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Adaptive reuse of Palazzo del Lavoro

Urban Forest: Reactivate as Multi-Program Hub

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“If a place can be defined as relational, historical and concerned with identity, then a space which cannot be defined as relational, or historical, or concerned with identity will be a non-place.”

- Marc Augé, Non-Places: An Introduction to Supermodernity, P. 77

ABSTRACT

Set within Turin's rich cultural context, this thesis addresses the sustainable adaptive reuse of the Palazzo del Lavoro, a monument of Structural Rationalism by Pier Luigi Nervi epitomizing his mastery of reinforced concrete. Vacant and progressively obsolete since the Italia '61 exposition, the building remains the focus of intense contemporary transformation debates. The structure embodies its movement through a raw, gray concrete framework where material directly dictates aesthetic form. As Nervi famously observed, *"Whenever we discover new techniques, we often foolishly cling to old forms. A new material, like concrete, creates its own forms."**

This research outlines an innovative rehabilitation framework that transforms the interior into a glowing architectural lantern through the strategic insertion of a chromatic, prefabricated timber modular system. The methodology simultaneously diagnoses material decay, establishes remediation strategies for its abandonment, and simulates current and future energetic comfort parameters. Engineered for structural reversibility, these temporary pods prioritize long-term spatial flexibility, allowing for seamless removal, alteration, or adaptation without compromising the historic monument.

The design thesis integrates this colossal volume by introducing a multi-programmatic ecosystem of activities to catalyze a vibrant internal city life. Within this micro-urban framework, a layered network of internal streets, elevated bridges, and public pockets systematically navigates the immense scale of the space. Concurrently, the modular pods redefine the user experience, clustering diverse functions while offering dynamic, shifting perspectives from which to engage with Nervi's overarching concrete phenomenon.

Ultimately, this project advocates for a paradigm shift in interior urbanism treating the massive internal volume of the hall as a covered civic ecosystem with its own street network and micro zones to safeguard architectural legacies through unified conservation methodologies. By reviewing the structural preservation issues and economic challenges of previous failed attempts, the thesis contextualizes past institutional investments to project a viable, sustainable alternative future for large-scale modern heritage, specifically the post-war structural masterpieces of Pier Luigi Nervi.

* Pier Luigi Nervi, 1964.

ACKNOWLEDGEMENTS

To Professors Lo Verso, Gron, Mattone, and Tosco: thank you for guiding me through the complex layers of this project and for offering the critical perspectives needed to navigate its challenges. I am deeply grateful for the intellectual freedom you granted me, allowing me the space to define my own path and shape this thesis with complete creative independence. Your trust and insights have been invaluable.

To my family, for your patience, boundless love, and steady presence throughout this journey.

To my mom: everything I am, every meaningful step I take, and all my love belong to you. Without you, I would have no direction. Thank you for standing firmly by my side, especially when the choices ahead felt the heaviest.

To my dad: you are my foundation. I owe you a level of respect and gratitude that words cannot fully capture. You taught me how to move through the world with resilience and integrity. Thank you for showing me how to live.

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To my friends: I am incredibly fortunate to have a circle that believes in me so completely. Your trust, encouragement, and unique perspectives have fundamentally broadened my mind and kept me grounded at every level.

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00 INTRODUCTION

0.1 WHY PALAZZO DEL LAVORO?

The primary reason to choose Palazzo del Lavoro as a case study is its nature as an architectural anomaly. It is not a traditional building but rather an indoor territory. With 25,000 square meters of empty space under a single roof, the structure operates like an unconditioned covered square rather than a standard building envelope. Past adaptive reuse strategies failed because it's not easy to convert this large-span column grid into a single, standard function. Forcing traditional walls and floors to tie into the existing structure is unfeasible, as each independent column is already fully loaded, holding the immense weight of its own 38x38 meter roof panel. This leaves a brutal choice, either carve up the interior and destroy

Nervi's legacy, or leave the building abandoned. The expressive concrete pillars and the roof grid are perfect and untouchable. This reality creates a massive design constraint that the building envelope cannot be altered. It forces the designer to treat the interior not as a shell to be modified, but as a topography, a permanent landscape where any new architecture must exist completely independently. Ultimately, a monument of this scale requires an equally radical conservation strategy. By treating the interior as an open urban territory rather than a traditional building envelope, this project uses adaptive reuse to redefine how modern heritage can coexist with the contemporary city.



Figure 0.1: Internal existing photograph of Palazzo del Lavoro

0.2 PROJECT VISION, OBJECTIVES, METHODOLOGICAL GOALS

This project aims to prove that a mid-century concrete monument can cleanly host modern digital and cultural networks. The goal is to establish a practical balance: the historic concrete shell and frame act as a protective micro-climate, while contemporary timber insertions bring active civic life back into the void. The primary objective is to return functional purpose to the space by respecting its architectural authenticity and repairing structural damage without invasive modifications. Rather than creating a passive museum experience, the intervention provides an active environment for learning and skill development. This user-centric approach relies heavily on passive strategies, optimizing natural daylight and ventilation to achieve a high-performance energy balance. The design relies on a modular, prefabricated timber system that occupies the monumental hall through independent, programmatically linked pods. This “city-within-a-city” approach creates a clear visual contrast between the warmth of the contemporary insertions and the raw concrete of the heritage structure. Built on a reversible logic, the system activates the quiet interior as a dynamic urban ecosystem. By breaking down the colossal volume into human-scaled environments and grouping varied, interconnected activities, the design ensures the interior remains functional.

The methodology begins with an honest diagnostic assessment of the building’s current state, utilizing a detailed Historical Building Information Modelling(HBIM), and mapping material decay and weathering damage before introducing new elements. Here, environmental simulation operates as a primary design tool rather than a final verification. The goal is to analyze exactly how the unconditioned macro-space of the Palazzo interacts with the highly conditioned micro-spaces of the timber pods to guarantee both energy efficiency and occupant comfort.

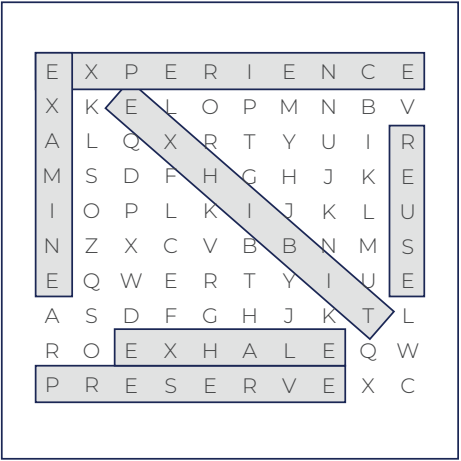


Figure 0.2: Word Search puzzle Diagram to define the core design strategies.

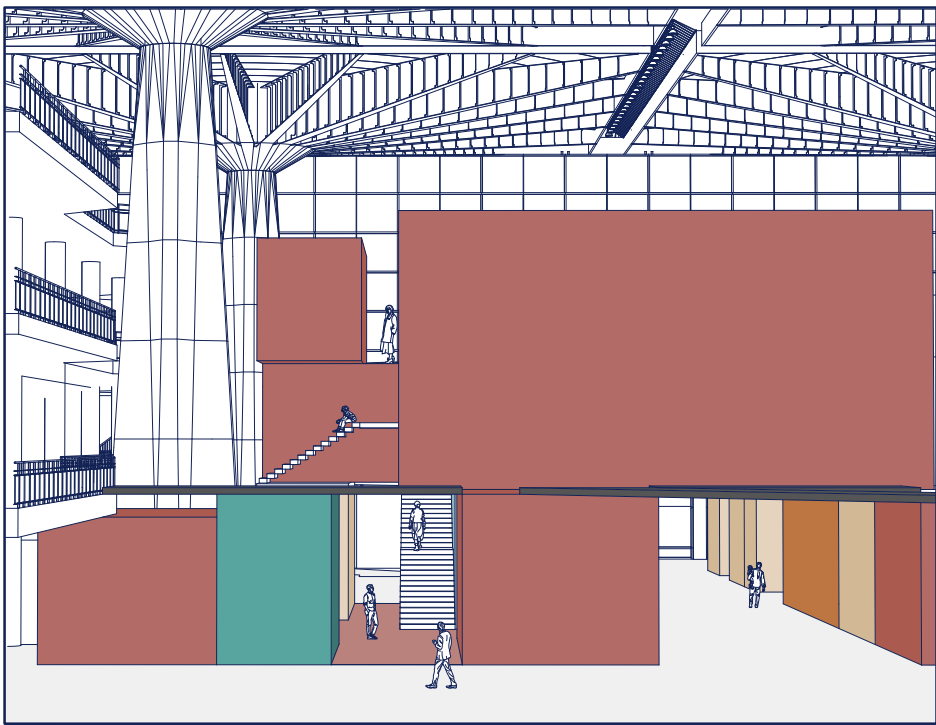


Figure 0.3: A schematic conceptual internal perspective of the museums in the design, demonstrating connections of users vertically and horizontally between clustered pods.

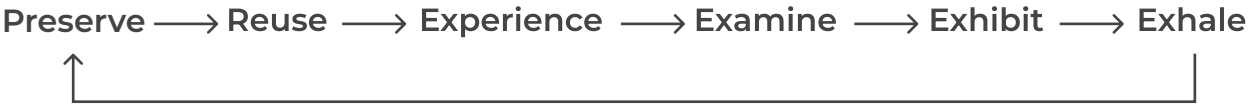


Figure 0.4: Design strategy definition, representing the loop of workability and sociality of the users inside the project..

0.3 THE LOGIC OF PREFABRICATED SYSTEM

0.3.1 Theoretical foundations and dimensional coordinations

The integration of a prefabricated modular framework within a monumental structure requires a clear understanding of dimensional theory, structural mechanics, and environmental lifecycle metrics. Rather than treating prefabrication simply as a tool for accelerated construction timelines, this project approaches it as a strict discipline of spatial organization and heritage conservation. By shifting the construction focus away from invasive, permanent on-site modifications toward independent, factory-finished volumetric components, the intervention creates a non-destructive dialogue with the historical architecture. The use of modularity in industrial construction is rooted in the necessity for absolute dimensional coordination, establishing a shared geometric language across the design, manufacturing, and assembly phases. The modern history of standardized dimensional discipline developed significantly prior to the Second World War. In 1936, Albert Farwell Bemis introduced a foundational 4-inch structural module, which was followed by Ernst Neufert's 12.5 cm Oktameter-System in Germany in 1943, and Jean-Pierre Paquet's 10 cm modular standard in France during the late 1940s. This global trajectory toward structural rationalization was further advanced by Le Corbusier's development of the Modulor system conceived in 1943 and published between 1948 and 1955, which

sought to resolve the chaotic discrepancies of post-war global manufacturing by unifying spatial proportions with human scale.

The Reference Grid Alignment and System Integration

To ensure complete spatial harmony between different architectural subsystems, this project utilizes a strict reference grid based on the international standard 1M base unit (10cm x 10 cm) finalized globally through the Monaco Agreement of 1955 and the European economic frameworks of the early 1960s. In advanced architectural design, these simple reference grids can be superimposed to form composite, multi-modular alignments known as "Scottish" grids. Each layer of the composite grid operates independently to organize a distinct building layer, such as the primary structural frame, internal partition layouts, service distributions, and ceiling configurations. The perfect overlapping of these distinct grids ensures absolute structural and formal integration between subsystems. In a digital design workflow, this cross-grid coordination aligns directly with automated drawing layer logic, eliminating spatial conflicts before components ever reach the fabrication floor.

Open Prefabrication Systems:

Rely on a universal, simplified regulatory framework of dimensional standards. This allows architectural components produced by completely independent manufacturers to be combined freely within any given project due to their flexible, pre-planned dimensional compatibility.

Closed Prefabrication Systems:

Depend on proprietary components engineered exclusively to interact with elements from the same manufacturer. While closed systems historically dominated large-scale public tenders and post-war reconstruction frameworks, they impose a severe aesthetic and structural rigidity.

This project leverages the flexible principles of open dimensional coordination, ensuring that internal partition subsystems and modular volume dimensions maintain a simple, interchangeable relationship with the metric geometry of the host building.

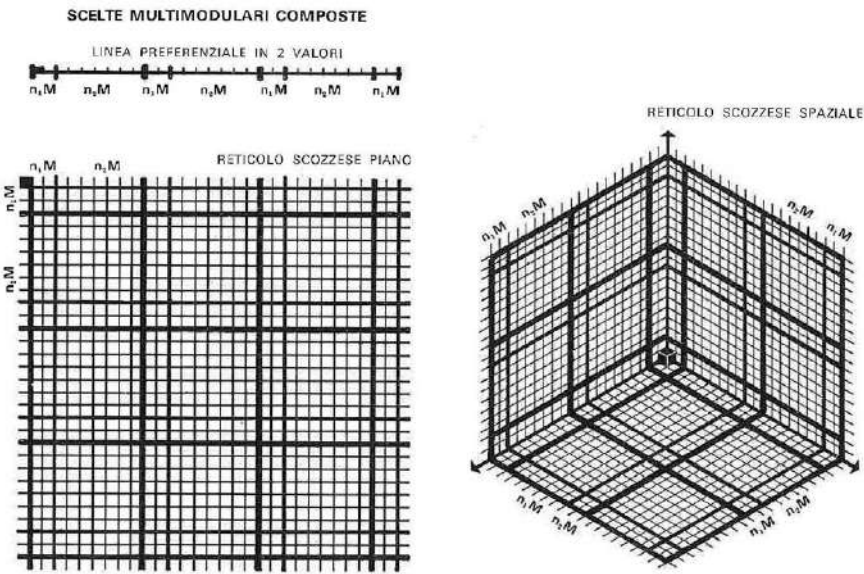


Figure 0.5: Scheme of composite multi-modular choices «Compound multi-modular choices can result in the combination of several fixed grids, thus the Scottish grid applied in the design of the building organism, or the reference line or variable grids, applying the system known as the "number pair"»

0.3 THE LOGIC OF PREFABRICATED SYSTEM

0.3.2 From 2D panels to 3D volumetric syntax

Industrialized construction can be categorized by its structural complexity and level of off-site finish, spanning five distinct levels: *components*, *panelized 2D structures*, *volumetric 3D modules*, *hybrid combinations*, and *unitized whole buildings*. While individual components (such as precast elements or standard trusses) offer design flexibility, they require significant on-site labor, precise manual alignments, and complex joint sealing. Two-dimensional panelized systems (such as structural insulated panels or unitized curtain walls) optimize transport volume and speed up envelope assembly, but still require extensive structural connection work on-site.



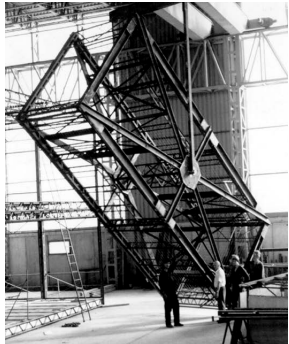
Figure 0.6: installation procedure transition from flat panel components to fully enclosed volumetric block.



Figure 0.7: Left: "Block-Volume" laid on formwork panels forming the basement floor. Middle: production and assembly of a "Block-Volume" element forming part of the villas plastered in the factory in the post-1985 period. Right: tipping of the "Block-Volume" using an overhead crane.

The Volumetric «Block-Volume» Organism

To achieve absolute structural independence within a historic monument, the intervention must transition from flat panel assembly to three-dimensional, self-supporting volumetric modules, historically pioneered as the *"Block-Volume"* system. Volumetric modules leave the factory completed to a level of 80% to 95%, collapsing traditional construction schedules by shifting finishing trades into a controlled indoor environment. The three-dimensional module operates effectively as the "engine" of the spatial program. Rather than treating walls, floors, and ceilings as separate elements to be joined on-site, the volumetric unit is manufactured as a monolithic structural organism.



0.3.3 REVERSIBILITY, LOGISTICS, AND DESIGN FOR DISASSEMBLY (DfD)

Traditional adaptive reuse projects frequently compromise historic structures by casting permanent concrete floors, drilling invasive structural connections, or permanently anchoring new configurations into the original fabric. To safeguard modern architectural heritage, contemporary interventions must adopt the strict principles of *Design for Disassembly (DfD)*. Design for Disassembly focuses on minimizing physical interdependence between separate building layers. By avoiding glued, wet, or chemically bonded connections, the interior layout remains entirely demountable, transforming the historic building into a flexible physical library of materials for the future.

Mechanical Detaching and Structural Isolation

In accordance with reversible design logic, the modular pods are detailed to remain structurally independent from the host building's vertical elements. The primary concrete columns and gridded roof of the monument are treated as an immutable topography, a permanent landscape within which the new architecture sits. To achieve this, the mechanical, electrical, and plumbing (MEP) distributions are consolidated into centralized core utility shafts to minimize

horizontal runs and avoid wrapping around historic elements. The structural connections rely entirely on dry-jointed, high-strength mechanical connections that allow parallel disassembly. This means individual pods or entire program clusters can be added, altered, or extracted over time without causing damage to the surrounding historic envelope.

Load-Bearing Optimization and Stability Paths

In multi-story modular applications, structural safety requires a clear division between vertical and horizontal load paths. The independent modules are engineered to transfer vertical dead loads and live occupancy loads directly down through their own corner columns to the floor plates. To handle lateral forces, such as wind loads acting on massive glazed envelopes or seismic events the modular units are clustered around an independent stabilizing structure or a rigid precast concrete core. Horizontal lateral loads on each floor plate are transferred across the modular cluster via factory-welded floor frames and field-bolted horizontal connections. These lateral forces are then funneled directly into the main stabilizing core, preventing eccentric rotational demands or structural stress from transferring to the individual volumetric units.

0.3 THE LOGIC OF PREFABRICATED SYSTEM

0.3.4 Lifecycle Assessment (LCA) Realities and Energy Balances

To accurately measure the sustainability of an industrialized intervention, architects must utilize process-based attributional *Lifecycle Assessments (LCA)* that evaluate a project from raw material extraction through factory manufacturing, transport logistics, and eventual end-of-life processing. Comprehensive LCA data reveals a critical environmental paradox: in traditional, inefficient commercial buildings, the operational occupancy phase completely dominates the lifecycle, accounting for 80% to 95% of total energy use and greenhouse gas emissions. However, as an architectural intervention incorporates advanced insulation, optimized natural daylighting, and high-performance building physics, its operational energy demand drops significantly. As a project approaches a highly efficient or net-zero energy balance, the environmental impact profile flips dramatically: the operational phase becomes secondary, and the manufacturing and material production phases emerge as the absolute dominant source of environmental impacts.

Logistical Thresholds and Sourcing Logic

Because material choice becomes the highest priority in sustainable design once operational energy is minimized, the carbon footprint of

industrial manufacturing must be carefully audited. This reality reframes standard logistical assumptions regarding transport distances. LCA models demonstrate that supply chain shipping distances contribute a consistently small proportion of a building's total environmental footprint, typically accounts for a mere 2% to 5% of lifetime greenhouse gas emissions. Consequently, it is environmentally justified to transport highly sophisticated, factory-controlled components over long distances if their superior manufacturing tolerances significantly improve the final thermal resistance and air-tightness of the building. The slight increase in transport emissions is rapidly erased by the massive lifecycle reductions achieved through optimized factory quality control.

Industrialized Waste Prevention and Material Cycles

The environmental advantage of volumetric prefabrication over traditional on-site construction is heavily driven by resource optimization at the factory level. Standard on-site construction methods generate vast amounts of material waste due to exposed storage weathering, cutting errors, and uncoordinated trade scheduling. In fact, in dense urban development zones, construction and demolition debris can account for up to 40% to 50%

of total landfill volume. In contrast, factory prefabrication operates on an industrialized logic of material optimization. Controlled factory settings enable precise raw material purchasing, systematic sorting, and near-instantaneous recycling of process scrap. Statistical reviews show that modular prefabrication successfully eliminates up to 70% of raw material waste compared to site-intensive concrete and masonry construction. Over a standard 50-year building lifecycle, a volumetric modular system generates 2.5 times less construction waste than conventional site-built structures, protecting valuable resources and providing an honest, measurable reduction in global warming potential.

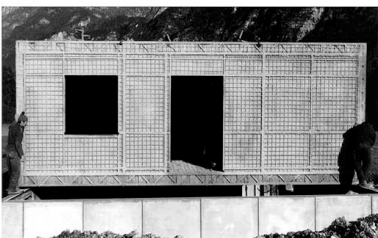
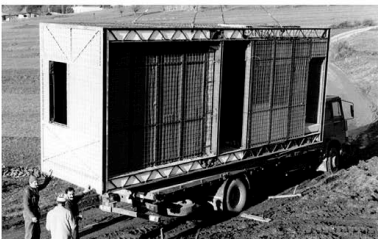


Figure 0.8: From the top, the assembly of a house with "Block-Volume" produced in the factory and plastered on site in the first years after the 1976 earthquake.

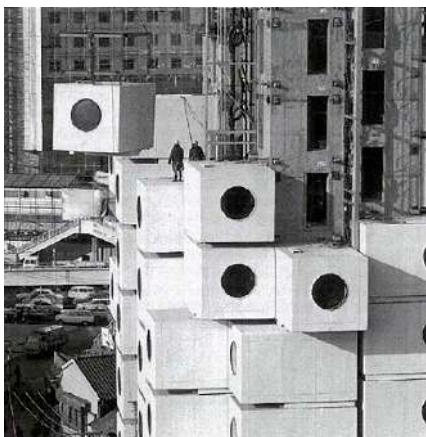


Figure 0.9: Kisho Kurokawa, Nakagin Capsule Tower, 1970–1972, Tokyo

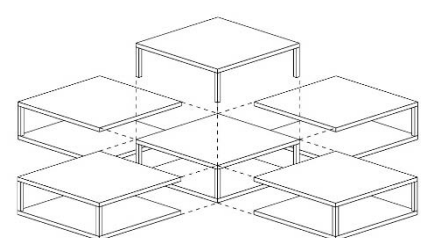


Figure 0.10: Blocks expansion if needed to facilitate the disassembly process.

01 Theoretical & Historical Framework

1.1 THE INDUSTRIAL LEGACY OF TURIN

1.1.1 Post-war growth and the 1961 Italia '61 Expo

Turin's urban trajectory in the second half of the 20th century represents one of the most significant examples of rapid industrialization and subsequent socio-spatial reconfiguration in Europe. Following the devastation of World War II, the city emerged as the undisputed motor of the Italian economic miracle, driven primarily by the exponential expansion of the automotive sector led by FIAT. This intense industrial expansion triggered massive internal migration, causing a structural and demographic explosion that forced the city administration to reconsider its infrastructure and boundary lines. The urban fabric rapidly transformed to accommodate a growing working-class population, turning a historically baroque, royal capital into a dynamic, dense industrial metropolis. By the late 1950s, municipal leaders sought an opportunity to re-frame Turin's identity transitioning it from a factory-driven labor hub into a modern capital of innovation and design. This conceptual leap materialized through the planning of the 1961 International Labour Exhibition, globally known as the Italia '61 Expo. Organized to celebrate the centenary of the Unification of Italy, the Expo was strategically located in the southern gateway of the city, along the banks of the Po River within the Nizza Millefonti district. The event acted as a structural catalyst for experimental infrastructural installations that showcased the city's futuristic vision to over six million international visitors.

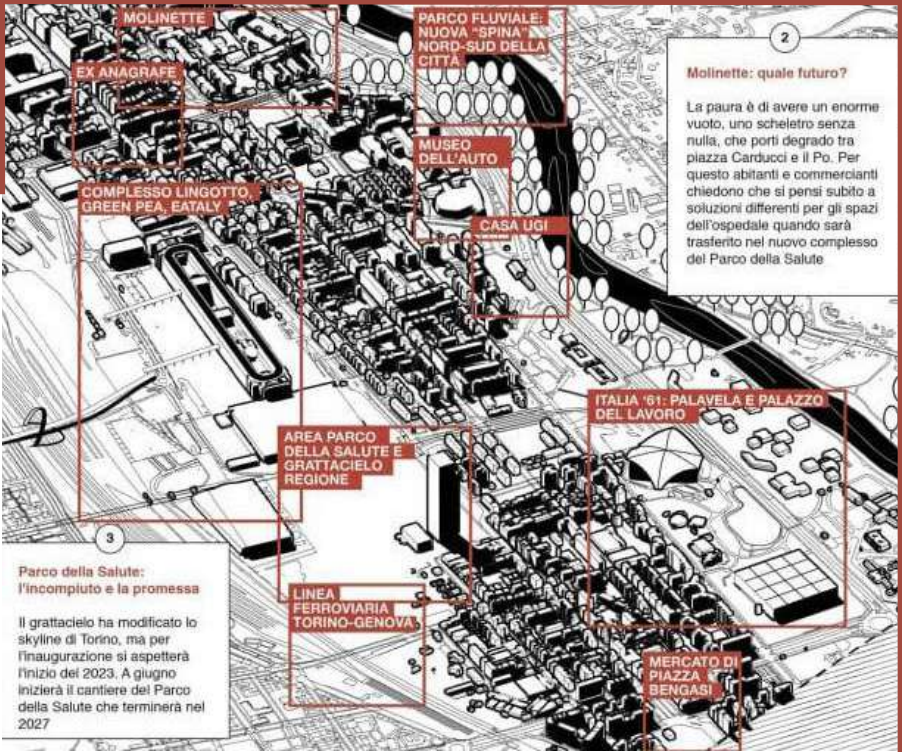
1961

Figure 1.1: Architecture as an embodiment of a teleological perspective of progress.



2022

Figure 1.2: A building intertwined with the conditions of the context in transformation.



1.1 THE INDUSTRIAL LEGACY OF TURIN

1.1.1 Post-war growth and the 1961 Italia '61 Expo

Among the most popular attractions was the ALWEG monorail, a saddle monorail railway extending for about 1,800 meters on an elevated reinforced concrete viaduct supported by truncated conical pylons. The system, powered by 600-volt direct current, connected North and South stations and featured a wide curve crossing an artificial lake. Additionally, FIAT sponsored the Disney Circarama, an absolute novelty in projection technology featuring a 360-degree circular screen with a 90-meter development housed in a dismantlable steel, aluminum, and plastic pavilion. Complementing these was the spectacular cable car (ovovia), which transported around 700 passengers per hour in 61 ovoid-shaped cabins, traveling 871 meters from the “Mostra delle Regioni” pavilions over the Po River to the Europa Park on the Cavoretto hill. Italia '61 was not merely an ephemeral festival; it was a permanent territorial intervention meant to leave a lasting architectural legacy, positioning Turin as the capital of technological prowess and modern design. Today, the area occupied by the Mostra delle Regioni has transitioned into international service, hosting a United Nations campus that contains the UN Staff College, the ILO training centre, and the UNICRI headquarters.



Figure 1.3: Pier Luigi Nervi (Sondrio, 21 June 1891 – Rome, 9 January 1979) was an outstanding author of structural architecture and a seminal figure of the twentieth century. An engineer, architect and builder, his career was driven by a continuous dialogue between conception and construction, where intellectual rigour met tangible material resistance. By combining design, experimentation, and construction, Nervi transformed reinforced concrete into an expressive and structural medium, creating a new architectural language based on logic, economy, and beauty.



Figure 1.4: Blocks expansion if needed to facilitate the disassembly process.

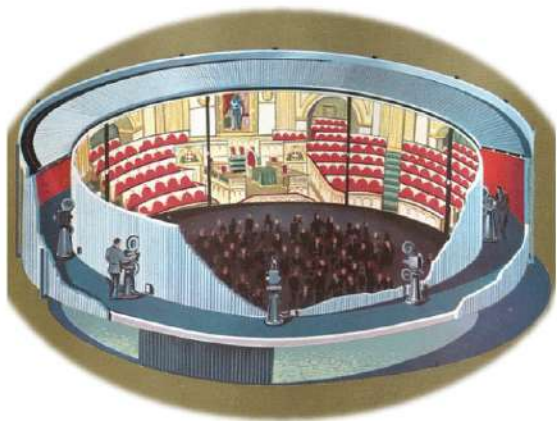


Figure 1.5: The Disney Circarama represented the fusion of entertainment, technological innovation, and architectural experimentation. Through its 360-degree projection system, it offered visitors an unprecedented immersive experience, embodying the futuristic aspirations that the Italia '61 Expo sought to communicate and reinforcing Turin's image as a city of innovation and modernity.



Figure 1.6: At the Italia '61 Expo in Turin, the ALWEG monorail embodied these aspirations. Extending approximately 1,800 meters on an elevated reinforced-concrete viaduct, it provided visitors with both a practical means of circulation and a visual demonstration of advanced transportation technology. As one of the most iconic attractions of the exhibition, the monorail contributed significantly to the image of Turin as a forward looking city embracing innovation and modern design.

1.2 PALAZZO DEL LAVORO

1.2.1 Pier Luigi Nervi's structural philosophy

Announced in July 1959 under the chairmanship of Giovanni Agnelli and the spatial layout coordination of architect Gio Ponti, the competition for a massive 47,000 square-meter pavilion to host the central exhibition of the Centenary was an immense logistical challenge. In October 1959, the jury awarded the contract to the firm Nervi & Bartoli, featuring the structural mastermind Pier Luigi Nervi, his son Antonio Nervi, and the prominent metal-structure specialist engineer Gino Covre. The proposal was uniquely convincing for its simplicity, structural legibility, and material differentiation, making it the only submission capable of guaranteeing compliance with the extremely tight deadlines. Construction began in February 1960, and through an intense operational synergy, the entire building was completed by December 1960. This efficiency leveraged Nervi's deep construction experience in Turin, referencing his earlier achievements like the Torino Esposizioni halls (1948–1950), the Fiat factory buildings (1955), and the municipal tram depot (1954). The structural logic of the Palazzo del Lavoro (originally named Palazzo delle Nazioni) stems from a profound synthesis of architectural poetry and raw engineering statics. Nervi operated on a core philosophical conviction that large-scale architectural expressions possess diminishing structural liberties as physical forces scale upward.

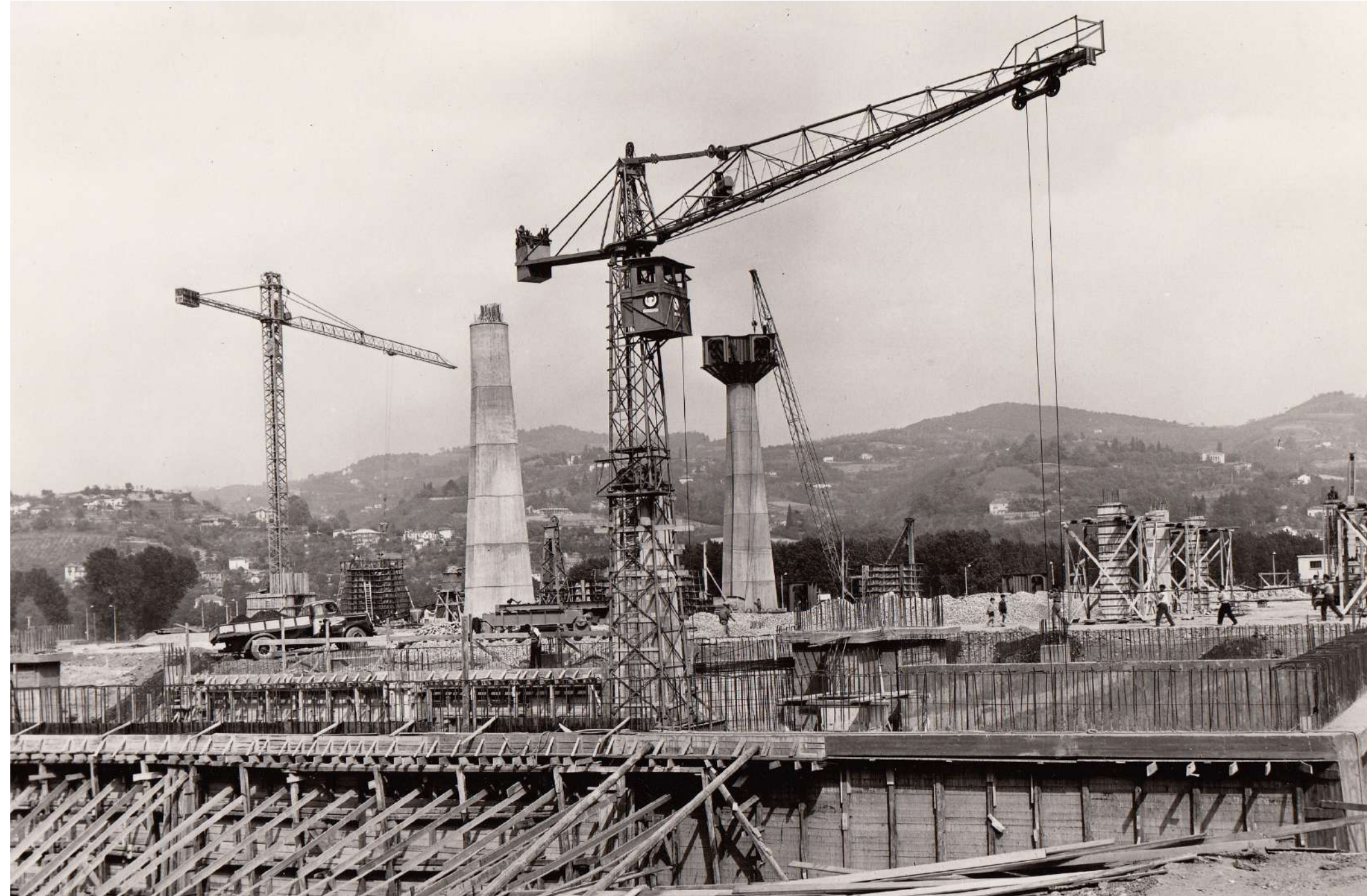


Figure 1.7: Palazzo del lavoro under construction
"Courtesy of Fondazione MAIRE - ETS. Materials
from the MAIRE Historical Archive."

1.2 PALAZZO DEL LAVORO

1.2.1 Pier Luigi Nervi's structural philosophy

Statics dictating the law of form meant that spatial quality had to emerge directly from the optimized flow of internal stresses, combining the roles of designer and entrepreneur to control all economic and quality aspects of execution. The resulting design defined an immense quadrangular space encompassing a base floor plate of approximately 22,500 square meters. The internal layout is governed by a strict geometric grid of sixteen independent, square “umbrella” modules measuring 40 meters by 40 meters each. Each individual module features a central tapered column rising over 20 meters high. The top of each column transitions smoothly into a radial pattern of reinforced concrete beams with a diameter of 38 meters, which in turn support a spoke-like wheel of steel cantilever I-beams designed by Gino Covre. By deliberately separating each independent module with a continuous loop of linear glass skylight slots, Nervi isolated the structural behaviors of the umbrellas, allowing natural light to pour downwards and trace the vertical lines of the columns. The layout of the exhibition rejected any solution that did not leave all the columns visible, utilizing extremely light, ephemeral partitions in aluminum and panels clad in translucent, reflecting stainless steel to contrast with the monumental concrete elements. The perimeter enclosure was constructed as an entirely independent glass curtain wall system standing 19 meters high.



Figure 1.8: Palazzo del lavoro under construction "Courtesy of Fondazione MAIRE - ETS. Materials from the MAIRE Historical Archive."

To control intense solar radiation, Nervi and Ponti integrated an intricate internal matrix of metal brise-soleil slats mounted on flexible cardan joints and piston rods to absorb structural deflections and thermal expansion. The structural envelope was intentionally disconnected at the corners to further emphasize that the perimeter walls carried zero structural load, framing the colossal concrete columns as the true primary visual anchors of the interior landscape.



Figure 1.9: Palazzo del lavoro under construction "Courtesy of Fondazione MAIRE - ETS. Materials from the MAIRE Historical Archive."



Figure 1.10: Palazzo del lavoro under construction "Courtesy of Fondazione MAIRE - ETS. Materials from the MAIRE Historical Archive."

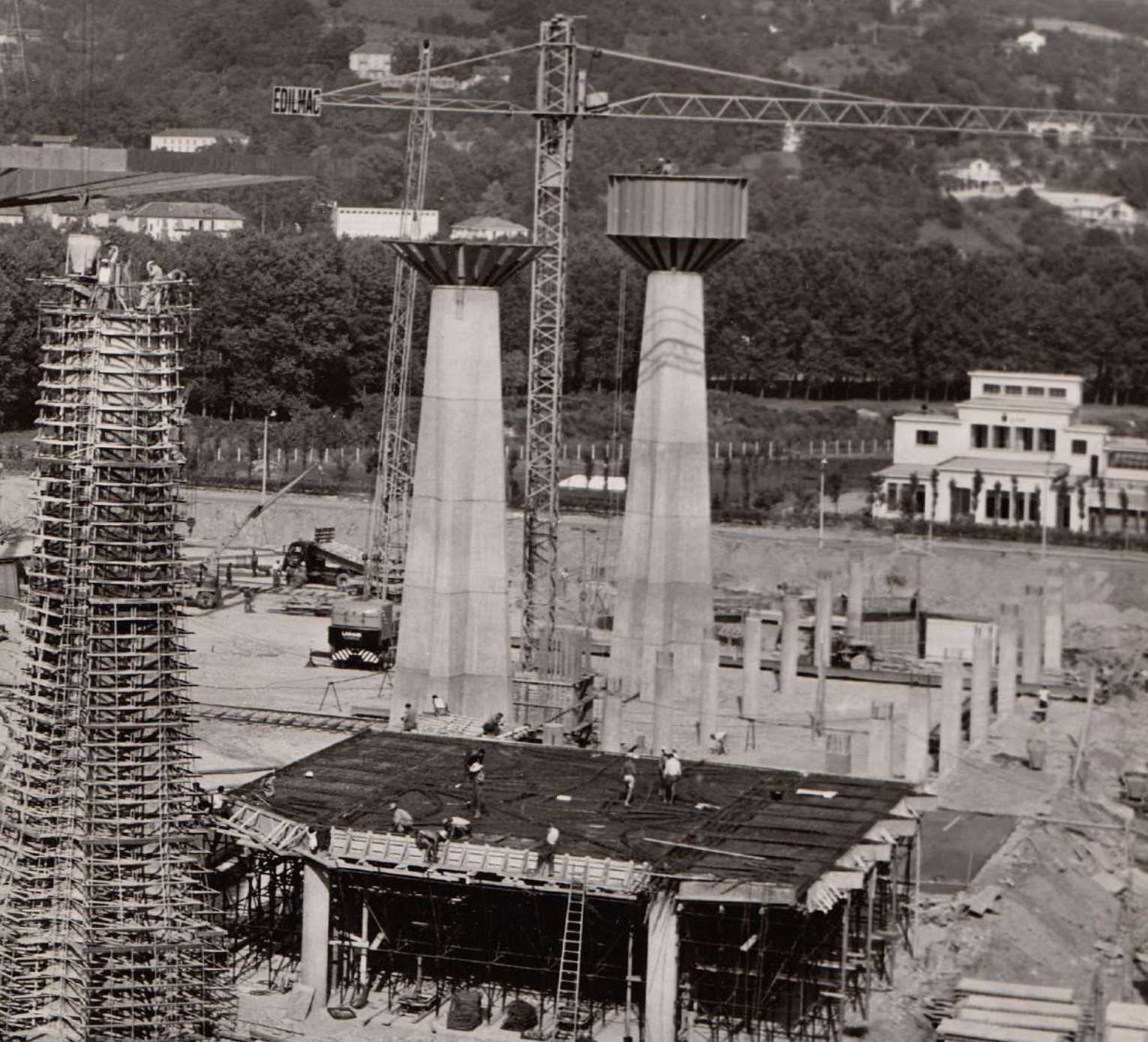


Figure 1.11: "Courtesy of Fondazione MAIRE - ETS. Materials from the MAIRE Historical Archive."

Figure 1.11 - Figure 1.12: In this specific stage of construction, the focus highlights the progress of the iconic, independent isoparametric concrete columns (often referred to as the "umbrella" columns). Each column branches outward from a variable geometric section at the base to support an independent square steel roof element. Documenting these structural micro-steps provides crucial insight into mid-century concrete casting techniques, scaffolding engineering, and the masterful synthesis of structural rationalism and architectural form that defined Nervi's work.



Figure 1.12: "Courtesy of Fondazione MAIRE - ETS. Materials from the MAIRE Historical Archive."

1.2 PALAZZO DEL LAVORO

1.2.2 The material crisis and fire devastation

The primary structural vulnerability of the Palazzo del Lavoro has always been rooted in its roof panelling and massive internal volume. Shortly after the close of the 1961 celebrations, building audits indicated that the thin sheet-steel roof panels were structurally unstable and lacked adequate thermal insulation. While proposals were put forth to replace them with light prefabricated ferro-cement components, the municipal financial interventions required to stabilize the envelope were deemed unviable at the time. This prolonged vulnerability culminated in severe material degradation, which escalated dramatically during the 2010s. Left unguarded, abandoned, and stripped of active fire suppression infrastructure, the building was targeted by multiple devastating arson attacks during the course of 2015. The most catastrophic event occurred in August 2015, when a massive fire tore through the southern quadrant of the complex. The intense localized heat caused severe calcination and structural distortion within Gino Covre's steel cantilever spokes and localized failures of the perimeter light-alloy frames. While the monolithic concrete cores of Nervi's monumental columns resisted progressive collapse due to their sheer mass and deep foundational piles, the structural integrity of the roof modules was severely compromised.



Figure 1.13: Palazzo del lavoro after the fire devastation in 2015.

1.2 PALAZZO DEL LAVORO

1.2.2 The material crisis and fire devastation

The fire caused extensive damage to the historic glazing, exposing internal steel reinforcements to atmospheric elements, while baking the remaining external brise-soleil layers into rusted, deformed sheets. The 2015 devastation effectively shifted the building from a state of passive architectural neglect into an active structural hazard zone, drastically increasing the capital expenditure required for any future adaptive reuse intervention. Although a planning agreement was hastily approved by the Turin City Council in mid-January 2016 to target a completion date of fall 2018, the project was continuously postponed for regulatory and economic reasons, leaving the site completely untransformed past 2019.



Figure 1.14: Interior after fire devastation.



Figure 1.15: Interior after fire devastation.



Figure 1.16: Interior after fire devastation.



Figure 1.17: Interior after fire devastation.



Figure 1.18: Interior after fire devastation.



Figure 1.19: Interior after fire devastation.

1.3 THE DORMANT MONUMENT

1.3.1 Chronicling unsuccessful transformation attempts

The post-exhibition history of the Palazzo del Lavoro is a complex chronicle of programmatic instability, massive operational overheads, and failed bureaucratic re-adaptations. Almost immediately following the closure of the Italia '61 Expo, the city struggled to find a long-term economic purpose for a structure enclosing such a staggering spatial volume. In 1962, the Nervi office was entrusted with drafting a comprehensive architectural scheme to convert the hall into a national center for vocational education. However, the cost of modifying the interior including the insertion of partition walls, secondary mechanical lines, and a massive subfloor heating array across the Montecatini marble plate proved financially prohibitive, demanding an estimated 3 billion lira in the absence of the initial project's requirements. To attract external capital, the Italian State successfully negotiated the placement of the United Nations International Labour Organization (ILO) / BIT International Centre within the building. The ILO occupied portions of the space until the mid-1980s, when they ultimately abandoned the premises due to unresolvable structural defects, recurring roof water infiltration, and the immense financial burden of heating a single-volume pavilion of that scale. The specialized retrofitting needed to make the space inhabitable—including new doors, windows, double-glazing, underfloor radiant heating panels, and fan coil units along the outside

walls—proved too costly to maintain against constant leaks from the radiant panel systems. Throughout the late 1980s and early 2000s, the monument entered a phase of fragmented, temporary reuse. It housed the Regional Administration Authority's cartographic center, a vocational training center, the Giorgio Quazza Institute for Information Technology and Electronics, a detached academic branch of the University of Turin's Faculty of Economics and Commerce (until 2008), the Historical Archive of the City of Turin (ASCT), and regional storage for the Central Police Headquarters. Since 2009, it has been occupied only by sporadic commercial activities, including a disco and themed musical evenings, but it was continuously abandoned due to the massive management costs. A series of visionary cultural proposals were put forward by various institutional actors, including a detailed 2000 feasibility study by Politecnico di Torino Professor Aimaro Isola to transform the shell into an interactive Science Center. Other notable proposals included converting the pavilion into a grand exhibition annex for the prestigious Egyptian Museum, utilizing it as an exhibition headquarters for products produced by Turin industries, or repurposing it as the primary engineering headquarters for Fiat Engineering.



Figure 1.20: Unsuccessful transformation attempts

Every single one of these structural proposals eventually faltered against the same fundamental barrier: the inability to resolve the building's thermal envelope without destroying its defining spatial characteristic the endless, unbroken perspective view across Nervi's monumental forest of columns. None of the projects tackled the crucial problem of reintegrating the building into the urban fabric with a real collective use, leaving its sheer volume as a permanent stumbling block.

1.4 SOCIO-ECONOMIC INVESTMENT FRAMEWORK

1.4.1 The Evolving Ownership Matrix

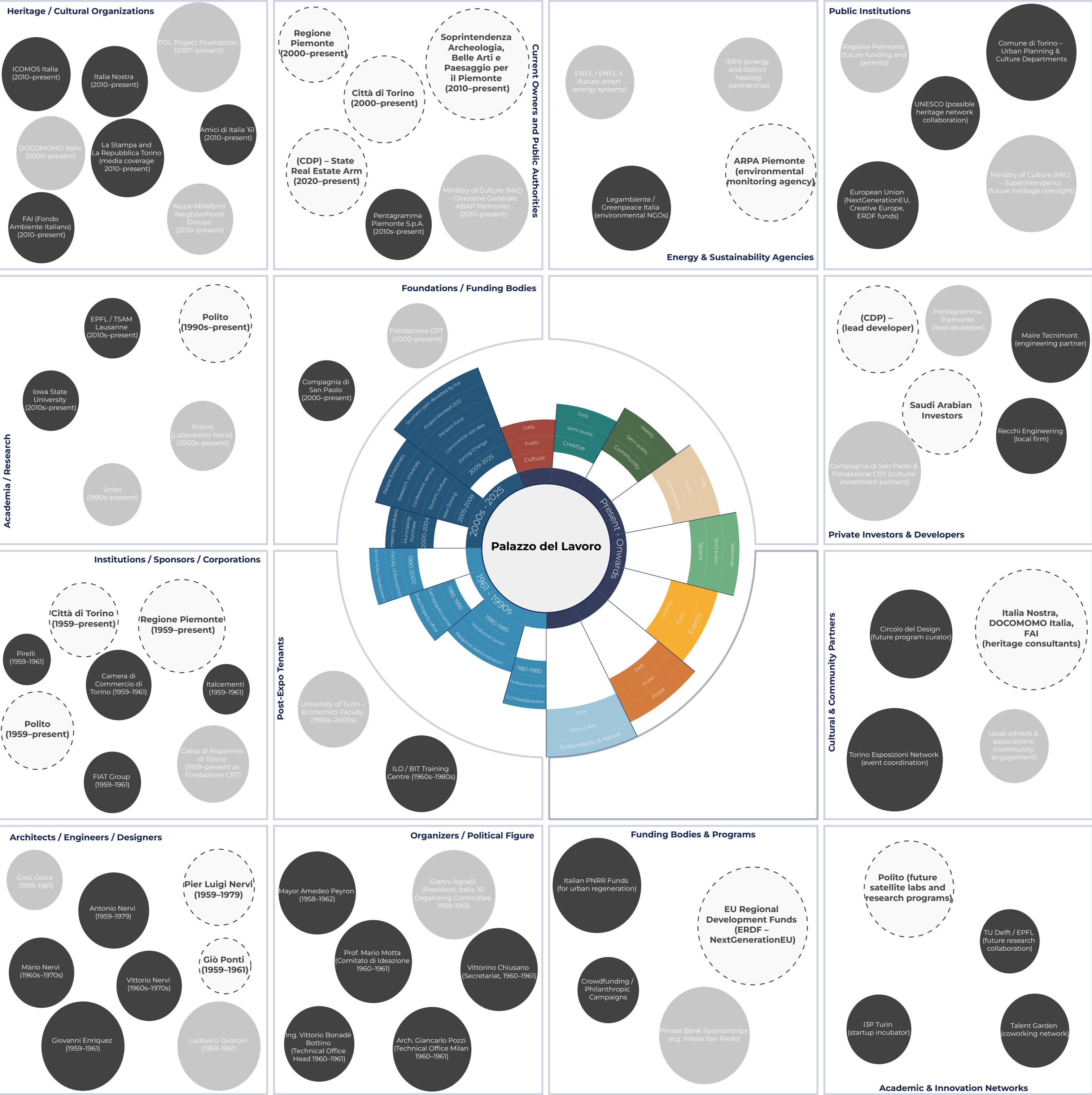
The financial and regulatory framework governing the Palazzo del Lavoro has undergone a complete shift from private real estate speculation back into state-controlled institutional management. In 2004, the Turin Municipality purchased the property for 20 million euros, aiming to manage its spatial deterioration ahead of the 2006 Winter Olympic Games, where it continued a precarious existence as a sporadic exhibition hall. Seeking to offload the building’s mounting maintenance liabilities, a pivotal variation of the zoning use clauses was approved in October 2005, expanding the permitted functions to include tourism, culture, conferences, research, and universities. This opened the door to the privatization of the asset, which passed into the hands of Pentagramma a joint-venture real estate vehicle split 50% by Fintecna and 50% by Gefim. In July 2009, a further change in the zoning allowed for commercial uses and a considerable increase in construction volume. Pentagramma subsequently identified a final user in the Dutch real estate investment group Corio, which sought to build a shopping mall using a pension fund. The project, designed by Turin architect Alberto Rolla and presented in 2011, proposed the insertion of bulky, multi-story independent internal commercial blocks rising up to six storeys high inside the historic envelope. This approach raised intense criticism from citizens and local traders, who feared severe commercial saturation.

The controversial project was abruptly halted in June 2012 by the Regional Administrative Court (TAR) following a legal complaint launched by the company managing the competing shopping mall in the nearby ex-Fiat Lingotto factory. Following nearly a decade of legal gridlock, economic stagnation, and the physical damage of the 2015 fires, a profound institutional correction occurred on August 17, 2020, when the Italian State officially re-acquired ownership of the building through Cassa Depositi e Prestiti (CDP).



Figure 1.21: Cassa Depositi e Prestiti (CDP).

The transition of control to Cassa Depositi e Prestiti marks a fundamental shift in the design parameters of the contemporary architectural intervention. Future restoration strategies shift away from maximizing commercial floor area ratios for private speculative funds, aligning instead with public-sector cultural financing and urban regeneration models. This framework draws from the adaptive reuse methodology of Gare Maritime in Brussels, where independent modular volumes are inserted within a large-scale historic envelope to foster public-cultural programming. To respect the historic fabric, the spatial constraints for this design intervention are derived directly from this precedent and a morphological analysis of the host structure: new internal volumes are strictly confined below the height datum of the original perimeter gallery, and their layout maintains a calculated setback from the monumental pillars to safeguard the continuous interior perspective defined by Nervi’s masterwork. Any future intervention must operate within a delicate ecosystem: balancing the strict structural preservation mandates enforced by the Soprintendenza, the research and civic needs of institutions like Politecnico di Torino, and a regional integration plan that can weave this industrial monument back into the social fabric of Turin.



1.5 HISTORICAL TIMELINE

1959-1961	1961-1962	1962-1970	1970-1980	1980-2000	2000-2015	2000-2022
Starting in 1959, Turin saw the construction of a series of buildings in the Nizza Millefonti district, on the occasion of the Italia '61 event, the celebrations for the centenary of the Unification of Italy. Among them, this building stood out for its cutting-edge dimensional and design characteristics.	  	Adapted as UN International Labour Organization (ILO) HQ. Nervi's studio performed a 1962 retrofit: added insulated panels, double-glazing, heating/cooling, fan-coil units, etc, to house the ILO. It remained in use until the mid-1980s	 	 On August 20 ,2015, a suspected arson fire severely damaged the (vacant) second floor. ArchDaily reports the “glass-encased” building was “devastated by fire” while under renovation. (This drew public attention to the urgent need for reuse.)	 Turin purchased the building in early-2000s (venal price ~€20M) and passed variant plans (,2006 2009) allowing mixed uses (tourism, culture, R&D, commercial). A 2007 selection gave equity to Gefim (Ponchia family); by 2010 Pentagramma/Corio proposed a large mall (2011, architect A. Rolla). None of these advanced beyond concept.	
	Palazzo del Lavoro opens as centerpiece exhibition pavilion. Built quickly (Feb–Dec 1960) using divided-site prefabrication.	Italia '61 is a sub- district of Nizza Millefonti , in Turin (Circumscription 9 ; 8 until 2016). It hosted the Expo 1961 (officially Esposizione Internazionale del Lavoro - Torino 1961, (International Labour Exhibition), also known as Italia '61 , which took place in Turin to celebrate the centenary of the unification of Italy . The exhibition attracted more than six million visitors from all over the world.		UN ILO departs (mid-80s) due to maintenance issues. Building saw partial institutional uses: regional cartography, some training centers, a university faculty annex until ≈2008, and occasional cultural events. A Various proposals(museum of art, shopping center, start-up incubator, etc.) surfaced but none were realized.	 	

02 SITE ANALYSIS & BUILDING INTERPRETATION

2.1 TERRITORIAL CONTEXT AND URBAN CONNECTIVITY

2.1.1 Macro-geographical context

The project area anchors the absolute southern edge of Turin's urban fabric, acting as the definitive gateway to the city. As demonstrated in Geographical Map, the site is significantly removed from the historic City Center, creating a clear spatial separation between the dense urban core and this peripheral sector. The site sits at the ultimate termination point of a major north-south infrastructural axis that channels traffic and rail movement from the northern entry points and central transport hubs, Porta Susa Station and Porta Nuova Station, straight down to the southern boundary. Geographically, the site is framed by several of Turin's most prominent post-industrial and natural landmarks. It lies directly south of the Lingotto district, positioned immediately down the line from Lingotto Station and the massive Lingotto Commercial Mall complex. The eastern boundary of this entire southern sector is dictated by the natural path of the Po River and the linear green network extending down from Valentino Park, which sits directly opposite the steep topography of the hill landscape. This macro-positioning creates a distinct urban paradox. On a territorial scale, the site is highly visible and tightly woven into regional mobility networks due to the adjacent rail lines and incoming highway arteries. Locally, however, its location at the extreme tip of the municipal fabric

places it in a zone of transition, caught between heavy infrastructural corridors and the river barrier, isolating it from the active daily life of the inner city neighborhoods.

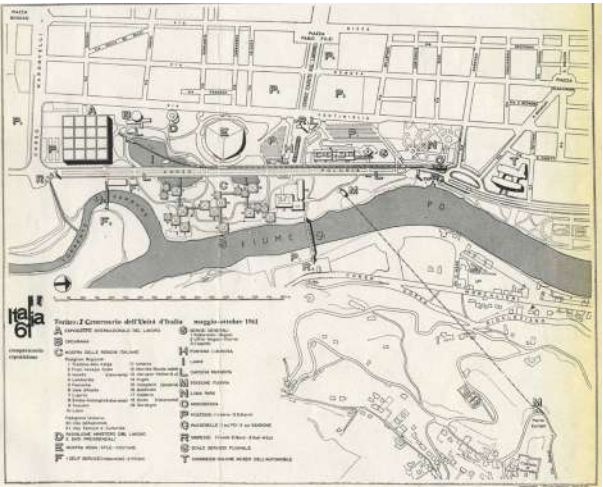


Figure 2.1: Proceedings and technical review of the Society of Engineers and Architects in Turin - New Series - A. 15 - No. 6 - June 1961



Figure 2.2: Proceedings and technical review of the Society of Engineers and Architects in Turin - New Series - A. 14 - No. 4 - April 1960

Figure 2.3: Current Geographical Map of Torino



2.1 TERRITORIAL CONTEXT AND URBAN CONNECTIVITY

2.1.2 Mobility, accessibility and neighborhood dynamics

The Palazzo del Lavoro is placed at a major infrastructural terminal point on Turin's southern edge near the Po river, and exists between fast-moving vehicular avenues, a subterranean metro line, and the barriers of the railway to the west. While regional connection is highly developed, local pedestrian access operates on tight, specific thresholds. Looking closely at walking distances, the site is positioned within a transit triangle between two key stops on the Metro Line 1 extension. Walking north brings the user to

the Italia '61 metro station in about 12 minutes, while heading south links the user to the Bengasi terminal station in 10 minutes. Getting to regional trains at Torino Lingotto station is a bit farther, requiring a 20 minute walk. Surface transit is dense, with multiple bus routes running down major corridors like Via Nizza and the riverside avenues. Cyclists can use dedicated bike paths that follow the Po River and cut through the local street grid. Huge open parking lots right next to the project area show how heavily the site favors car access.

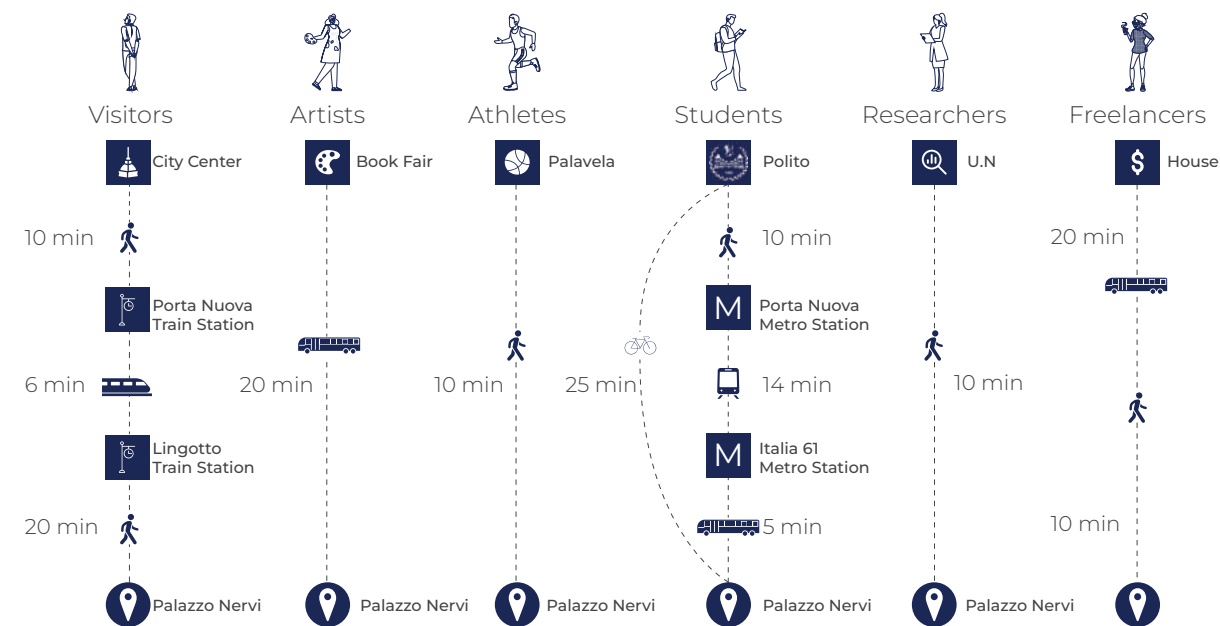


Figure 2.4: Users Chronological Public Access Timing and Pattern



Figure 2.5: Site Transportation Analysis

2.1 TERRITORIAL CONTEXT AND URBAN CONNECTIVITY

2.1.2 Mobility, accessibility and neighborhood dynamics

The neighborhood surrounding the Palazzo del Lavoro doesn't feel like a typical, quiet residential grid. Instead, it functions as a highly specialized institutional hub driven by large-scale urban anchors. These structures organize the immediate territory into separate zones for administrative work, scientific research, higher education, and major events. To the west and north, the landscape is defined by massive post-industrial conversions and governance centers. The legacy of the Lingotto factory forms a heavy commercial and exhibition spine, anchored by the Lingotto Mall, the International Book Fair Hall, and the OVAL pavilion, all dominated by the towering Palazzo della Regione Piemonte.

Right above the site's northern boundary sits a major sports and recreation cluster centered on the Palavela and local athletic associations. Tucked between these large hubs is an active educational network, including the SAA School of Management, specialized language academies, and research spaces like SIOI Piemonte. Moving toward the river park to the east, the program shifts to global environmental research, anchored by the UNESCO center and the S.M.A.T. Research Center. The combination of this data allows the designer to understand how each kind of user thinks and what each user need in that area to experience. The lack of innovative functions in that area makes it the perfect place to input creative activities.

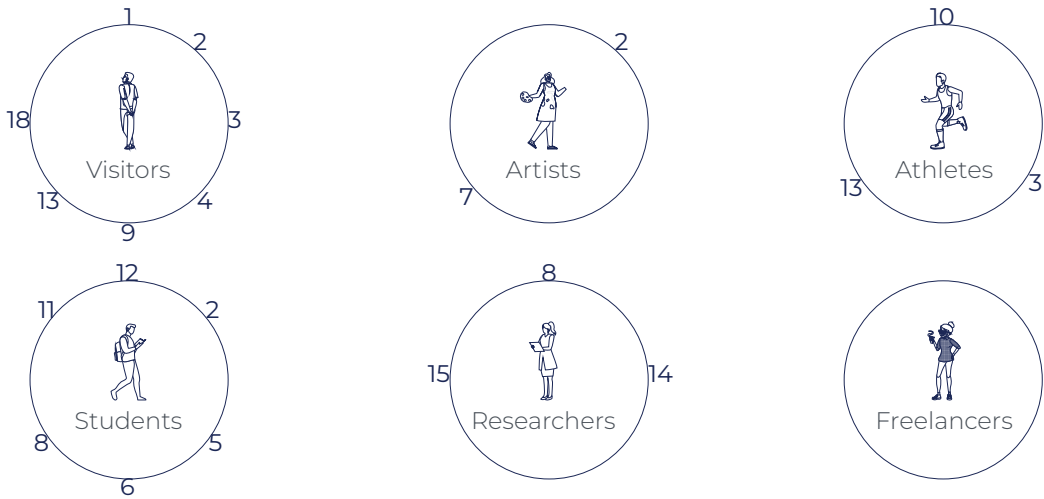


Figure 2.6: Users envxmental functions in the area of the project. This represents each type of user does not have enough innovative spaces to experience according to their need.

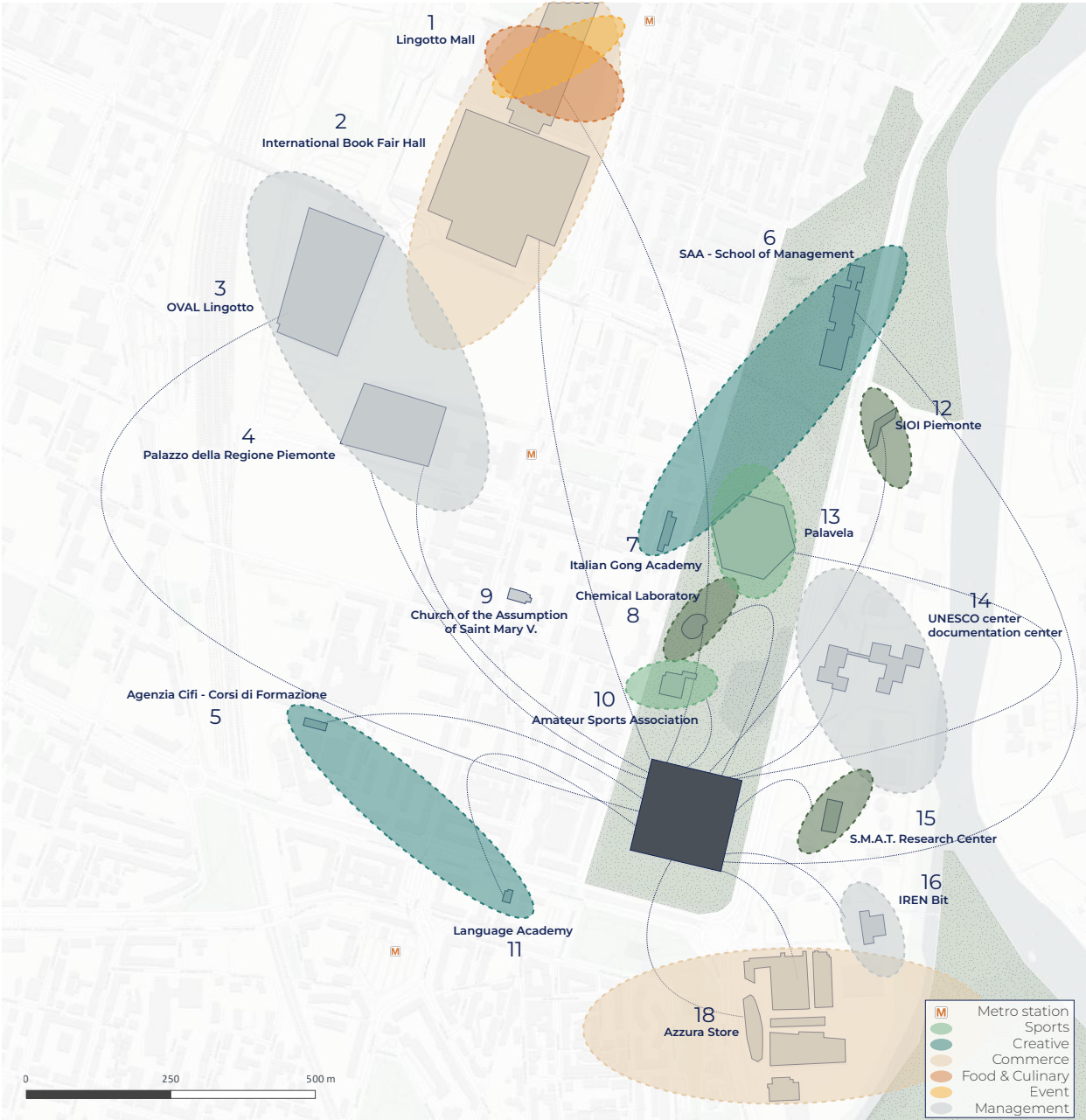


Figure 2.7: Site Functional Analysis

2.2 BUILDING ANALYSIS

2.2.1 Direct survey

During the initial phase of this thesis, an official request to access the Palazzo del Lavoro was coordinated through architectural historian Cristina Chiorino. However, formal permission to enter the complex was denied by the building's current management and safety custodians due to the hazardous structural conditions of both the interior and the immediate perimeter. The entire pavilion is sealed behind permanent security fencing, strictly prohibiting unauthorized entry. As a result, this research had to proceed without the support of an on-site physical survey. The absence of direct spatial measurement created a significant methodological hurdle. The initial phase of the Diagnostic HBIM* model had to be built using a highly limited baseline of public documentation and secondary records. This digital scarcity was eventually overcome after securing permission to access the private archives of Fondazione MAIRE, which provided the comprehensive drawing sets necessary to model the complete architectural organism. To supplement the lack of an on-site inspection, the diagnostic assessment relied on recent interior video documentation sourced during the research phase. This footage confirmed extensive, deep-seated structural decay throughout the main hall. Widespread water infiltration, surface spalling, and heavy fungal growth were clearly visible across the historic concrete elements, showing the building's advanced state of abandonment.

*HBIM: Historical Building Information Modelling

Figure 2.8: Umbrella columns defining the buildings architecture



Figure 2.9: Palazzo Nervi after fire devastation and attempted renovation.

Figure 2.10: Picture taken from the West side 2nd floor.



Figure 2.11: 1st floor perimeter demonstrating colorful columns and destroyed glasses on the facade.

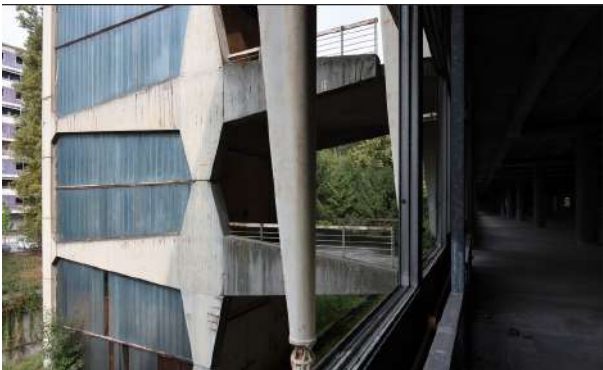


Figure 2.12: 1st floor West side perimeter representing destroyed glasses on the facade and the exterior staircase.

2.2 BUILDING ANALYSIS

2.2.2 Indirect survey

This phase of the research relies on original design documentation made available through the courtesy of Fondazione MAIRE. While the historical records are remarkably complete, the original execution drawings for the building's deep basement level were unavailable during the research phase. This gap introduces a major programmatic challenge: while massive surface parking zones currently surround the pavilion, any successful contemporary reuse must find a way to integrate internal parking networks directly within the subterranean footprint, or carefully reconfigure the surrounding landscape grid to prevent cars from dominating the historic park.

The consulted archive also reveals previous, unbuilt conversion attempts most notably a mid-lifecycle proposal to transform the Palazzo into a professional sports center. Though this sports program was ultimately shelved due to the close proximity of existing Olympic venues like the Palavella and the Oval Lingotto, the archive itself remains a rich, heterogeneous mix of original 1960 construction drawings and modern adaptive design layers.

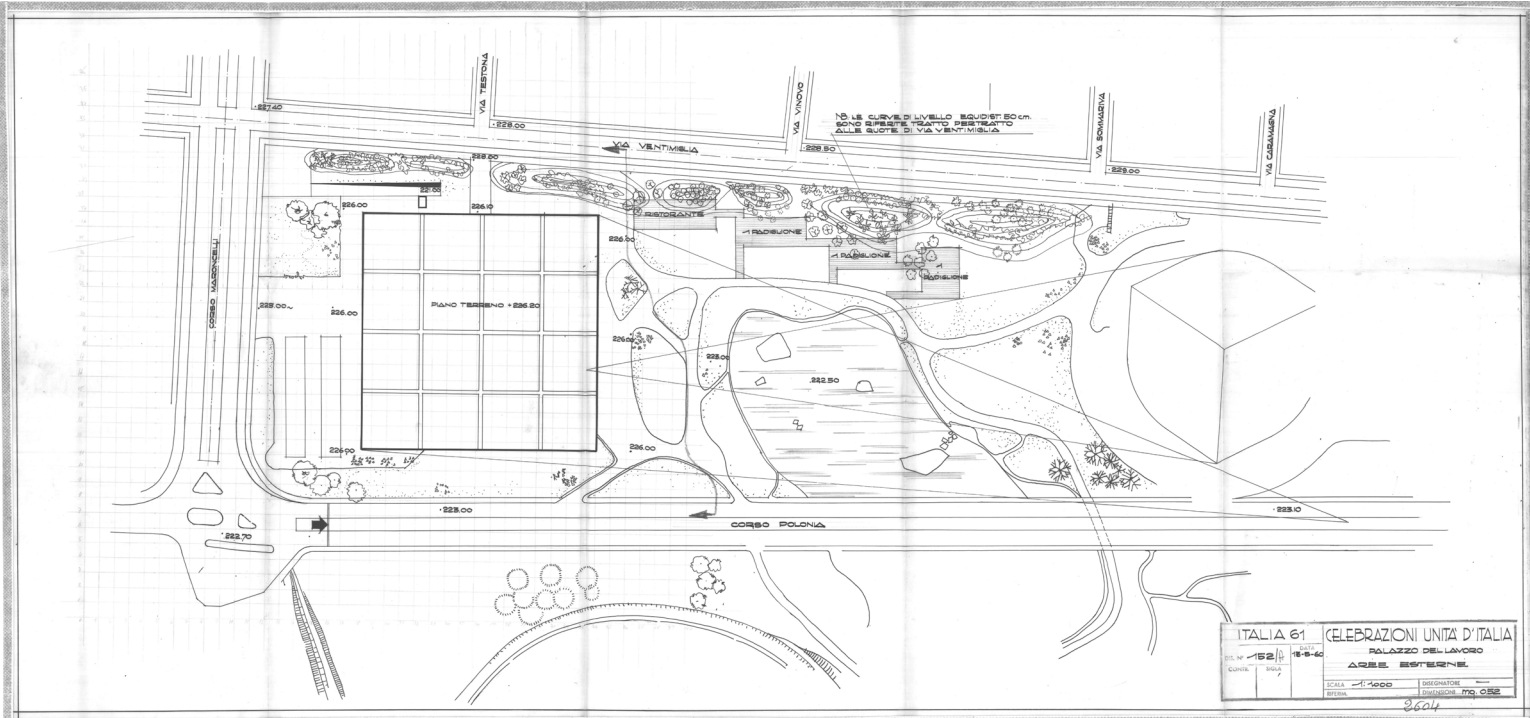


Figure 2.14: Site Master-plan of the external areas "Courtesy of Fondazione MAIRE - ETS. Materials from the MAIRE Historical Archive."



Figure 2.13: Unexecuted Internal perspective "Courtesy of Fondazione MAIRE - ETS. Materials from the MAIRE Historical Archive."

2.2 BUILDING ANALYSIS

2.2.2 Indirect survey

The internal layout of the pavilion is governed by a strict, monumental structural grid. The building outlines a massive square footprint measuring 150.75 m × 150.75 m at the ground plane. The primary internal volume is anchored by the 16 central concrete columns, organized on a regular orthogonal matrix with a wide 40 m spacing between axes. At the first-floor mezzanine level, the floor plate extends beyond this primary structural line, creating a 3.625 m cantilever that projects outward toward the perimeter envelope. The perimeter framework relies on secondary rectangular columns spaced at regular 10 m intervals, which directly frame the modular window and door assemblies of the lower facade. The vertical distribution of the peripheral galleries changes significantly depending on the exposure. Along the East, South, and West sides, the mezzanine levels span up to the second floor. The North exposure features a distinct layout, extending upward to include a third level, making it the most programmatically dense perimeter zone in the original layout. Vertical circulation is handled by an organized, symmetrical circulation network designed to distribute large crowds efficiently. Movement between levels is anchored by four primary staircases positioned at the outermost corners of the perimeter galleries. These are paired with four central escalators arranged in a precise cross-axial

alignment, creating a clear geometric cross that channels pedestrian flow directly from the main ground floor entries up into the upper gallery tiers.

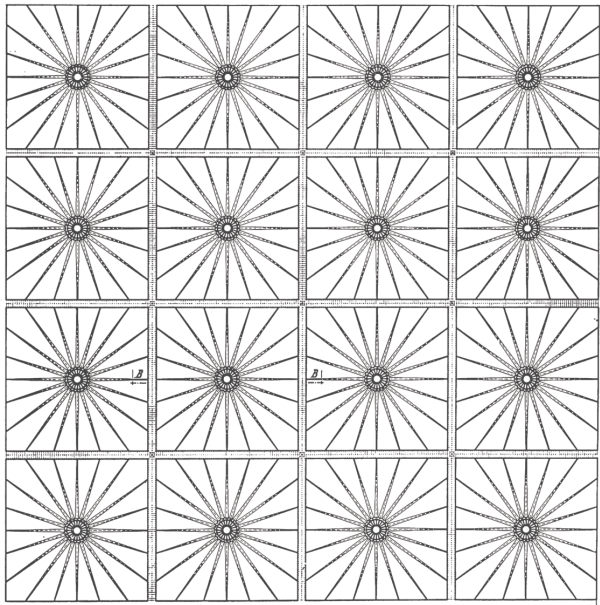


Figure 2.15: Main Ceiling view demonstrating the spiral beams and skylights strips.

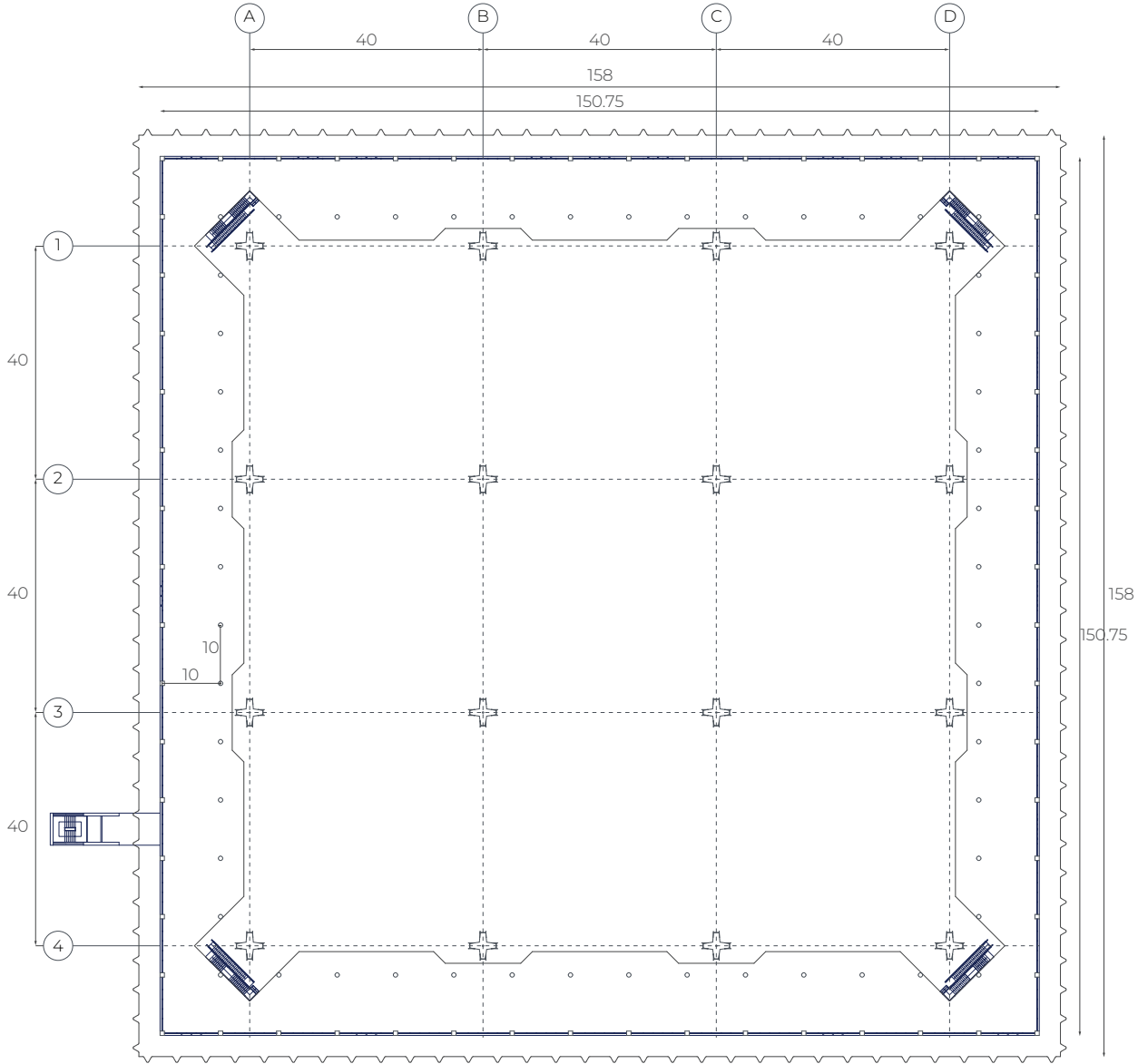


Figure 2.16: Existing Ground floor plan with dimensions.

2.3 MATERIALITY AND CONSTRUCTION TECHNOLOGY OF THE EXISTING FABRIC

Main Umbrella-shaped Columns

The roof is supported by 16 impressive 26 meter high-ferrocement pillars whose cross-shaped base is 5 m and at the top of which the metal beams that support the roof are bolted. The steel was painted utilizing a rather cement-like light grey gloss paint, which defeated any intent of contrast and tended to conform it with the concrete, revealing Nervi's propensity for the original idea of a building all in ferro-concrete, including the roofing. Beneath the monumental concrete columns lies a complex subterranean topography that required three heavy pile drivers operating constantly throughout the spring of 1960. The geotechnical profile of the Po River plain at the southern gateway consists of three distinct layers.

- A 5 meter upper layer of loose, uncompacted urban landfill.
- A 5 meter secondary layer of fine sand and loose alluvial silt.
- A massive, stable 20 meter of compacted river sand and heavy gravel.

To bypass the unstable upper strata, the foundations sit on heavy concrete Franki piles, each 500 mm in diameter. The pile heads are driven deep into the gravel bed, anchoring the building's immense dead loads at a final geological depth of approximately 30 meters beneath the floor line.

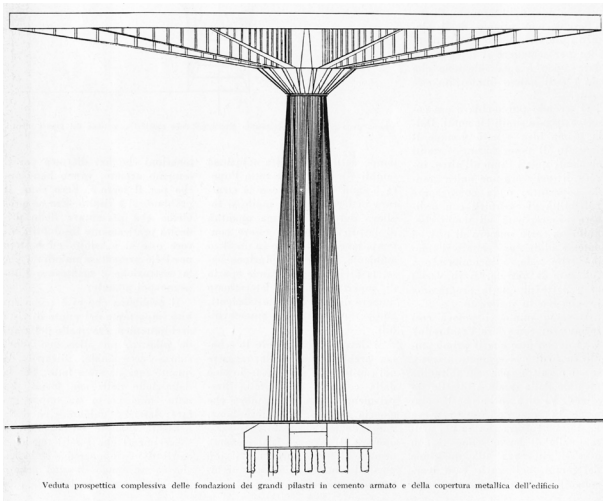


Figure 2.17: Overall perspective view of the foundations of the large reinforced concrete pillars and the metal roof of the building.

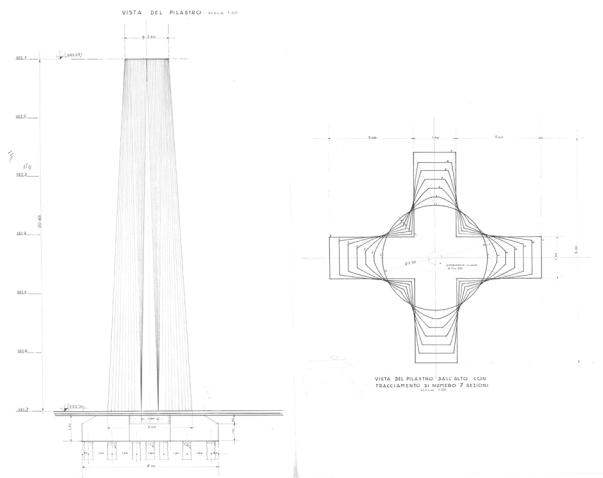


Figure 2.18: Details of the Main Pillars Supporting the Roof. "Courtesy of Fondazione MAIRE - ETS. Materials from the MAIRE Historical Archive."

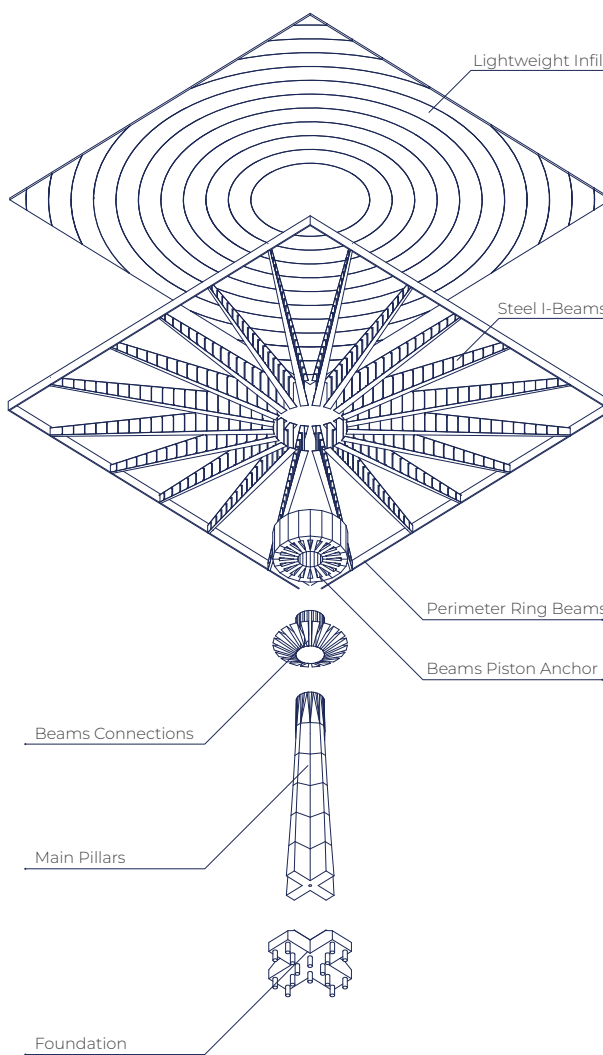


Figure 2.19: 3D Isometric explosion of the roof and column connections. Assembling all the components with piston joints while placed on the 15 meters high foundation.

The structure does not use a continuous roof truss. It is split into 16 independent, 40x40 m "umbrellas":

- **Variable-Section Cantilevers:** Solid ribbed steel I-beams radiate outward from the capital of each central concrete column, tapering in depth as they reach the outer margins.

- **Perimeter Ring Beams:** A continuous steel perimeter beam circumscribes each individual umbrella bay, unifying the outer tips of the ribs and redistributing local deflection forces.

- **Lightweight Tectonic Infill:** Light steel cladding panels and continuous wire-mesh glass skylights are nested between the independent umbrellas, allowing ribbons of natural light to slice through the structural grid.

These sixteen reinforced concrete (R/C) columns with variable section along the height each one supporting a steel roof panel with radial beams spanning from the centre of each column.



Figure 2.20: Detailed picture of an umbrella column.

2.3 MATERIALITY AND CONSTRUCTION TECHNOLOGY OF THE EXISTING FABRIC

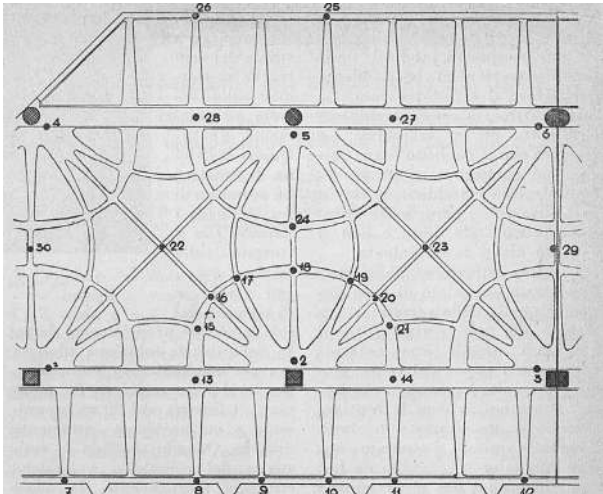


Figure 2.21: Section of the isostatic ribbed floor supporting the perimeter tunnel; with the positions of the deflection gauges for isostatic testing.

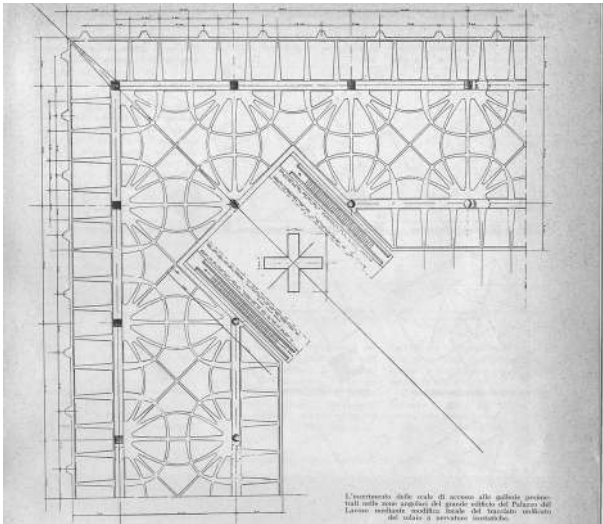


Figure 2.22: The insertion of the access stairs to the perimeter galleries in the corner areas of the building by means of local modification of the unified layout

Isostatic Roof Slabs

The mezzanine floor plates lining the perimeter of the hall highlight a central theme in Pier Luigi Nervi's career: the deliberate tension between pure engineering logic and conscious aesthetic choice. While Nervi consistently maintained that his structural forms were entirely dictated by the objective laws of physics, the physical layout of the mezzanine ceilings reveals a highly curated artistic intervention. This approach is explicitly evident in the design of the isostatic floor ribs. The structural patterns molded into the intrados of these slabs map the principal stress trajectories specifically, the strain-lines of the bending moments generated within a rectangular slab pinned at its corners by four columns. Rather than mapping the infinite, dense bundle of lines produced by pure mathematical calculations, Nervi selected a limited number of these curves to generate an elegant, legible geometric pattern. He then deliberately projected these lines downward, exposing them beneath the actual flat plane of the slab. To build these intricate ceilings rapidly during the tight 1960 construction schedule, the contracting team utilized a standardized system of movable form work fabricated from ferro-cemento. These reusable, pre-formed mesh-mortar molds allowed the builders to pour concrete panels efficiently in repeating cycles.

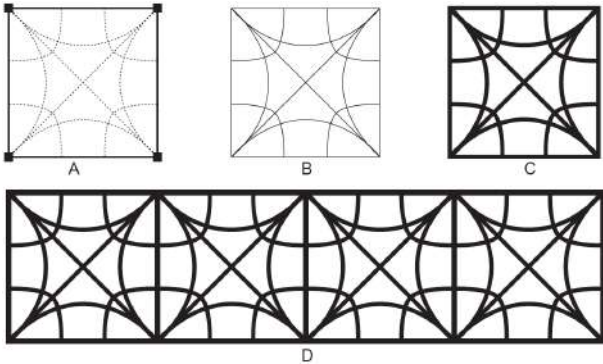


Figure 2.23: Diagrams of the isostatics (A), the reinforcement lines (B), the definition of a ribbed slab (C), and the final ceiling pattern (D) [Manuel Cresciani's personal archive].

The structural reinforcement bars were bent and laid directly within these curved channels, aligning the steel along the calculated paths of tensile stress.



Figure 2.24: Ground floor ceiling

However, this highly celebrated feature contains a profound structural paradox. From a strict building mechanics standpoint, the projecting ribs represent a brilliant architectural illusion rather than a mathematically perfect structural solution. True isostatic lines are coplanar they exist entirely within the flat, uniform thickness of a thin plate. By pulling these lines downward to form distinct concrete ribs, Nervi fundamentally changed the cross-sectional geometry of the slab. This geometric change alters the very stiffness of the floor plate, distorting the original calculation and forcing the actual internal stress paths to flow differently than the decorative ribs imply. The ceiling stands not as a piece of raw, automated engineering calculation, but as a carefully calculated piece of structural expressionism.



Figure 2.25: Direct photograph showing the ground floor ceiling and the main roof

2.3 MATERIALITY AND CONSTRUCTION TECHNOLOGY OF THE EXISTING FABRIC

Doors and Windows

The primary entrance doors are fabricated from heavy iron laminates to ensure structural durability, security, and resistance to high pedestrian traffic at the street interface. In contrast, the surrounding window frames are executed in a lightweight, light-alloy aluminum system, mirroring the material choice of the upper facade while maintaining a significantly smaller modular division.

To prevent the intense daytime mirror effect that would otherwise blind the approach to the entrance, these lower window components integrate opaque insulation backing panels. This design choice allows the public floor line to maintain a clear visual relationship with the park outside while mitigating solar heat gain at the building's base.

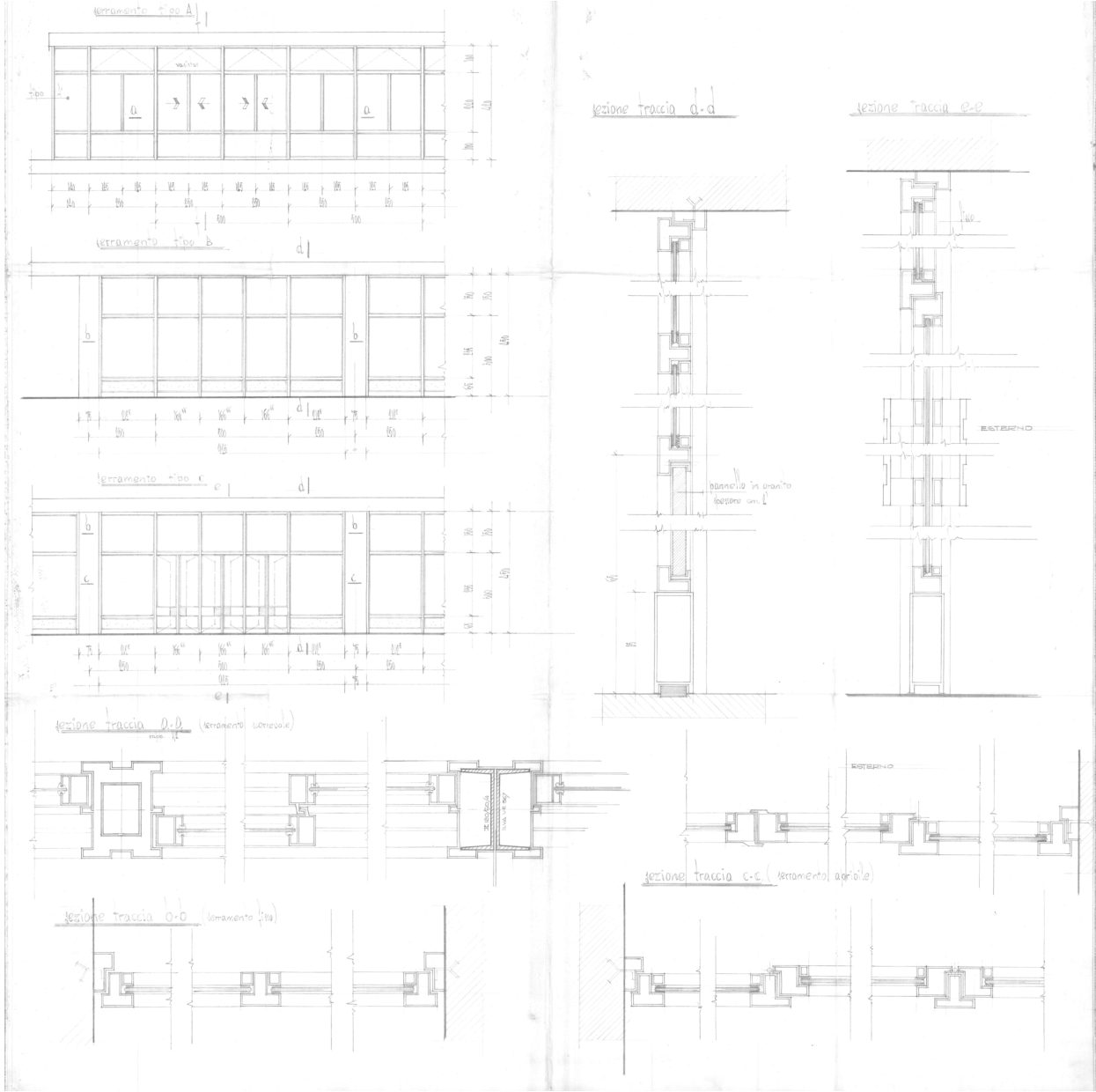


Figure 2.26: Ground floor Doors and Windows section and elevation details
"Courtesy of Fondazione MAIRE - ETS. Materials from the MAIRE Historical Archive."

2.3 MATERIALITY AND CONSTRUCTION TECHNOLOGY OF THE EXISTING FABRIC

Exterior Curtain Walls

The building's exterior envelope is formed by continuous curtain walls that wrap all four exposures of the pavilion. This massive glazing system spans a vertical height of nearly 20 meters, starting from the first-floor mezzanine gallery line at an elevation of +5.25 m and running up to the main roof line at +25 m. The perimeter layout is strictly organized by a rhythmic placement of 32 external vertical fins on each facade, spaced exactly 5 m apart center-to-center. To manage solar heat gain, the spaces between these deep structural uprights are filled with fixed horizontal shading louvers across the East, South, and West elevations with different angles on each side. The North elevation breaks from this pattern, completely omitting the horizontal louvers to allow an unobstructed intake of indirect, uniform northern daylight into the hall. The primary glass skin relies on modular single-pane window units set within lightweight metal

framing. These 2.5x5 m glass panels are interconnected and anchored directly to the external vertical aluminum elements for structural support. The exterior skin represents a famous aesthetic and functional debate between the project's authors. Gio Ponti strongly insisted that the interior lighting should originate entirely from floor-mounted fixtures, shooting upward to illuminate the concrete capitals and emphasize the structural poetry of the columns. The Nervi team flatly rejected this idea. In a direct letter to Ponti, they argued that this upward lighting scheme would render the vast ceiling flat, black, and completely devoid of its plastic, three-dimensional value when viewed against the light. This tension extended to contemporary architectural critiques. While the independent glass facade was celebrated for its scale, critics like Bruno Zevi attacked the glass envelope as "vague and anonymous," claiming that the reinforcing corner pillars felt structurally weak and detached from the inner context of the hall.

Figure 2.27: Elevations for ordering doors and windows for the upper floor and the ground floor "Courtesy of Fondazione MAIRE - ETS. Materials from the MAIRE Historical Archive."

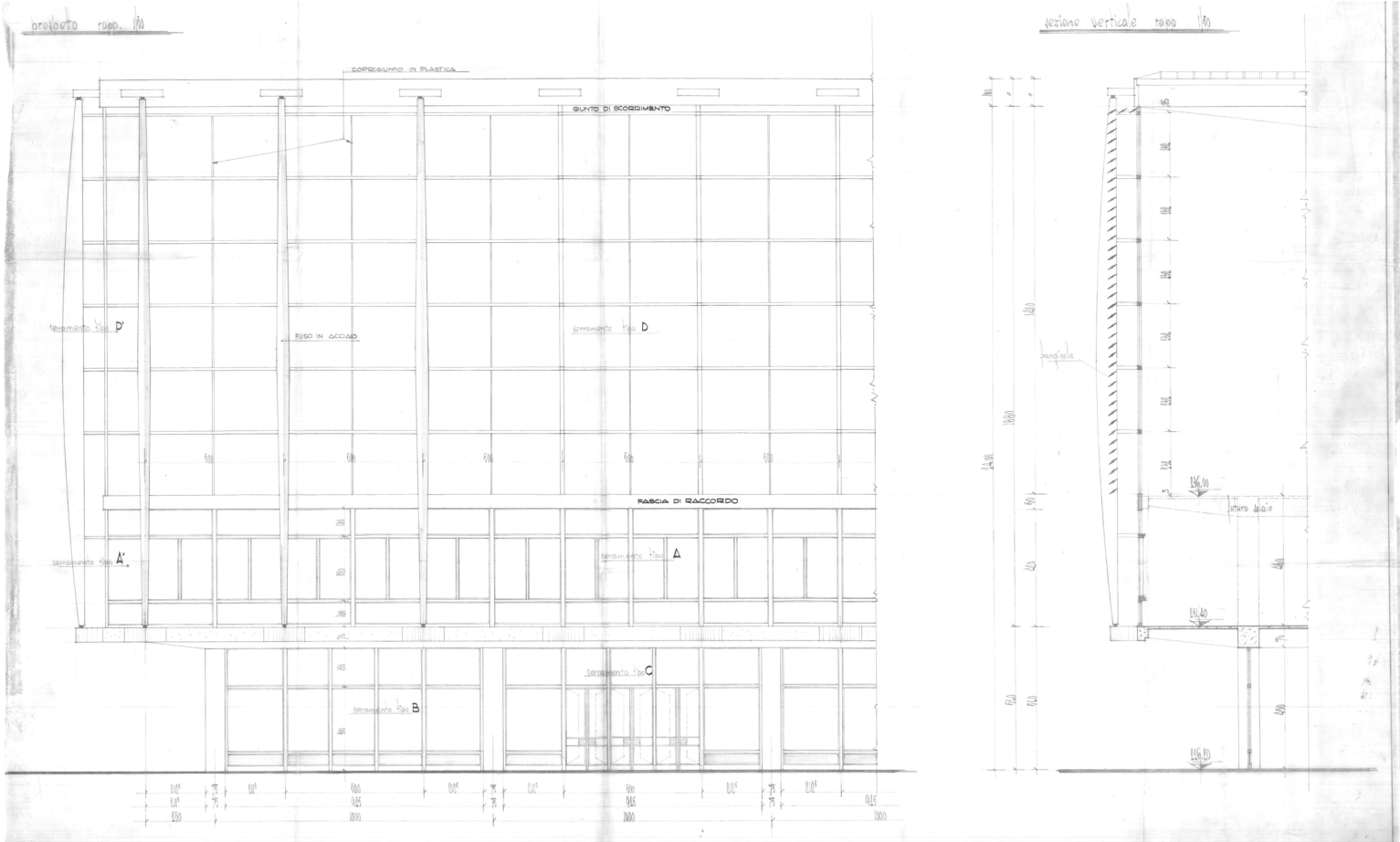
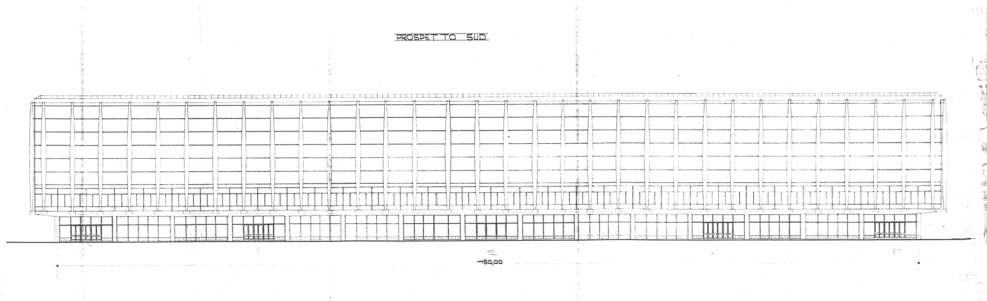
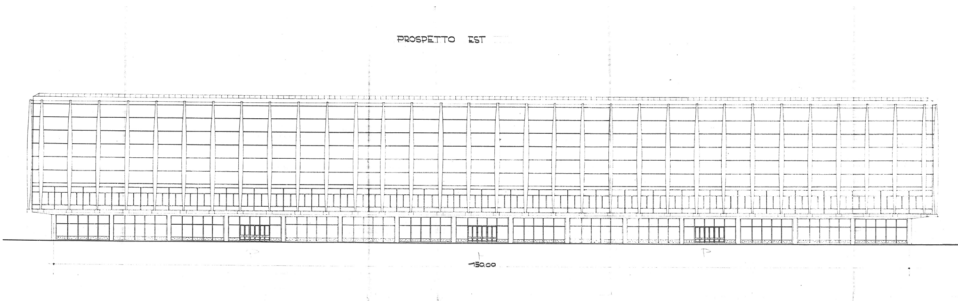
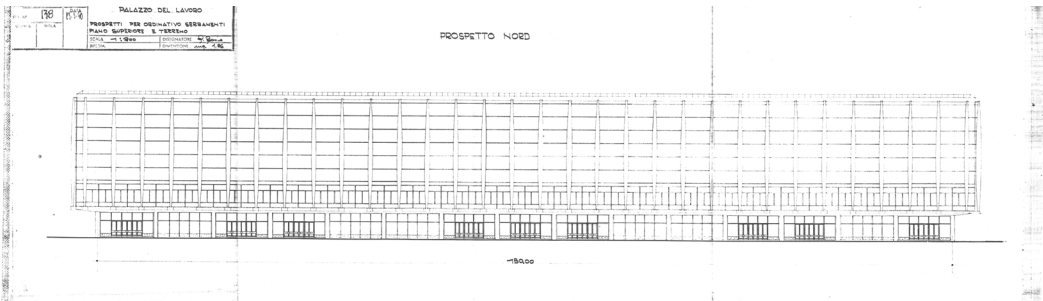


Figure 2.28: Detail of the elevation Representing the doors and windows sizes "Courtesy of Fondazione MAIRE - ETS. Materials from the MAIRE Historical Archive."

2.3 MATERIALITY AND CONSTRUCTION TECHNOLOGY OF THE EXISTING FABRIC

Exterior Curtain Walls

The main curtain wall stands 19 meters high, split horizontally by an opaque metal band that aligns precisely with the thickness of the internal mezzanine gallery designed to be completed at a later date. This exterior wall was left entirely undefined during the initial public tender competition, ensuring its design remained structurally detached from the inner load-bearing concrete frame. Curtain Wall Tectonics and Material Specifications Mechanically, the glass envelope is a masterclass in industrial tolerances, engineered to be erected entirely from the inside without external scaffolding. The vertical mullions and external steel brise-soleil profiles are mounted to sheet-metal upright shafts. To handle intense wind loads and thermal expansion without cracking the glass, the bottoms of these uprights are anchored on mechanical cardan joints, while the tops slide within telescopic piston rods, allowing the entire facade to flex independently of the concrete frame. All window profiles, uprights, and solar fins were coated in a protective, high-gloss martinorint finish tinted in a custom-blended shade known as London smoke grey (grigio fumo di Londra). Ground floor is surrounded by glazing doors and windows, while first floor is surrounded by windows without any shading fins and louvers.

The material archival ledger lists highly specific glazing parameters:

Framing Elements: Window profiles are executed in light-alloy aluminum, while the primary entry doors are fabricated from heavy iron laminates. (Antonio Nervi originally specified aluminum for the massive solar fins, but fell back on steel to control escalating project costs).

Glazing Thicknesses: Steel laminate door frames utilize semi-double glazing. The internal gallery frames use a 5+6 mm light-alloy plate glass system, incorporating an opaque insulation backing panel to block out the mirror effect from below.

Primary Envelope: The main external curtain walls are fitted with heavy 8-9 mm plate glass. The roof lanterns use wire-mesh safety glass, while the back-of-house cleaning utility zones are finished in opaque rolled figured plate glass. This independent glazing logic creates a dramatic day-and-night reversal. The corners of the facade are intentionally left open and transparent, proving that the skin carries no load and that Nervi's columns are the true spatial anchors. During the day, the glass acts as a reflective shield, turning the building into an opaque, solid mirror that conceals the interior. At night, the relationship flips completely: internal illumination turns the envelope fully transparent, revealing the deep structural geometry to the surrounding city fabric.



Figure 2.29: Photograph taken on the second perimeter floor visualizing the curtain walls and framings.

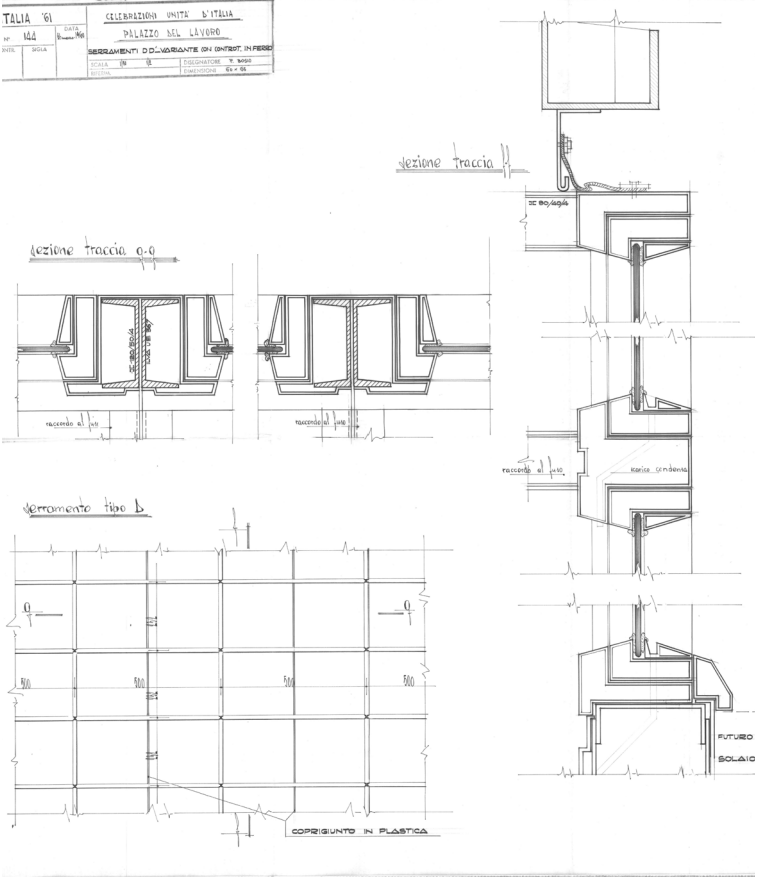


Figure 2.30: Detailed sections and elevations of the curtain walls "Courtesy of Fondazione MAIRE - ETS. Materials from the MAIRE Historical Archive."

Figure 2.31: Glazing framings to Shading connection, Transferring Load to Isostatic Slabs.



2.3 MATERIALITY AND CONSTRUCTION TECHNOLOGY OF THE EXISTING FABRIC

Figure 2.32: East, South, West Horizontal louvers detailed section demonstrating their dimensions, spacings and angles on each side (Source: Fondazione MAIRE Historical Archives).

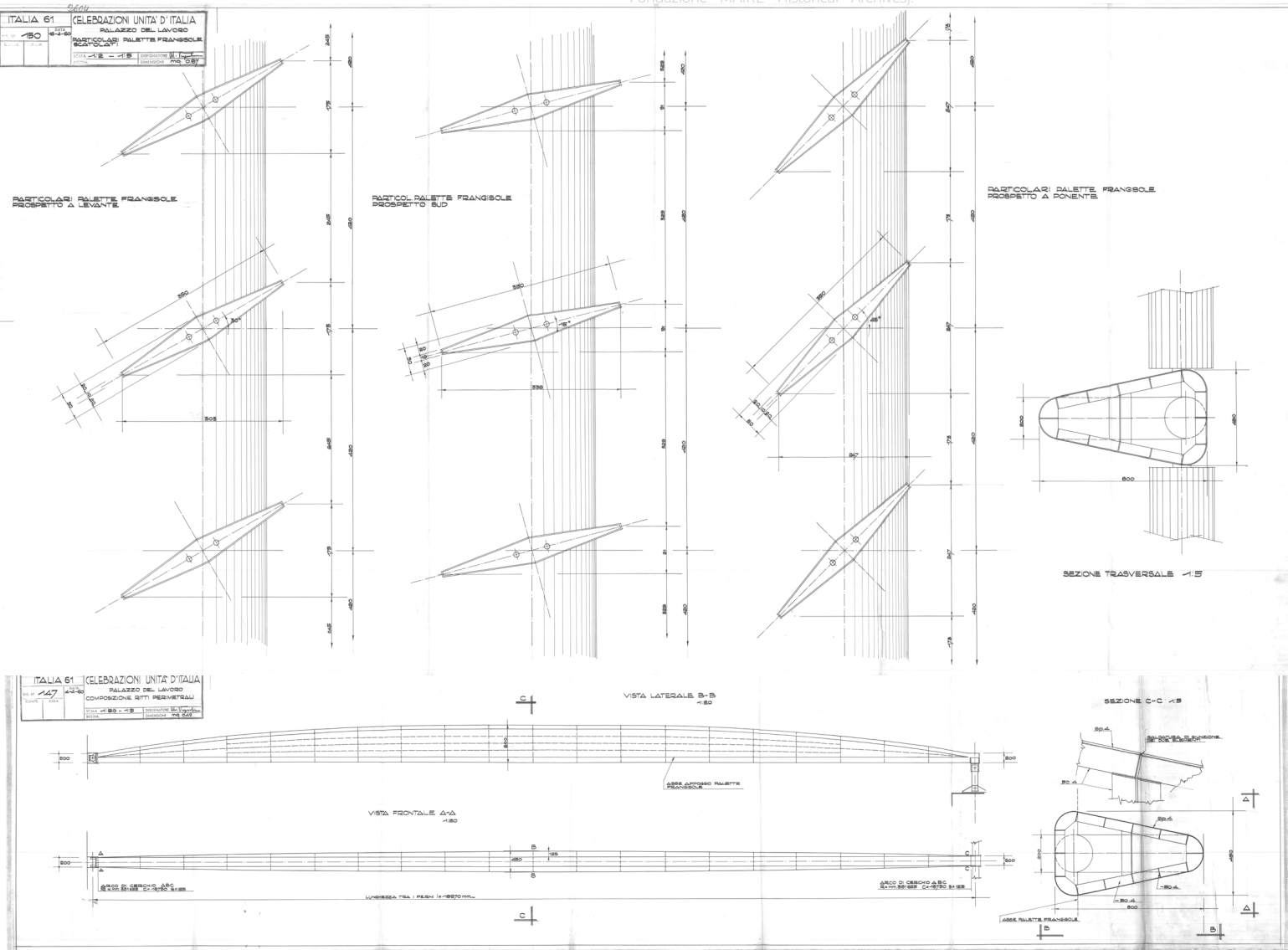


Figure 2.33: Detailed front and side elevation, and the plan of the vertical fins with dimensions "Courtesy of Fondazione MAIRE - ETS. Materials from the MAIRE Historical Archive."

Shading Devices

To fulfill the architectural concept of a fully transparent envelope sheltered beneath a monumental roof, the perimeter glass facade is engineered across two distinct, functional planes. The external plane consists of vertical, spindle-shaped steel mullions that span continuously between the intermediate mezzanine gallery and the upper roof line. By placing these deep structural uprights on the exterior, they directly absorb the facade's wind loads and structural inertia. This external loading path unburdens the interior envelope, allowing the cross-section of the inner window frames to remain exceptionally thin and lightweight, maximizing visual transparency into the hall. On the exposures subjected to intense solar radiation, the East, South, and West elevations, these vertical mullions serve a dual purpose by acting as the structural chassis for a system of horizontal metal louvers. These integrated brise-soleil blades are precisely spaced to act as a static mechanical filter, blocking high-angle direct sunlight and preventing glare while permitting uniform, diffused daylight to penetrate deep into the perimeter gallery spaces. Although Antonio Nervi originally intended to fabricate these horizontal blades from light-alloy aluminum, the execution ultimately utilized steel sections to manage project costs without compromising structural stiffness.

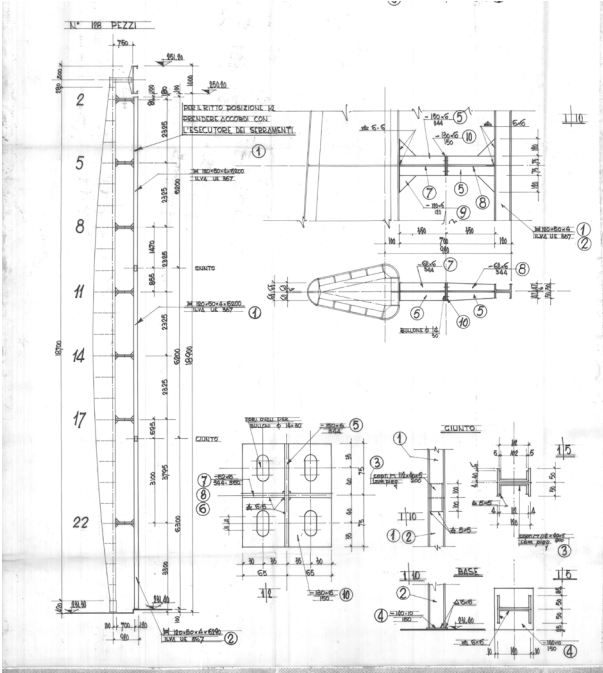


Figure 2.34: Detailed sections and elevations of the fins connection to the framings (Source: Fondazione MAIRE Historical Archives).

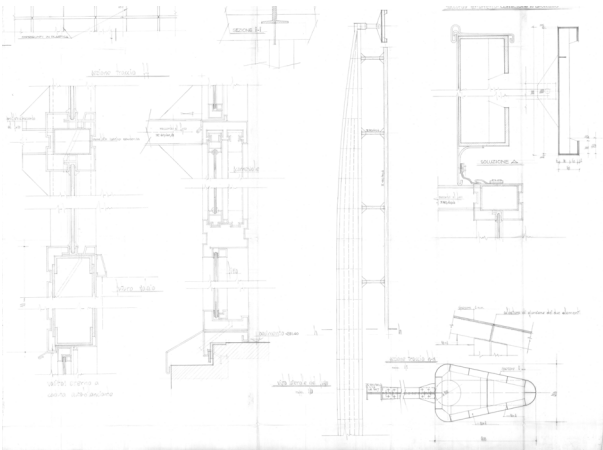


Figure 2.35: Detailed sections and elevations of the fins top level connection to the steel perimeter beams of the main roof "Courtesy of Fondazione MAIRE - ETS. Materials from the MAIRE Historical Archive."

2.3 MATERIALITY AND CONSTRUCTION TECHNOLOGY OF THE EXISTING FABRIC

Roof Glazed Strips

The sixteen independent square bays are separated and linked by an orthogonal network of 2-meter-wide linear skylight strips. Structurally, these roof lanterns consist of inverted, V-shaped steel frameworks engineered with specialized putty-free metal glazing profiles to ensure long-term weather tightness. These high-level glass bands channel natural light deep into the central core of the hall, accentuating the monumental scale of the concrete space and directly illuminating the radial steel cantilever beams from above.

To handle night-time illumination, artificial lighting is integrated directly into the structural logic of the roof lanes. Floating light fixtures are mounted along the central axis of the inverted V-framework at precise 1.5-meter intervals. This equipment placement aligns perfectly with the geometry of the building's envelope: since each individual glass frame measures exactly 0.5 x 0.95 meters, exactly three glazing frames sit between each successive lamp, maintaining a strict modular rhythm across the entire ceiling plane.

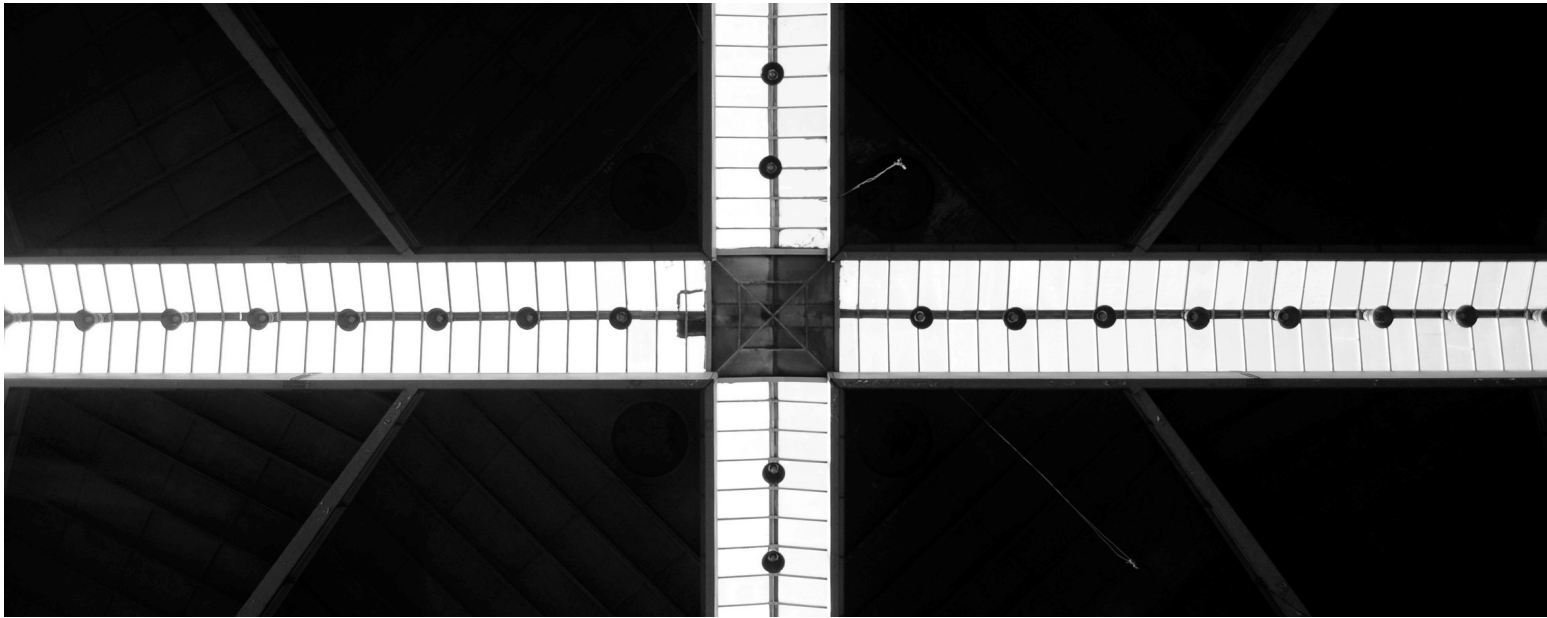
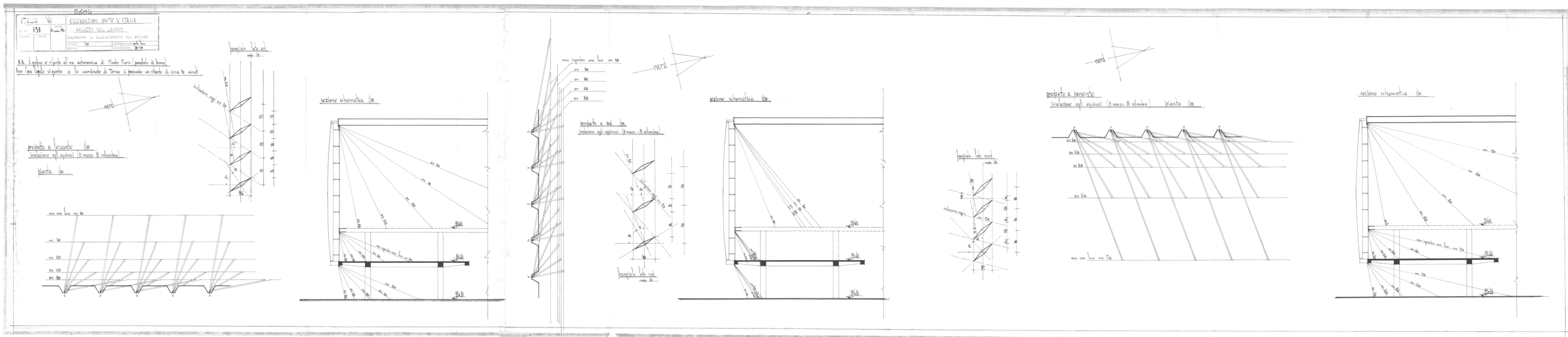


Figure 2.36: Direct photography of the roof skylights and their connections.

2.3 MATERIALITY AND CONSTRUCTION TECHNOLOGY OF THE EXISTING FABRIC



Solar Rays and Equinox

The structural layout of the envelope was heavily shaped by a detailed thermodynamic study. The designers did the precise calculations behind the facade's vertical dividers and horizontal panels, mapping exactly how solar rays penetrate the 19-meter-high open hall during the spring and autumn equinoxes. The drawing maps the geometric path of solar angles at specific hourly intervals throughout the day. The core engineering objective was to maximize natural indoor daylight

while blocking harsh glare and excessive heat gain. The cross-sections show that the deep external brise-soleil fins function as a static mechanical filter. Their depth, angle, and horizontal spacing are calculated to block direct, high-angle solar radiation during mid-day peaks, while allowing indirect, diffused light to bounce deep into the ground-floor open space and across the intermediate levels. The solar rays plotted in the diagram demonstrate how this horizontal mass casts a wide shadow across the lower levels, protecting the gallery spaces underneath from overheating.

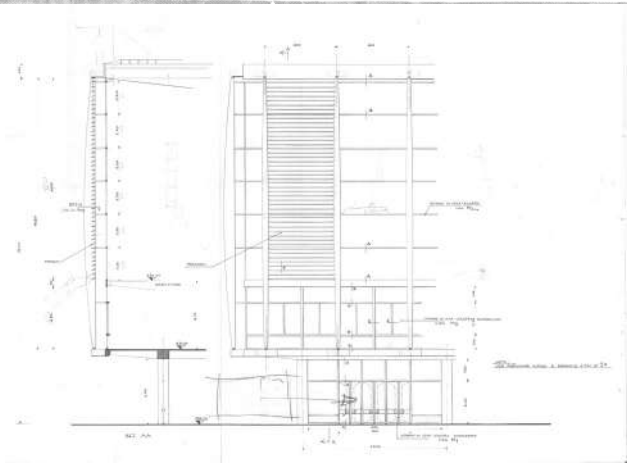


Figure 2.37: Technical sequence of sunlight Diagram at the Equinoxes visualizing solar rays angles.
Left Section (East Facade/Morning): Tracks low-angle morning rays striking the eastern envelope, calculating how the individual louver profiles cast early shadows at the component scale.
Center Section (South Facade/Midday): Evaluates high-altitude midday sun hitting the southern exposure, detailing how the deep spindle-shaped mullions and horizontal blades block peak solar radiation.
Right Section (West Facade/Afternoon): Maps descending afternoon solar paths through the modular roof skylights and across the western mezzanine gallery, checking late-day thermal control and interior shadow depths.
"Courtesy of Fondazione MAIRE - ETS. Materials from the MAIRE Historical Archive."

Figure 2.38: Detail of the elevation demonstrating the brise soleils "Courtesy of Fondazione MAIRE - ETS. Materials from the MAIRE Historical Archive."

2.3 MATERIALITY AND CONSTRUCTION TECHNOLOGY OF THE EXISTING FABRIC

ID Code	System Component	Primary Geometry & Dimensions	Material Specification	Structural / Functional Role
SUB-01	Deep Foundations	500 mm diameter Franki Piles; driven up to 30 m deep	Reinforced concrete	Transfers massive column dead loads past loose landfill into stable gravel banks.
STR-01	Monumental Pillars	Variable-section tapered columns; height: 25 m	Cast-in-place fair-face concrete	The primary load-bearing skeleton; carries independent vertical roof loads
STR-02	Isostatic Mezzanine Slabs	Rectangular perimeter plates with variable-depth projecting ribs	Concrete with curved tensile steel rebar layouts	Perimeter mezzanine gallery lines at elevation +5.25 m; cast via ferro-cemento forms.
ROOF-01	Umbrella Cantilevers	40 x 40 m square steel modules; tapered I-beam radial ribs	Solid ribbed structural steel profiles	16 independent, non-continuous roof assemblies supported at central column capitals.
ROOF-02	Perimeter Ring Beams	Continuous linear profiles circumscribing each 40x40 m bay.	Structural steel sections	Unifies the outer tips of the radial cantilever ribs to redistribute local deflection forces.
ENV-01	Primary Curtain Wall	19 m vertical height spanning from elevation +5.25 m to 25 m.	Lightweight light-alloy aluminum framing	Independent perimeter glass enclosure; completely detached from internal load-bearing structures.
ENV-02	Glazing Modules	2.5 x 5 m uniform repeating rectangular window sheets	8-9 mm heavy monolithic plate glass	Transparent skin inserts anchored directly onto the external aluminum vertical components.
ENV-03	Solar Louvers (Brise-Soleil)	Fixed horizontal external sun-shading profiles (omitted on North exposure)	Standard structural steel profiles	Static mechanical climate filter calculated to block high-angle direct solar radiation and glare.
ENV-04	Expansion Joints	Bottom: Cardan joint supports; Top: Piston rods	Cast steel mechanical hardware	Absorbs building deflections, wind shear, and independent thermal expansion patterns.
INT-01	Roof Skylights	Continuous horizontal bands bridging the gaps between umbrella modules, 2m wide	Wire-mesh safety glass set in metal frames	Structural glass tracks that channel diffused natural daylight deep into the central core of the hall.

Figure 2.39: As-Built Component Registry Table - Existing Fabric

2.4 DIAGNOSTIC HBIM MODELLING

2.3.2 Archival documents transition

Interior HBIM Model

The interior HBIM model serves as the primary structural and spatial anchor of the digital baseline. Because the physical survey was restricted due to site safety hazards, the internal geometry was systematically reconstructed by translating the archival cross-sections from the Fondazione MAIRE into highly detailed parametric Revit models. The modeling strategy focuses on the highly repetitive, industrial logic of the main hall. Rather than creating static, in-place masses, the 16 monumental umbrella columns were

modeled as variable-section adaptive components. The complex, fluid transition of the concrete pillars moving from a sharp, cross-shaped base at the ground plane to a perfect circle at the 25-meter capital line was captured using precise geometric constraints. The perimeter mezzanine galleries were built to capture the distinct ferro-cemento formwork patterns. The isostatic floor plates were modeled as nested floor families, where the projecting, curved intrados ribs map the calculated paths of the bending moments.

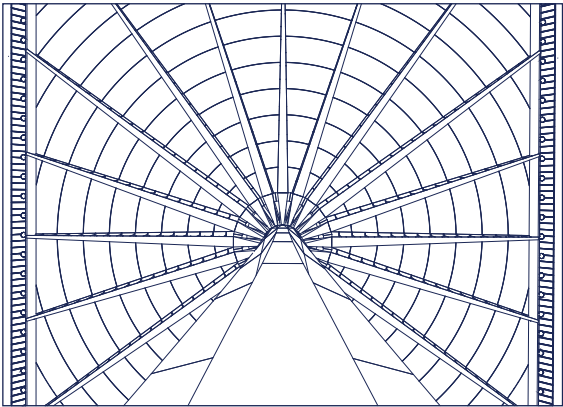


Figure 2.40: Palazzo del Lavoro BIM Model - Main Pillars



Figure 2.41: Palazzo del Lavoro photo - Main Pillars

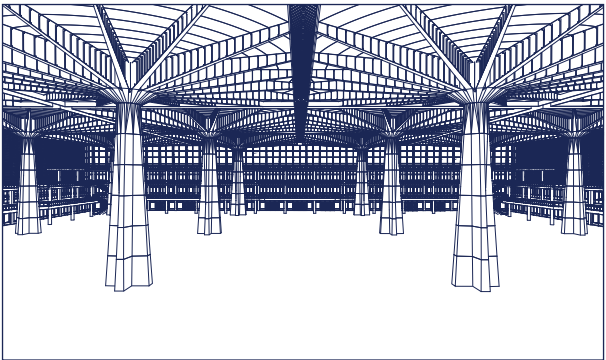


Figure 2.42: Palazzo del Lavoro BIM Model - Interior view from the 2nd level.

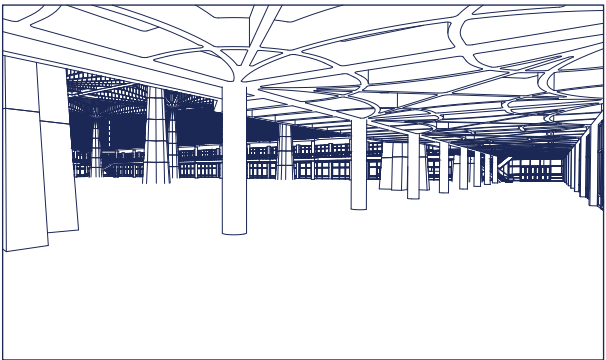


Figure 2.43: Palazzo del Lavoro photo - Ground floor ceiling



Figure 2.44: Palazzo del Lavoro photo - Interior view from the 2nd level.



Figure 2.45: Palazzo del Lavoro photo - Ground floor ceiling

2.4 DIAGNOSTIC HBIM MODELLING

2.3.2 Archival documents transition

Exterior HBIM Model

The execution of the exterior HBIM baseline shifts the focus from volumetric masses to a highly structured curtain wall classification. To handle the unique geometry of the pavilion's envelope without bloating the file size, the perimeter was rationalized into a highly repetitive, type-driven curtain wall system within Revit. This digital discretization mirrors the original construction's modular logic, transforming the envelope into an object-oriented dataset.

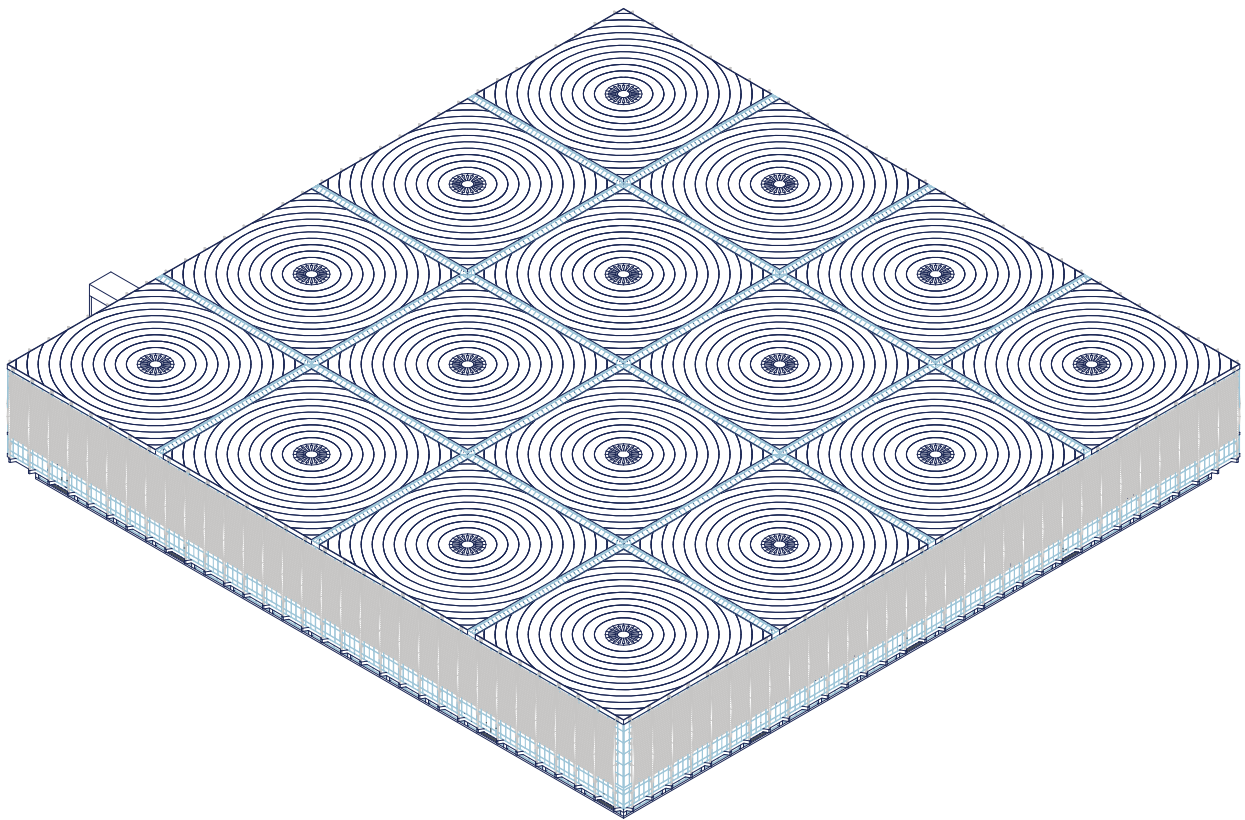


Figure 2.46: Palazzo del Lavoro BIM Model - 3D Isometric

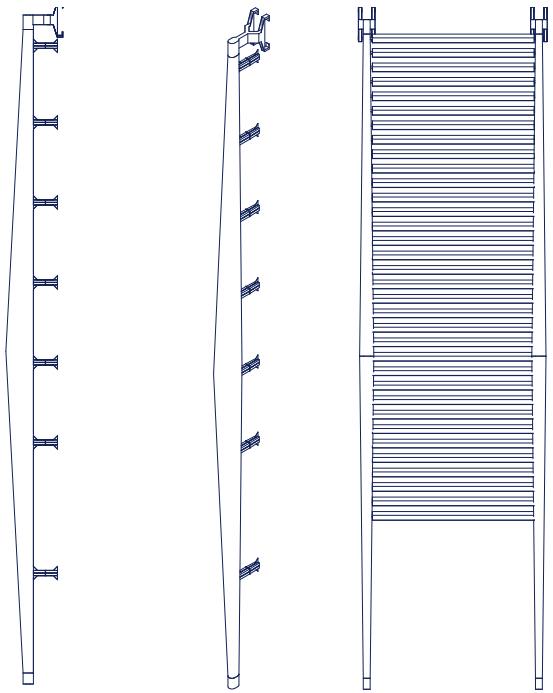


Figure 2.47: Vertical Fins Model

Figure 2.48: Horizontal Louvers Model

Every structural and envelope component was built to a high level of geometric fidelity using the precise datasets retrieved from the archives. history of the pavilion into a single static model, the Revit environment uses chronological phase mapping to separate the structural baseline from contemporary interventions. This temporal separation isolates the historic 1961 fabric as a controlled, unaltered data layer. The proposed adaptive reuse elements are then integrated as a completely discrete, subsequent phase within the modeling framework. . This clean database division guarantees a precise distinction between the historic monument and the new, reversible interventions, establishing an accurate parametric framework for the entire project.

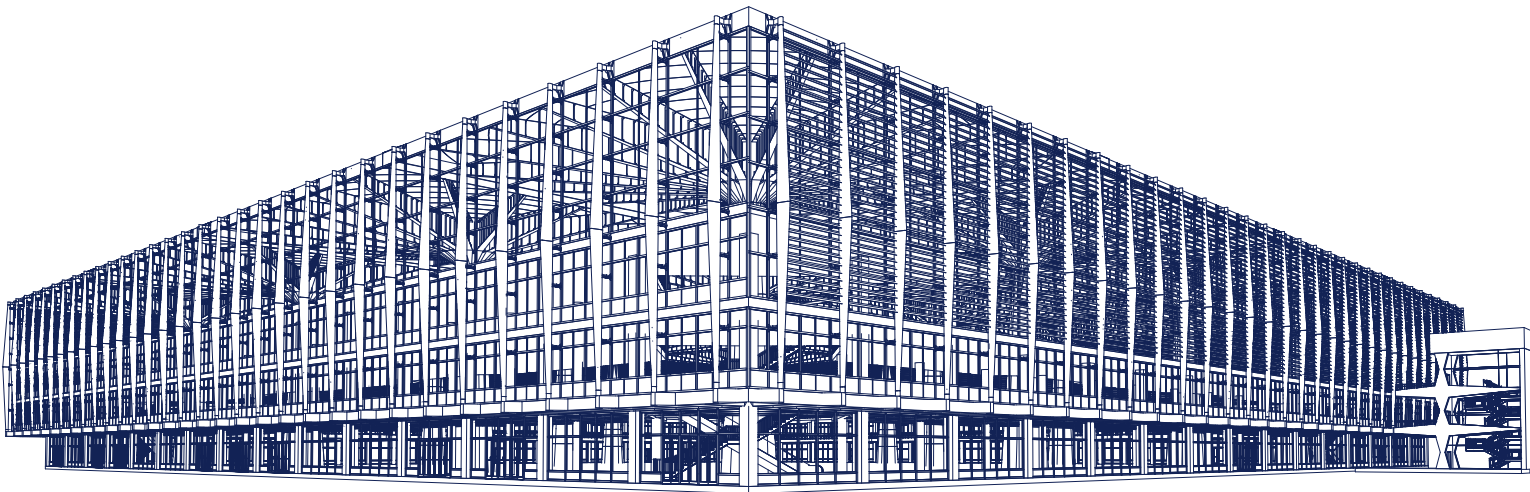


Figure 2.49: Palazzo del Lavoro BIM Model - Exterior North-West Perspective

2.5 ARCHITECTURAL SWOT ANALYSIS

2.4.1 Sustainability key strategies

Strengths

- 1) Monumental Nervi structure: iconic heritage asset.
- 2) Large open spans enabling flexible adaptive reuse.
- 3) Strategic urban location in Turin: strong cultural context.
- 4) Potential for integration of renewable energy systems.
- 5) Visibility and symbolism: reactivation of a national modernist landmark.

Figure 2.50: Sustainability Pillars SWOT Analysis of the existing fabric.

Weaknesses

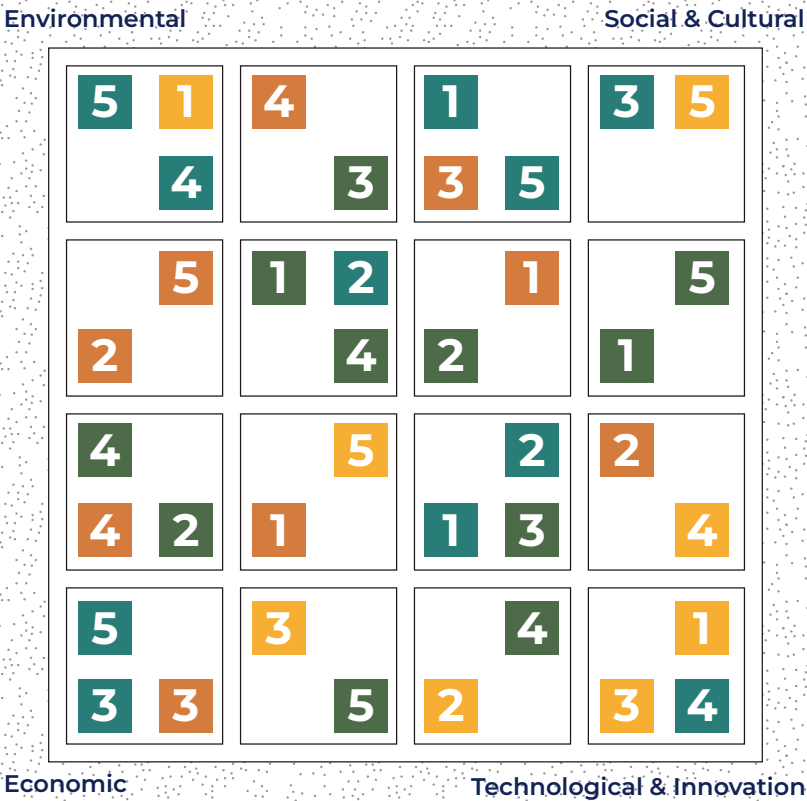
- 1) High restoration and maintenance cost of the structural shell.
- 2) Complexity in meeting energy and safety standards for heritage concrete.
- 3) Difficult climate control due to vast interior volume.
- 4) Limited existing insulation and natural ventilation strategy.
- 5) Bureaucratic challenges in public ownership and funding.

Opportunities

- 1) Becoming Turin's model for large-scale sustainable heritage retrofit.
- 2) Cultural tourism growth through exhibitions and education.
- 3) Partnerships with Politecnico di Torino, ENEL, other local and national institutions.
- 4) Integration of photovoltaic/energy systems on adjacent roof.
- 5) Social regeneration and creative economy activation.

Threats

- 1) Possible under-utilization if management or programming fails.
- 2) Energy retrofitting may face structural or heritage restrictions.
- 3) Competition from newer cultural centers in Turin.
- 4) Economic instability and limited long-term funding.
- 5) Environmental regulations delaying implementation.



03

State of Conservation, Pathology & Restoration

3.1 ARCHITECTURAL PATHOLOGY

3.1.1 Facade system degradation: Mullions and Glazing

The degradation of the architectural envelope and structural components of the Palazzo del Lavoro represents a complex intersection of material fatigue, atmospheric exposure, and compromised mechanical joints. Over sixty years of exposure to Turin's humid climate has resulted in a widespread breakdown of the original protective coatings across the building's perimeter envelope. The following sections detail the specific pathological mechanisms affecting the facade, the solar shading systems, and the primary reinforced concrete elements. On the primary facade system, prolonged environmental exposure has caused severe surface and deep oxidation of the steel mullions, or ritti. This progressive pitting corrosion manifests as deep craters within the steel profile, which significantly reduces the structural thickness of the metal and diminishes its capacity to withstand wind pressure. This material loss is compounded by severe differential thermal expansion. Because steel and concrete expand and contract at vastly different rates, the vertical steel profiles require functional joints to absorb movement. However, because the original expansion joints have become entirely seized or blocked by debris, the ritti undergo a phenomenon known as thermal bowing, physically bending under the intense heat of the summer sun.

This deformation triggers a destructive “glass-crushing” effect. As the steel mullions bend and twist due to thermal stress and advanced rust, they exert immense, concentrated point pressure on the edges of the original 1961 single-pane glazing. The resulting stress leads to spontaneous fractures, typically characterized by distinctive butterfly-pattern cracks or sharp corner fractures. Once a single pane fails, the localized structural equilibrium of that specific bay is broken, frequently initiating a “zipper effect” where neighboring glass panes crack in rapid succession due to the sudden shifting of loads. Consequently, the building is systematically losing its defensive perimeter shield; the failure of the ritti and the subsequent shattering of the glazing allows rain and humidity to penetrate deep into the main hall, directly accelerating the degradation of the internal reinforced concrete structure.

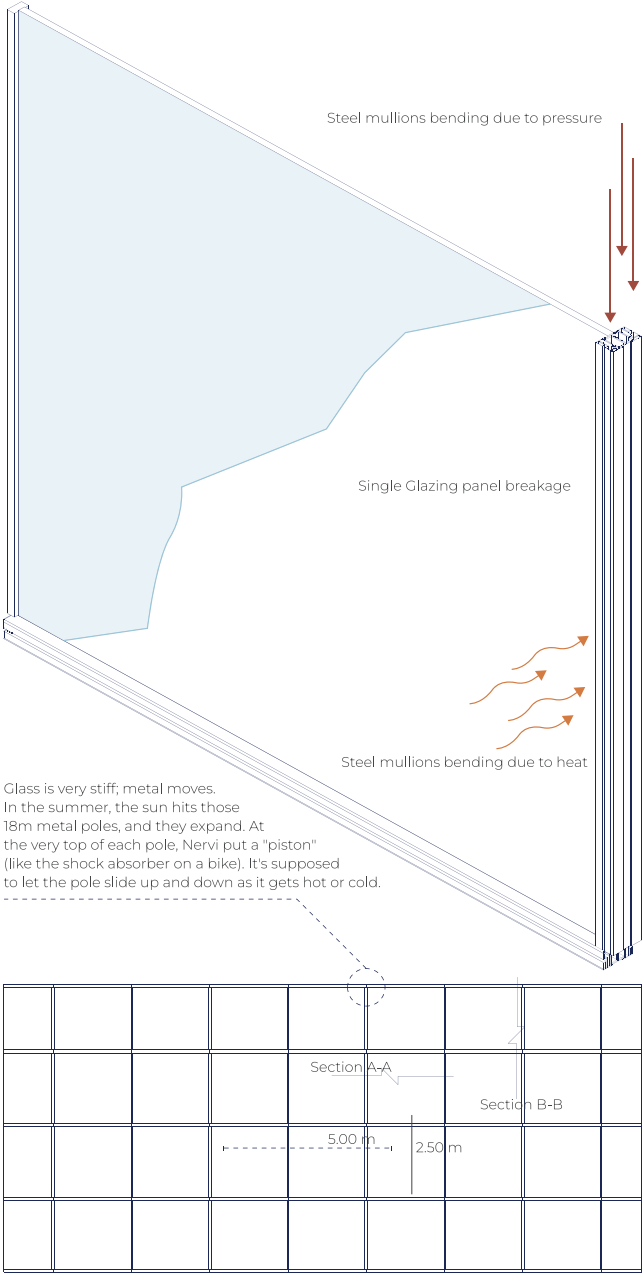


Figure 3.1: Single pane glass breakage analysis.

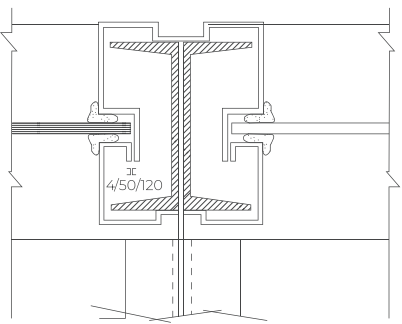
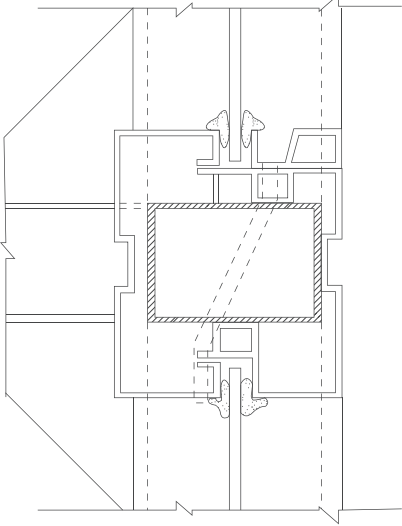


Figure 3.2: Visualization of the connections between glass and mullions.

3.1 ARCHITECTURAL PATHOLOGY

3.1.2 External solar shading: Fins and Louvers

The steel fins and louvers distributed across the eastern, southern, and western elevations exhibit a uniform, generalized layer of oxidation, signaling the total failure of their original protective paint layers and leaving the bare iron exposed to atmospheric oxygen and moisture. This is not merely a surface aesthetic issue; deep pitting corrosion has actively compromised the cross-sectional area of the fins, leaving them structurally weakened against localized wind loads. This deterioration is most acute at the base of the shading fins. Due to capillary rise, moisture originating from the ground and surrounding vegetation creates a permanently damp microenvironment at the foot of these elements. This localized moisture accelerates the rate of corrosion at the base, presenting a critical structural hazard since the foundation of the fin is precisely where the maximum mechanical stress occurs.

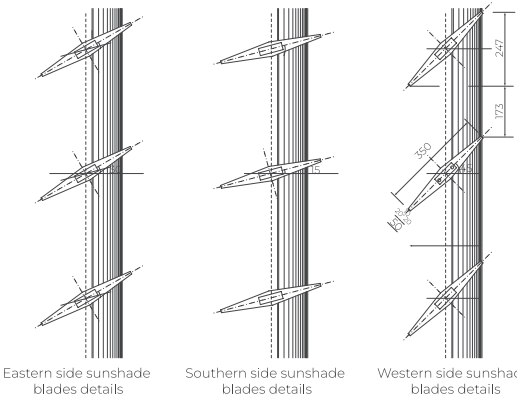


Figure 3.3: Horizontal louvers and vertical fins elevation and sections.

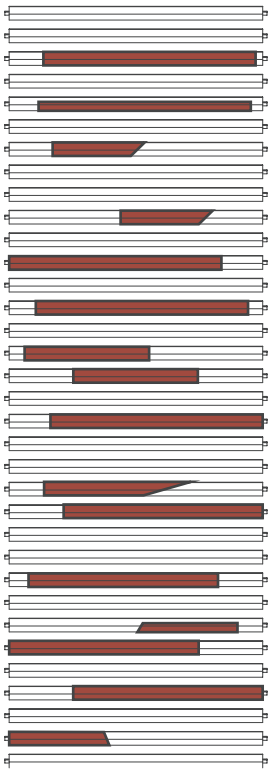
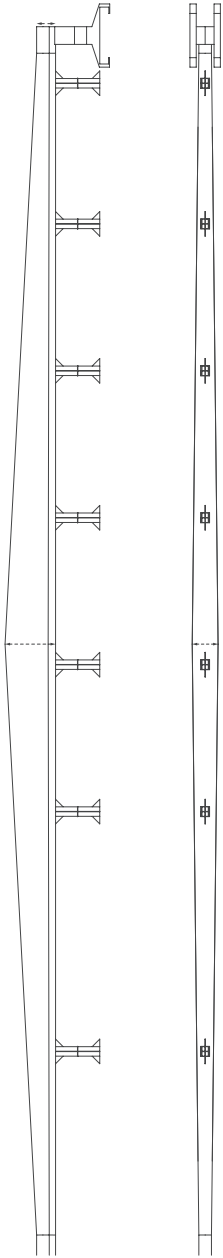
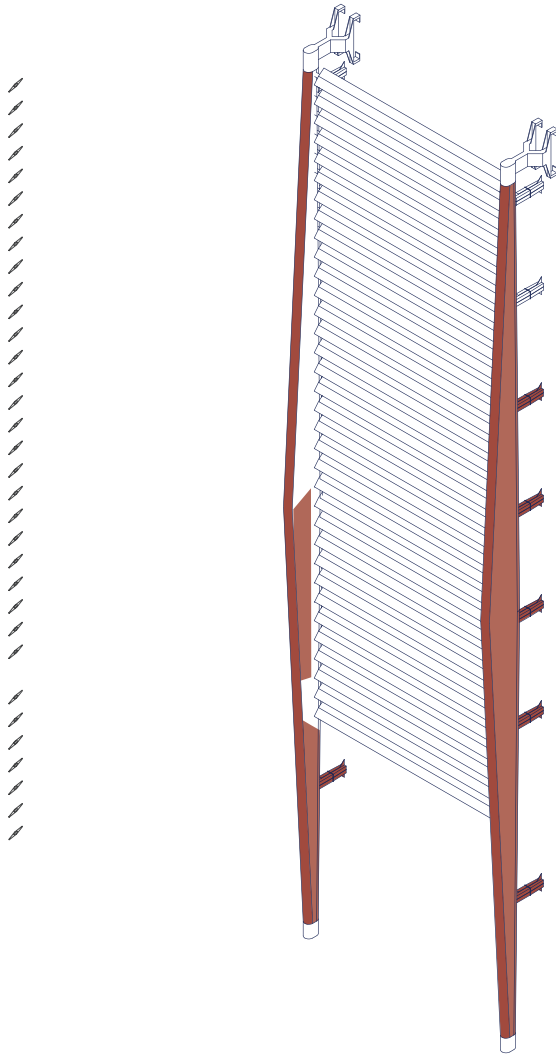


Figure 3.4: Degradation mapping of the facade system, identifying patterns of oxidation and structural decay across the steel fins and sun-shading louvers



3.1 ARCHITECTURAL PATHOLOGY

3.1.3 Structural concrete pathologies and infiltration

Internally, the monumental reinforced concrete columns and the overhead roof infrastructure suffer from severe water infiltration and chemical degradation. The concrete supports on the highly exposed southern elevation exhibit advanced carbonation, a process that lowers the material's natural pH and destroys the passivating layer that protects the internal steel reinforcement. As moisture and air reach these un-passivated elements, the internal steel bars begin to rust. Because rust occupies a significantly larger volume than the original steel, it expands and exerts intense internal tensile pressure, ultimately spalling and pushing the concrete cover off. This water migration is further evidenced by widespread efflorescence, visible as white, powdery salt stains where migrating water has dissolved internal minerals and deposited them as it "sweats" out through the concrete surface. This porous, damp concrete environment has invited extensive biological colonization. Moss, algae, and weeds have taken root across the structure, thriving solely on the persistent moisture and organic dust present within the abandoned hall. The root systems of these plants secrete organic acids that actively eat away at and chemically erode the concrete matrix, indicating a systemic water infiltration problem that originates at the roof level, where failing skylights allow rain to fall directly onto the columns and become trapped inside the material's structural cracks.

Thermal Degradation:

This material degradation is severely exacerbated in the South-East bay, which bears the scars of a significant fire impact in 2015. The high temperatures of the fire caused severe surface degradation and intense thermal shock. The rapid, uneven thermal expansion during the event induced extensive micro-cracking throughout the concrete matrix, leaving this specific zone structurally compromised due to combined thermal stress and subsequent impact damage.

Figure 3.5: Thermal degradation mapping and historical documentation of the 2015 fire impact within the South-East bay, showing the localization of thermal shock and micro-cracking across the concrete slab structure.

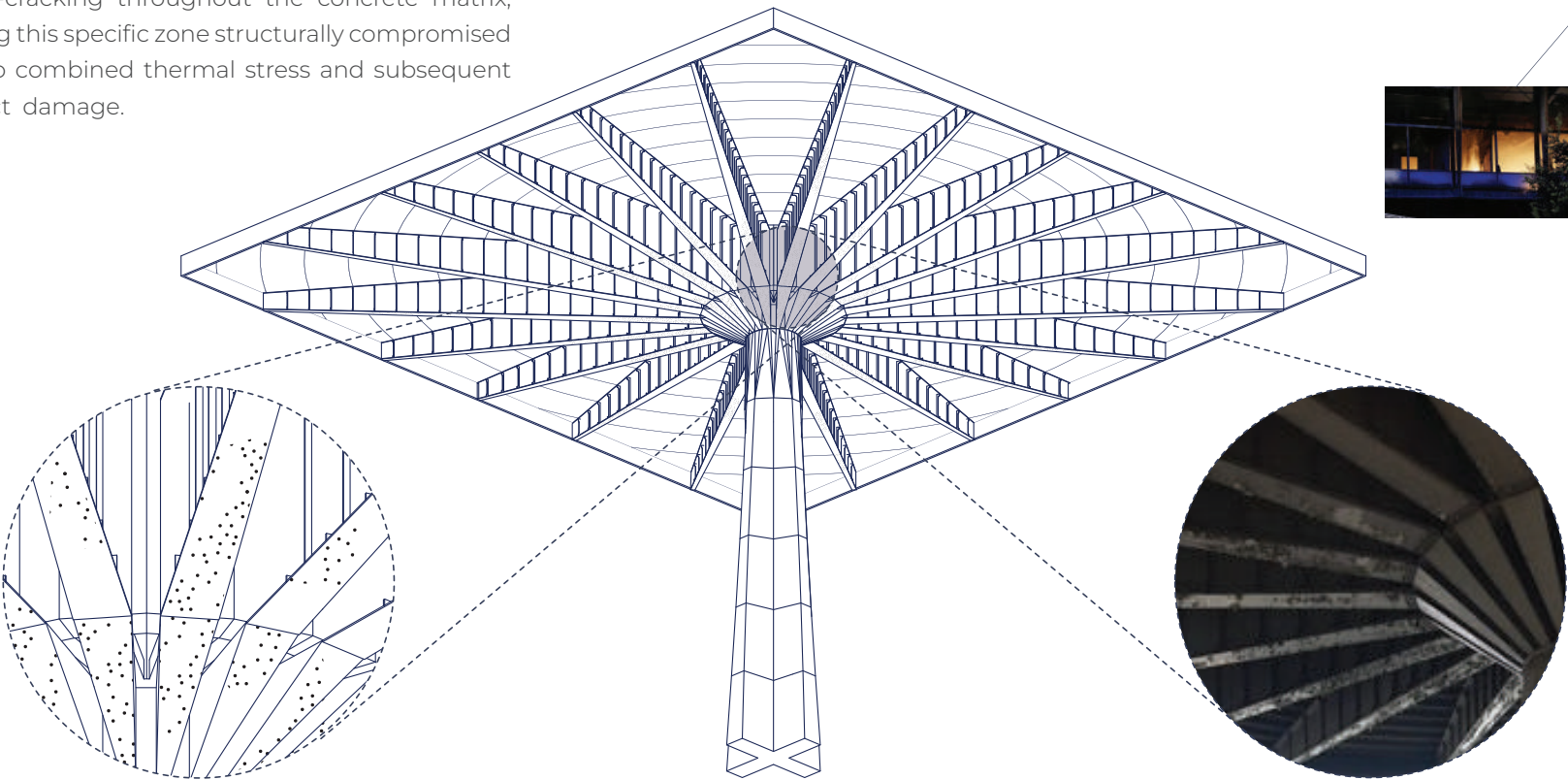
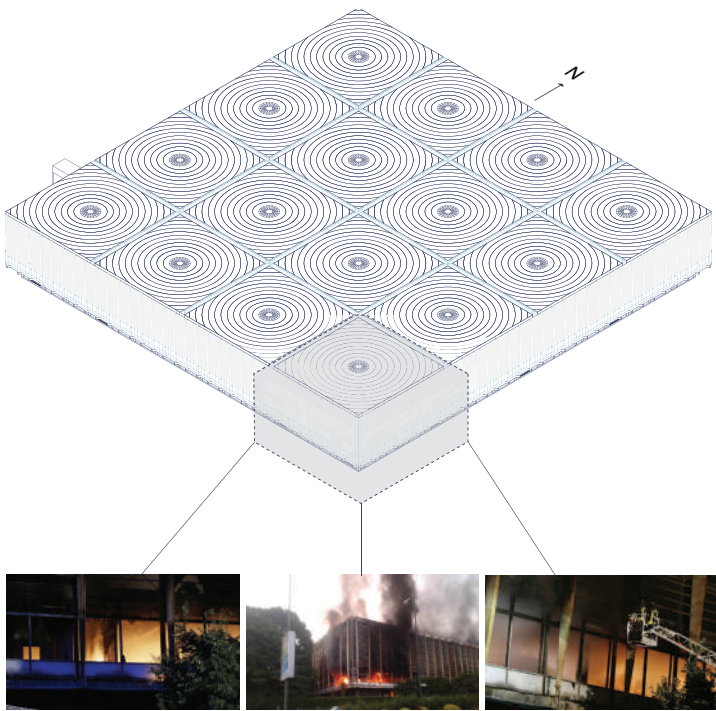


Figure 3.6: Structural concrete pathologies of a monumental column unit, illustrating systematic water infiltration areas, concrete spalling zones, and detail callouts of material decay.

3.1 ARCHITECTURAL PATHOLOGY

3.1.3 Structural concrete pathologies and infiltration

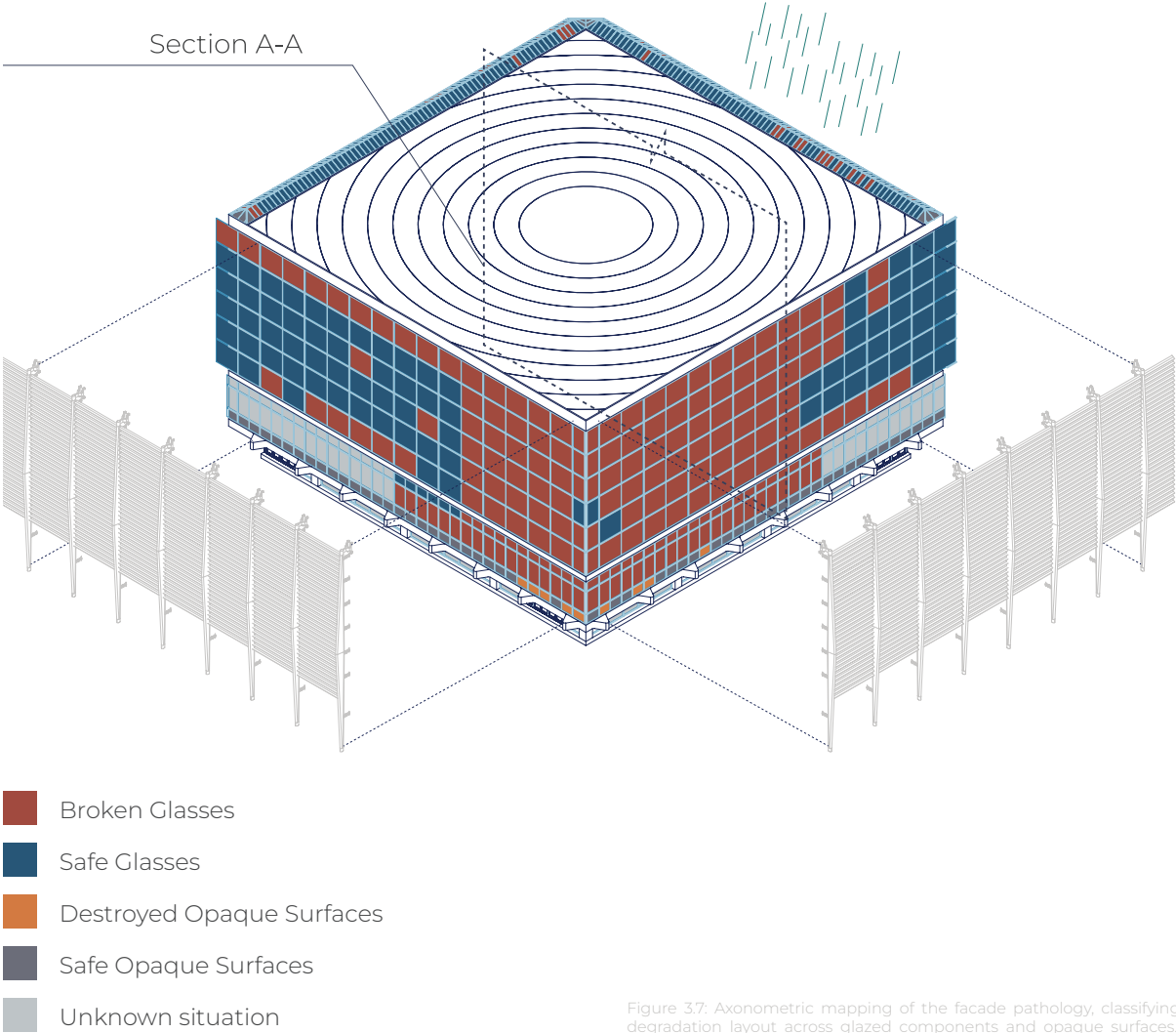


Figure 3.7: Axonometric mapping of the facade pathology, classifying the degradation layout across glazed components and opaque surfaces.

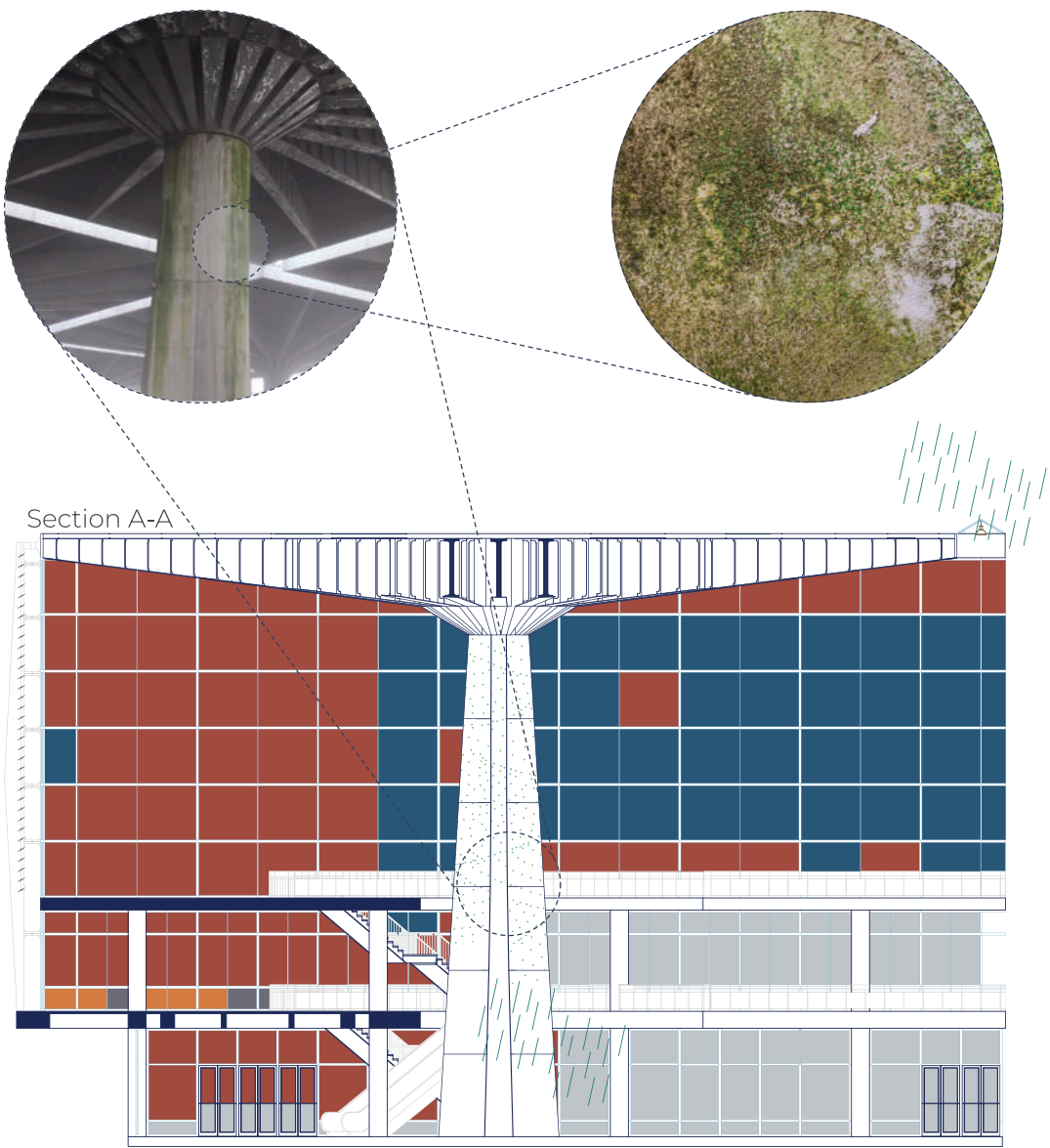


Figure 3.8: Section A-A showing localized infiltration patterns along the vertical envelope, accompanied by macro photographic callouts tracking biological colonization and surface efflorescence on the structural column.

3.2 STRUCTURAL INTEGRITY ASSESSMENT

3.2.1 Structural performance and geometric vulnerabilities of the roof beams

The evaluation of the primary structural systems of the Palazzo del Lavoro requires a rigorous analysis of both the steel roof infrastructure and the surrounding reinforced concrete floor components. The overall structural response under safety loads, seismic activity, and geometric instabilities underscores a clear need for targeted structural remediation. A critical vulnerability within the building's overhead infrastructure lies in the technical capacity of the steel roof beams. Computational finite element buckling analysis shows that the slender steel profiles are underdimensioned relative to modern safety regulations and code requirements. Specifically, structural verifications highlight that the poorest mechanical resistance occurs in terms of the local buckling of the web panels. This instability is a direct consequence of the exceptionally high slenderness ratio of the internal webs. Simulations mapping the first buckling mode indicate that the maximum lateral deformation is concentrated within the fourth panel of the beam assembly. The corresponding critical buckling factor is evaluated at 0.259 a value that reaches only about one-fourth of the safety threshold of 1.0 required to guarantee secure conditions. Under extreme environmental actions, such as a heavy snow load, this deficiency creates a high risk of structural deformation, causing the roof beams to twist, wiggle, or bend significantly.

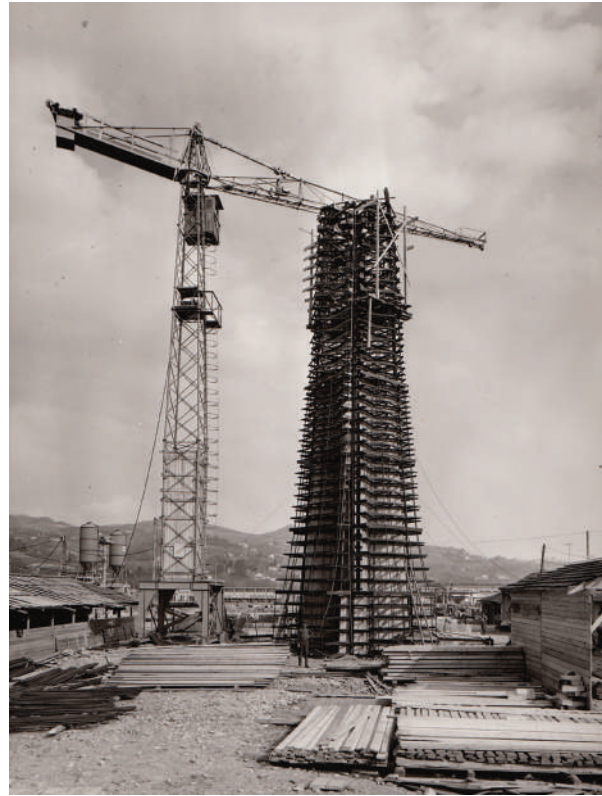


Figure 3.9: Palazzo del Lavoro columns under construction "Courtesy of Fondazione MAIRE - ETS. Materials from the MAIRE Historical Archive."



Figure 3.10: Palazzo del Lavoro roof under construction "Courtesy of Fondazione MAIRE - ETS. Materials from the MAIRE Historical Archive."

3.2 STRUCTURAL INTEGRITY ASSESSMENT

3.2.2 Dynamic Behavior and Spatial Modal Analysis

The overall dynamic response of the monumental complex was evaluated through a complete finite element model that reproduces all core structural components, including the continuous glass facades, frame elements, and integrated perimeter bracing systems. The modal analysis reveals that the primary global response is driven by its first two natural modes of vibration. These modes are characterized by mixed behavior, combining a rotational movement around the vertical z-axis with translational vectors along the principal horizontal x and y axes of the plan. Both foundational modes exhibit a vibration period of 1.36 seconds. The effective modal masses associated with the translational components represent approximately 20.8% of the total seismic mass of the building, while the rotational components account for 7%. The extended vibration period reflects a relatively flexible macro-structure, whose global behavior is fundamentally influenced by the structural interaction between the massive concrete columns and the peripheral framing systems.

Figure 3.11: Roof and ceiling Plan views highlighting the global structural layout and spatial grid configuration utilized for the finite element modal analysis.

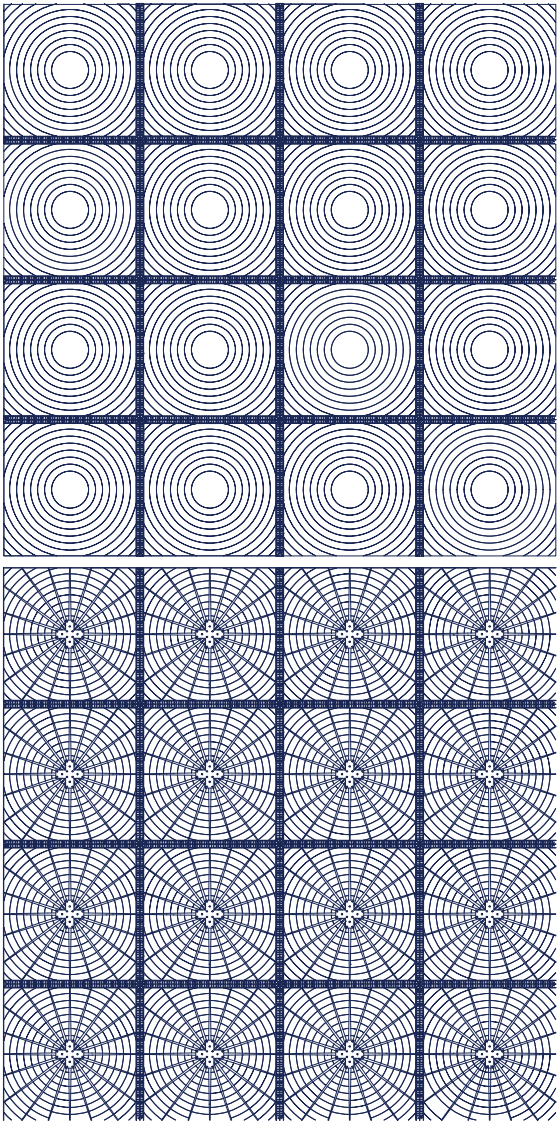
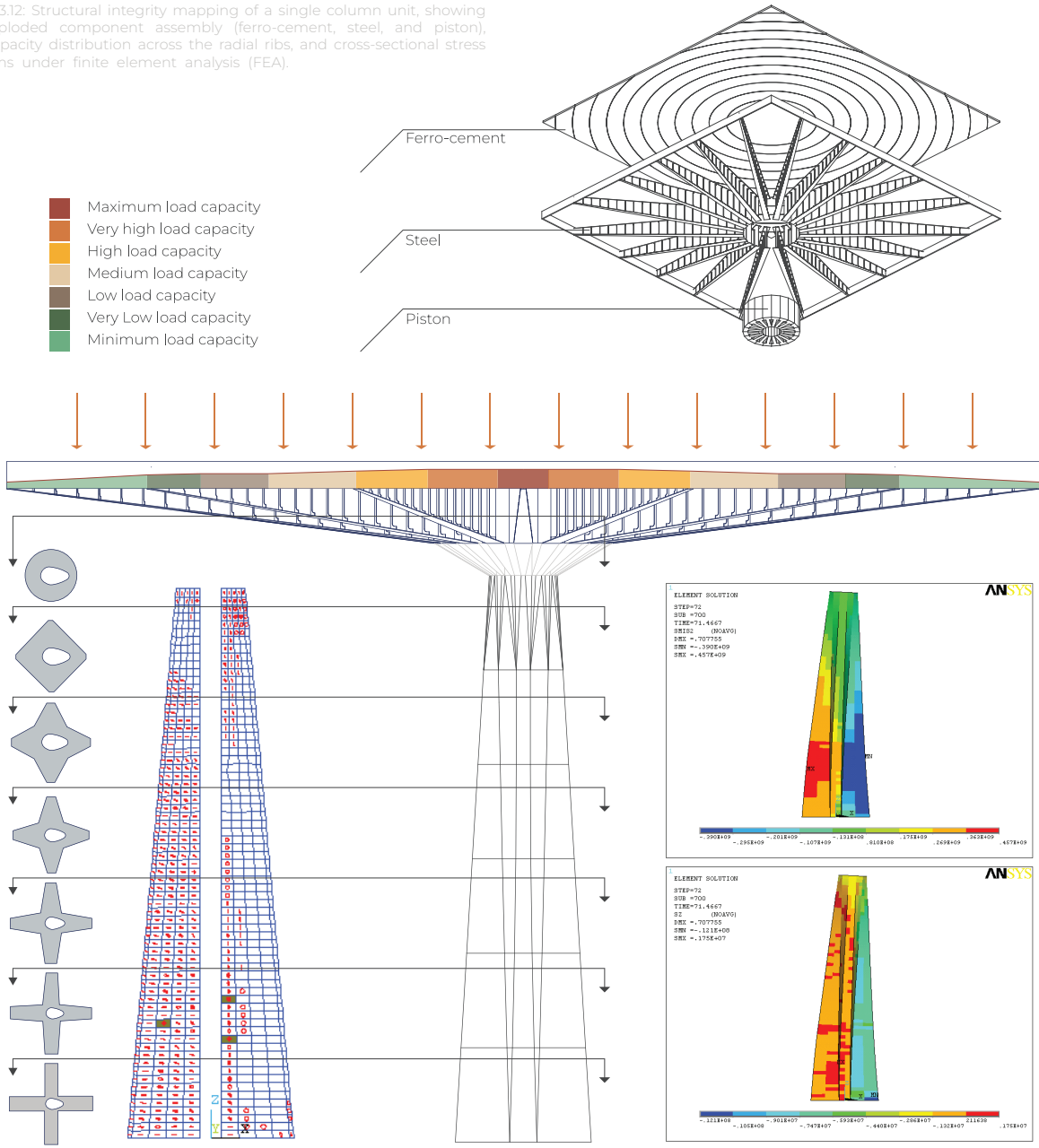


Figure 3.12: Structural integrity mapping of a single column unit, showing the exploded component assembly (ferro-cement, steel, and piston), load capacity distribution across the radial ribs, and cross-sectional stress diagrams under finite element analysis (FEA).



3.2 STRUCTURAL INTEGRITY ASSESSMENT

3.2.3 Stress Distribution and Finite Element Modeling of Gallery Floors

The intermediate gallery floors consist of monumental reinforced concrete ribbed slabs that follow the structural philosophy of Pier Luigi Nervi. The structural layout of these slabs was historically traced out to mirror the analytical equal-stress lines of their plate model, optimizing material use along primary load paths. To analyze their current structural capacity, finite element models were generated to isolate the specific slab regions divided by the building's symmetrical technical joints. These joints segment the gallery floor into four identical angular zones and eight central zones. Numerical stress checks indicate that the most heavily stressed members belong exclusively to the angular portions of the gallery layout. In the simulation model, flat slabs are represented via shell elements, while the structural ribs, longitudinal beams, transversal beams, internal perimeters, and cantilevers are represented via frame elements. Bending moment diagrams generated across these frame elements show substantial stress concentrations near the internal supports and cantilever junctions. Furthermore, detailed pushover analyses mapping the ultimate limit states illustrate the progressive cracking configuration of the concrete matrix under incremental lateral loads. Cross-sectional extractions perpendicular to the loading direction map the distribution of normal vertical stress alongside the axial tension developing

within the internal steel reinforcement bars. This mapping confirms that while the historical layout successfully aligns with primary bending pathways, localized strengthening is necessary to prevent yielding under modern load arrangements and seismic combinations.



Figure 3.13: Historical construction photographs illustrating the casting process and geometry of the monumental reinforced concrete ribbed gallery slabs.

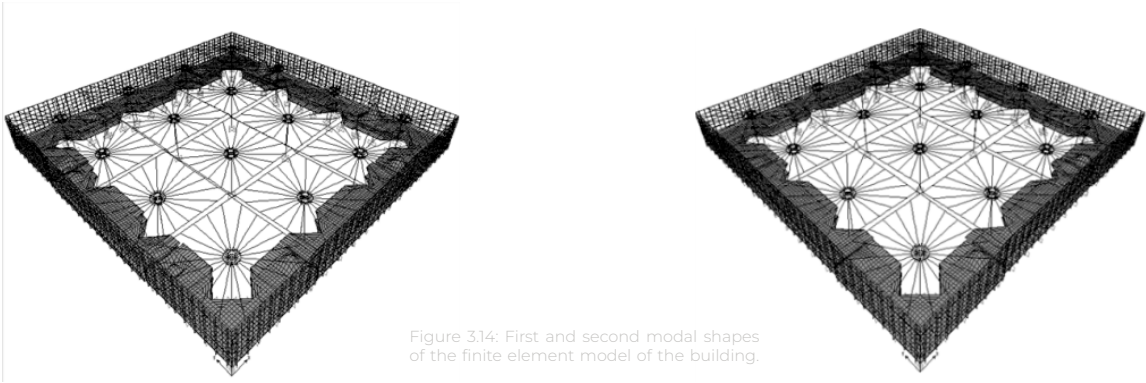


Figure 3.14: First and second modal shapes of the finite element model of the building.

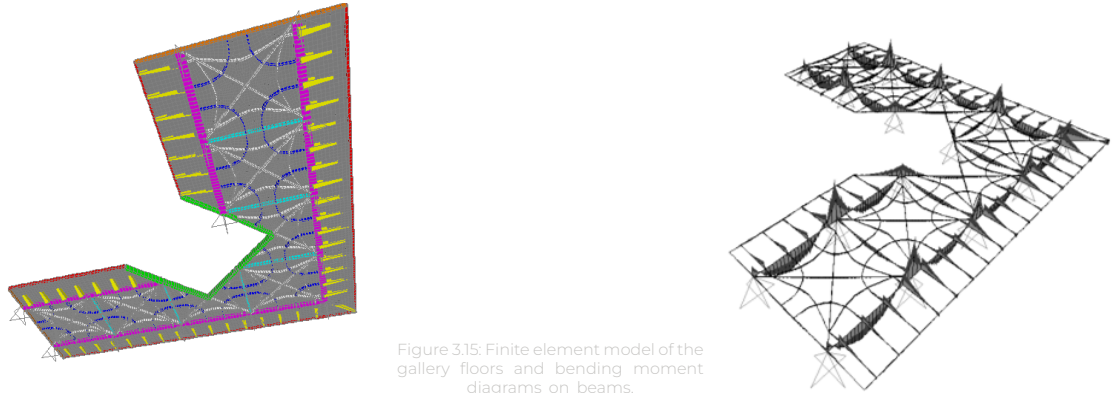


Figure 3.15: Finite element model of the gallery floors and bending moment diagrams on beams.

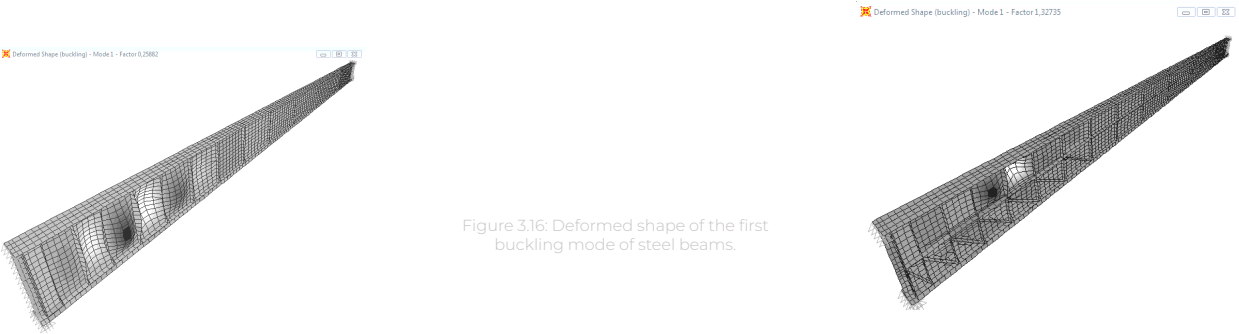


Figure 3.16: Deformed shape of the first buckling mode of steel beams.

3.3 REVERSIBLE CONSERVATION STRATEGY

3.3.1 Remedial Interventions for Concrete Elements

To align with contemporary restoration criteria specifically the principles of minimum intervention, material compatibility, and reversibility the proposed structural remedies avoid altering the iconic architectural expression of Pier Luigi Nervi's masterwork. The intervention focuses on stabilizing existing historical materials, restoring original structural mechanics, and mitigating future weathering using non-invasive techniques. The rehabilitation of the 16 primary concrete pillars and the surrounding structural elements requires targeted actions based on the specific degradation vectors identified during the survey.



Figure 3.17: Manual application of shrinkage-compensated, thixotropic, fiber-reinforced mortar during localized micro-concrete recasting to restore structural concrete cover without altering original column geometry.

Treatment of the 2015 Fire Impact Zone (South-East Bay):

The structural components affected by intense thermal shock require specialized stabilization. Micro-cracks within the concrete matrix will be sealed via the low-pressure injection of ultra-low viscosity epoxy resins. This restores the monolithic integrity of the concrete and halts the destructive cycle where rainwater, pouring through damaged skylights, becomes trapped inside the column core.

Neutralization of Carbonation and Rebar Passivation:

For zones showing advanced carbonation predominantly on the exposed southern elevation the concrete cover must be restored. Loose and delaminated concrete cover caused by the volumetric expansion of rust is mechanically removed to expose the corroded reinforcement. Exposed steel reinforcement rebars are sandblasted to Sa 2½ grade to remove oxidation, coated with a zinc-rich anti-corrosion passivation primer, and the surface profile is rebuilt using a shrinkage-compensated, thixotropic, fiber-reinforced mortar that matches the porosity and aggregate size of the original Nervi mix.

Desalination of Efflorescence Stains:

The white, powdery salt stains caused by water migration will be treated using sacrificial cellulose pulp poultices saturated with distilled water. Applied directly to the concrete surface, these poultices draw out trapped soluble salts as they dry, preventing subsurface crystallization and subsequent crumbling of the concrete face.

Eradication of Biological Colonization:

To eliminate existing biological colonization caused by past water infiltration, the concrete surfaces will be treated with a biocidal washing compound during initial remediation. This eliminates active micro-organisms and their root systems before structural repair. Following surface cleaning, a vapor-permeable, hydrophobic protection layer will be applied to the newly restored envelope. This treatment seals the historical material against future environmental moisture while allowing internal vapor to escape safely.

3.3 REVERSIBLE CONSERVATION STRATEGY

3.3.2 Structural Consolidation of the Roof

The structural analysis indicates that the radial steel fan beams are under-dimensioned to meet modern safety legislation regarding exceptional snow and wind loads, while carrying the significant dead load of the 1963 ferro-cement panels.

Reversible Structural Reinforcement:

To upgrade the load capacity of the radial steel beams without altering their historic form, the intervention introduces bolted steel reinforcement plates to the beam flanges. Mechanical connections fulfill the requirement of structural reversibility, ensuring that the reinforcement can be altered, strengthened, or dismantled in the future. By utilizing bolts instead of permanent welding, the strategy minimizes physical interventions on Nervi's original steel framework.

Skylight and Water Infiltration Overhaul:

To address the root cause of both internal concrete decay and water trapping, the roof-level skylights will undergo a comprehensive joint-sealing replacement. High-durability EPDM rubber gaskets and modern silicone sealants will replace the failed original seals, completely restoring the overhead waterproof shield.

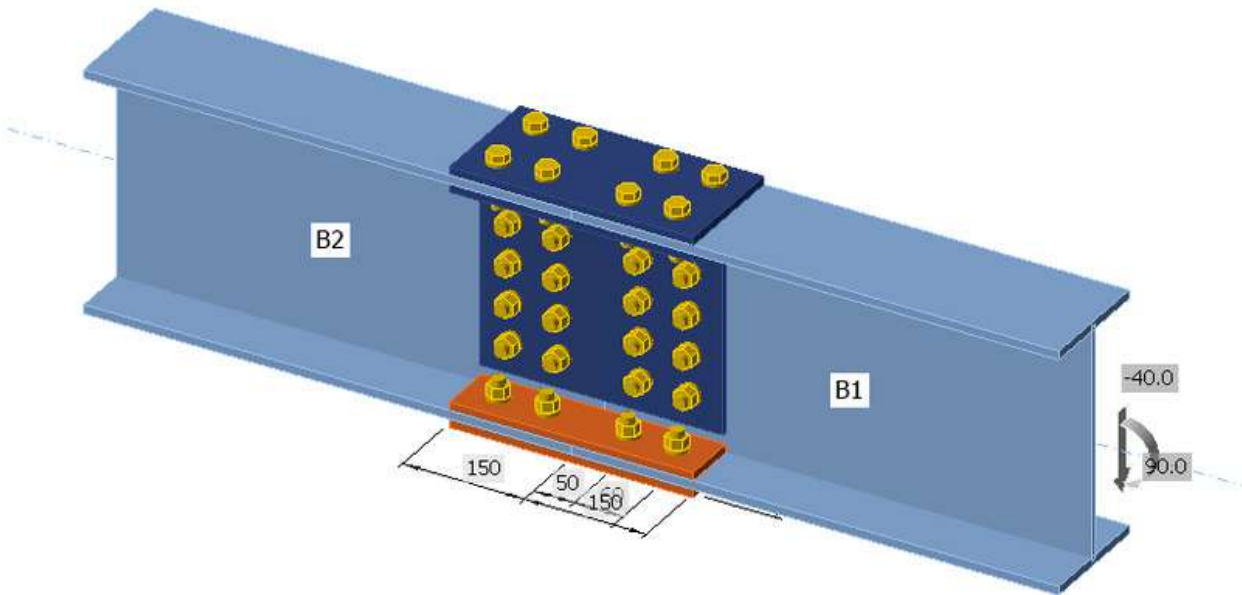


Figure 3.18: 3D structural model of a fully reversible, high-strength bolted plate reinforcement applied to beam flanges to handle increased snow and wind load demands.

3.3 REVERSIBLE CONSERVATION STRATEGY

3.3.3 Rehabilitation of the Perimeter Facade and Glazing Kinetics

The intervention on the facade focuses on restoring the building’s perimeter shield while maintaining the single-pane glass configuration through updated flexible detailing.

Mechanical Rehabilitation of the Column-Summit Piston Joints:

The critical turning point for the facade envelope is freeing the seized mechanical joints located at the top of the 16 columns. These pistons, which act as the mechanical heart of the structural movement system, are currently blocked by decades of debris and corrosion. The intervention involves mechanical cleaning, rust-removal flushing, and pressure-lubrication of the piston units. This restores the vertical sliding displacement of the 18-meter steel ritti, allowing them to safely expand and contract during summer and winter temperature cycles without structural restraint.

Mitigation of Facade Corrosion:

The 18-meter-tall ritti and the external sunshade blades will undergo uniform mechanical cleaning via controlled abrasive blasting to eliminate generalized surface rust and deep pitting craters. Carbon steel surfaces handle this aggressive treatment well, stripping the metal down to bare

material while creating a rough micro-profile that dramatically improves the adhesion and long-term durability of a new polyurethane protective coating.



Figure 3.19: Controlled abrasive blasting using aluminum oxide media on structural steel to achieve an Sa 2½ surface preparation grade prior to the application of the high-durability coating system.



Figure 3.20: Controlled abrasive blasting using aluminum oxide media on structural steel to achieve an Sa 2½ surface preparation grade prior to the application of the high-durability coating system.

Mechanical Rehabilitation of the Column-Summit Piston Joints:

To address economic constraints, new single-pane glass panels will be installed within the existing steel framework rather than a complete double-glazing retrofit. To permanently eliminate the original “glass-crushing” effect and the resulting zipper fractures, the glazing installation method must be updated. The glass will not be rigidly fixed to the steel ritti. Instead, the panes will be fitted using

flexible, high-elasticity EPDM dry-glazing perimeter gaskets and articulated, sliding pressure beads. This detailing creates a cushioned, mechanical buffer zone. Even if residual thermal expansion causes minor movement or bowing in the steel poles, the flexible gaskets absorb the displacement without transferring localized point loads to the edge of the glass, preventing spontaneous fractures.



Figure 3.21: Manual installation of high-elasticity EPDM profiles using dry-glazing roller tools to establish a flexible, UV-resistant mechanical buffer zone.

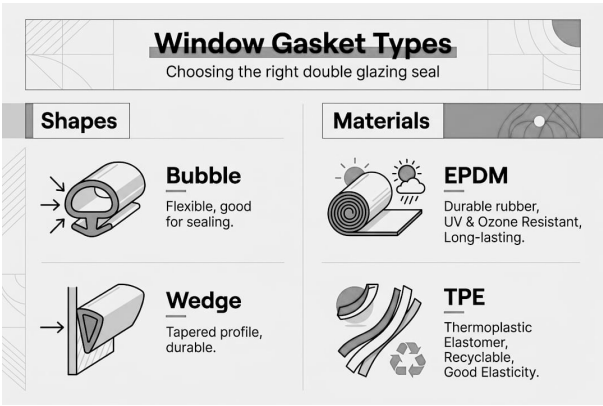


Figure 3.22: Gaskets typologies

04

The Interior Megacity: Architectural Design Strategy

4.1 THE METAPHOR OF URBAN FOREST

4.1.1 Architectural Strategy and Spatial Vision

The adaptive reuse proposal relies on an intentional shifting of scales to colonize the monumental interior. Rather than utilizing traditional, full-height partitions that permanently slice open space, the intervention operates under a strict box-in-a-box framework. This methodology utilizes the original building envelope as a macro-climatic shield, an unconditioned skin that houses a completely autonomous internal ecosystem. This layout treats interior space planning as a form of urbanism, establishing an Interior Megacity. By organizing the floor plate into a decentralized network of independent units, the open expanse is carved into distinct programmatic quarters, public central common areas, and specialized nodes. This configuration replicates the density, flexibility,

and connectivity of an urban grid, allowing the masterplan to host a diverse mix of public workflows without compromising the open visual character of the host structure. The distribution of the new blocks is specifically designed to guarantee extensive visibility of the original structure and its roof, preserving the immense perception of the interior spatial dimension. The core of this spatial configuration is driven by a city-within-a-city strategy. The programmatic modules are grouped into compact, floor-bound clusters that function as an architectural understory layer. By keeping these prefabricated blocks self-contained and structurally detached, wide circulation pathways are carved out between the distinct quarters.

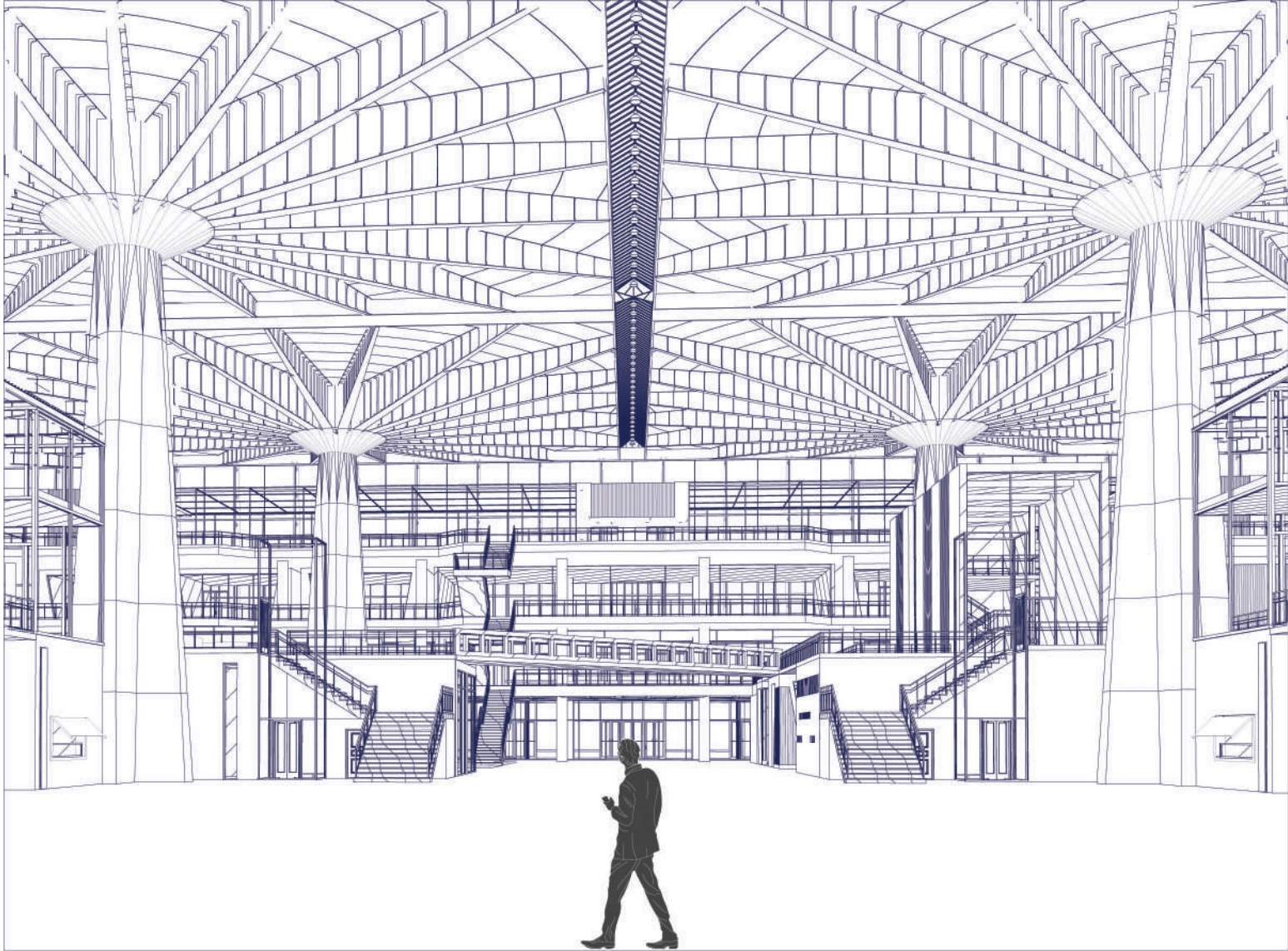
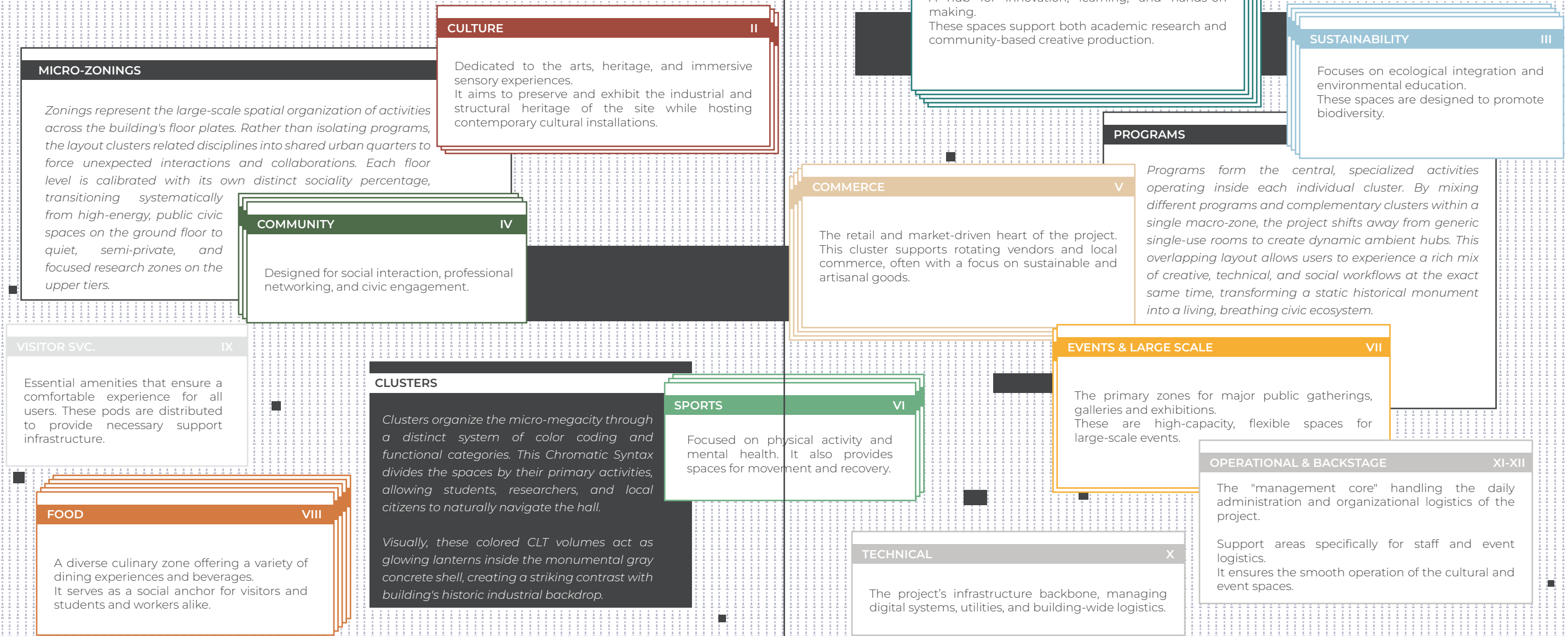


Figure 4.1: Illustration of the volumetric relationship between the grand unconditioned public floor and the high-level circulation pathways.

4.1 THE METAPHOR OF URBAN FOREST

4.1.2 The Chromatic Syntax



4.1 THE METAPHOR OF URBAN FOREST

4.1.3 Programs per cluster



Figure 4.2: Programs within the creativity cluster.

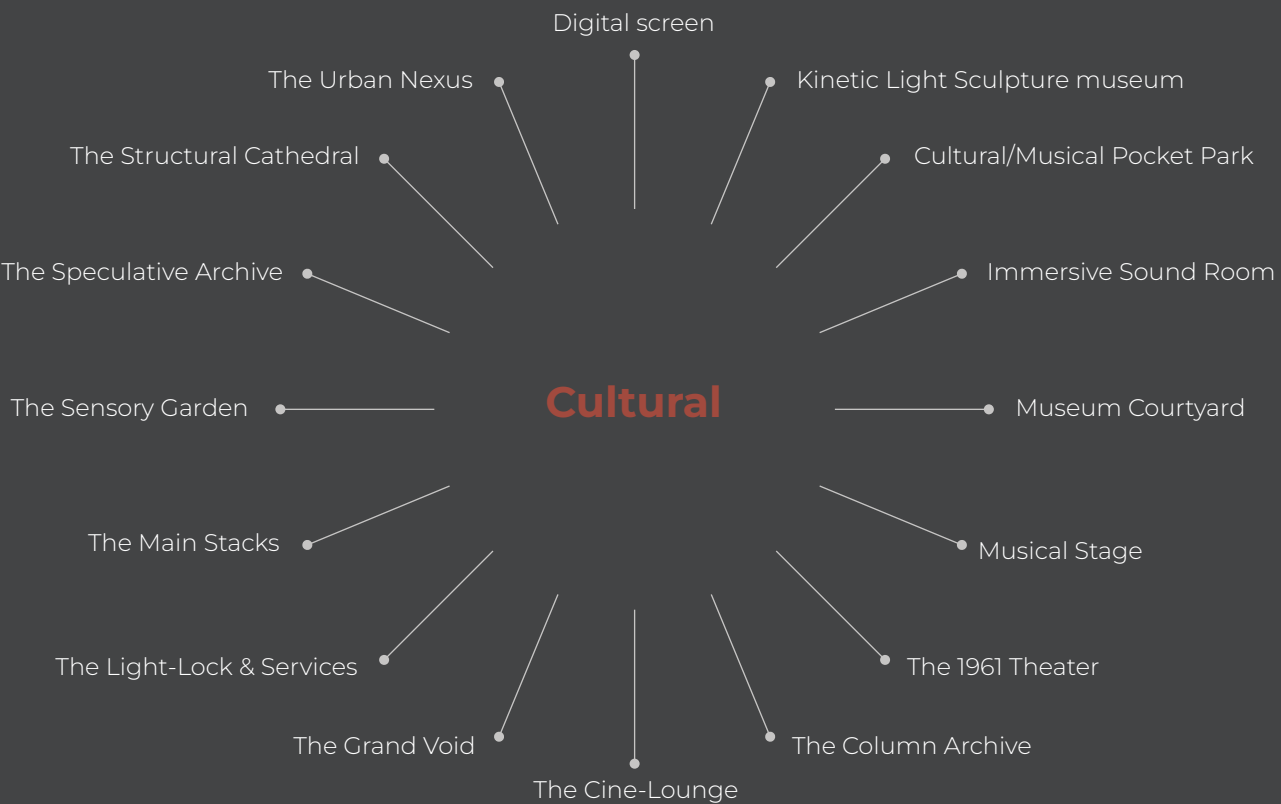


Figure 4.3: Programs within the cultural cluster.

4.1 THE METAPHOR OF URBAN FOREST

4.1.3 Programs per cluster



Figure 4.4: Programs within the sustainability cluster.



Figure 4.5: Programs within the community cluster.

4.1 THE METAPHOR OF URBAN FOREST

4.1.3 Programs per cluster



Figure 4.6: Programs within the commerce cluster.

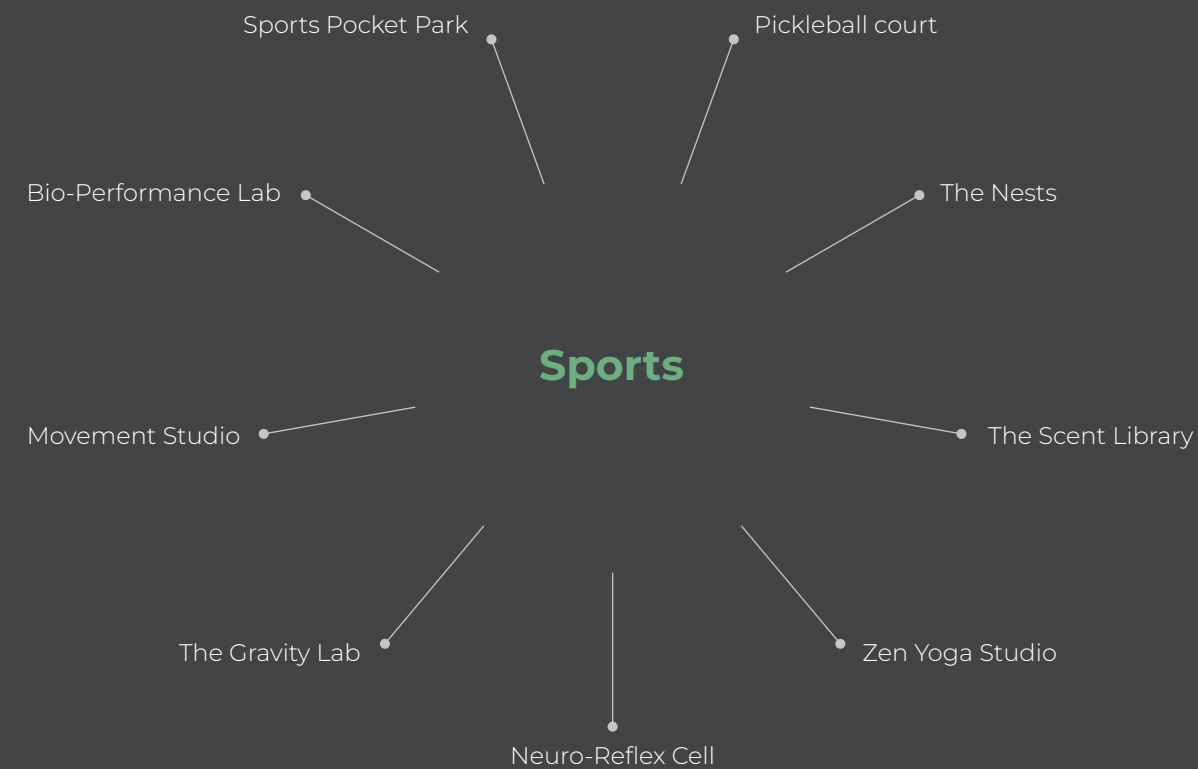


Figure 4.7: Programs within the sports cluster.

4.1 THE METAPHOR OF URBAN FOREST

4.1.3 Programs per cluster

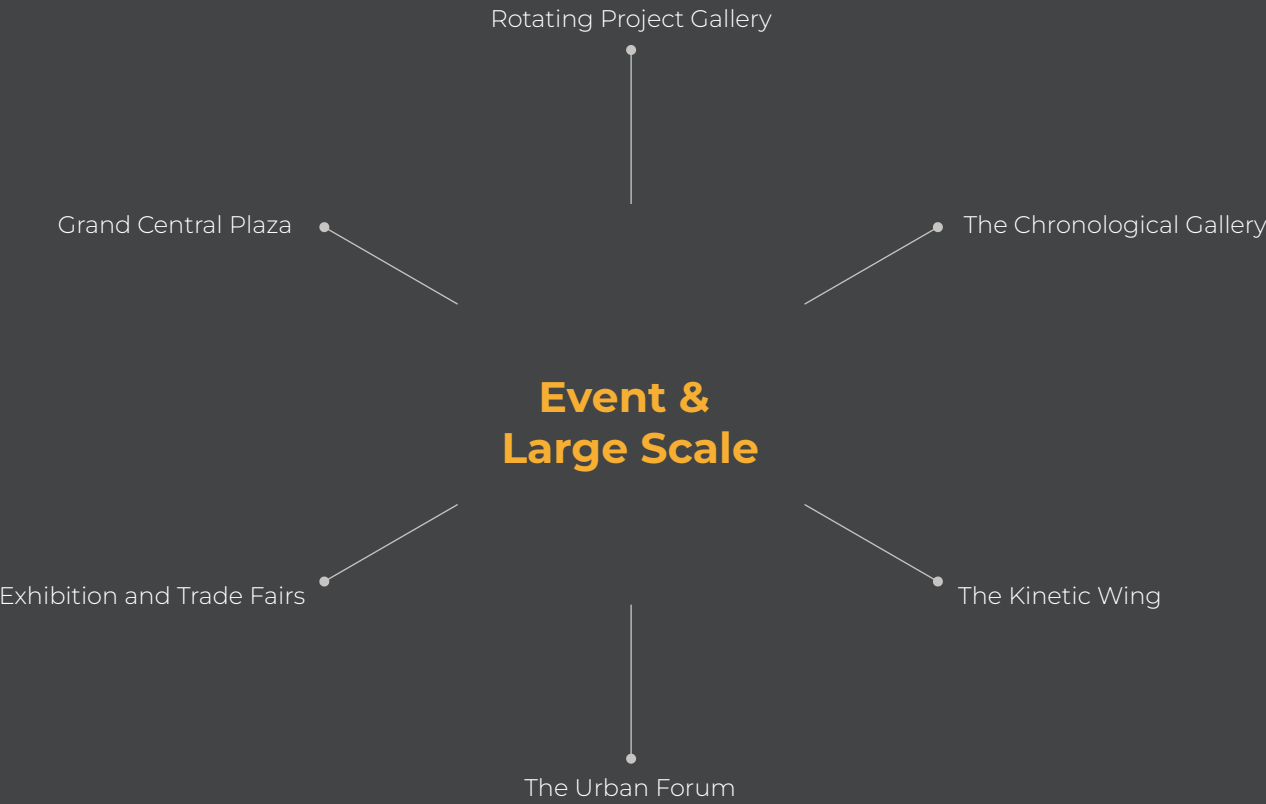


Figure 4.8: Programs within the events cluster.



Figure 4.9: Programs within the food cluster.

4.1 THE METAPHOR OF URBAN FOREST

4.1.3 Programs per cluster



Figure 4.10: Programs within the visitor svc cluster.

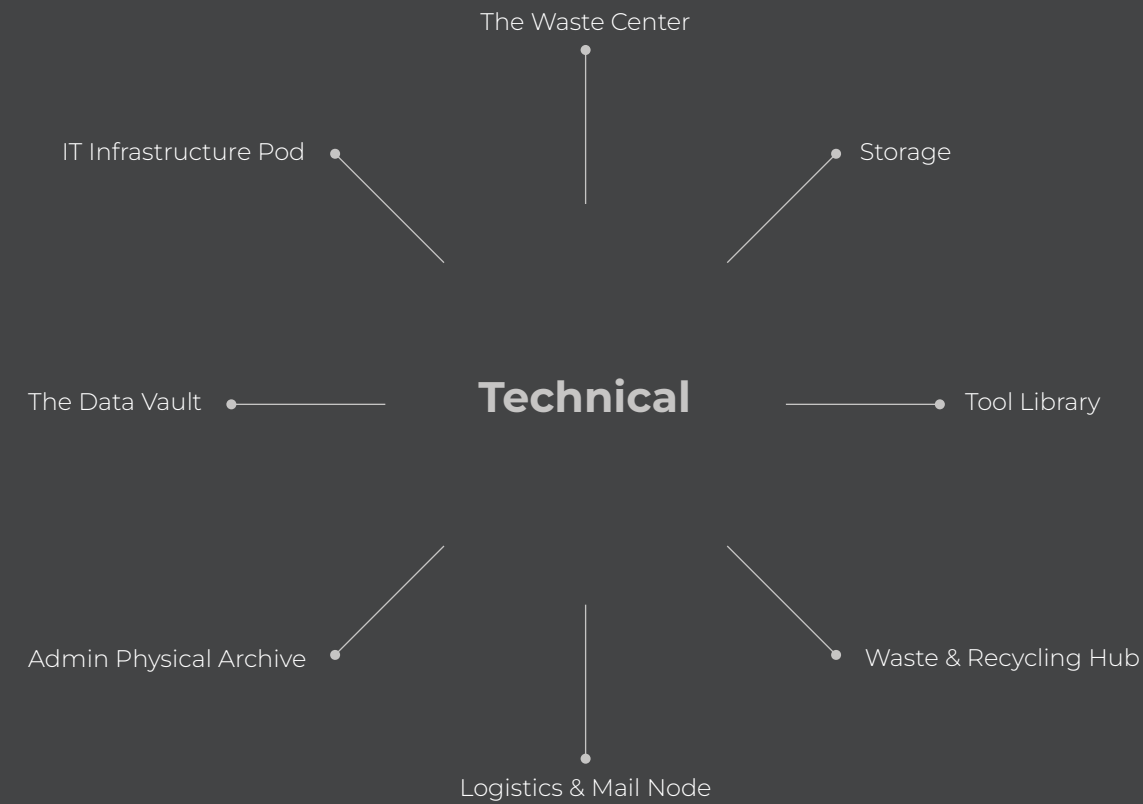


Figure 4.11: Programs within the technical cluster.

4.1 THE METAPHOR OF URBAN FOREST

4.1.3 Programs per cluster



Figure 4.12: Programs within the operational cluster.

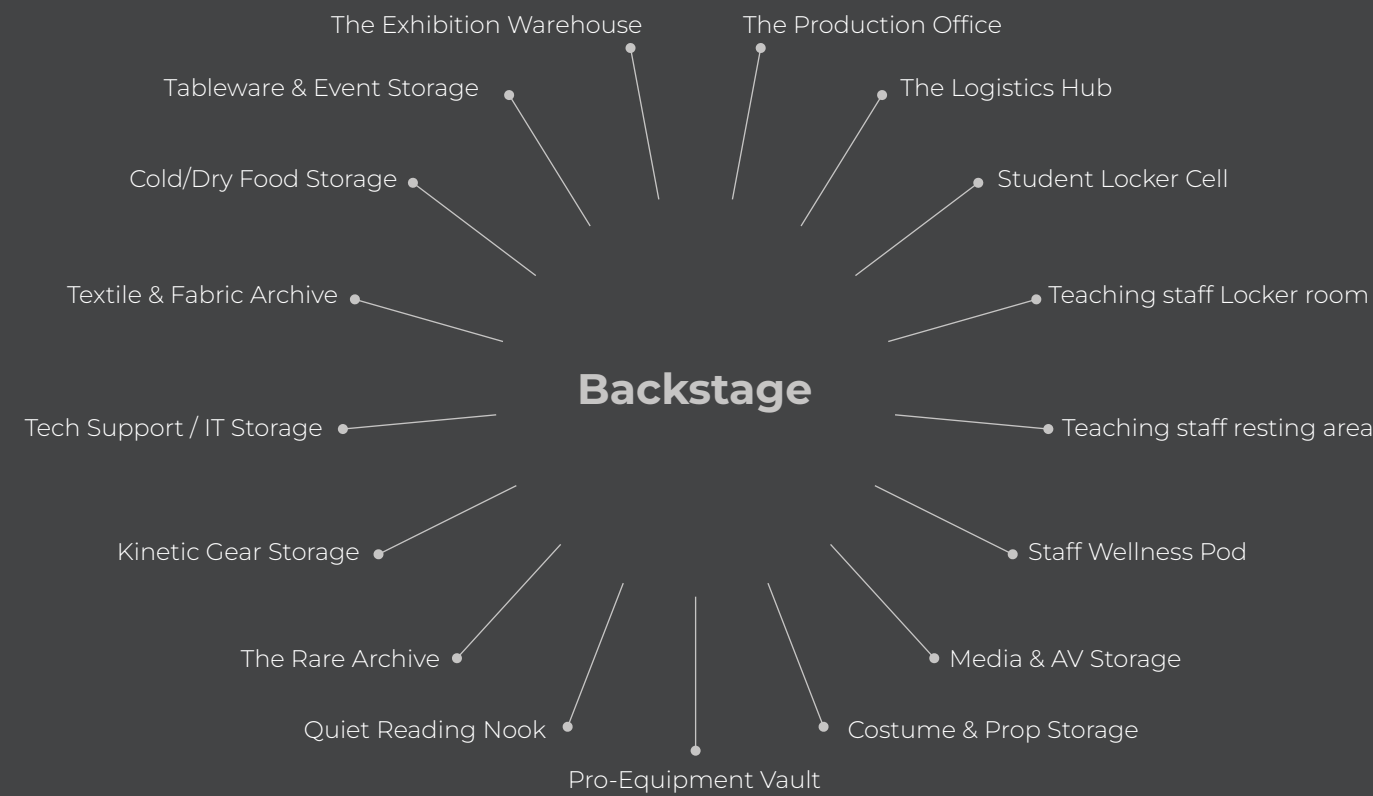


Figure 4.13: Programs within the backstage cluster.

4.2 Systemic Modularity

4.2.1 The modular prefab systems logic

The intervention introduces a modular, prefabricated system conceived as a flexible “city-within-a-city” that populates the monumental interior through independent architectural clusters. Rather than introducing static permanent divisions, this strategic composition organizes the vast open floor plate into human-scaled environments that respect the grand scale of the host building. In accordance with contemporary heritage restoration legislation (D.Lgs 42/2004), these self-contained pods do not transfer loads to or permanently touch Nervi’s concrete pillars or the perimeter steel frame. By utilizing entirely dry-assembled, factory-prefabricated elements, the system satisfies the requirement of architectural reversibility. The configuration can be assembled, expanded, altered, or removed without leaving permanent scars on the historic fabric of the monument. Operating under a strict “box-within-a-box” framework, the new additions bypass the traditional structural requirements of foundation driving or invasive anchoring into the existing slab. Each cluster loads are disaggregated and distributed evenly across standard floor plates, turning the interior architecture into highly stable, floor-bound elements. This self-supporting structural configuration ensures that the monumental vault of the building remains uncompromised, allowing the original open spans to be appreciated in their historical context.

Furthermore, the choice of factory-based prefabrication solves the intense physical and logistical challenges of working within a heritage building. Traditional wet construction methods such as cast-in-place concrete or extensive plastering introduce dangerous levels of moisture, airborne chemical particles, and continuous vibration that could accelerate the deterioration of the historic concrete and iron finishes. Moving the entire fabrication phase off-site to a controlled environment guarantees exceptional material accuracy, clean tolerances, and rigorous quality control. The pre-milled pieces are delivered to the main hall as a series of finished, dry components optimized for fast assembly. This setup minimizes on-site construction timelines, heavy machinery usage, and noise pollution within the neighborhood. From an environmental standpoint, this modular layout creates a vital acoustic and thermal shield between the localized workspaces and the vast macro-volume of the hall. Maintaining a comfortable temperature in an open-plan building of this size throughout the year would demand unsustainable amounts of energy. The self-contained modular approach resolves this dilemma by focusing active climate control strictly inside the timber volumes. The surrounding air volume of the grand atrium acts as a natural buffer zone, absorbing extreme outdoor weather changes, while the pods maintain highly regulated internal conditions.

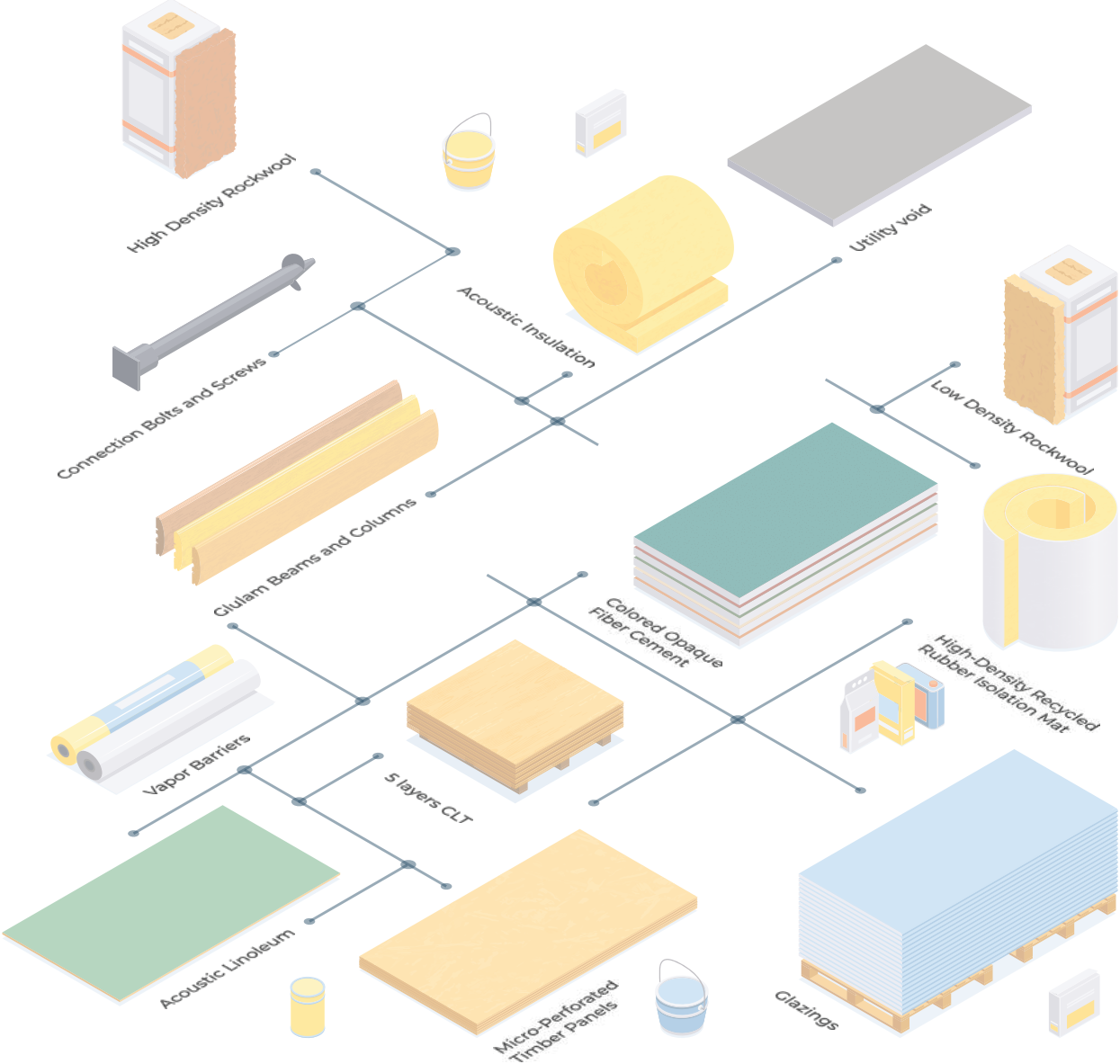


Figure 4.14: Material used inside the pods diagram

4.2 Systemic Modularity

4.2.2 Structural Anatomy of the “C-Frame” Module

The core structural skeleton of each pod relies on a standardized Reversible “C-Frame” Chassis. This lightweight frame is constructed primarily from 5-Layer Cross-Laminated Timber (CLT) panels, configured in a heavy-duty thickness layup of 30+20+50+20+30mm. The panels are fastened on-site using high-tension structural steel angle brackets and bolted shear connections. This approach completely eliminates the need for wet cast-in-place concrete or permanent welding, supporting carbon sequestration while ensuring that every component remains part of a circular, dismountable lifecycle. The structural integrity of this arrangement is derived entirely from the perpendicular orientation of its alternating timber layers. By stacking sawn timber boards at strict 90-degree rotations relative to one another, the resulting panel achieves uniform dimensional stability and isotropic load-bearing capabilities across both directional axes. This cross-lamination technique dramatically counteracts the natural directional weakness of raw wood, significantly reducing wood expansion or contraction while matching the high structural requirements needed to span across our custom street grid. When calculating the spatial boundaries of the pod layout, the physical properties of the C5 mass timber plates dictate the spatial limits of our volumetric chassis.

The choice of a 5-layer panel provides the necessary structural rigidity to handle internal floor loads and overhead platform weights without requiring mid-span structural columns, keeping the internal floor plans completely free and open. By relying on dry-fitted shear joints, metal angle plates, and tension bolts, the assembly behaves as a structural kit-of-parts. This design features excellent ratings for disassembly and fast assembly times compared to traditional light frames, providing a material baseline that protects the architectural fabric of the Palazzo del Lavoro. To integrate necessary thermal insulation and underfloor building systems, the existing ground floor slab is strategically cut and lowered; this technical adjustment is leveraged to embed the chassis base, ensuring a completely flush, barrier-free entry threshold.

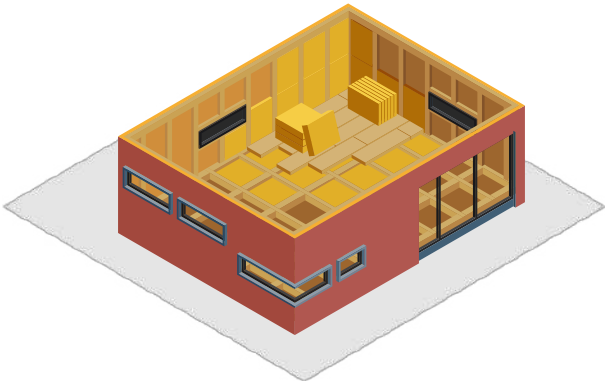


Figure 4.15:CLT prefab construction 3D isometric, illustrating the pod chassis integrated within the lowered ground slab zone to accommodate thermal insulation layers and guarantee flush accessibility.

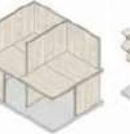
		Traditional	Mass Timber				
Construction Typology		Light Frame	Post and Beam	Post and Platform	Braced Mass Timber Frame	Mass Timber Panels	Shell Structure
Wood Product							
Most Common Building Height	Low Rise	✓	✗	✗	✗	✗	✗
	Mid Rise	✓	✓	✓	✓	✓	✓
	High Rise	✗	✓	✓	✓	✓	✗
Assembly Time		●●○○	●●●○	●●●●	●●○○	●●●○	●●●○
Ease of Transport		●●●●	●●●○	●●●○	●●●○	●●○○	●●○○
Design Flexibility		●●○○	●●●○	●○○○	●●●○	●●●●	●●●●
Disassembly		●○○○	●●●●	●●●●	●●●●	●●●○	●●●○
Maximum Span		●○○○	●●●○	●●○○	●●●○	●●○○	●●●●

Figure 4.16: Typologies of timber comparison



Figure 4.17: CLT Construction



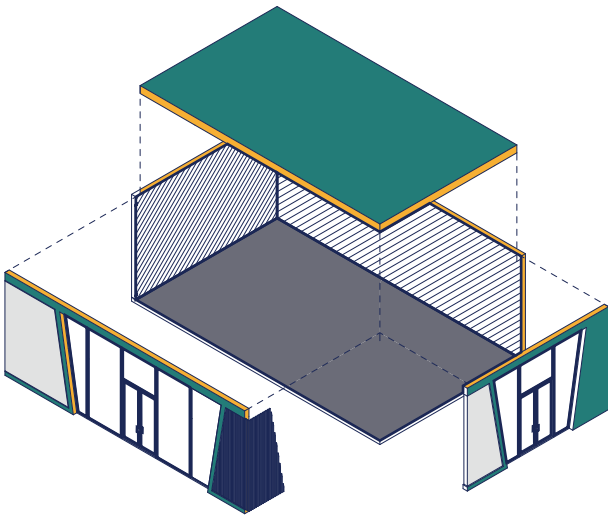
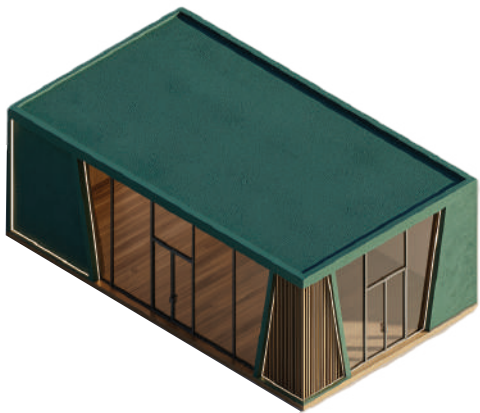
Figure 4.18: CLT layers showing how the boards rotate perpendicularly

4.2 Systemic Modularity

4.2.3 Material Layering & Technical Performance

The prefabricated pods are engineered as completely autonomous, self-supporting spatial cells designed for rapid assembly and total structural reversibility within the grand volume. By decoupling the programmatic spaces from the host building frame, these modules can be dry-assembled on-site, configured, or entirely dismantled without leaving a permanent footprint on the historic floor plate. The structural engineering of the long-span pods underwent a critical optimization phase, moving away from an initial hypothesis of a traditional beam-and-slab layout. The original concept relied on a network of deep, secondary Glulam ribs to support a thin timber deck, scaling member depth to standard deflection formulas. However, when applied to factory-prefabricated volumetric units, this hybrid layout introduced major architectural penalties: it required complex, multi-point CNC milling, bloated the overall thickness of the roof and floor sandwiches, and fragmented the clean vertical clearance inside the spaces. To resolve these inefficiencies, the Glulam ribs were eliminated entirely, upgrading the structural skeleton to a heavy-duty, solid Cross-Laminated Timber (CLT) diaphragm. By shifting the structural load-bearing capacity to a thick, continuous panel, the multi-layered plate clears the long span independently under public assembly load requirements. This shift establishes true tectonic purity, allowing the horizontal plates to interface

directly with the load-bearing walls through continuous linear joints. The resulting assembly compresses the entire insulation and utility profile into a highly efficient, streamlined monocoque frame, giving the pods a completely flat, seamless wood grain ceiling.



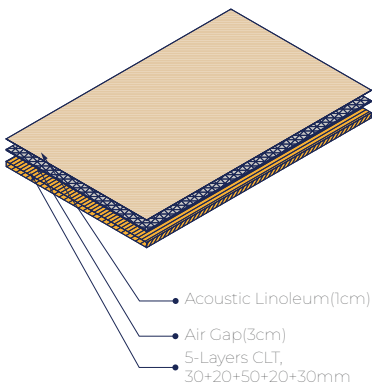
Architectural Intent

These pods provide a "Maximum Quietness and Comfort" zone inside so each program can be experienced with highest quality. The core utilizes a 5-layer CLT structure, balancing structural rigidity with bio-material warmth. The exterior is wrapped in fiber cement for durability and aesthetic continuity.

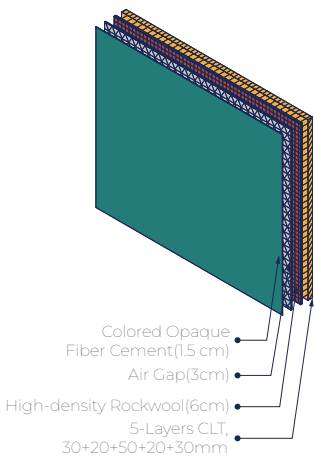
Exploded Isometric

The module utilizes a modular CLT chassis with high-performance acoustic and thermal envelopes, designed for rapid assembly within cultural hub environments.

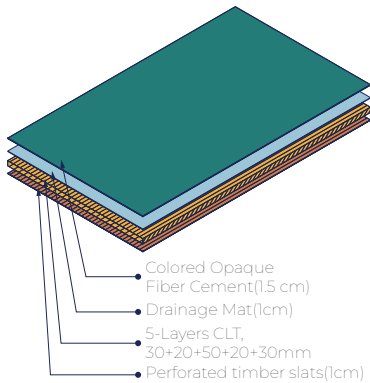
Floor Material Parts



Wall Material Parts



Non-walkable Roof Material Parts



4.3 Programmatic Ecosystem

4.3.1 Design process and macro-zoning plans

Ground Floor:

The design methodology implements a ‘box-within-a-box’ intervention strategy, designed to preserve the original building’s vast spatial scale and optimize natural daylight penetration throughout the public volumes. The process translates broad spatial zoning into micro-architectural clusters, where modular pods house highly specialized functions. By intentionally alternating between dense programmatic volumes and expansive open areas, the plan creates a dynamic urban fabric within the building. These diverse activities are strategically overlapped and physically connected, establishing functional synergies that cater to distinct user groups while maintaining a cohesive, fluid interior ecosystem.

Ground Floor Base Plan

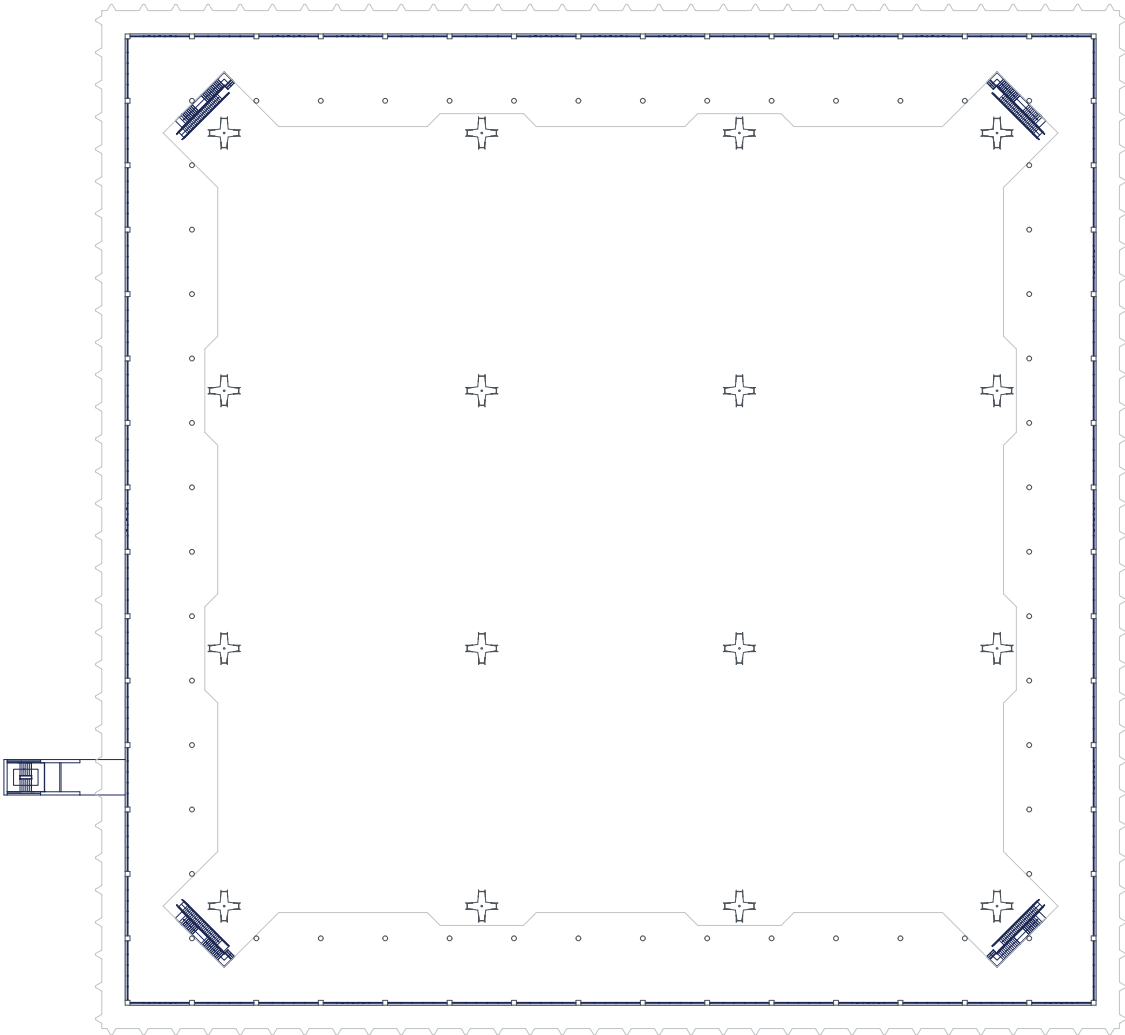


Figure 4.19: Ground floor base plan design process.

Ground Floor Accessibility

Using the entrances and exits to define the layout, the street grid and main boulevard align directly with the glazed roof strips to maximize daylight availability in the open areas.

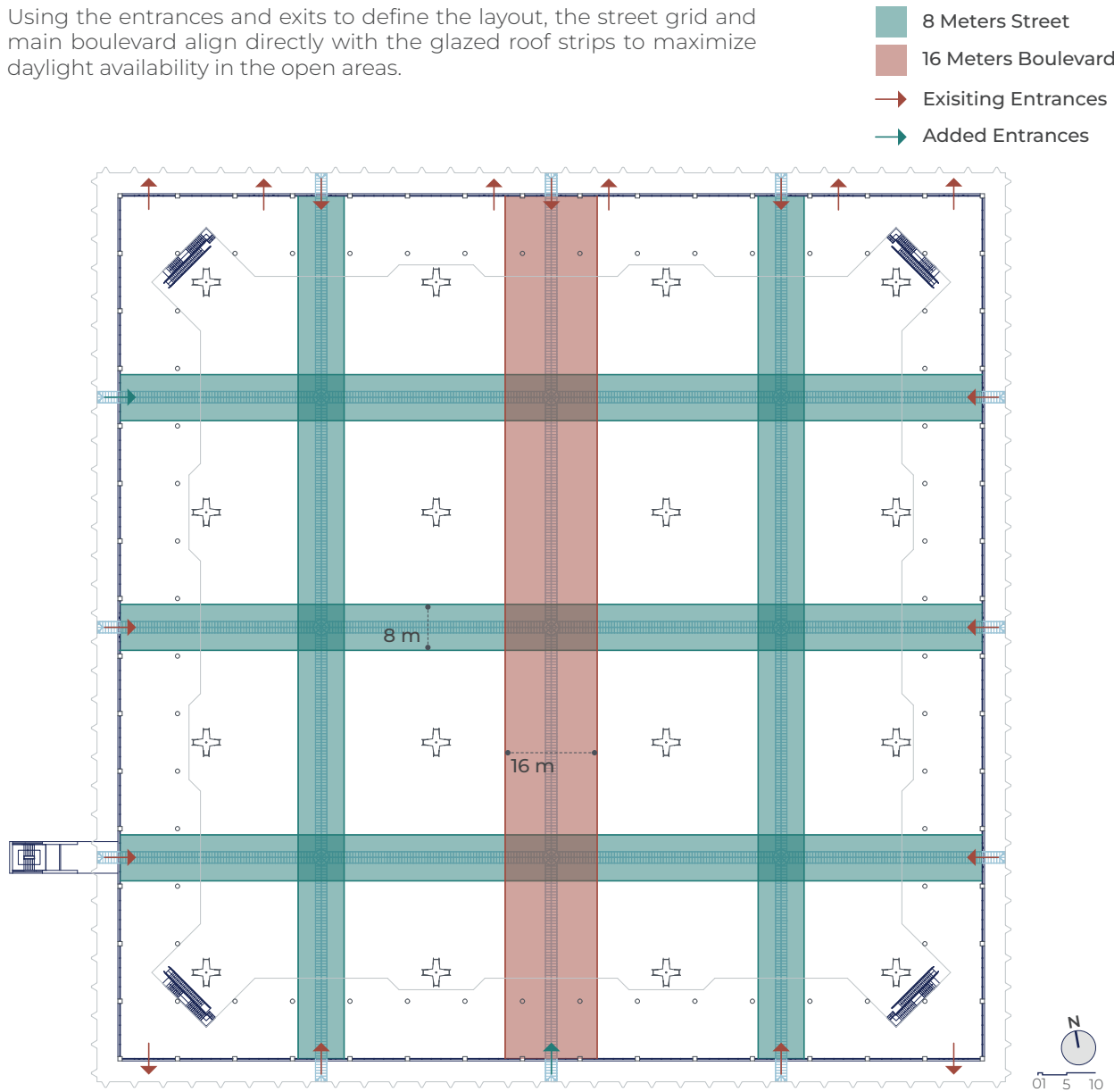


Figure 4.20: Ground floor accessibility design process.

Ground Floor Vertical Connections

The structural grid defines the primary zones, anchoring eight central vertical cores. Three emergency staircases were added along the North, South, and East axes, while corner escalators were replaced with elevators.

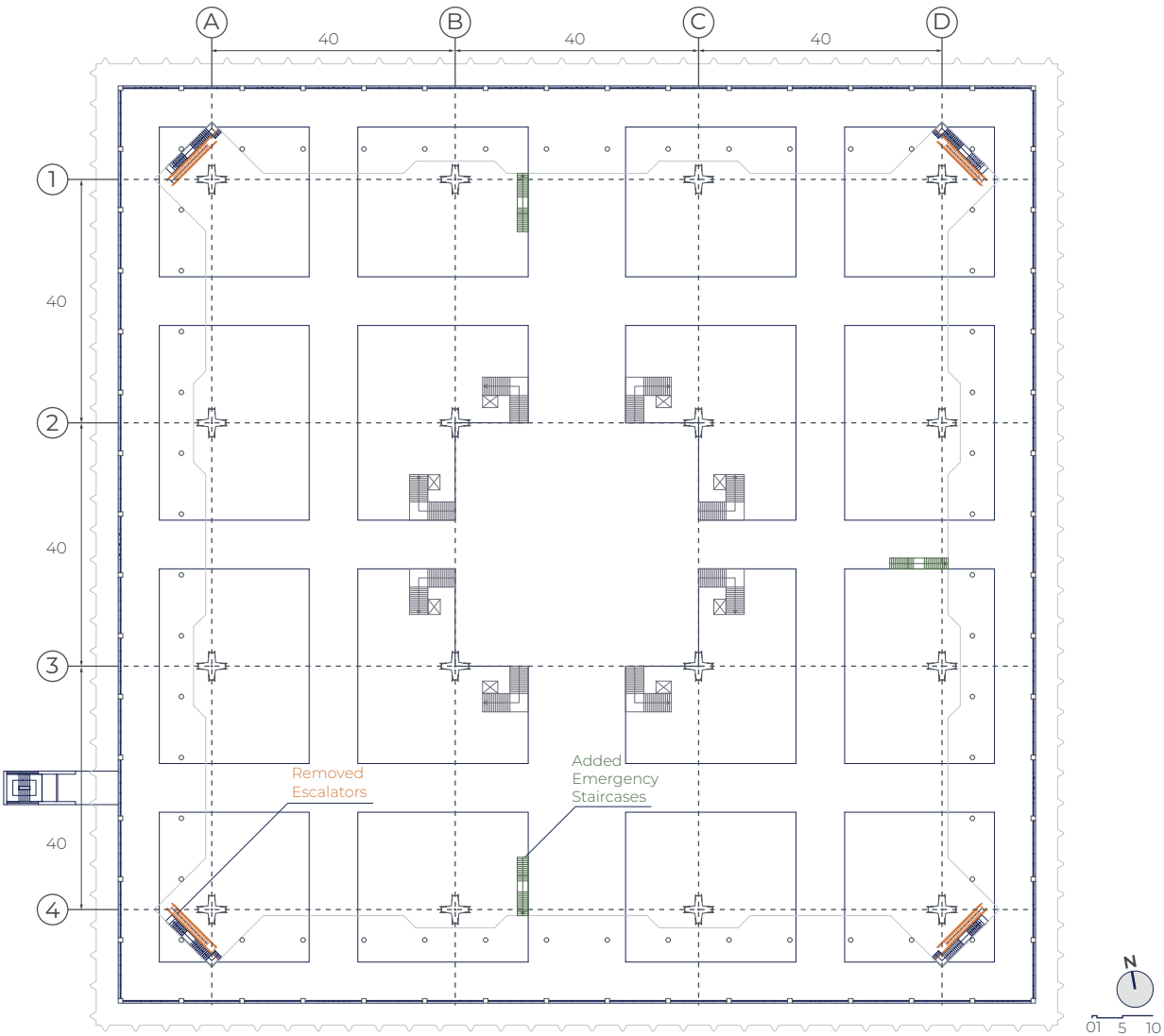


Figure 4.21: Ground floor vertical Connections design process.

Ground Floor General Activity

The absolute center forms a high-capacity public Core, wrapped by an active circulation ring (Ring 1) for vertical transit. The outer ring (Ring 2) distributes the modular thematic zones, while the Perimeter handles services and main entrance buffering.

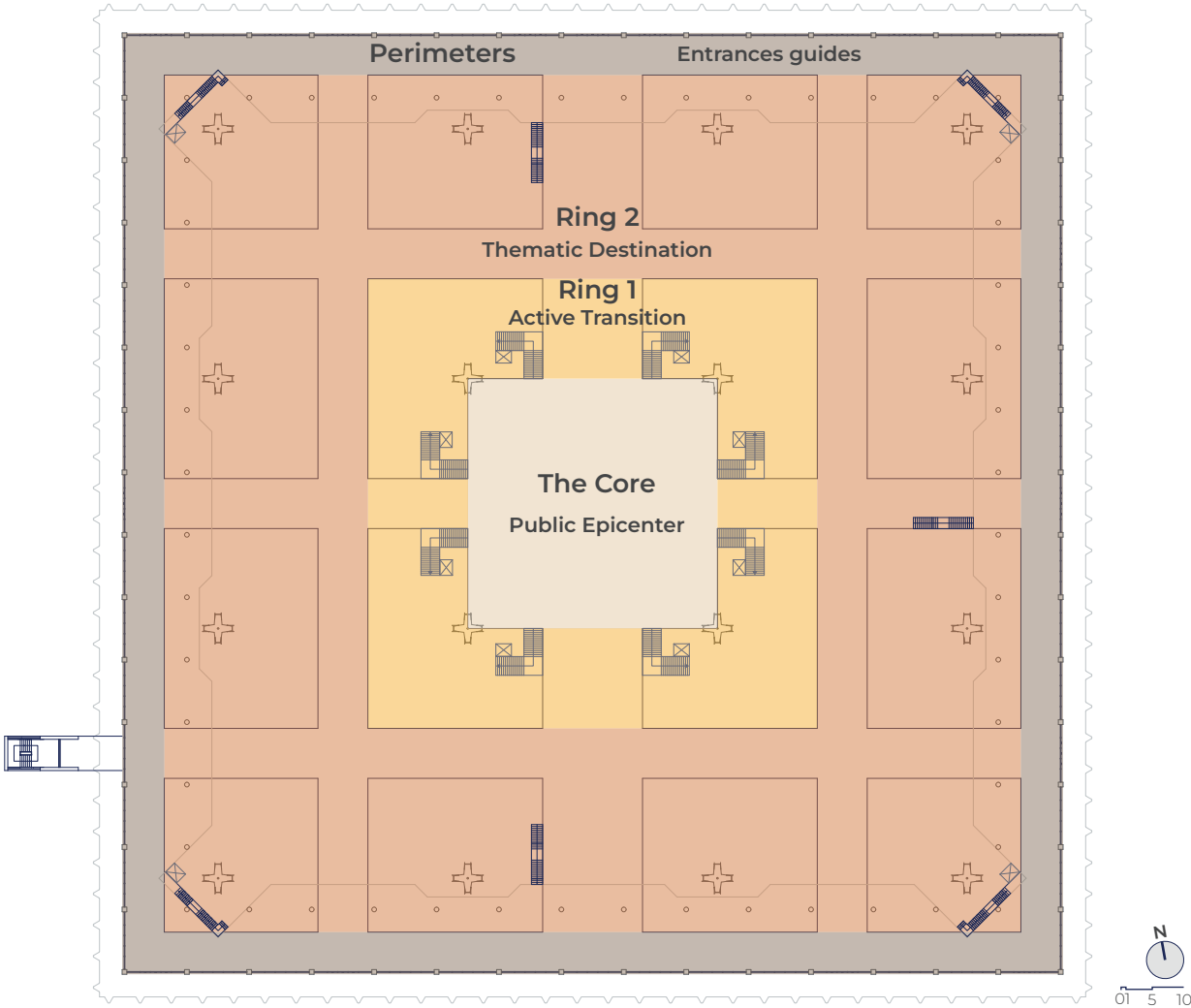


Figure 4.22: General Activities defined in the Ground floor.

Ground Floor General Workability

The plan is subdivided into four clear programmatic quadrants intersected by the main circulation avenues. This quadrant strategy groups compatible public uses together to streamline wayfinding.

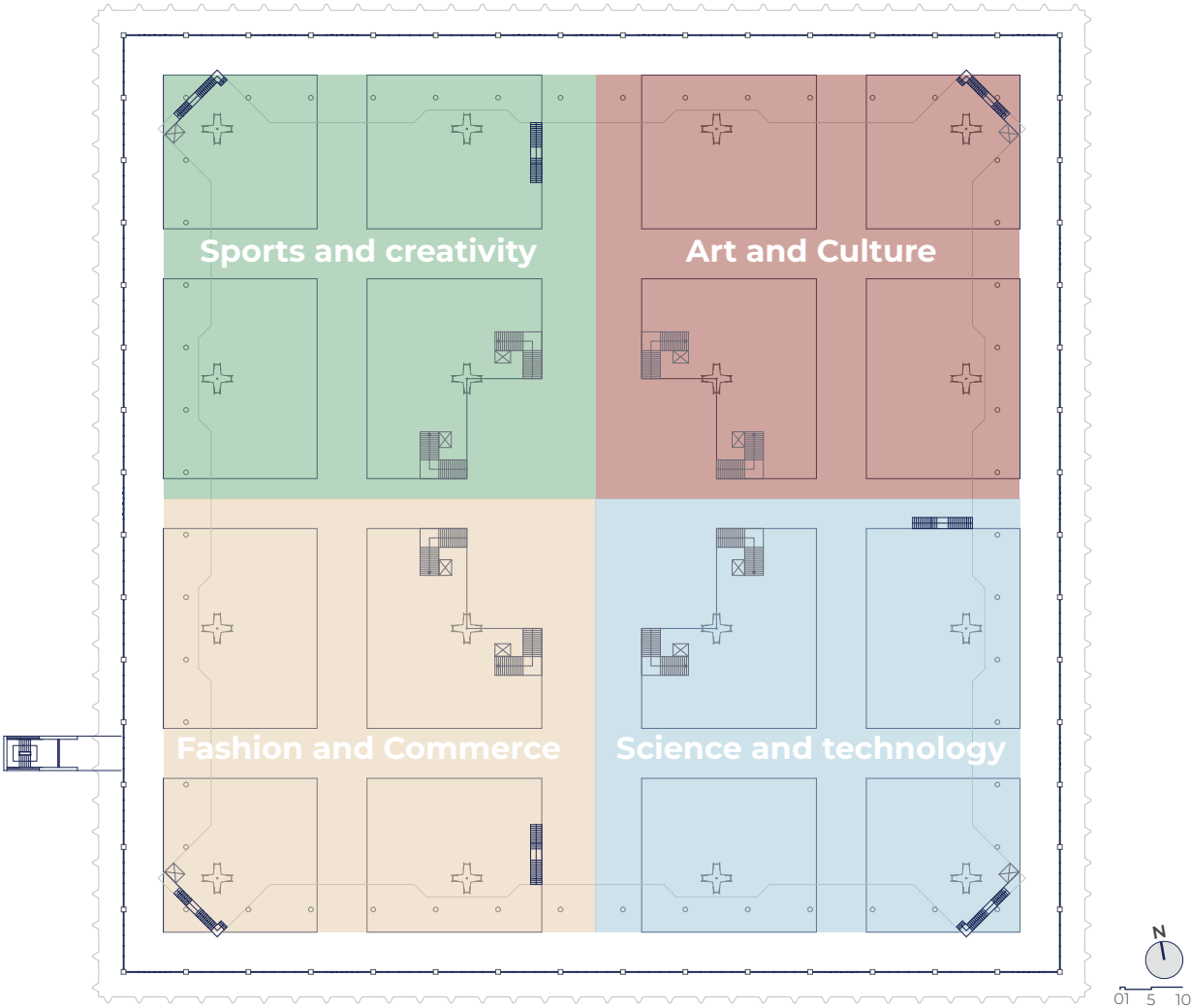


Figure 4.23: General Workabilities defined in the Ground floor.

Main Zones

The structural grid, circulation cores, and street network establish the primary zoning, with each distinct program category organized around the main columns.



Figure 4.24: Ground floor general Zonings design process.

Main Central Plaza: The grand central core; a flexible event space for festivals, concerts, fashion runways, and sports events.

A1 - Bloom Sanctuary: A nature-focused wellness zone featuring a sensory meadow, bark-path, bamboo corridor, family care, and a ventilated smoking room.

A2 - Children Center: A youth play and development hub with a toddler sensory garden, a creative maker lab, and a 5-meter climbing structure.

A3 - Indoor Urban Market: A glass-enclosed commercial anchor with an open-oven bakery, vertical living mushroom wall, dry goods silos, and fermentation bars.

A4 - Harvest Hub: An agricultural and logistical zone with an edible citrus forest, soil floor, bamboo corridor, and refrigerated grocery lockers.

B1 - Civic Pavillion: A tranquil public sanctuary featuring living green walls, integrated seating areas, cascading water elements, and dense indoor greenery.

B2 - Sport: A high-energy athletic zone containing an enclosed glass pickleball court, biometric tracking lab, sneaker shop, and supplement apothecary.

B3 - Fashion/Creative: A circular design hub featuring a historic textile archive, a plant-based natural dye studio, and a photographic pocket park.

B4 - Civic Pavillion: A high-tech public hub combining dynamic digital screens and tiered amphitheater stair-seating with relaxed lounges, water elements, and lush greenery.

C1 - Heritage Museum: An architectural gallery with a material library comparing 1960s concrete to modern CLT, a VR/AR heritage lab, and blueprint archives.

C2 - Cultural/Musical: A performing arts space with an immersive sound room, live performance stage facing the park, bookstore, and cafe.

C3 - Bio-Digital Hub: A futuristic eco-zone centered on an 18-meter glass vertical greenhouse, an algae CO2-scrubbing bar, and a VR testing pod.

C4 - Art-House Cinema: A premium cinema hub featuring a 60-seat Black Box theater with 4K laser projection, a cine-lounge, and a holographic foyer.

D1 - Reflecting Portal: A contemplative zone anchored by a black-bottomed pool mirroring the building's columns, alongside a first aid station.

D2 - Pop-up Art Boutiques: A modular retail collective for fine art prints, handmade furniture, botanical items, and pottery kilns.

D3 - Exhibition: A professional trade venue equipped with a massive LED media wall and an underfloor utility grid for custom booth setups.

D4 - Zen Terminal: A relaxation oasis featuring a rocky hydro-garden waterfall, oxygenating ferns, and visitor amenities.

Perimeter Zones: Core building operations, security, reception kiosks, smart lockers, and a pet shop with an enclosed play area.

Ground Floor Zoning Plan

Programs are integrated within the zoning plan, mixing innovative activities inside the pods to meet specific zonal needs. Related functions are strategically clustered within each thematic category and seamlessly connected to optimize user comfort and programmatic synergy.



Figure 4.25: Ground floor zoning Plan.

Legends

- A1-2: Female Bathroom

A1-3: Male Bathroom

A1-4: Bamboo Corridor for activities

A1-5: Baby-Care & Family Room

A1-6: Smoking Room

A1-7: Bamboo Corridor for activities

A2-1: The Sensory Garden

A2-2: The Maker Lab

A2-3: The Gravity Lab

A2-4: The "Stroller & Gear" Hub

A2-5: The "Tiny Toilets" & Nursing Room

A3: Indoor Urban Market

A3-1: The Bakery Hearth

A3-2: The Mushroom Wall

A3-3: The Dry Goods Silos

A3-4: Fermentation Bar

A3-5: Spice & Tea Bazaar

A3-6: The Fromagerie

A3-7: The Logistics Hub

A3-8: The Waste Center

A4-1: The Edible Forest

A4-2: Female Bathroom

A4-3: Male Bathroom

A4-4: Bamboo Corridor for activities

A4-5: Bulk Grocery Lockers

A4-6: Locker Room

A4-7: Bamboo Corridor for activities

B1-1: Green walls

B2-1: Storage

B2-2: Enclosed glass Pickleball court

B2-3: Wearable Tech Lab

B2-4: Sustainable Sneaker Shop

B2-5: Supplement Apothecary

B2-6: Sport/gear hub

B2-7: Juice & Bio Elixir Bar

B2-8: Sports Pocket Park

B2-9: Storage

B3-1: Storage

B3-2: Fashion Archive

B3-3: Clothing Store

B3-4: Clothing Store

B3-5: Clothing Store
- B3-6: Snack / Grab-and-Go

B3-7: Natural Dye studio

B3-8: Photographic Pocket Park

B3-9: Storage

B4-1: Digital screen

B4-2: Seating area stairs

C1-1: Material Library

C1-2: Augmented Heritage Lab

C1-3: The Column Archive

C1-4: The 1961 Theater

C1-5: Structural Model Shop

C1-6: The Blueprint Gallery

C1-7: Museum Courtyard

C2-1: Storage

C2-2: Immersive Sound Room

C2-3: Bookstore

C2-4: Cafe

C2-5: Musical/Acting Stage

C2-6: Musical Supply

C2-7: Gelateria

C2-8: Cultural/Musical Pocket Park

C2-9: Storage

C3-1: Storage

C3-2: Urban Vertical Greenhouse

C3-3: Algae Oxygen Bar

C3-4: VR / AR Testing Pod

C3-5: Seed & Genetics Library

C3-6: Kinetic Light Sculpture museum

C3-7: Hydronic Tasting Bar

C3-8: Generative AI pocket park

C3-9: Storage

C4-1: The Cine-Lounge

C4-2: The Light-Lock & Services

C4-3: The Grand Void

C4-4: The Director's Corner (Discussion Pit)

C4-5: The "Holographic" Foyer

D1-1: Reflecting Pool

D1-2: Female Bathroom

D1-3: Male Bathroom

D1-4: Bamboo Corridor for activities

D1-5: First Aid Station
- D1-6: Locker Room

D1-7: Bamboo Corridor for activities

D2-1: The Canvas Gallery

D2-2: The Maker's Atelier

D2-3: The Botanical Box

D2-4: The Gem Vault

D2-5: The Kiln Gallery

D2-6: The Sculptor's Cube

D2-7: The Neon Vault

D2-8: The Aperture Shop

D2-9: The Loom Boutique

D3-1: The Media Wall

D3-2: Exhibition and Trade Fairs

D3-3: The Production Office

D3-4: The Exhibition Warehouse

D4-1: The Hydro-Garden

D4-2: Female Bathroom

D4-3: Male Bathroom

D4-4: Bamboo Corridor for activities

D4-5: Baby-Care & Family Room

D4-6: Smoking Room

D4-7: Bamboo Corridor for activities

Perim-1: Currency exchange

Perim-2: Smart lockers

Perim-3: Reception and Info kiosk

Perim-4: Security

Perim-5: Pet shop

Perim-6: Enclosed Pet playing area

Perim-1: Storage

Perim-2: Security

Perim-3: Reception and Info kiosk

Perim-4: Storage

Perim-1: Enclosed Pet playing area

Perim-2: Pet shop

Perim-3: Security

Perim-4: Reception and Info kiosk

Perim-5: Smart lockers

Perim-6: Farmacy

Perim-1: Storage

Perim-2: Security

Perim-3: Reception and Info kiosk

Perim-4: Storage

4.3 Programmatic Ecosystem

4.3.1 Design process and macro-zoning plans

The ground floor layout uses Louis Kahn’s “Served and Serving” architectural theory to organize the immense scale of the Palazzo del Lavoro. By dividing the plan into three distinct graphic and functional layers, the project establishes a highly organized interior ecosystem that balances structured infrastructure with public flexibility:

Static Serving Infrastructure (Dark Charcoal):

This layer anchors the physical and operational backbone of the design. It centralizes the vertical circulation cores, isolates localized back-of-house facilities (such as restrooms, storage, and mechanical utilities) within the perimeter blocks, and highlights the historic structural column grid.

Fluid Serving Circulation (Medium Gray):

Rather than leaving the expansive gaps between modules as empty floor area, this layer defines a deliberate “megacity” street network. It encompasses the Grand Central Plaza, the primary central avenues, and the perimeter streets. These spaces act as active horizontal conduits that streamline user navigation and frame dynamic vistas of the historic structure.

Active Served Destinations (Light Gray):

These zones represent the primary programmatic heart of the intervention. It isolates the highly flexible modular thematic pods and the active public or academic program rooms embedded along the outer perimeter blocks. Liberated from structural and mechanical clutter, these light-filled spaces remain open, adaptable, and fully optimized for user experience.

Ground Floor Served and Serving Spaces

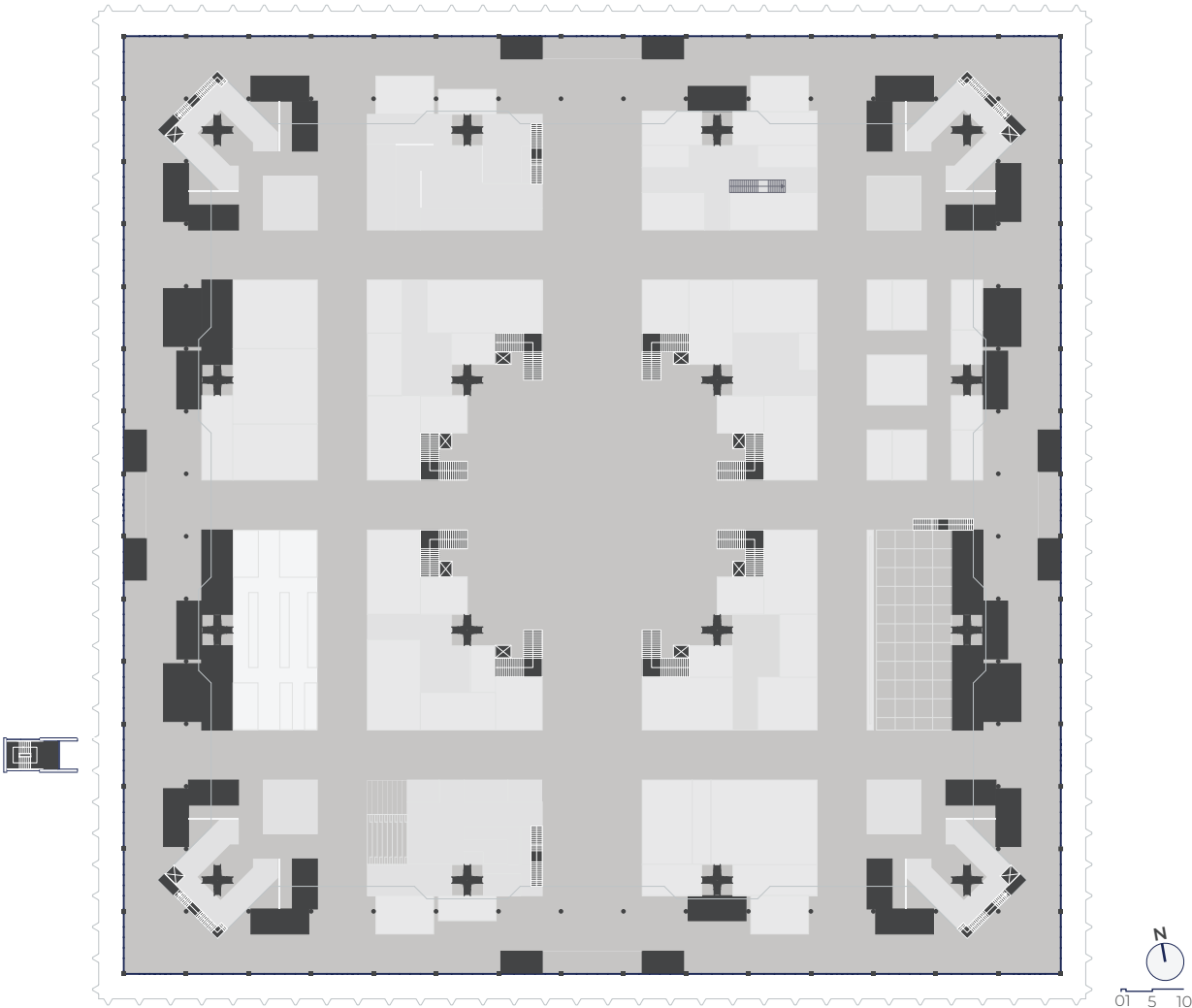
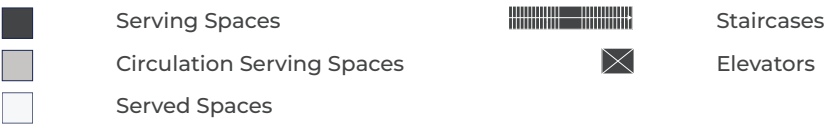


Figure 4.26: Ground floor served and serving spaces.

4.3 Programmatic Ecosystem

4.3.1 Design process and macro-zoning plans

First Floor:

To activate the immense scale of the Palazzo del Lavoro, our design operates as a megacity inside a single building. The urban experience is driven by two main gestures: column-free pedestrian bridges that float between programmatic pods, and an expansive ground-level street network. As users move across these elevated bridges, they experience dynamic, changing views of the building's iconic concrete and steel structure. Furthermore, positioning the new pods directly around the existing structural columns acts as an explicit adaptive reuse strategy, drawing a clear visual distinction between the landmark original architecture and the new modular interventions.

First Floor Accessibility

In response to the ground-floor programming and new vertical circulation cores, additional entrances were introduced on the first floor. Elevated bridges were then implemented to seamlessly interconnect the distinct zones.

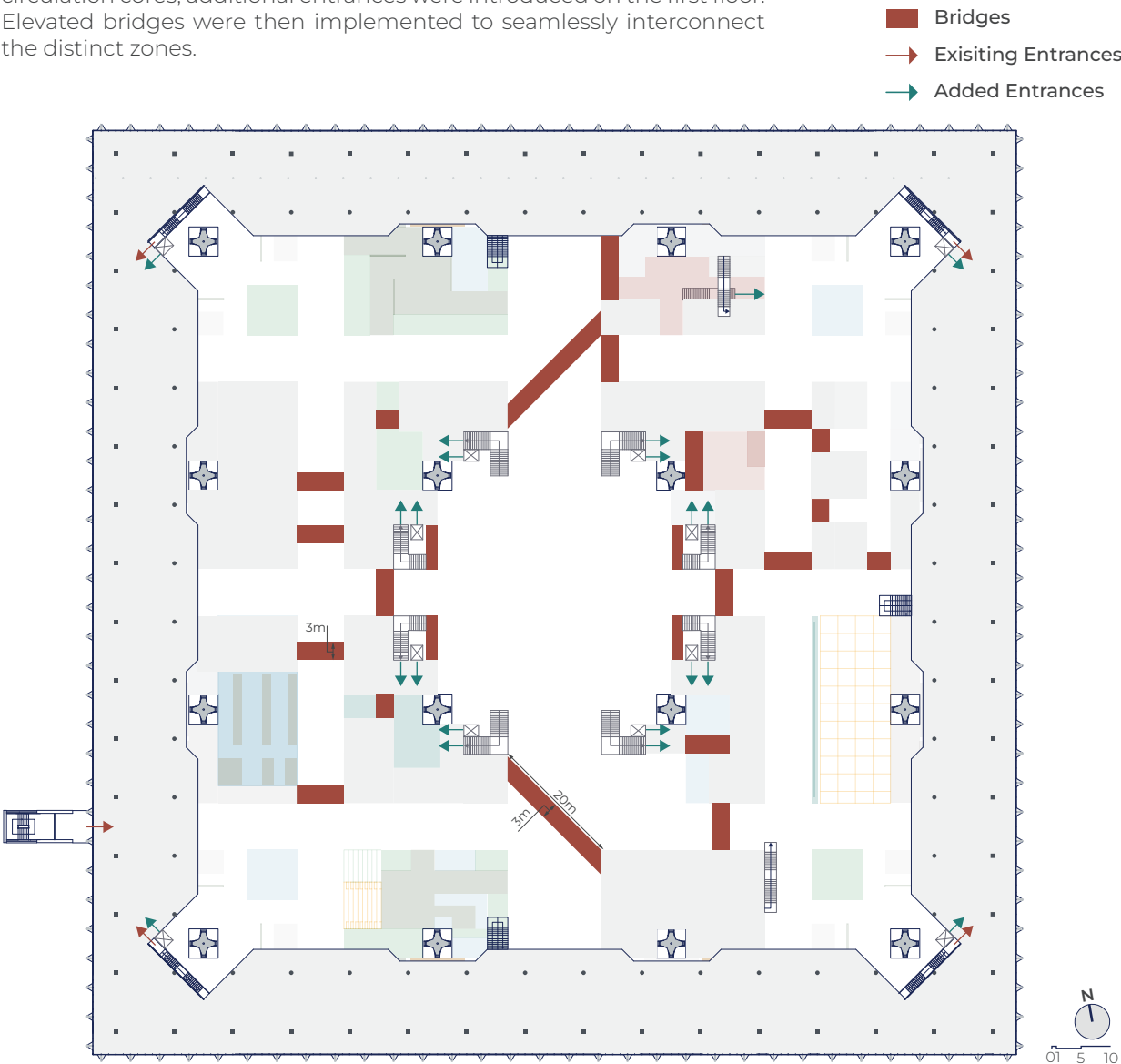


Figure 4.27: First floor accessibility design process.

First Floor Main Zones

The first floor zoning was established based on vertical and horizontal connectivity and the required activities for a multi-program hub. By carefully distributing programs within each zone, the areas offer a diverse mixture of innovative activities tailored to every user type.

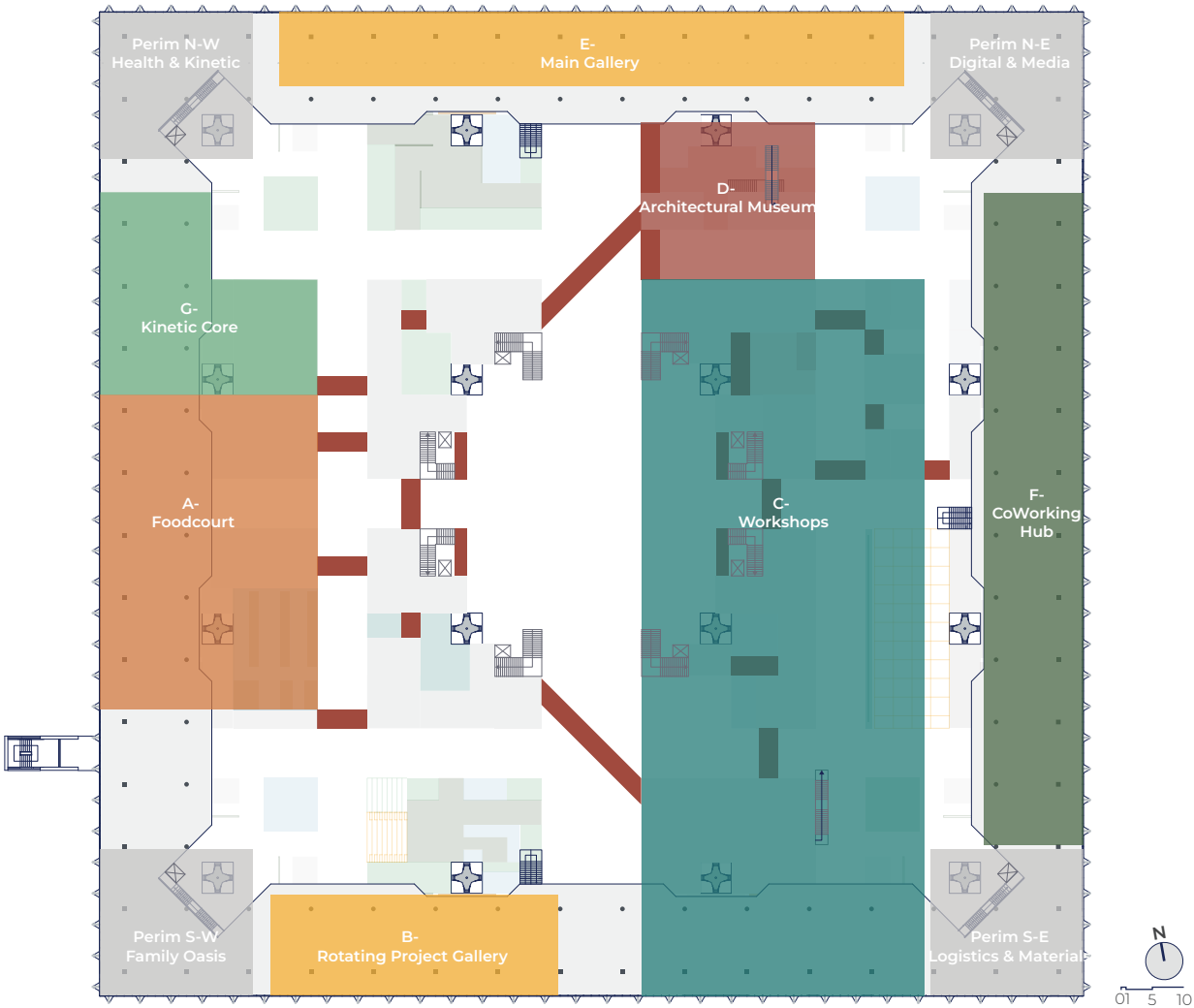


Figure 4.28: First floor general Zonings design process.

- A - Foodcourt & Perimeter West:** A culinary destination with international food stations, including an artisanal fresh pasta kitchen and pizza lab.
 - B - Rotating Gallery (Perimeter South):** A fast-turnover exhibition loop showing workshop projects with integrated QR codes for instant purchase or class enrollment.
 - C - Workshops & Perimeter South:** A massive production hub featuring media/podcast pods, a soundproof music room, dance/acting studios, and a ceramics kiln.
 - D - Architectural Museum:** An exhibition space displaying 1:5 scale structural joint models and AR tablets mapping the building's urban connection.
 - E - Main Gallery (Perimeter North):** A curated arts wing split into a fine art gallery, an urban forum for model study, and a kinetic sculpture wing.
 - F - CoWorking Hub (Perimeter East):** A large co-working space featuring semi-quiet acoustic glass studios, a social cafe, and open hot-desking.
 - G - Kinetic Core & Perimeter West:** An athletic hub with a 9.4-meter climbing wall, cryotherapy recovery pods, cognitive training cells, and an e-sports center.
- Perimeter Service Zones:** Specialized support hubs providing medical first aid, heavy material storage for timber and clay, and event supply warehousing.

First Floor Zoning Plan

The floor integrates diverse programs ranging from food court cuisines and community co-working spaces to an architectural museum. It also creates a dynamic micro-economy where workshop users can showcase and sell their creations to the public using the adjacent galleries, events, and retail boutiques.

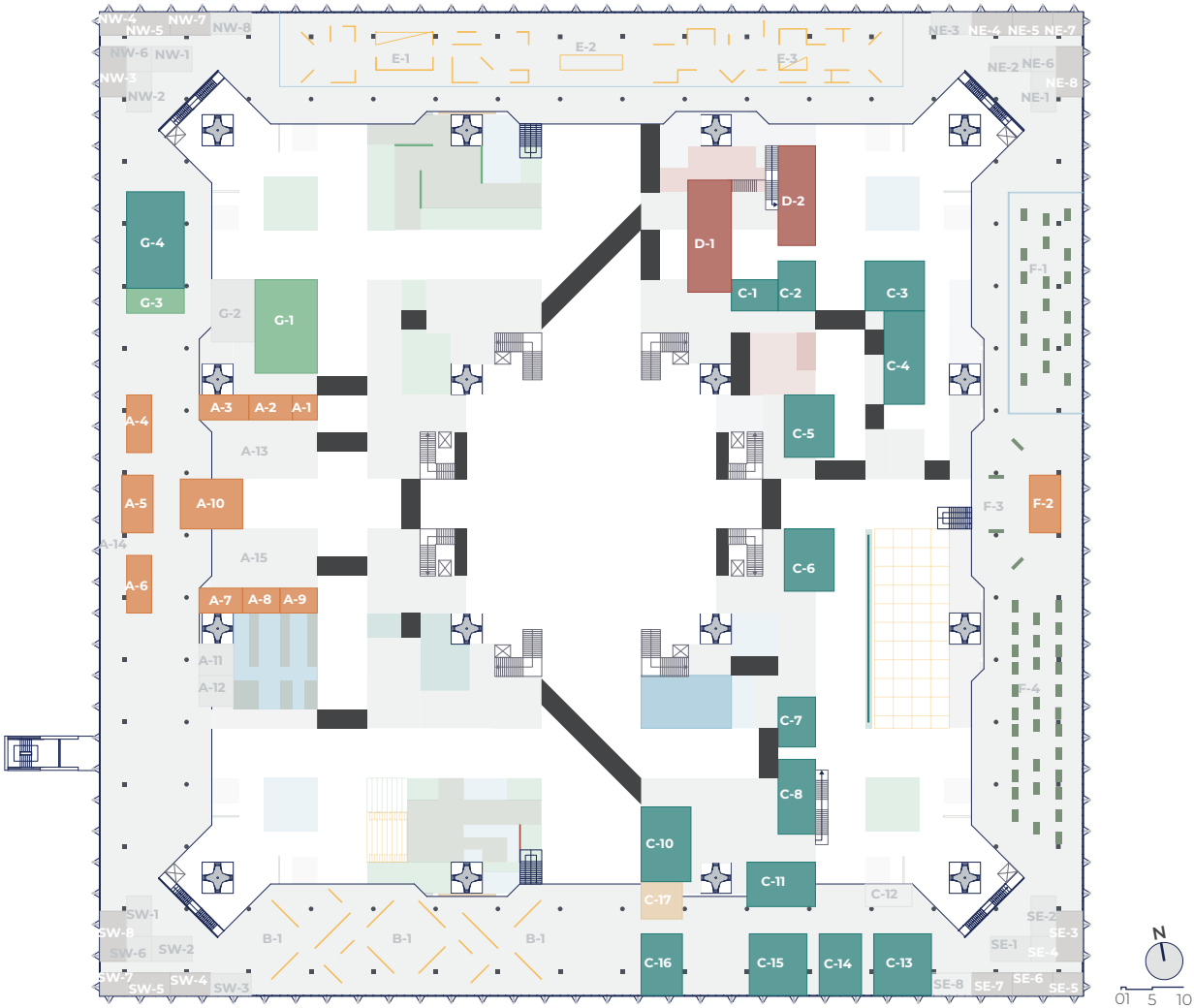


Figure 4.29: First floor zoning Plan.

Legends

- A-1: The Gelato Pavilion

A-2: The Green Verticalist

A-3: Sushi Arena

A-4: The Agnolotti Atelier

A-5: The Bicerin Bar

A-6: The Pizza Lab

A-7: The Levant Grill

A-8: The Taco/Arepa Forge

A-9: The Ramen Station

A-10: The Piazza Brasserie

A-11: Female Bathroom

A-12: Male Bathroom

A-13: Open Seating area

A-14: Open Seating area

A-15: Open Seating area

B-1: Rotating Project Gallery

C-1: Media Pod

C-2: Makeup & SFX

C-3: Sound Box

C-4: Dance Studio

C-5: Acting Studio

C-6: The Darkroom

C-7: Precision Cell

C-8: Fashion Atelier

C-10: Timber Lab

C-11: Ceramic Studio
- C-13: Culinary School

C-14: Pastry & Baking

C-15: Fine Arts Loft

C-16: Botanical Lab

C-17: Material library

D-1: The Structural Cathedral

D-2: The Urban Nexus

E-1: The Chronological Gallery

E-2: The Urban Forum

E-3: The Kinetic Wing

F-1: The Glass Studio

F-2: The Piazza cafe

F-3: Central East perimeter Plaza

F-4: The Open Commons

G-1: Movement Studio (Climbing & Bouldering)

G-2: Recovery & Cryo Pod

G-3: Neuro-Reflex Cell

G-4: Video Game Center

Perim(N-W)-1: Female Bathroom

Perim(N-W)-2: Male Bathroom

Perim(N-W)-3: Medical Care / First Aid

Perim(N-W)-4: Kinetic Gear Storage

Perim(N-W)-5: Tech Support / IT Storage

Perim(N-W)-6: Staff Bathroom

Perim(N-W)-7: Public Locker Room

Perim(N-W)-8: Smoking Room
- Perim(N-E)-1: Female Bathroom

Perim(N-E)-2: Male Bathroom

Perim(N-E)-3: Smoking Room

Perim(N-E)-4: Parcel & Delivery Pod

Perim(N-E)-5: Media & AV Storage

Perim(N-E)-6: Staff Bathroom

Perim(N-E)-7: Janitorial / Maintenance

Perim(N-E)-8: Costume & Prop Storage

Perim(S-E)-1: Male Bathroom

Perim(S-E)-2: Female Bathroom

Perim(S-E)-3: Heavy Material Storage

Perim(S-E)-4: Staff Bathroom

Perim(S-E)-5: Textile & Fabric Archive

Perim(S-E)-6: Cold/Dry Food Storage

Perim(S-E)-7: Tool Library

Perim(S-E)-8: Smoking Room

Perim(S-W)-1: Male Bathroom

Perim(S-W)-2: Female Bathroom

Perim(S-W)-3: Smoking Room

Perim(S-W)-4: Cold/Dry Food Storage

Perim(S-W)-5: Tableware & Event Storage

4.3 Programmatic Ecosystem

4.3.1 Design process and macro-zoning plans

As the design rises into the monumental volume of the building, the horizontal and vertical support mechanisms adapt to maintain maximum flexibility for the primary functional destinations:

Static Serving Infrastructure (Dark Charcoal):

The eight primary vertical circulation cores, structural columns, and corner egress points remain anchored in this tone, demonstrating structural continuity from the ground up. This layer also isolates localized back-of-house elements, such as upper-level mechanical shafts, equipment rooms, restrooms, and the smoking room, ensuring that building services are tightly grouped and structurally integrated.

Fluid Serving Circulation (Medium Gray):

On this elevated level, the circulation network transitions into a system of column-free pedestrian bridges and wide perimeter walkways. These elements work as elevated urban corridors that weave between the upper volumes, providing high-vantage circulation pathways that connect distinct zones while offering dramatic views of the historic structural canopy.

Active Served Destinations (Light Gray/White):

These zones shows the upper programmatic levels of the modular pods. By elevating these workshop, museum, foodcourt and collaborative environments and disconnecting them from the continuous circulation grid, they gain an inherent gradient of privacy and acoustic comfort while remaining visually connected to the broader interior ecosystem.

First Floor Served and Serving Spaces

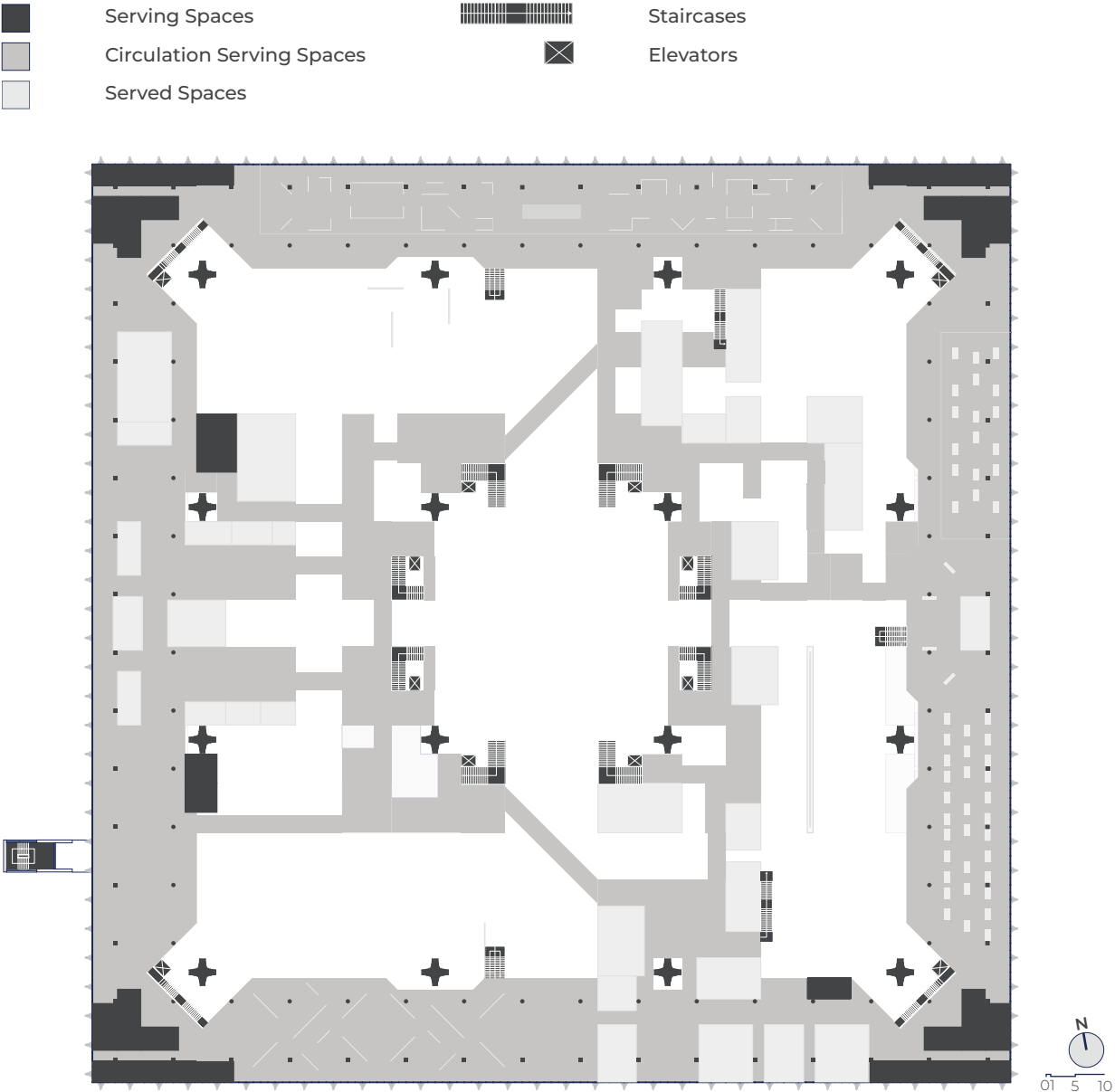


Figure 4.30: First floor served and serving spaces.

4.3 Programmatic Ecosystem

4.3.1 Design process and macro-zoning plans

Second Floor:
The design establishes a vertical gradient of privacy, where ascending levels transition from active public zones to quiet, low-density spaces. From these elevated vantage points, the vibrant, multi-colored pods form a striking visual contrast against the monochrome gray of the historic structure, creating a dynamic ambient landscape. By nesting these warm, inviting programmatic clusters within the monumental shell, the intervention breathes new life into the building, successfully softening its industrial scale.

Second Floor Accessibility
Due to lower foot traffic, only four of the eight central vertical circulation cores extend to the second floor. Elevated bridges connect the outer perimeters and these vertical cores to the floor's single centralized zone.

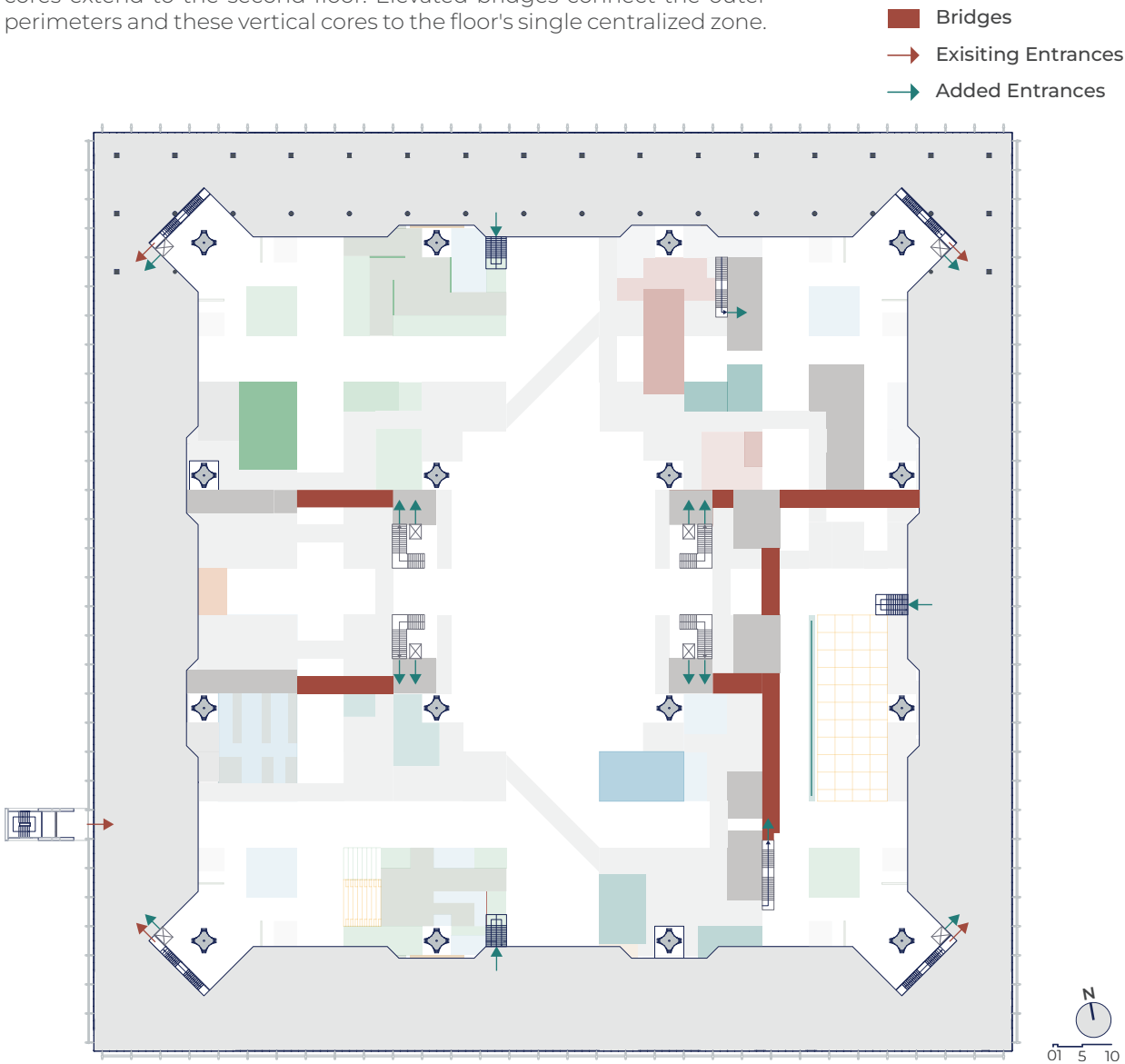


Figure 4.31: Second floor accessibility design process.

Second Floor Main Zones

Due to lower foot traffic, only four of the eight central vertical circulation cores extend to the second floor. Elevated bridges connect the outer perimeters and these vertical cores to the floor's single centralized zone.

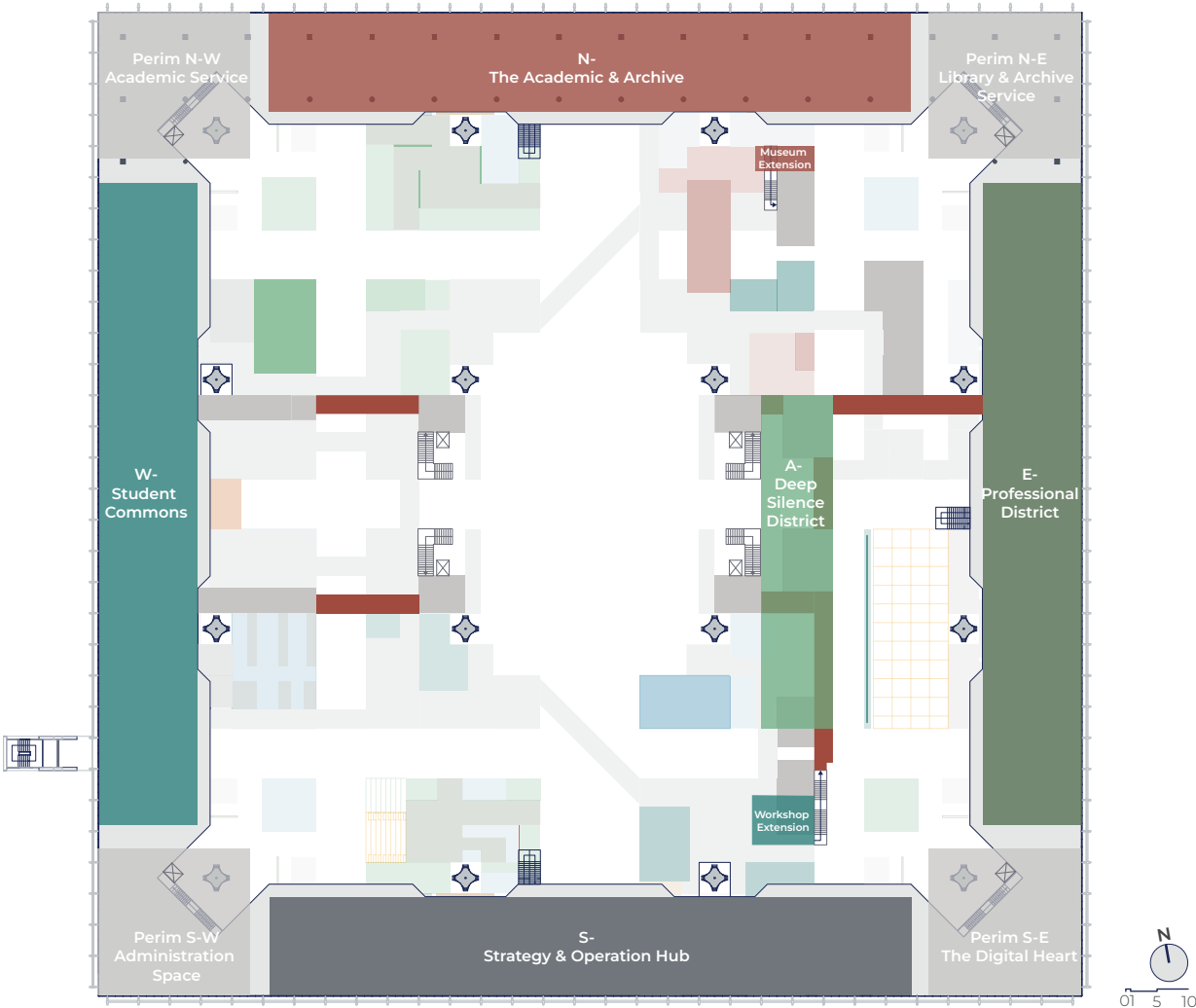


Figure 4.32: Second floor general Zonings design process.

A - Deep Silence District: An ultra-quiet sanctuary containing a mental-reset scent library, lie-flat acoustic sleeping nests, and a glass yoga studio.

E - The Professional District: An executive hub featuring private focus cells, business lounges, startup incubators, and corporate meeting spaces.

N - The Academic & Archive Gallery: An educational zone with university lecture classrooms, collaborative design critique spaces, and the main library stacks.

S - Strategy & Operations Hub: The administrative core housing the building's central command, municipal boardrooms, and an urban climate research lab.

W - The Student Commons: A high-density student workspace equipped with long CLT tables, a print/plot center, a robotics fabrication lab, and a climate simulator.

Perimeter Service Zones: Infrastructure hubs housing the main 5G/AI server vault, rare book archive services, student lockers, and staff wellness spaces.

Workshops & Museum Extensions: Satellite spaces including a fashion design studio and a speculative archive for holographic unbuilt projects.

Second Floor Zoning Plan

The second floor targets focused, low-traffic demographics, distributing its space among students, researchers, administration, and freelancers, while hosting limited public amenities.



Figure 4.33: Second floor zoning Plan.

Legends

- A-1: The Scent Library
- A-2: The Nests
- A-3: Zen Yoga Studio
- C-9: Fashion Design Studio
- D-3: The Speculative Archive
- N-1: Classroom A
- N-2: Classroom B
- N-3: Classroom C
- N-4: The Main Stacks
- N-5: Seminar Nooks
- N-6: Classroom D
- E-1: Reception
- E-2: Office
- E-3: Professional Node
- E-4: Business Lounge
- E-5: The Hatch
- E-6: Private Focus Cells
- E-7: Office
- E-8: Reception
- S-1: The Nerve Center (Admin)
- S-2: Executive Meetings
- S-3: Seminar and Conference Room
- S-4: Urban Strategy Lab
- W-1: Student Workspace
- W-2: Print & Plot Center
- W-3: Robotics & AI Lab
- W-4: Climate Sim Lab
- Perim(N-W)-1: Female Bathroom
- Perim(N-W)-2: Male Bathroom
- Perim(N-W)-3: Student Locker Cell
- Perim(N-W)-4: Janitorial/Maintenance
- Perim(N-W)-5: Teaching staff resting area
- Perim(N-W)-6: Staff Bathroom
- Perim(N-W)-7: Teaching staff Locker room
- Perim(N-W)-8: Smoking Room
- Perim(N-E)-1: Female Bathroom
- Perim(N-E)-2: Male Bathroom
- Perim(N-E)-3: Smoking Room
- Perim(N-E)-4: Quiet Reading Nook
- Perim(N-E)-5: The Rare Archive
- Perim(N-E)-6: Staff Bathroom
- Perim(N-E)-7: Library Management
- Perim(N-E)-8: Pro-Equipment Vault
- Perim(S-E)-1: Male Bathroom
- Perim(S-E)-2: Female Bathroom
- Perim(S-E)-3: The Data Vault
- Perim(S-E)-4: Staff Bathroom
- Perim(S-E)-5: IT Management
- Perim(S-E)-6: IT Infrastructure Pod
- Perim(S-E)-7: Tech Support Node
- Perim(S-E)-8: Smoking Room
- Perim(S-W)-1: Male Bathroom
- Perim(S-W)-2: Female Bathroom
- Perim(S-W)-3: Smoking Room
- Perim(S-W)-4: Staff Wellness Pod
- Perim(S-W)-5: Admin Physical Archive
- Perim(S-W)-6: Staff Bathroom
- Perim(S-W)-7: Admin Physical Archive
- Perim(S-W)-8: Logistics & Mail Node

4.3 Programmatic Ecosystem

4.3.1 Design process and macro-zoning plans

As the design reaches the upper threshold of the building, the spatial allocation shifts to prioritize panoramic views, deep quiet zones, and acoustic isolation:

Static Serving Infrastructure (Dark Charcoal):

The structural columns, central vertical circulation cores, and heavy corner egress zones maintain strict alignment from the lower floors to anchor the building's physical grid. This layer groups the highest points of the mechanical extraction paths, specialized service rooms, and utilities to ensure that the main open spaces remain uninterrupted by technical requirements.

Fluid Serving Circulation (Medium Gray):

Horizontal movement on this level is defined by expansive peripheral gallery decks, wide balconies, and connecting walkways. These elements serve as the primary circulation ring that frames the vast central void, allowing users to move seamlessly between major functions while interacting directly with the monumental volume and natural daylight of the historic envelope.

Active Served Destinations (Light Gray/White):

This layer comprises the ultimate destinations of the vertical journey, including the quietest zones of the Grand Library, specialized research spaces, and deep collaborative study areas. Positioned at the highest level, these light-filled volumes are completely insulated from the heavy public traffic of the ground floor, optimizing the spatial experience for focused work, learning, and cultural engagement.

Second Floor Served and Serving Spaces

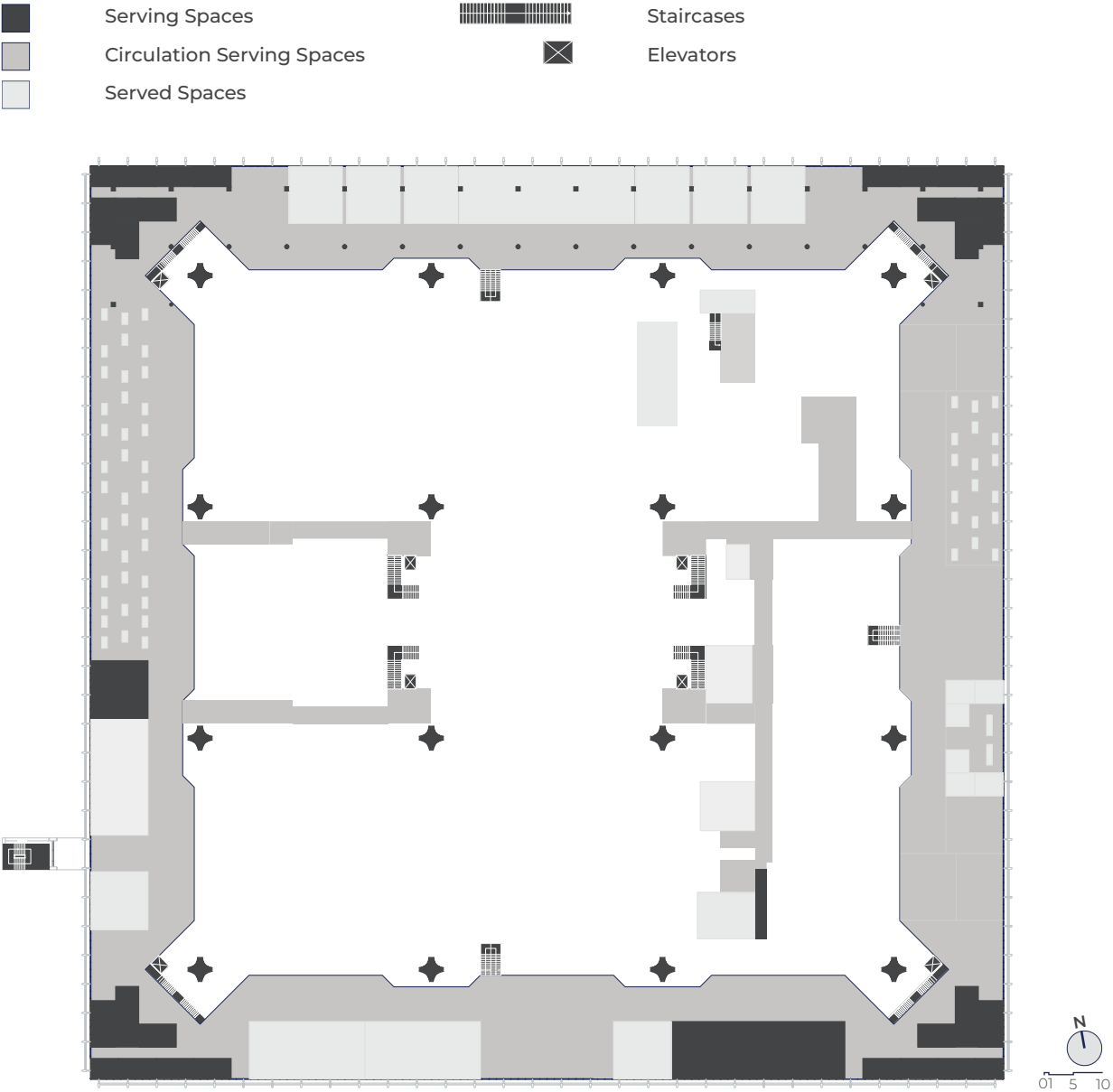


Figure 4.34: Second floor served and serving spaces.

4.3 Programmatic Ecosystem

4.3.1 Design process and macro-zoning plans

Third Floor:
The top floor features an enclosed structural glass library, creating a highly specialized sanctuary dedicated to quiet, high-concentration study. Positioning this private library on the building's final level isolates it from the active lower floors, while its north-axis orientation floods the space with diffuse natural daylight and offers expansive, panoramic views of the entire interior design below.

Third Floor Zoning Plan

The third floor is dedicated exclusively to students and researchers, housing a long library hall along the north axis. The space is accessible via two main entrances served by the side stairs and elevators.

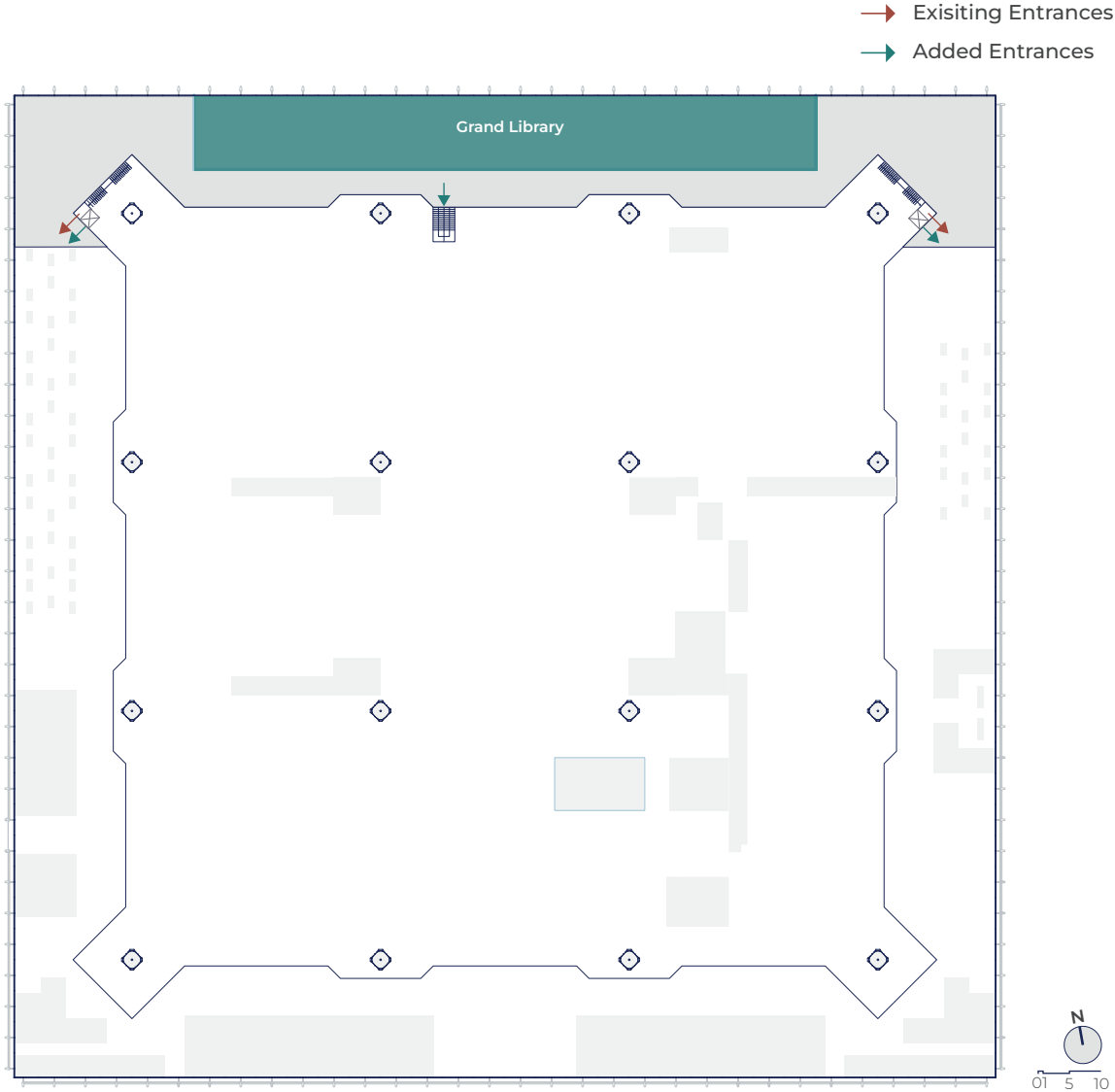


Figure 4.35: Third floor zoning plan.

4.3 Programmatic Ecosystem

4.3.2 Pocket parks as vertical Atriums

To punctuate the dense footprint of the programmatic blocks, the design integrates a network of Pocket Parks that function as full-height vertical atriums. These open courtyards rise entirely unobstructed from the ground floor to the roof canopy, slicing through the intermediate levels. Architecturally, they create soaring, sun-drenched voids that offer instant visual relief within the dense “Megacity” grid, acting as localized public commons where private pod activities naturally spill out and become interactive social experiences.

Environmentally, these atriums operate as active micro-climatic balancing shafts. By capturing ambient solar radiation within the upper volume and utilizing motorized top vents at the roof level, they induce natural stack-effect buoyancy. This convective thermal pull draws fresh air through low-level perimeter facades and flushes warm air out through the roof, cooling the surrounding modular volumes passively without disrupting the historic envelope.

Pocket Parks

A pocket park is a small-scale public space tucked into a dense urban environment, typically built on a vacant lot, irregular street corner, or leftover piece of land. It transforms underutilized spaces into localized social hubs equipped with seating, playgrounds, or public art.

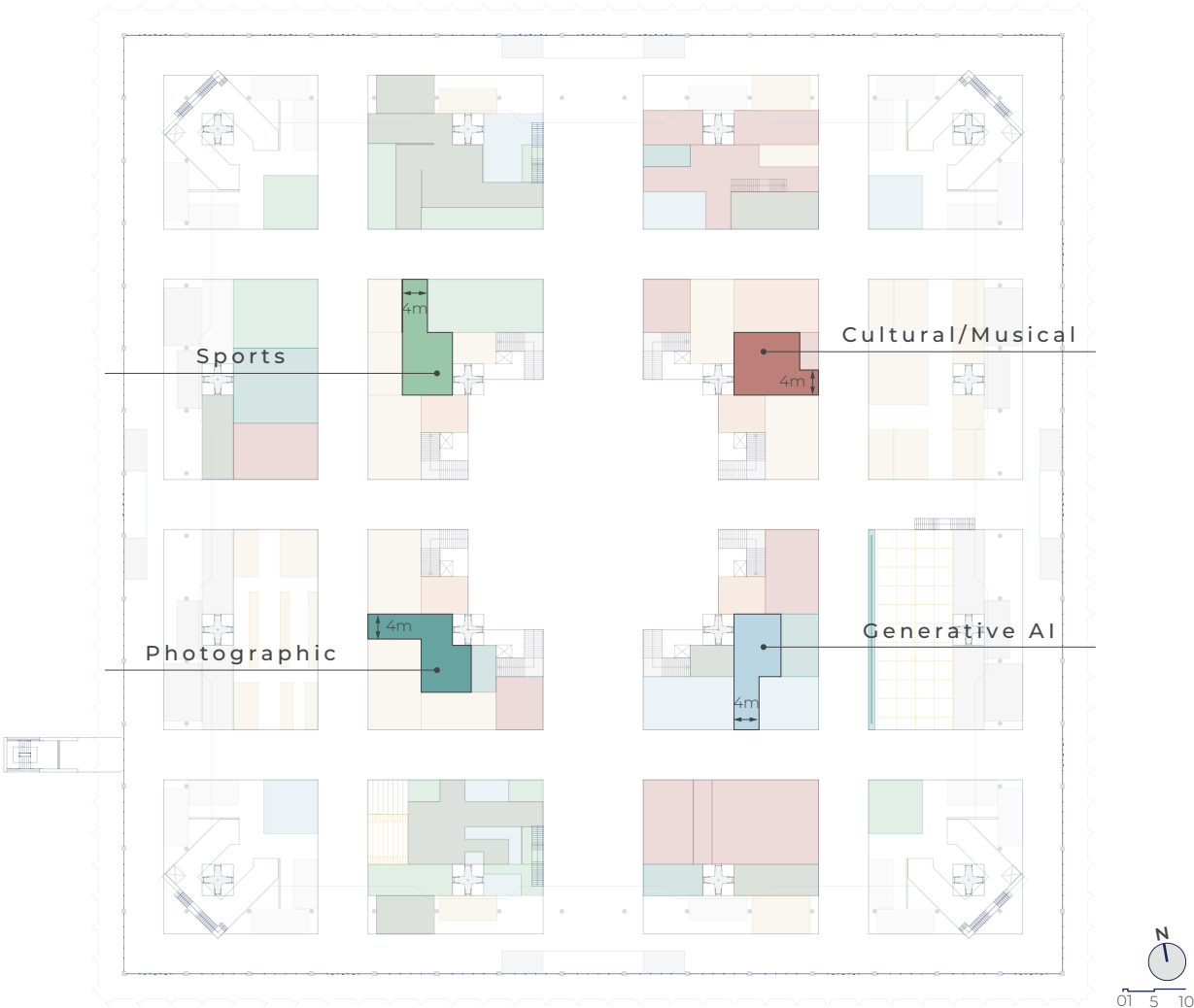


Figure 4.36: Pocket parks visualization plan.

4.3 Programmatic Ecosystem

4.3.3 Programs list categorization

All the programs and activities in this design have been categorized into clusters and zones along with the gross areas and dimensions of each pod or open area in a spreadsheet layout. By scanning the provided QR code, reviewers can access this high-fidelity data matrix. The accompanying images presenting the individual functions are included solely for illustrative purposes. This interactive ledger includes:

Programmatic Mapping:

A line-by-line breakdown linking macro-zones and functional clusters directly to specific daily activities.

Volumetric Calculations:

The exact dimensional metrics for the prefabricated insertions, specifying the precise width, length, height, and square-meter area for individual pods.

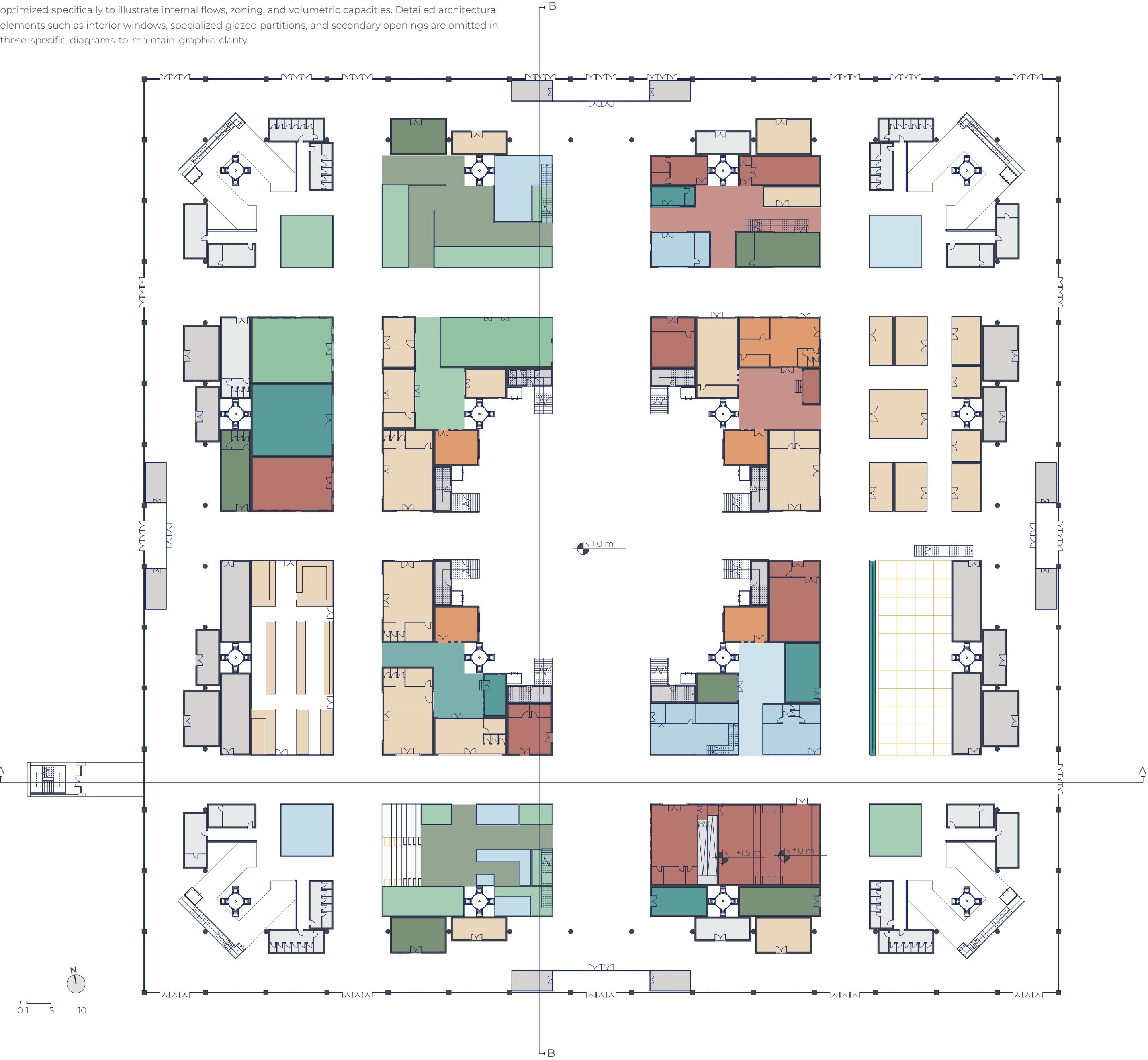


Figure 4.37: Interactive QR code linking to the complete digital spreadsheet ledger containing the detailed programmatic matrix and volumetric calculations for the design layout.

4.4 Architectural Drawings & Spatial Syntax

4.4.1 The Core Masterplans and Zoning Plan(Ground Floor)

Note on Functional Diagrams: The subsequent focus layouts are programmatic planar schemes optimized specifically to illustrate internal flows, zoning, and volumetric capacities. Detailed architectural elements such as interior windows, specialized glazed partitions, and secondary openings are omitted in these specific diagrams to maintain graphic clarity.





A2- Children center

A playful landscape designed to grow with the child. It's a safe, enclosed world where kids transition from tactile crawling to high-altitude climbing, all within a warm, wood-based environment. It was decided to be here to provide a high-energy, protected zone that uses the building's massive vertical volume to let children explore physical and digital creativity.



A2 Gross area: 567 m²
Capacity: Designed to accommodate up to 80 children simultaneously across all age groups.

A2-1
A2-2
A2-3
A2-4
A2-5
PW-1
PW-4

Culture
Creative
Sports
Community
 Visitor Svc.
 Technical
 Technical

The Sensory Garden
The Maker Lab
The Gravity Lab
The "Stroller & Gear" Hub
 The Nursing Room
 Storage
 Storage

A2-1

The Sensory Garden

For toddlers (0–3). Soft CLT "hills," tactile walls, and low-level "nooks" for crawling.



A2-2

The Maker Lab

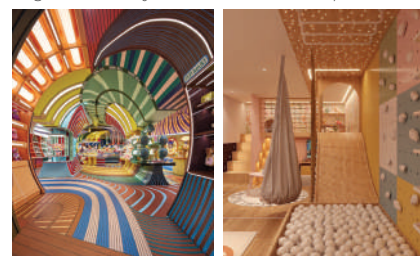
For ages 4–8. Large-scale foam building blocks, digital painting walls, and water-play tables.



A2-3

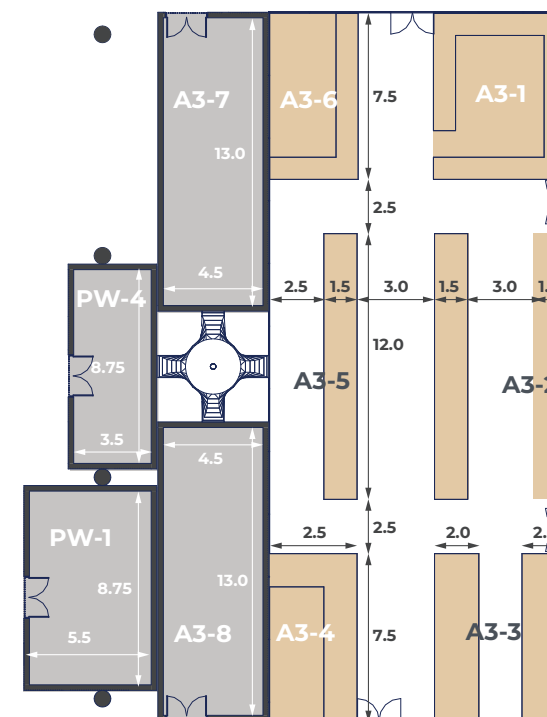
The gravity Lab

For ages 9–12. A climbing structure that uses the 5 m height with safety nets and "tree-house" pods.



A3- Indoor Urban Market

It's the place where the smell of fresh bread and spices meets the high-tech output of the vertical farms. It is the destination for everything grown and crafted within the project's walls where the "Science" of the Bio-Digital Hub (C3) becomes something that can be actually eaten and enjoyed.

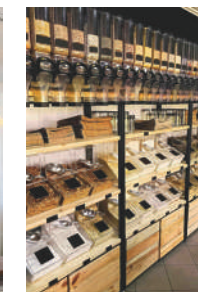
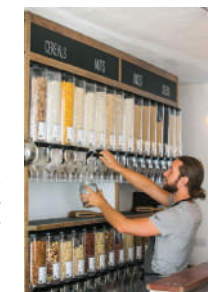


A3 Gross area: 567 m²

A3-3

The Dry Goods Silos

Vertical CLT/Glass tubes for zero-waste shopping.



A3-4

Fermentation Bar

A social counter for tasting kombucha and pickles.



A3-5

Spice & Tea Bazaar

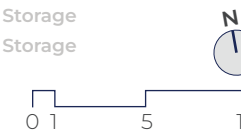
Open tiered "Island" in the center for high olfactory impact.

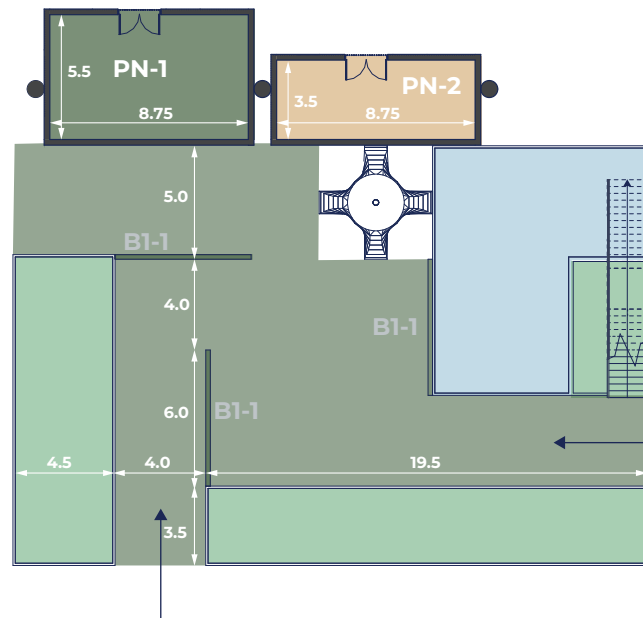


A3-1
A3-2
A3-3
A3-4
A3-5
A3-6
A3-7
A3-8
PW-1
PW-4

Commerce
Commerce
Commerce
Commerce
Commerce
Commerce
Backstage
Technical
Technical
Technical

The Bakery Hearth
The Mushroom Wall
The Dry Goods Silos
Fermentation Bar
Spice & Tea Bazaar
The Formagerie
The Logistics Hub
The Waste Center
Storage
Storage





B1- Civic Pavilion

It is a quiet, vertical forest. It uses soaring green walls and water to create a cool, fresh atmosphere that acts as a natural reset for anyone entering from the city. To provide a biological balance to the entrance. It was placed here to act as a "buffer zone" that scrubs the air and dampens the noise of the 16m boulevard, offering a restorative space for those who prefer nature and quiet over the digital hum of the opposite pavilion.



B1, PN-1, PN-2 Gross area: 610.5 m²



B1-1
PN-1
PN-2

Sustainability
Community
Commerce

Green Walls
Pet playing area
Pet shop

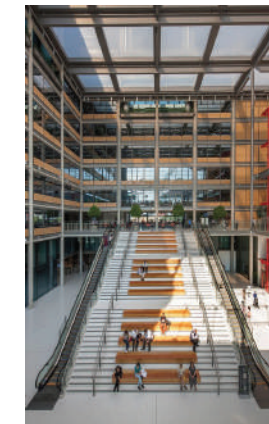
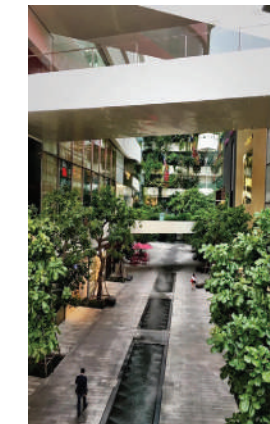


B4- Civic Pavillion

It's a grand, terraced landscape that blends nature, water, and digital media to create a welcoming transition from the street to the interior. Think of it as a vertical park that doubles as a public living room. To act as the "handshake" between the 16m-wide boulevard and the project. It was placed at the entrance to offer a cooling, refreshing space where people can pause, gather, or watch live news and events before entering the deeper zones of the building.



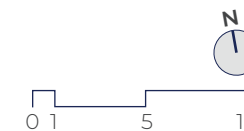
B4, PS-5, PS-6 Gross area: 610.5 m²

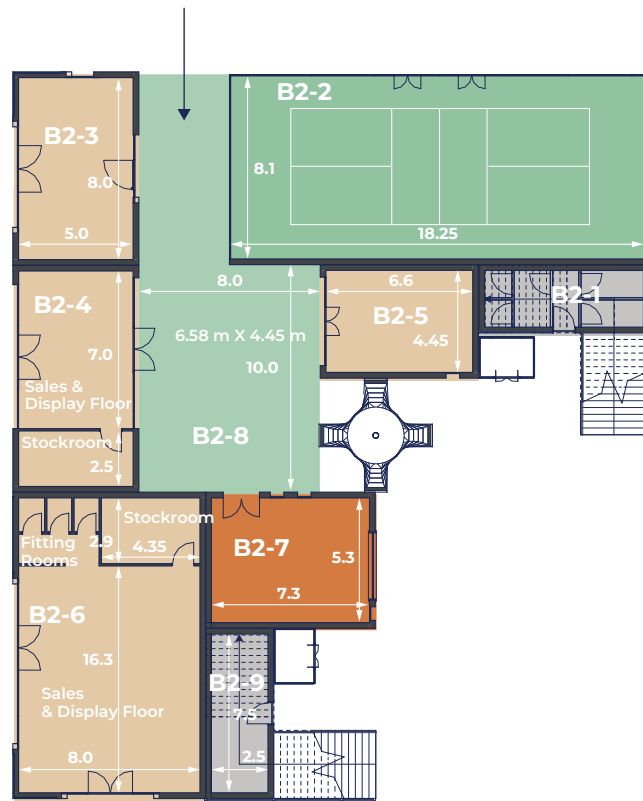


B4-1
B4-2
PS-5
PS-6

Culture
Community
Commerce
Community

Digital Screen
Stairs Seating Area
Pet Shop
Pet playing area





B2-1
B2-2
B2-3
B2-4
B2-5
B2-6
B2-7
B2-8
B2-9

Operational
 Sport
 Commerce
 Commerce
 Commerce
 Commerce
 Food
 Culture
 Operational

Storage
 Pickleball court
 Wearable Tech Lab
 Sustainable Sneaker Shop
 Supplement Apothecary
 Sport/gear hub
 Juice & Bio Elixir Bar
 Kinetic Pocket Park
 Storage

B2-2
Pickleball court

High-energy, social, often 2-on-2 (doubles). Looks like a mini-tennis court. Very colorful and "active." Extremely easy to start. All ages can play together.



B2-8
Kinetic Pocket Park

A high-tempo corridor designed for "street-style" mini-sports interactive floor-games and gaming walls. The layout preserves a 4m-wide central clearway for pedestrian flow, allowing visitors to commute through the zone while active "micro-matches" happen on the periphery.

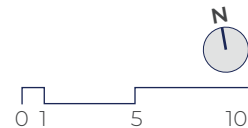


B2- Sports

A high-performance wellness district fusing physical activity with future-facing technology. It transforms the industrial core into an engine for movement and data-driven health. It anchors the "Kinetic Axis" of the project, serving as a social and physical catalyst where tech-testing (Wearable Tech) meets active play (Pickleball).



B2 Gross area: 578.75 m²
Capacity: Designed to accommodate up to 50 concurrent users across all active zones.



B3- Fashion

A circular fashion ecosystem where historic textile research meets hands-on sustainable production and retail. It is a "living lab" for the future of the local garment industry. The quality wins over the quantity of fashion commercial stores. Since this is a megacity not a commercial mall, there's only this zone dedicated to fashion retail stores.

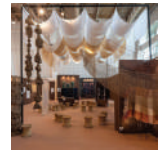
B3-1
B3-2
B3-3
B3-4
B3-5

Operational
 Culture
 Commerce
 Commerce
 Commerce

Storage
 Fashion Archive
 Clothing Store
 Clothing Store
 Clothing Store

B3-2
Fashion Archive

A controlled environment for showcasing the rare historic textiles.



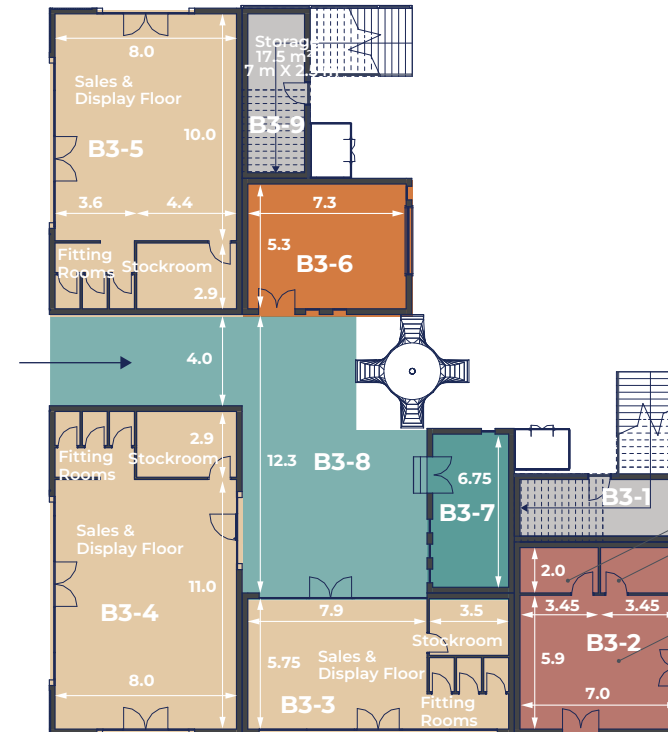
B3-9
Natural Dye studio

A public space dedicated to garment coloring. Users utilize plant based and culinary waste dyes to personalize plain apparel, exploring circular fashion through direct application.



B3-10
Photographic Pocket Park

Designed with Mycelium (Growing lamps and stools from fungal spores.) for photographic exposures. A "living" backdrop for fashion editorial shoots and portfolio building.



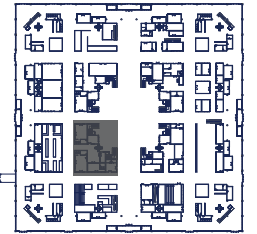
B3-6
B3-7
B3-8
B3-9

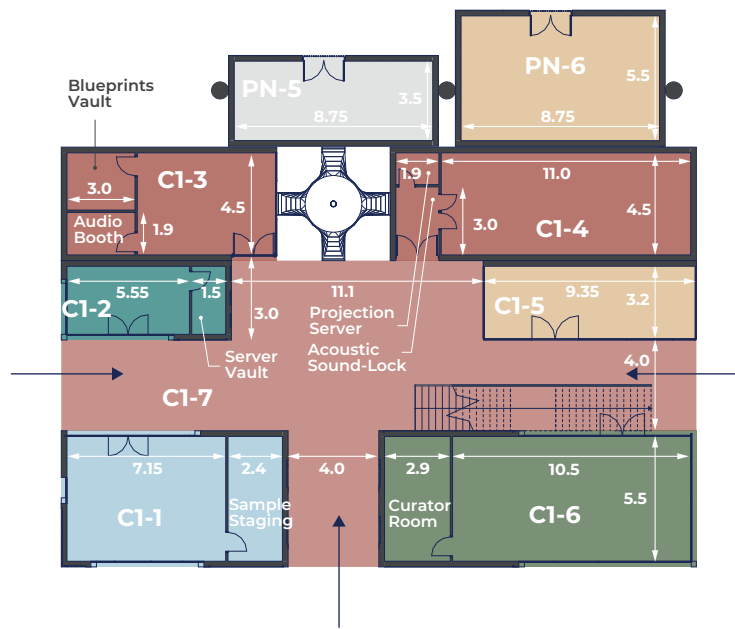
Food
 Creative
 Creative
 Operational

Snack / Grab-and-Go
 Natural Dye studio
 Photographic Pocket Park
 Storage

Conservation Lab
 Archive Vault
 Exhibition Zone

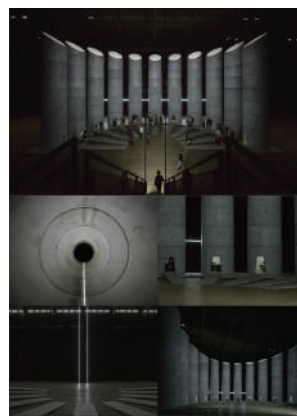
B3 Gross area: 578.75 m²





C1- Heritage Museum

Positioned in the Outer Ring, it offers a slower, contemplative pace compared to the high-energy center. It is decided to be here to provide the historical and structural context that justifies the entire "Restore and Reuse" strategy of the project. It serves as the "Architectural / structural Memory" of the building, honoring Pier Luigi Nervi's industrial legacy.



C1-4

The 1961 Theater

A dark, soundproofed room showing archival footage of the building's construction. A dedicated screening space for archival footage and documentaries about the "Italia '61" International Labor Exhibition



C1-2

Augmented Heritage Lab

Interactive tablets/VR that "overlay" the original blueprints onto the current view. An immersive lab using AR to overlay the original 1961 construction process onto the modern-day structure

C1-1
C1-2
C1-3
C1-4
C1-5
C1-6
C1-7
PN-5
PN-6

Sustainability
Creative
Culture
Culture
Commerce
Community
Culture
Visitor Svc.
Commerce

Material Library
Augmented Heritage Lab
The Column Archive
The 1961 Theater
Structural Model Shop
The Blueprint Gallery
Museum Courtyard
Smart Lockers
Farmacy

C1 Gross area: 493 m²
Capacity: Optimized for a maximum of 45 concurrent visitors to maintain a quiet, contemplative exhibition environment.



C4-1

The Cine-Lounge

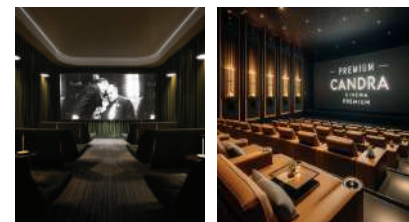
A high-end bar for film discussion and drinks before/after the show. A "compression" space. Ticket desk and coffee/bar.



C4-3

The Grand Void

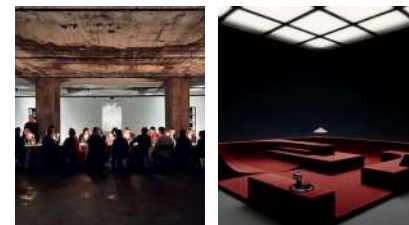
A 60-seat "Black Box" theater with 4K laser projection and Dolby Atmos.



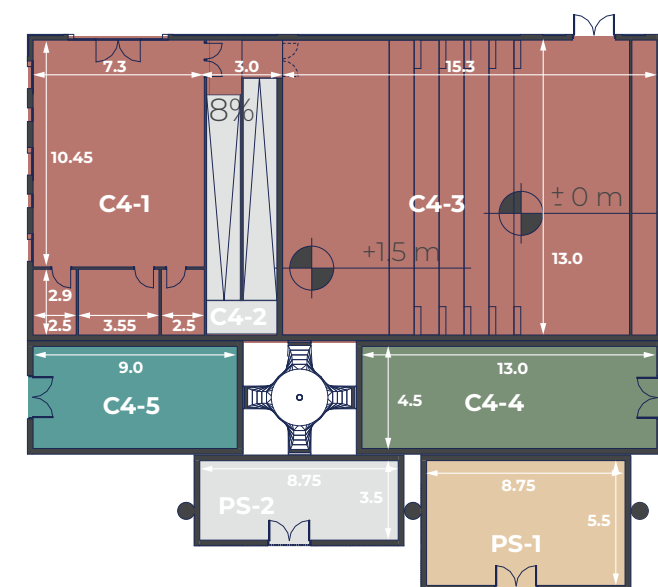
C4-4

Light Sculpture museum

A sunken seating area designed for small "Post-Film" debates, book signings, or Q&A sessions with visiting filmmakers.



C4 Gross area: 493 m²
Capacity: 60 fixed theater seats (plus secondary lounge and foyer seating layouts)



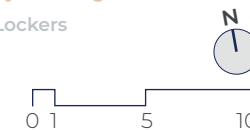
C4- Art-house Cinema

A place to disappear into stories. It's the "quiet corner" of the project where the lights go down and the rest of the building fades away. It's designed for people who don't just want to watch a movie, but want to feel it and talk about it afterward. This location was chosen to ensure total light and sound control, providing a high-fidelity environment that balances the high-energy "Bio-Digital" hub next door (C3).

C4-1
C4-2
C4-3
C4-4
C4-5
PS-1
PS-2

Culture
Culture
Culture
Community
Creative
Commerce
Visitor Svc.

The Cine-Lounge
The Light-Lock & Services
The Grand Void
The Director's Corner
The "Holographic" Foyer
Currency Exchange
Smart Lockers



C2-1	Operational	Storage
C2-2	Culture	Immersive Sound Room
C2-3	Commerce	Bookstore
C2-4	Food	Cafe
C2-5	Culture	Musical/Acting Stage
C2-6	Commerce	Musical Supply
C2-7	Food	Gelateria
C2-8	Culture	Cultural/Musical Pocket Park
C2-9	Operational	Storage

C2-2

Immersive Sound Room

A dark, acoustically treated room for surround-sound audio experiences and daily podcasts with high-quality sounds and soundtrack/Vinyl with screen Visualization.



C2-5

Musical/Acting Stage

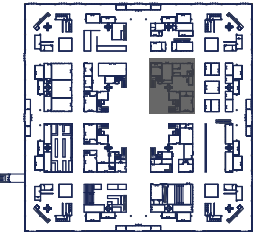
A small musical/Acting stage presenting the art of the experts and a test for people learning in the workshops performing for people inside the pocket park.



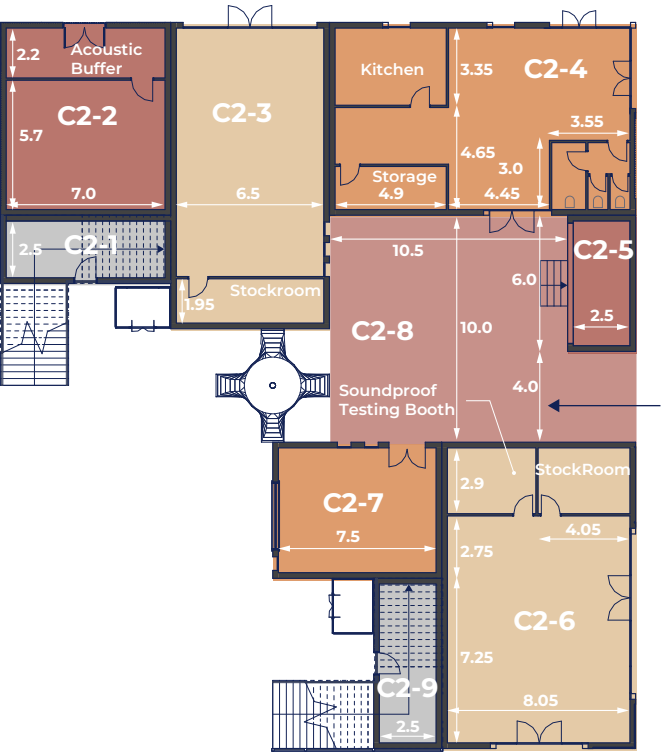
C2-8

Cultural/Musical Pocket Park

A multi-sensory cultural anchor bridging digital innovation with physical performance. It has seating areas with musical/acting stage.

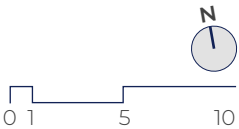



C2 Gross area: 578.75 m²
Capacity: Designed to accommodate up to 60 concurrent users across the performance, acoustic, and social spaces.



C2- Cultural/Musical

A sensory-driven anchor merging digital soundscapes with live performance. It transforms the industrial shell into a "living stage" for Turin's music and literary culture. It creates a "Cultural Loop" where users can learn (Bookstore), create (Musical Supply), and experience (Stage/Sound Room) in one specialized district. A green buffer designed for impromptu performances and acoustic testing.



C3-2

Urban Vertical Greenhouse

A 16m glass tower glowing with bluple (neon-purple growing LED) light in the middle of a concrete and CLT structure. Because it's glass-enclosed, a "Micro-Climate" can be created inside the farm (higher CO₂, specific humidity) that is different from the rest of the hall. Cylinder Vertical Farm inside a Glassed Digital Screen Mesh. By day, it's a farm; by night, it's a massive digital art pillar.



C3-3

Algae Oxygen Bar

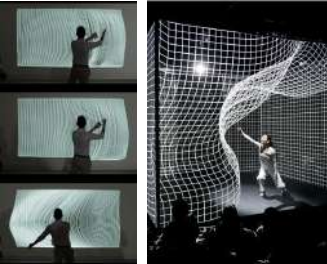
Enclosed Glass pub with "Transparent tubes of bubbling green algae that scrub CO₂ from the air."



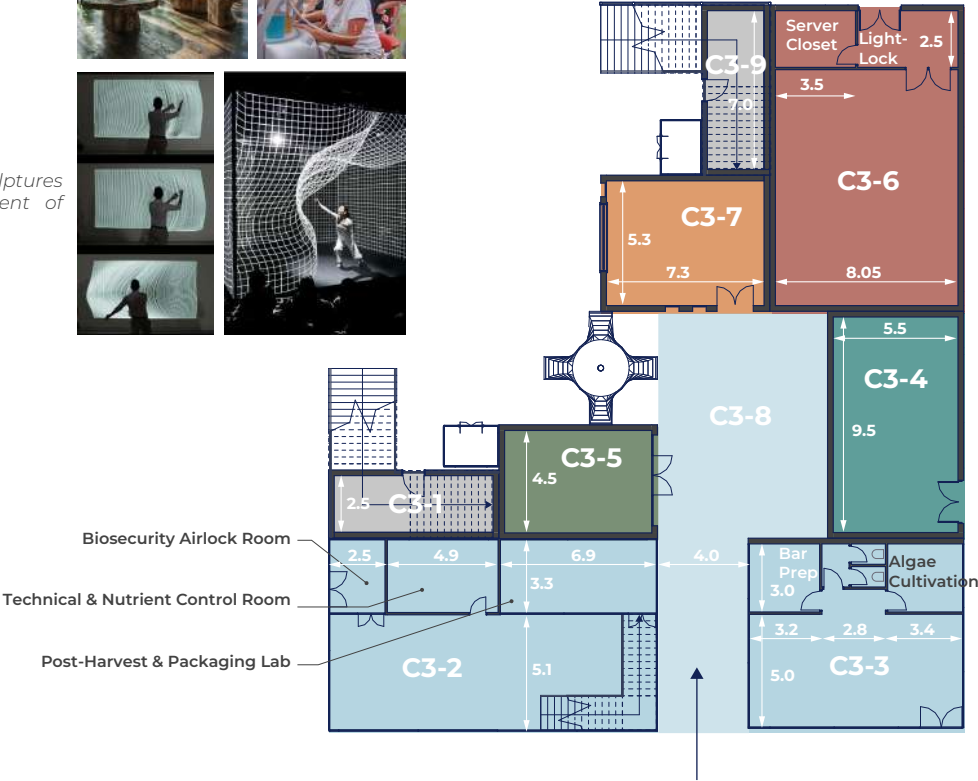
C3-6

Light Sculpture museum

Moving LED rods and Sculptures that react to the movement of citizens.



C3 Gross area: 578.75 m²



C3- Bio-Digital Hub

A futuristic synthesis of urban agriculture and digital intelligence. It functions as the building's "Scientific Heart," where nature is managed by technology to create a self-sustaining micro-ecosystem. It serves as a high-tech spectacle that draws people from the Monumental Hall into a vision of future city life. Building's technological research with tangible, biological benefits like oxygen production and food security.

C3-1	Operational	Storage
C3-2	Sustainability	Urban Vertical Greenhouse
C3-3	Sustainability	Algae Oxygen Bar
C3-4	Creative	VR / AR Testing Pod
C3-5	Commerce	Seed & Genetics Library
C3-6	Culture	Light Sculpture museum
C3-7	Food	Hydronic Tasting Bar
C3-8	Sustainability	Generative AI pocket Park
C3-9	Operational	Storage

D2-1
The Canvas Gallery
Paintings, fine-art prints, and sketches.



D2-4
The Gem Vault
Fine jewelry and artisanal metalwork.



D2-7
The Neon Vault
Light-based sculptures and digital/NFT art.



D2-2
The Maker's Atelier
Large-scale handmade art, furniture, materials.



D2-5
The Kiln Gallery
Sculptural and functional ceramics/clay art.



D2-8
The Aperture Shop
Fine-art photography and artist books.



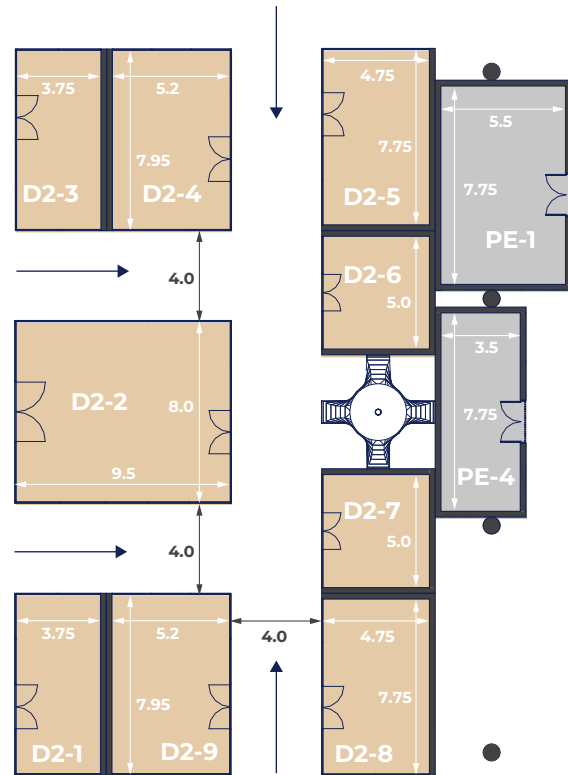
D2-3
The Botanical Box
Floral installations and preserved botanical art.



D2-6
The Sculptor's Cube
3D-printed and structural mini-sculptures.



D2-9
The Loom Boutique
Textiles, wall-hangings, and fiber art.

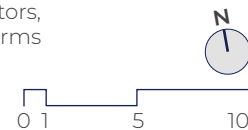


D2-1	Commerce	The Canvas Gallery
D2-2	Commerce	The Maker's Atelier
D2-3	Commerce	The Botanical Box
D2-4	Commerce	The Gem Vault
D2-5	Commerce	The Kiln Gallery
D2-6	Commerce	The Sculptor's Cube
D2-7	Commerce	The Neon Vault
D2-8	Commerce	The Aperture Shop
D2-9	Commerce	The Loom Boutique
PE-1	Technical	Storage
PE-2	Technical	Storage

D2 Gross area: 567 m²

D2- Pop-up Art Boutique

A curated retail landscape for the physical output of the building's upper-floor studios. It acts as the commercial "gallery" where student prototypes and expert craftsmanship from the first-floor workshops are exhibited and sold. This zone was decided upon to empower creators, providing them with a direct-to-consumer platform that transforms academic and artisanal labor into a sustainable creative economy.



D3-1 The Media Wall

A massive LED mesh screen showing live data from the Bio-Digital Hub and exhibition advertisement.



D3-2 Exhibition and Trade Fairs

3x 3 m grid of floor boxes. Each box contains power, high-speed data, and compressed air. This allows any exhibitor to set up a booth anywhere in the zone without cables crossing the floor.



D3-1	Creative	The Media Wall
D3-2	Event & Large Scale	Exhibition and Trade Fairs
D3-3	Backstage	The Production Office
D3-4	Backstage	The Exhibition Warehouse
PE-1	Technical	Storage
PE-2	Technical	Storage

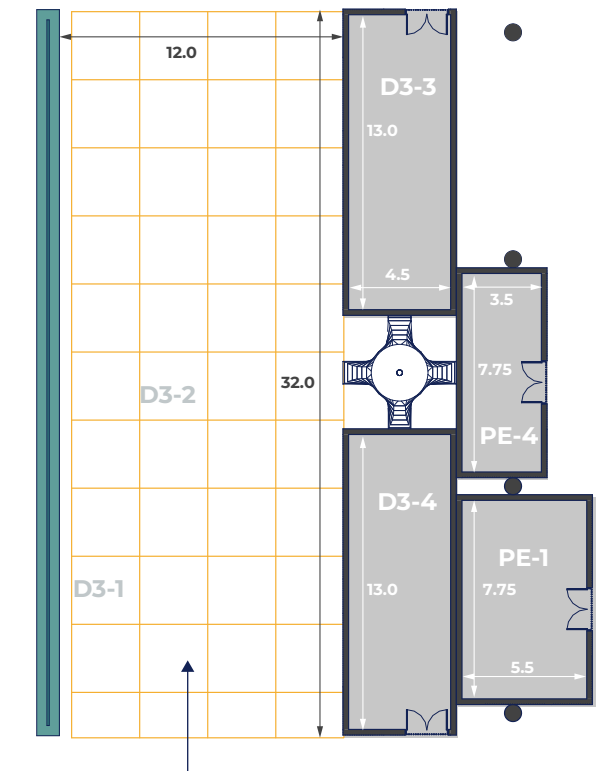


D3- Exhibition and Trade Fairs

It's a massive, high-tech empty canvas that can transform into anything from a global tech expo to a local furniture fair. It is designed to be the most flexible room in the project. To bring the outside world in. It's where the research happening in the labs meets the industry, and where big crowds gather. It was placed here because it needs heavy-duty infrastructure and easy access for people and equipment to move in and out without disturbing the rest of the building.

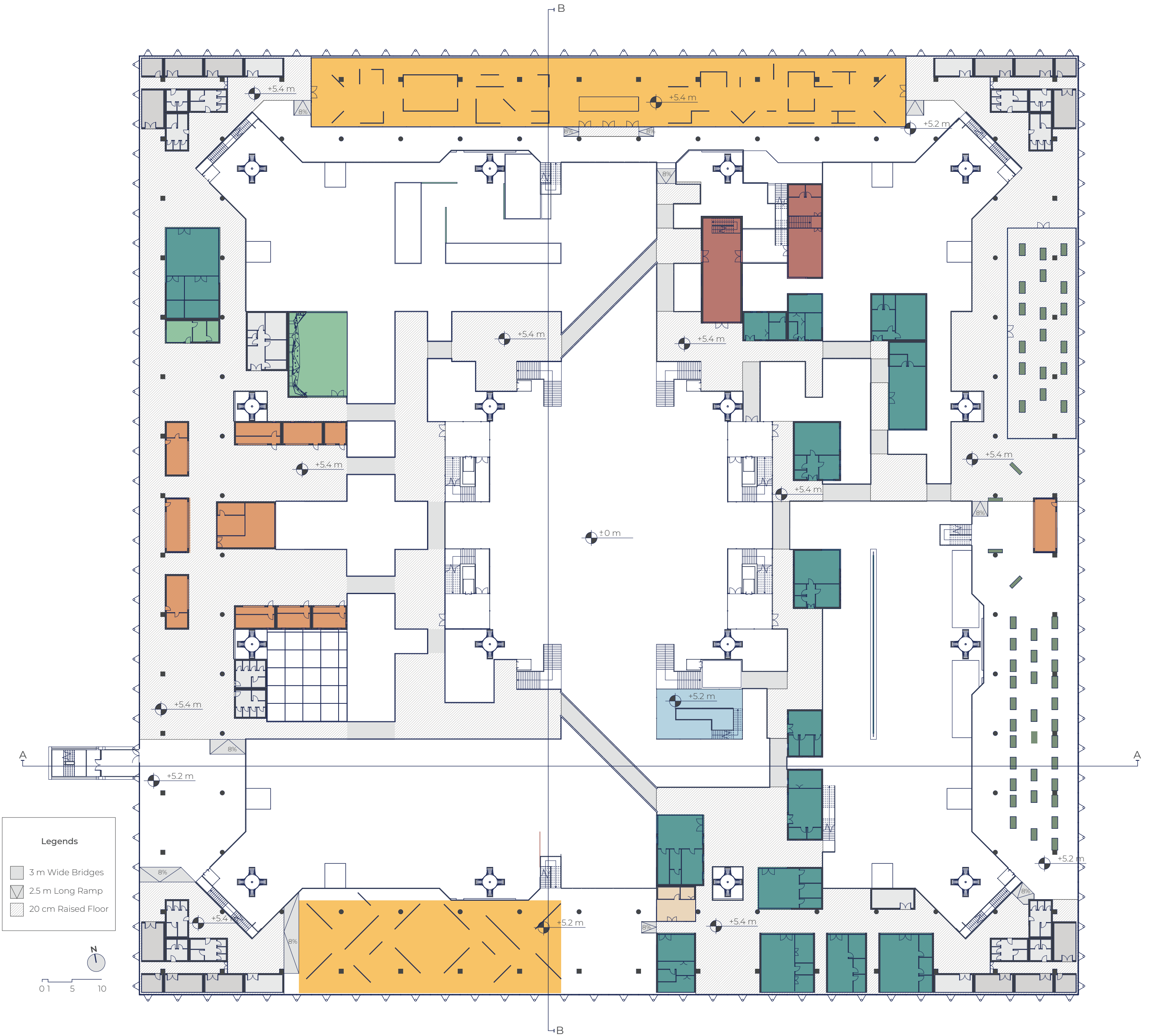
D3 Gross area: 567 m²

Capacity: Flexible layout configurations accommodating up to 150 concurrent visitors during active expos, trade fairs, and large-scale public events.



4.4 Architectural Drawings & Spatial Syntax

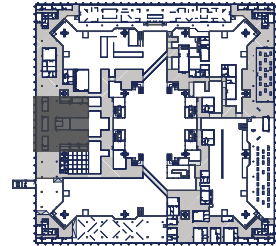
4.4.1 The Core Masterplans and Zoning Plan(First Floor)



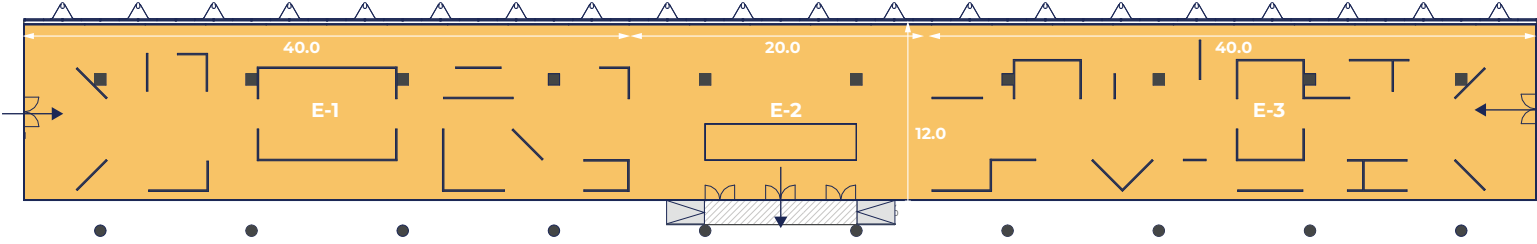
A- Foodcourt

A high-energy culinary crossroads where the world meets Turin. It is a social ecosystem that blends the city's historical flavors with a global street-food market. To act as the building's primary social anchor. Located in the West Perimeter, it utilizes the natural light and openness of the hall to create a massive "indoor piazza" where students, workers, and tourists can gather over a shared meal.

A Gross area: 735.5 m²
Capacity: 200 seats



- A-1 The Gelato Pavilion
- A-2 The Green Verticalist
- A-3 Sushi Arena
- A-4 The Agnolotti Atelier
- A-5 The Bicerin Bar
- A-6 The Pizza Lab
- A-7 The Levant Grill
- A-8 The Taco/Arepa Forge
- A-9 The Ramen Station
- A-10 The Piazza Brasserie



E Gross area: 1200 m²
Capacity: 90 Visitors

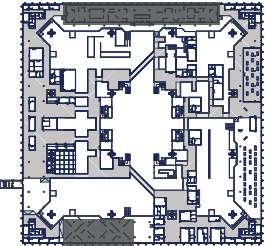
E- Main Exhibition Gallery

It is where the output from the upper-floor studios and the historical archives finally meets the public. It is a space designed to change your pace moving you from a quiet, rhythmic walk to a social gathering, and finally into a dynamic, shifting environment.



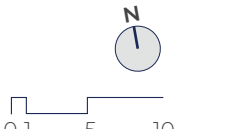
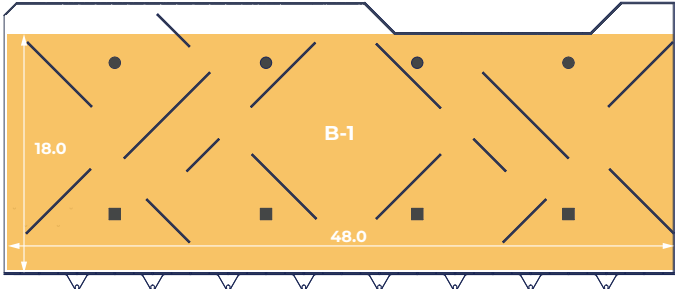
- E-1 The Chronological Gallery
- E-2 The Urban Forum
- E-3 The Kinetic Wing
- B-1 Rotating Gallery

B Gross area: 848 m²
Capacity: 60 Visitors



B- Rotating Project Gallery

The gallery functions as a High-Frequency Exhibition Loop where projects move from "Under Construction" in the workshops to "On Display" on the walls every 2-4 weeks. The "Making-of" Layer: Integrated digital strips behind the CLT walls play time-lapse videos of the work being created in the adjacent pods.



C- Workshops

This is a high-intensity multidisciplinary hub where the "act of making" happens. It is a collection of professional-grade laboratories and studios designed to bridge the gap between academic theory and physical craft. Students and experts share tools to create everything from physical furniture to digital performances.

- C-1 Media Pod

Podcast & Video. Soundproof glass; integrated green-screen wall.
- C-2 Makeup & SFX

Application & Sculpting workshop; high quality makeup studio.



- C-3 Sound Box

Musical Practice. Acoustic "Room-within-a-Room" insulation.
- C-4 Dance Studio

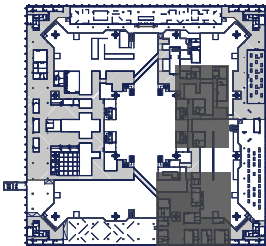
High-energy movement for different group dance styles.



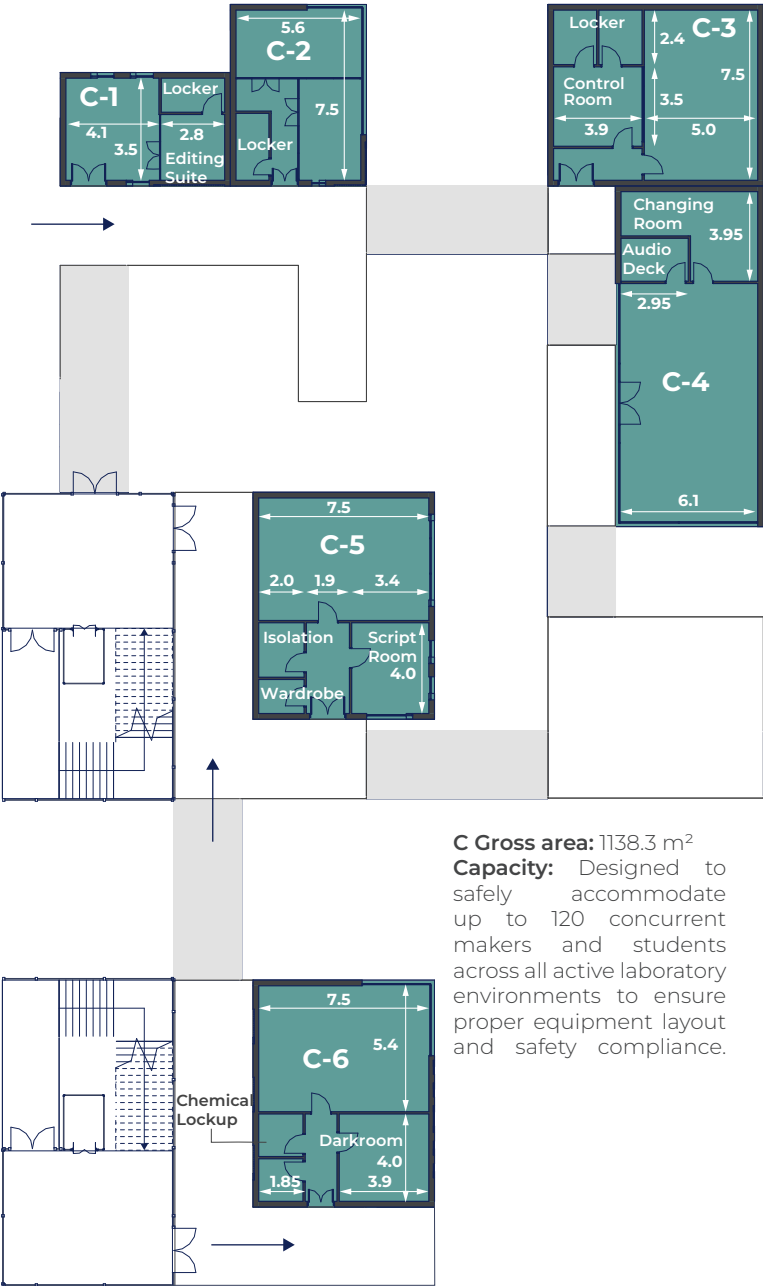
- C-5 Acting Studio

Rehearsal & Voice. English and Italian act training scenes.
- C-6 The Darkroom

Photography. Split into a light-studio and dark-zone.



- C-1 Media Pod
- C-2 Makeup & SFX
- C-3 Sound Box
- C-4 Dance Studio
- C-5 Acting Studio
- C-6 The Darkroom



C Gross area: 1138.3 m²
Capacity: Designed to safely accommodate up to 120 concurrent makers and students across all active laboratory environments to ensure proper equipment layout and safety compliance.

To turn the building into a living factory of ideas. It was placed on the first floor to act as a "creative filter" everything designed here eventually flows down to the ground floor to be sold in the boutiques (D2), or performed in the Grand Plaza.

- C-7 Precision Cell
- C-8 Fashion Atelier
- C-10 Timber Lab
- C-11 Ceramic Studio
- C-12 The Cleanup Hub
- C-13 Culinary School
- C-14 Pastry & Baking
- C-15 Fine Arts Loft
- C-16 Botanical Lab
- C-17 Material library



C-7 Precision Cell
Jewelry. High-intensity task lighting and fume extraction.



C-8 Fashion Atelier
Sewing & Textile. Long cutting tables; "Runway" glass frontage.



C-10 Timber Lab
Carpentry. Industrial dust collection; heavy-duty tool storage.



C-11 Ceramic Studio
Clay & Pottery. Integrated waterproof floor and kiln ventilation.



To bridge the gap between "Learning" and "Doing." It sits on the first floor to act as a high-tech filter: raw materials come in, are transformed in the studios, then descend to the ground floor as finished products or live events.

- C-7 Precision Cell
- C-8 Fashion Atelier
- C-10 Timber Lab
- C-11 Ceramic Studio
- C-12 The Cleanup Hub
- C-13 Culinary School
- C-14 Pastry & Baking
- C-15 Fine Arts Loft
- C-16 Botanical Lab
- C-17 Material library



C-13 Culinary School

Teaching Kitchen. Central demonstration island + 6 stations.



C-14 Pastry & Baking

Temp-controlled dough work, chocolate tempering, Oven craft.



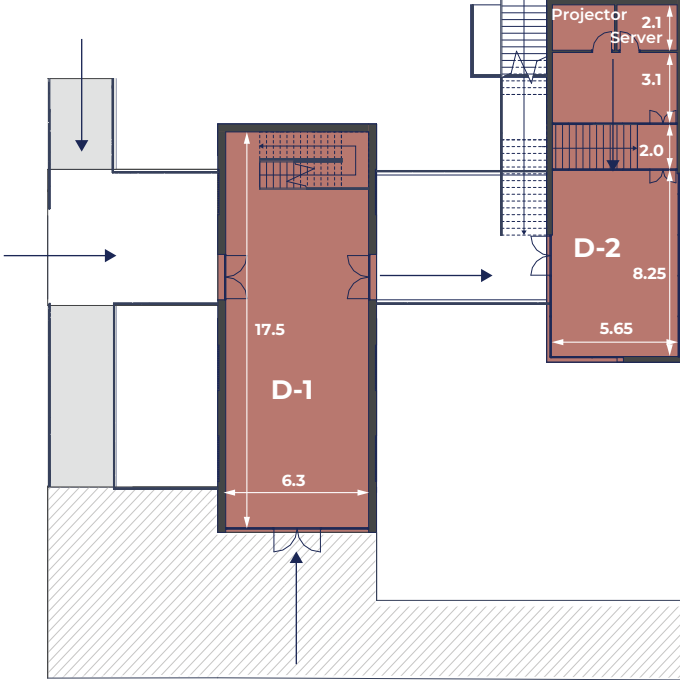
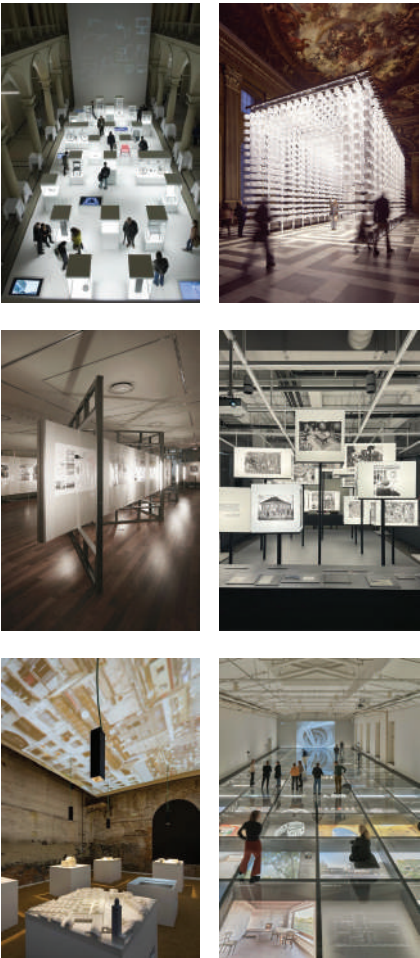
C-15 Fine Arts Loft

Painting & Sculpture. Requires South-facing perimeter light.



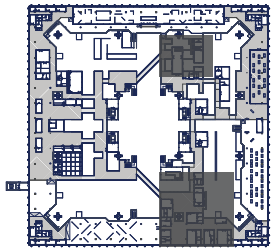
C-16 Botanical Lab

Floral Design. High humidity controls and floor drainage.



D- Architectural Museum

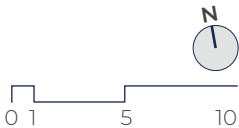
While the ground floor focuses on the physical facts of construction, this level is about the aesthetics and the soul of the city. It's an immersive space where you can walk through the building's "bones" and see how it lives as a citizen of Turin. It creates a vertical journey of understanding. By placing it directly above the structural museum, visitors move from the blueprints (C1) to the three-dimensional experience (1st Floor). It uses the extra height to let people feel the true scale of Nervi's genius, moving from technical details to a bird's-eye view of the city.



D Gross area: 262 m²
(including the upper-floor archival space and integrated vertical circulation)
Capacity: 30 concurrent visitors

D-1
D-2

The Structural Cathedral
The Urban Nexus



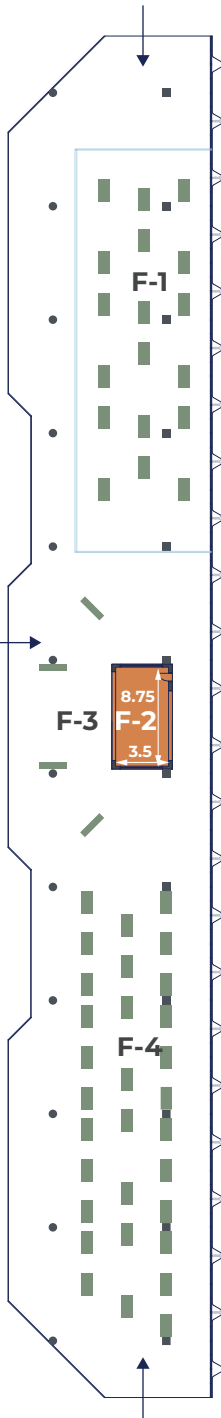
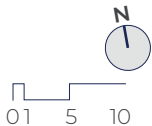
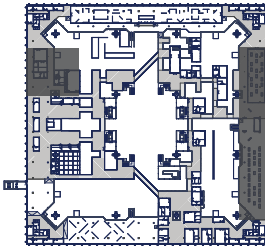
F- Coworking Hub

A "multi-speed" workspace that adapts to how you work. It's a hybrid environment where you can choose between the high-energy buzz of a shared table or the focused silence of a glass sanctuary, all centered around a social coffee heart. To give the building's students and creators a productive home. It's located in the Central East Perimeter to act as a bridge—balancing the social energy of the ground-floor bazaar with the academic focus of the upper-floor labs.



- F-1 The Glass Studio
- F-2 The Piazza cafe
- F-3 Central East Plaza
- F-4 The Open Commons

F Gross area: 1486.25 m² (including open desks, private glass studios, and the plaza cafe)
Capacity: Designed to accommodate up to 200 concurrent users across the diverse shared and focused workspace configurations.



G- Kinetic Core

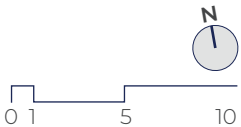
It is a high-tech playground where physical movement meets biological data. This zone is dedicated to the science of the body, shifting from raw exercise to data-driven performance and recovery. It was designed to turn "wellness" into an interactive experience, using the building's verticality for climbing while providing the technical tools needed to track and repair the human frame.



G Gross area: 390.37
Capacity: Optimized for a maximum of 35 concurrent users to ensure proper athletic space clearances and data tracking protocols.



- G-1 Bio-Performance Lab
- G-2 Movement Studio
- G-3 Recovery & Cryo Pod
- G-4 Neuro-Reflex Cell
- G-5 Video Game Center



4.4 Architectural Drawings & Spatial Syntax

4.4.1 The Core Masterplans and Zoning Plan(Second Floor)



A- Deep Silence district

A sensory retreat designed for mental and physical restoration. a place where the focus shifts from external production to internal balance through scent, light, and movement.

A-1
The Scent Library

A tiny, focused pod where users can choose essential oil diffusions to reset their mental state (Focus, Relax, or Energize).



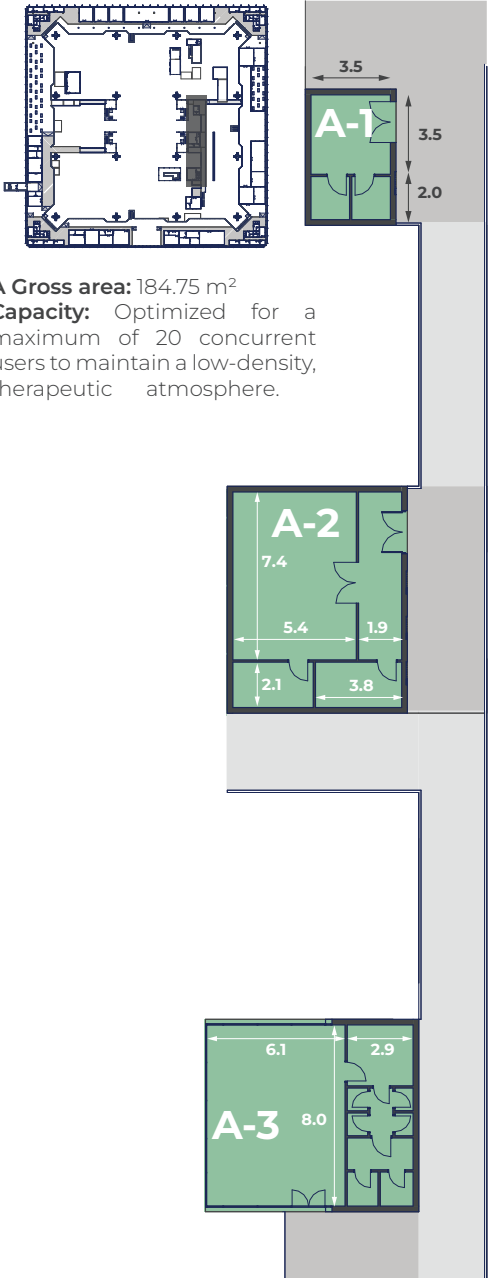
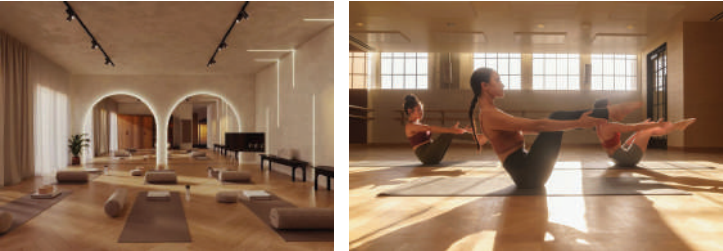
A-2
The Nests

Individual acoustic capsules with 180° lie-flat beds, dimmable "sunset" lighting, and fresh air filtration.



A-3
Zen Yoga Studio

A glass-walled pod with heated CLT floors. This should sit right at the base of the cantilever to look out over the urban greenhouse..



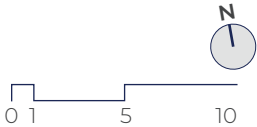
A Gross area: 184.75 m²
Capacity: Optimized for a maximum of 20 concurrent users to maintain a low-density, therapeutic atmosphere.

Main Central Plaza

- Fashion Catwalks
- Culinary Contests
- Tech Festivals
- Sports events
- Concerts

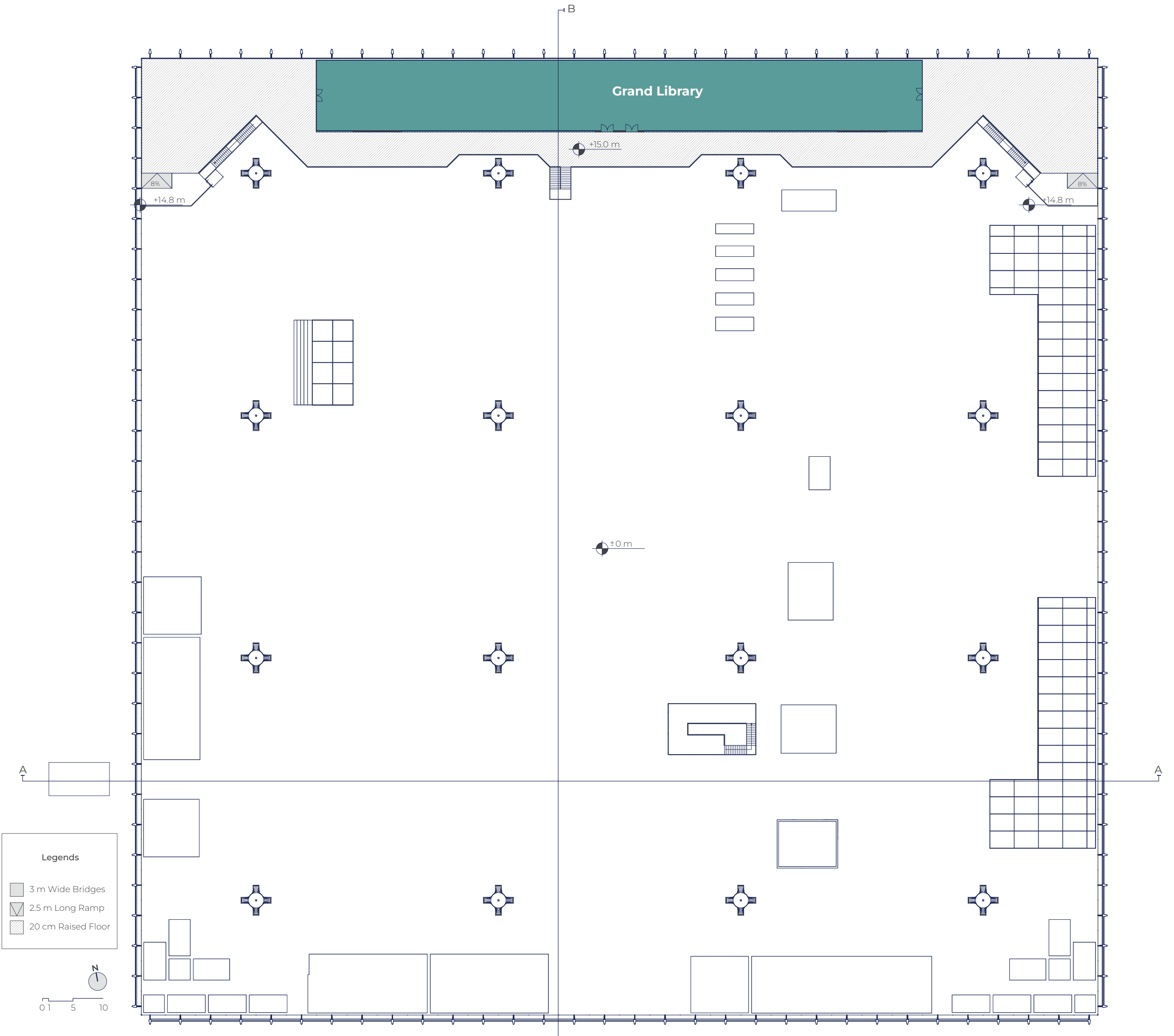


Grand Plaza Gross area: 1600 m²
Capacity: Variable design configurations accommodating up to 800 concurrent visitors during main events, temporary exhibitions, and performances.



4.4 Architectural Drawings & Spatial Syntax

4.4.1 The Core Masterplans and Zoning Plan(Third Floor)



4.4 Architectural Drawings & Spatial Syntax

4.4.2 Life safety and Fire escape strategy

The intervention introduces an open, monumental escape staircase conceived as a stacked sculptural element that rejects vertical columns or enclosing walls to preserve the spatial fluidity of the main hall. Because it serves as a primary emergency egress route, traditional timber is replaced by a non-combustible steel and concrete hybrid system that secures the mandatory fire resistance rating. To optimize efficiency and eliminate visual clutter, the staircase width is set to a constant 1.80 meters (exactly three evacuation modules), which handling high-occupancy loads safely while eliminating the code-mandated requirement for an intermediate central handrail. Active smoke evacuation is integrated into the layout, maintaining a travel distance under 45 meters from the foot of the stair to the exterior exits. Bridging the 10.20-meter vertical rise column-free requires splitting the circulation into two independent floor-to-floor systems anchored to the first-floor concrete slab. The lower 5.20-meter segment is a straight run supported by a deep, central welded steel box girder that spans as a continuous rigid bridge from the ground to the first floor. Its flat intermediate landing is welded directly into this spine, remaining completely rigid in mid-air without ground supports. The upper 5.00-meter segment transitions into a 180-degree switchback run utilizing twin parallel rectangular hollow steel sections. This switchback geometry creates a self-stabilizing scissors effect where

opposing forces partially cancel each out, while the upper landing is engineered as a hollow steel torque box to resist rotational twisting from asymmetrical crowd loads. The interface at the first-floor slab represents the critical structural node, resolving the forces of both systems without vertical ground columns. A steel header beam is cast directly into the concrete slab perimeter during construction, providing a rigid armor that distributes the heavy point loads uniformly. The primary box girder and hollow steel profiles are fastened to this embedded header with high-strength tension bolts and gusset plates to establish a fully rigid moment connection. This fixes the joint, leveraging the rotational stiffness of the floor slab to neutralize vibrations and dynamic swaying under crowd egress. High-tensile steel rebar extensions extend deeply into the floor plate, allowing it to act as a rigid diaphragm that safely dissipates horizontal thrust forces away from the main hall.

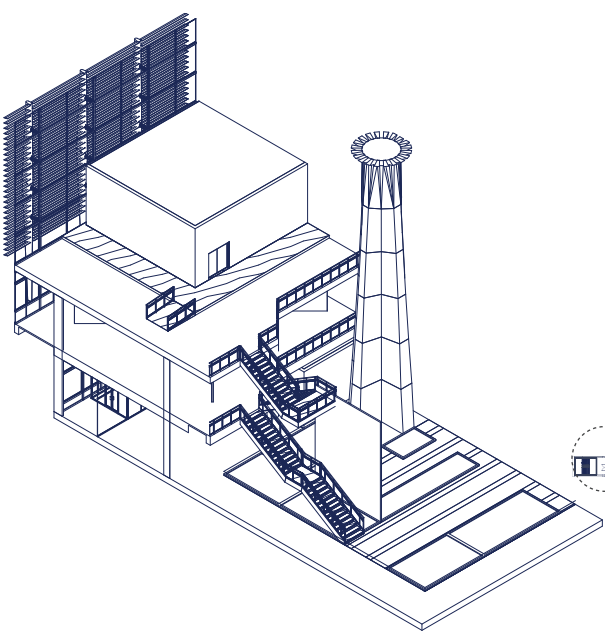


Figure 4.38: Detailed structural and dimensional diagrams of the column-free escape assembly.

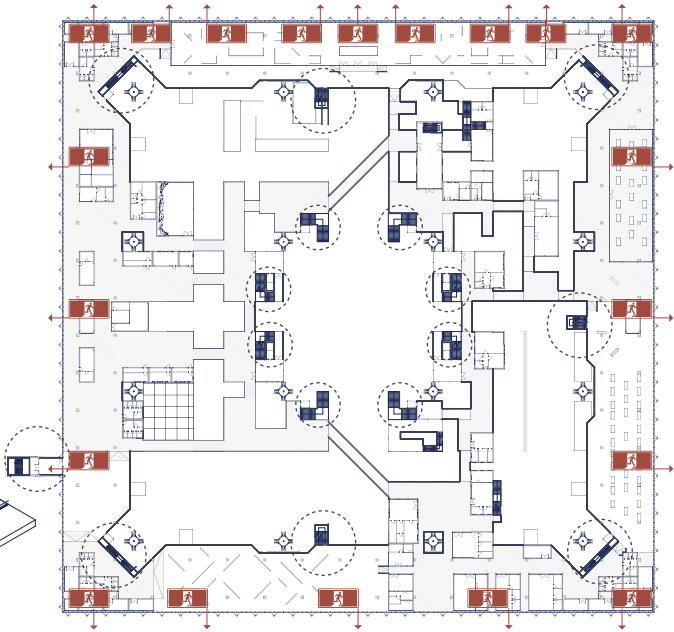
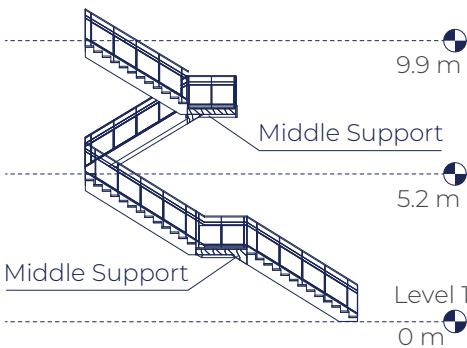
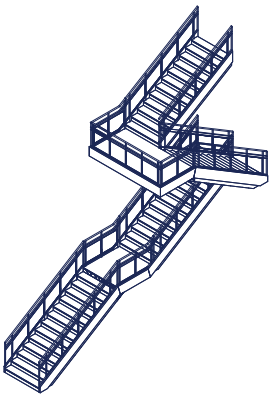
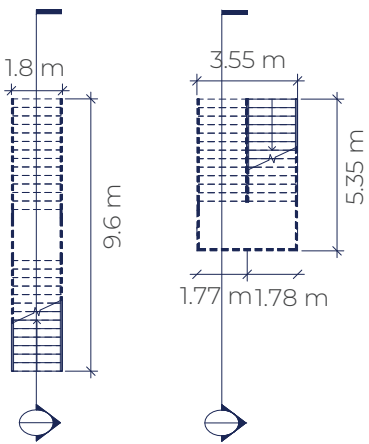


Figure 4.39: Overall building safety plan schematic illustrating exit paths, emergency egress distribution, and localized strategic positions of the core escape staircases.



4.4 Architectural Drawings & Spatial Syntax

4.4.3 The bridge structure

Connecting two prefabricated modules across a 23 meter void requires a design where architecture and engineering function as one, utilizing a self-supporting structural trough to avoid adding heavy columns that would disrupt the exhibition floor. Instead of conventional decorative handrails, the 1.2 meter high safety barriers themselves are engineered as the primary load-bearing elements, styled as a rigid Vierendeel frame a rhythmic geometric ladder of solid timber that possesses the necessary stiffness to span the gap without sagging. The 3-meter-wide walking deck is sandwiched directly between the bottom edges of these side walls; because the deck only spans the short distance from wall to wall, it remains just 16 centimeters thick, giving the bridge a clean, floating silhouette when viewed from below. To keep the structure completely open to the soaring ceiling above, a perfectly rigid connection between the floor and the side frames stabilizes the walls from the bottom up, preventing any tilting or swaying without requiring overhead bracing.

Where the bridge meets the pods at a dramatic diagonal angle, the timber floor is cut to rest flush against the volume, clamped tightly by a concealed internal frame to avoid bulky, exposed steel brackets. The massive downward weight of the span is caught right at the threshold and transferred through glulam columns hidden entirely inside the prefabricated pod walls, channeling the forces safely to the existing concrete floor plate without requiring disruptive new foundations. To preserve visual transparency and honor the historic character of the hall, the large rectangular openings of the Vierendeel frames are enclosed with clear laminated safety glass, meeting strict building codes while framing open views of the industrial surroundings as users cross through the air.

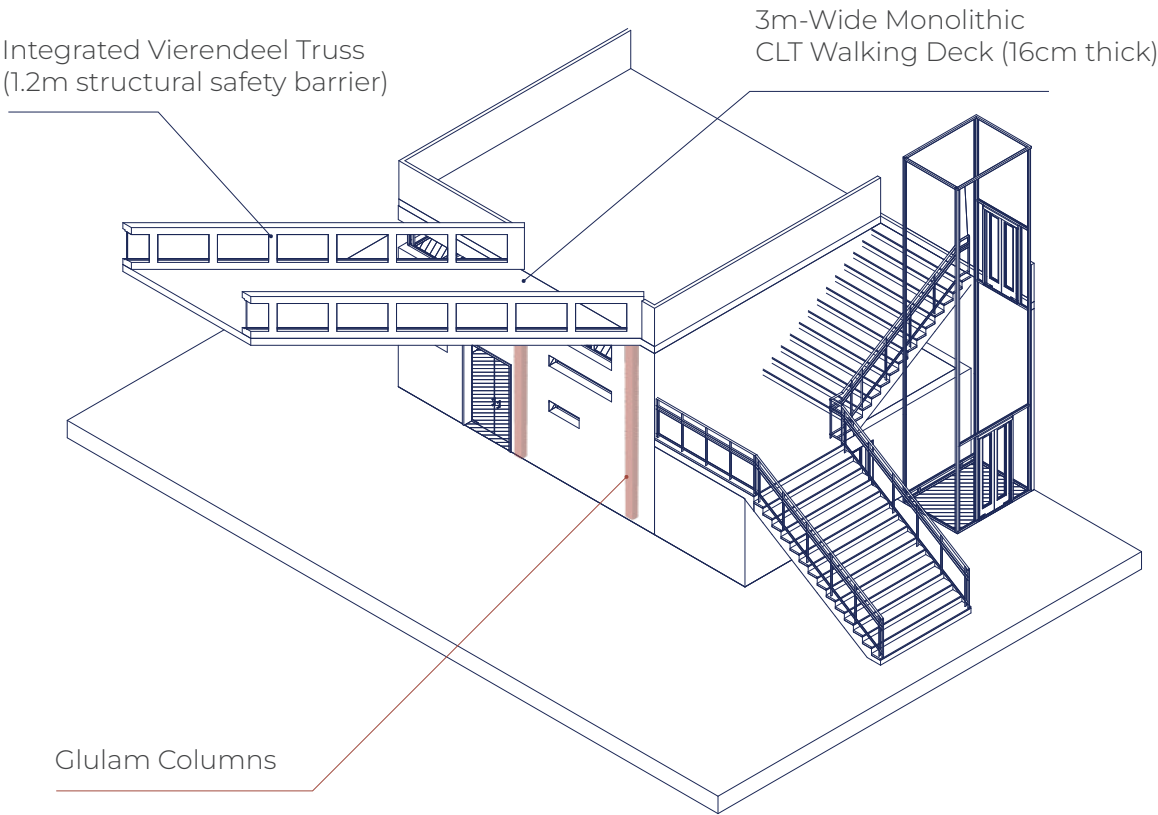


Figure 4.40: Isometric structural schematic illustrating the diagonal intersection between the 23-meter spanning Vierendeel bridge assembly and the prefabricated pod load-bearing volume.

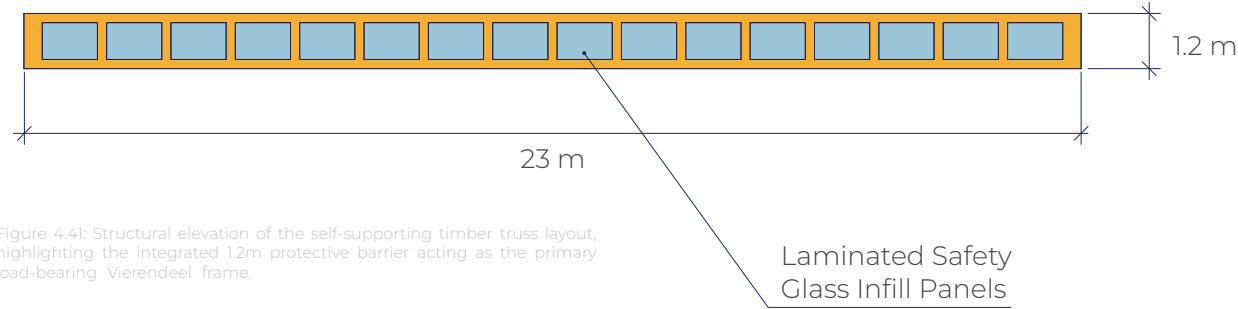


Figure 4.41: Structural elevation of the self-supporting timber truss layout, highlighting the integrated 1.2m protective barrier acting as the primary load-bearing Vierendeel frame.

4.4 Architectural Drawings & Spatial Syntax

4.4.4 Sections and internal perspective

Section A-A

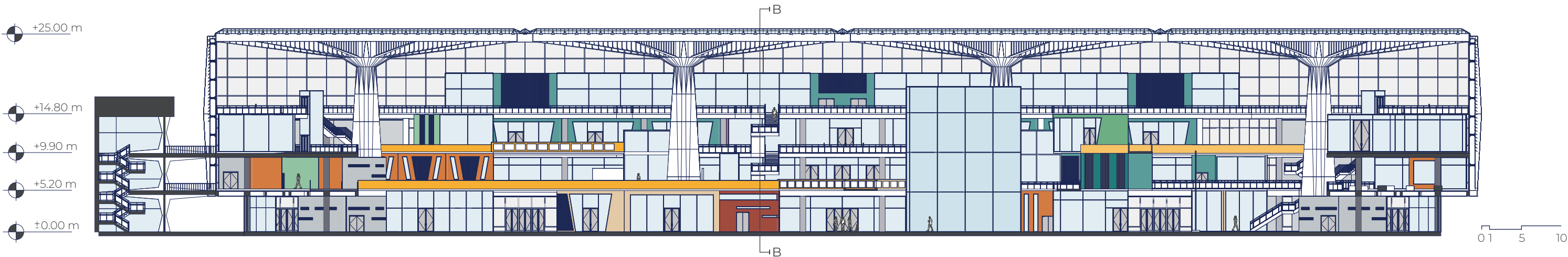


Figure 4.42: Longitudinal Section A-A highlighting the relationship between the modular, light-timber pod insertions and the historic, long-span concrete vault system. The programmatic stratification shows the flow from high-energy public hubs on the ground floor to focused research zones above.

Section B-B

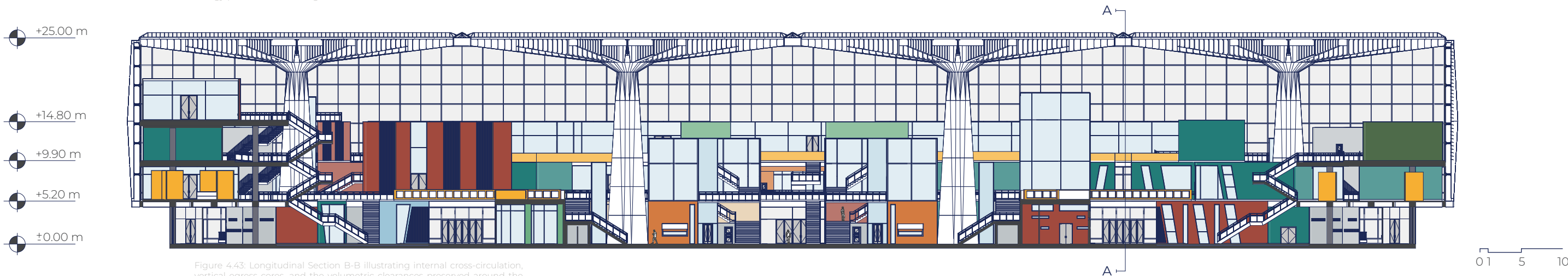


Figure 4.43: Longitudinal Section B-B illustrating internal cross-circulation, vertical egress cores, and the volumetric clearances preserved around the primary structural columns to maintain the open-hall spatial narrative.

4.4 Architectural Drawings & Spatial Syntax

4.4.4 Sections and internal perspective

Figure 4.44: Historical archive photograph showing the raw interior volume of the main hall prior to intervention, focusing on the unaltered structural configuration of Pier Luigi Nervi's columns and roof grid.

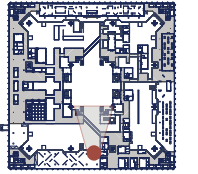


Figure 4.45: Internal perspective render from the upper gallery axis, showcasing the visual dialogue between the historic concrete shell and the newly inserted light-timber modular programmatic ecosystems.





Figure 4.46: Aerial isometric perspective looking down onto the central circulation spine of the museum.

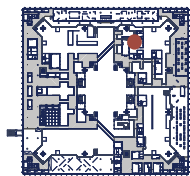


Figure 4.47: Museum entrance perspective from the 16 meter boulevard.





Figure 4.48:
Perspective between
the children center and
urban indoor market.



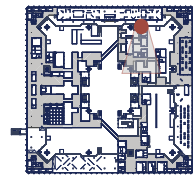


Figure 4.49:
Perspective from the
2nd southern gallery
floor.

Figure 4.50:
Architectural museum
interior perspective.

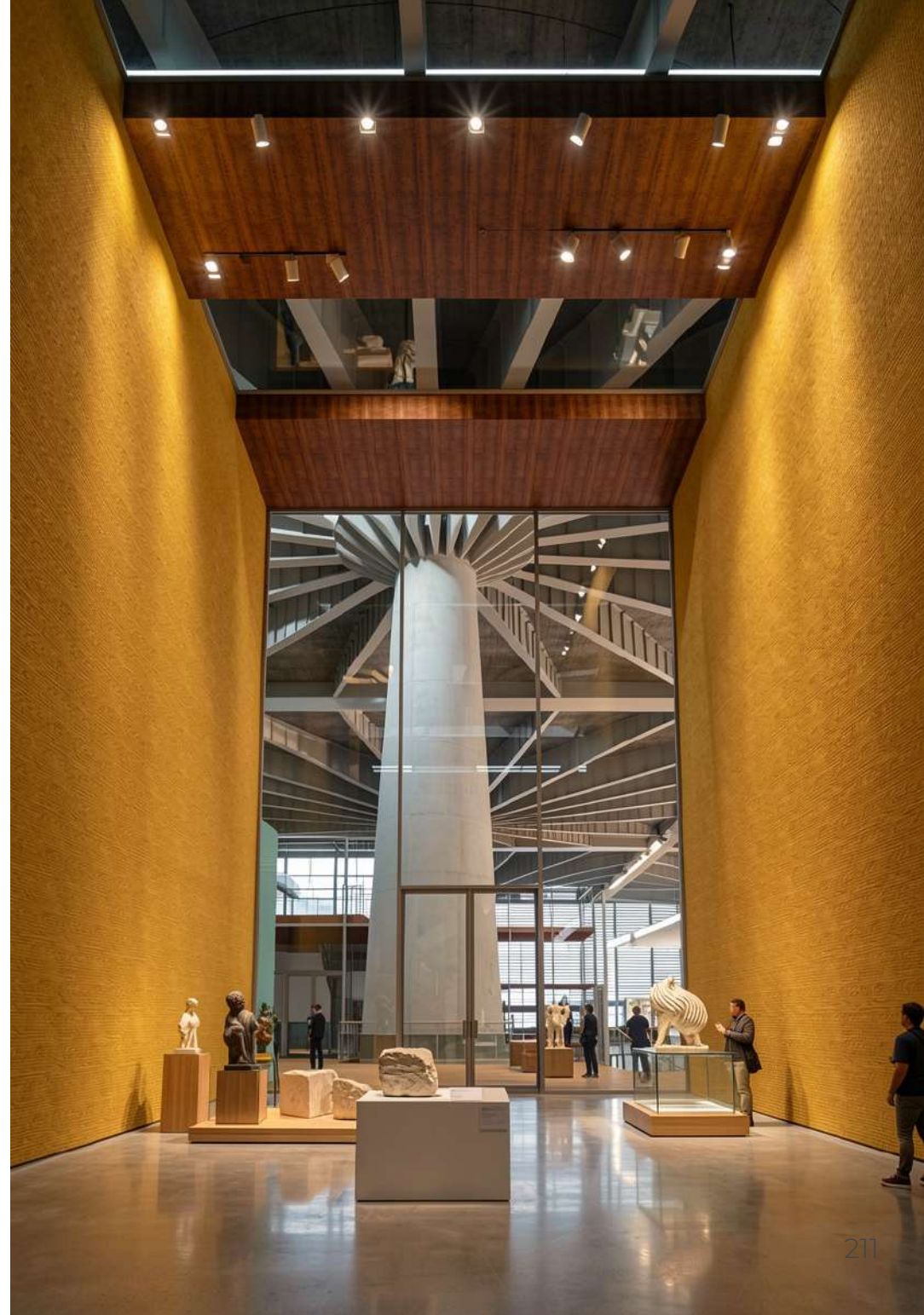
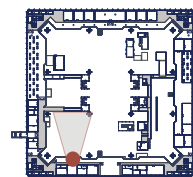




Figure 4.51: Perspective from the north east first perimeter floor.



Figure 4.52: Perspective from the central workshop showing climbing area.



Figure 4.53: Perspective main central plaza showing south western area of the design.

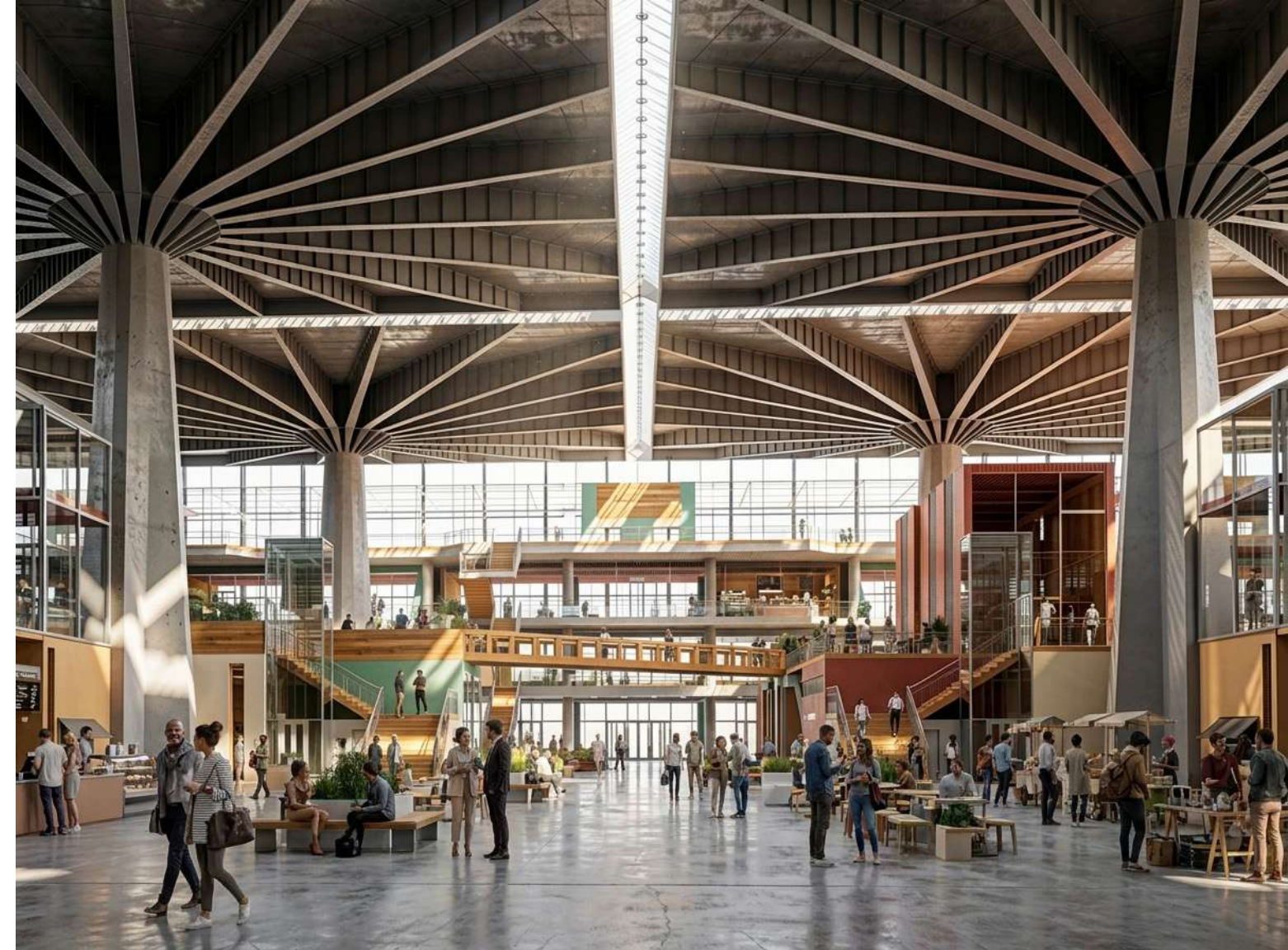
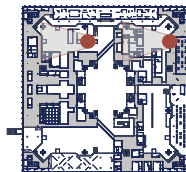
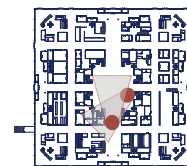


Figure 4.54: Perspective main central plaza showing north area of the design. Visualizing the vertical and horizontal connections.



4.4 Architectural Drawings & Spatial Syntax

4.4.5 3D Isometrics



Figure 4.55: Overall exploded 3D isometric schematic displaying the complete spatial organization and programmatic distribution inside the building's envelope. The drawing highlights the strategic placement of modular clusters, perimeter circulation, and interconnected bridge frameworks.

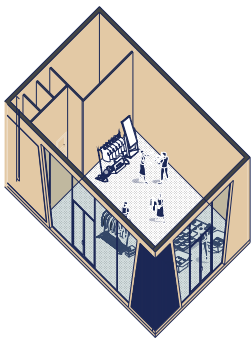


Figure 4.56: Clothing store pod ground floor zone B3 axonometric.

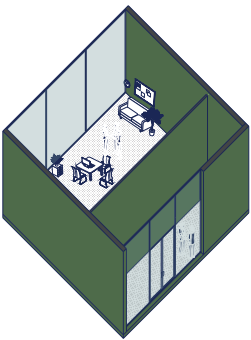


Figure 4.57: Executive Meetings pod second floor zone S axonometric.

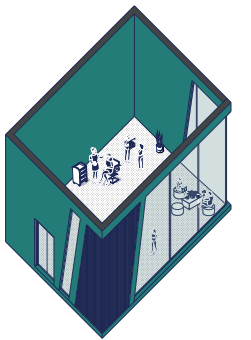


Figure 4.58: Makeup workshop pod first floor zone C axonometric.

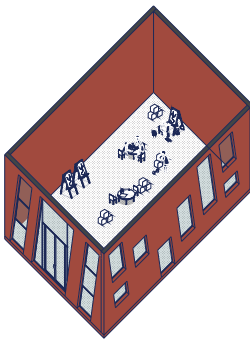


Figure 4.59: Children center pod ground floor zone A2 axonometric.



Figure 4.60: Exhibition and trade fairs ground floor zone D3 axonometric.

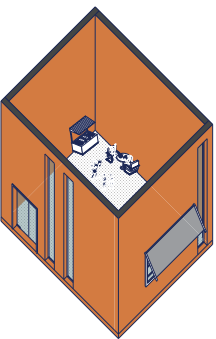


Figure 4.61: Gelateria pod ground floor zone C2 axonometric.

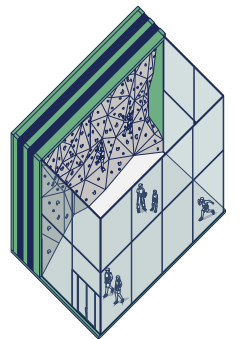


Figure 4.62: Climbing&Bouldering pod first floor zone G axonometric.

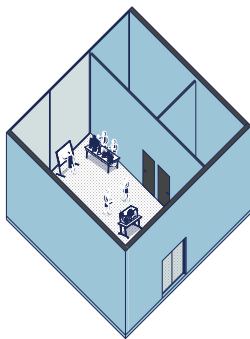


Figure 4.63: Climate sim lab pod second floor zone W axonometric.

4.5 Socio-Economic Resiliency

4.5.1 The Connectivity Networks

The long-term viability and operational capacity of the interior megacity are mapped through a multi-layered relational ecosystem. Rather than evaluating the project as a static space, these six connectivity graphs trace the fluid dependencies running between functional programs, physical spatial zones, user demographics, material lifecycles, institutional frameworks, and financial backers to establish a clear blueprint for long-term project resilience.

Clusters Connectivity:

Maps the functional cross-talk between public programmatic sectors (Creative, Commerce, Culture, Food, etc) and the essential service layers (Technical, Operational, Backstage) that stabilize the internal economy.

Main Zones Connectivity:

Tracks physical and functional spatial relationships, illustrating how high-energy nodes like the Main Central Plaza and Kinetic Core physically feed quieter peripheral zones like the Deep Silence District.

Users Connectivity:

Charts demographic overlaps across the street grid, demonstrating how specialized profiles (Researchers, Students, Artists) naturally intersect with the public (Visitors, Children, Staff) to form an inclusive social mixer.

Materials Connectivity:

Documents the tectonic and acoustic assembly of the reversible pods, detailing how the 5-Layer CLT chassis, steel hardware, insulation layers, and acoustic membranes interface as a circular system.

Institutions Connectivity:

Coordinates the administrative alliance between university anchors (PoliTo, UniTo, TU Delft), heritage preservation (UNESCO, DOCOMOMO, ICOMOS), and regional public agencies managing the hub.

Stockholders and Private Investors Connectivity:

Outlines the economic ecosystem backing the project, linking public funding streams (Italian PNRR, EU Regional Development Funds) with private banking foundations and project coordinators to guarantee financial longevity.

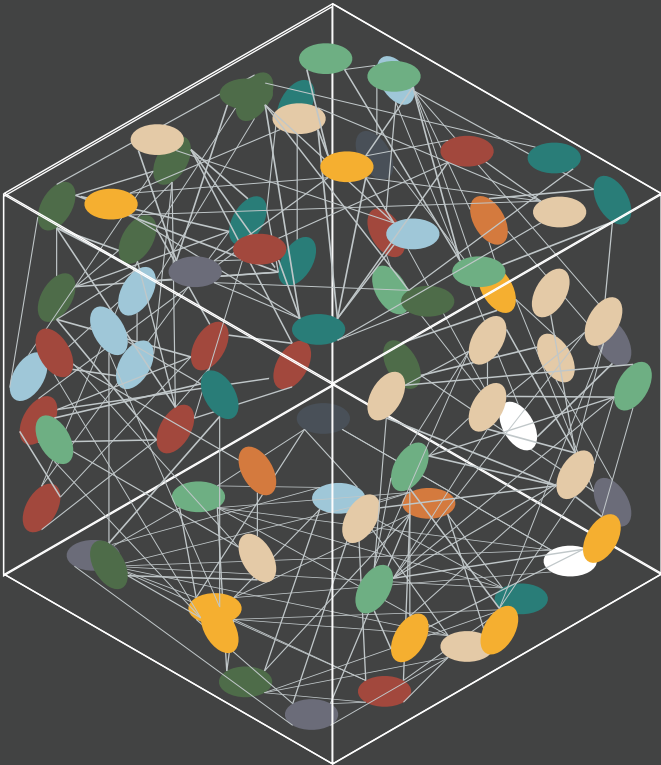
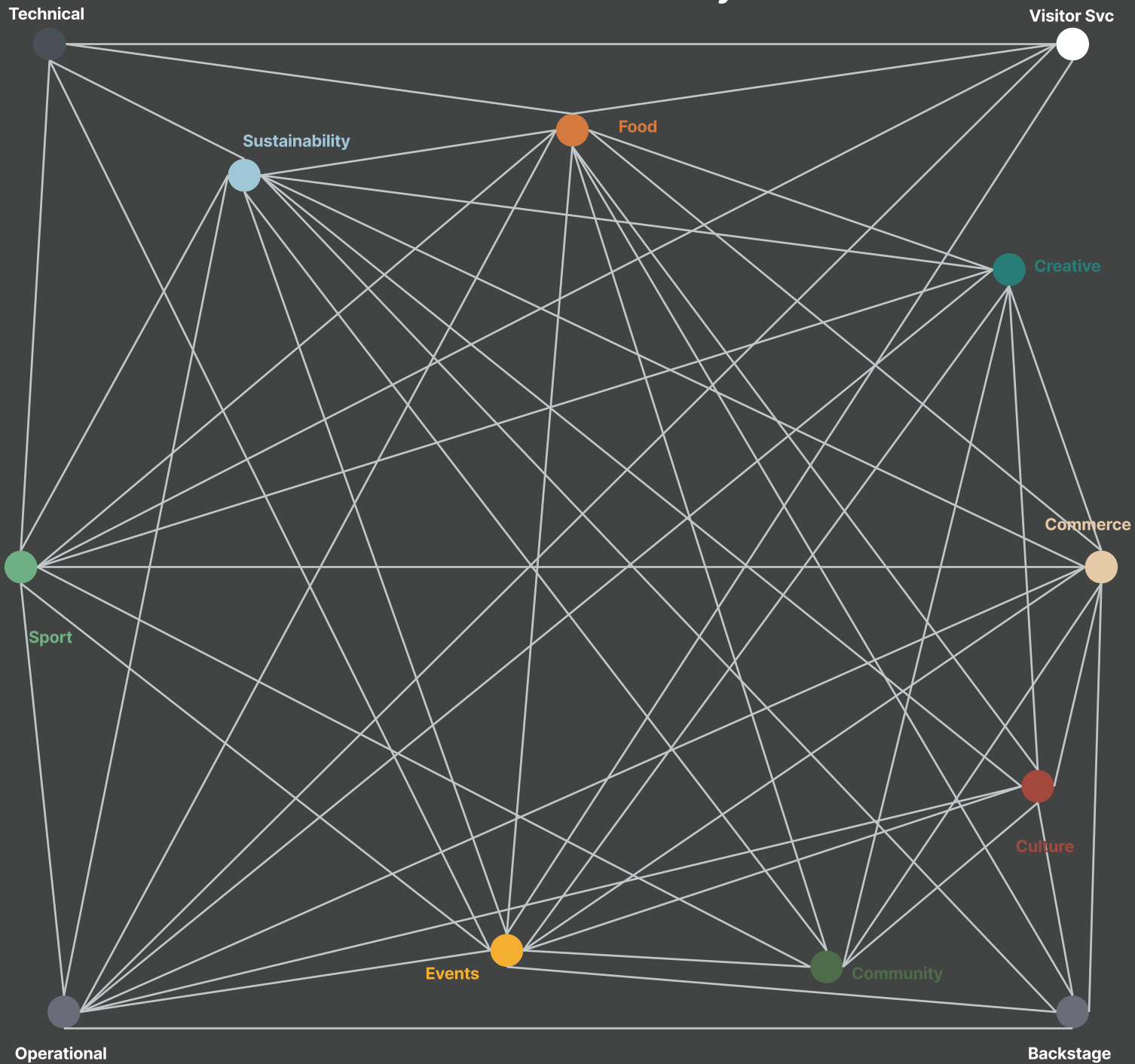
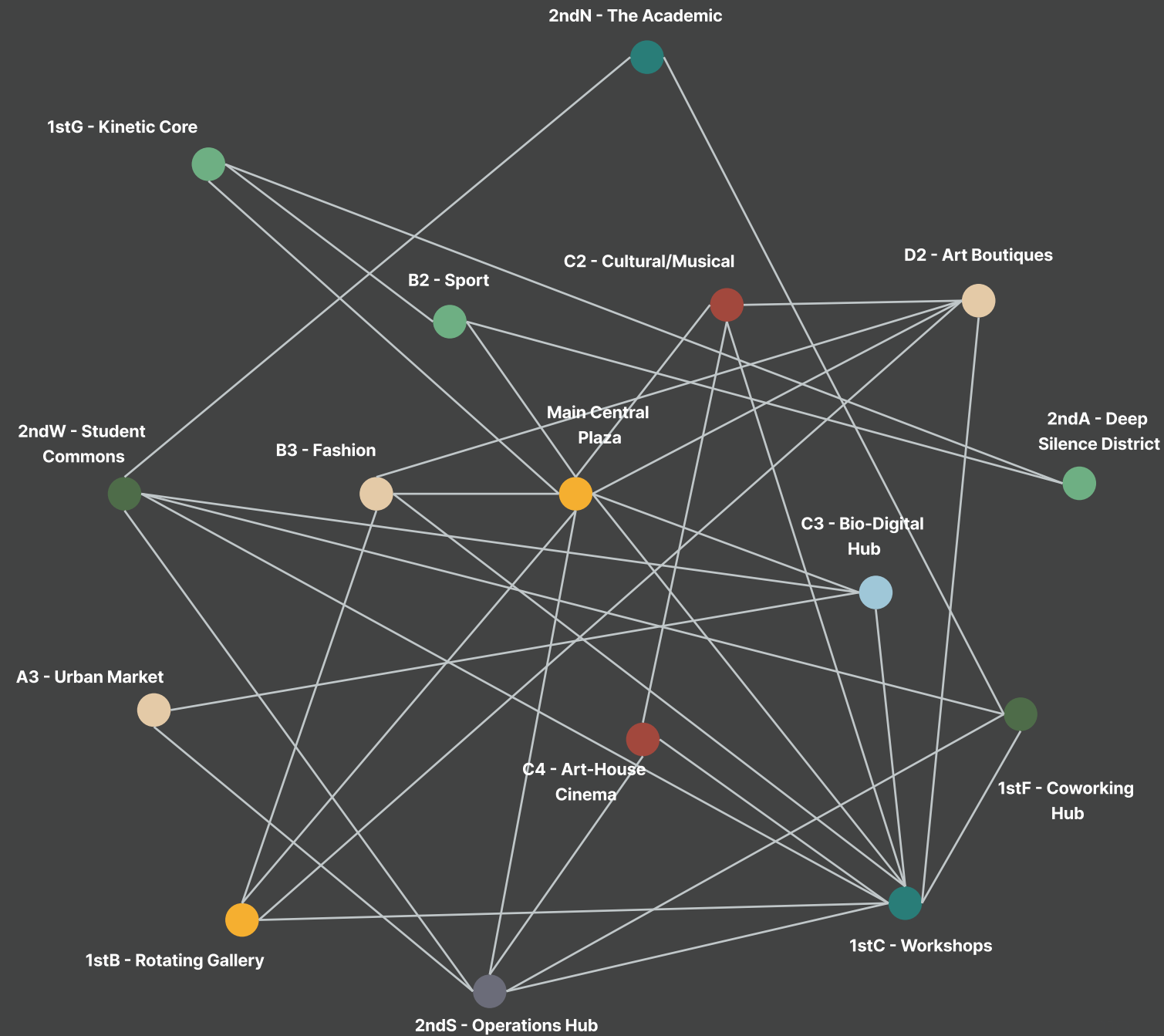


Figure 4.64: Connectivities combined into one single cube which is all the information that creates a prefabricated pod.

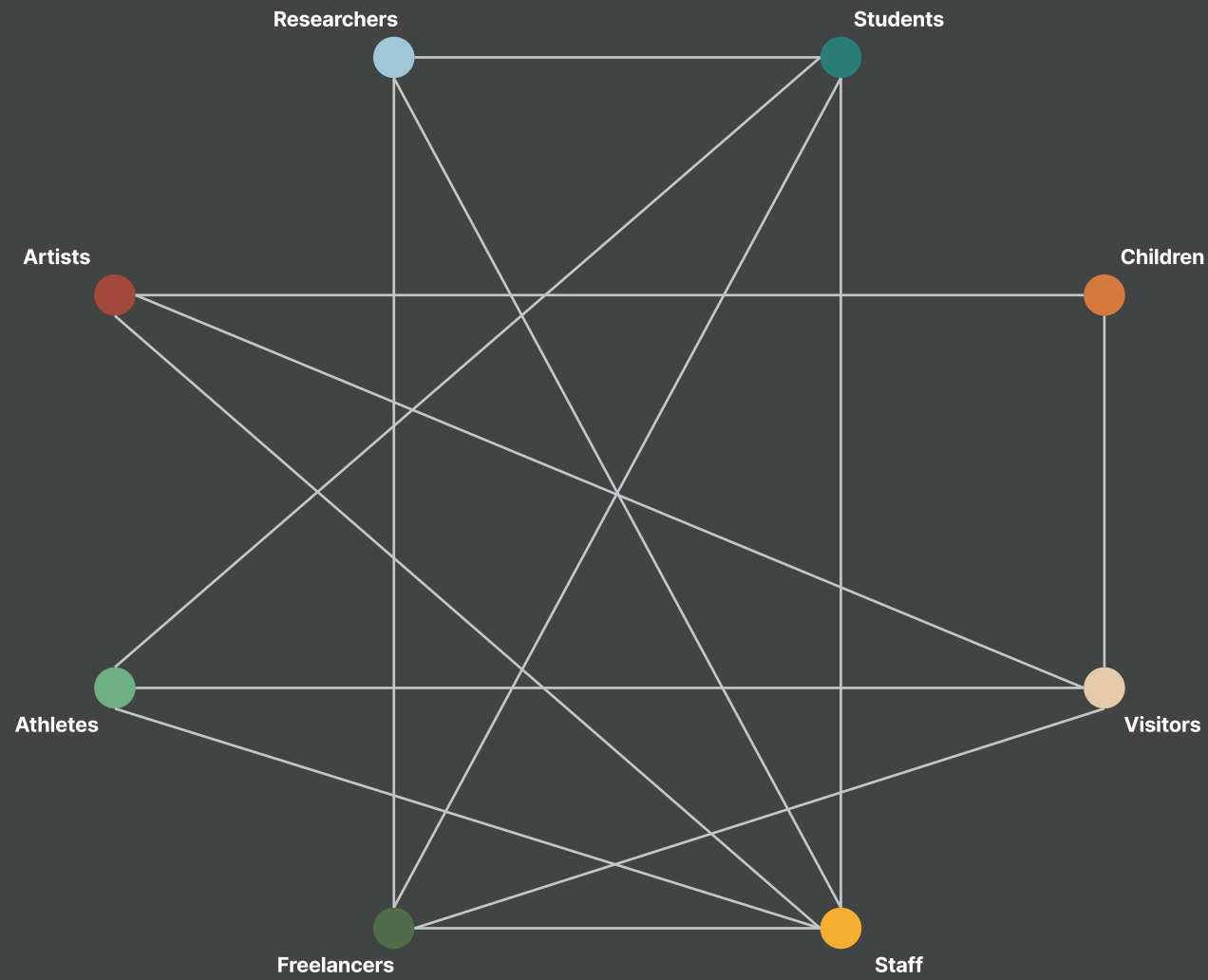
Clusters Connectivity



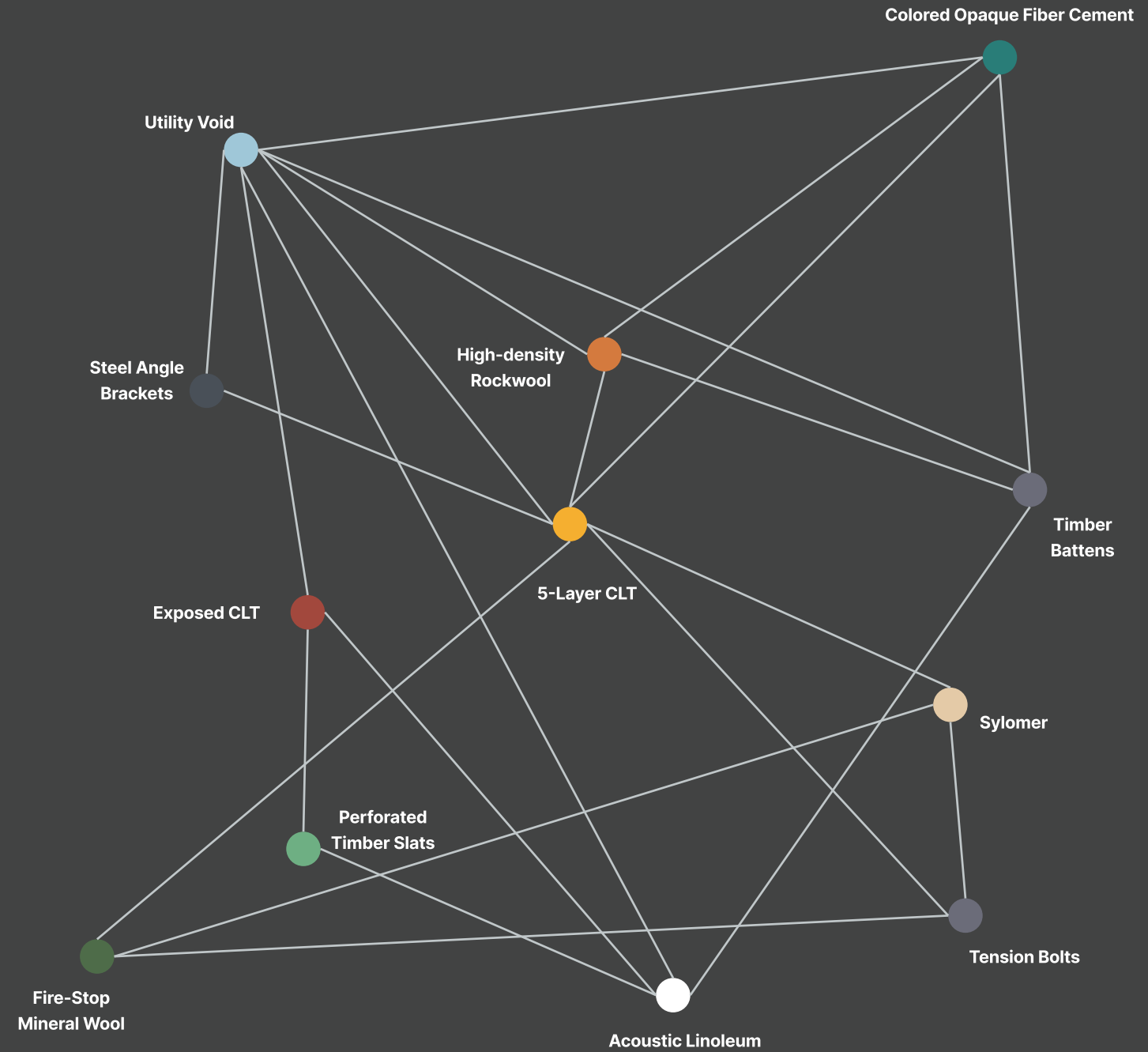
Main Zones Connectivity



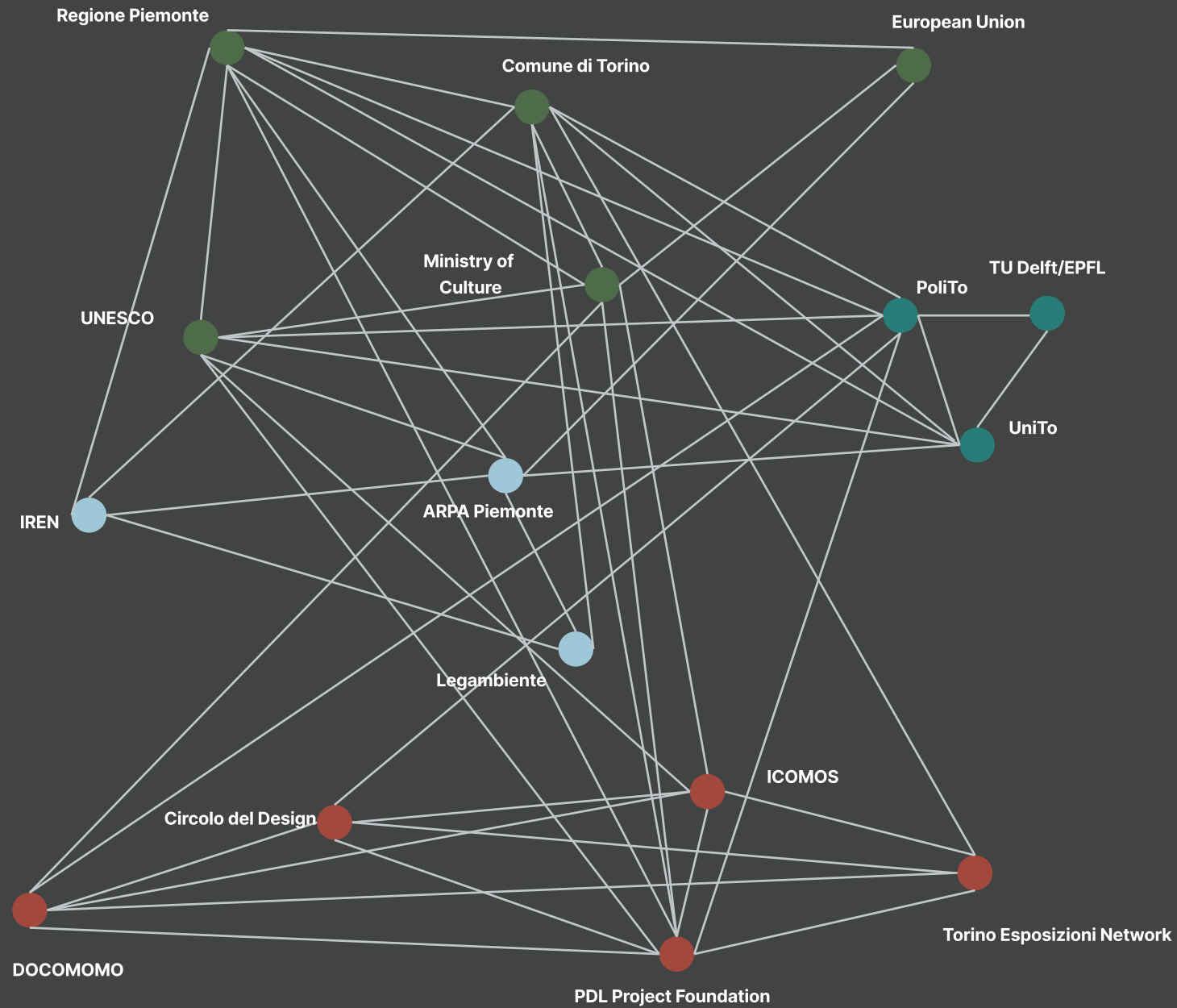
Users Connectivity



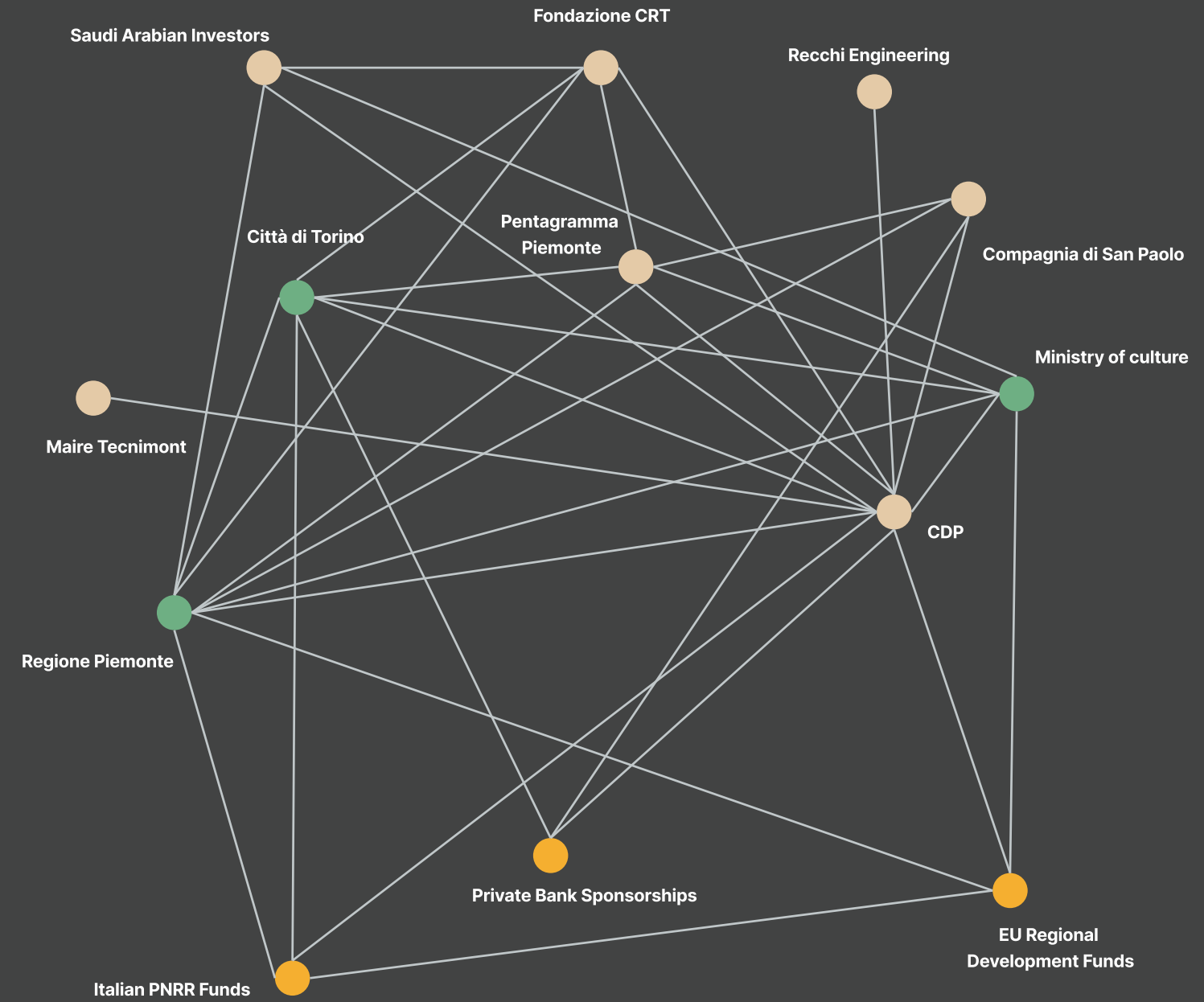
Materials Connectivity



Institutions Connectivity



Stockholders and Private investors Connectivity



4.5 Socio-Economic Resiliency

4.5.2 Programs workability sustainability

The architectural transformation of the grand hall relies on shifting from static spatial functions to dynamic, user-driven lifecycles. To demonstrate how these physical volumes operate as human incubators, the daily workflows are mapped across four evolutionary phases: Experience, Examine, Exhibit, and Exhale. These layers track the progressive transition from individual learning to collective production, ensuring the hub acts as an active socio-economic engine rather than a passive container. The creative and technical ecosystem operates as a vertical incubator for skill development and cross-disciplinary incubation. The diagram illustrates a loop where individual users enter as spectators and exit as collaborative leaders:

Experience: The journey initiates at the baseline street level where public occupants engage with fundamental tactile, digital, and performative disciplines. Through direct physical contact with localized labs, ranging from carpentry, pottery, and culinary arts to media production and botanical studies, users absorb raw technical knowledge.

Examine: Once these baseline skills are acquired, users advance to the testing phase. Isolated disciplines collide within collaborative frameworks like the Natural Dye Studio, Photographic Pocket Park and trade fairs. In this layer, a fashion designer, a botanist, and a woodworker actively blend their workflows to test specialized hybrid methodologies.

Exhibit: Refined collaborative outputs transition into the public realm. The physical architecture provides high-visibility platforms such as the Rotating Project Gallery, Fashion Catwalks, and Arthouse Cinema allowing users to broadcast their completed works, build professional networks, and test market viability.

Exhale: The peak of the lifecycle marks the user's ultimate success and independence, stepping into the Pop-up Art Boutique or main performance stages. At this threshold, accomplished makers do not leave the system; instead, they pull the next generation of participants upward. By initiating fresh activities and mentoring incoming cohorts, they expand the user base and convert the physical workshop cluster into a self-sustaining creative economy.

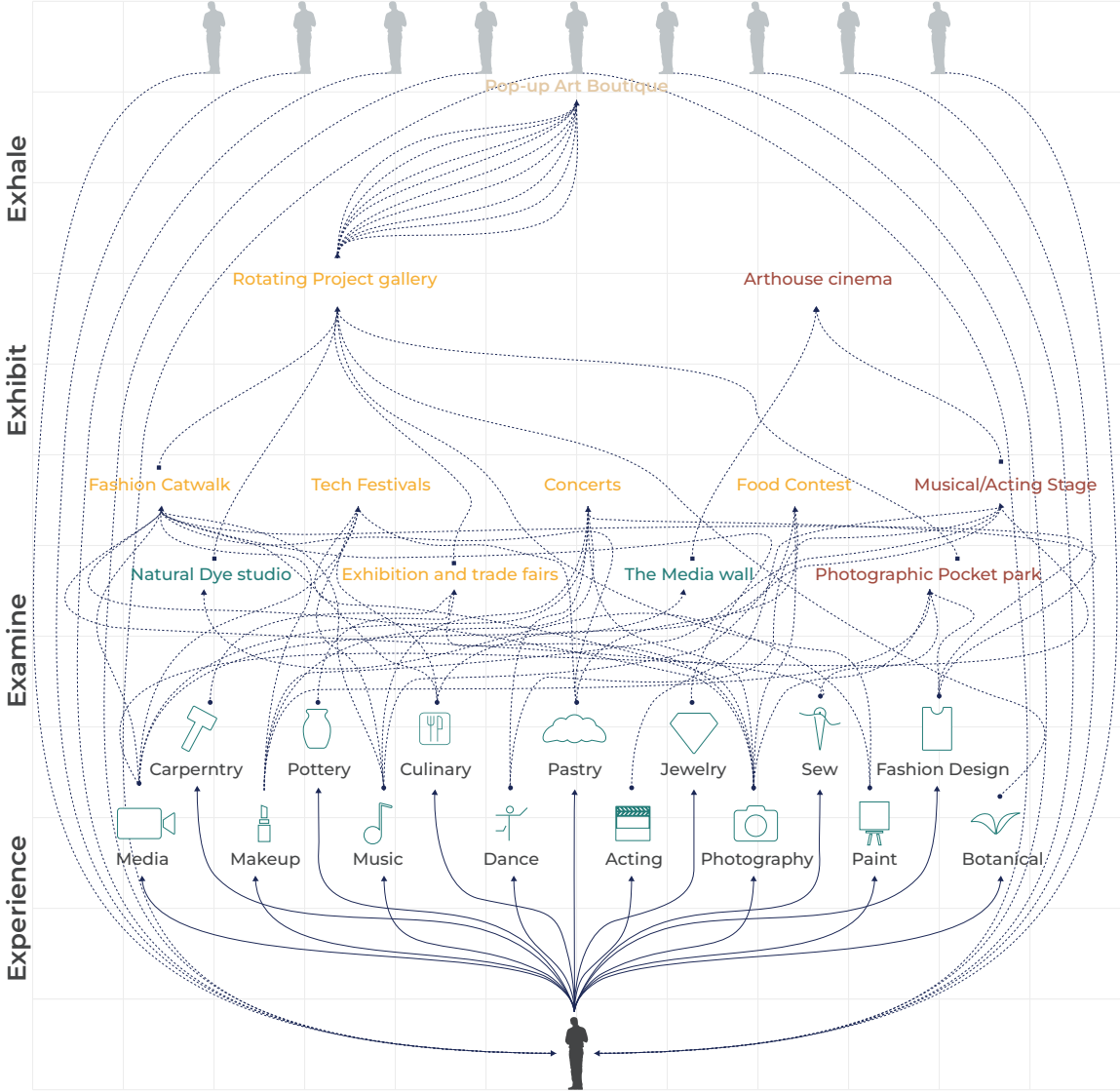


Figure 4.65: Workshop workability strategy diagram.

4.5 Socio-Economic Resiliency

4.5.2 Programs workability sustainability

The sustainability cluster functions as an active feedback loop that translates digital environmental tracking into tangible public assets. The system processes raw building physics data into physical spatial infrastructure through an integrated scientific pipeline:

Experience: The workflow originates inside the Urban Strategy Lab. Here, researchers capture the macro environmental variations of the grand hall, running advanced multi-zone climate, daylight autonomy, and thermal comfort simulations to understand the structural microclimate.

Examine: The virtual simulation data is translated into physical biology within the Seed & Genetics Library. In this testing environment, researchers analyze how specific botanical variations react to the simulated microclimatic conditions, selecting resilient plant species optimized for the interior climate.

Exhibit: Verified botanical systems scale up into the Urban Vertical Greenhouse. This architectural insertion acts as a massive, visible testing ground where environmental research is physically displayed through vertical food production, filtering the air and demonstrating circular agriculture directly to the public.

Exhale: The cycle achieves full circularity by discharging direct environmental and commercial benefits back to the local community. The purified air feeds the Oxygen Bar, the agricultural yield stocks the Indoor Market, and the environmental data scales into generalized microclimate research, closing the loop and directly upgrading the interior streetscape's air quality and metabolic health.

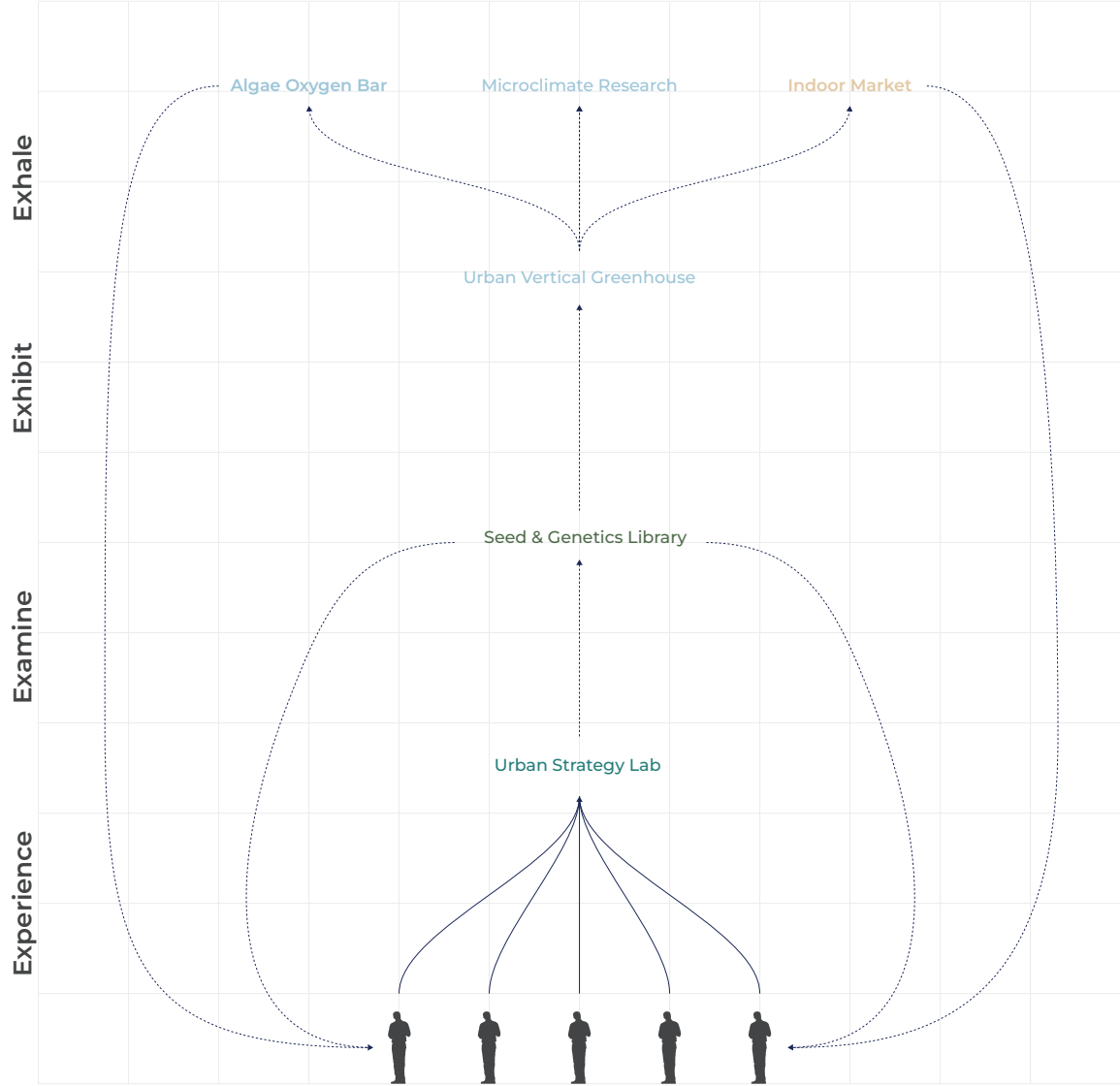


Figure 4.66: Sustainability workability strategy diagram.

4.5 Socio-Economic Resiliency

4.5.3 Schematic sociality section

The cross-section maps how different user demographics naturally distribute themselves across the programmatic clusters, visualizing the layout as a clear vertical gradient of public exposure. Rather than enforcing rigid boundaries, the pods are organized by calculated publicness thresholds to naturally balance social intensity and acoustic comfort:

90% to 60% Public (Lower Levels): Concentrates hyper-social clusters like Food, Commerce, and Events. These zones act as the main public mixers, drawing in high volumes of transient Visitors, Children, and Staff.

60% to 40% Public (Mid-Levels): Balances community collaboration with active production, housing the Community, Sports, and Creative clusters. It serves as a shared studio space for Students, Artists, and Athletes.

40% to 10% Public (Upper Levels): Elevates specialized sectors like Sustainability research, administration, and quiet workspaces. This acoustic buffer provides deep isolation for Researchers and Freelancers away from the busy streetscape below. To protect this environment, certain zones, such as the grand library, remain restricted, accessible only to Students and academic researchers to guarantee undisturbed focus.

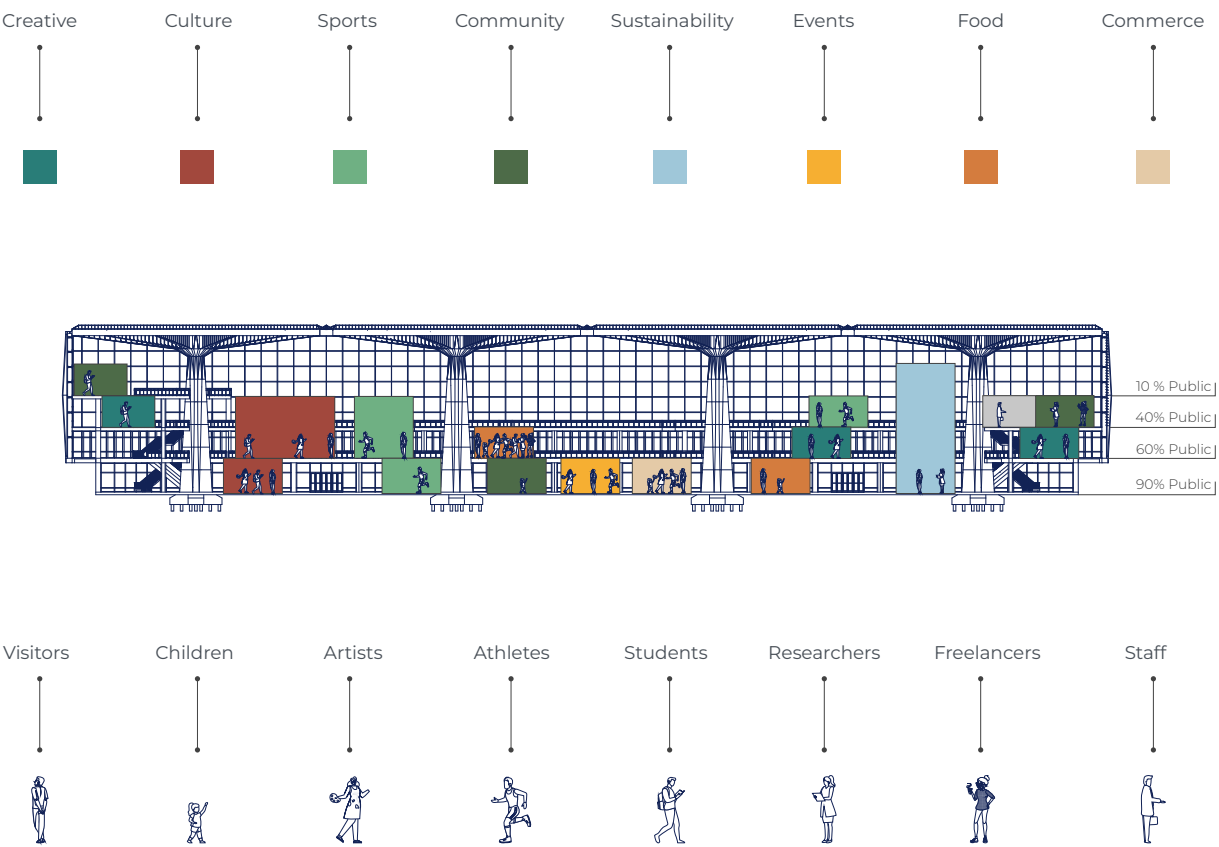


Figure 4.67: Schematic section of the design showing the sociality between floors

05 Environmental Performance & Building Physics

5.1 MACRO-CLIMATE BASELINE

5.1.1 Thermodynamic Matrix and Psychrometric Distribution

In Turin's humid subtropical climate, analyzing the intersection of ambient temperature and atmospheric moisture is essential for crafting an effective passive design strategy. The provided psychrometric chart(Fig. 5.2) maps the city's annual environmental data point by point, revealing a significant concentration of hours clustered in the lower-left quadrant. This distribution indicates that for a substantial portion of the year, Turin experiences cold, low-absolute-humidity conditions where heating is required. However, during the summer months, the data shifts toward the right, stretching past 30° dry-bulb temperature while absolute humidity rises toward 15 g/kg to 17 g/kg. This shift results in warm, humid conditions that demand careful attention to thermal comfort. When correlating these conditions with the hourly dry-bulb temperature heatmap, the temporal distribution of these thermal stresses becomes clear. The winter period from December through February shows persistent temperatures dipping below 0° or hovering in the low single digits, particularly during early morning and late night hours. As the seasons progress through spring, temperatures gradually stabilize within a temperate range. However, the summer months specifically July and August present prolonged peaks where temperatures consistently exceed 30° to 35° between midday and late afternoon.

This intense summer heat, paired with the heightened moisture levels visualized on the psychrometric chart, underlines the necessity of balancing a robust, insulated envelope for winter retention with dynamic passive cooling and dehumidification strategies to mitigate summer overheating.

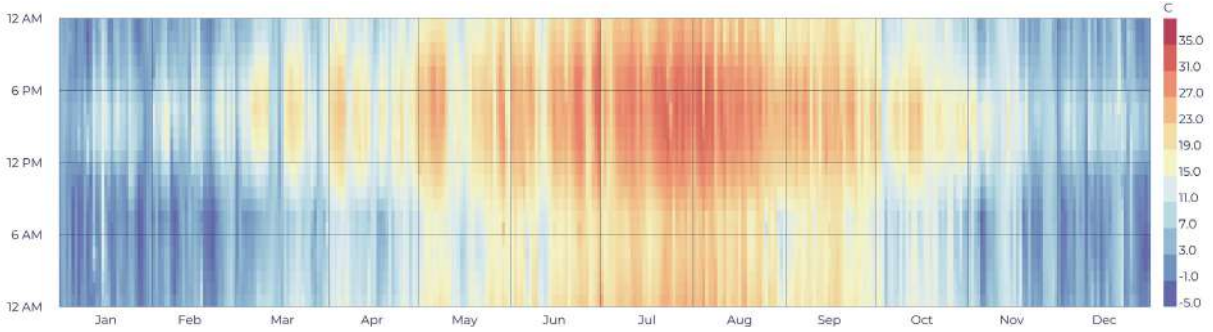


Figure 5.1: Hourly dry-bulb temperature distribution in Turin across a full calendar year, showcasing intense summer afternoon peaks alongside sustained sub-zero winter conditions.

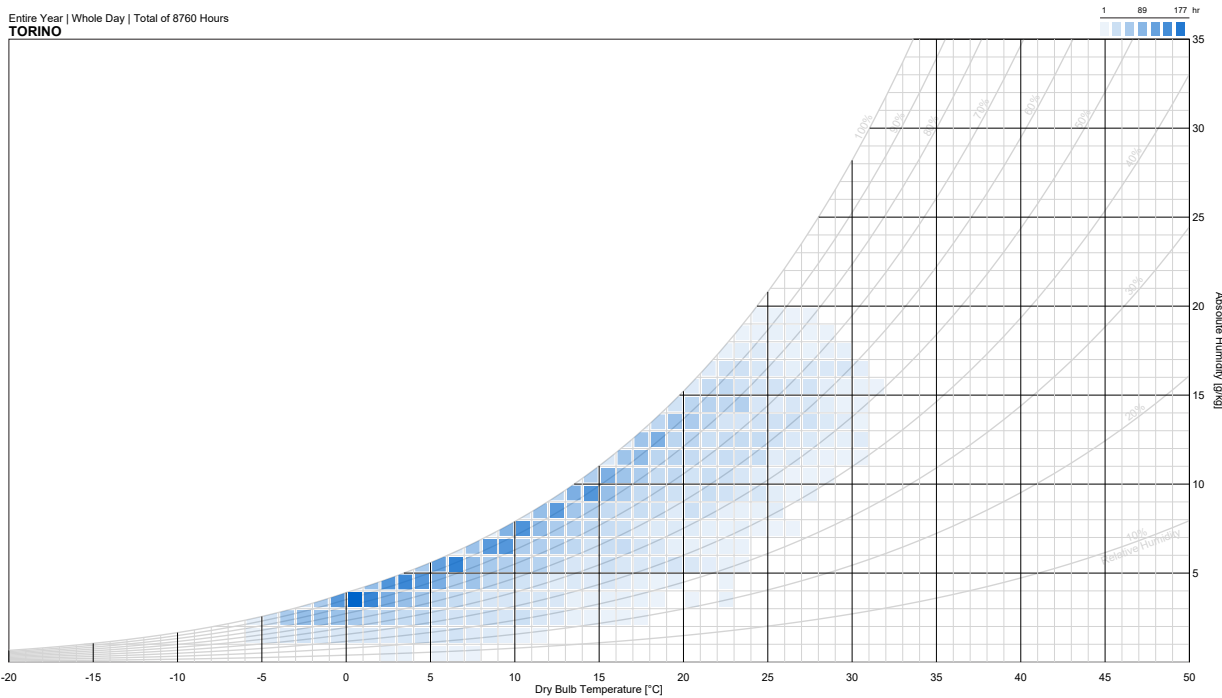


Figure 5.2: Annual psychrometric chart for Turin illustrating the distribution of hourly climatic data across dry-bulb temperature and absolute humidity ranges to define regional thermal comfort challenges.

5.1 MACRO-CLIMATE BASELINE

5.1.2 Radiation Flux and Solar Path Geometry

Solar radiation represents the most critical passive heat vector interacting with the massive glass perimeter facade of the Nervi shell. Projecting the meteorological data directly onto a stereographic sun path diagram exposes the precise geometric relationship between the sky vault and the building orientation.

Direct Normal Radiation (DNR):

Peak direct normal radiation flux values reach up to 763.0 Wh/m². This severe radiation exposure occurs predominantly along the southern sky track at mid-day elevations and along the eastern/western tracks during low-angle morning and late-afternoon periods. Diffuse Horizontal Radiation (DHR): The diffuse solar radiation component remains consistently strong throughout the year, peaking at 399.0 Wh/m². This high diffuse baseline is a direct consequence of seasonal cloud cover and atmospheric scattering over the Po Valley region, creating a highly uniform omnidirectional sky dome radiation profile. Energy Intensity Balance: When compiling the monthly cumulative values, the solar energy intensity data highlights an aggressive spike during the summer solstice period, where combined global radiation vectors surpass 700 Wh/m² on horizontal surfaces. This demands a highly adaptive shading and envelope mitigation response to prevent catastrophic interior greenhouse effects within the open atrium.

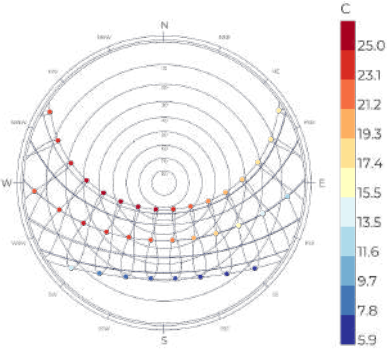


Figure 5.3: Stereographic chart correlating ambient dry-bulb temperatures with solar position, highlighting the late afternoon thermal peak.

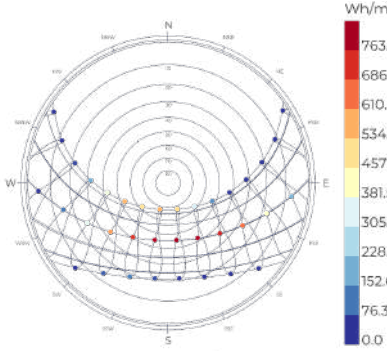


Figure 5.4: Stereographic sun path diagram showcasing the sharp directional distribution of direct normal solar radiation across seasonal paths.

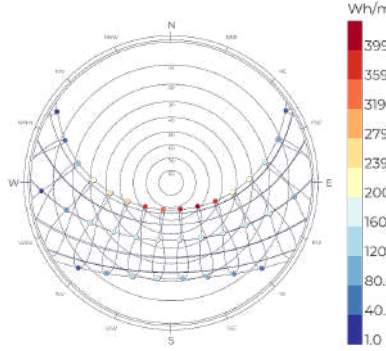


Figure 5.5: Stereographic sun path diagram for Turin mapping annual diffuse horizontal radiation levels to identify multi-directional ambient solar gains.

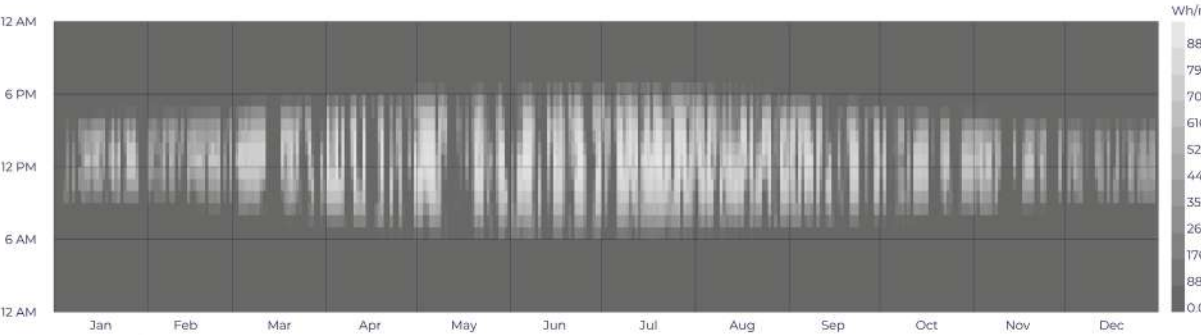


Figure 5.6: Annual hourly heatmap highlighting intense direct normal radiation peaks during transitional seasons and winter clear-sky periods.

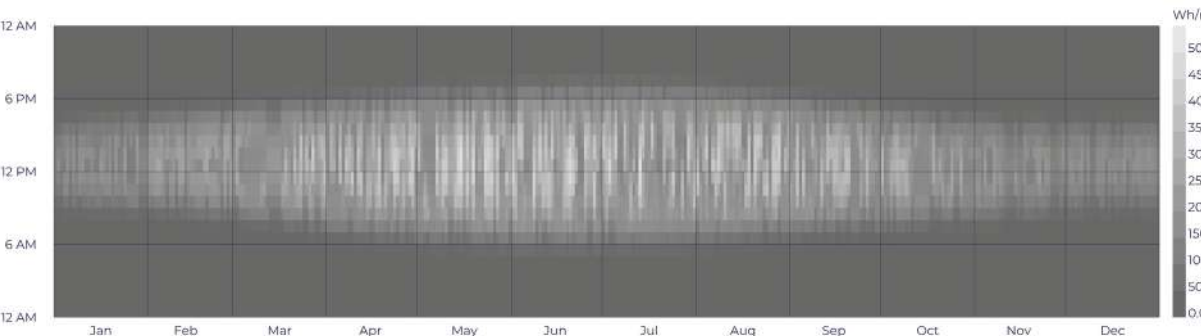


Figure 5.7: Annual hourly heatmap showing the steady, high-intensity distribution of diffuse horizontal radiation concentrated during summer middays.

5.1 MACRO-CLIMATE BASELINE

5.1.3 Aerodynamic Regime and Wind Rose Vectoring

To leverage microclimatic air movement for natural ventilation and passive cooling strategies, the local wind patterns of Turin were analyzed across a full annual dataset. The temporal distribution patterns shown in Wind Direction (degrees) and Wind Speed (m/s) heatmaps reveal that Turin is characterized by a predominantly low-velocity wind environment throughout the year. A critical finding, detailed in the wind rose metrics, is that the site experiences calm conditions for 48.89% of the total annual hours, amounting to 4,283 hours where air velocity is virtually static. When air movement does occur, the prevailing wind direction is strictly polarized along a north-south axis, with a highly frequent, distinct prevailing wind blowing directly from the north (0° / 360°). The correlation between direction and velocity highlights specific design parameters for the architectural envelope. As illustrated in the high-range wind rose diagram, the most frequent wind vector stems from the north, but these currents are consistently gentle, maintaining low velocities that rarely disrupt ambient conditions. However, the second wind rose graph reveals that the maximum wind speeds climbing up to 16.40m are associated with distinct west-northwest (WNW) and west (W) vectors. The Wind Speed (m/s) heatmap confirms that these high-velocity spikes are rare, highly episodic events occurring primarily during seasonal transitions in late winter (February), early spring (March), and late autumn (November).

For the adaptive reuse of a large-scale historic structure like the Palazzo del Lavoro, these wind dynamics indicate that relying entirely on wind-driven cross-ventilation may be insufficient during hot, calm summer periods due to the high percentage of calm hours. Instead, the architectural strategy should exploit the low-velocity, highly structured north-south breeze for gentle night flushing, while building geometry and internal spaces must be configured to encourage stack effect (buoyancy-driven ventilation) to compensate for the frequent lack of mechanical wind pressure. Additionally, the rare but intense western wind gusts during transitional months require robust detail design in any lightweight extensions or modular interventions to manage structural wind loads safely.

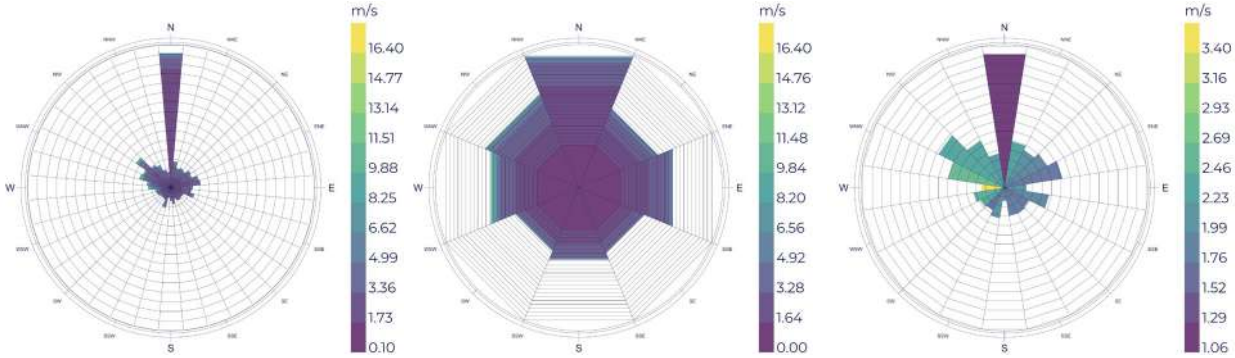


Figure 5.8: Wind rose diagram mapping higher velocity distributions, revealing that peak wind gusts up to 16.40 m/s originate predominantly from western and west-northwestern directions.

Figure 5.9: Radial wind rose illustrating the directional frequency of wind in Turin, indicating that the site remains calm for 48.89 of the year with a primary direction from the north.

Figure 5.10: Detailed low-velocity wind rose capturing the gentle breeze distribution pattern that characterizes the majority of Turin's active air movement hours.

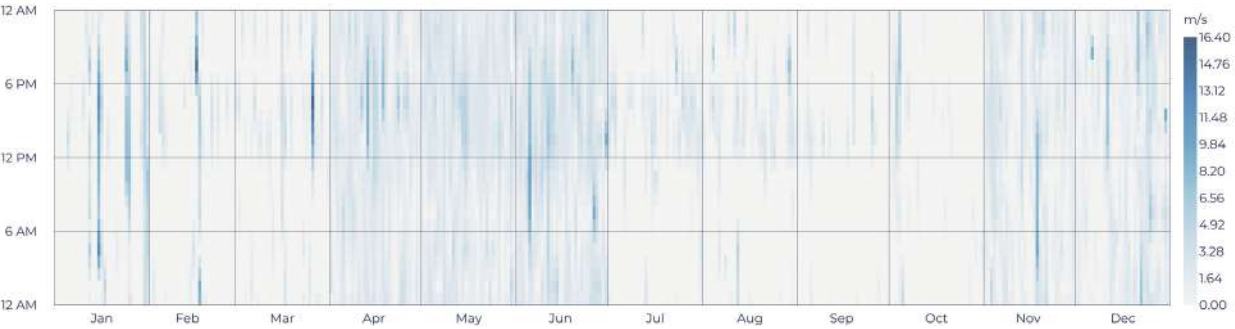


Figure 5.11: Annual hourly heatmap showcasing local air velocities, indicating a generally calm climate punctuated by rare, high-velocity spikes during seasonal shifts.

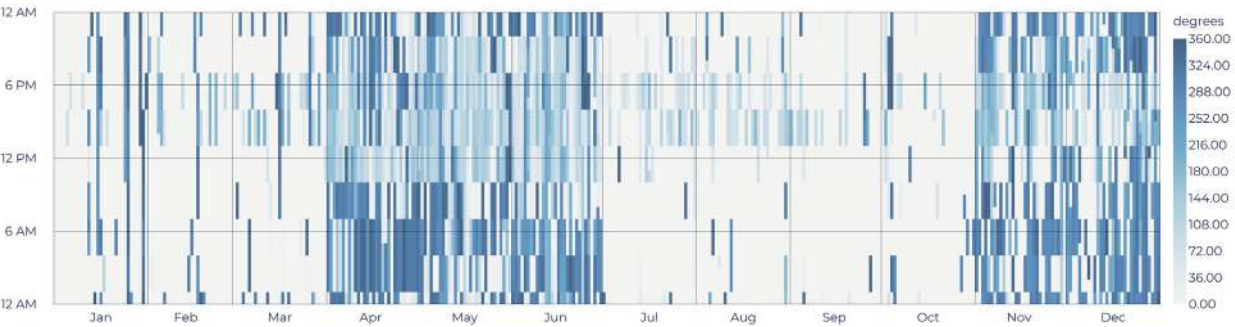


Figure 5.12: Annual hourly heatmap mapping wind direction variations in Turin, highlighting a dominant and consistent northern vector throughout the year.

5.1 MACRO-CLIMATE BASELINE

5.1.3 Aerodynamic Regime and Wind Rose Vectoring

To establish a complete baseline for the building envelope’s thermal response, the final phase of environmental mapping examines atmospheric moisture alongside annual energy demands and outdoor human comfort. Analyzing the Relative Humidity (%) heatmap reveals that Turin experiences consistently high moisture levels throughout the year. Relative humidity frequently hovers between 80% and 100% during winter mornings and late nights, which intensifies the perception of cold. Crucially, even during the hot summer months of July and August, a significant drop in humidity only occurs during peak

afternoon heating periods, leaving mornings and evenings highly humid and complicating passive cooling via natural ventilation due to latent heat risks. This seasonal contrast matches the site’s energy profile shown in the Temperature Time (degC-days) graph. The data reveals that Turin’s climate is heavily heating-dominated. The Heating Degree Time (HDT) bars show massive thermal deficits from November through March, peaking at nearly 20 degC-days in January, which requires a highly insulated envelope and high thermal mass to retain indoor heat.

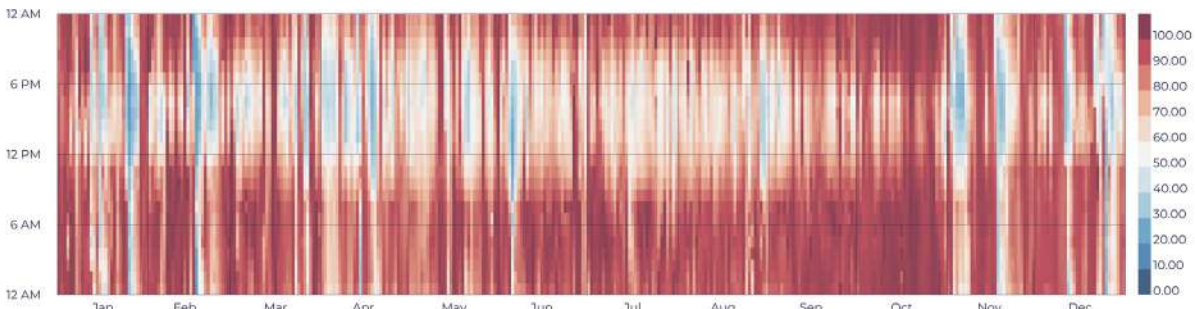


Figure 5.14: Annual hourly heatmap mapping atmospheric relative humidity in Turin, showing persistent high-moisture conditions across most seasons.

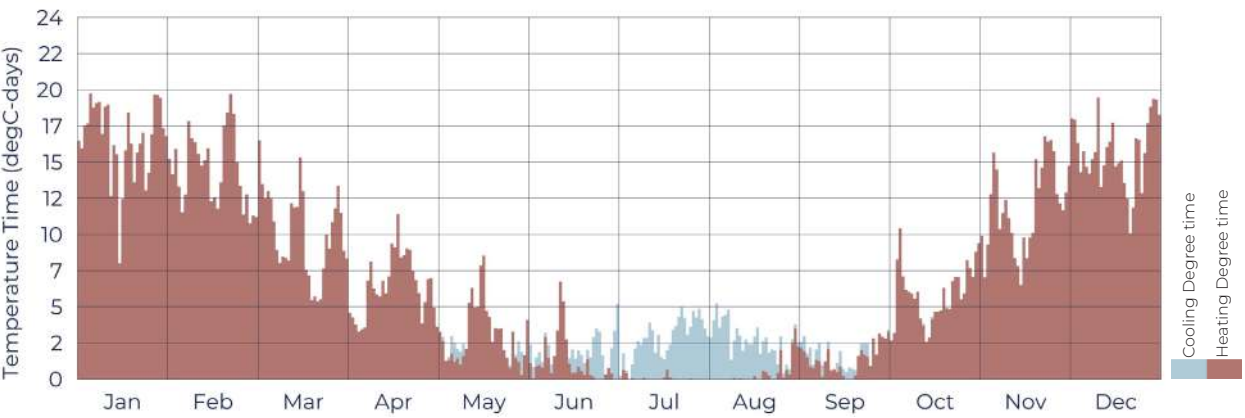


Figure 5.15: Annual comparison of Heating Degree Time and Cooling Degree Time, highlighting Turin’s heavily heating-dominated climate.

Conversely, the Cooling Degree Time (CDT) peak is much smaller and concentrated entirely within a short summer window between late June and August, indicating that while active summer cooling is necessary, the absolute yearly energy load is predominantly shaped by winter conditions valuating these environmental factors through the Universal Thermal Climate Index (UTCI) provides a clear picture of outdoor human comfort across the year. Out of 8,760 annual hours, the site offers “No Thermal Stress” for a substantial period of 4,435 hours, primarily spanning across late spring, early autumn, and summer nights. However, the remaining hours reveal significant exposure to cold conditions, with “Strong Cold Stress” dominating winter mornings and nights for 1,030 hours, alongside thousands of hours of moderate cold. Meanwhile, “Strong Heat Stress” is confined to a tight band of 145 hours, appearing strictly during summer afternoons. This UTCI profile emphasizes that while large-scale public or semi-outdoor spaces require protection from winter winds and dampness, the primary seasonal challenge remains optimizing building performance to mitigate winter cold stress without inducing summer overheating.

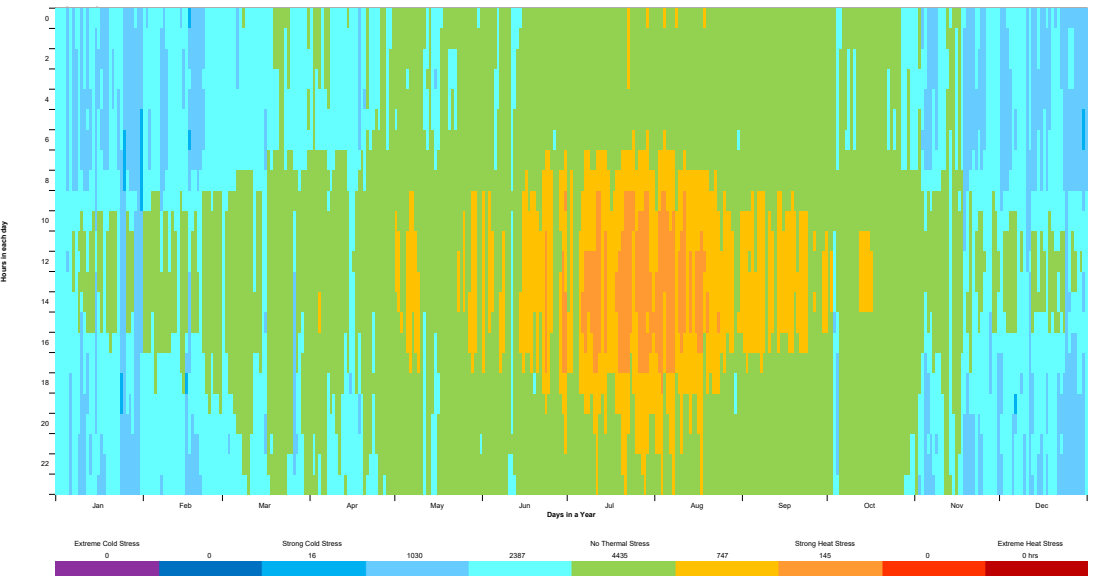


Figure 5.13: Universal Thermal Climate Index calendar graph for Turin charting the yearly distribution of outdoor human comfort, from sustained winter cold stress to brief summer heat peaks.

5.2 MICRO-CLIMATE INFILL

5.2.1 Existing envelope Direct Sun Hour Analysis

To evaluate the critical performance of the building envelope under peak summer conditions, a spatial simulation of direct sun hours was conducted specifically for the summer solstice. This specific solar analysis helps map out how direct sunlight interacts with the immense volumetric surfaces of the Palazzo del Lavoro when the sun reaches its maximum annual altitude. By observing the simulation results across both the roof plan and the vertical elevations, the solar exposure patterns reveal a clear contrast between the horizontal overhead plane and the massive perimeter glass facades. The simulated plan view clearly illustrates that the vast horizontal roof surface absorbs the most intense solar exposure, receiving maximum direct sun hours, which is indicated by the solid red zone covering the entire top plane. This extreme exposure creates an unavoidable thermal load that can lead to severe interior overheating if left unmanaged. On the other hand, the vertical elevations demonstrate a different, more shaded condition during the summer solstice. Because the sun sits at a very high angle in the sky at this time of year, the roof's prominent 25 meter high cantilevered profile acts as a massive passive horizontal overhang. This edge geometry successfully shades a significant portion of the main upper glazed facade, keeping large areas in a lower solar exposure zone, as shown by the light green and yellowish bands.

However, looking at the base of the structure, the lower glass bands and specific unshaded perimeter zones particularly those away from the deepest parts of the cantilever still show pockets of direct solar exposure during certain hours of the day. This distribution pattern proves that while the historic, structural expressionist roof geometry provides excellent self-shading during peak summer middays, additional high-performance solutions are still necessary. To protect the unshaded glass areas and the lower perimeter, the adaptive reuse strategy must combine the building's natural self-shading with dynamic internal partitions, selective performance glazing, or lightweight modular shading layers. This ensures a comfortable, low-energy indoor environment without disrupting the clean, historic aesthetic of the structural grid.

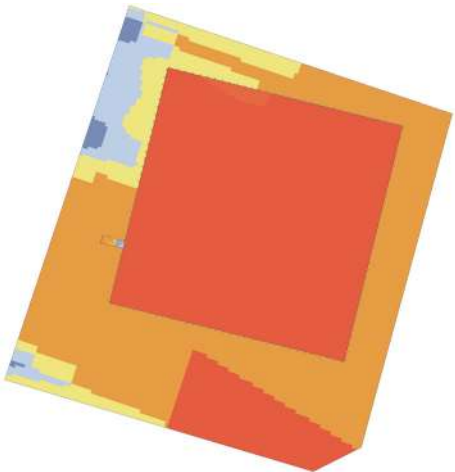


Figure 5.17: Direct sun hours visualized in plan during summer solstice.

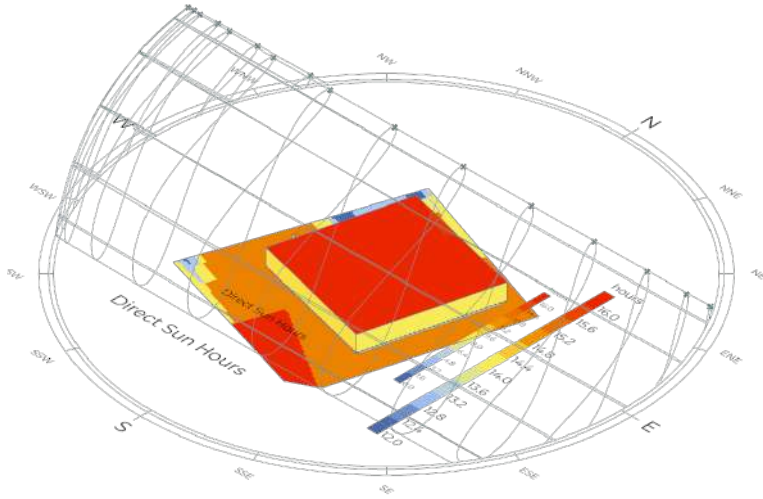


Figure 5.18: Direct sun hours isometric visualization during summer solstice.



Figure 5.19: Direct sun hours amount on south facade during summer solstice.



Figure 5.20: Direct sun hours amount on west facade during summer solstice.

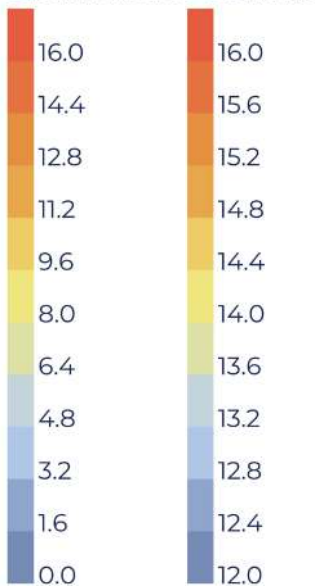


Figure 5.21: Direct sun hours amount on north facade during summer solstice.



Figure 5.22: Direct sun hours amount on east facade during summer solstice.

Ground hours PDL hours



5.2 MICRO-CLIMATE INFILL

5.2.1 Existing envelope Direct Sun Hour Analysis

To track how solar exposure shifts as the seasons transition, a spatial simulation of direct sun hours was conducted for the autumnal equinox. Comparing this analysis to the previous summer solstice data reveals how the changing solar geometry fundamentally alters the thermal behavior of the building envelope. As the sun drops to a lower altitude in the sky around September 21st, the direct angle of incidence hits the building surfaces differently, shifting the primary solar thermal stress from the horizontal overhead roof down onto the vertical glass facades. The simulated elevations clearly illustrate this seasonal shift. While the high summer sun was effectively blocked by the prominent 25-meter-high cantilevered roof structure, the lower-angle autumn sun easily penetrates beneath this geometric edge. As a result, the main vertical glass panels experience a substantial increase in direct solar exposure, turning large portions of the facade into higher sun-hour zones, indicated by the extensive orange and yellowish heat maps across the main building elevations. Conversely, because the sun is no longer striking from a stark zenith position, the expansive horizontal roof plane sees a noticeable decrease in absolute daily solar duration compared to its extreme summer peaks. This behavior highlights a critical design challenge for the rehabilitation project: the building envelope faces a dual thermal threat.

It must handle high overhead solar gains during the peak of summer and deeper solar penetration through the vertical glazing during transitional autumn months. The fact that the glass facades receive extensive direct sun hours during mid-season afternoons means that fixed horizontal shading alone cannot maintain interior comfort. To mitigate this deep solar gain and prevent seasonal indoor overheating, the design must incorporate adaptable internal partitions or dynamic shading strategies within the glass grid. This approach successfully manages solar heat gain throughout the changing seasons while respecting the historic, structural expressionist character of the original pavilion.

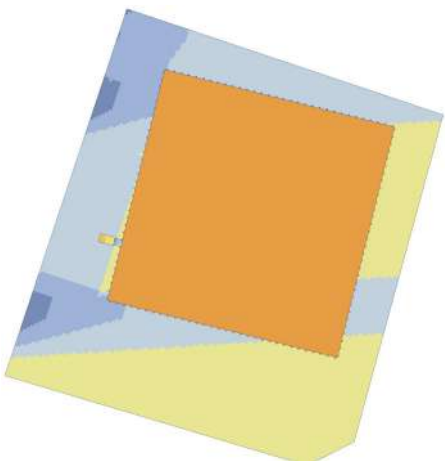


Figure 5.23: Direct sun hours visualized in plan during autumnal equinox.

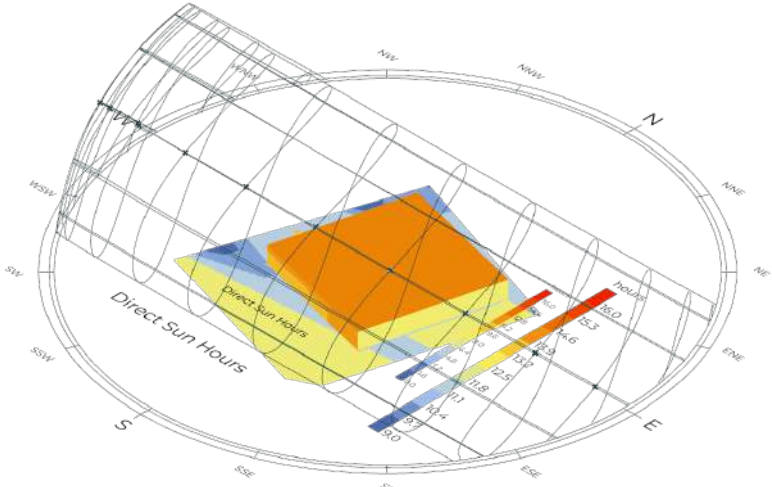


Figure 5.24: Direct sun hours isometric visualization during autumnal equinox



Figure 5.25: Direct sun hours amount on south facade during autumnal equinox



Figure 5.26: Direct sun hours amount on west facade during autumnal equinox



Figure 5.27: Direct sun hours amount on north facade during autumnal equinox

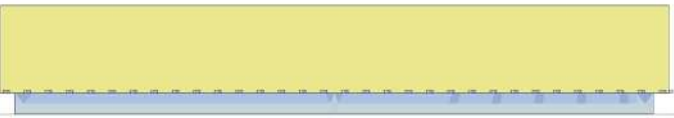
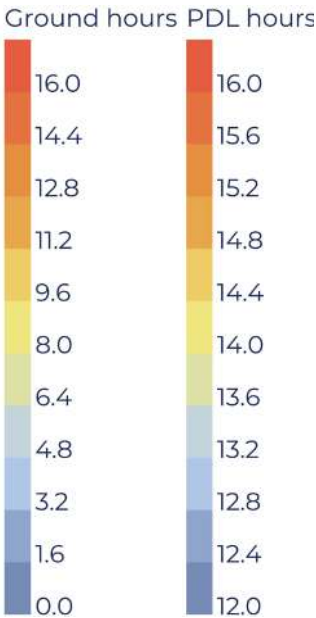


Figure 5.28: Direct sun hours amount on east facade during autumnal equinox



5.2 MICRO-CLIMATE INFILL

5.2.1 Existing envelope Direct Sun Hour Analysis

To complete the seasonal performance mapping of the building envelope, a spatial simulation of direct sun hours was conducted for the winter solstice. Analyzing this coldest period of the year specifically around December 21st reveals how the lowest annual solar trajectory interacts with the geometric forms of the Palazzo del Lavoro. During this phase, the building faces an environment where maximizing passive solar gains through the vertical facades is highly beneficial for offsetting winter heating loads, while the vast horizontal roof plane experiences its minimum seasonal exposure. The simulation graphics highlight this stark winter transition across all surfaces. Looking at the simulated roof plan view, the horizontal overhead surface is no longer a major source of intense thermal load, as shown by the uniform light greenish-yellow zone covering the top plane. On the vertical facades, the low angle of the winter sun completely reconfigures the shading dynamics of the 25 meter high cantilevered roof structure. Because the sun rays hit at a shallow angle, the deep cantilever no longer acts as a restrictive horizontal overhang. Instead, it allows direct winter sunlight to strike the expansive glazed elevations with minimal obstruction, keeping the main upper glass facade entirely out of the deep shadow zones seen during the summer solstice. However, the lower perimeter bands and specific surrounding grade zones show a distinctly shadowed behavior,

represented by the widespread cool purple and light blue zones. This indicates that while the upper vertical glazing successfully catches direct sunlight, ground-level surfaces and the lowest sections of the envelope are deeply affected by site topography and self-shading at low sun angles. For the adaptive reuse strategy, this winter distribution profile confirms that the upper glazed facades can act as major passive solar collectors to help heat the massive interior volume naturally. Therefore, any internal layout modifications or partition placements must be carefully coordinated to allow this low-angle winter sun to penetrate deep into the building core, while high-performance insulated glazing remains essential to minimize heat loss through the shaded lower perimeter.

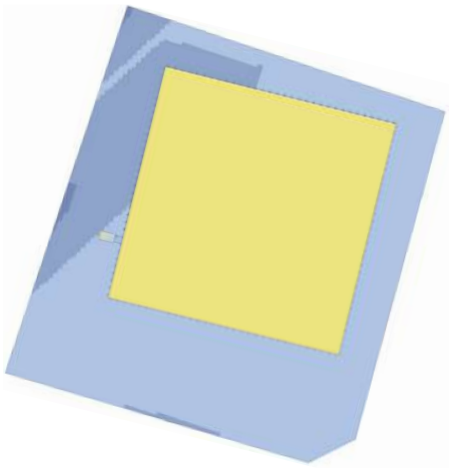


Figure 5.29: Direct sun hours visualized in plan during winter solstice..

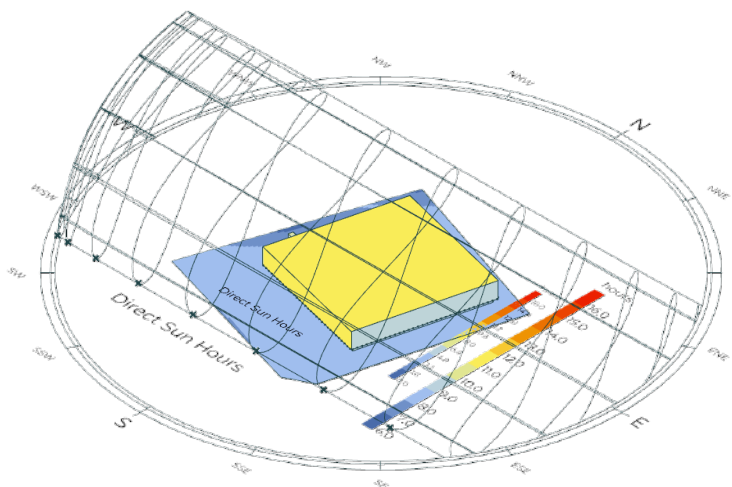


Figure 5.30: Direct sun hours isometric visualization during winter solstice.

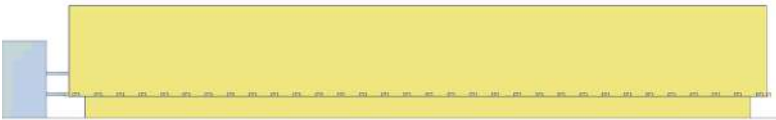


Figure 5.31: Direct sun hours amount on south facade during winter solstice.



Figure 5.32: Direct sun hours amount on west facade during winter solstice.

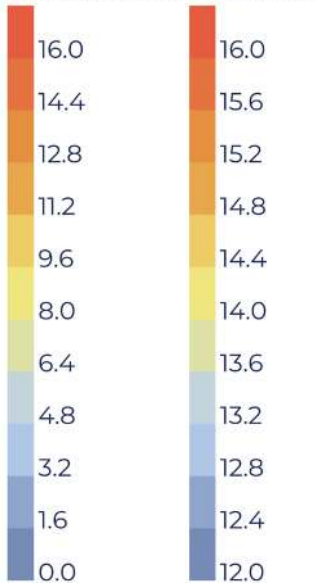


Figure 5.33: Direct sun hours amount on north facade during winter solstice.



Figure 5.34: Direct sun hours amount on east facade during winter solstice.

Ground hours PDL hours



5.2 MICRO-CLIMATE INFILL

5.2.2 Cumulative Incident Radiation

To transition from seasonal solar tracking to long-term renewable energy generation, a cumulative incident radiation analysis was conducted for both the ground plane and the roof surface. This simulation calculates the total annual solar energy striking the building's horizontal boundaries, measured in kilowatt-hours per square meter kWh/m². By mapping these cumulative values, the analysis establishes a precise, data-driven foundation for assessing the building's active solar potential and determining the most effective placement for photovoltaic (PV) arrays across the site. The simulation results reveal a significant contrast in solar potential between the two horizontal planes. In (fig. 5.36), the expansive, unobstructed roof surface operates as a high-yield solar zone, consistently receiving peak annual radiation levels that climb up to 1,300.0 kWh/m². This uniform, high-intensity distribution confirms that the horizontal roof plane is an ideal location for active renewable energy systems, offering excellent solar exposure over the course of the year to support a large-scale PV installation. Conversely, the ground-level analysis presented in (fig. 5.35) displays a much more varied radiation profile. While unshaded open areas of the plot reach similar peak values, a substantial portion of the ground plane drops into lower radiation brackets climbing down through 520.0 kWh/m² to 260.0 kWh/m²

due to the persistent overshadowing caused by the massive 25-meter-high pavilion structure and surrounding site feature. For the adaptive reuse and rehabilitation of the Palazzo del Lavoro, these cumulative radiation profiles dictate a clear hierarchy for active passive design interventions. The roof plane should be prioritized as the primary energy-generation hub, where a coordinated PV layout can maximize the 1,300.0 kWh/m² solar availability to significantly offset the building's operational energy footprint. Meanwhile, the highly irregular radiation patterns on the ground suggest that ground-mounted PV arrays would suffer from reduced efficiency due to structural self-shading. Instead, the varied ground-level solar profile should guide the spatial organization of outdoor public programs, landscape design, and microclimatic comfort zones, placing active outdoor spaces in high-exposure areas while utilizing the permanently shaded ground zones to mitigate urban heat island effects.

Figure 5.35: Cumulative Incident Radiation on the ground.

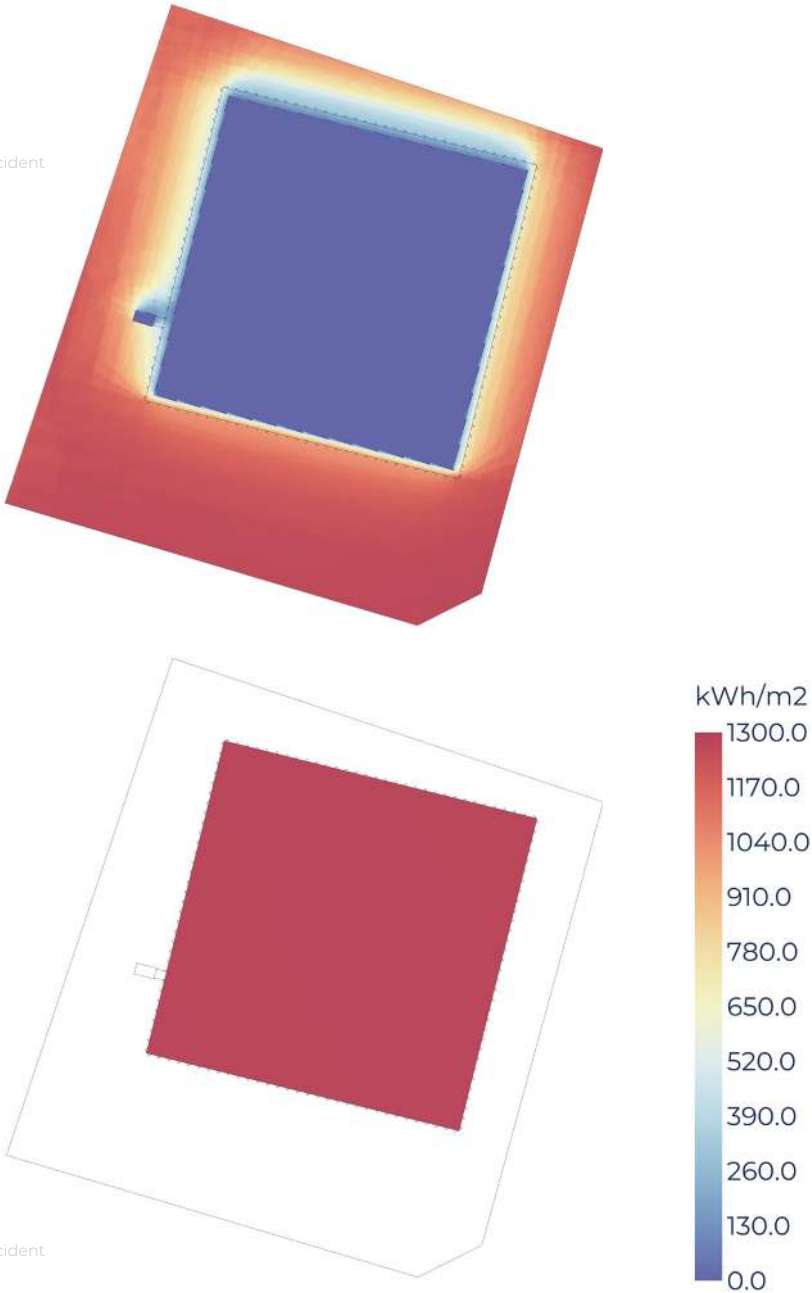


Figure 5.36: Cumulative Incident Radiation on the roof

5.2 MICRO-CLIMATE INFILL

5.2.2 Cumulative Incident Radiation

To optimize the thermal performance of the building envelope, a comparative cumulative incident radiation analysis was performed on the vertical glazing, contrasting an unshaded baseline scenario against a retrofitted facade incorporating an external shading system. Given the immense glass surface area of the Palazzo del Lavoro, calculating the total annual solar radiation striking the vertical planes is crucial for mitigating greenhouse effects and reducing peak cooling demands. The simulation results provide a clear, quantifiable look at how macro-scale architectural modifications can regulate solar heat gain across the expansive envelope. In the unshaded baseline models, the vertical facades are fully exposed to regional solar paths, leading to high cumulative radiation values across the glazed grid. The unshaded simulation diagrams reveal extensive mid-to-high radiation zones stretching uniformly across the primary elevations, represented by prominent orange, yellow, and bright blue thermal bands. This continuous exposure indicates that without any physical intervention, the massive interior volume would experience intense solar heat infiltration throughout the spring, summer, and autumn months. This high solar load would place an extreme burden on mechanical cooling systems and increase the risk of internal glare for occupants.

In the unshaded baseline models, the vertical facades are fully exposed to regional solar paths, leading to high cumulative radiation values across the glazed grid. The unshaded simulation diagrams reveal extensive mid-to-high radiation zones stretching uniformly across the primary elevations, represented by prominent orange, yellow, and bright blue thermal bands. This continuous exposure indicates that without any physical intervention, the massive interior volume would experience intense solar heat infiltration throughout the spring, summer, and autumn months. This high solar load would place an extreme burden on mechanical cooling systems and increase the risk of internal glare for occupants.

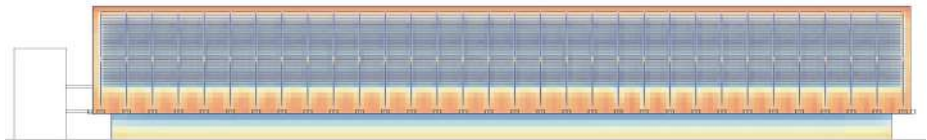


Figure 5.37: Cumulative incident radiation on south facade and the south shading system

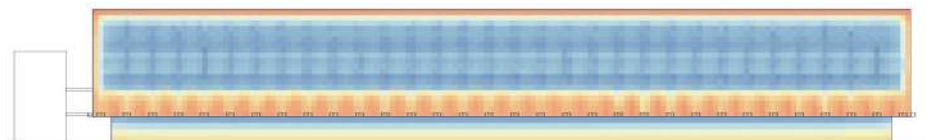


Figure 5.38: Cumulative incident radiation on south facade



Figure 5.39: Cumulative incident radiation on west facade and the south shading system

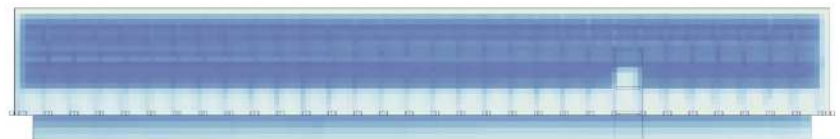


Figure 5.40: Cumulative incident radiation on west facade

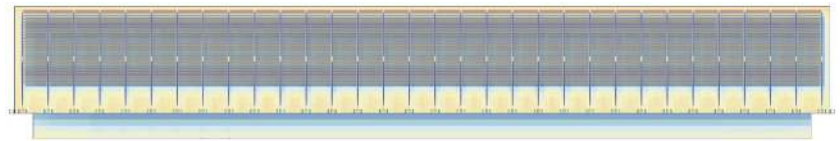


Figure 5.41: Cumulative incident radiation on east facade and the east shading system

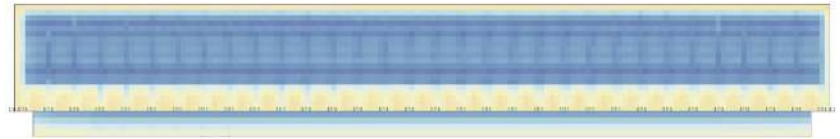
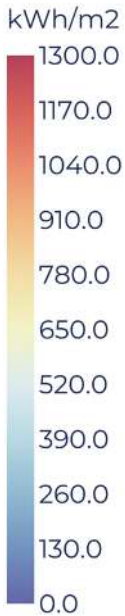


Figure 5.42: Cumulative incident radiation on east facade

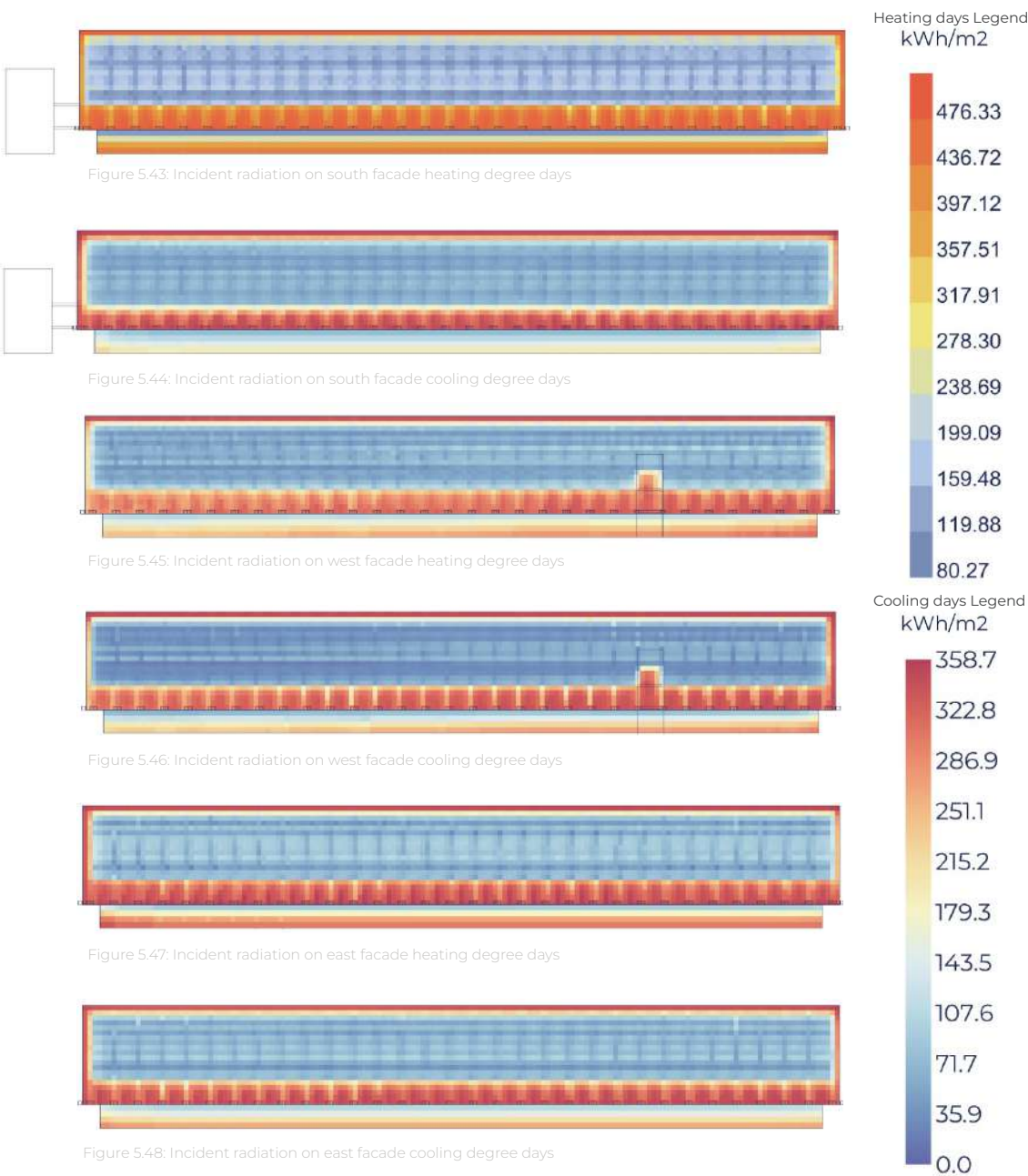


5.2 MICRO-CLIMATE INFILL

5.2.3 Thermal Demands

To refine the environmental response of the building envelope, a specialized seasonal radiation study was conducted, mapping facade incident radiation separately across heating and cooling degree hours. This step addresses a common limitation in standard annual simulations by separating the solar energy received when the building requires heating from the energy received when it requires cooling. Additionally, this analysis includes a precise calibration and correction of the simulation legends, ensuring that the numerical ranges directly correspond to the distinct thermal thresholds of Turin's climate. The simulation results during heating degree hours reveal that the vertical facades act as valuable passive assets during the cold winter and transitional months. When evaluating the envelope during periods that require heating, the solar radiation gradients show significant exposure across the southern and eastern orientations, with cumulative seasonal values climbing through stable ranges like 192.1 kWh/m² to 237.6 kWh/m². Because the sun travels along a much lower path during these months, its rays strike the vertical glazing at a highly effective angle, allowing a controlled amount of solar energy to penetrate the envelope and naturally warm the large interior volume. This passive solar heat gain is highly beneficial, as it directly offsets the building's heavy winter heating load without consuming mechanical energy.

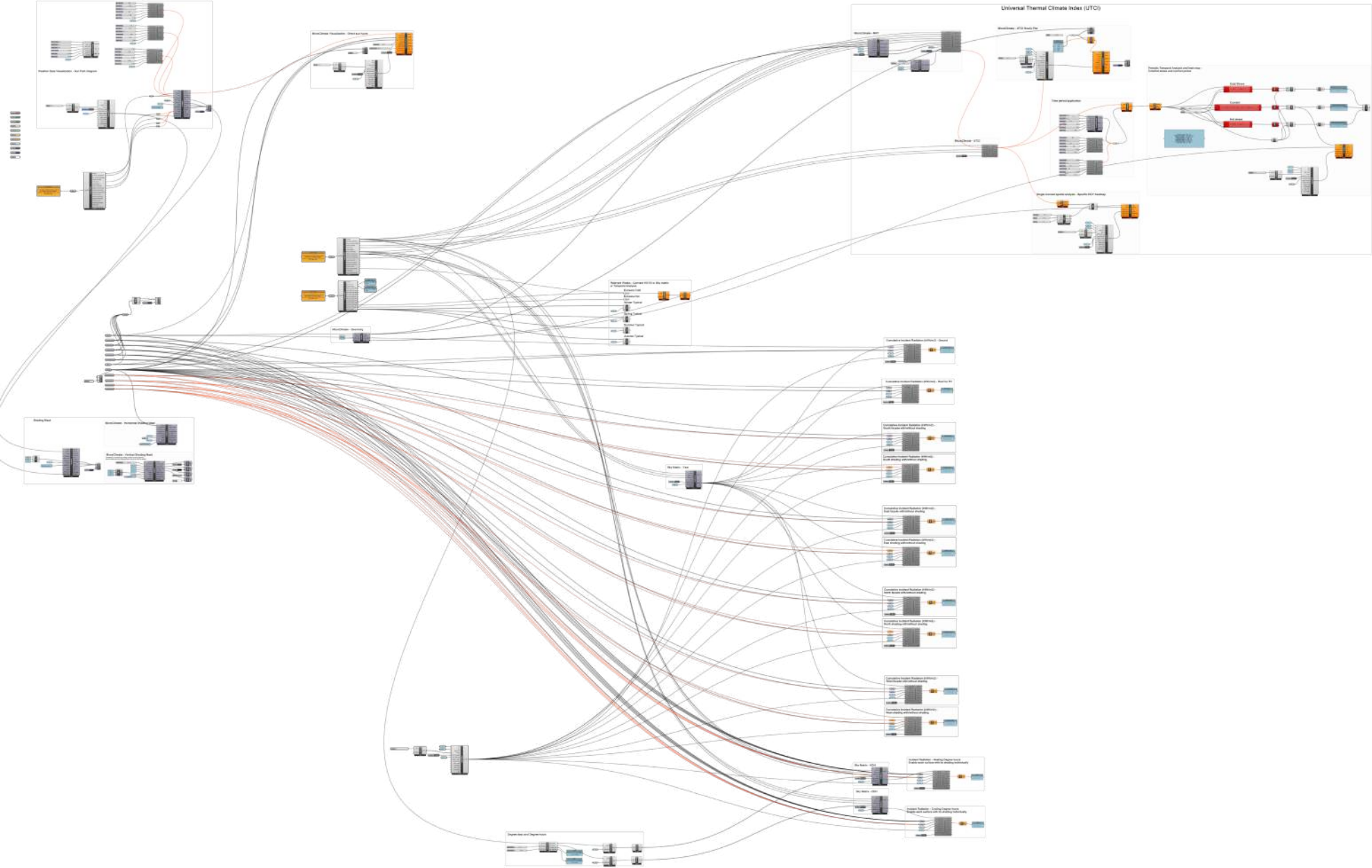
In contrast, the simulation across cooling degree hours isolates the exact solar stress the envelope must withstand during the hot summer period. During these hours, the western and southern vertical planes face intense, sustained solar radiation, with localized peaks reaching from 299.4 kWh/m² up to 365.9 kWh/m² and 476.33 kWh/m². This high concentration of solar energy occurs when the outdoor temperature is already high, turning unprotected glazing into a major liability for greenhouse overheating. By correcting and standardizing the legends across these seasonal states, the analysis highlights a clear performance duality: the adaptive reuse envelope must remain open and receptive to the low-angle 237.6 kWh/m² winter solar gains, while deploying robust, targeted shading to block the intense 476.33 kWh/m² summer exposure. This targeted approach ensures year-round thermal stability and significantly reduces the total operational energy footprint of the pavilion.



5.2 MICRO-CLIMATE INFILL

5.2.4 Software Usage

Usage of grasshopper and ladybug tools as the primary analysis software.



5.3 DAYLIGHT ANALYSIS

5.3.1 The Environmental Diagnosis (Baseline Chapter)

To accurately evaluate the microclimatic performance of the historic structure, a comprehensive environmental simulation was conducted using ClimateStudio. A global annual performance analysis reveals an environmental conflict within the building's original, unconditioned state. The massive historical glazing envelope delivers an exceptional global Spatial Daylight Autonomy (sDA_{300/50%}) of 91.6%, meaning that nearly the entire interior volume remains fully illuminated by natural light throughout the year. However, this unmitigated light penetration creates immediate, severe microclimatic problems. The structure's global Annual Sunlight Exposure (ASE_{1000,250}) reaches 12.0%, failing the premium 10% target standard for comfortable workspace occupancy. This high baseline exposure subjects major zones across the open floor plates to more than 1,000 lux of direct, unshaded sunlight for over 250 hours a year. This unchecked radiation path pushes the global average illuminance to a high baseline mean of 1,139 lux, forcing a highly volatile luminous climate characterized by extreme visual contrast, rapid

heat gains, and widespread glare. This exposure translates directly into structural visual discomfort. Annual baseline tracking shows that 3.7% of critical view views experience severe, disturbing glare (sDG) for more than 45% of operational hours. To combat these intense solar spikes and maintain basic habitability, the building envelope is forced into heavy reliance on its shading systems. Baseline simulations track that the automated perimeter blinds must remain closed for a significant portion of the year, leaving the facade fully open only 88.8% of the time. The structural lack of native architectural shading is further confirmed by evaluating the hall under a completely overcast sky distribution. Under these uniform, cloud-covered conditions, the building records an intense 4.4% Mean Daylight Factor (DF) and a 3.9% Median Daylight Factor. In daylighting design, an overcast cloudy winter days, confirming that the shell requires an independent, internal architectural intervention to protect its programmatic zones.



Figure 5.49: Base average annual glare results

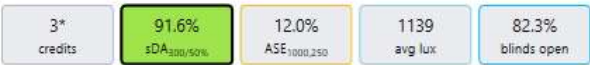


Figure 5.50: Base average daylight availability results



Figure 5.51: Base average daylight factor results

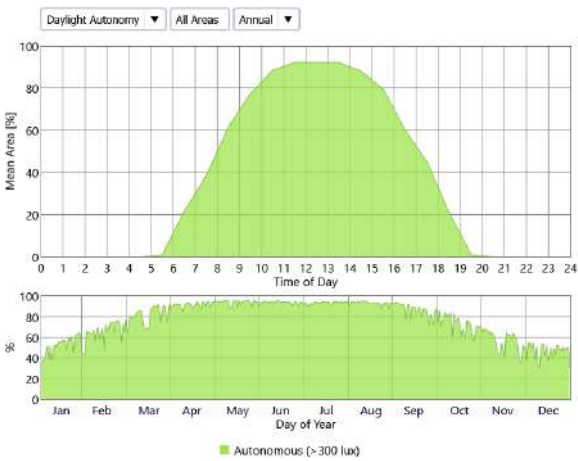


Figure 5.52: Base daylight autonomy chart average.

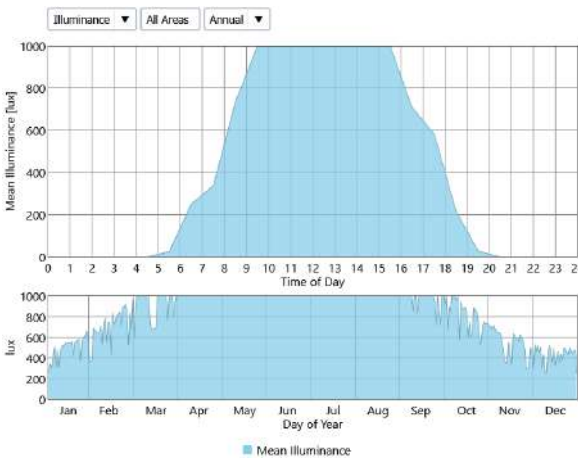


Figure 5.53: Base illuminance chart average.

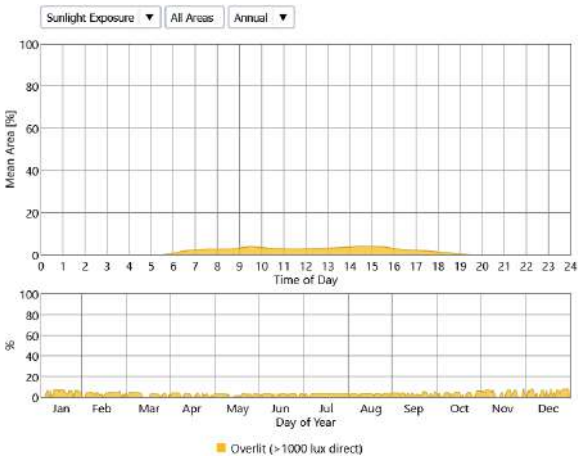


Figure 5.54: Base sunlight exposure chart average.

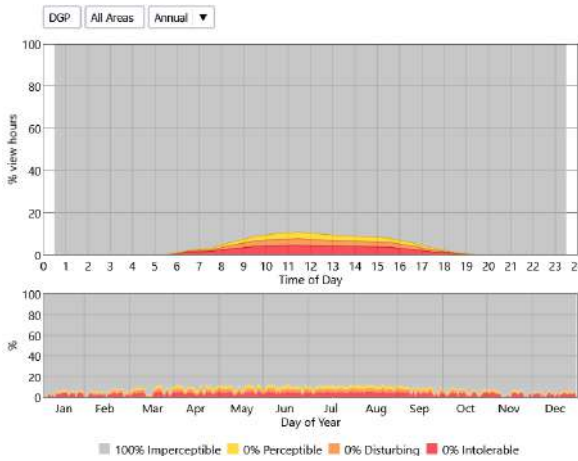


Figure 5.55: Base annual daylight glare probability chart average.

5.3 DAYLIGHT ANALYSIS

5.3.1 The Environmental Diagnosis (Baseline Chapter)

Spatial Daylight Autonomy (sDA) Localized Mapping

Evaluating the baseline building envelope down to individual floor plates illustrates the severe vertical stratification of natural light penetration. The Ground Floor plate demonstrates near total luminous availability with minor sensor dropouts appearing only along perimeter column blockages. On the intermediate 1st Floor loop platform,

structural shadows cast by the deep upper concrete cantilever slabs introduce localized protection, pulling the tier down to its baseline area average. The upper 2nd and 3rd Floor platforms sit fully exposed to unobstructed lateral light tracks through the high-angle glazing, creating permanently over-irradiated zones that lack any spatial depth or shade.

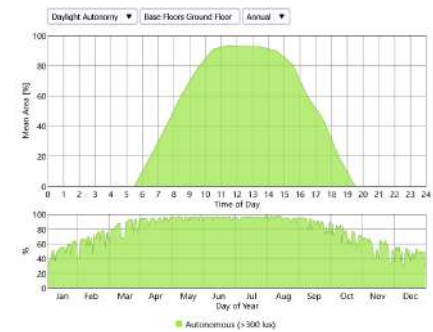


Figure 5.56: Base daylight autonomy chart ground floor.

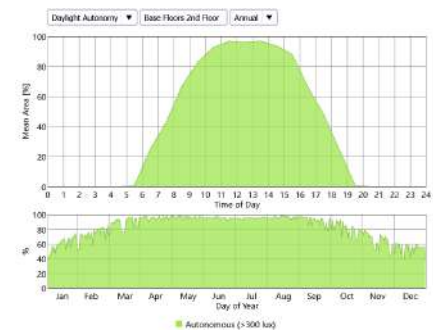


Figure 5.58: Base daylight autonomy chart second floor.

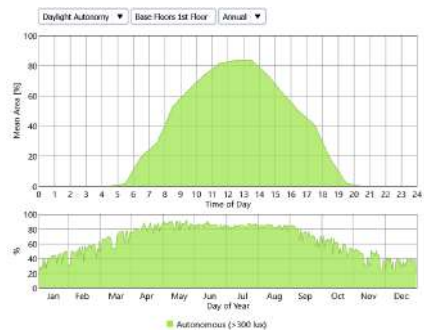


Figure 5.57: Base daylight autonomy chart first floor.

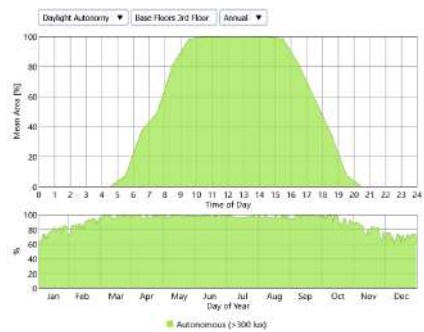


Figure 5.59: Base daylight autonomy chart third floor.



Figure 5.60: Base daylight autonomy ground floor plan.

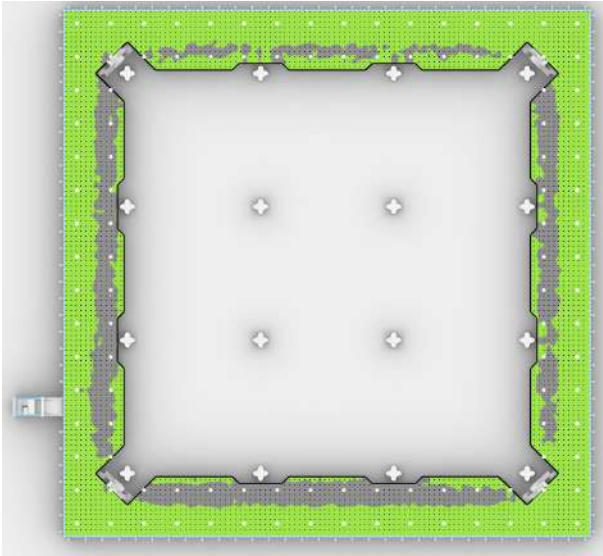


Figure 5.61: Base daylight autonomy first floor plan.

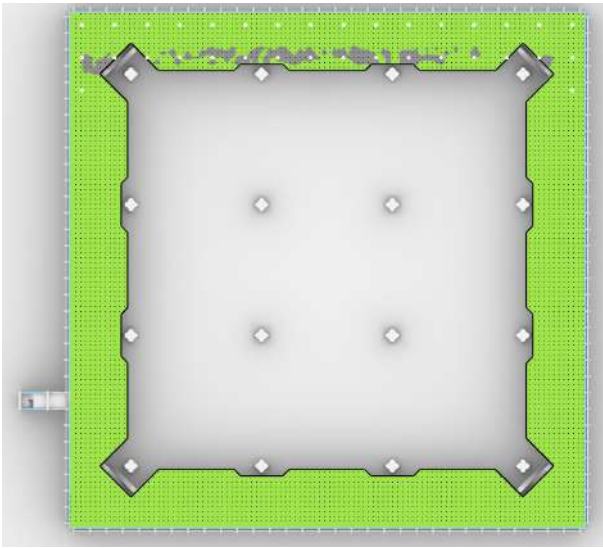


Figure 5.62: Base daylight autonomy second floor plan.

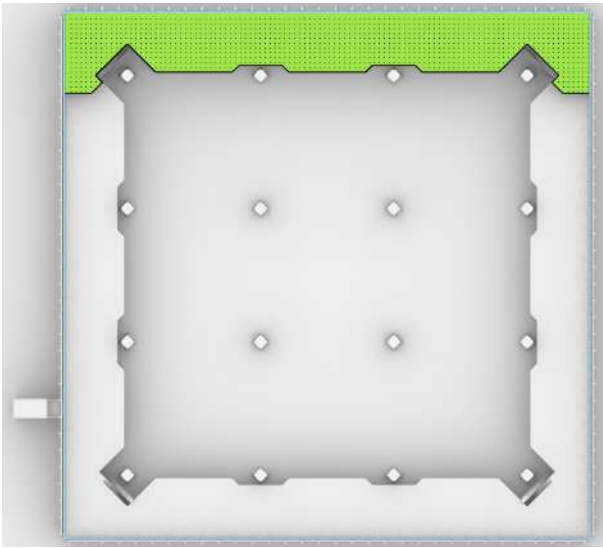
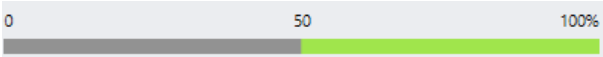


Figure 5.63: Base daylight autonomy third floor plan.



5.3 DAYLIGHT ANALYSIS

5.3.1 The Environmental Diagnosis (Baseline Chapter)

Annual Sunlight Exposure (ASE) Spatial Penetration

Localized floor by floor ASE simulations clarify exactly where high-intensity solar tracks undermine internal habitability. The Ground Floor plate demonstrates a persistent ribbon of over-lit territory directly behind the southern and eastern glazing, alongside a clear horizontal solar track cutting through the lower core.

On the elevated intermediate tiers, this exposure sharpens significantly. The 1st and 2nd Floor loop platforms are subjected to deep, direct solar penetration along their perimeter edges during high-angle sun conditions. The 3rd Floor tier shows direct solar gains localized on its northern platform edge, confirming that the vast, open volume lacks a permanent geometric filter to shield active programming zones.

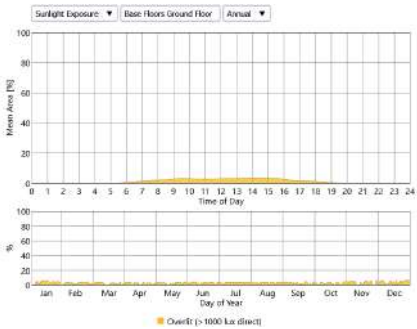


Figure 5.64: Base sunlight exposure chart ground floor.

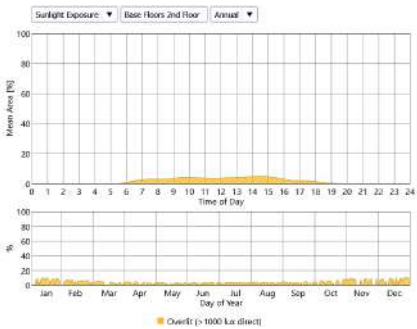


Figure 5.66: Base sunlight exposure chart second floor.

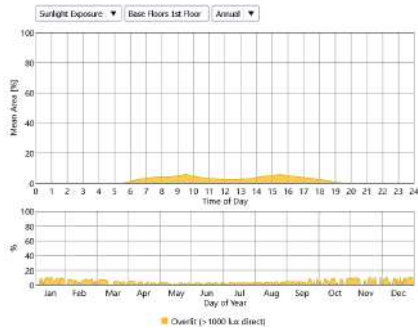


Figure 5.65: Base sunlight exposure chart first floor.

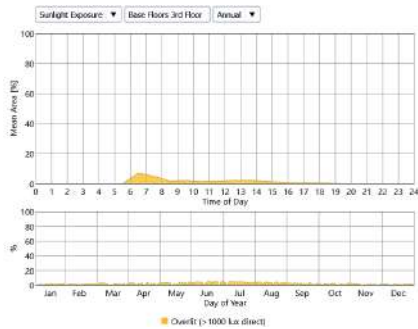


Figure 5.67: Base sunlight exposure chart third floor.

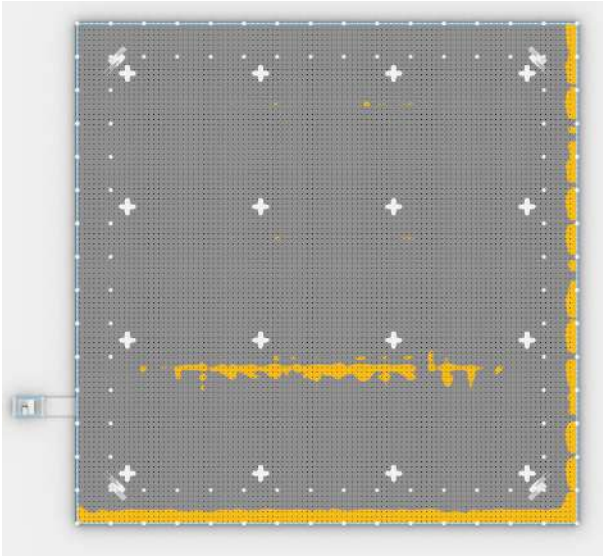


Figure 5.68: Base sunlight exposure ground floor plan.

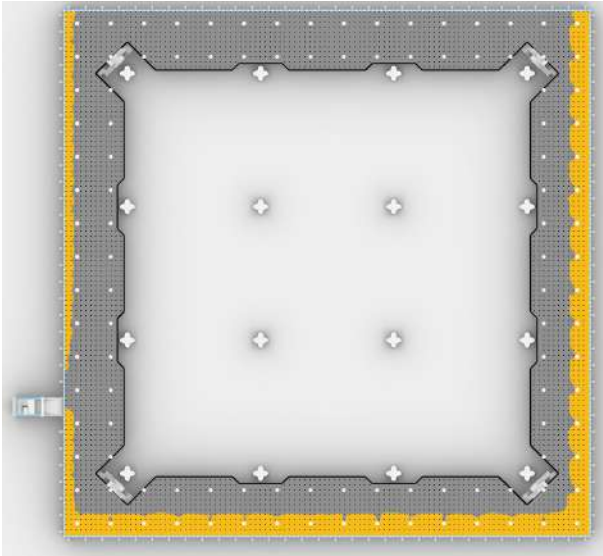


Figure 5.69: Base sunlight exposure first floor plan.

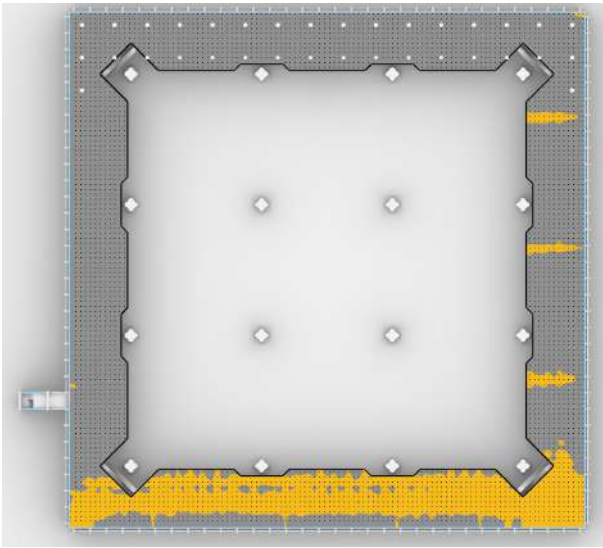


Figure 5.70: Base sunlight exposure second floor plan.

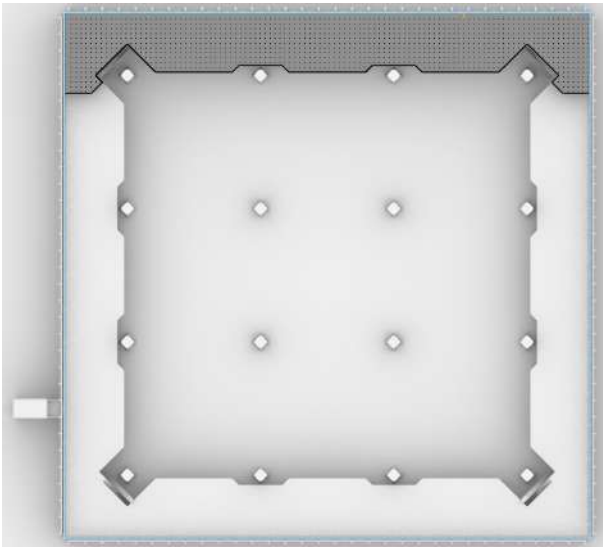
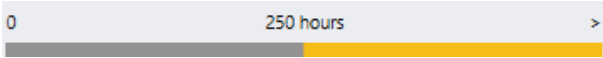


Figure 5.71: Base sunlight exposure third floor plan.



5.3 DAYLIGHT ANALYSIS

5.3.1 The Environmental Diagnosis (Baseline Chapter)

Mean Ambient Illuminance (Avg Lux) Distribution
Floor by floor annual illuminance mapping highlights the high solar concentration and severe light gradients within the unmitigated historic envelope. The Ground Floor plate maintains a highly volatile green to yellow core averaging over 1,100 lux, with clear orange linear tracks mapping direct sun paths under the roof structure.

On the intermediate loops, a steep lighting gradient occurs, shifting rapidly from hot red facade boundaries to deep purple interior voids. The upper 3rd Floor platform experiences severe over exposure under clear skies, pushing a massive 2,247 lux annual mean that confirms a volatile visual climate lacking any architectural depth or shade.

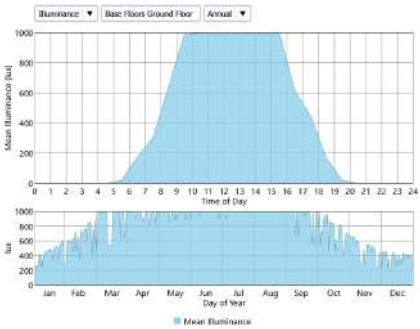


Figure 5.72: Base illuminance chart ground floor.

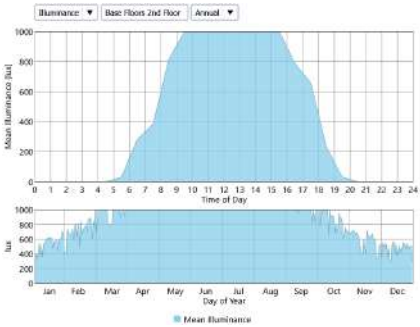


Figure 5.74: Base illuminance chart second floor.



Figure 5.73: Base illuminance chart first floor.



Figure 5.75: Base illuminance chart third floor.

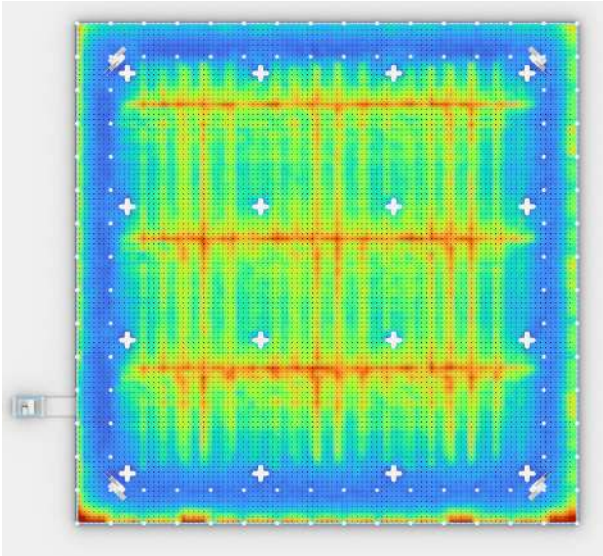


Figure 5.76: Base illuminance ground floor plan.

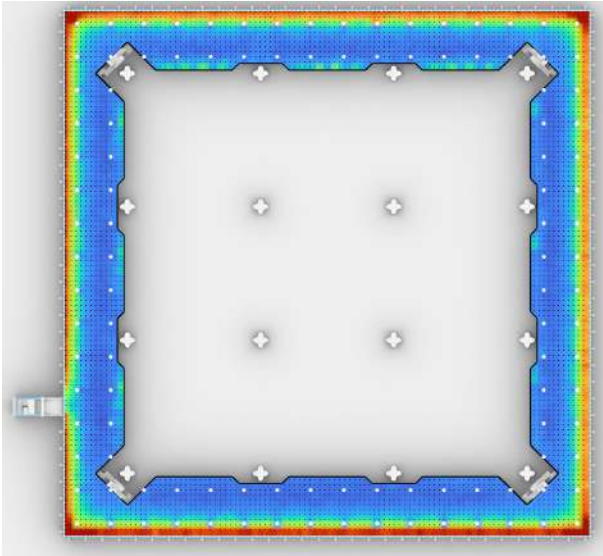


Figure 5.77: Base illuminance first floor plan.

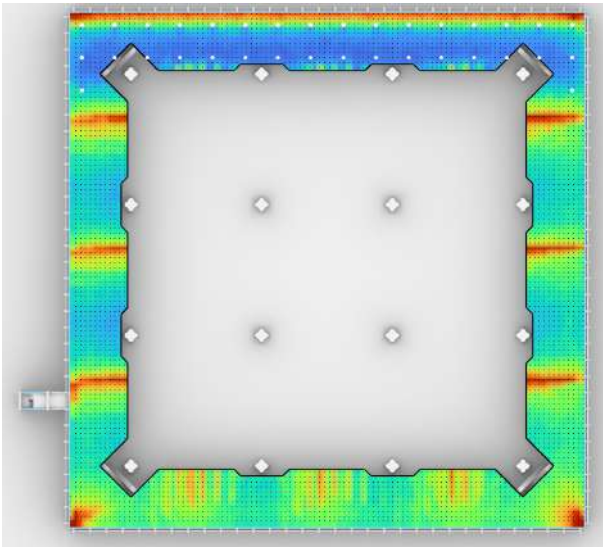


Figure 5.78: Base illuminance second floor plan.

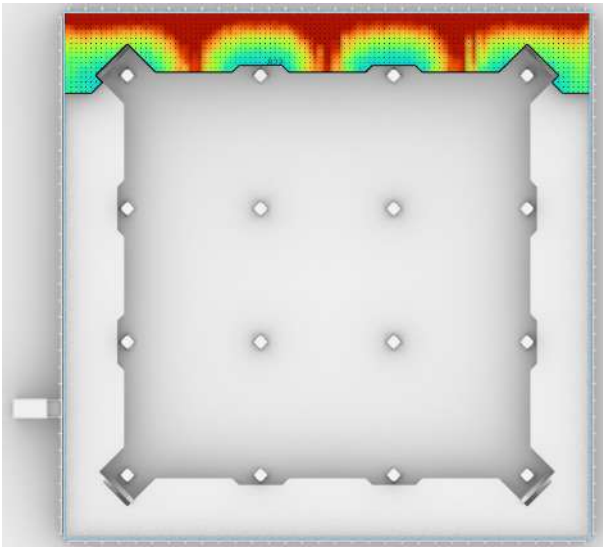


Figure 5.79: Base illuminance third floor plan.



5.3 DAYLIGHT ANALYSIS

5.3.1 The Environmental Diagnosis (Baseline Chapter)

Daylight Factor (DF) Overcast Distribution

Evaluating the historic structure under a static, completely overcast sky distribution isolates the native performance of the shell independent of variable direct solar positions. The resulting spatial maps track exactly how light behaves as it travels through the 25 meter high glazed volume under uniform, cloud-covered winter conditions. The Ground Floor plate displays an intensely saturated layout, featuring a large yellow grid across the central core. This occurs because the massive open volume allows top-down ambient light to collect heavily at the base, leaving only the deep perimeter column junctions in darker purple shadow zones. On the intermediate 1st and 2nd Floor loops, a sharp geometric shift is visible: the upper concrete cantilevers cast deep structural shadows over their own levels, restricting the bright yellow zones strictly to the facade edges while the inner walking paths drop into low purple and blue percentage ranges. The isolated 3rd Floor platform remains entirely enveloped in a uniform yellow field, demonstrating that the highest tier is completely over-irradiated even when there is zero direct sun outside.

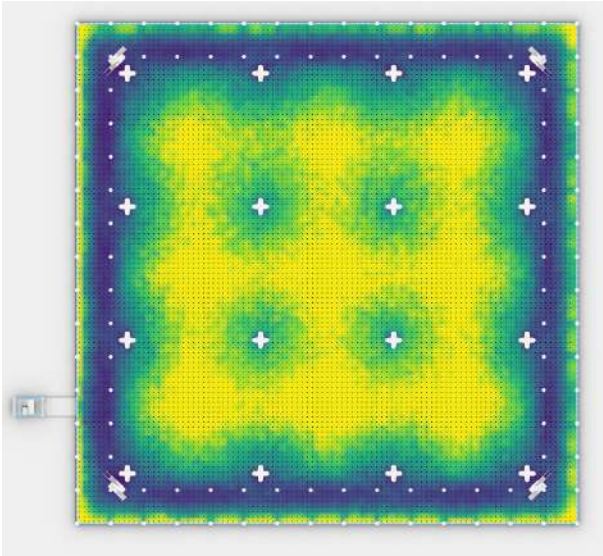


Figure 5.80: Base daylight factor ground floor plan.

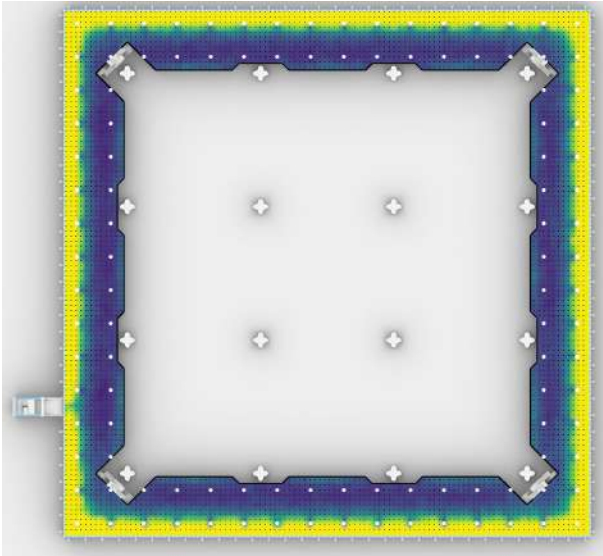


Figure 5.81: Base daylight factor first floor plan.

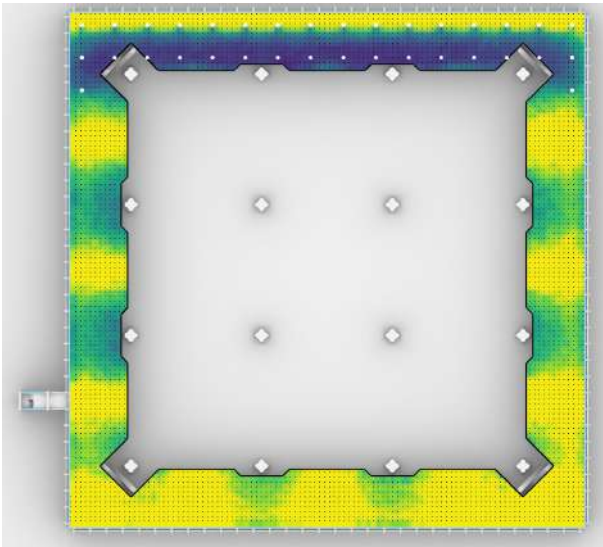


Figure 5.82: Base daylight factor second floor plan.

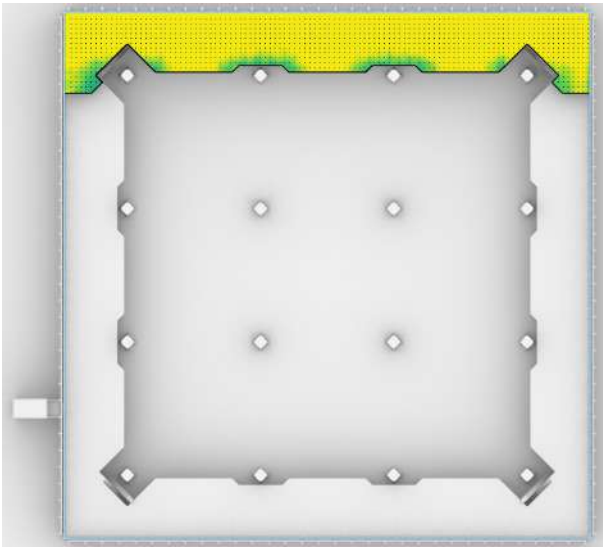


Figure 5.83: Base daylight factor third floor plan.



5.3 DAYLIGHT ANALYSIS

5.3.1 The Environmental Diagnosis (Baseline Chapter)

Localized Glare Probability (DGP) Stratification

Floor by floor annual Daylight Glare Probability metrics expose a severe vertical comfort imbalance native to the unmitigated historic shell. The Ground Floor plate remains highly protected by the deep geometric volume overhead, registering 100% Imperceptible glare hours over the entire annual timeline. However, moving up into the intermediate platforms reveals immediate visual vulnerability as the view paths clash with direct solar angles. The 1st Floor loop records a combined 8% compromised view hours (3% Disturbing, 5% Intolerable), while the 2nd Floor plate stabilizes slightly but still maintains 5% critical glare (2% Disturbing, 3% Intolerable). The environmental crisis peaks on the highest occupied level; the 3rd Floor platform experiences severe solar exposure, forcing a critical breakdown with only 71% Imperceptible conditions, leaving 9% Disturbing and 13% Intolerable glare fields dominating mid-year occupancy.

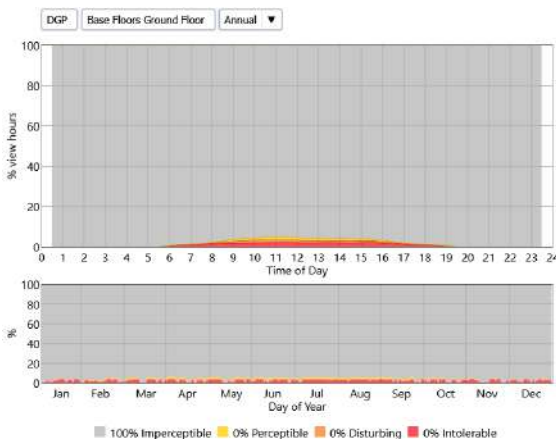


Figure 5.84: Base daylight glare probability chart ground floor.

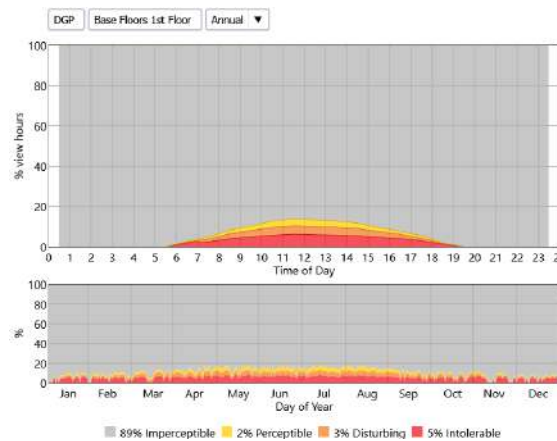


Figure 5.85: Base daylight glare probability chart first floor.

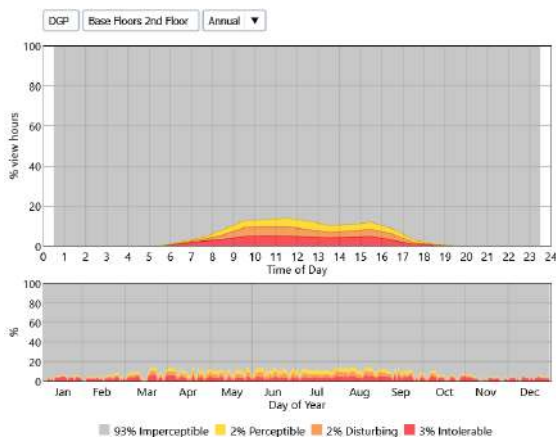


Figure 5.86: Base daylight glare probability chart second floor.

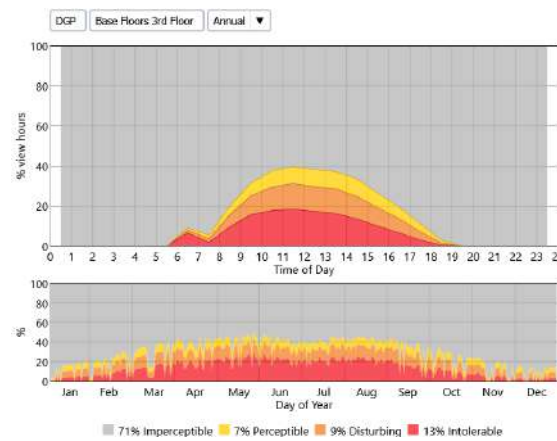


Figure 5.87: Base daylight glare probability chart third floor.

5.3 DAYLIGHT ANALYSIS

5.3.2 The Architectural Solution (Design Chapter)

The introduction of the modular architectural intervention successfully balances the severe environmental challenges of the unconditioned envelope without altering the historic glass facade. By introducing strategic internal geometries, the global Spatial Daylight Autonomy (sDA_{300/50}) is optimized from the original over-irradiated baseline down to a functional 65.5%. This shift preserves generous natural light throughout the public circulation zones while carving out reliable, naturally shaded areas specifically for the new programming pods. The impact of this architectural filtering is most evident in the reduction of high-intensity exposure risks. The global Annual Sunlight Exposure (ASE_{1000,250}) drops sharply to 6.5%, bringing the entire building safely below the strict 10% international comfort threshold. By eliminating these direct solar spikes, the ambient luminous climate stabilizes, maintaining a comfortable and uniform global average illuminance of 787 lux.

The spatial shielding provided by the intervention secures permanent visual comfort across the floor plates, dropping the percentage of views experiencing disturbing glare (sDG) to a negligible 1.5%. Because the internal structure handles the solar mitigation naturally, the building achieves almost total independence from heavy motorized shading. Under the design state, the automated facade blinds remain fully retracted 92.9% of the year, preserving the clear, transparent architectural expression of the landmark hall. Testing under overcast sky distributions further validates this layout. The cloudy performance records a balanced 2.9% Mean Daylight Factor and a 2.0% Median Daylight Factor. This confirms that the interior platforms stay perfectly bright and usable on overcast winter days without risking the solar over-exposure that plagued the original baseline. The simulations were done by sensor spacing of 1.5 meters for base floors and 0.5 meter for pods.

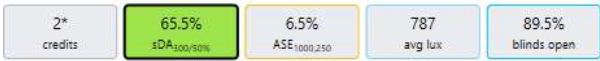


Figure 5.89: Design average daylight availability results



Figure 5.88: Design average annual glare results



Figure 5.90: Design average daylight factor results

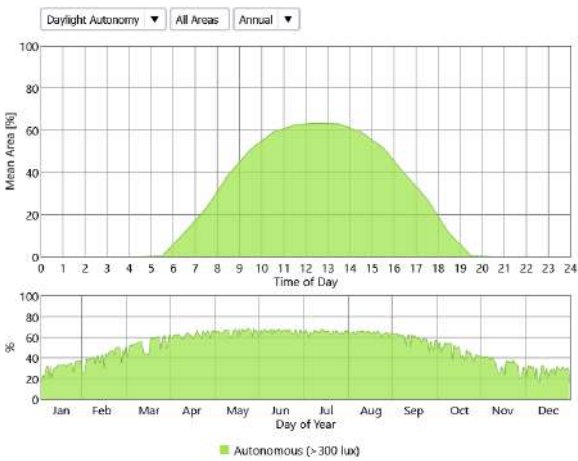


Figure 5.91: Design daylight autonomy chart average.

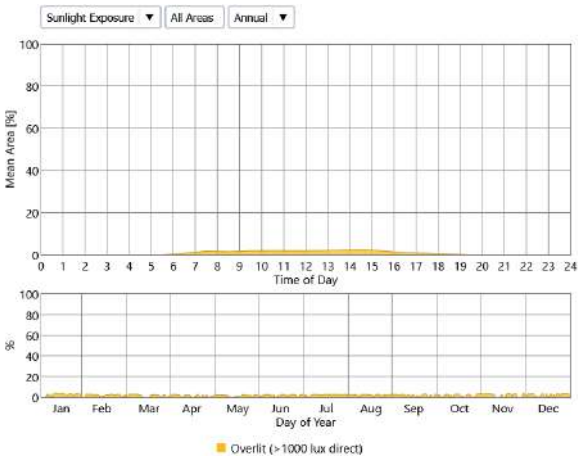


Figure 5.93: Design sunlight exposure chart average.

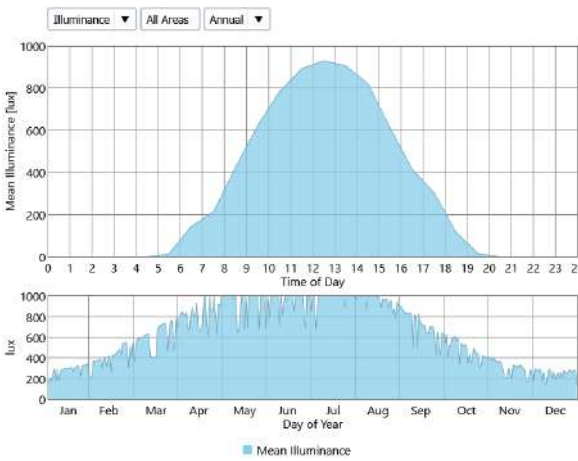


Figure 5.92: Design illuminance chart average.

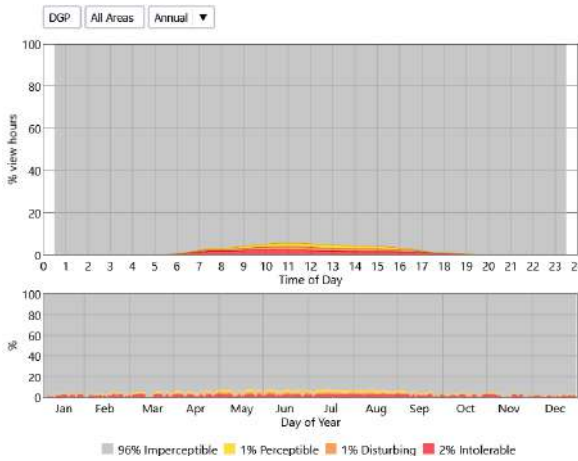


Figure 5.94: Design annual daylight glare probability chart average.

5.3 DAYLIGHT ANALYSIS

5.3.2 The Architectural Solution (Design Chapter)

sDA & Programmatic Zoning

The modular intervention successfully resolves the over-lit baseline environment by organizing natural light based on precise programmatic needs. Public walkways, perimeter bridges, and outer edge platforms retain high daylight exposure (bright green fields). This natural illumination is directly leveraged on the first and second floor perimeters, where workshops, classrooms, and offices are positioned to maximize occupant well-being.

Conversely, the central core areas experience a deliberate, calculated drop in sDA. This protected, low-irradiation zone is intentionally paired with cultural and commercial programs such as the museum, cinema, and retail spaces which natively depend on controlled artificial lighting. By shielding these sensitive zones from the aggressive lateral facade vectors, the design ensures total visual control where it is most required while letting active work environments breathe along the perimeter.

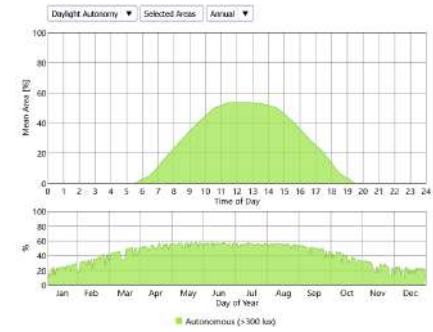


Figure 5.95: Design daylight autonomy chart ground floor.

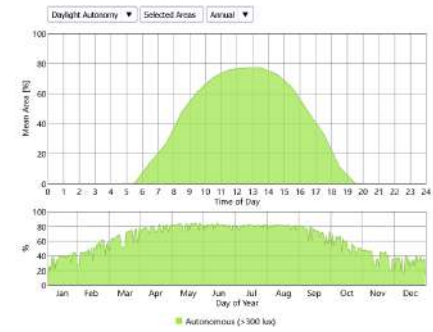


Figure 5.97: Design daylight autonomy chart second floor.

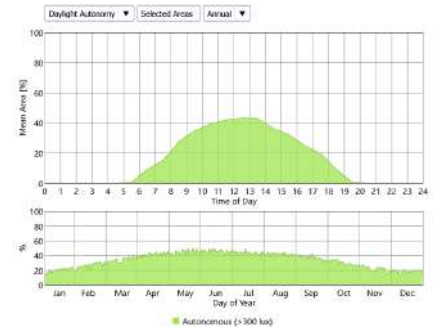


Figure 5.96: Design daylight autonomy chart first floor.

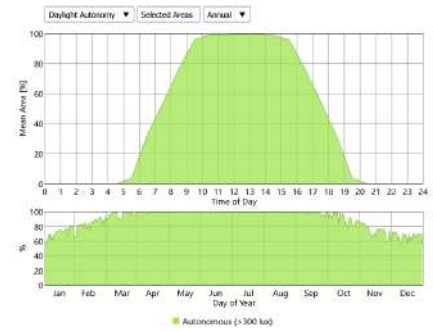


Figure 5.98: Design daylight autonomy chart third floor.



Figure 5.99: Design daylight autonomy ground floor plan.

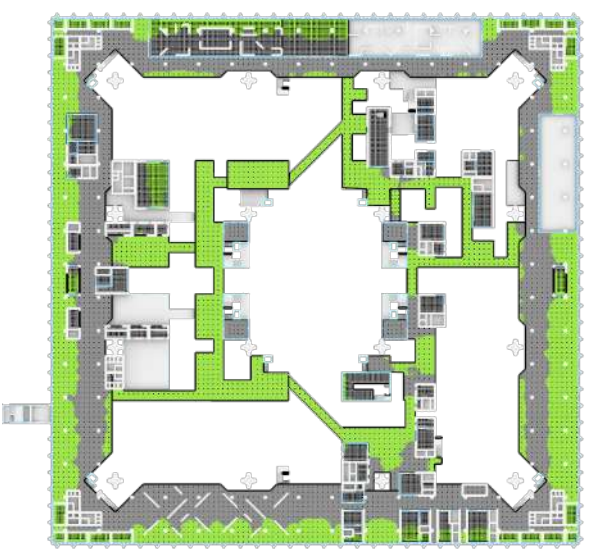


Figure 5.100: Design daylight autonomy first floor plan.



Figure 5.101: Design daylight autonomy second floor plan.

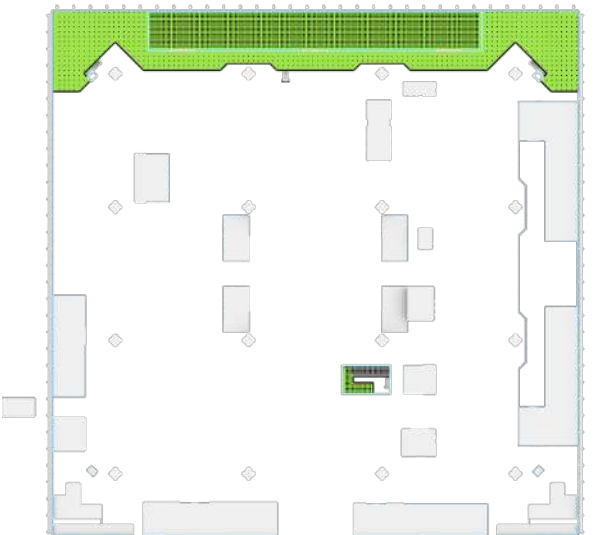
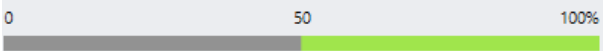


Figure 5.102: Design daylight autonomy third floor plan.



5.3 DAYLIGHT ANALYSIS

5.3.2 The Architectural Solution (Design Chapter)

ASE Mitigation & Structural Shielding

The architectural intervention successfully lowers the high solar exposure from the original baseline shell. With the introduction of the modular pods and solid roof geometries, the building's global ASE drops safely to a balanced 6.5%. The spatial layout maps show that high-intensity, direct sunlight exposure tracks (the yellow zones) are now tightly restricted. While select pods use controlled roof glazing to bring soft light inside,

the vast majority utilize opaque roof planes to block harsh direct rays. On the ground, first, and second floors, these solar peaks are confined strictly to the outer perimeter circulation edges. The internal office pods, classrooms, and workshops are protected by their solid enclosures, eliminating localized heat gains and intense glare. On the third floor, the design shields the perimeter walkway, ensuring a stable visual climate across the highest occupied platform.



Figure 5.103: Design sunlight exposure chart ground floor.

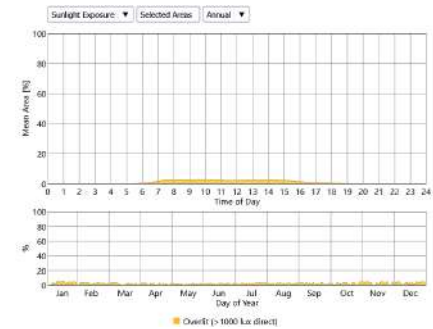


Figure 5.105: Design sunlight exposure chart second floor.

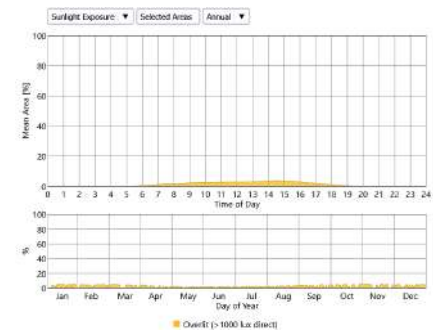


Figure 5.104: Design sunlight exposure chart first floor.



Figure 5.106: Design sunlight exposure chart third floor.

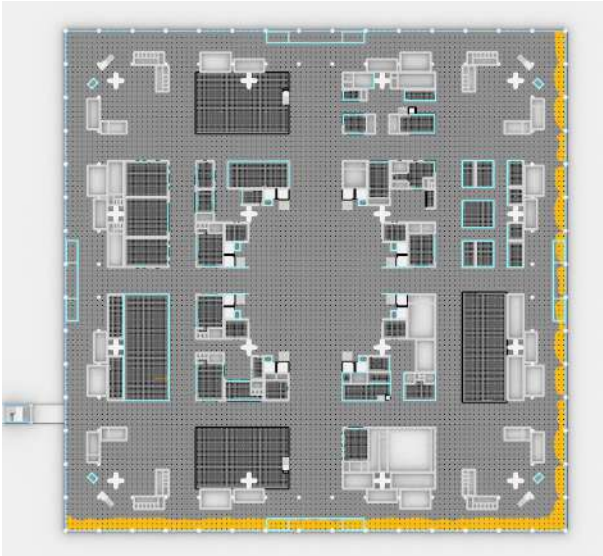


Figure 5.107: Design sunlight exposure ground floor plan.

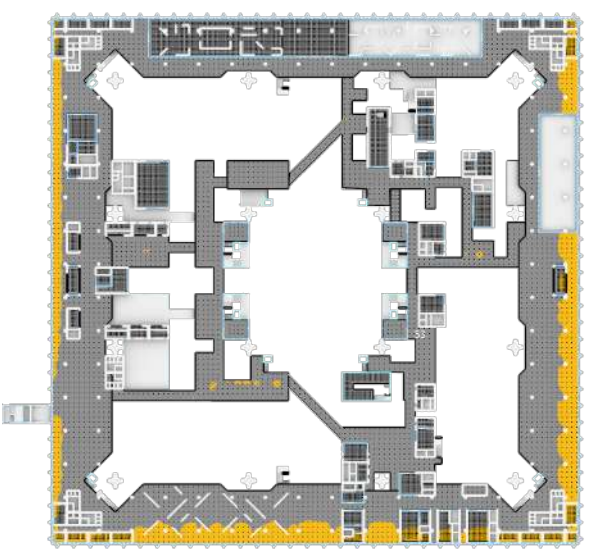


Figure 5.108: Design sunlight exposure first floor plan.



Figure 5.109: Design sunlight exposure second floor plan.

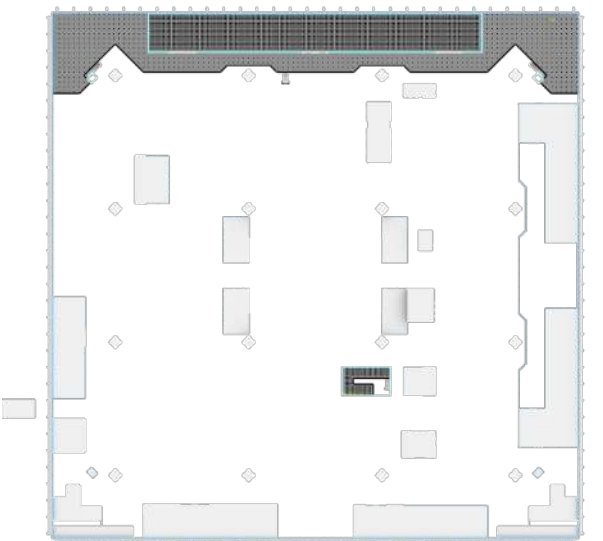
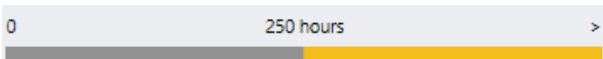


Figure 5.110: Design sunlight exposure third floor plan.



5.3 DAYLIGHT ANALYSIS

5.3.2 The Architectural Solution (Design Chapter)

Illuminance Distribution & Luminous Balance

The spatial distribution of annual average illuminance confirms that the design intervention successfully balances light levels throughout the deep open plan. The global average illuminance stabilizes at 787 lux, providing high-quality natural light without causing visual strain. The plan maps show a clear transition from the bright perimeter edges into the protected core pods. The outer circulation pathways naturally

receive the highest illuminance levels, matching peak daylight hours. This natural light penetrates into the perimeter work spaces on the first and second floors, significantly reducing the need for artificial lighting. Inside the central core pods, the solid roofing and partitions filter out the intense solar rays, maintaining a lower, highly consistent lux range. This controlled environment ensures that the museum and retail functions operate with optimal visual comfort and no direct solar interference.

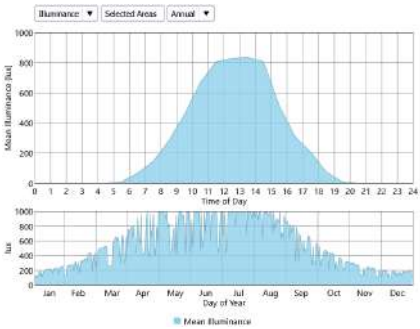


Figure 5.111: Design sunlight exposure chart ground floor.

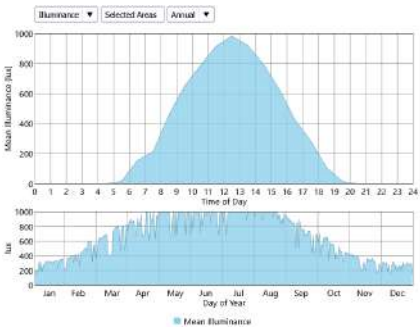


Figure 5.113: Design sunlight exposure chart second floor.

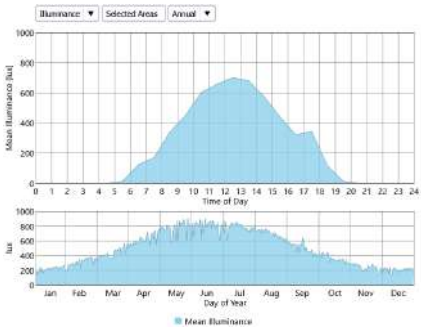


Figure 5.112: Design sunlight exposure chart first floor.

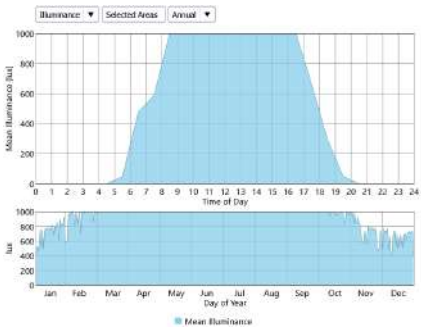


Figure 5.114: Design sunlight exposure chart third floor.

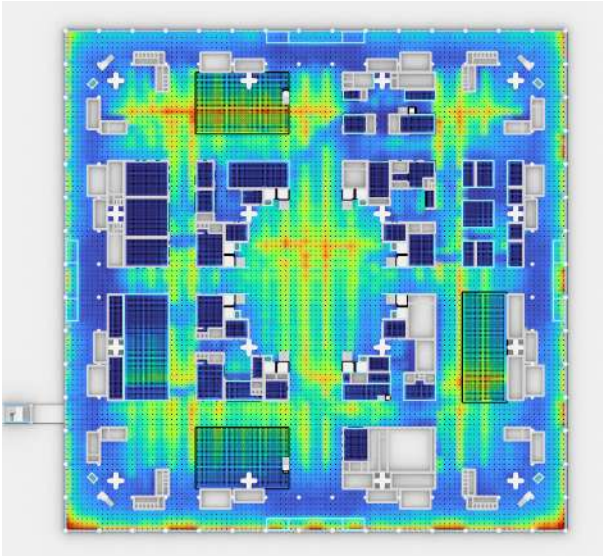


Figure 5.115: Design sunlight exposure ground floor plan.

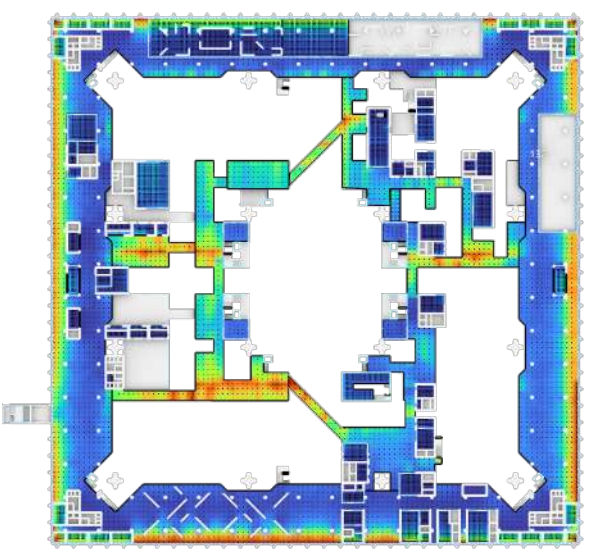


Figure 5.116: Design sunlight exposure first floor plan.

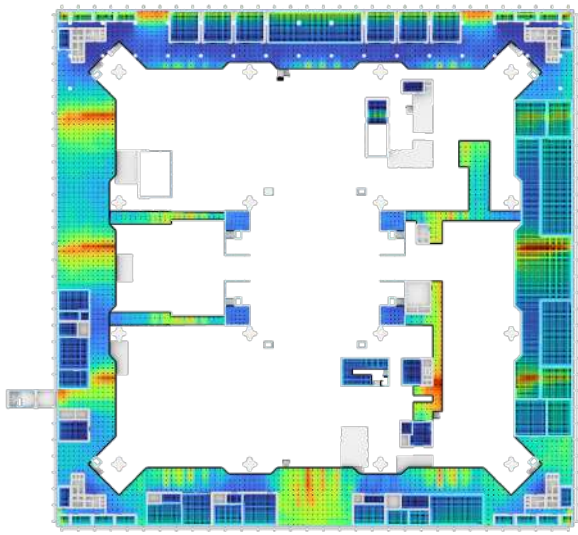


Figure 5.117: Design sunlight exposure second floor plan.

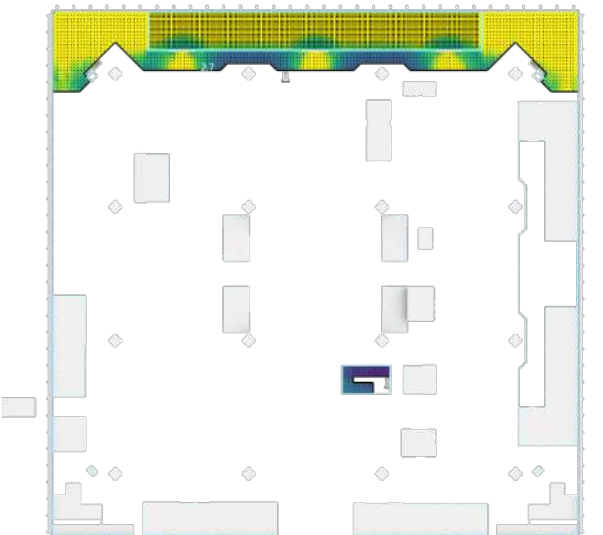


Figure 5.118: Design sunlight exposure third floor plan.



5.3 DAYLIGHT ANALYSIS

5.3.2 The Architectural Solution (Design Chapter)

Daylight Factor (DF) Overcast Distribution

The spatial evaluation under a completely overcast sky distribution confirms a highly balanced daylight organization across the new layout. With the intervention in place, the building stabilizes at a 2.9% Mean Daylight Factor and a 2.0% Median Daylight Factor. These values prove that the interior levels remain perfectly viable under low-light winter conditions, satisfying standard indoor illumination requirements without relying entirely on artificial energy loads during the day. The plan maps show that the highest daylight factors (the bright yellow and green fields) are naturally concentrated near the historic envelope boundaries and perimeter corridors. This sky exposure effectively penetrates into the first and second floor perimeter workspaces, classrooms, and administrative zones, providing sufficient, soft ambient light even on cloudy days. In contrast, the central core zones transition into deeper, more shaded values due to the physical obstruction of the upper tiers and pod ceilings. This protective drop under overcast skies matches the programmatic positioning of the cinema, museum, and retail spaces, ensuring they remain visually stable and fully reliant on controlled environments without any weather-dependent glare.

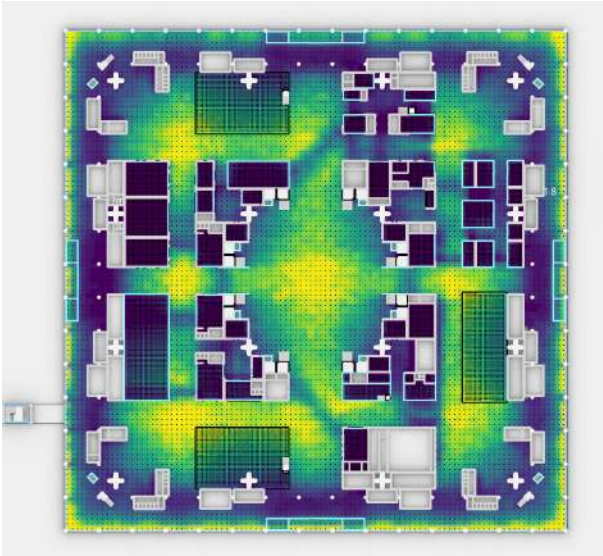


Figure 5.119: Design daylight factor ground floor plan.

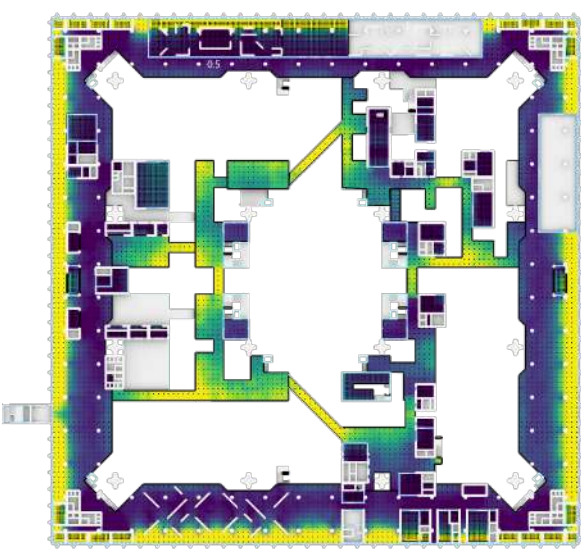


Figure 5.120: Design daylight factor first floor plan.

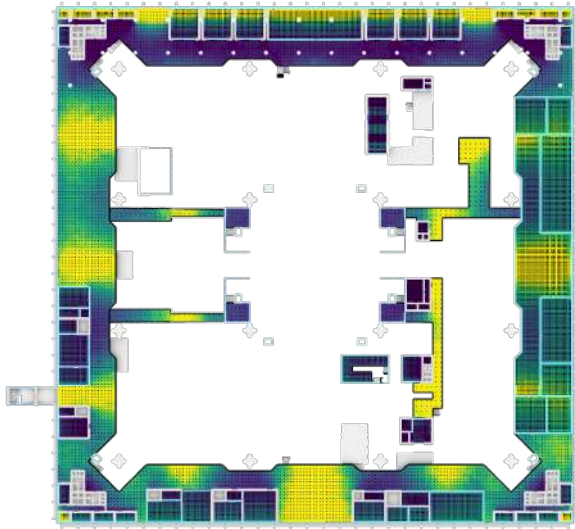


Figure 5.121: Design daylight factor second floor plan.

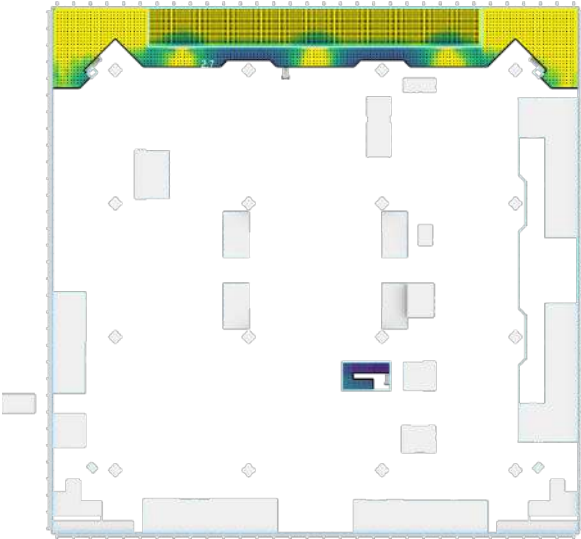


Figure 5.122: Design daylight factor third floor plan.



5.3 DAYLIGHT ANALYSIS

5.3.2 The Architectural Solution (Design Chapter)

Annual Glare Probability Analysis (DGP)

The annualized tracking of DGP confirms that the architectural intervention successfully maintains a comfortable visual environment across the entire building. By utilizing the modular pods as localized geometric filters, the risk of glare is almost entirely mitigated, ensuring optimal conditions for long-term occupant activities. The floor-by-floor charts demonstrate exceptional control of solar discomfort. On the Ground, First, and Second floors, the percentage of occupied hours experiencing any form of perceptible or disturbing glare remains near zero, staying dominated by imperceptible light levels. This stable condition directly benefits the perimeter classrooms, workshops, and administrative zones, where occupants can work without visual fatigue. On the Third Floor, which houses the library program, the space features extensive glazing to establish clear visual connections. However, to eliminate the extreme visual discomfort present in the baseline, the three main sections most exposed to solar stress are wrapped in completely opaque wall and roof surfaces. This targeted architectural shielding successfully limits glare peaks, protecting reading and study areas throughout the year.

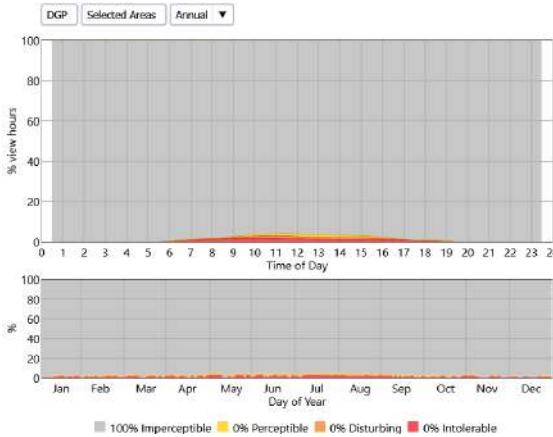


Figure 5.123: Design daylight glare probability chart ground floor.

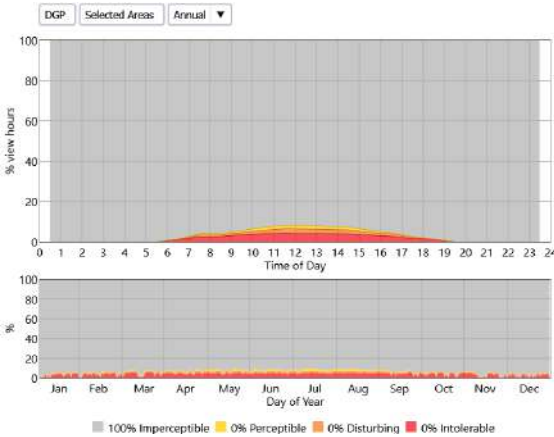


Figure 5.124: Design daylight glare probability chart first floor.

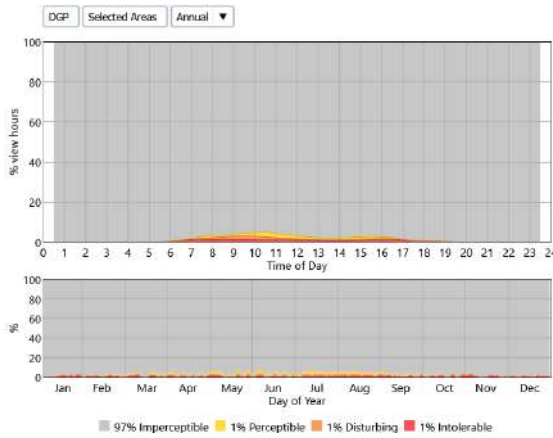


Figure 5.125: Design daylight glare probability chart second floor.

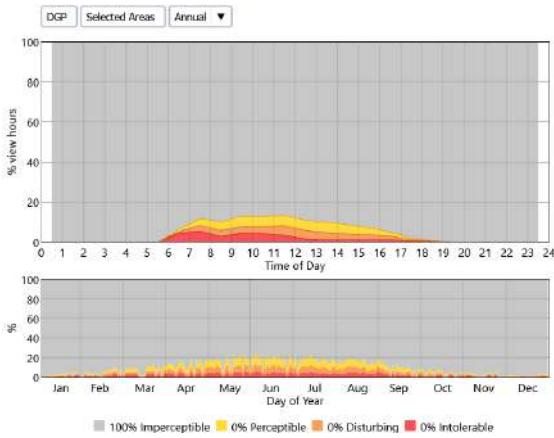


Figure 5.126: Design daylight glare probability chart third floor.

5.3 DAYLIGHT ANALYSIS

5.3.3 Volumetric Shadow Studies (Design Chapter)

Seasonal Solar Penetration & Shadow Cast Analysis

To visually verify the formal behavior of the architectural intervention, localized shadow studies were conducted across the three critical solar milestones of the year: the Summer Solstice, the Winter Solstice, and the Autumnal Equinox. By mapping the sun paths at 09:00, 12:00, and 15:00, the plans track how the new geometries shade the interior spaces throughout the changing seasons. The resulting matrices show that during the summer peaks, the high-angle sun is intercepted effectively by the upper tier projections and pod envelopes, casting wide shadows that protect the primary working perimeters. In contrast, the low-angle winter sun penetrates deeply into the open volume, allowing natural warmth to reach the interior circulation loops. Throughout the equinoxes, the combination of opaque pod roofs and controlled glazing maintains a balanced, rhythmic interplay of light and shade. This seasonal flexibility proves that the design does not create static dark zones, but rather dynamic microclimatic transitions that naturally respond to the environment.



Figure 5.127: Summer solstice solar penetration at 09:00



Figure 5.128: Summer solstice solar penetration at 12:00



Figure 5.129: Summer solstice solar penetration at 15:00



Figure 5.130: Autumnal equinox solar penetration at 09:00



Figure 5.131: Autumnal equinox solar penetration at 12:00



Figure 5.132: Autumnal equinox solar penetration at 15:00



Figure 5.133: Winter solstice solar penetration at 09:00



Figure 5.134: Winter solstice solar penetration at 12:00



Figure 5.135: Winter solstice solar penetration at 15:00

5.3 DAYLIGHT ANALYSIS

5.3.4 Localized Architectural Case Studies

Case Study 1: Fine Art Painting Workshop (First Floor - South)

The Fine Art Painting Workshop is isolated to evaluate southern perimeter performance. To block aggressive direct glare, the pod utilizes a completely opaque roof plane to neutralize high-angle summer rays, paired with controlled glass partitions featuring 100% open framing on lateral panels and an 87% open layout on facade-facing junctions. Localized metrics confirm a highly regulated interior environment. The sDA map shows active daylighting concentrated near the envelope boundary, while the deep drafting zone transitions into a soft, glare-free field, peaking annually at 58% of the area during summer middays. Direct over-exposure is successfully contained; the ASE plan confirms that levels above 1000 lux are restricted to the absolute glass edge, remaining safely under 18% of the total floor area in July. The annual average illuminance stabilizes at 770 lux during peak hours, transitioning smoothly from vibrant perimeter fields into a stable, comfortable ambient zone across the core working floor. Finally, annual DGP tracking verifies that the design completely eliminates severe visual discomfort, keeping the space securely within 100% imperceptible glare thresholds year round.

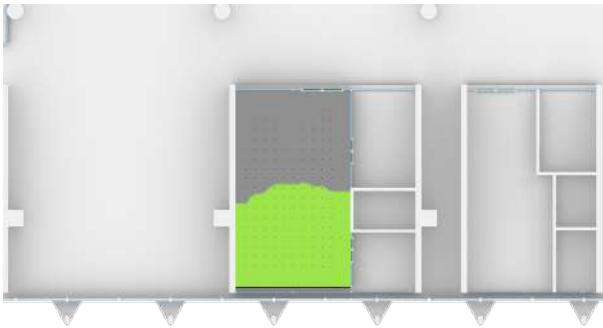


Figure 5.136: Workshop daylight autonomy plan first floor south perimeter.

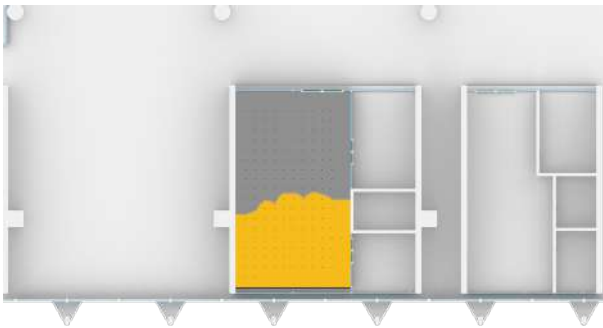


Figure 5.137: Workshop sun exposure plan first floor south perimeter.

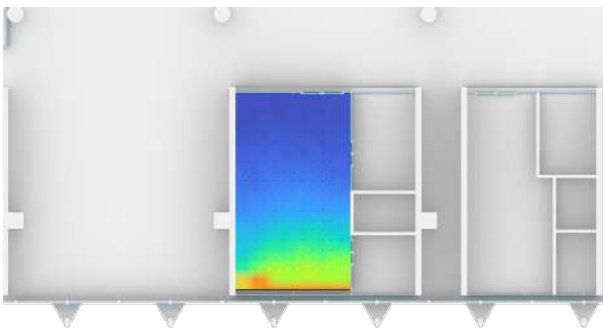


Figure 5.138: Workshop illuminance plan first floor south perimeter.

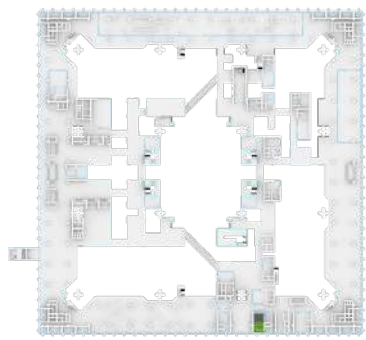


Figure 5.139: Workshop position first floor.

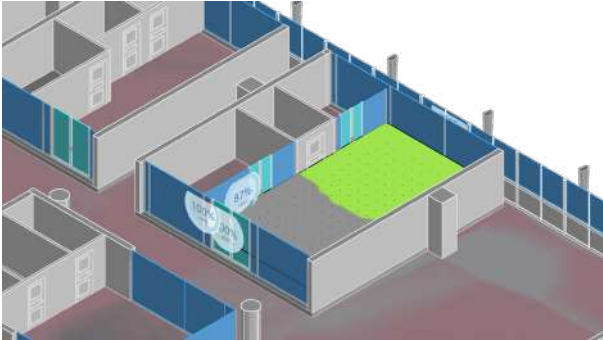


Figure 5.140: Workshop isometric first floor south perimeter.

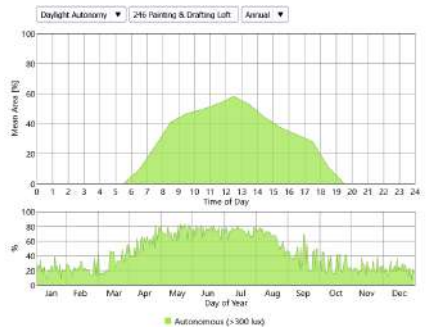


Figure 5.141: Workshop daylight autonomy chart first floor south perimeter.

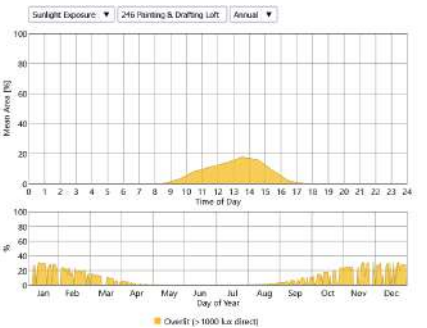


Figure 5.142: Workshop sun exposure chart first floor south perimeter.



Figure 5.143: Workshop illuminance chart first floor south perimeter.

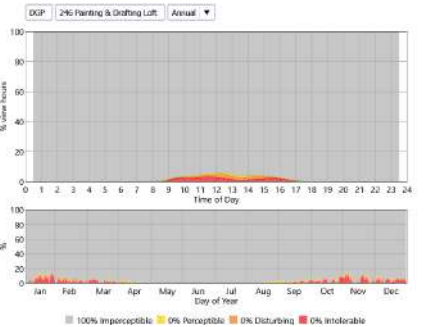


Figure 5.144: Workshop glare chart first floor south perimeter.

5.3 DAYLIGHT ANALYSIS

5.3.4 Localized Architectural Case Studies

Case Study 2: Academic Classroom (Second Floor - North)

The Academic Classroom is isolated to evaluate its performance along the northern facade. Positioned within a separate double-glazing glass enclosure system behind the historic building envelope, this module exploits diffuse northern light vectors to create an optimal learning environment. To guarantee high visual comfort, the design introduces a controlled roof glazing strip that pulls ambient sky light deep into the space while avoiding direct sun exposure. Localized metrics confirm an exceptionally stable luminous microclimate. The sDA map shows adequate, glare-free daylight coverage across the primary student desk layouts, with annual tracking confirming that autonomous light availability peaks up to 76% of the area during midday intervals. Because the northern orientation is inherently protected from direct solar rays, the ASE plan remains entirely clear, maintaining a perfect 0% over-exposure reading throughout the entire year. The annual average illuminance stabilizes at 765 lux during peak daytime hours, distributing softly from the glazed perimeter partition down into a uniform, balanced blue ambient zone across the floor plate. Finally, the annual DGP analysis tracks flawless comfort levels, with occupied teaching hours remaining securely within the 100% imperceptible glare threshold year-round.

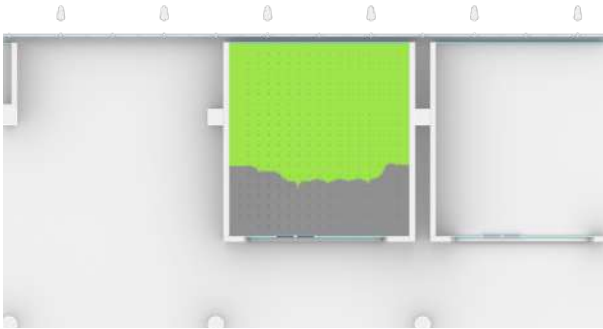


Figure 5.145: Classroom daylight autonomy plan second floor north perimeter.

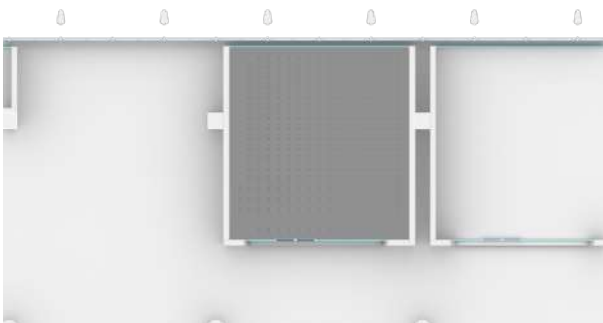


Figure 5.146: Classroom sun exposure plan second floor north perimeter.

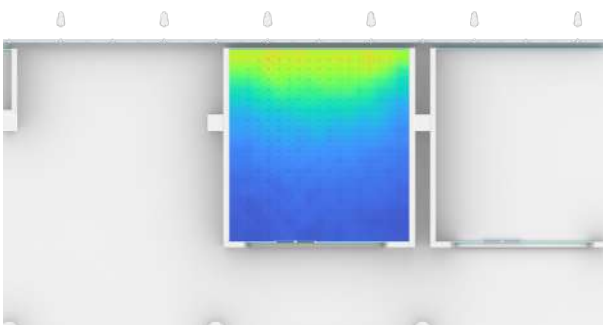


Figure 5.147: Classroom illuminance plan second floor north perimeter.

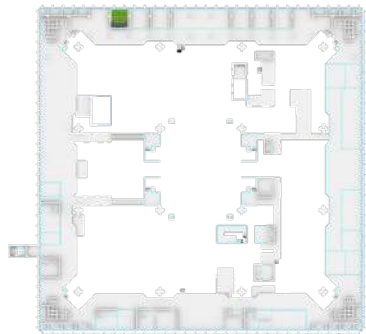


Figure 5.148: Classroom position second floor.

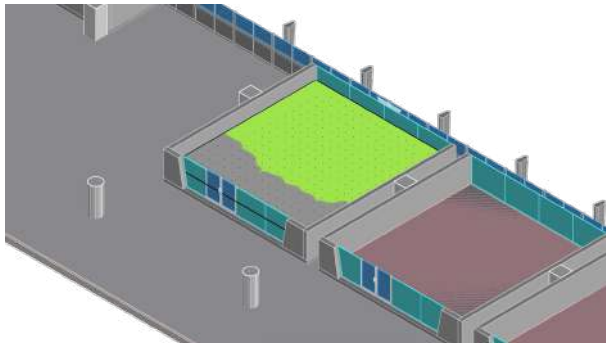


Figure 5.149: Classroom isometric second floor north perimeter.

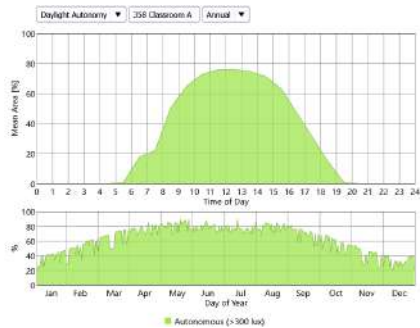


Figure 5.150: Classroom daylight autonomy chart second floor north perimeter.

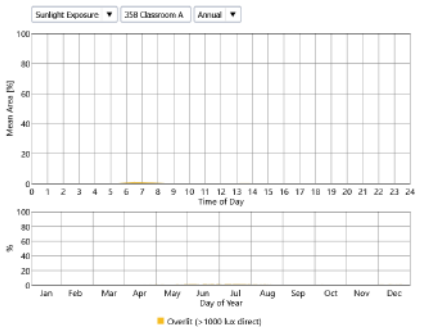


Figure 5.151: Classroom sun exposure chart second floor north perimeter.

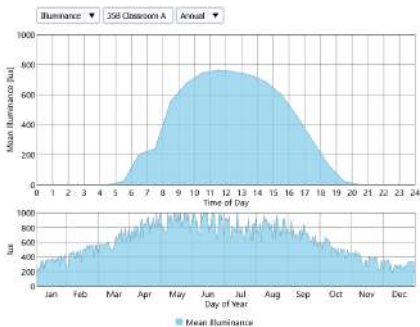


Figure 5.152: Classroom illuminance chart second floor north perimeter.

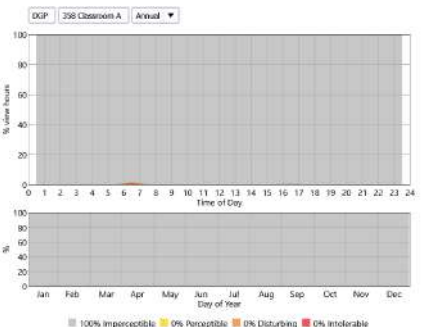


Figure 5.153: Classroom glare chart second floor north perimeter.

5.4 POD PERFORMANCE OPTIMIZATION

5.4.1 Methodology & Key Performance Indicators (KPIs)

To ensure a comprehensive and representative environmental assessment of the proposed architectural interventions, two distinct spatial typologies have been isolated within the historic volume of the Palazzo del Lavoro. The selection of these specific zones creates a direct continuity with the spatial boundaries previously established and evaluated during the computational daylight analysis phase:

The Art Workshop Pod (South Facade, First Floor): This zone represents a highly public, deep-plan workshop space subjected to high dynamic solar radiation due to its southern exposure. It functions as the primary test case for evaluating how the introduction of micro-envelope modular systems interacts with intense solar heat gains and large internal operational profiles.

The University Classroom (North Facade, Second Floor): Serving as a strict comparative control envelope, this academic zone is characterized by a high occupant density but zero access to direct solar radiation throughout the year.

By running parallel thermal simulations on these two contrasting orientations and functional programs, the analysis directly addresses how identical envelope strategies such as the transition to structural timber panels and selective glazing perform under opposing micro-climatic exposures. This comparative framework allows for the cross-examination of localized winter conduction losses against summer internal heat traps, guiding targeted, passive architectural optimizations for each unique typological placement. Both the painting workshop and the classroom have the same gross dimensions which is: 9.25 x 10 meters.

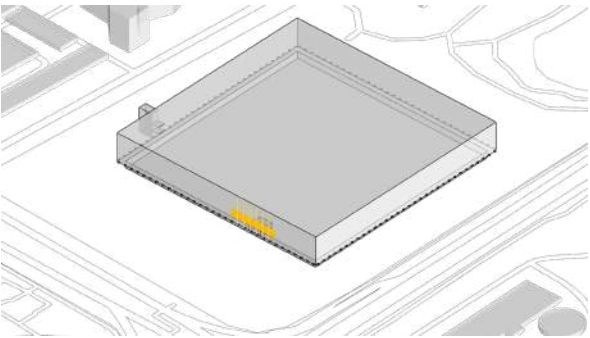


Figure 5.155: Workshop pod location in the 3D Isometric.

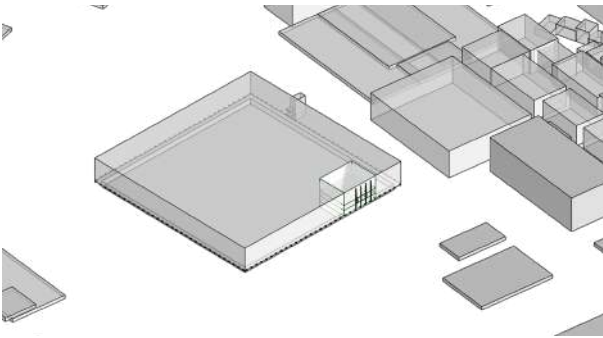


Figure 5.156: Classroom pod location in the 3D Isometric.

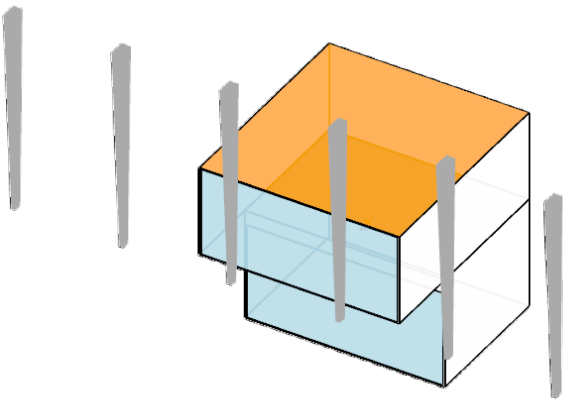


Figure 5.157: Workshop pod 3D Isometric south perimeter.

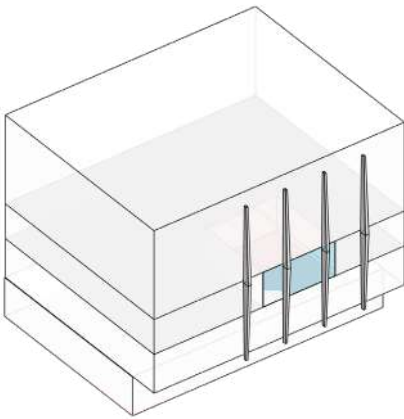


Figure 5.158: Classroom pod 3D Isometric north perimeter.

5.4 POD PERFORMANCE OPTIMIZATION

5.4.2. Comparative Materials Matrix (The CLT Analysis)

Before evaluating the sequential simulation results, it is critical to establish the raw thermodynamic rationale behind the material selection for the intervention. In an adaptive reuse project housing localized micro-climates within a vast historic concrete volume, the material composition of the structural boundaries dictates the building’s overall energy behavior. To justify the shift from the uninsulated structural concrete of the original architecture to the prefabricated panel system of the new interventions, the table below highlights the exact thermophysical properties compiled in accordance with standard European calculation protocols (EN ISO 10456).

The structural data details two critical phenomena that directly explain the performance trends observed in the subsequent dynamic energy simulations:

The Conductivity Drop (λ)

The thermal conductivity of Cross-Laminated Timber (~ 0.12 W/m·K) is approximately 15 times lower than that of the original reinforced concrete slabs (~ 1.80 W/m·K). This indicates that the CLT core functions natively as a structural insulator. When introduced into the pod walls, floors, and ceilings, it drastically lowers the overall thermal transmittance (U-value) of the micro-envelope without requiring excessive, thick insulation layers.

The Volumetric Heat Capacity Shift (C_v)

While timber possesses a higher specific heat capacity per unit of mass than concrete (1,600 vs. 1,000 J/kg·K), its significantly lower density modifies its volumetric behavior. The resulting Volumetric Heat Capacity of CLT (720–800 kJ/m³·K) is 3 times lower than that of reinforced concrete.

By utilizing CLT as the primary building block for the pods, the interior spaces are thermodynamically decoupled from the slow, high-inertia concrete mass of the historical shell. In winter, this low active thermal capacity ensures that internal heat gains from equipment, lighting, and occupants immediately heat the air volume rather than being lost to dense structural floors and ceilings. In summer, this same lack of a heavy concrete heat sink means internal operational gains accumulate quickly within the timber envelope during the day, creating a distinct cooling trade-off that is thoroughly evaluated in the following simulation profiles.

Material Classification	Core Engineering Material	Density(ρ)[kg/m3]	Thermal Conductivity(λ) [W/m·K]	Specific Heat Capacity(c)[J/kg·K]	Volumetric Heat Capacity (C_v = $\rho \cdot c$)[kJ/m3·K]	Thermodynamic Role in Architecture
Heavyweight Mass(Historic Base)	Reinforced Concrete (Heavyweight)	2,300 – 2,400	1.800 – 2.000	1,000	2,300 – 2,400	High Thermal Sponge: Strong thermal mass/lag; slows down temperature changes but acts as a massive cold sink in winter.
Lightweight Structure(Proposed Intervention)	Cross-Laminated Timber (CLT)	450 – 500	0.110 – 0.130	1,600	720 – 800	Insulating Structural Core: Low conductivity stops heat transfer; low volumetric capacity prevents a cold structure from draining space heat.
Thermal Insulation(Envelope Optimization)	Mineral Wool	40 – 100	0.035 – 0.040	1,030	41 – 103	Conductive Barrier: Maximizes thermal resistance (R-value) to stop winter heat dissipation through the envelope joints.
Interior Linings(Pod Finishes)	Plywood / Wood Panels	550 – 650	0.130 – 0.150	1,700	935 – 1,105	Hygroscopic Finish: Low thermal conductivity surface that feels warm to the touch, improving localized indoor operative comfort.
Baseline Mortars(Finishing Regimes)	Cement / Lime Mortar	1,600 – 1,800	0.800 – 1.000	1,000	1,600 – 1,800	Dense Protective Layer: High conductivity, baseline structural skin with negligible thermal resistance properties.

Figure 5.159: Thermophysical Properties Matrix of Structural and Finish Materials (compiled according to EN ISO 10456 parameters).

5.4 POD PERFORMANCE OPTIMIZATION

5.4.3 Envelope Stratigraphy & Phase Specifications

To isolate the specific drivers of the building’s thermal performance, the simulation framework breaks down the structural alterations into distinct evolutionary phases. By systematically mapping the transitions from the heavy, uninsulated concrete shell of the historic baseline to the highly insulated, low-emissivity glazed modular pod interventions, the simulation isolates how material shifts alter energy flows. The exact physical layer metrics, optical values, and thermal properties that govern these boundary components are detailed in the structural matrices below. Transparent Assembly Evolution. The transparent envelope components undergo a targeted optimization across the three design phases to strike a balance between structural daylighting targets and

defensive thermal parameters. As detailed on (fig 5.160), the progressive strategy moves from the high-conductivity single pane baseline to advanced multi-layer low-E selective glazing. This systematic shift cuts center-of-glass thermal transmittance while refining the Solar Heat Gain Coefficient (SHGC) to defend the internal micro-climate against external solar fluctuations.

Design Phase	Component Specification	Simulation Layer Matrix (Outside to Inside)	Thermal Transmittance (U-Value) [W/m2 · K]	Thermal Transmittance (U-Value) [BTU/ (ft2 · °F · h)]	Solar Heat Gain Coefficient (SHGC)	Visible Light Transmittance (TVIS)
Phase 1: Baseline	Single Pane Clear	Simple Glazing Model	5.894	1.038	0.905	0.913
Phase 2: Retrofit	Starphire - Solarban 60 (3)	1. Starphire 6mm 2. Krypton Gas Gap 3. Solarban 60 on Starphire 6mm	1.26	0.222	0.504	0.744
Phase 3: Final Pod	Solarban 60 (2) on Solexia	1. Solarban 60 on Solexia 6mm 2. Krypton Gas Gap 3. Clear Float Glass	1.26	0.222	0.306	0.604

Figure 5.160: Glazing System Performance Indicators and Optical Properties

The opaque building boundaries define the immediate thermal capacitance and surface conduction limits of each simulated zone. The strategy decouples the functional interior volumes from the heavy structural concrete components of the original architecture. By replacing high-inertia concrete assemblies with low-capacity, multi-layered Cross-Laminated Timber (CLT) modular pods backed by mineral wool insulation, the intervention introduces a protective envelope. This setup drastically lowers active thermal transmittance (U-value) and scales down the volumetric heat storage properties of the immediate interior partitions.

Assembly Code	Design Phase Assignment	Layer Breakdown (From Outside to Inside)	Thickness [m]	U-Value [W/m2 · K]	Thermal Capacitance [kJ/K/m2]
Perimeter Floor	Phase 1 & 2 Baseline	1. Cement/Lime Mortar Stucco 2. Heavyweight Concrete Slab	0.05 0.18	2.476	434.88
Perimeter Ceiling	Phase 1 & 2 Baseline	1. Heavyweight Concrete Slab	0.15	4.61	302.4
Opaque Exterior Wall	Phase 1 Baseline	1. Default Baseline Mass Construction	0.25	3.588	504
Modular Pod Wall	Phase 2 & 3 Interior	1. Cement/Lime Mortar Stucco 2. Air Cavity 3. Mineral Wool Insulation 4. Cross-Laminated Timber (CLT)	0.01 0.03 0.06 0.15	0.292	142.06
Modular Pod Floor	Phase 3 Final Design	1. Linoleum/Vinyl/Rubber Finish 2. Air Cavity 3. Cross-Laminated Timber (CLT)	0.02 0.03 0.15	0.468	120.04
Modular Pod Ceiling	Phase 3 Final Design	1. Cement/Lime Mortar Stucco 2. Air Cavity 3. Mineral Wool Insulation 4. Cross-Laminated Timber (CLT) 5. Plywood/Wood Panel Lining	0.02 0.03 0.04 0.15 0.01	0.333	156.61

Figure 5.161: Opaque Construction Stratigraphies and Performance Indicators

5.4 POD PERFORMANCE OPTIMIZATION

5.4.3 Envelope Stratigraphy & Phase Specifications

To guarantee absolute data integrity and consistency across all dynamic thermal runs, a strict control framework was established inside the simulation engine. The internal heat loads, ventilation schedules, and HVAC threshold setups act as fixed variables. This ensures that the observed shifts in operational energy relate entirely to envelope retrofits and the introduction of the modular pod geometry.

Space Use, Internal Loads, and Lighting Design Criteria

The internal load settings dictate the baseline heat dissipation generated within the simulated air volumes. These profiles are governed by precise human, mechanical, and lighting power variables modeled within the interface shown in Zone Settings. (fig. 5.162)

Occupant Profile & Metabolic Rates: The occupant layout is locked at a density of 0.2 P/m² with a metabolic heat output rate of 1.2 met corresponding to standard seated, light studio work. Human thermal adaptation is dynamically tracked using the standard ASHRAE 55 clothing model to alter insulation values (clo) according to seasonal variation.

Equipment Power Density: The internal heat gain from machinery, laptops, and studio tools is set to a constant baseline of 12 W/m², utilizing a standby power schedule to minimize false overnight gains.

Art Workshop Lighting Logic (7.5 W/m² / 750 Lux): The lighting setup for the Art Workshop is deliberately configured to meet demanding creative tasks. Fine arts production, drafting, and detailed manual work require high visual acuity and excellent color rendering. Therefore, the target illuminance threshold is set to a sharp 750 Lux, requiring a lighting power density of 7.5 W/m² to guarantee precision visual comfort.

Classroom Lighting Logic (6.0 W/m² / 550 Lux): In contrast, the secondary control classroom zone functions as a standard lecture space. Traditional text reading, digital presentation viewing, and standard seminar activities require less intense light focus. The design restricts the illuminance target to a standard 550 Lux, allowing the baseline lighting power density to drop to a conservative 6.0 W/m².

Thermodynamic Conditioning & Airflow Controls

The mechanical settings establish the efficiency loops and temperature boundaries required to calculate the sensible ideal air loads:

Ideal Air Loads HVAC Infrastructure: As mapped in Ideal air loads settings (fig. 5.163), the simulation isolates net energy needs using a high-efficiency conditioning template. The heating branch operates with a Coefficient of Performance (COP) of 3.5 backed by a structural safety sizing factor of 1.25 and a maximum supply air ceiling of 40°C.

The cooling branch operates with a highly defensive COP of 4.0, utilizing a 1.15 sizing factor and a minimum supply air floor of 14°C. Humidity control parameters are deactivated to focus exclusively on sensible thermal balance shifts.

Mechanical Ventilation & Heat Recovery: Managed via the interface shown in Mechanical Ventilation settings (fig. 5.164), fresh air delivery operates under a sensible conditioning loop. To prevent incoming winter fresh air streams from instantly chilling the zones, the system utilizes a sensible air-to-air heat recovery core with an efficiency rating of 0.75, completely mitigating the fresh air load penalty during deep winter operation.

Infiltration Control Boundaries: To reflect the contrasting airtightness profiles between the historic envelope and the new construction, structural leakage is tightly controlled. As defined in Infiltration Settings (fig. 5.165), continuous infiltration is limited to an airtight parameter of 0.1 ACH (Air Changes per Hour) to represent the localized tightness of the modular pod skins.

Operational Schedules & Occupancy Profiles

Operational timelines dictate when internal gains and mechanical setups switch between active, setback, and dormant states. The simulation splits these behaviors across two distinct calendar tracking setups:

1) Palazzo del Lavoro (PDL) Institutional Base: Tracked across (fig. 5.166) and (fig. 5.167), this schedule handles the overarching building shell background. It features a gradual operational ramp-up starting at 08:00, peaks at full institutional capacity from 10:00 through 21:00, and steps down to a low nighttime conservation setback baseline between 22:00 and 07:00 to mirror standard public university operations.

2) Art Workshop & Classroom Module Schedules: Illustrated in (fig. 5.168) and (fig. 5.169), these timelines capture the intense, high-occupancy usage windows typical of student design hubs. On weekdays, the schedule registers a dual occupancy peak climbing rapidly at 09:00, maintaining high density through the morning, dipping slightly during the midday break, and rising back to a secondary peak in the afternoon before dropping to an empty baseline at 22:00. Weekend schedules mirror a compressed, flexible seminar use timeline, peaking between 10:00 and 19:00 to catch fluid studio work habits.

5.4 POD PERFORMANCE OPTIMIZATION

5.4.3 Envelope Stratigraphy & Phase Specifications

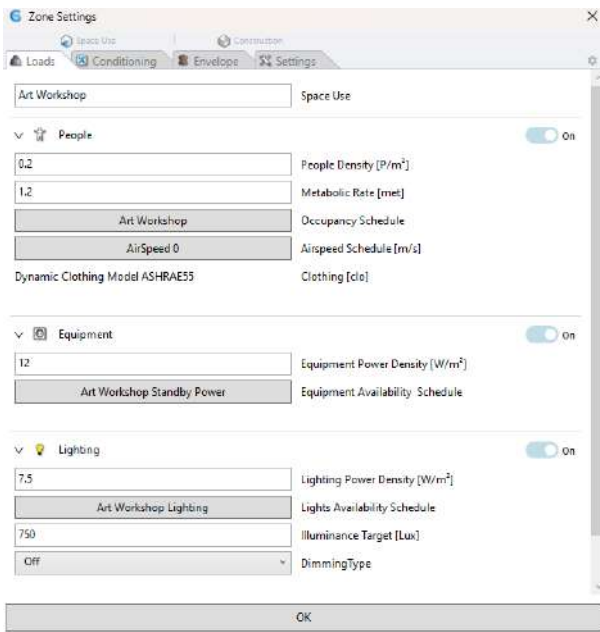


Figure 5.162: Pods zone settings

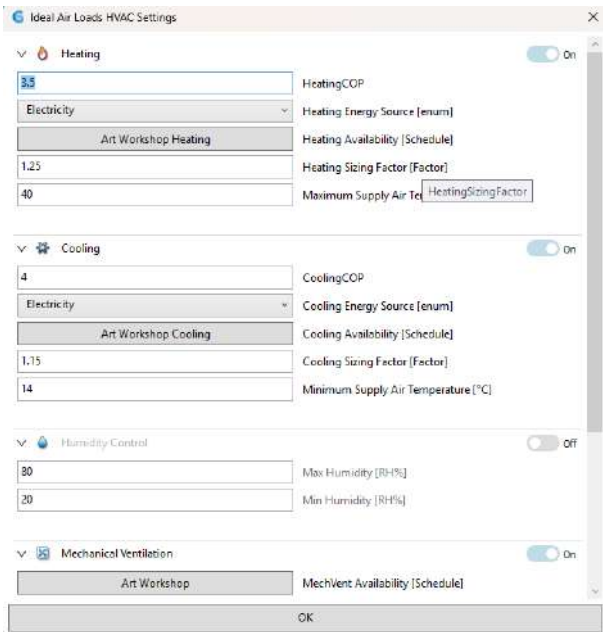


Figure 5.163: Pods Ideal air loads HVAC settings

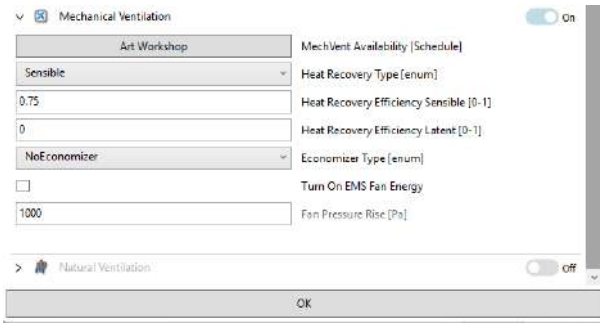


Figure 5.164: Pods mechanical ventilation settings



Figure 5.165: Pods infiltration settings

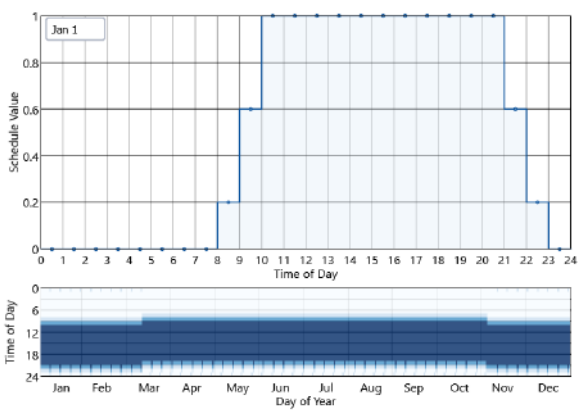


Figure 5.166: Building working hours schedule weekdays.

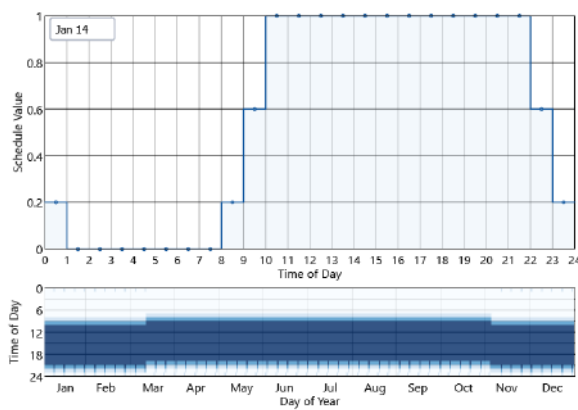


Figure 5.167: Building working hours schedule weekends.

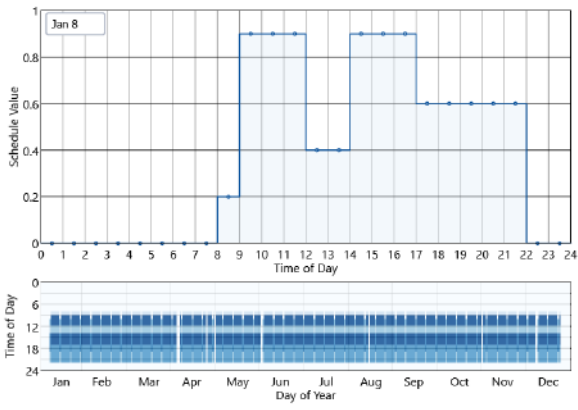


Figure 5.168: Pods working hours schedule weekdays.

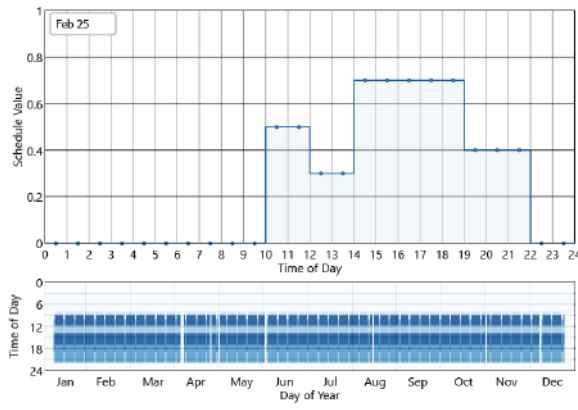


Figure 5.169: Pods working hours schedule weekends.

5.4 POD PERFORMANCE OPTIMIZATION

5.4.4 Macro-Zone Performance: The painting workshop

Phase 1: Historical Baseline Scenario

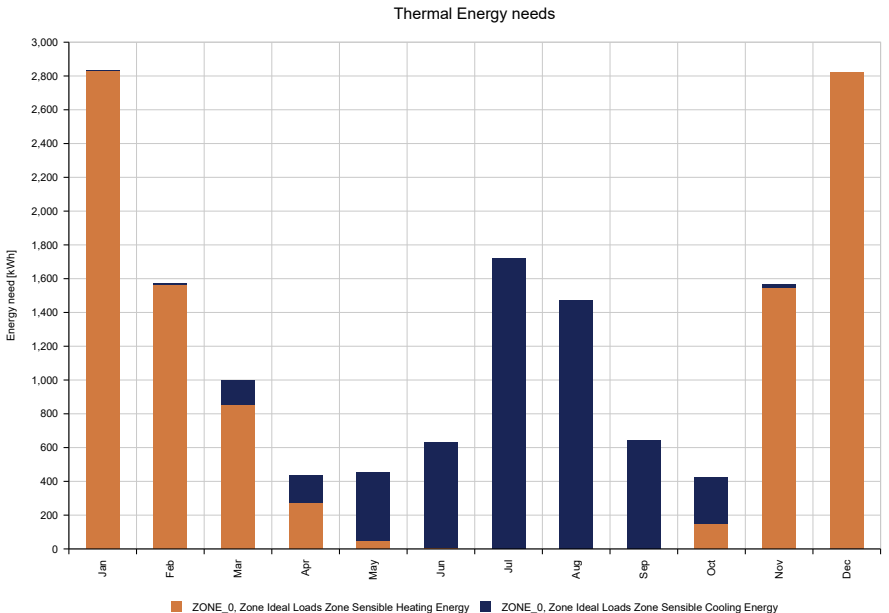
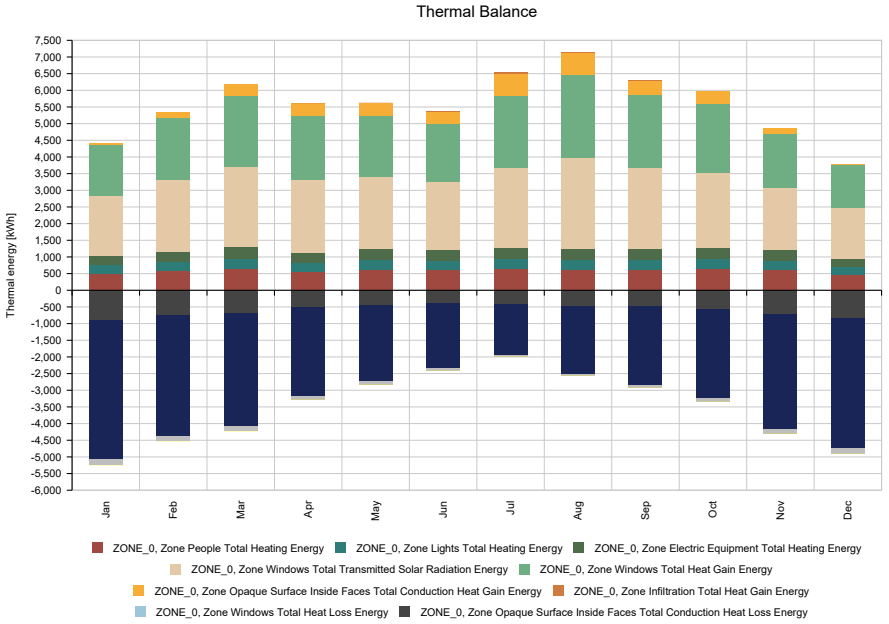
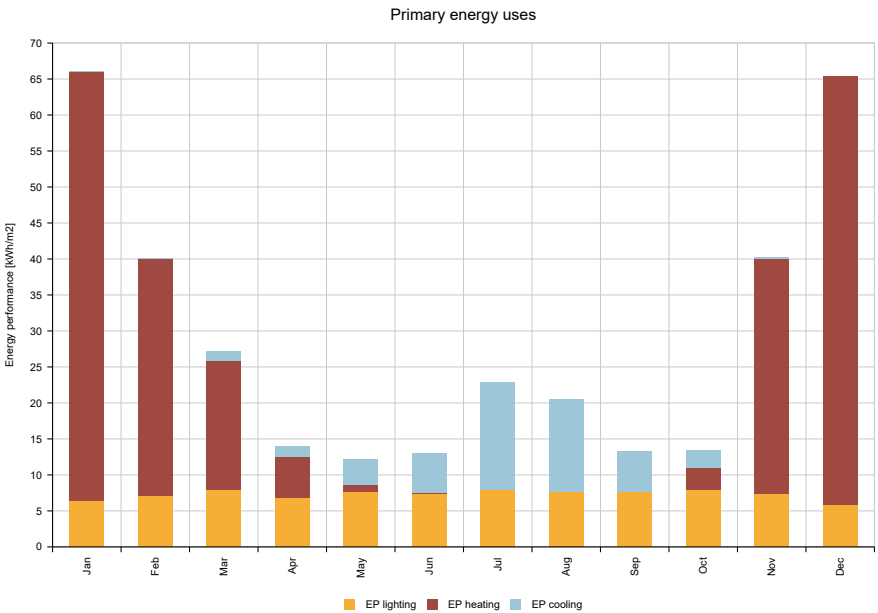
The initial configuration models the uninsulated, high-inertia concrete structure and highly conductive iron-framed single industrial glazing of the original architecture. This phase establishes the baseline thermodynamic vulnerability of the space before any optimization. As evidenced by the primary energy uses profile, winter heating demands completely dominate operation. Monthly heating demands peak sharply in January and December at roughly 60 kWh/m², while the artificial lighting network remains flat year-round due to the rigid 750 Lux studio design targets.

Sensible Demands: The mechanical plant faces extreme seasonal stress, with winter sensible heating loads peaking near 2,830 kWh in January and December, while cooling loads disappear completely outside of the late summer period.

Thermodynamic Failures: The lack of insulation causes massive, continuous conduction heat losses through opaque surfaces and windows. The exposed concrete functions as an unregulated thermal sponge, absorbing internal gains without stabilizing indoor air temperatures, causing rapid heat dissipation to the outside.

Operational Primary Energy Metrics (EP):

EPH: 212.89 kWh/m²/year
EPC: 47.76 kWh/m²/year
EPL: 87.41 kWh/m²/year
EPgl: 348.06 kWh/m²/year



5.4 POD PERFORMANCE OPTIMIZATION

5.4.4 Macro-Zone Performance: The painting workshop

Phase 2: Pod Envelope Retrofit

The second phase introduces localized envelope retrofitting to the primary perimeter of the workshop area without modifying the internal layout or structural components. The intervention completely replaces the raw, uninsulated default construction assumptions established in Phase 1 with an optimized pod wall assembly. The primary objective is to test how effectively upgrading the building’s outer shell boundaries regulates energy consumption before any internal spatial partitioning occurs.

Operational Primary Energy Metrics (EP)

EPH: 62.67 kWh/m²/year

EPC: 31.10 kWh/m²/year

EPL: 87.41 kWh/m²/year

EPgl: 181.18 kWh/m²/year

Structural Methodology and Core Intervention

Rather than treating the historical masonry with traditional internal linings, Phase 2 implements a high-performance modular boundary transition. The original default wall is replaced by a specialized pod wall assembly utilizing a Cross-Laminated Timber (CLT) core integrated with mineral wool insulation and an internal air cavity layer as documented in (fig. 5.161).

To optimize the glazed perimeter, the pod is strategically moved 30 cm away from the historic, single industrial glazing. In this generated space,

a new high-performance double-glazed unit (DGU) specified with Starphire Solarban 60 on Starphire with a krypton gas filling is introduced. While the vertical boundaries are thoroughly insulated by this new pod wall skin and high-efficiency DGU system, the entire assembly remains nested directly between the original uninsulated perimeter floor and ceiling, meaning it continues to sit between the highly conductive, historic concrete slabs.

Cavity Dynamics and Thermodynamic Behavior

Upgrading the primary building envelope yields an immediate 70.5% reduction in heating loads, dropping the EPH to 62.67 kWh/m²/year. Restricting thermal conduction prevents the rapid escape of internal heat during winter, mitigating the severe baseline transmission losses. Concurrently, the cooling load drops significantly to 31.10 kWh/m²/year. This drop is achieved because the enhanced external envelope successfully blocks external solar radiation and conductive heat transfer from entering the workspace during the peak summer months. The fundamental physical driver behind this efficiency increase is the structural reconfiguration of the perimeter glazing assembly. The single outer pane of the historic facade remains untouched, serving as an external windshield and rainscreen while providing minimal thermal resistance. The introduction of the new Starphire Solarban 60 DGU as the inner vertical barrier generates a controlled 30 cm air gap. This captured air cavity functions as an unconditioned thermal buffer zone. During winter, the stagnant air layer within the cavity stays significantly warmer than the external environment due to attenuated radiation exchange and reduced convective currents. Consequently, the temperature gradient across the inner high-performance DGU is drastically lowered, minimizing the heat transmission rate out of the painting workshop.

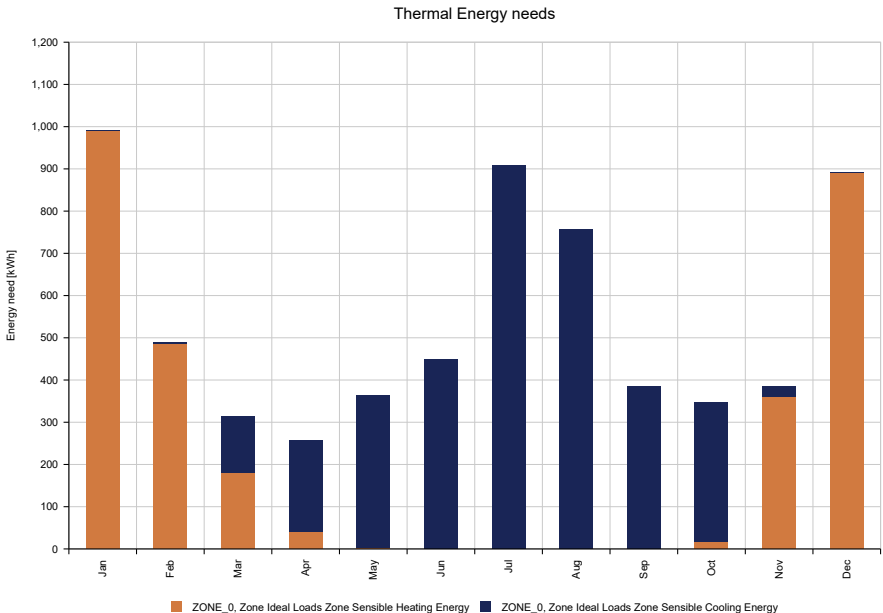
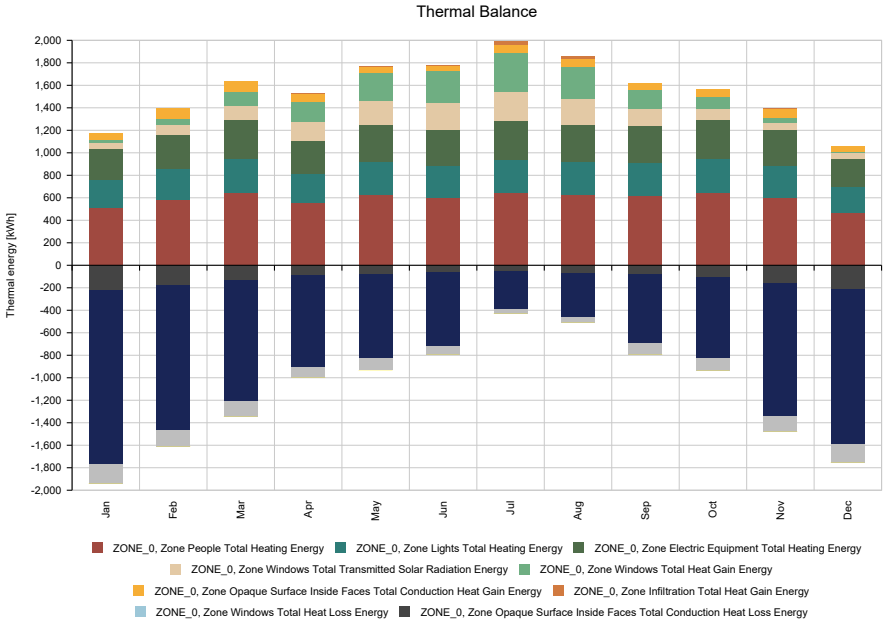
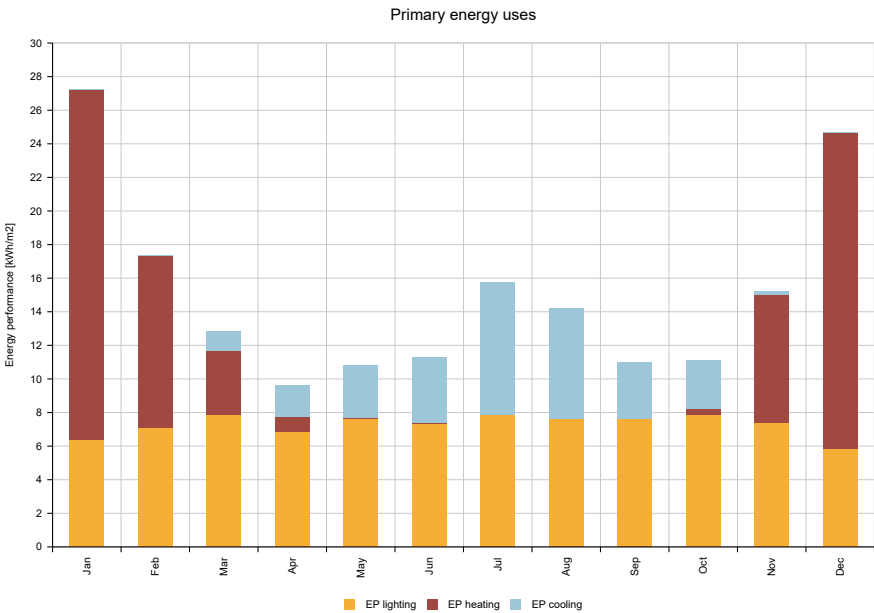
5.4 POD PERFORMANCE OPTIMIZATION

5.4.4 Macro-Zone Performance: The painting workshop

Primary Energy Efficiency: The Primary energy uses chart illustrates a highly flattened distribution curve. The massive baseline winter heating peaks are suppressed, limiting maximum monthly allocations to under 28 kWh/m² in January, while the rigid 750 Lux illuminance profile maintains a stable EPL base across all seasons. **Sensible Demands:** The Thermal Energy needs profile tracks a sharp drop in overall mechanical plant stress. Peak winter conditioning demands collapse from original baseline levels down to a maximum of 1,000 kWh in January,

while midsummer sensible cooling loads emerge as a tightly regulated 900 kWh peak in July. **Thermodynamic Balance Shifts:** The Thermal Balance chart decodes the underlying boundary physics. High-performance glazing and insulated opaque layers slash direct perimeter transmission losses, though the internal zone remains partially influenced by the uninsulated, high-inertia historic concrete floor slabs and ceilings which still interact with internal heat gains.

Operational Primary Energy Metrics (EP):
EPH: 62.67 kWh/m²/year
EPC: 31.10 kWh/m²/year
EPL: 87.41 kWh/m²/year
EPgl: 181.18 kWh/m²/year



5.4 POD PERFORMANCE OPTIMIZATION

5.4.4 Macro-Zone Performance: The painting workshop

Phase 3: Integrated Pod Deployment

The final design phase introduces the core architectural concept: the installation of a prefabricated, self-contained Fine Art Pod inside the historic volume. Unlike Phase 2, which left the thermal envelope exposed to the raw structural masonry at the horizontal boundaries, this final intervention introduces an independent floor and ceiling assembly for the pod. By decoupling the micro-environment entirely from the perimeter concrete floor and ceiling slabs, Phase 3 establishes an optimized, thermally isolated environment.

Operational Primary Energy Metrics (EP)

EPH: 32.35 kWh/m²/year

EPC: 38.49 kWh/m²/year

EPL: 87.41 kWh/m²/year

EPgl: 158.25 kWh/m²/year

Structural Methodology and Envelope Assembly

The structural methodology centers on eliminating the final remaining thermal bridges. The pod is enclosed horizontally using prefabricated Cross-Laminated Timber (CLT) systems: **Pod Floor:** A 0.15 m CLT base integrated with a 0.03 m internal air cavity and finished with a resilient 0.02 m composition layer (linoleum).

Pod Ceiling (Non-walkable): A 0.15 m CLT structural layer combined with 0.04 m of mineral wool insulation, a 0.03 m air buffer, and protected by an external 0.02 m cement-lime mortar coating.

Simultaneously, the transparent perimeter is upgraded to an advanced high-performance selective glazing system. The configuration utilizes a Solarban 60 (2) on Solexia clear assembly with a specialized krypton gas filling layer. This selective system is coupled with custom external shading geometry engineered to intercept high-altitude summer radiation while permitting low-angle winter solar gains.

Thermodynamic Analysis of the CLT Selective & Glazing Strategy

Swapping the heavy concrete floor and ceiling slabs for the lightweight, insulated CLT modular system reconfigures the internal physics of the workspace: **The Winter Triumph:** Isolating the occupied volume within timber panels reduces energy waste since the heating system no longer continuously charges the dense, uninsulated historic concrete mass. Timber features lower thermal conductivity and lower volumetric thermal capacity than concrete, acting as a highly efficient localized barrier. Furthermore, the selective low-E glass traps internal heat gains generated by occupants, lighting networks, and equipment, allowing the pod to utilize passive internal loads to maintain comfort and cutting heating needs by an additional 48.3% compared to Phase 2.

The Summer Rebound: While the external shading and selective glass block direct solar radiation during peak summer months, the cooling demand experiences 23.7% rebound compared to the phase 2. Operational heat remains contained within the timber air volume, and the high thermal resistance of the selective glazing limits night-time outward radiation. This rapid temperature response during operating hours triggers a higher cooling load in June, July, and August.

5.4 POD PERFORMANCE OPTIMIZATION

5.4.4 Macro-Zone Performance: The painting workshop

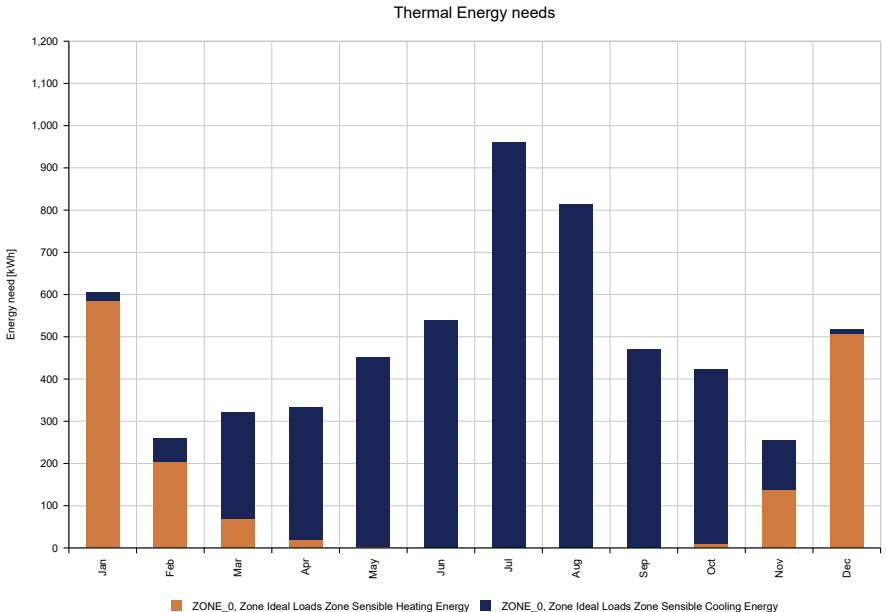
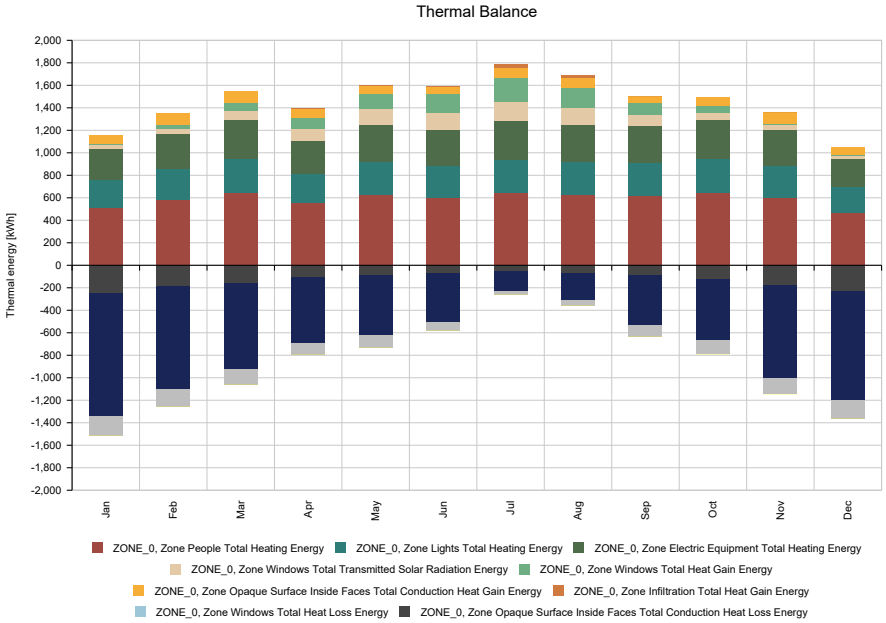
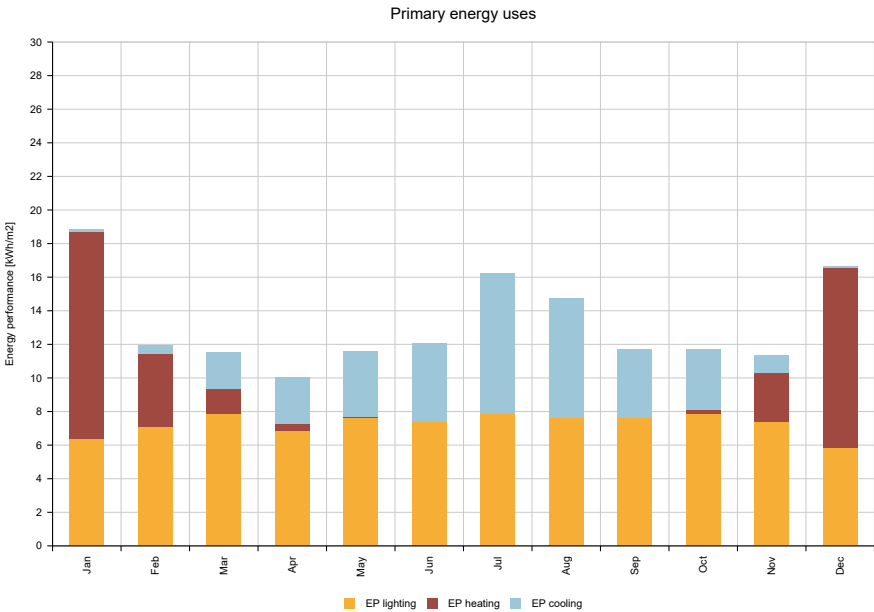
Primary Energy Efficiency: The Primary energy uses chart tracks the comprehensive stabilization of the workshop's energy inputs. Winter heating demands are suppressed to a maximum monthly value under 19 kWh/m² in January, while the midsummer cooling demands (EPC) show a minor increase due to the sealed timber envelope, and the lighting energy (EPL) maintains its rigid, flat baseline throughout the year.

Sensible Demands: The Thermal Energy needs profile displays the structural rebalancing of localized conditioning loads. Absolute winter

heating peaks drop to their lowest thresholds (580 kWh in January), while the lack of thermal lag in the CLT panels yields a distinct cooling penalty during high-exposure periods, peaking sharply at approximately 960 kWh in July.

Thermodynamic Balance Shifts: Because the pod micro-environment is isolated from the historic masonry slabs, internal gains from occupants, equipment, and lighting form a dominant positive load that maintains winter warmth but drives the summer cooling demand.

Operational Primary Energy Metrics (EP)
EPH: 32.35 kWh/m²/year
EPC: 38.49 kWh/m²/year
EPL: 87.41 kWh/m²/year
EPgl: 158.25 kWh/m²/year



5.4 POD PERFORMANCE OPTIMIZATION

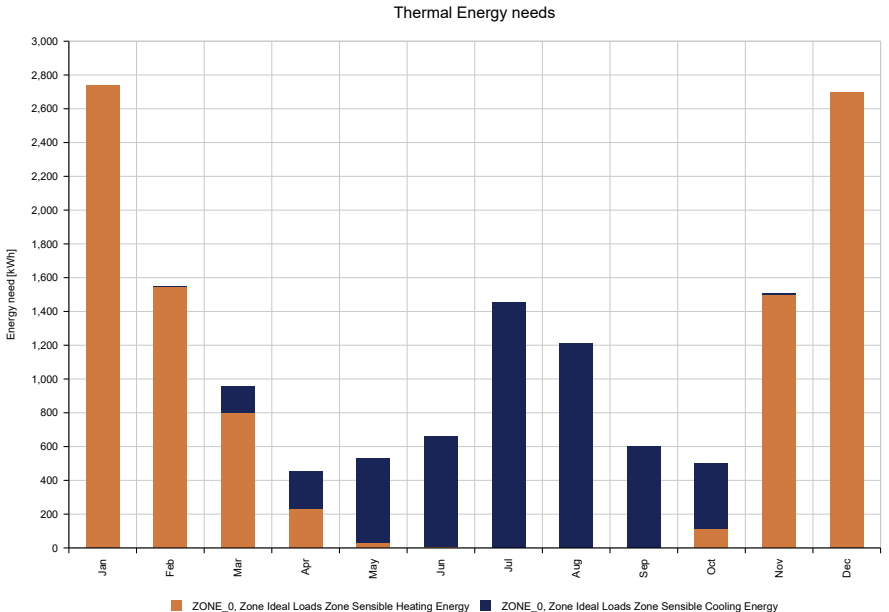
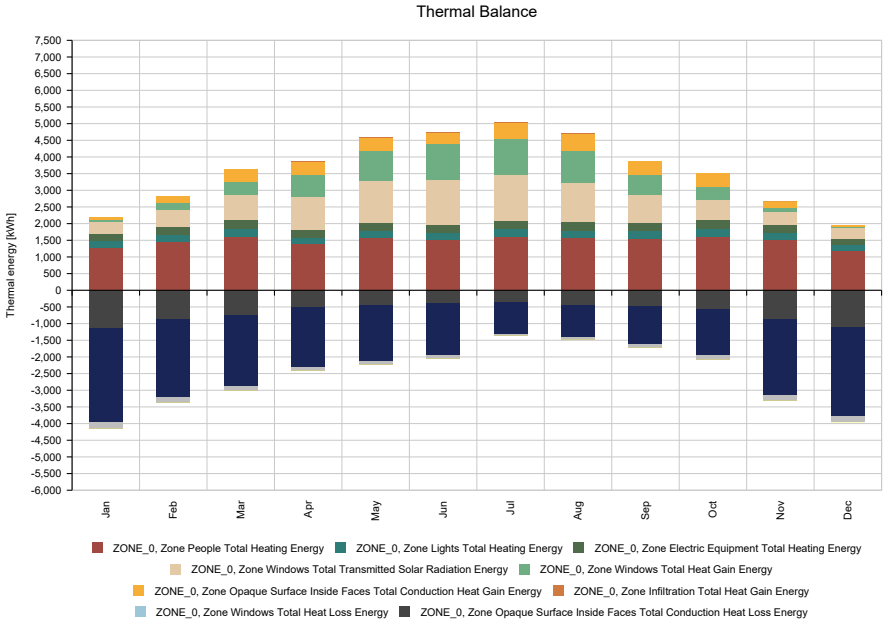
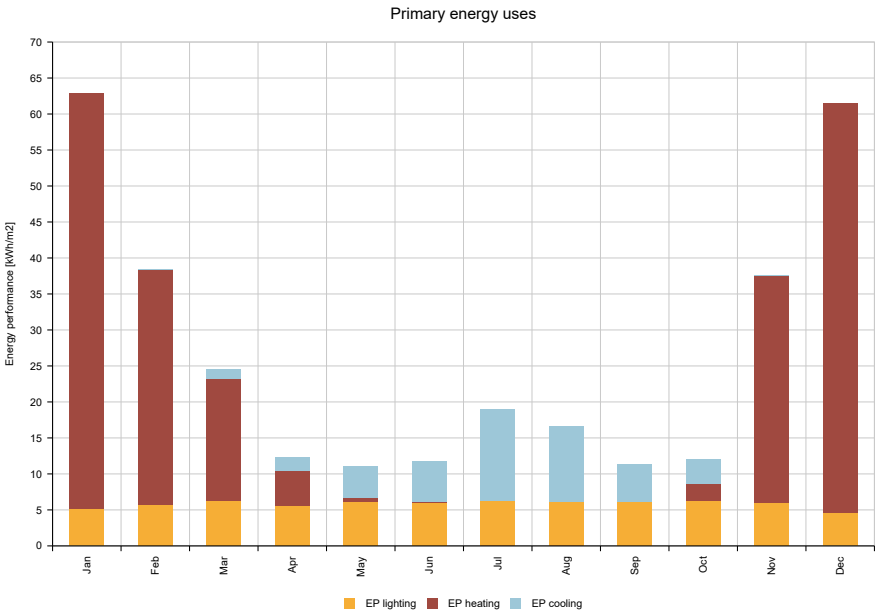
5.4.5 Macro-Zone Performance: The classroom

Phase 1: Historical Baseline Scenario

The baseline configuration models the original uninsulated classroom envelope. It establishes the initial thermal vulnerabilities of the historic structure prior to any retrofitting. Without insulation, the envelope suffers from severe winter transmission losses through the single-glazed facade and concrete walls, driving heating demands up. In summer, unchecked solar radiation gains pass freely through the unprotected glazing, yielding a significant cooling demand. **Primary Energy Efficiency:** Heating requirements dictate the annual performance profile, peaking

at over 60 kWh/m² in January, while the artificial lighting load remains perfectly flat year-round. **Sensible Demands:** Peak winter conditioning loads reach extreme thresholds near 2,740 kWh in January and December, whereas midsummer sensible cooling demands create a concentrated 1,450 kWh peak in July. **Thermodynamic Balance Shifts:** Window and opaque wall conduction dominate the negative thermal balance vectors in winter, while high solar radiation transmission acts as the primary heat gain driver during summer.

Operational Primary Energy Metrics (EP):
EPH: 203.86 kWh/m²/year
EPC: 45.29 kWh/m²/year
EPL: 69.93 kWh/m²/year
EPgl: 319.07 kWh/m²/year



5.4 POD PERFORMANCE OPTIMIZATION

5.4.5 Macro-Zone Performance: The classroom

Phase 2: Pod Envelope Retrofit

The second phase models the primary step of the localized envelope intervention, focusing entirely on upgrading the vertical boundary parameters of the classroom. The uninsulated baseline default walls from Phase 1 are completely replaced with the high-performance modular pod wall system. Structurally, this new assembly is moved 30 cm behind the historic, single industrial glazing layer, creating an unconditioned vertical air cavity that acts as a protective thermodynamic buffer. To complete the transparent perimeter upgrade, a high-performance double-glazed unit (DGU), utilizing a Starphire Solarban 60 on Starphire composition with an insulating krypton gas filling, is introduced into the system. Crucially, this phase isolates the performance of the vertical skin alone; no spatial modifications are made to the horizontal boundaries, leaving the new perimeter pod wall and high-efficiency glazing system nested directly between the raw, highly conductive original concrete floor and ceiling slabs.

Operational Primary Energy Metrics (EP)

EPH: 6.07 kWh/m²/year

EPC: 97.12 kWh/m²/year

EPL: 69.93 kWh/m²/year

EPgl: 173.12 kWh/m²/year

Retrofit Thermodynamic Behavior

Sealing the classroom's vertical perimeter alters the internal physics of the space and triggers a massive 97% reduction in winter heating demands, with the EPH dropping to just 6.07 kWh/m²/year. By introducing the insulated pod wall layers and the krypton-filled DGU, the envelope successfully blocks internal heat from rapidly escaping via transmission and infiltration through the perimeter facade. However, this airtight, highly insulated configuration creates a severe thermal containment effect. Classrooms feature a dense internal occupancy profile, generating high internal heat gains from students, laptop equipment, and artificial lighting networks. While the old, drafty baseline envelope allowed this internal heat to freely dissipate to the outside, the newly retrofitted vertical boundaries trap these operational heat gains inside the volume. Because the space is thoroughly sealed but still lacks targeted horizontal slab insulation or passive ventilation mechanisms to flush the heat, this trapped internal load drives the summer cooling demand (EPC) up to 97.12 kWh/m²/year.

5.4 POD PERFORMANCE OPTIMIZATION

5.4.5 Macro-Zone Performance: The classroom

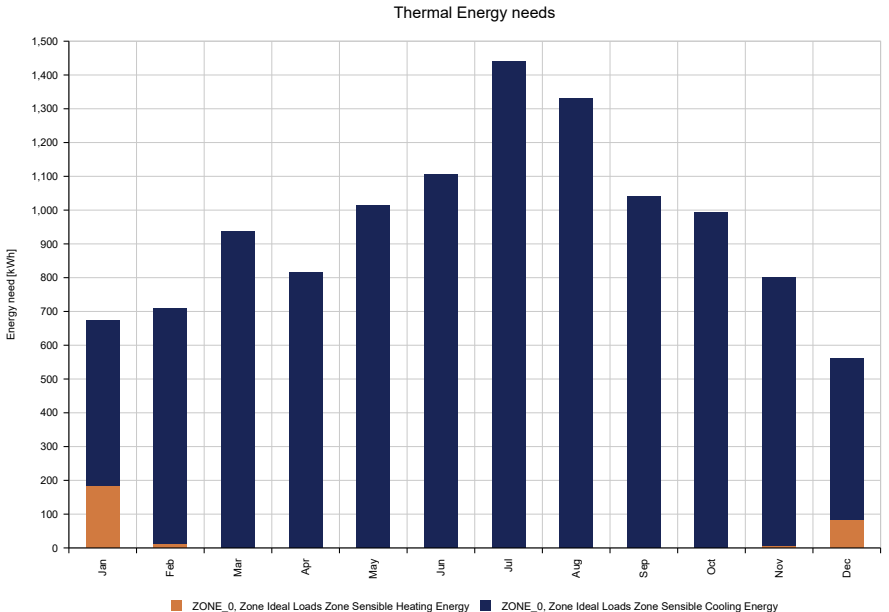
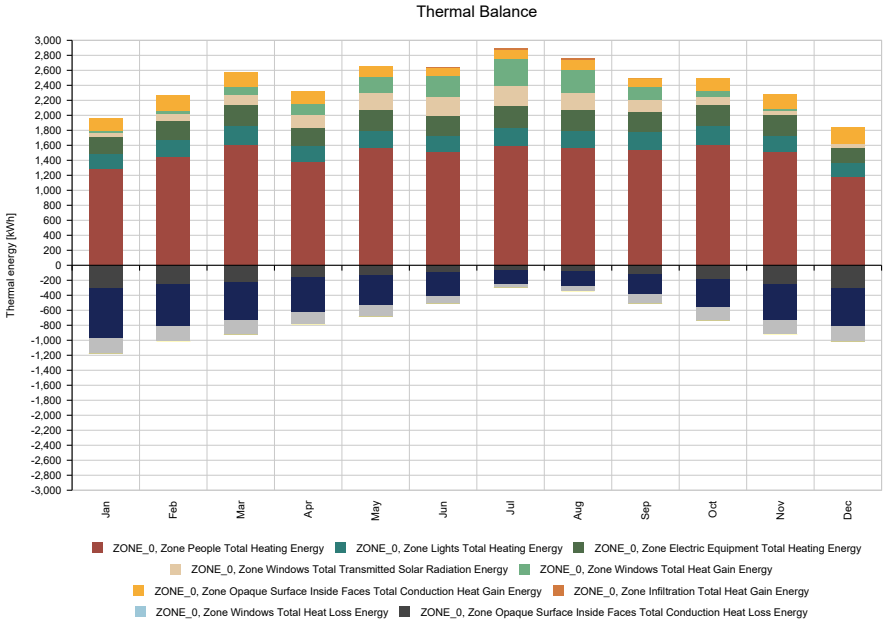
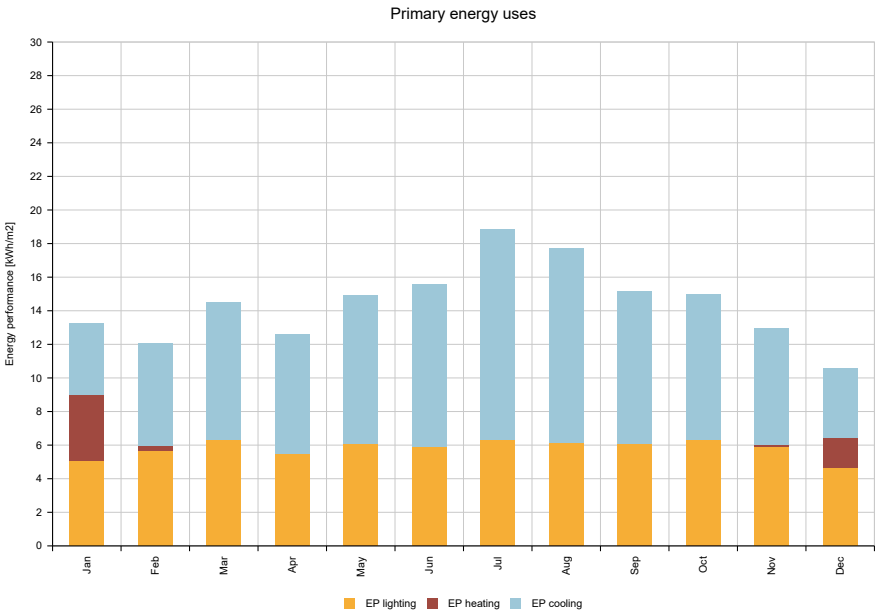
Primary Energy Efficiency: The monthly distribution curve flattens drastically during winter, limiting active heating energy to small allocations in January and December, while summer cooling demands rise to dominate the annual operational energy profile.

Sensible Demands: Total mechanical plant stress tracks a complete seasonal reallocation, where peak winter heating needs collapse to a minor 220 kWh in January, while sensible summer cooling loads expand into a high-volume curve peaking at 1,440 kWh in July.

Thermodynamic Balance Shifts: Vertical window and wall conduction heat losses drop near zero; however, because the pod sits directly between the uninsulated historic concrete slabs, these unmitigated horizontal surfaces continue to exchange heat, failing to buffer the heavy internal heat gains from occupants, equipment, and lights.

Operational Primary Energy Metrics (EP)

EPH: 6.07 kWh/m²/year
EPC: 97.12 kWh/m²/year
EPL: 69.93 kWh/m²/year
EPgl: 173.12 kWh/m²/year



5.4 POD PERFORMANCE OPTIMIZATION

5.4.5 Macro-Zone Performance: The classroom

Phase 3: Integrated Pod Deployment

The third design phase introduces the independent, self-contained modular pod envelope inside the classroom volume, separating the micro-environment entirely from the main building structure. Building on the vertical advancements of Phase 2, this phase addresses the remaining thermal bridges by adding a dedicated floor and ceiling assembly to the pod. The pod structure is nested within the space but structurally decoupled from the original, high-inertia historic concrete floor and ceiling slabs. The transparent perimeter is also upgraded to an advanced double-glazing system with a highly selective low-E coating (Solarban 60 (2) on Solexia clear with a krypton gas filling). This selective unit is paired with custom external shading geometry engineered to block direct solar radiation during high-altitude summer sun angles while permitting lower winter sun angles. This creates a fully isolated, performance-optimized timber micro-envelope within the historic masonry shell.

Operational Primary Energy Metrics (EP)

EPH: 7.13 kWh/m²/year

EPC: 92.91 kWh/m²/year

EPL: 69.93 kWh/m²/year

EPgl: 169.97 kWh/m²/year

Decoupled Thermodynamic Behavior

Swapping the raw, highly conductive concrete floor and ceiling slab boundaries for the independent, insulated timber pod assemblies reconfigures the internal physics of the classroom. During winter, the heating system no longer wastes energy continuously charging the dense, cold historic concrete mass. The lightweight timber panels provide high thermal resistance and low volumetric thermal capacity, keeping the mechanical heating demand exceptionally low at 7.13 kWh/m²/year. However, fully enclosing the classroom in an independent, lightweight timber volume intensifies the summer thermal containment. Classrooms experience high internal heat gains from dense occupancy, lighting networks, and equipment. Because the lightweight timber structure lacks the heavy thermal mass lag of raw concrete, it cannot absorb daytime heat spikes. The advanced Solarban 60 selective glazing successfully blocks external solar gains, but its high thermal resistance also prevents internal operational heat from radiating outward. With the internal gains trapped inside the sealed air volume and no passive cooling mechanism introduced yet, the room temperature rises rapidly during operating hours, maintaining a high cooling demand (EPC) of 92.91 kWh/m²/year.

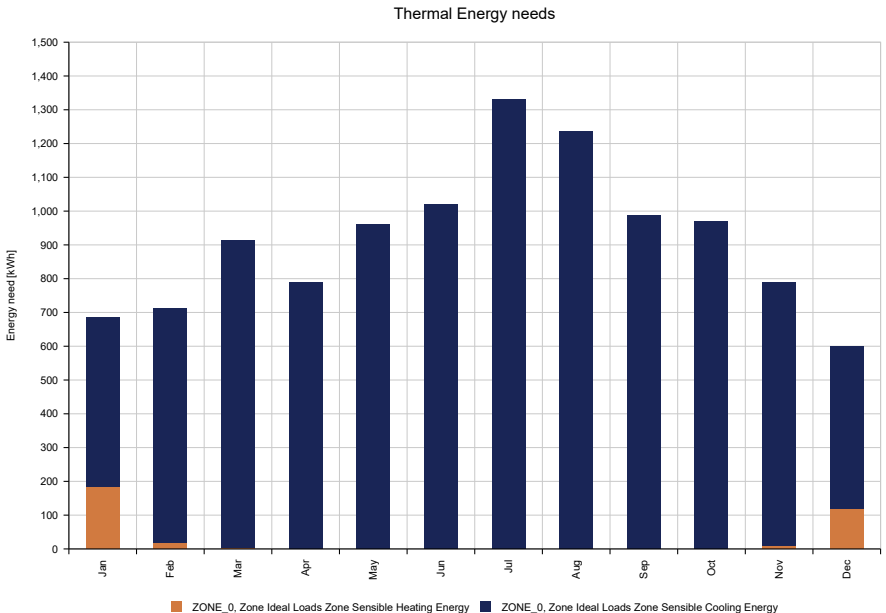
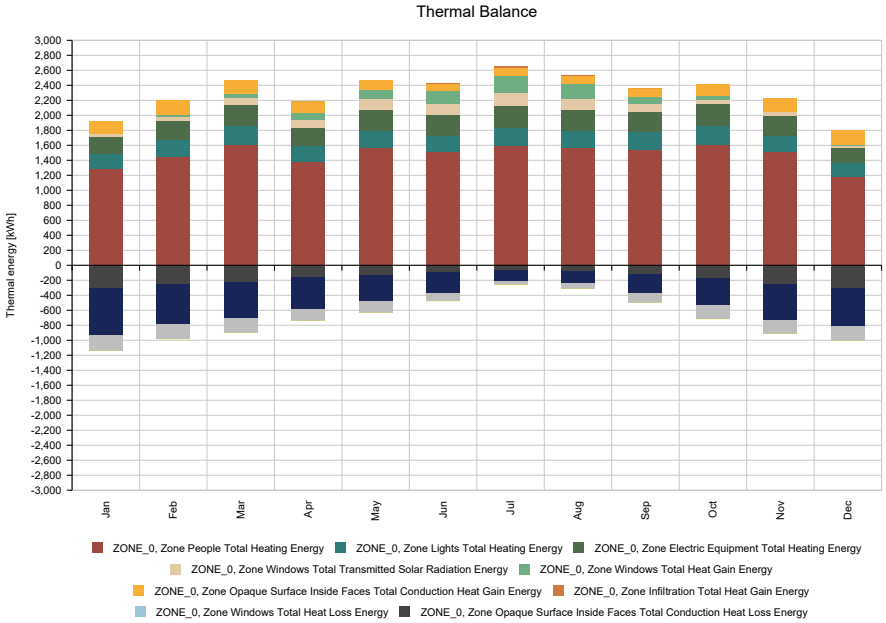
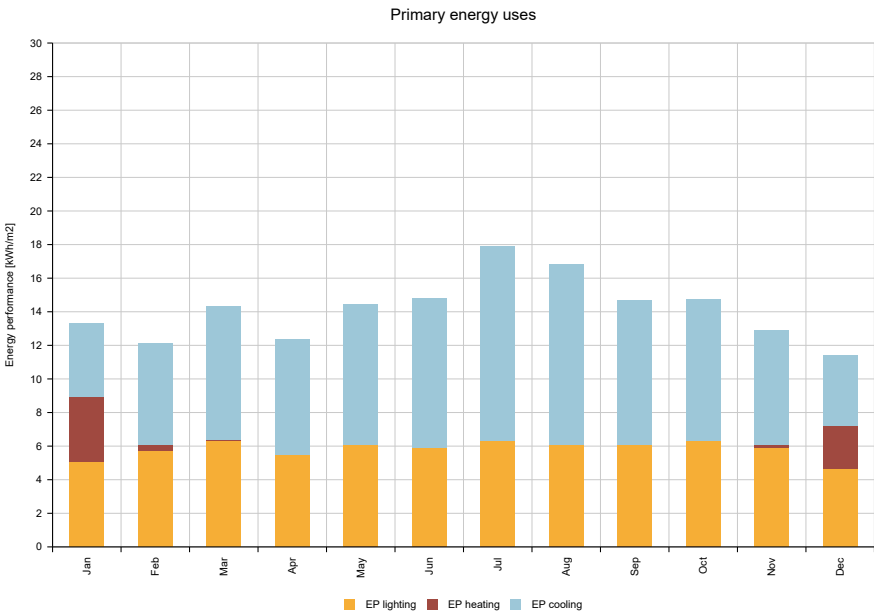
5.4 POD PERFORMANCE OPTIMIZATION

5.4.5 Macro-Zone Performance: The classroom

Primary Energy Efficiency: The annual distribution shows winter heating demands kept to minimal levels, while midsummer cooling loads dominate the monthly operational footprint, peaking in July. **Sensible Demands:** Peak winter heating needs remain suppressed at a minor 680 kWh in January. Meanwhile, the lack of thermal lag in the timber panels drives peak summer cooling demands to a high of 1,330 kWh in July.

Thermodynamic Balance Shifts: Structural conduction losses through the floor and ceiling slabs are minimized by the independent pod panels. Internal gains from occupants, equipment, and lights become the absolute dominant positive drivers in the space, keeping winter loads low but dictating the summer cooling demand.

Operational Primary Energy Metrics (EP)
EPH: 7.13 kWh/m²/year
EPC: 92.91 kWh/m²/year
EPL: 69.93 kWh/m²/year
EPgl: 169.97 kWh/m²/year



5.4 POD PERFORMANCE OPTIMIZATION

5.4.5 Macro-Zone Performance: The classroom

Phase 4: Passive Cooling Integration (Natural Ventilation Scenario)

To address the summer thermal containment identified in the previous stages, an additional optimization phase was implemented for this pod located along the north perimeter. Phase 4 introduces an integrated natural ventilation strategy. This intervention supplements the decoupled timber micro-envelope and high-performance selective glazing by utilizing targeted passive airflow patterns. The objective is to determine how effectively natural ventilation can flush out the high internal heat gains that become trapped within the lightweight, airtight classroom module during warmer periods.

Operational Primary Energy Metrics (EP)

EPH: 12.61 kWh/m²/year

EPC: 77.76 kWh/m²/year

EPL: 69.93 kWh/m²/year

EPgl: 160.30 kWh/m²/year

Thermodynamic Behavior

Activating natural ventilation successfully breaks the thermal containment cycle within the classroom pod, resulting in a notable reduction in active cooling demands (EPC) to 77.76 kWh/m²/year. During peak operating hours in spring and summer, the passive introduction of outdoor air carries away the dense internal heat gains generated by occupants, lighting, and electronics before they can heat up the lightweight timber volume. This passive flushing mechanism reduces total mechanical air conditioning stress. However, because outdoor air is actively introduced into the zone, the winter heating load (EPH) experiences a slight, predictable increase to 12.61 kWh/m²/year due to transient ventilation heat losses during colder shoulder-month operation. Despite this minor trade-off, Phase 4 achieves the lowest overall primary energy consumption (EPgl) for the classroom at 160.30 kWh/m²/year.

5.4 POD PERFORMANCE OPTIMIZATION

5.4.5 Macro-Zone Performance: The classroom

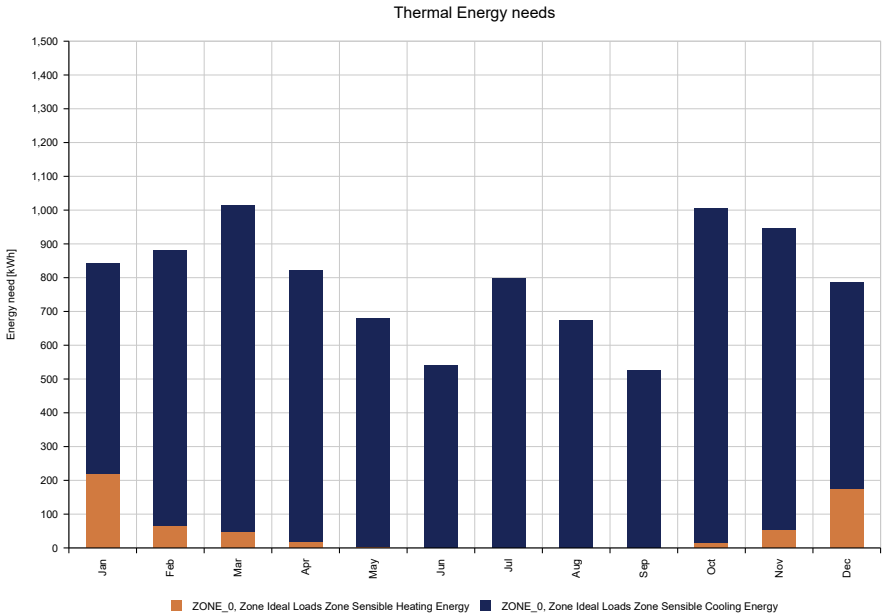
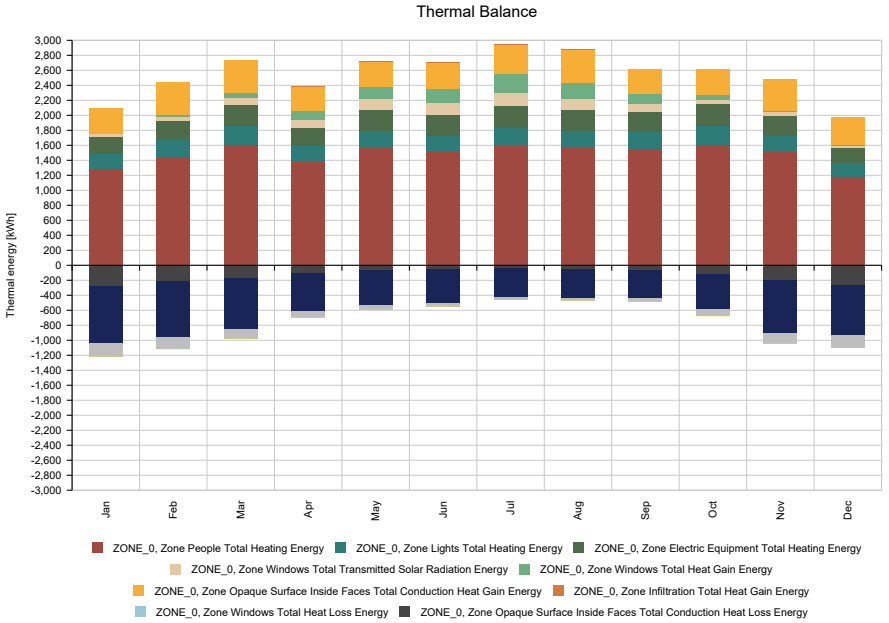
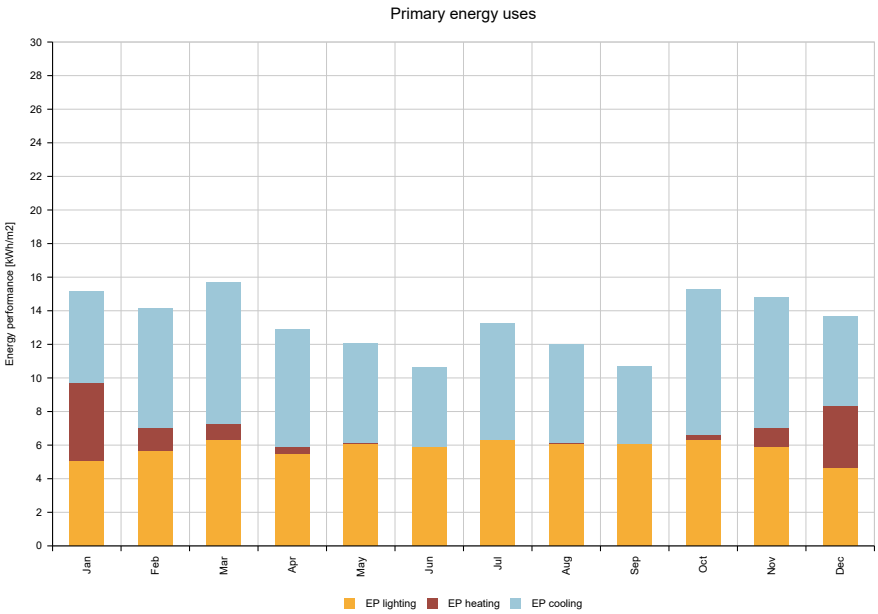
Primary Energy Efficiency: The annual profile reflects a highly balanced distribution, where midsummer cooling peaks are visibly suppressed compared to Phase 3, and the fixed lighting base remains constant year-round.

Sensible Demands: Peak summer conditioning needs decline significantly, with the maximum sensible cooling load in July dropping to approximately 800 kWh due to passive heat removal.

Thermodynamic Balance Shifts: Infiltration and ventilation heat exchange expand as a cooling vector, directly counterbalancing internal heat gains and preventing them from driving up room temperatures during peak seasonal exposures.

Operational Primary Energy Metrics (EP)

EPH: 12.61 kWh/m²/year
EPC: 77.76 kWh/m²/year
EPL: 69.93 kWh/m²/year
EPgl: 160.30 kWh/m²/year



5.4 POD PERFORMANCE OPTIMIZATION

5.4.6 Cross-Zone Comparison: Workshop vs. Classroom

A direct comparison of the primary energy metrics across both macro-zones reveals distinct thermodynamic behaviors rooted in their specific internal profiles and boundary exposures. In the baseline configuration (Phase 1), both the Painting Workshop and the Classroom exhibit severe winter vulnerabilities, with heating demands (EPH) exceeding 200 kWh/m²/year due to the uninsulated historic concrete structure and highly conductive single glazing. When transitioning to the vertical envelope retrofit (Phase 2), their trajectories snapshot a sharp divergence. The classroom achieves a dramatic 97% drop in heating demand, plummeting to 6.07 kWh/m²/year, whereas the workshop retains a higher demand of 62.67 kWh/m²/year. This variance stems from orientation differences and the specific transparent area distributions along the north perimeter facade. However, this aggressive vertical isolation triggers a massive containment of internal heat gains. Because the classroom accommodates a high people density, with students acting as constant internal heat sources, its cooling load (EPC) more than doubles, skyrocketing to 97.12 kWh/m²/year. Conversely, the painting workshop features a sparse occupancy profile; with significantly fewer human thermal loads within the spatial volume, its summer cooling increase remains highly manageable (31.10 kWh/m²/year).

The deployment of the fully decoupled modular pods in Phase 3 completely eliminates structural concrete thermal bridging. By introducing independent insulated timber floor and ceiling panels, the workshop's heating demand is cut nearly in half (32.35 kWh/m²/year). In the classroom, completely separating the module from the massive historic slabs slightly adjusts the winter heating baseline to 7.13 kWh/m²/year while trimming the unventilated midsummer cooling peak to 92.91 kWh/m²/year. The intense thermal containment observed within the lightweight timber classroom envelope highlights why an additional optimization phase was required for this high-density north perimeter pod. By implementing Phase 4 (Passive Cooling Integration), targeted natural ventilation loops are utilized to flush out internal metabolic heat gains during warm operating hours. This passive strategy reduces mechanical cooling demands (EPC) by 15.15 kWh/m²/year, driving the total primary energy performance (EPgl) down to its lowest point of 160.30 kWh/m²/year. This confirms that while highly insulated timber pods are exceptionally efficient for winter conservation, high-occupancy zones must balance structural insulation with passive airflow strategies to counter localized internal gains.

Zone & Optimization Phase	EPH [kWh/m²/year]	EPC [kWh/m²/year]	EPL [kWh/m²/year]	EPgl [kWh/m²/year]
Painting Workshop				
Phase 1: Historical Baseline	212.44	25.14	87.41	324.99
Phase 2: External Envelope Retrofit	62.67	31.1	87.41	181.18
Phase 3: Integrated Pod Deployment	32.35	38.49	87.41	158.25
Classroom (North Perimeter)				
Phase 1: Historical Baseline	203.86	45.29	69.93	319.07
Phase 2: External Envelope Retrofit	6.07	97.12	69.93	173.12
Phase 3: Integrated Pod Deployment	7.13	92.91	69.93	169.97
Phase 4: Passive Cooling Integration (Natural Ventilation)	12.61	77.76	69.93	160.3

Figure 5.170: Comparative Performance Analysis table.

5.5 ACTIVE SUSTAINABILITY

5.5.1 Theoretical Framework & Site Constraints

Architectural Geometric Constraints

The adaptive reuse of the Palazzo del Lavoro requires balancing renewable energy generation with strict heritage preservation. The structural roof plan consists of 16 independent concrete modules, each measuring 38 m x 38 m.

Gross Roof Footprint: $38\text{ m} \times 38\text{ m} \times 16 = 23,104\text{ m}^2$

The Structural Rotation: The building's structural grid is physically rotated 14° clockwise from the true North-South axis to align with the urban layout of Corso Unità d'Italia.

The Boundary Strategy: To preserve the continuous perimeter skylights separating the umbrellas and to account for high-altitude wind uplift forces, a strict 1.5-meter perimeter setback is enforced within each square module. This restricts the net usable width for panel rows to exactly 35 meters.

The design balances micro-architectural intervention with macro-scale urban sustainability. Given the vast, unshaded footprint of roof infrastructure, this project rejects the traditional model of building isolated energy calculation. Instead, the roof is treated as an active urban power plant designed to anchor a district-scale Renewable Energy Community (REC) for the city of Turin. The following photovoltaic strategy evaluates how to optimize this historic landmark as a massive clean energy contributor while respecting its strict heritage constraints.

Core Radiometric Photovoltaic Definitions

Kilowatt-Peak (kWp):

The nominal maximum power output of a PV array under Standard Test Conditions (STC): an irradiance of $1,000\text{ W/m}^2$, cell temperature of 25°C , and an air mass (AM) of 1.5.

Global In-Plane Irradiation (kWh/ m²/year):

The total solar energy (direct, diffuse, and reflected) received on a tilted surface over a full annual cycle.

Angle of Incidence (AOI) Loss: The percentage of solar energy lost due to light reflecting off the panel glass when the sun hits it at an oblique angle.

Temperature Coefficient (Thermal Loss):

The efficiency drop experienced by photovoltaic cells as their operating temperature rises above 25°C .

Row Pitch:

The center-to-center distance required between consecutive solar panel rows to prevent them from casting shadows on one another.

Baseline System Calculations

Using standard high-efficiency monocrystalline silicon panels (21% efficiency, yielding 0.21 kWp/m^2) and an assumed 70% layout density across the net available roof space, the maximum potential installed system capacity is calculated as follows:

Net Usable PV Area = $23,104\text{ m}^2 \times 0.70 = 16,172.8\text{ m}^2$

Installed Peak Power (kWp) = $16,172.8\text{ m}^2 \times 0.21\text{ kWp/m}^2 = 3,392\text{ kWp}$

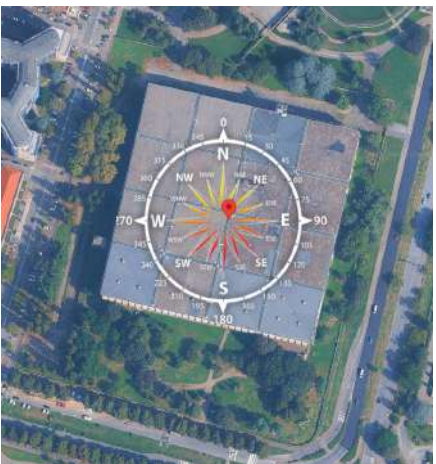


Figure 5.171: Aerial site plan of the Palazzo del Lavoro overlaid with a compass rose, illustrating the structural grid's 14 degrees clockwise rotation off true North (Azimuth 14 degrees West of South) to align with Corso Unità d'Italia.

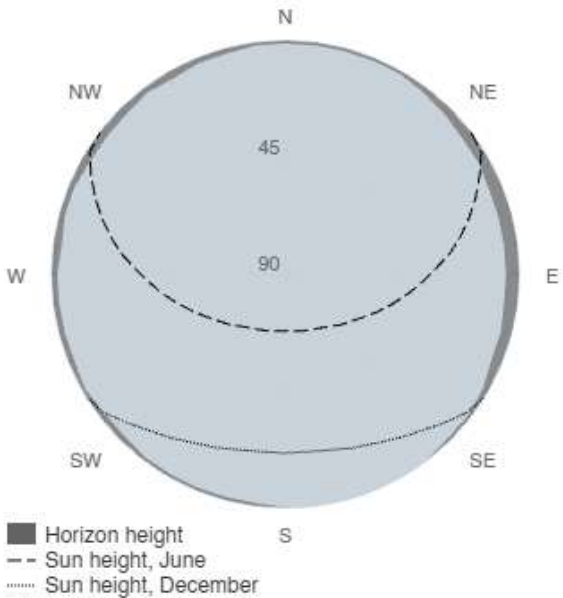


Figure 5.172: Local horizon profile and calculated solar path diagrams for Turin (Latitude 45.019° N , Longitude 7.668° E) indicating the low solar altitude angle during the winter solstice.

5.5 ACTIVE SUSTAINABILITY

5.5.2 Methodology & Baseline Inputs

A macro-scale analysis was conducted using the European Commission’s PVGIS-SARAH3 satellite database for Turin. System losses were fixed at 11% to model a high-performance modern installation. Because the panels are aligned with the building’s structural grid to maintain order, the orientation is fixed at a 14° Azimuth (facing South_South-West). Two independent slope configurations were simulated at this fixed capacity to evaluate energy performance against architectural heritage constraints.

Configuration A: The Preservation Strategy (15° Tilt)

This layout employs a shallow 15° slope designed to keep the entire array hidden behind the roof edge from pedestrian view lines.

Annual Energy Yield: 4,301,879.48 kWh
In-Plane Irradiation: 1,650.69 kWh/ m²
Total Combined System Losses: -23.17% (with Temperature/Low Irradiance at -11.59%)

Configuration B: The Ideal Performance Strategy (35° Tilt)

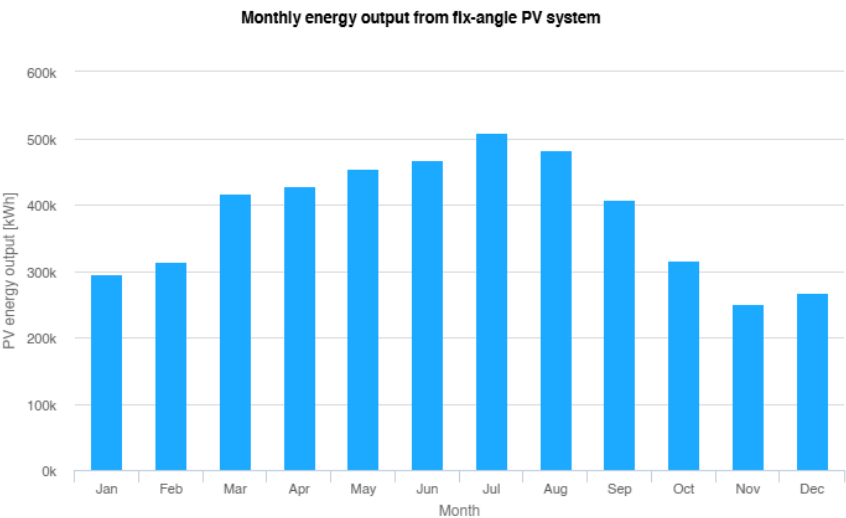
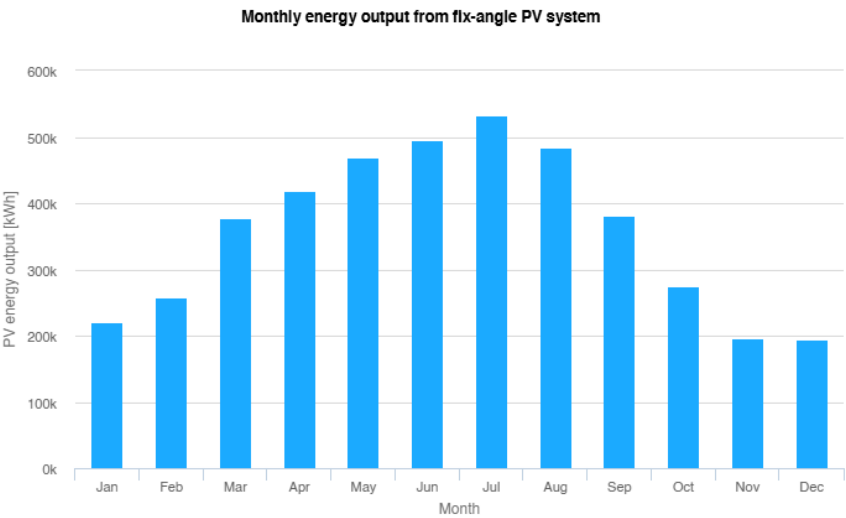
This layout employs a steep 35° tilt, optimizing the panels for maximum annual solar capture at Turin’s latitude.

Annual Energy Yield: 4,607,443.11 kWh
In-Plane Irradiation: 1,767.93 kWh/ m²
Total Combined System Losses: -23.17% (with Temperature/Low Irradiance increasing to -12.13%)

Provided inputs	
Location [Lat/Lon]	45.019, 7.668
Horizon	Calculated
Database used	PVGIS-SARAH3
PV technology	Crystalline Silicon (original)
PV installed [kWp]	3392
System loss [%]	11
Simulation outputs	
Slope angle [°]	15
Azimuth angle [°]	14
Yearly PV energy production [kWh]	4301879.48
Yearly in-plane irradiation [kWh/m2]	1650.69
Year-to-year variability [kWh]	152619.87
Changes in output due to	
Angle of incidence [%]	-3.22
Spectral effects [%]	0.9
Temperature and low irradiance [%]	-11.59
Total loss [%]	-23.17
PV electricity cost [per kWh]	

Provided inputs	
Location [Lat/Lon]	45.019, 7.668
Horizon	Calculated
Database used	PVGIS-SARAH3
PV technology	Crystalline Silicon (original)
PV installed [kWp]	3392
System loss [%]	11
Simulation outputs	
Slope angle [°]	35
Azimuth angle [°]	14
Yearly PV energy production [kWh]	4607443.11
Yearly in-plane irradiation [kWh/m2]	1767.93
Year-to-year variability [kWh]	187323.29
Changes in output due to	
Angle of incidence [%]	-2.7
Spectral effects [%]	0.98
Temperature and low irradiance [%]	-12.13
Total loss [%]	-23.17
PV electricity cost [per kWh]	

Figure 5.173: PVGIS summary tables demonstrating the 7.1% mathematical yield advantage of the performance-optimized 35° angle over the shallow 15° orientation under unshaded, isolated conditions.



5.5 ACTIVE SUSTAINABILITY

5.5.3 Micro-Scale Architectural Modeling (Rhino & ClimateStudio)

The Geometry of Self-Shading (The Pitch Formula)

To translate these strategies into a physical 3D model in Rhino, row-to-row spacing was calculated to guarantee shade-free performance during the lowest winter sun angle in Turin (21.5° on December 21st). The rows are modeled in a “2-portrait” configuration, creating a continuous surface length (slope height) of 4.6 meters.

Vertical Height (H) = Surface Length x sin(Θ)

Horizontal Footprint (W) = Surface Length x cos(Θ)

For the 15° Layout:

Height is 1.19 m, Footprint is 4.44 m, resulting in a required center-to-center pitch of 7.46 m.

For the 35° Layout:

Height is 2.64 m, Footprint is 3.77 m, resulting in a required center-to-center pitch of 10.47 m.

Spatial Array Assembly Rhino Centering

When these physical pitches are constrained inside the 35-meter net usable area of the concrete umbrellas, a major spatial conflict emerges:

The 15° Model: Can comfortably fit 5 complete rows spaced at a compressed center-to-center pitch of 7.0 m. When perfectly centered, this leaves a balanced 2.78 m setback at the northern and southern edges.

The 35° Model: Due to its massive shadow profile, it is strictly limited to 3 complete rows spaced at a center-to-center pitch of 10.47 m. When centered, this leaves a wide 6.64 m perimeter clearance.

Dynamic Micro-Scale ClimateStudio Results

The physical 3D configurations were simulated within ClimateStudio using an hourly EnergyPlus .epw weather file for Turin, capturing real-world geometry, local microclimatic variations, and row-to-row self-shading.

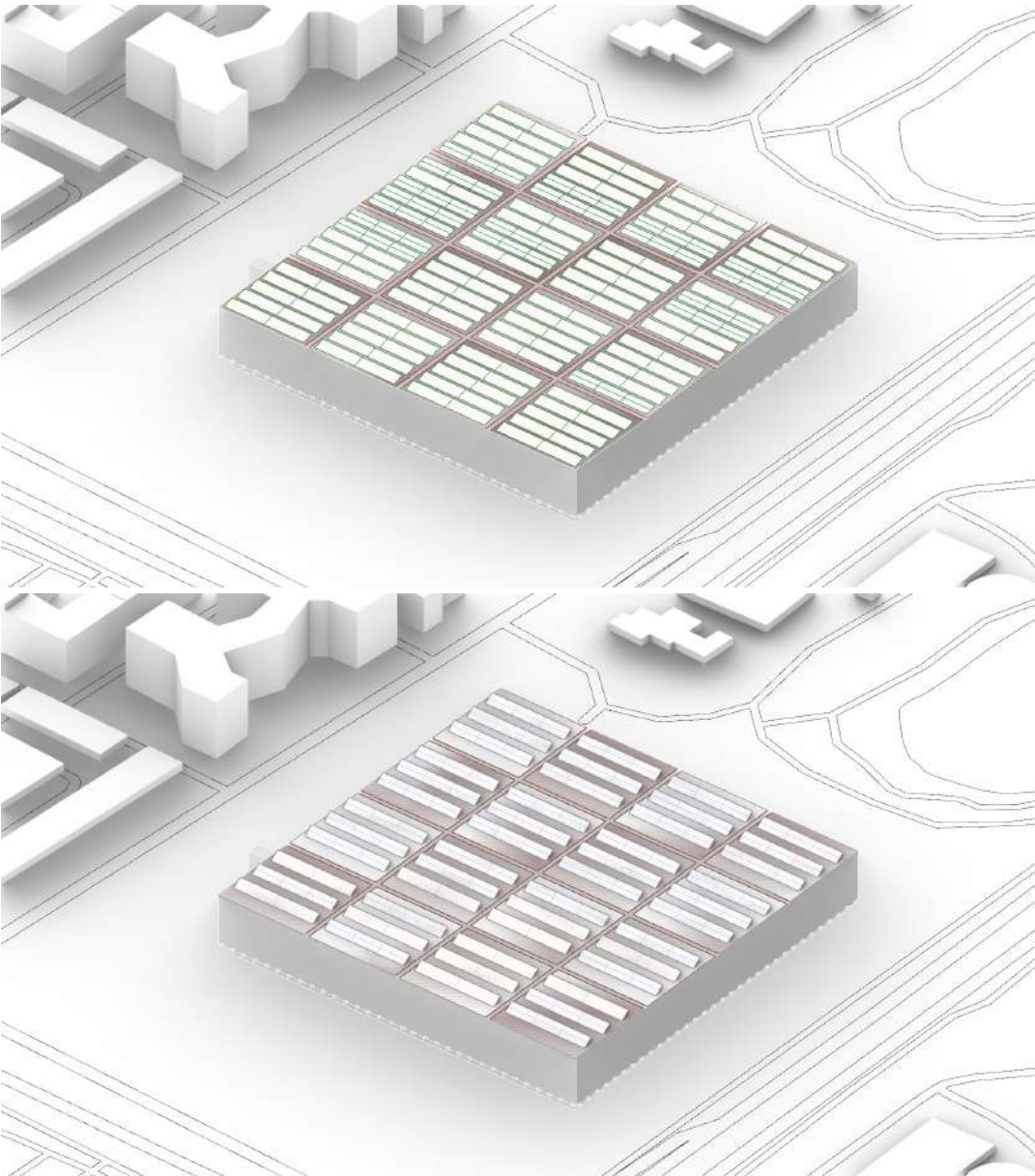


Figure 5.174: Isometric 3D Rhino models of the architectural intervention on the roof of the Palazzo del Lavoro. Top: High-density 5-row layout optimized for maximum area coverage at a 15° tilt. Bottom: Low-density 3-row layout required to clear winter shadow paths at a steep 35° tilt.

5.5 ACTIVE SUSTAINABILITY

5.5.4 Dynamic Micro-Scale ClimateStudio Results

The Spatial Density Paradox

The ultimate findings present an architectural paradox: while macro-scale satellite calculations (PVGIS) state that a 35° tilt is 7.1% more efficient per panel, micro-scale modeling (ClimateStudio) proves that the 15° layout yields significantly higher total energy for the building.

By lowering the tilt to 15°, the shadow footprint shrinks, allowing 5 rows instead of 3. This increases the total active panel area on the roof by 40%. The massive spatial advantage of keeping the roof densely populated far outweighs the minor efficiency gain of a steeper angle.

Normalized Performance Indices

To present these results comprehensively, environmental impacts are calculated using the Italian national grid environmental efficiency factor (0.215 kg CO₂/kWh) and normalized by surface area: **Annual Offset (kg CO₂)** = Annual Energy Yield (kWh) x 0.215

Final Design

For the rehabilitation of the Palazzo del Lavoro, the 15° layout with 5 rows is selected. It delivers the highest total carbon mitigation (924.9 metric tons/year), maintains the horizontal profile of Nervi's 25-meter-high masterpiece, minimizes structural wind loading on the historic concrete umbrellas, and turns a flat roof into a highly efficient, high-density energy asset

Performance Indicator	15° Low-Profile Strategy (5 Rows)	35° Optimized Strategy (3 Rows)
Physical Array Footprint	5 Rows (Maximum Spatial Density)	3 Rows (Low Spatial Density)
Annual Energy Yield	Higher Total Output (4.30 CWh baseline)	Lower Total Output (Due to 40% area loss)
Normalized Yield Efficiency	1,268.2 kWh/kWp/year	1,358.3 kWh/kWp/year
Carbon Avoidance Intensity	57.2 kg CO ₂ /m ² /year	61.2 kg CO ₂ /m ² /year (On active panels)
Total Annual CO ₂ Mitigation	~924.9 Metric Tons	~642 Metric Tons (Due to reduced area)
Pedestrian Sightline Visibility	100% Invisible (Hidden below roof edge)	Potentially visible at distance silhouettes
Structural Wind Sail Vulnerability	Low profile, aerodynamic	High profile, requires heavy roof ballast

Figure 5.175: Comparison table between the two PV options.

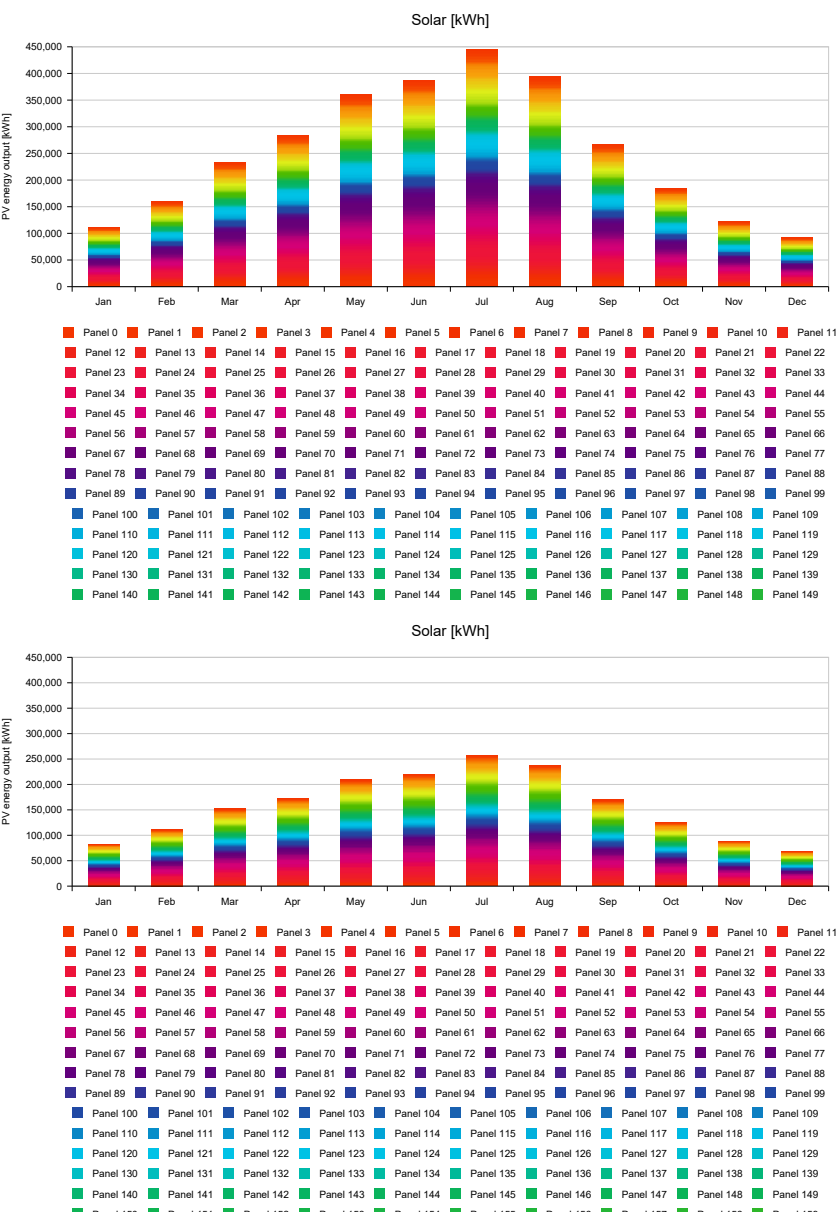


Figure 5.176: ClimateStudio monthly generation chart mapping the dynamic solar output highlighting seasonal bell-curve patterns and array performance uniformity. Top: results at 15° tilt, Bottom: results at 35° tilt

REFERENCES & CASE STUDIES

Gare Maritime, Brussels (Neutelings Riedijk Architects)

The Architectural Narrative

The adaptive reuse of the Gare Maritime transit hub in Brussels represents a pioneering benchmark for large-scale timber micro-architecture inserted within a historic industrial envelope. Spanning a monumental early 20th-century iron-and-glass framework measuring 280 meters long by 140 meters wide, the design avoids introducing major structural interventions into the historic iron hall. Instead, the layout populates the expansive internal side aisles with multiple freestanding timber volumes, prefabricated Cross-Laminated Timber (CLT) pavilions. These independent, modular timber structures function as a reversible “city within a city,” accommodating a mixed program of offices, retail, and public spaces while leaving the monumental central nave open as a sheltered public core.

The Architectural Connection

This precedent establishes a direct structural, ecological, and material validation for the project. By treating an existing monumental historic envelope as a weather-sheltered urban micro-climate, it demonstrates the viability of utilizing lightweight, prefabricated CLT pods to fulfill complex contemporary program requirements. The structural strategy of transferring new volumetric loads independently through light timber matrices, rather than impacting the original frame or requiring deep new foundations, directly validates the independent modular assembly proposed within the historic long-span bays.



REFERENCES & CASE STUDIES

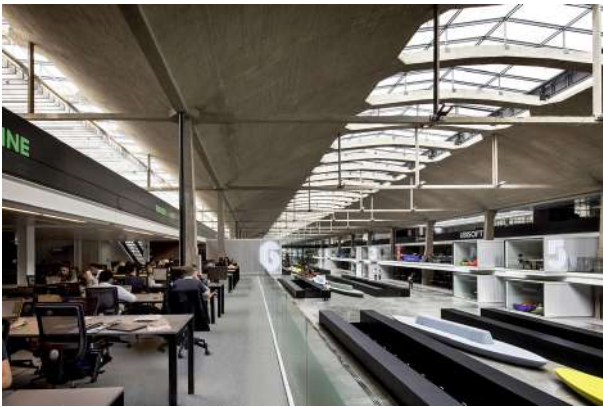
Halle Freyssinet / Station F, Paris (Wilmotte & Associés)

The Architectural Narrative

Originally constructed between 1927 and 1929 by engineer Eugène Freyssinet, the former railway freight depot in Paris stands as an iconic masterpiece of early pre-stressed concrete architecture. The transformation into the Station F startup campus successfully preserves the building's striking 310-meter linear perspective while introducing a massive, multi-layered contemporary workspace program. The design is structured around rigorous graphic legibility and programmatic stratification, dividing the cavernous volume into three distinct zones (Share, Create, Chill). New internal additions rely on lightweight steel frames, clean glass partitions, and independent concrete containers that rest underneath the historical concrete vaults without altering the original structural rhythm or structural bay identity.

The Architectural Connection

This case study provides a precise conceptual model for managing programmatic stratification and graphic hierarchy inside a monumental concrete mega-structure. It outlines the strategic division of a single, continuous hall into distinct neighborhoods of varying focus, ranging from high-intensity active zones to quiet, translucent work sanctuaries. Furthermore, it reinforces the technical drawing strategy where new architectural interventions remain visually and structurally subordinate, utilizing lighter, distinct line weights and material opacity to ensure the original architectural memory and primary structural frame overhead retain absolute visual dominance.



REFERENCES & CASE STUDIES

Roskilde Festival Folk High School, Denmark MVRDV

The Architectural Narrative

The transformation of a former concrete factory into the Roskilde Festival Folk High School centers on vibrant programmatic density and dynamic volumetric composition. Situated inside an old raw concrete warehouse (Hall 10) characterized by historic concrete girders and pillars, the design introduces an expressive “box-in-a-box” system. The interior space is populated by learning rooms, individually colored and textured modular volumes arranged in an interlocking composition in a staggered formation underneath the original ceilings. These capsules isolate high-intensity creative programs, such as music studios, dance halls, digital workshops, and lecture spaces, while leaving the dynamic “space in between” to act as an open communal spine for informal public interaction and collaborative exchange.

The Architectural Connection

This precedent serves as a primary typological template for the internal arrangement of specialized workshop cells within an open industrial hall. It proves that clustering diverse, high-intensity technical and creative programs into self-contained, acoustically isolated capsules can transform a large, single unconditioned volume into a functional, safe, and highly collaborative environment. The staggered volumetric composition and clear functional boundaries between enclosed research spaces and open public thoroughfares directly justify the spatial division, acoustic isolation, and cluster configuration utilized throughout the design layout.



REFERENCES & CASE STUDIES

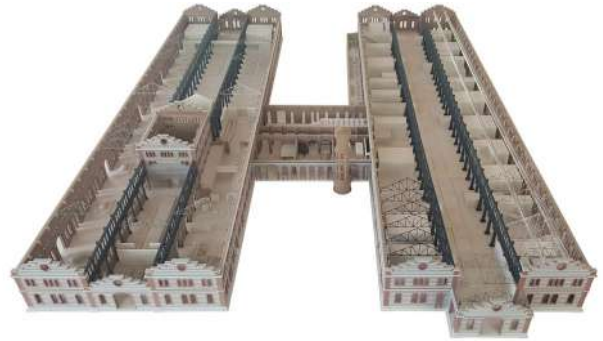
OGR (Officine Grandi Riparazioni), Turin

The Architectural Narrative

The Officine Grandi Riparazioni in Turin represents an essential contextual reference for the conversion of massive, late 19th-century post-industrial infrastructure into a multidisciplinary platform. Originally built as a heavy rail repair depot, the monumental H-shaped brick and iron complex presented a highly regular and rhythmic spatial layout. The contemporary restoration transformed the cavernous industrial naves into a highly flexible, open-plan cultural platform and technological innovation hub. The intervention successfully balances heavy industrial heritage with fully reversible contemporary installations, preserving the authentic material memory of the site while establishing a multi-layered infrastructure for artistic experimentation, research, and public engagement.

The Architectural Connection

As a highly relevant local precedent within the fabric of Turin, this project demonstrates how a historic, mono-functional industrial shell can be reprogrammed to house hybrid programmatic ecosystems without stripping the building of its raw spatial volume. The intervention model highlights the successful juxtaposition of post-industrial masonry shells with sleek, adaptable contemporary layouts. It serves as a strong typological validation for transforming large-scale mid-century structural bays into active hubs of advanced design and cultural production, aligning directly with the urban and functional logic of the project.



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