 'A Városligeti Lepel.'

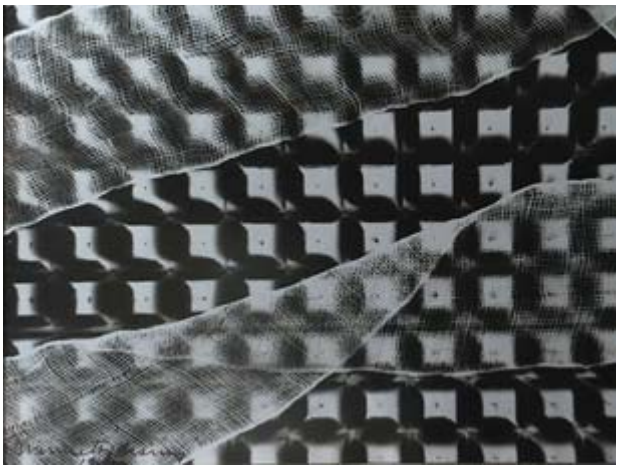
Park Axis

In a simple yet strong gesture, a new pedestrian promenade will meander along the edge of the existing City Park meadow. It will better connect the park and its existing desire lines with the eastern and western edges of the greater city beyond. This proposed serpentine path will reinforce an organic, axial connection among the many new museums including: the new museums of Architecture and Photography, the new House of Hungarian Music, and the New National Gallery and Ludwig Museum. The path will provide increased access to the existing open meadow while reinforcing the Park's historic past as a sanctuary of urban ecology. The path will create an interesting sequence of space as it weaves in and out of the woods to complete its route. Scattered plantings of cherry trees sited in drifts will act as way-finding devices with their colorful, seasonal bloom.

2. ARCHITECTURAL CONCEPT

Renewal and the Historical Significance of the City Park

The City Park has been designed as a picturesque public park, although its structure always incorporated strict geometrical arrangements. At present, one of the most important routes of Hungary crosses the Park, and the plans for its current renewal aims to re-introduce a formal axis with an outset of a rondo. We have inherited the former focal point of the Park- a place in which a range of curvilinear paths intersect and are insomuch empowered by this notion of a symbolic, historical axis. In the middle of the axis once stood the Industrial Hall, conceived in perfect symmetry. A dynamic, contrasting interaction of organic and geometric shapes define the outline of our building.



Utilizing grid+ organic forms.
Photogram of Tihamér Gyarmathy

Complementary Architectural Form

The duality of organic and geometric shapes informs the massing of the building. Free forms on the ground levels host public functions with a multi-story, direct link to the park. A distinguished system of approach is introduced on these levels. Much like the strata of limestone formations, the strict geometrical slab expression of exhibition and office space steps inward and outward to offer a contrasting, yet intimate user relationship with the artifacts. This elevated volume floats, shrouded in a skin of natural pattern inspired by the organic structure of leaves. Its porous skin allows an abundance of light and a kaleidoscopic pageant of shade and shadow to bath the limestone cladding. The ephemeral quality of the shroud, in combination with the tension created by the more geometric formal gestures, allows infinite perceptions of the proposal

massing within the line of the tree canopy. It gives free, visual access to public functions and a glimpse of an artificial, wild world consistent with the park context. Two concise vertical cores of circulation and services interconnect these levels, supported by escalators.

Cultural uses or functions are elevated in a way that allows for the insertion of public plazas above and below them. Public areas, both interior and exterior, are in close physical and visual proximity to the park. They are defined by spectacular views from infinite locations, especially from the rooftop.

Detailed Description of Functions
The Ground Level emerges from the landscape and blends into it again with openness to the environment. An aperture is formed by diverging slopes, downward grades connect existing desire lines to define diagonally opposed entry plazas that gravitate into the entrance hall. After accessing the building, a constant flow of spaces offer a wide variety of functions that serve the inside as well as the outside.

In the center stands the Info Desk to help orientation and the navigation of spaces. Shops serve the Entry Plaza as well as the Entrance Hall. There is separate, direct access from the underground parking lot. There is a separate entrance for services, also connected to the car park.A flight of stairs connects the lower level of the entrance hall with the Café and the separated event spaces of the New National Gallery. Event spaces and the Café are located on the upper level of landscape, in line with the axis which passes through and helps to organize the building.

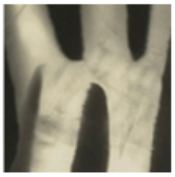
Functional cores with escalators enable circulation throughout the building. All public spaces are freely accessible and are interconnected.

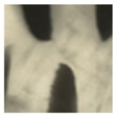
Soft forms on the ground plane are the base of the superstructure of the Exhibition spaces, which are in relative proximity to the museum offices. The organization of the complex is stratified by function and follows a vertical order organization: the Ludwig Museum is on the Lower Level and the New National Gallery is above it. The levels of Exhibitions and Offices follow an access protocol, each separated by the core. While it is possible to visit the exhibition spaces in a systematic, linear manner, one may also adopt a less formal route consistent with the meandering pathways of the parkscape.

Sudden, dramatic views of the park offer an enhanced visitor experience. The overall arrangement of functions presents a wide range of flexibility- which is useful not only in the spaces of temporary exhibitions but also in the areas of the permanent collection. The roof garden, situated on the top of the museums, is an elevated public space with viewpoints above the tree canopy and the city.

3. SITE RELATIONS

The lot, being situated in a primary focal point, has the capacity to celebrate and enliven the dense landscape of the City Park in terms of public experience. Due to scale of program allocated on this site, the museum will become a natural counterpart of the Heroes' Square — the great routes radiate from these two points. The landscape surrounding the building offers the possibility of both crossing and entering. The open-air features of the proposal provide an extension to the great meadow.





Interaction of building and landscape.
Photogram of László Moholy-Nagy

TECHNICAL NARRATIVE - ARCHITECTURAL

Planning & Stacking

The overall planning and stacking strategy for the building situates public and event based programs at grade and atop the building, while the galleries and staff offices are located in between. This placement of dark and dense gallery program higher up in the building helps to liberate the ground plane, freeing it up to become a civic based event plaza. The planning of the gallery floor plates provides both the New National Gallery and Ludwig Museum their own individual floor plates to better reinforce each institutions singular identity. Temporary and permanent collections are split via an open air atrium that intuitively draws patrons up and through the building, reinforces the city axis, and allows natural light to come deep into the center of the sheltered plaza below. Back of house loading, curatorial functions, and parking are accommodated in a singular below grade level.

- Level +4 +5 Cafeteria / Special Events / GAIA / Obs Deck
- Level +3 National Gallery Permanent & Temporary Exhibition
- Level +2 Staff Offices / Ludwig Museum Perm & Temp Exhibit
- Level +1 National Gallery Events Hall / Public Plaza
- Level +0 Arrival Hall / Ticketing / Parking
- Level -1 Loading Dock / Artifact Handling / Service / MEP

Level -1 Loading Dock / Artifact Handling / Service / MEP
Back of House spaces are housed in a distinct below grade level and separated from front of house public program elements. Construction of the loading dock is typically designed as a blast rated construction. The planning of the space provides a bifurcated service level with "clean" curatorial spaces organized to the south and "dirty" building support spaces along the north. The loading dock is located along the eastern side of the site providing secure below grade access for loading of goods and artifacts. Screening of the trucks can be accommodated at the top of the ramp via a sally port. The two northern most truck bays are dedicated "dirty" bays to day to day non curatorial delivers and refuse pick up. The southern two bays are dedicated Collections bays which can accommodate two semi-trucks up to 18m in length. Bringing the Collections bays deeper into the space provides an added level of security and oversight for the loading dock by isolating non curatorial delivers to the immediate north, well away from collection related deliveries.

The southern Curatorial bays are individually dedicated by shipment / gallery type. The southernmost bay is identified for temporary collections use while the northern most bay is identified for permanent collection use. Each bay has an immediate adjacency to a dedicated freight lift. Both freight lifts are envisioned to be share by both institutions. The northern most lift is for permanent collections while the southernmost lift is assigned for temporary collections use given its higher frequency of use. Collections spaces are separately zoned and planned for each institution. Two light wells penetrate deep into this lowest level providing natural light for the back of house workshops.

The preliminary calculations for sizing the Central Plant is estimated at 10-15% of the overall floor area in addition to dedicated shaft and closet space provided on each individual floor. In addition a dedicated cooling tower is provided in a below grade well adjacent to the loading dock service ramp for ease of access for any required maintenance.

Level +0 Arrival Hall / Ticketing / Parking

Upon entering the Level 0 Arrival hall visitors encounter a centrally located ticketing and information point Located to the north and the south patrons have the option to proceed to one of the two vertical circulation cores or visit the Sculpture Gallery located on the western façade. The Museum Shops are situated along the southern glass façade to maximize the volume of patrons passing by. The Children's Gallery is situated on the ground level towards the north façade. A secure staff entry is provided in the northwest corner of the plan. Additionally two underground parking levels are provided for staff and public patrons alike connecting directly with the central arrival hall.

Vertical Circulation

The vertical circulation strategy for the building uses both elevators and escalators to circulate patrons throughout the building. Ticketed passenger lifts and escalators are located in both the north and south cores, serve distinct program spaces, and are accessed via a ticketing checkpoint. The two elevators in the northern core provide visitor access to the permanent galleries. The core houses an additional elevator outside the ticketing checkpoint for public access to the roof terrace and cafeteria. In a similar fashion the southern core provides ticketed access to the temporary galleries as well as separate dedicated access to the GAIA LAB.

Both permanent and temporary cores are flanked with escalators inside the ticketing checkpoint. By utilizing singular institutional floor plates, both the permanent and temporary collections of the two museums naturally stack permanent atop permanent and temporary atop temporary. This allows for an intuitive connection to be made via escalators between the floors thus reducing the required number of elevators needed to properly service the building.

Conversely should the museum consider a singular core circulation strategy for each institution the dual core elevator scenario works in a similar fashion. It simply provides the added benefit of future flexibility.

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Level +1 National Gallery Events Hall / Public Plaza

The National Gallery Events Hall creates a striking visual connection to the City Park grounds while allowing for large indoor / outdoor gatherings for special events. Its central placement on the site is accented with the two lecture halls, educational and conference facilities, the VIP lounges, press rooms, and a public café. The Events Hall connects vertically with lower reception and ticketing halls. The combined spaces form the heart of the educational, assembly, and after hours program and are easily accessed with vertical connections throughout the building.

Level +2: Staff Offices / Ludwig Museum Permanent & Temporary Exhibition

Staff Offices (2.5.2, 2.5.3, & 3.4)

Offices spaces are located on the L+2 and the +2.5 Mezzanine Levels separate from public access. The L2 Staff Offices utilize the entire northern half of the floor plate while the Level 2.5 Offices step back from the edge to creating a double high space to allow natural light to penetrate deeper into the floor plate. A light court is positioned into the deepest part of the floor plate to bring light from above and is programmed with the staff cafeteria which connects both levels with a double height space.

Staff access is provided by a Level 0 connection from the parking garage into a dedicated staff lobby. The 2 staff elevators located in the northeast core connect staff to all levels of the building. Reception points are located off of the staff elevators to provide a checkpoint for visitors and office workers alike.

The office floor plates are broken down and organized by departments. Level 2 is programmed with the offices for the New National Gallery (2.5.2) and is broken down by the departments. Level 2.5 situates program elements for the Ludwig Offices (3.4) towards the east while the remaining floor plate is dedicated for the New National Gallery Museum Professionals Offices (2.5.3).

The layout for the offices utilize a 2.5m planning module with a suggested open to closed workstation ratio of 80-20%. The planning of the office levels layers the workstations from the glass line inward in an open to closed fashion to maximize access to natural light and ventilation. To the highest degree possible the open offices are placed to the immediate perimeter of the floor plate, with closed offices layered towards the center and support functions such as file storage and print rooms placed furthest away from the facade. Department breakdowns are each provided with: a print room, mail room, meeting rooms, file storage, and tea kitchens.

The Ludwig Museum (3.2.1.1, 3.2.1.2, 3.2.3)

The formal program for the Ludwig Museums Permanent Exhibition, the Temporary Exhibition, and the Museum Learning functions (3.2.1.1, 3.2.1.2, 3.2.3) are situated in their entirety on the Level 2 floor plate. This stratification of institution specific functions helps reinforce the unique identity of the museum and provides added operational flexibility and management via the singular level planning approach. Two dedicated public elevators located in the southern core provide public access to the Ludwig Museum Level. The Permanent and Temporary Galleries are bifurcated by the central atrium providing a physical and visual link to the National Gallery level above.

The permanent exhibition is locates to the north of the floor plate while the temporary exhibition and museum learning functions are situated to the south. The column spacing for the floor plate provides a 20m gallery bay to maximize the flexibility of the floor plate for exhibit specific layouts and future flexibility. Ceiling heights meet the 5.5m clear requirement. Separate collections lifts are provided for both the Permanent and Temporary Galleries and zoned accordingly. Dedicated MEP, AV/IT, electrical, & security closets are provided within each core to serve the respective galleries. Four Points of egress are distributed through the 2 cores along with public restrooms.

The Ludwig Temporary Gallery utilizes a 3,000m2 space that can be subdivided into 2 distinct galleries along its 20m module each with separate entries. Divisions between galleries are complimented by glazed lenses which provide glimpses outward to the surrounding park landscape. The Temporary Gallery can utilize the entire 3,000m2 floor plate, be separated into (2) 1,500m2 bays, or 6 distinct 10m bays to provide maximum flexibility.

With its commanding view of the entry plaza the Ludwig Museum Learning suite (3.2.3) is sited in the northeast corner of the floor plate adjacent to the Temporary Exhibition. Accessed off the main atrium its open planning layout locates the two workshops and the main reading room as an overlook veiled by the outer shroud with clear site lines of the roof waterfall.

Level +3: The New National Gallery Permanent & Temporary Exhibition (2.2.1.1 & 2.2.1.2)

The formal program for The New National Museums Permanent Exhibition, the Temporary Exhibition, the Shrine, and the Graphics Cabinets (2.2.1.1 & 2.2.1.2) are located in their entirety on the Level 3 floor plate. This stratification of institution specific functions helps reinforce the unique identity of the museum and provides added operational flexibility and management via the singular level planning approach. Two dedicated public elevators located in the northern core provide public access to The New National Museum Level. The Permanent and Temporary Galleries are bifurcated by the central atrium providing a physical and visual link to the Ludwig Museum level below and the Special Events Rooftop above.

The permanent exhibition is located to the north of the floor plate while the temporary exhibition and museum learning functions are located to the south. The column spacing for the floor plate provides a 20m gallery bay to maximize the flexibility of the floor plate for exhibit specific layouts and future flexibility. Ceiling heights meet the 5.5m clear requirement. Gallery spaces are further enhanced by the Gallery Lenses. The Gallery Lenses offer visitors areas for respite and contemplation as well as educational points with their visual connections to historic points throughout the city. The New National Gallery Temporary Exhibit utilizes (4) 20m wide gallery bay with 3 distinct points of entry. The space can be subdivided on a 10m module to maximize flexibility.

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Both the Shrine and the Graphics Cabinets ask for a scaling of space to better acclimate the visitor to the size of the works or artifacts being presented. The formal planning for both spaces locates them on the northeast corner of the floor plate into an outer chamber of the gallery floor. Upon approach from the Central Atrium and the Temporary Gallery one perceives the walls of the outer chamber that envelope both programs. Glimpses of light act as a wayfinding device drawing the museum goers forward. Upon entering the outer chambers visitor's eyes are drawn outward to the Varosliget Park through the veiled view of the shroud. This intentional scaling up of the views provides a contrast to the size of the artifacts and works presented within the chambers. The floor over both the Graphics Cabinets and the Shrine is dropped by 1m providing a 4.5m clear floor height to the ceiling above to add to the contrast of scale. Both the Shrine and the Graphics Cabinets will be fit-out with light lock to protect the sensitive materials housed within.

Four points of emergency egress and MEP shafts are distributed throughout the two cores with public elevators and restrooms occupying both. A separate freight and staff elevators occupy the north core to serve the permanent collection. The southern core additionally provides a dedicated collections lift to serve the Temporary Gallery. Dedicated MEP, AV/IT, electrical, & security closets are provided within each core to serve the respective galleries.

Gallery Ceiling Heights (2.2 & 3.2 Exhibition)

Gallery ceiling heights are defined as 5.5m floor-to-ceiling. As requested by the program special consideration has been given to the placement of the Graphics Cabinets and the Shrine. The clear ceiling height in this area has been lowered by 1m provide a more intimately scaled space providing a clear height of 4.5m.

Level +4 +5 GAIA / Ludwig Special Events / Cafeteria

The highest level of the building houses three main program spaces; the GAIA Lab, the Ludwig Museum Special Events & Lecture Hall, and is complimented with the consumption spaces of the Cafeteria and Brasserie.

The GAIA Lab is accessed off the main atrium space from the south west corner of the floor plate. It's special theme and interstellar vision structures the program around the rooftop oculus dome for presentations and gathering. The GAIA Lab integrates a flexible raked assembly space and is complimented by the GAIA Hall. These spaces are flanked by a staff offices and storage spaces with direct access to the adjacent freight lift.

The Ludwig Special Events Hall is located on the eastern face of the rooftop with views focusing outward through the shroud. The space provides a direct adjacency to the kitchen and is equipped with the required catering, storage, and cloakrooms.

The southernmost corner of the building houses the Ludwig Lecture Hall. Its outward siting is complimented with and open-air terrace which can be used as spill out space with its prominent southerly views. Prior to the start of lectures patrons will be able to enjoy the view towards the park. The space has the ability to be used as a daylight space or shielded from direct sun via a retractable perimeter curtain track. Two additional Lecture Rooms are located directly adjacent to the hall along with the Lecture Hall Support and IT Storage spaces.

Food and beverage facilities within any museum are considered one of the largest revenue generating programs. Special consideration was given to the placement of the consumption spaces placing both the Cafeteria and the Brassiere atop the building in order to create a memorable place while maximizing the potential to generate revenue. Their location atop the Level 4 Roof Terrace creates a distinctive terminus to the museum with ample outdoor seating space. Visitors will marvel at the commanding outward views of the City Park and the greater Budapest beyond.

Outdoor Plazas and Greenspaces

Quality public greenspaces and plazas are a critical need for the success of any civic institution. A common goal established in the design was to give back more open space than we take for the above grade building footprint by actively integrating it into the design and the planning. The level 0 Reception Hall and the level 1 Events Hall form a split level composition of publicly activated greenspaces and plazas which tie together the natural desire lines present within the City Park. It is planned to better serve the institutions by creating flexible spill out space for events and gatherings as well as attract and hold visitors from the surrounding neighborhoods and City Park. The rooftop observation deck integrates a cultivated environment / habitat of wild flowers and grasses. Given the size of the plot boundary the building itself creates 38% more open space. When compared to the largest above grade level, the greenspace ratio is close to double.

Level	Area	Units	Note
Site boundary	19,706.00	m2	Property line
Level 4	13,606.00	m2	Largest occupyable footprint above grade
	69%		***Lot Coverage***
Level 4	2,369.00	m2	Open Air Public space
Level 5	11,816.00	m2	Landscape overlook (non occuplyable greenspace)
Level 1 & 2	12,730.00	m2	Reception & events plaza (outdoor space)
Total	**26,915.00**	**m2**	Landscape & outdoor civic space
Property Line	19,706.00	m2	
	37%		***Increase in landscape & civic space created on site***
Total	**26,915.00**	**m2**	Landscape & outdoor civic space
Level 4	13,606.00	m2	Largest occupyable footprint above grade
	198%		***Ratio of landscape & civic space versus largest floorplate***

Findings

A. The lot coverage of the largest floorplate above grade utilizes 69% of the site.

B. Assuming a greenfield site, the building creates 37% more landscape & civic space than exists within the site boundary.

C. The landscape & outdoor civic spaces are 198% larger than the largest floorplate.

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Landscape Concept
The landscape design consists of an organization of serpentine bands or striations that respond to the organic geometry of the museum building and the topology of the historic park setting. Landscape curvatures are ultimately derived from the museum's roof section, thus establishing a relationship between building and landscape. The subtle integration of building and landscape through curvature, within the park context, generates an overall impression of movement and natural rhythms.

The Green Roof Meadow
The proposed green roof consists of a 300mm soil growing medium. At the green roof level, the serpentine bands of landscape will contain plantings of meadow grasses and wildflowers that are divided by 1-meter wide lines of crushed blue glass. Light and dark gray paving is integrated with planted areas at terrace locations. The wildflowers will create broad drifts of color across the canvas of the grasses, creating an undulating visual amenity for terrace users. This amenity will be further enhanced by natural breezes, which will reinforce the sensation of movement created by the plantings. Roof water will be captured and stored for reuse. It will be used for irrigating the meadow and other museum landscape plantings.

Our inspiration for the Green Roof Meadow comes from Pal Szinyei's 1896 painting "Meadow With Poppies", which resides in the Hungarian Nation Gallery collection.

Ground Level Terraces
The serpentine lines of the roof landscape are projected down to the ground plane to create patterns of light and dark grey stone paving at major entry locations. A dramatic waterfall feature will anchor the main entry terrace. Water will fall through the oculus from the roof level into a pool at the terrace level. The sound of falling water and reflected sparkles of light will animate the museum's entrance.

Rainwater Harvesting And Reuse
The green rood will be the primary rain-water capture surface. The rain water storage will be incorporated into the water fall system design at the entry terrace. The waterfall pool will serve as the visible part of the rain re-capture and reuse system. Below-grade cisterns will provide water capacity for the waterfall and irrigation supply needs.

Park Axis
In a simple yet strong gesture, a new pathway along the West side of the existing City park meadow will connect the New National Gallery and Ludwig Museum to the new House of Hungarian Music to the south. This proposed serpentine path will reinforce axial connectivity among museums, including the museums of Architecture and Photography, and also provide access to the existing open meadow, in addition to psychic connection to City Park's historic design. The path will create interesting spaces as it weaves in and out of the woods to complete its trajectory. Scattered plantings of cherry trees planted in drifts will exist along the path. Their blooming will serve as indicators of seasonality.

4. TECHNOLOGICAL OPERATION

The scheme proposed for the LIGET museum is a four-story structure with an additional level below grade. While the below-grade level fills most of the site, the interior building area dramatically reduces at the events level, creating a large outdoor space. The building area increases for the upper level galleries such that the upper levels overhang a large portion of the outdoor event space. The outdoor space is intended to have limited vertical structure.

It is likely that this building would be constructed with both reinforced concrete and structural steel. The below-grade level and likely the ticketing level would be built with reinforced concrete. To create the area over the outdoor event space with limited vertical structure and large cantilevers, the structure would need to be steel. The spans and cantilever lengths are not conducive to reinforced concrete construction. Stability for lateral loads, such as wind, will be provided by two reinforced concrete cores located at the northwest and southeast portions of the building. The cores would be reinforced concrete through the full height of the building regardless of the type of structure used for the floors.

5. SUPPORTING STRUCTURE

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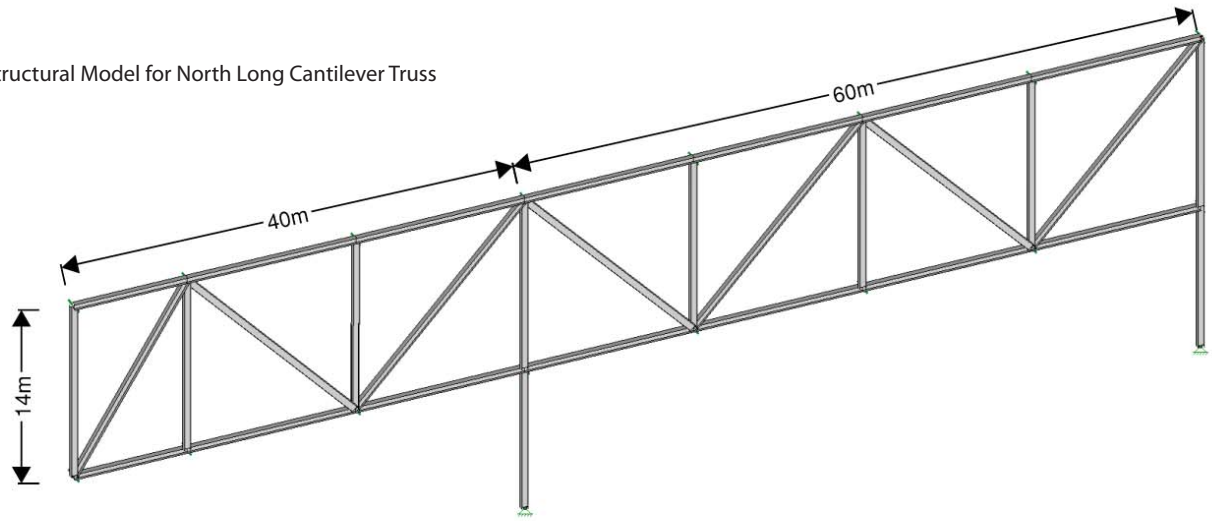
The only vertical supporting structure in the exterior space would be three or four columns as well as the southeast core. To achieve the spans required, both between the supports and for cantilevers, most of the level 2 gallery would be framed with full story height steel trusses varying from approximately 40m to 80m in length. The trusses and the dividing walls between galleries and other program spaces would be carefully coordinated such that trusses are either hidden, or architecturally expressed depending on the location. The most structurally ambitious aspect of the proposed structure is a large cantilever portion of the northeast portion of the building. This cantilever would be supported by a double story 14m deep cantilever truss spanning east-west along the north edge of the building. The cantilever would be 40m long with a 60m backspan. This results in a truss that is feasible though is at the upper limit of what could be achieved for the span and depth of the truss. Because it is at the upper limit, the amount of steel required for the truss will be large. During the design phase, we would recommend that several aspects of the cantilever truss be considered to create a more economical truss. As examples, reducing the cantilever distance by 5 or 10 meters would significantly reduce the amount of steel required for the truss. This could be achieved either by actually shortening the cantilever length, by moving the supporting column to the east or a combination of both such that the visual impact of the changes is minimal.

Structural Model for North Long Cantilever Truss



6. SUSTAINABILITY

Executive Summary
The vision for this building maintains larger ambitions than to simply facilitate the delivery of a high-performance building. The design intent is meant to illustrate a proposed shift of paradigm. The development of a new conscience of sustainable energy use is embedded in the museum design.
The objective has been to stimulate the senses and impart a sense of wonder to the visitors and generate a space that builds, links and promotes dialogue on the subject of sustainable design.

The LIGET Museum intends to become an exemplary model in sustainable design for others to follow and aspires to be a very low energy building, with a target Energy Use Intensity (EUI) of 85 kWh/ m2/ yr.
The museum is designed to include exhibit, performance and work spaces which have different thermal requirements and therefore also different energy usage requirements. These various space types and their thermal comfort needs have been taken into account and specific systems have been selected for optimum efficiency, as opposed to a 'one size fits all' approach.

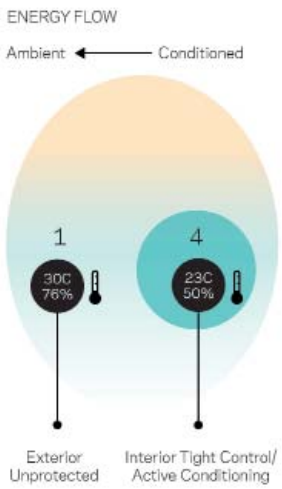
Low Energy Strategy
A sustainable, low-energy environmental strategy is at the heart of the design for the LIGET Museum. A clear hierarchy of design measures have been applied to reduce the base load of energy and other resources through passive measures. The building will utilize efficient mechanical systems and controls in order to make sure that energy and resources are distributed with minimal waste. This hierarchy considers technologies with maximum leverage and minimum cost first before applying technologies with smaller savings and higher costs.

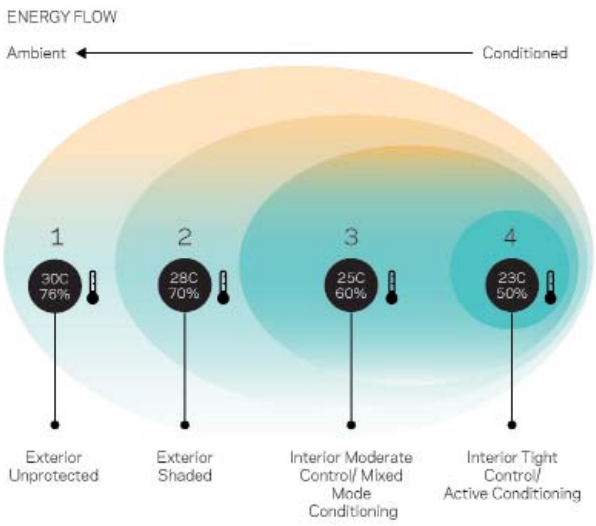
For the LIGET Museum, located in ASHRAE climate zone 5, a heating dominated climate, it has been estimated that approximately 52% of total energy used by the building will be for heating, 10% for cooling, 17% for ventilation, 8% for lighting and 13% for plug loads.The Energy Use Intensity (EUI) the project has been designed for is a maximum 85 kWh/m2/yr.

Passive Strategies
The environmental strategy for the building is to use low-energy and passive methods to optimize the internal environment through the range of seasons. First and foremost, passive strategies were addressed, in order to reduce energy demand. Thermal, Daylight and Computational Fluid Dynamics (CFD) modelling is a powerful tool that will be used to optimize and verify the proposed passive design measures.

Orientation, Massing & Thermal Mass
Building orientation and massing have been optimized for solar control and natural ventilation, taking into account prevailing wind directions (primarily from the Northwest during summer and from the East during the rest of the year).The project takes advantage of the solar declination angle in the cold months of the year in order to maximize solar heat gain. In the warmer months, the highest heat gain occurs through the roof which has the added 'insulation' and reduced 'absorption' provided by the soil and vegetation, resulting in a lower surface temperature.

The roof is, therefore, well insulated in order to mitigate the potential added heat gain and peak cooling demand. The inclusion of interior open spaces and light and air wells helps create a microclimate and also enables the use of passive strategies such as daylighting and natural ventilation.





Exposed thermal mass has been incorporated throughout for added thermal comfort and reduced energy demand. The green roof will maintain a high thermal resistance which will allow protection from direct solar incidence. Its beneficial use of thermal mass will result in steadier thermal conditions in the interior spaces. This will reduce the daily thermal fluctuation in indoor spaces, reducing the thermal loads and energy consumption related to space conditioning.

Thermal Buffers
During the preliminary design, careful consideration has been given to reducing the energy loads required to operate the building by identifying which areas require the highest environmental control and making a gradual transition to these from the external environment. The architectural space planning has been arranged to provide this thermal transition while buffering the inner spaces so as little energy as possible is required to condition them.

Daylighting & Solar Shading
Massing and openings have also been configured to improve daylight penetration and access for all spaces requiring it. Through the introduction of various light wells within the building, daylight becomes abundant in all spaces requiring it. In the perimeter zones and the zones adjacent to the light wells, lighting levels are above 60 foot candles (fc). Preliminary analysis predicts that implementing a daylight harvesting strategy can result in energy savings of up to 6%. The daylight harvesting control logic should be set up as such that when daylight levels are above 33 fc in the space, only 38% of the electric light is consumed.

These control parameters would be set for each sensor in all spaces. The daylight levels in most of the perimeter spaces shall be above 50 fc on an average day. Solar shading has been incorporated to control glare, excess solar gains and peak cooling demand. Shading will protect the transparent elements from direct solar incidence.

Natural Ventilation
The Budapest climate has suitable ambient air temperature and optimal humidity levels for the use of natural ventilation in transient and non-exhibit spaces during summer months. Wind speed does not pose a concern due to draft discomfort as wind speeds are not generally high and the critical outdoor spaces have been shielded from prevailing wind directions. Ambient relative humidity is generally below 65% for most of the year, which makes it ideal for natural ventilation without humidity problems or condensation risk. The light and ventilation wells are instrumental in providing ample access to fresh air.

Massing and openings have been configured to allow for fresh air access for all spaces able to take advantage of it when ambient conditions allow it.

High-Performance Envelope
The external building envelope will be sufficiently glazed to allow for maximum daylight penetration where applicable, thus allowing for a reduction in the energy required for electric lighting during the day. All glazing will have a high solar performance to allow light in while minimizing heat gain. All interfaces on the building envelope will be robustly designed and sealed to prevent unwanted infiltration. The table below lists the minimum building performance criteria established by the competition brief and the proposed assembly performance for the various building elements:

BUILDING ELEMENT	BUILDING ASSEMBLY	MIN. REQUIRED U-VALUE (W/m2 °K)	PROPOSED U-VALUE (W/m2 °K)
EXTERNAL WALL	Steel frame with insulation in its cavity and 100 mm continuous exterior rigid insulation, clad in locally-sourced, large-format limestone panels.	0.22	0.19
ROOF	Extensive (150mm-300mm soil buildup) vegetated roof system on composite roof deck with continuous 200 mm insulation above decking.	0.15	0.12
FLOOR SLAB	Combination of composite and concrete decking with 100mm rigid insulation at underside.	0.25	0.12
GLAZING (METAL)	Triple-glazed, structural IGU system with high performance thermally broken frame.	1.3	1.25

See architectural section for more information.

Active systems
In order to achieve the sustainability goals for the project, a holistic approach will be taken to the design of all the environmental control systems with focus on the points of maximum leverage to achieve a low-energy/resource design. In addition to the various passive strategies, the use of high-efficiency cooling systems such as radiant cooling systems, underfloor air distribution, high-efficiency chillers and efficient LED lighting will further drive the reduction in annual energy consumption, as compared to a conventional, minimum code compliant building.

Plant Efficiency & BMS
All operating plant and systems will be of the highest efficiency possible with variable speed drives and smart controls installed to make sure that wastage is reduced to a minimum and advantage is taken of the passive design elements of the building. All the environmental control plant will be monitored by a central Building Management System (BMS), configured to identify faults or plant operations when not performing optimally. The controls will be tuned to different seasons and operating modes to ensure peak operation and energy saving.

District Heating
Peak heating and domestic hot water demand will be met with heating hot water provided from the district heating system.

Hybrid Geothermal System
Geothermal systems take advantage of the stable ground temperatures and its thermal mass by harnessing heat from the ground and using it to heat the space during colder days and rejecting the heat from the spaces to the ground during warmer days. These systems work best in applications with balanced annual heating and cooling loads to help maintain the stable ground temperature conditions. The Budapest climate is heating dominated, however a hybrid system of ground source heat pumps could be efficiently utilized and scaled to satisfy a smaller base annual cooling and heating load with additional peak heating provided by the district heating system and additional peak cooling provided by water cooled chillers rejecting heat to atmosphere via cooling towers located adjacent to the parking garage ramp.

Underfloor Air Distribution
Displacement ventilation systems utilizing the introduction of supply air at low levels will be used in high-ceilinged spaces, providing excellent levels of comfort and tight temperature and humidity control in the art display zones, while reducing the overall energy required to heat and cool these spaces.
In potentially high-occupancy areas, the use of underfloor air distribution systems is also ideal. This configuration presents advantages when there is a large floor area and high space volume, such as in the lobby, event spaces and exhibition spaces. It is a more efficient system than an overhead delivery system because the conditioned air is supplied at low-level and at higher discharge air temperature for cooling and lower temperature for heating. The amount of air supplied to condition the room is typically less than that required for an overhead system since only the occupied and art display zones are being conditioned. This results in significant fan energy savings.

Displacement ventilation systems use less energy than overhead supply systems because only the zone with exhibits and occupants is conditioned, allowing the warmer air to stratify to high levels above these zones. Supply air will be provided at close to 18°C. Single-height galleries may be served either with UFAD systems or with overhead air supply. In all instances, climate within the spaces shall be strictly controlled to provide an ideal environment for exhibits.

Radiant Heating and Cooling Systems
Radiant heating and cooling systems, such as radiant slabs and active chilled beams, are widely used in Europe. In a climate such as Budapest's, they present an optimal solution for energy savings. These systems can save more than 30% on the overall energy consumption in a building. The low humidity levels associated with the Budapest climate also assists in making this a feasible technology for meeting sensible cooling loads with radiant means. At LIGET, the comfort conditioned areas surrounding the exhibition spaces can be efficiently cooled with these types of systems.

Mixed-Mode Ventilation
Areas such as circulation, atrium and café spaces will utilize mixed-mode ventilation strategies, where they are conditioned to maintain thermal comfort for much of the year with overhead VAV systems or a combination of overhead ventilation and radiant floor elements but have the ability to open to the exterior when outdoor conditions are favorable. Interlocking operation of HVAC systems with operable façade elements is a beneficial measure to ensure that energy is not expended wastefully when spaces are open to the outdoors.

Air Handling Units
Each close control air handling unit will comprise of an airside economizer, pre-filter and main filter, gas-phase filtration, pre-heat coil, cooling coil, re-heat coil and supply and return fans with variable speed drives. Heat pipe ‹wrap-around› coils will be placed upstream and downstream of the cooling coil in order to provide free pre-cooling and re-heat of the supply

air stream to minimize the high energy use associated with the potentially wasteful simultaneous cooling and reheat required to give full humidity control.

CO2 Monitoring
The outdoor air supply to all regularly occupied spaces will be controlled by local CO2 sensors in the spaces to ensure that acceptable levels are maintained at all times and also to reduce the amount of fresh air that needs to be brought in to the building and conditioned.

Ancillary Space Conditioning
Local heating and cooling for rooms and support spaces of intermittent use will be provided via variable-volume fan coil units fitted with electronically commutated DC motors to reduce electricity consumption.

Electric Lighting
Besides taking advantage of natural daylight and implementing dimming sensors, the project also integrates the use of efficient lighting, which will considerably reduce the lighting energy consumption. Electric lighting will be provided by highly efficient LED and compact fluorescent (T5) fittings that are grouped to provide variable control with time switches for some areas to reduce energy consumption.

With the use of LED lighting both within the building and at the exterior, lighting energy can be reduced to less than 50% as it would be in a conventional building. The control strategies and sensors will avoid the use of additional electric lighting where the daylight levels are adequate according to the required luminance levels for each type of space.

Lights in the perimeter and atrium zones will also be dimmable in order to take advantage of daylight offsetting the requirement for artificial light. Local task lighting will be provided for all permanent workstations in office areas so that users may adapt the lighting scenes to suit the tasks they are executing while reducing energy consumption. The car park areas on the lower floors will be partly lit using light wells and innovative fiber-optics which 'pipe' light from receivers above ground without the use of electrical power.

Artifact Handling & Programming Functionality
The exhibition and collections storage areas are spaces that will require an increased level of control in order to maintain climate conditions that are not detrimental to the artwork. For the larger gallery spaces with high ceilings, underfloor air distribution (UFAD) systems will be used, taking advantage of displacement ventilation techniques where appropriate. From gallery spaces with tight environmental control, the team identified a series of buffer zones which allow progress through marginally looser temperature and humidity requirements, with beneficial pressure and thermal gradients. Buffer zones then provide additional protection against the impact of undesirable air from starkly different surroundings and reduce the energy burden of the close control systems as visitors transition through all interior spaces, in potentially high numbers.

Similarly, collections storage areas will be considered close control spaces, with buffer zones surrounding them, but due to the lower foot traffic and other space heat gains these spaces can be provided with a constant volume of conditioned air delivered overhead. This strategy allows for high air quality and good space conditions, tailored to the specific preservation needs of the artifacts in storage.

Low Water Strategy
Early analysis of available water sources and water demand for various end uses helped identify rainwater harvesting as the optimum strategy for the LIGET Museum. This strategy not only provides all non-potable water demand for the building and site irrigation, but it also becomes a stormwater management strategy, which combined with a few integrated strategies, eliminates discharge from the site.

Building Water Management
The team is proposing a low water strategy with all stormwater to be retained on-site and municipal water being used for potable needs only.The water consumption of the building with an estimated rate of 6 L/ day per person can still be as high as 5 million liters per year, or 5,000 m3. A reduction up to 40% can be accomplished with the inclusion of water efficient fixtures such as low flush urinals, push button water saving faucets, and sensor activated flushometers. This will not only reduce the demand for water but also the volume of discharge to the sewers.

Even with these strategies, the water consumption rate per year results in a considerable figure of 3,000 m3 per year. Of this volume, 55% will be required for non-potable needs, met with harvested rainwater, and only 45% for potable needs, met with municipal water delivered to the site. This brings the total potable water savings to 73% from a conventional building.

Rainwater in Budapest is approximately 630 mm per year and falls consistently throughout the year. The building roof has been designed in such a way as to retain some of the runoff while also enabling rainwater harvesting. Integrated with the roof design is a waterfall pool at the entry terrace for rainwater detainment. Here, rainwater will be captured prior to release to the on-site filtration system. Once filtered, this water will be stored in cisterns located below grade for reuse.

There will be enough harvested and treated rainwater to supply the non-potable water demands for the building, including cooling tower make up water, flushing and irrigation. Surplus harvested rainwater will be discharged to an on-site water feature which will be able to accommodate the overflow when needed. The intent to minimize waste generation and waste volumes to be removed from site will have a significant impact on the museum's construction and operations.Waste from the construction will be carefully controlled and where possible recycled or repurposed.

Operational Waste:
Organic Waste Processed On-Site
Operational waste from the building will be carefully segregated so that it can be easily processed and a sustainable purchasing strategy for the museum will consider reduction of packaging waste as part of the measures employed.Given the inclusion of a café and restaurant on-site, the waste composition will be more than 50% organic, which includes paper products. For this reason, we propose incorporating an in-vessel composter to process organic waste on-site. The output, soil amendment, can be used within the landscaped areas. This strategy will significantly simplify waste removal requirements.

Operational Waste: Non-Organic Waste
Other, non-organic waste streams will be stored and compacted on-site prior to removal to reduce the number of truck trips required.

Green Building Certification
The competition brief identifies a BREEAM 'Excellent' rating as the desired Green Building Certification path for the project.

BREEAM Definition
"BREEAM" stands for "Building Research Establishment (BRE) Environmental Assessment Method". It is one of many environmental assessment methods for buildings. It sets the standard for best practice in sustainable design and has become a common measure used to describe a building's environmental performance, especially in the UK and Europe in general.

BREEAM Aims and Objectives
The aims and objectives of BREEAM are:
- To mitigate the impacts of buildings on the environment
- To enable buildings to be recognized according to their environmental benefits
- To provide a credible, environmental label for buildings
- To stimulate demand for sustainable buildings

Areas of Assessment
BREEAM will assess the performance of the LIGET Museum in the following areas:
- Management — overall management policy, commissioning, site management and procedural issues
- Energy Use — operational energy and carbon dioxide (CO2) issues
- Health and Well-Being — indoor and external issues affecting health and well-being
- Pollution — air and water pollution issues
- Transport — transport-related CO2 and location-related factors
- Land Use — greenfield and brownfield sites
- Ecology — ecological value, conservation and enhancement of the site
- Materials — environmental implication of building materials, including life-cycle impacts
- Water — consumption and water efficiency

Credits are awarded in each area according to performance.
The LIGET Museum has been designed as part of an integrated design process with all of the aspects above being covered across various disciplines, looking for synergies when possible so that the final design is not just an excellent BREEAM project but a fully integrated, high-performance design that works in beautiful harmony with its context and brings delight to those who visit.