NATURAL HISTORY MUSEUM

T.U., Kirtipur, Kathmandu

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A thesis submitted in partial fulfillment
of the requirements for the
Degree of Bachelor of Architecture

Purbanchal University
KHWOPA ENGINEERING COLLEGE
DEPARTMENT OF ARCHITECTURE
Libali, Bhaktapur, Nepal

AUGUST 2025

An Undertaking of Bhaktapur Municipality

KHWOPA ENGINEERING COLLEGE

(Affiliated to Purbanchal University)

Estd. 2001

PAN No. 201382918

CERTIFICATE

This is to certify that the thesis entitled **NATURAL HISTORY MUSEUM** at ***T.U., Kirtipur, Kathmandu***, submitted to the Department of Architecture of Khwopa Engineering College by **Ms. Kusum Sharma** of Class Roll No. 018/ B.Arch./ 076 has been declared successful for the partial fulfillment of the academic requirement towards the completion of the degree of Bachelor of Architecture of Purbanchal University.

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Abstract

The Natural History Museum thesis proposes an educational and research-oriented space that tells the story of nature through Nepal's unique biodiversity and geological evolution. The aim is to design a museum that effectively communicates natural history while responding to the academic setting of Tribhuvan University, Kirtipur. A contextual design methodology was adopted, analyzing site conditions, climate, circulation, and users need to create a spatial framework that balances exhibition, education, and experience. Focus was given to zoning, sequencing, and visitor flow, ensuring a coherent narrative journey through natural history.

The content is structured around a timeline-based exhibition, starting from the formation of Earth, tectonic activity, prehistoric life, species evolution, and human development. At its core, the museum comprises galleries arranged around courtyards, offering both indoor and outdoor spatial engagement. Exhibition themes highlight the formation of the Himalayas, fossils, native flora and fauna, and early civilizations. Complementary spaces include a lecture hall, library, administrative offices, technical zones, and a recreational zone with a café and souvenir store.

The outcome is a museum that not only presents natural history in a localized and accessible manner but also fosters interdisciplinary learning and appreciation for Nepal's natural legacy. With thoughtful planning, user-centric design, and contextual sensitivity, the project aspires to be both educational and experiential. It emphasizes that understanding our natural past is key to protecting the environment for the future.

Keywords:

Natural History, Nepal, Educational Museum, Exhibition Design, Tribhuvan University, Biodiversity, Geology, Architecture Thesis,

Declaration

I hereby affirm that the thesis titled "Natural History Museum" is the outcome of my independent research. This work has been conducted under the guidance and supervision of Ar. Rashish Lal Shrestha, my Thesis Supervisor.

I confirm that this thesis has not been submitted, either in full or in part, for any other degree or diploma at any other institution. All sources and references utilized in the research have been duly acknowledged.

I have adhered to the ethical standards and guidelines set by Khwopa Engineering College, Libali, Bhaktapur, throughout the research and writing process.

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August 2025

Acknowledgement

I would like to sincerely thank my thesis supervisor, Ar. Rashish Lal Shrestha, for his valuable guidance, support, and encouragement throughout the development of this project. His insights have helped me refine my ideas and move forward with more clarity and confidence.

I am also grateful to the faculty members of the Department of Architecture for their constructive suggestions during reviews and discussions, which have been instrumental in shaping the direction of my work. My heartfelt thanks also go to my classmates, friends, and everyone who, in one way or another, supported me both morally and physically during this journey.

Above all, I am deeply thankful to my family for their unwavering love, patience, and encouragement, which have been my greatest source of strength throughout this process.

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Kusum Sharma

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1. Chapter 1: Project Introduction

1.1 Introduction: Natural History Museum

The design and development of a Natural History Museum in Nepal represent a critical step toward preserving and showcasing the country's unique and rich natural heritage. This project proposes the establishment of such a museum within the campus of Tribhuvan University, Kirtipur, which is strategically located near various academic institutions, creating an ideal environment for both public education and scholarly research.

Natural history museums serve as vital cultural and educational institutions worldwide, acting as repositories for specimens and artifacts that tell the story of Earth's geological evolution, biodiversity, and ecological processes. They offer visitors not only an opportunity to explore the natural world but also foster a sense of awareness and responsibility toward environmental conservation. In the context of Nepal, a country characterized by dramatic geological features including the towering Himalayas, active tectonic plates, and diverse ecosystems ranging from tropical lowlands to alpine zones the establishment of a dedicated natural history museum is both timely and necessary.

1.2 Project Justification

Despite diverse natural environments, there is currently a lack of adequate public institutions that represents Nepal's natural history, geological phenomena, and biodiversity in an accessible, scientifically accurate, and engaging manner.

The existing Natural History Museum located in Swayambhu faces limitations in terms of space, infrastructure, and technological capacity, hindering its ability to serve the growing needs of educational institutions, researchers, and the public. As the government and academic authorities plan to relocate the museum to Tribhuvan University in Kirtipur, this relocation offers a unique opportunity to rethink and elevate the museum's role in Nepal's educational and cultural landscape.

A well-designed natural history museum in Kirtipur will address multiple needs: it will act as a hub for scientific research and data collection, supporting Nepal's academic institutions and contributing to national and international knowledge exchange. Moreover, it will provide an

engaging platform for public education, raising awareness of Nepal's natural environment and the critical importance of biodiversity conservation and sustainable development.

Furthermore, locating the museum within the university campus promotes interdisciplinary collaboration between architects, scientists, educators, and policymakers, strengthening the museum's potential as a catalyst for knowledge creation. The design's focus on clusters of buildings not only enhances environmental performance and visitor experience but also reflects the natural processes and ecosystems represented within the museum.

In summary, this project is justified by the need to preserve and communicate Nepal's natural heritage in a manner that is accessible, educational, and forward-looking. It supports national goals of cultural preservation, and scientific development, positioning the new Natural History Museum as a landmark institution of national pride and global relevance.

1.3 Project Objectives

The primary objective of this project is to design a functional Natural History Museum that serves as a center for education, research, and awareness focused on Nepal's unique natural environment. The design will incorporate architectural, spatial, and environmental considerations to create an engaging visitor experience while supporting scientific activities.

The specific objectives of the project include:

- **To showcase Nepal's geological evolution and natural biodiversity:** Through thoughtfully designed exhibition halls, the museum will illustrate key aspects such as the origin of the earth, formation of the Himalayas, diverse ecosystems, and endemic species, providing a holistic understanding of Nepal's natural history.

- **To create an educational facility that fosters learning and curiosity:** The museum will provide spaces for interactive exhibitions, lectures, research, making it an important resource for students, scholars, and the public interested in natural sciences and environmental studies.

- **To design a spatial layout that enhances visitor circulation and accessibility:** Using a cluster-based architectural form arranged around courtyards, the design will ensure clear

zoning, comfortable visitor flow, and seamless connectivity between exhibition spaces, research facilities, and support areas.

- **To promote environmental conservation awareness:** By integrating educational content that highlights environmental challenges and conservation efforts, the museum will encourage visitors to appreciate and participate in protecting Nepal's natural heritage.

- **To support interdisciplinary collaboration:** The museum will function as a hub for collaboration among scientists, educators, architects, and policymakers, encouraging the exchange of knowledge and ideas that advance natural history research and public education.

- **To ensure functional and operational efficiency:** The design will consider the logistical requirements of specimen storage, exhibit maintenance, visitor amenities, and administrative operations, ensuring that the museum can operate smoothly and sustainably over the long term.

1.4 Scope and Limitations

1.4.1 Scope

This project focuses primarily on the architectural design and spatial planning aspects of the Natural History Museum at Tribhuvan University, Kirtipur. It covers the following key areas:

- Site Analysis: Understanding the topography, climate, accessibility, and surrounding context of the proposed location within the university campus.
- Concept Development: Formulating an architectural concept that integrates natural history themes with spatial organization, visitor experience, and sustainability.
- Space Programming: Defining and allocating functional spaces, including exhibition halls, research and archive rooms, educational facilities, administrative offices, visitor amenities, and service areas.
- Zoning and Circulation: Planning effective visitor flow, accessibility, and connectivity between different sections of the museum complex.
- Architectural Design: Designing building forms, materials, and environmental strategies that respond to the local context and project objectives.

1.4.2 Limitations

The project has several limitations that define the extent and depth of the study:

- The design focuses only on exhibition spaces, excluding research labs, storage vaults, and back-end scientific facilities.
- Only immediate restoration and basic maintenance areas are included; no advanced conservation labs are proposed.
- Technical systems like conservation-grade lighting, vibration control, and specialized HVAC are not addressed in detail.
- The design does not include dedicated zones for traveling exhibitions, large-scale loading, or artifact logistics.

1.5 Methodology

a. General Data and Literature Review

A broad range of data was collected from books, research papers, articles, and other published sources listed in the references. This helped build a foundation for understanding the functional, spatial, and technical aspects relevant to the project.

b. Case Studies

To gain deeper insight into natural history museums, both national and international case studies were conducted.

National Case Studies: Existing museums were visited to study spatial planning, functional zoning, and workflow. The following tools were used:

- Photographic documentation
- On-site building surveys

International Case Studies: Online research methods were used to study international natural history museum, which included:

- Official museum websites
- Documentaries and architectural drawings

- Videos and photographs

c. Site Analysis

Site criteria were first researched to determine suitability for a natural history museum. Based on these criteria, a site inside T.U. premises was selected. The site was analyzed with respect to:

- Land use
- Topography
- Climate
- Site context
- Zoning and Bye-laws

d. Program Formulation

Based on research findings and design needs, the program was developed through:

- Finalization of space requirements
- Concept development
- Exploration of alternative designs
- Preparation of drawings and presentation models

2. Chapter 2: Literature Review

2.1 Introduction to Museums

The word **"museum"** comes from the **Latin** word *museum*, which itself is derived from the **Greek** word *Mouseion.*

In ancient Greece, a *Mouseion* was a place dedicated to the **Muses**, the goddesses of art, literature, and science. It originally referred to institutions of learning, such as the famous Library of Alexandria, rather than a collection of artifacts. Over time, the term evolved to refer to buildings that house and display objects of historical, artistic, or scientific significance.

"A museum is a not-for-profit, permanent institution in the service of society that researches, collects, conserves, interprets and exhibits tangible and intangible heritage. Open to the public, accessible and inclusive, museums foster diversity and sustainability. They operate and communicate ethically, professionally and with the participation of communities, offering varied experiences for education, enjoyment, reflection and knowledge sharing." **– ICOM**

Source: International Council of Museums. (2022, August 24). Museum definition

So, to conclude, museums are a place where history, culture, and nature come to life through preserved objects and artifacts. Museums house unique, tangible items that provide a direct connection to the past. Whether showcasing ancient fossils, artistic masterpieces, or scientific marvels, museums serve as educational hubs, research centers, and even sources of entertainment. They can spark curiosity, inspire creativity, and offer a glimpse into worlds long gone or yet to be discovered.

2.2 History and evolution of museums

Museums have evolved into essential cultural destinations, housing invaluable collections that offer a glimpse into history, art, science, and culture. What began as private collections in the fifteenth century, driven by the rise of global trade, has grown into a global phenomenon. With the democratization of knowledge and access, museums today are not only spaces to view artifacts but also to engage with the idea of art itself, sometimes challenging traditional perceptions. As the world has changed, so too has the way we curate, experience, and evaluate museums, pushing them to the forefront of both architectural innovation and cultural dialogue.

The roots of museums trace back to the *Wunderkammer*, or cabinet of curiosities, of the 16th century. These eclectic private collections, filled with rare objects and natural wonders, were the precursors to modern museums, showcasing an early interest in cataloging and preserving the world's wonders. These collections were not focused on art but spanned a wide array of interests, including anthropology, science, and the bizarre. Over time, with the advent of public access and a growing middle class, museums began to take more structured forms. The Louvre's transformation into a public gallery in 1793 during the French Revolution marked a pivotal moment, making art accessible to the masses and setting the stage for the modern museum as we know it today.

Below is a timeline, covering the key developments in the history of museums and its evolutions starting from the Rome and Greece temple collections to the modern 2000s museums.

Source: Geczy, A. (n.d.). How did museums begin, and how did they evolve? It Starts With Adam. [Online]

2.3 Functions of museum

A museum functions to collect, conserve, study, interpret, and exhibit objects of historical, cultural, scientific, or artistic significance. It preserves valuable heritage, supports research and learning, and helps the public engage with meaningful stories and knowledge through thoughtfully curated displays and programs.

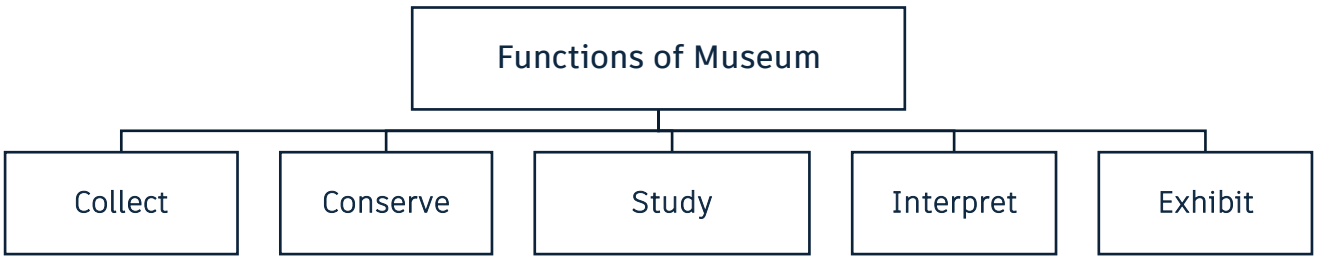
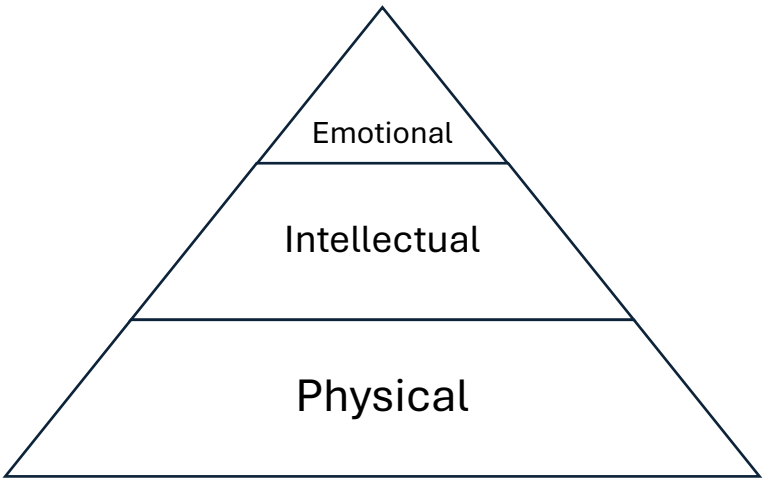


Figure 2.1: Function of Museum
Source: Pickard, Q. (Ed.). (2002). The architects' handbook. Blackwell Science.

2.4 Principal of Museum Design



1. Motivate Visitors
2. Captivate Curiosity
3. Interaction
4. Immersion
5. Focus Content
6. Modularity
7. Skim ability
8. Layer Content
9. Circulation
10. Sequence

Figure 2.2: Principal of museum design

Source: Lehman, M. L. (n.d.). Top 10 tips to great museum exhibit design.

1. **Space Planning:** Good museum design starts with organizing the space well. It's about arranging exhibits in a way that makes it easy for visitors to move around without feeling crowded. The layout should guide people naturally through the exhibits.
2. **Lighting:** Lighting plays a big role in showcasing exhibits. Proper lighting highlights important items, sets the right mood, and can even influence how visitors move through space. A mixture of natural and artificial light is needed to protect the exhibits while making the space visually appealing.
3. **Material Selection:** Choosing the right materials is key in museum design. The materials need to be strong, easy to care for, and some must help control the environment, like temperature and humidity, to protect fragile items.
4. **Interactive Features:** Adding interactive elements, like touch screens or hands-on exhibits, can make a museum visit more engaging. However, these features should be carefully integrated into the design, so they don't take away attention from the main displays.
5. **Clear Signage and Navigation**: Good signage helps visitors find their way around the museum easily. It should be clear and intuitive, helping people locate exhibits or other facilities without confusion.

6. **Flexible Spaces:** Museums need to be adaptable. Spaces should be designed so that they can be easily rearranged to accommodate different types of exhibits and events, giving the museum more flexibility in what it can showcase.

Source: Rethinking The Future. (n.d.). Exhibition and museum design [Online]

2.5 Space Planning in Museum

2.5.1 Space Requirements

The spatial requirements of a museum fall into primary spaces, supportive spaces, and amenities, each essential for smooth operations and visitor experience. Primary spaces include exhibition areas, the core of the museum, showcasing displays and interactive exhibits. Supportive spaces cover technical areas like laboratories and storage, educational spaces such as lecture halls, and administrative offices. Amenities like the cafeteria, parking, and retail areas enhance visitor comfort. Together, these spaces create a functional and engaging museum environment.

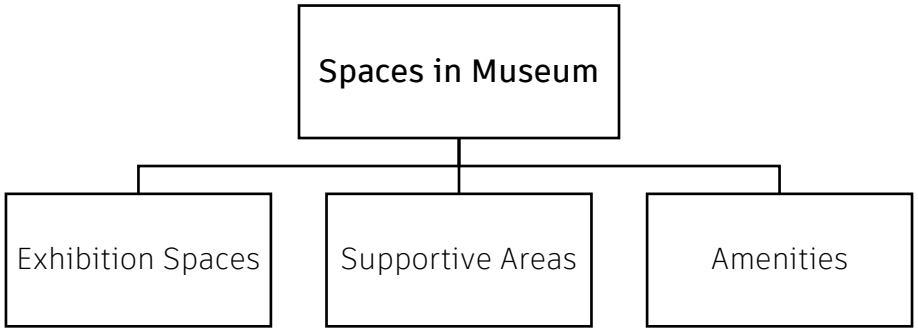


Figure 2.3: Space Requirement in Museum

It can also however be separated on the basis of Public and Non-Public spaces. A well-planned museum must address the needs of both public and non-public spaces. Public spaces cater to visitor engagement, while non-public spaces support essential behind-the-scenes functions.

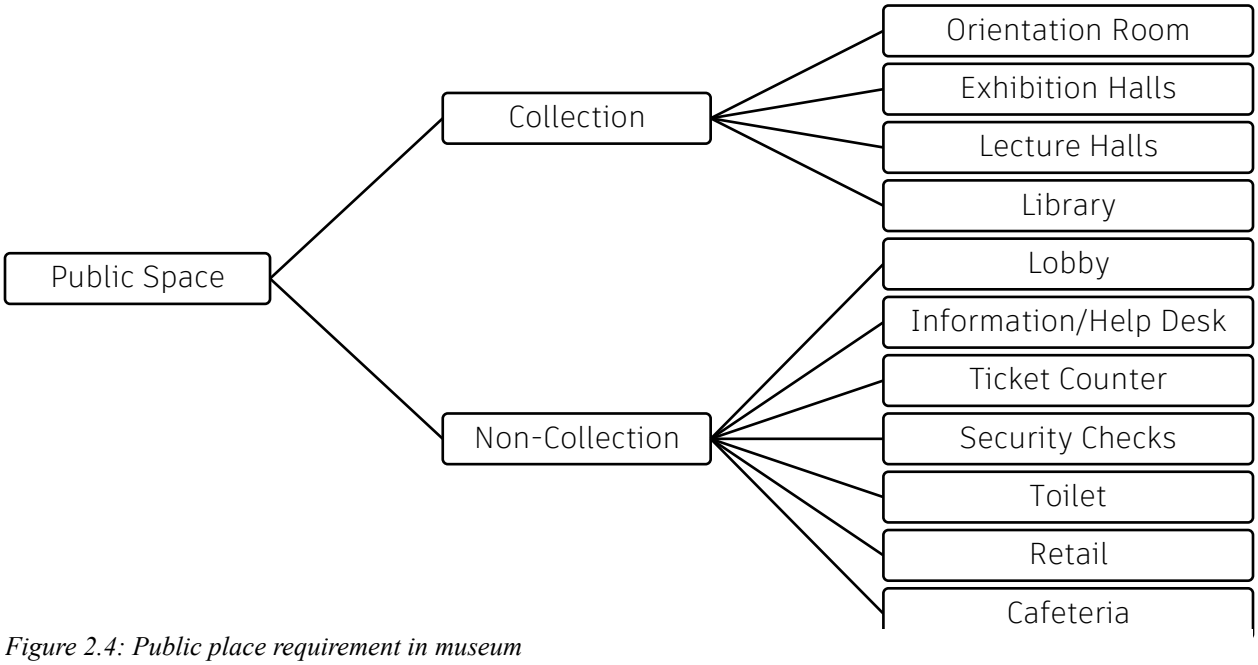


Figure 2.4: Public place requirement in museum

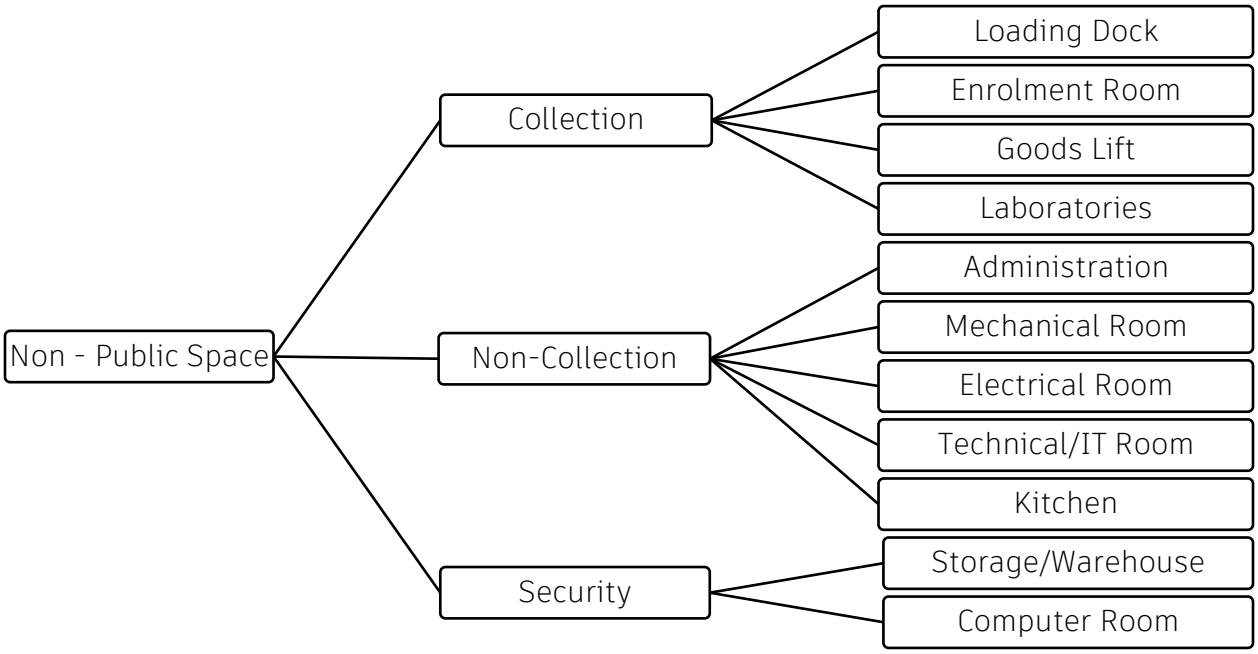


Figure 2.5: Non-Public place requirement in museum

Source (for fig:2.4, 2.5): Harisdani, D., & Chandra, A. (2019). The emphasis of metaphorical form on cultural park.

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2.5.2 Entrance and Exits

The entry and exit experience of a museum extends beyond just the main entrance and exit points. Each gallery also has its own entry and exits points, contributing to the overall flow of the museum. The experience of exiting is distinctly different from entering, as time has passed, new ideas have been absorbed, and museum fatigue can shift the visitor's perspective.

Upon entering, visitors are focused on:

1. Locating the museum,
2. Understanding the parking situation,
3. Finding the front door,
4. Grasping the context of the exhibits to be viewed.

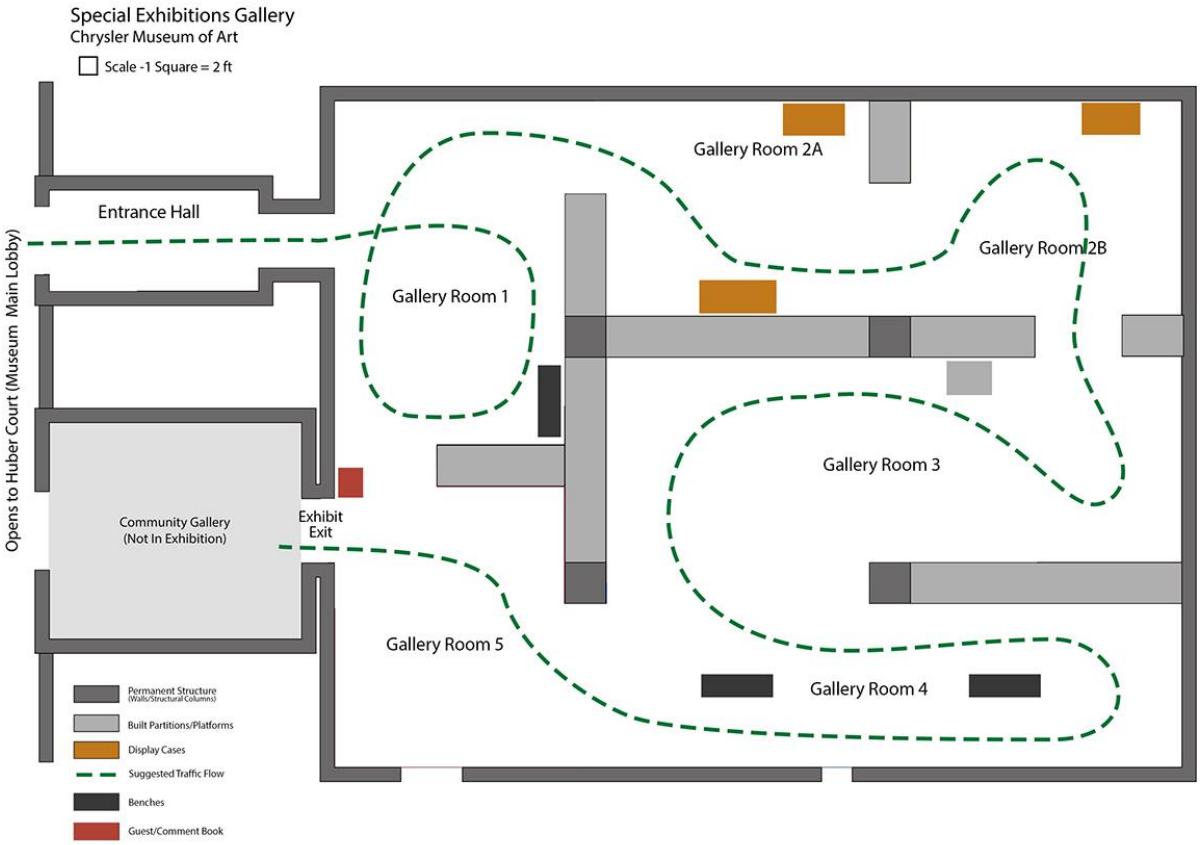

Figure 2.6: Entrance and exit strategy in museum.

Source: Bowers, A. (2016, July 27). Exhibition/spaces design.

The mode of arrival and departure, as well as the size of the visiting groups, heavily influence the spatial arrangement. For instance, busloads of children require large areas for disembarking, boarding, orientation, and waiting, which can create congestion at the entry. In such cases, having separate entry and exit points becomes essential.

On the other hand, the exit experience is centered around different concerns:

a. Waiting for a group,

b. Retaining information and reflecting on the visit,

c. Finding closure to the experience,

d. Seeking relaxation,

e. Or even locating one's vehicle.

The exit often serves as a gathering space for visitors waiting for others, and the opportunity to watch other people come and go can create a sense of community. However, being directed straight to the street, especially from a different exit than where one entered, can be disorienting and overwhelming. A poor exit experience can negatively impact the post-visit perception, potentially tainting an otherwise positive experience.

Designing a seamless and thoughtful exit is therefore crucial to ensuring that the museum visit concludes on a positive note.

2.5.3 Functional Scheme of a Museum

The functional scheme of a museum refers to the organization and layout of spaces within the museum, designed to facilitate the optimal display, conservation, and education of collections. A well-organized functional scheme ensures that the museum can operate smoothly while providing engaging experience for visitors. Below is a flowchart of the museum functional scheme.

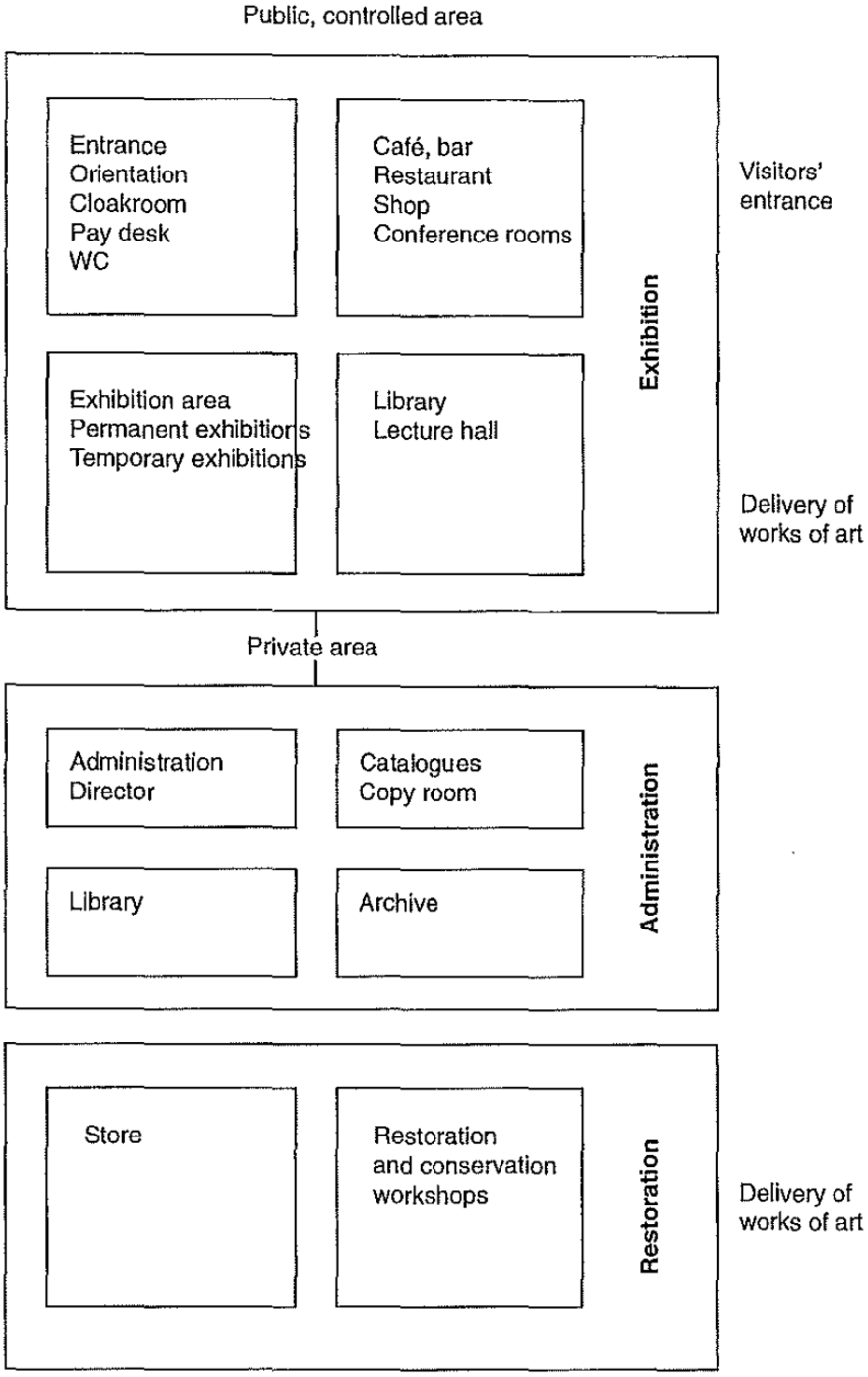

Figure 2.7: Functional scheme of a museum

Source: Neufert, E., & Neufert, P. (2012). Architects' data (4th ed.). Wiley-Blackwell.

2.5.4 Exhibition Route Formation

Exhibition routes can be influenced both by architectural design and the arrangement of exhibits. These routes not only guide the flow of visitors but also shape the sequence in which information, activities, and objects are experienced. A well-designed layout and the architectural formation of a museum are closely linked to these routes.

a. Open Plan
b. Core and Satellite
c. Linear Chaining
d. Labyrinth
e. Complex
f. Round Tour (Loop)

1. Open Plan: Large, uninterrupted space with no internal walls. Encourages free movement and flexible viewing across themes.

2. Core and Satellite: A central core exhibit with smaller, related rooms branching off. Highlights a main theme while offering deeper exploration.

3. Linear Chaining: Rooms linked in a sequence along one axis. Clear and continuous but may need variation to avoid monotony.

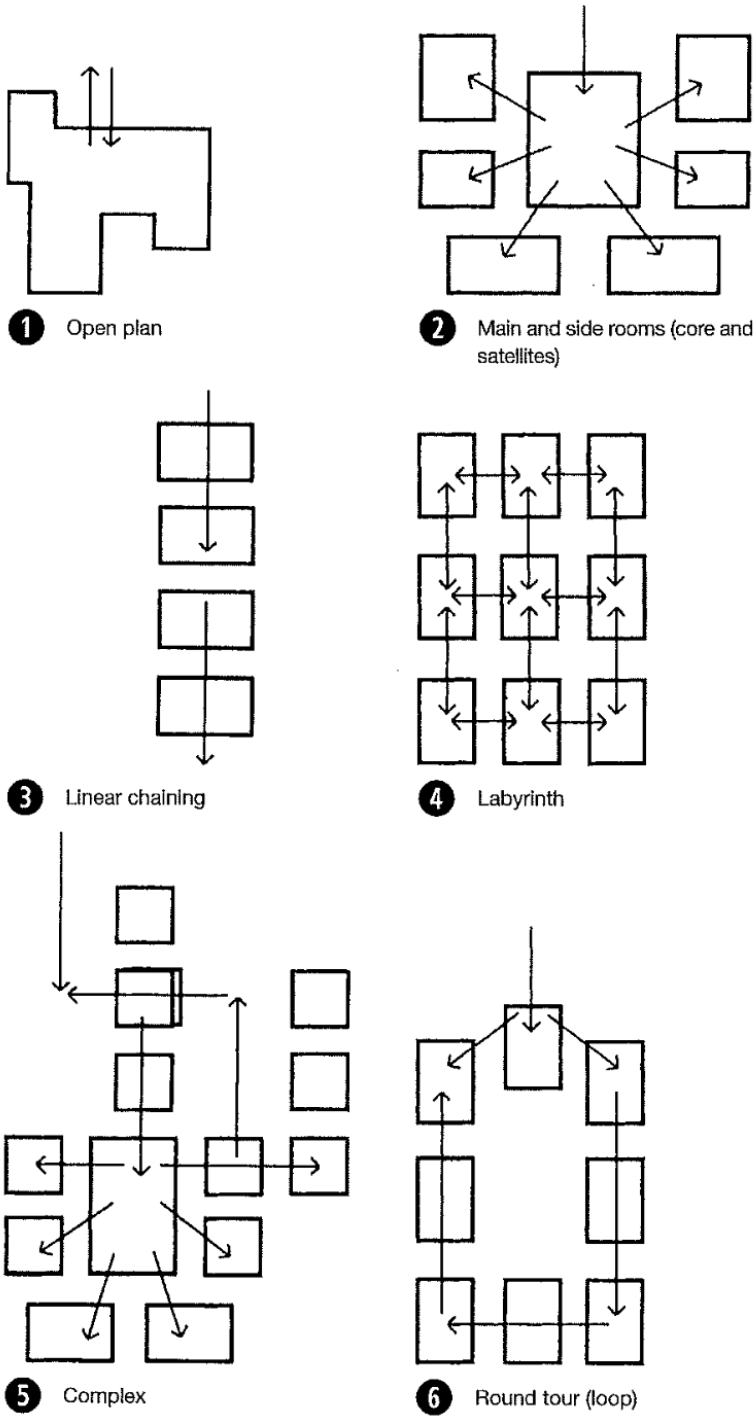

Figure 2.8: Exhibition route formation

Source: Neufert, E., & Neufert, P. (2012). Architects' data (4th ed.). Wiley-Blackwell.

4. Labyrinth: Multiple paths with no fixed route. Promotes exploration and playful discovery, especially engaging for children.

5. Complex: multi-directional layout with interconnected spaces. Offers flexible movement and diverse visitor experiences.

6. Round Tour (Loop): Circular path leading back to the start. Ensures a complete, immersive journey through the exhibits.

2.5.5 Visitor Flow and Circulation

This study in China examined how museum layouts affect visitor movement by analyzing 27 museums and creating a prototype model. Six layout scenarios tested parallel, serial, and mixed circulation patterns. Results showed visitors prefer routes with more variation and turns. The model used a square layout with U-shaped circulation, featuring parallel corridors (2.7 m wide) and serial connected spaces.

1. Serial and Parallel Space Configurations with Pedestrian Flow Lines

In Scenario 1, most visitors preferred the straight, parallel Route A over the twisting, serial Route B. In Scenario 2, after shifting Route B to one side, more visitors chose Route B, while fewer chose Route A. This shows that changing the position of the serial route made it more attractive to visitors.

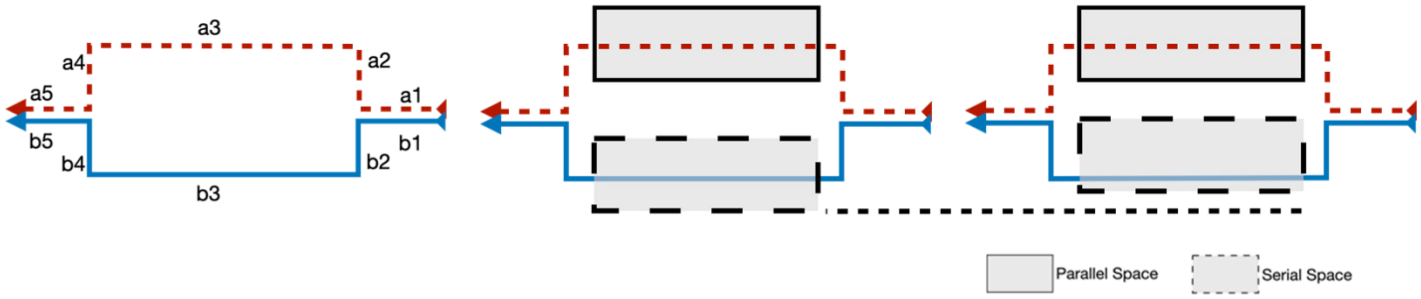

Figure 2.9: Scenario 1 and 2 of the experiment

2. Spatial Turns and Pedestrian Flow Lines

In Scenario 3, visitors preferred the serial route with more turns and shorter segments over the one with fewer turns. In Scenario 4, with parallel routes, visitors favored the path that had more turns rather than the straighter one. Overall, people tended to choose routes with more turns and spatial complexity, regardless of the layout type.

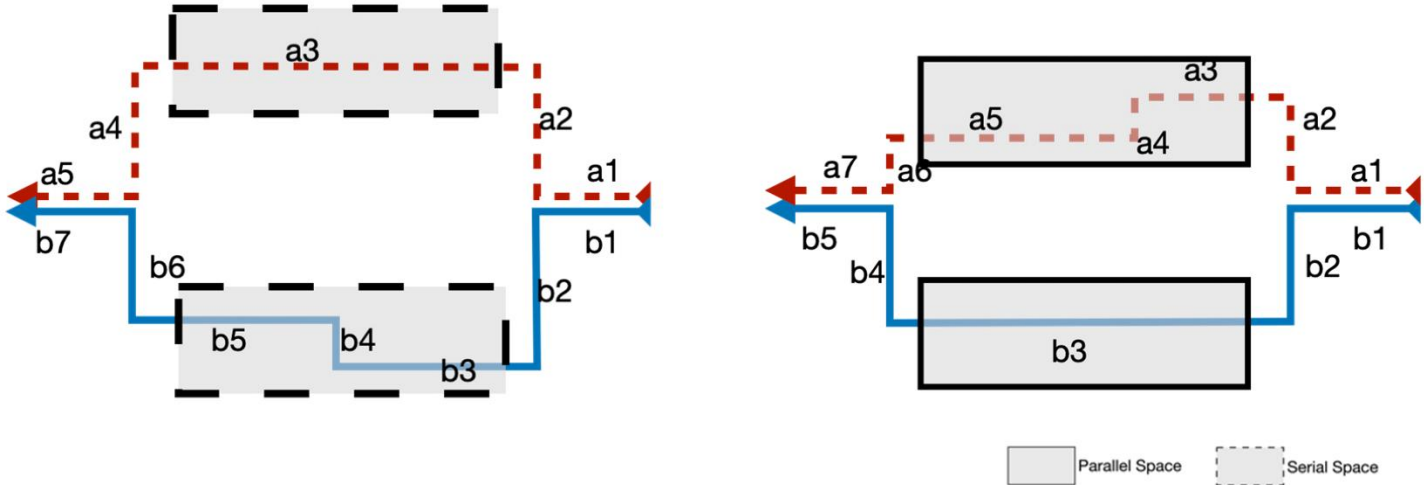

Figure 2.10: Scenario 3 and 4 of the experiment

3. Spatial Variation and Pedestrian Flow Lines

In Scenario 5, visitors chose between three routes: all parallel, all serial, and a mix of parallel and serial spaces. Most visitors preferred the mixed route, indicating that a combination of different spatial experiences is more appealing than a uniform layout.

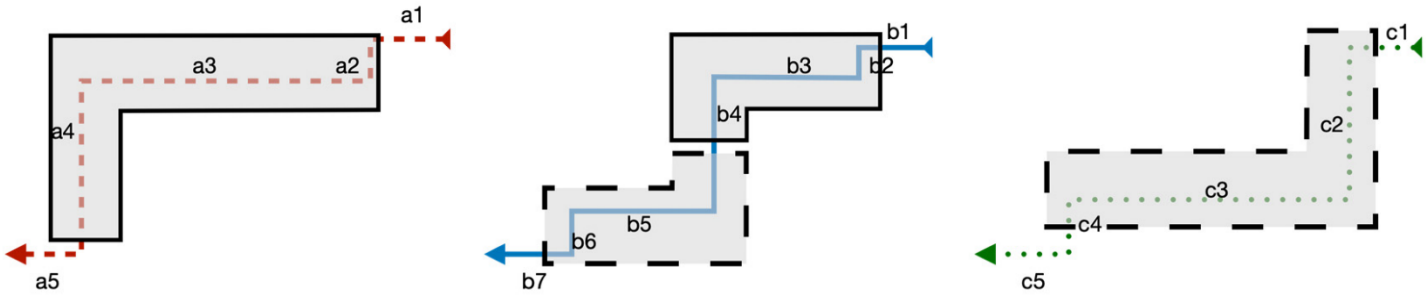

Figure 2.11: Scenario 5 of the experiment

Source (for fig: 2.9, 2.10, 2.11): Liu Y, Chen L, Xu Y, Yang J. Exhibition Space Circulation in Museums from the Perspective of Pedestrian Simulation. Buildings.

2.6 Displays

2.6.1 Types of Exhibition Display

The exhibition spaces can be broadly divided into Physical Displays and Digital Displays:

1. Exhibition Spaces for Physical Display
2. Exhibition spaces for Digital, Audio visual and Interactive Display.

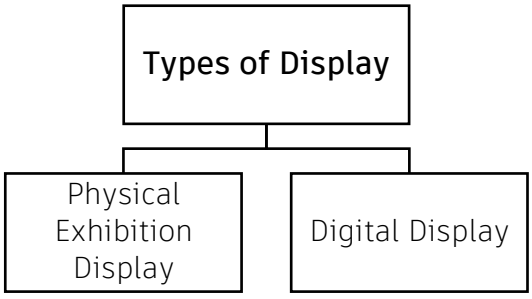

Figure 2.12: Types of display in museum

a. Exhibition spaces for Physical Display.

Traditional exhibitions involve the physical presentation of artifacts, artworks, or specimens within a carefully curated environment. These exhibitions are designed with controlled lighting, display cases, and spatial arrangements that enhance visibility, protection, and visitor engagement.

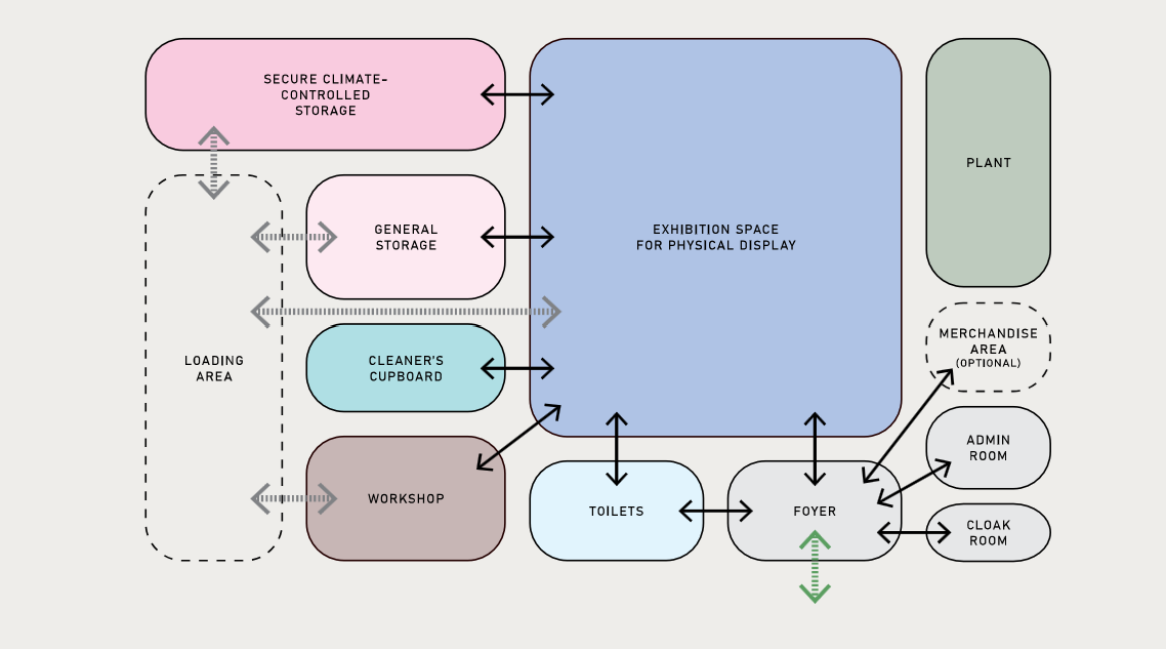

Figure 2.13: Bubble diagram of spaces arrangement for physical display

b. Exhibition spaces for Digital, Audio visual and Interactive Display

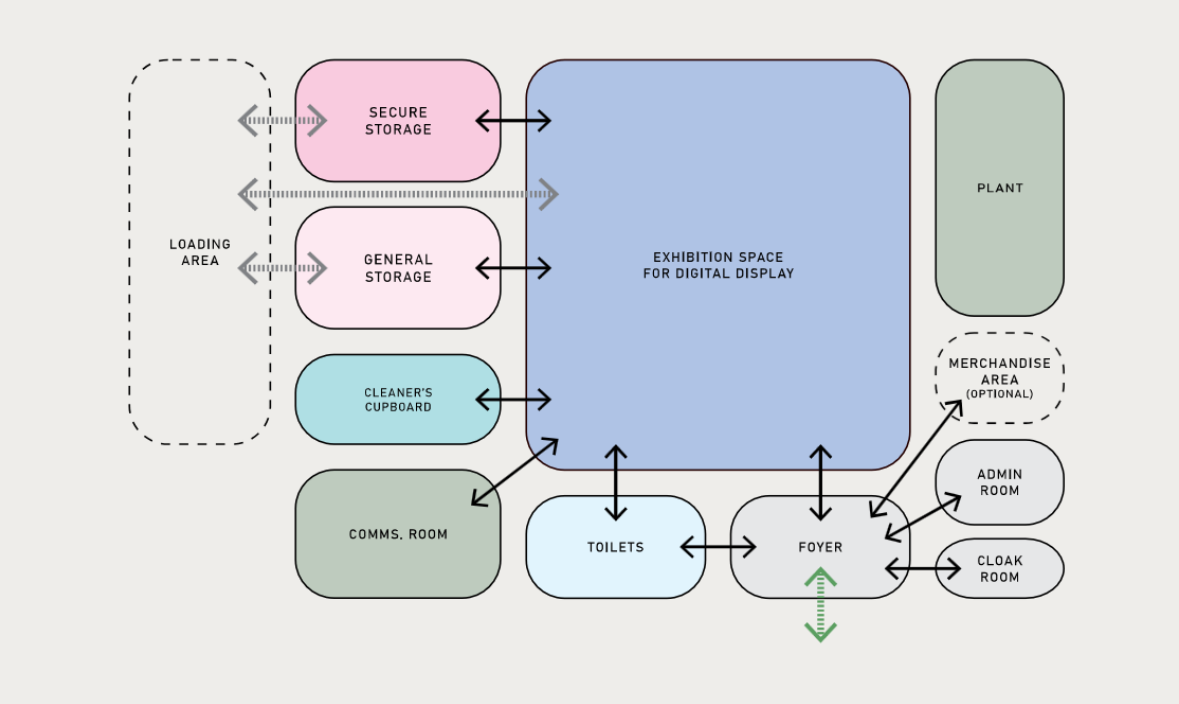

Figure 2.14: Bubble diagram of space arrangement for digital display

Source (for fig 2.13, 2.14): Creative Victoria. (2023). Creative spaces design guides part 3: Exhibition spaces.

2.6.2 Storage and Display Materials in Museums

Proper selection of storage and display materials is crucial for the long-term preservation of collections. Many materials contain unstable chemicals that can react with objects, leading to corrosion, discoloration, and deterioration.

How Damage Occurs

a. **Harmful Vapors** – Some materials release acidic or sulfuric gases that cause tarnishing, fading, or embrittlement.

b. **Direct Contact Reactions** – Poor choices in storage materials can result in staining, chemical migration, or physical degradation.

c. **Environmental Factors** – High temperatures and humidity accelerate chemical reactions, worsening the damage.

Table 2. 1 Storage and display materials in table

Category	Problematic Materials	Issues	Safe Alternatives
Harmful Substances	Formaldehyde, Sulphur dioxide, Nitrogen dioxide	Corrosion, discoloration	Use inert materials; store separately
Dangerous Objects	Paints, Glues, Adhesive tapes	Emit harmful vapors	Avoid or use protective barriers
Metals	Silver, Copper, Lead	Corrode due to acidic gases	Use protective coatings, stable environments
Paper & Photos	Acidic boards, Adhesives, PVC	Discoloration, silver mirroring	Use acid-free boards, Melinex sleeves
Textiles	Fire-retardants, Metal tacks	Fading, rust stains	Use cotton/linen, acid-free materials
Bone & Ivory	Rubber, Vinyl adhesives	Discoloration from sulfur compounds	Avoid rubber; store in separate enclosures
Plastics & Rubber	PVC, Plasticizers	Degrade from ozone, metals	Use polyethylene or Tyvek
Wood	Oak, Cedar, MDF	Emit acids that corrode metals	Use pine, walnut, or seal with barrier foil
Mounts & Storage	MDF, Non-archival foams	Acid release, chemical damage	Use Ethafoam, acid-free supports
Finishes & Covers	Oil-based paints, Some adhesives	Harmful vapors	Use acrylic latex; fully cure before use

Source: Museums Galleries Scotland. (n.d.). Introduction to storage and display materials.

2.6.3 Display Case Technology

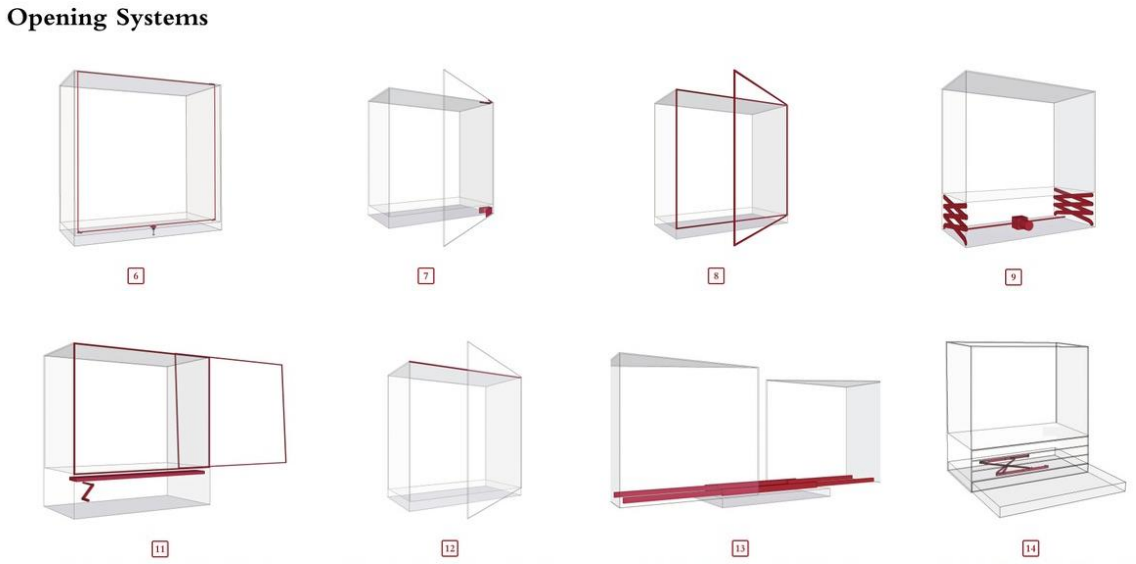

Figure 2.17: Opening techniques for display

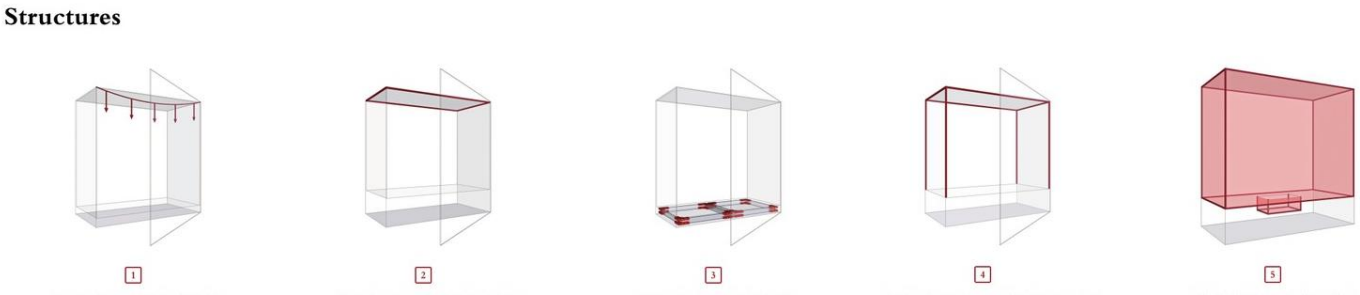

Figure 2.16: Structures for display case

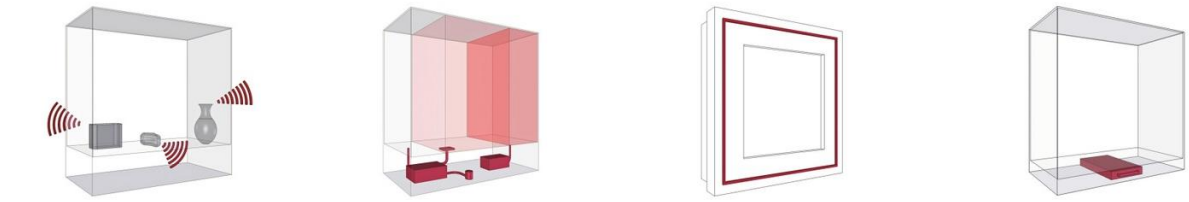

Figure 2.15: Conservation strategies of the exhibit

Source (for fig 2.15, 2.16, 2.17): Cao, L. (2020, April 1). How to design museum interiors: Display cases to protect & highlight the art.

2.6.4 Role of Augmented Reality/Virtual Reality in Enhancing Museum Experience

AR and VR technologies play a transformative role in reshaping how visitors experience museums. By layering digital content over physical exhibits or creating fully immersive virtual environments, these tools enhance storytelling, accessibility, and engagement in ways traditional methods cannot.

a. Immersive storytelling and engagement:

AR and VR create vivid, experiential environments that transport visitors into past worlds—such as prehistoric ecosystems or the ancient Tethys Sea. Through animation, sound, and spatial effects, these technologies help explain complex narratives like evolution, extinction, and tectonic activity in emotionally resonant and memorable ways.

b. Spatial context and layered interpretation:

These tools allow visitors to see things in context—whether it's a dinosaur roaming through its environment or tectonic plates moving beneath the Himalayas. AR can overlay data, movement, or reconstructed visuals directly onto physical objects or spaces, enriching understanding without overwhelming the exhibit. It adds interpretive depth while preserving spatial clarity in the design.

c. Interactivity and visitor participation:

With AR/VR, visitors are no longer passive observers. They can simulate natural events, rotate digital fossils, or take virtual tours through deep time. This hands-on interaction increases curiosity and makes the learning process more engaging, particularly for younger audiences.

Figure 2.18: Use of A/R in Museum.

Figure 2.19 Use of V/R in museum

2.7 Relief Areas

Relief areas are spaces within a museum that are designed to offer visitors a break from intense learning and immersive exhibits. These areas allow for physical rest and provide an opportunity for visitors to process information, relax, and engage in quiet reflection. For natural history museums, relief areas are essential as they support long-duration visits and maintain a comfortable atmosphere.

These spaces also serve a psychological function, offering moments of quiet contrast in between complex exhibits that are heavy with information, thereby promoting a more well-rounded experience.

Additionally, interactive relief zones help enhance learning by fostering engagement in a more casual environment.

Types of Relief Areas in Natural History Museums:

a. Rest Zones

Provide comfortable seating areas for visitors to rest, recharge, and reflect on what they have seen. Design Considerations: These spaces should be strategically placed near major exhibition sections or at transitions between different zones to give visitors a chance to pause.

b. Themed Cafeterias or Lounges

Offer visitors a place to refresh and enjoy a meal or snack while remaining within the museum. Cafeterias can be themed around nature or local ecosystems, adding to the immersive experience. Design Considerations: Theming should reflect the museum's content, such as natural environments, indigenous cultures, or environmental sustainability.

c. Outdoor Spaces and Courtyards

Utilize the external surroundings of the museum to create a more relaxed and natural experience for visitors. Design Considerations: These spaces offer natural breaks between the indoors and outdoors. They can be used for events, exhibitions, or simply for relaxation.

2.8 Lighting Strategies

Proper lighting is crucial in museums to protect artifacts while ensuring an optimal viewing experience. Direct daylight should never fall on museum objects, as it can cause deterioration over time. Therefore, display rooms should have flexible lighting systems that do not include permanently built-in lights or fixed wall and ceiling fixtures.

a. Lighting Guidelines for Display Objects:

- Very sensitive objects (e.g., textiles, manuscripts, watercolors) – 50-80 lx
- Sensitive objects (e.g., paintings, wood, organic materials) – 100-150 lx
- Less sensitive objects (e.g., metals, ceramics, stone sculptures) – 150-300 lx

Additionally, UV radiation should not exceed 25 W/m² to prevent long-term damage to displayed materials. It is essential to provide the ability to completely darken all display rooms when needed.

In public areas where no artifacts are displayed—such as entrances, cafes, and libraries, a greater amount of daylight is desirable to create a welcoming and comfortable environment. While lighting calculations in museums are largely theoretical, the quality of lighting is the most important factor, and practical testing methods, such as those developed in the U.S., can provide valuable insights.

- Recommended lighting levels (lux)
- Office: 300 ambient, 500 task
- Demonstration theatre: seating area 300, Demonstration area 600
- Exhibition hall: 500/300/100
- workshop: 200/500/750

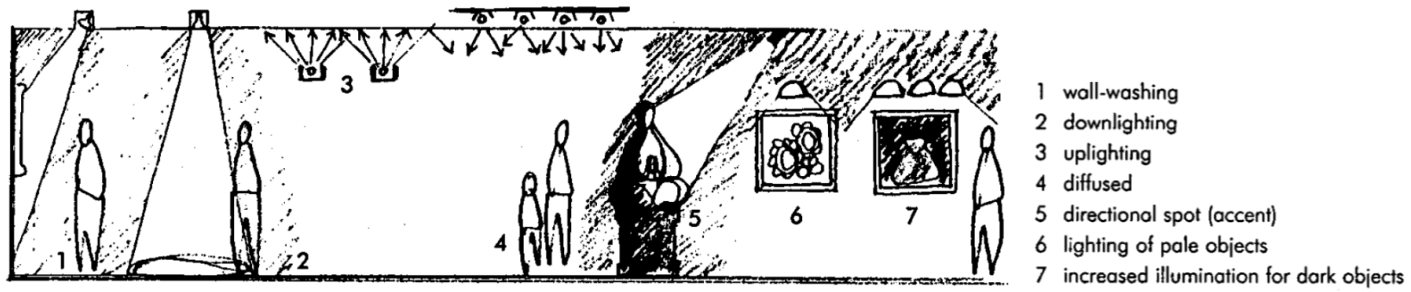

Figure 2.20: Lighting strategies in museum

Source: Pickard, Q. (Ed.). (2002). The architects' handbook. Blackwell Science.

Note on fluorescent fittings: modern fluorescent lighting is nearly indistinguishable from natural daylight in colour rendering; walls can be washed with even light rather than cause distracting pools of light; the fittings can be concealed easily

2.8.1 Use of Daylight in Museum

In cooler climates, particularly in northern Europe, daylight is one of the most effective passive solar solutions. Integrating daylight into museum design can enhance the visitor experience while reducing energy consumption. A daylight illuminance control system can further optimize lighting conditions.

Advantages of incorporating daylight through windows and rooflights include:

Reduced energy consumption by utilizing natural light.

Connection to the exterior environment, creating a more engaging and dynamic space.

Variation in light patterns, which adds depth and character to the interiors.

Sunlight can create strong contrasts, adding visual interest to the display areas.

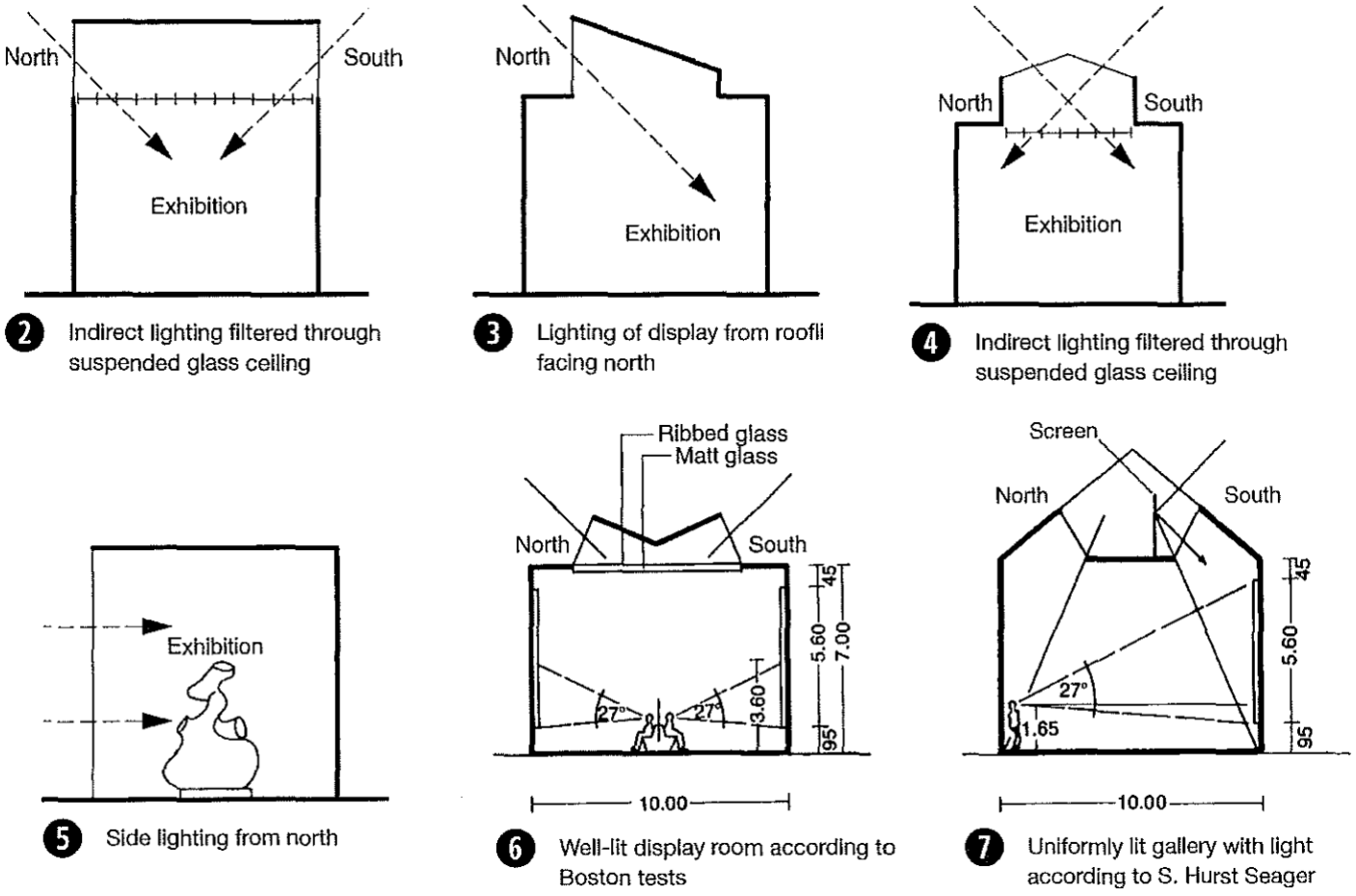

Figure 2.21: Strategies to incorporate natural lighting in museum

Source: Neufert, E., & Neufert, P. (2012). Architects' data (4th ed.). Wiley-Blackwell.

2.8.2 Artificial Lighting in museum

a. **Tungsten & Halogen Spotlights** – Provide warm, focused lighting suitable for highlighting objects.

b. **Fluorescent Strip Lighting** – Offers even illumination, closely resembling natural daylight in color rendering. It can be easily concealed and used for wall-washing effects.

c. **Velarium (Ceiling Diffusers)** – Utilizes daylight or artificial light to create soft, diffused illumination.

d. **Flexible Lighting Systems** – Includes grid, track, or a combination of lighting sources like tungsten, display case spill light, and baffled sources for controlled illumination.

e. **Adaptive Lighting** – Example: The Henry Moore Institute uses adjustable tungsten-halogen lamps with UV filters, electrotonic controls, and photocells to alter artificial lighting based on daylight fluctuations.

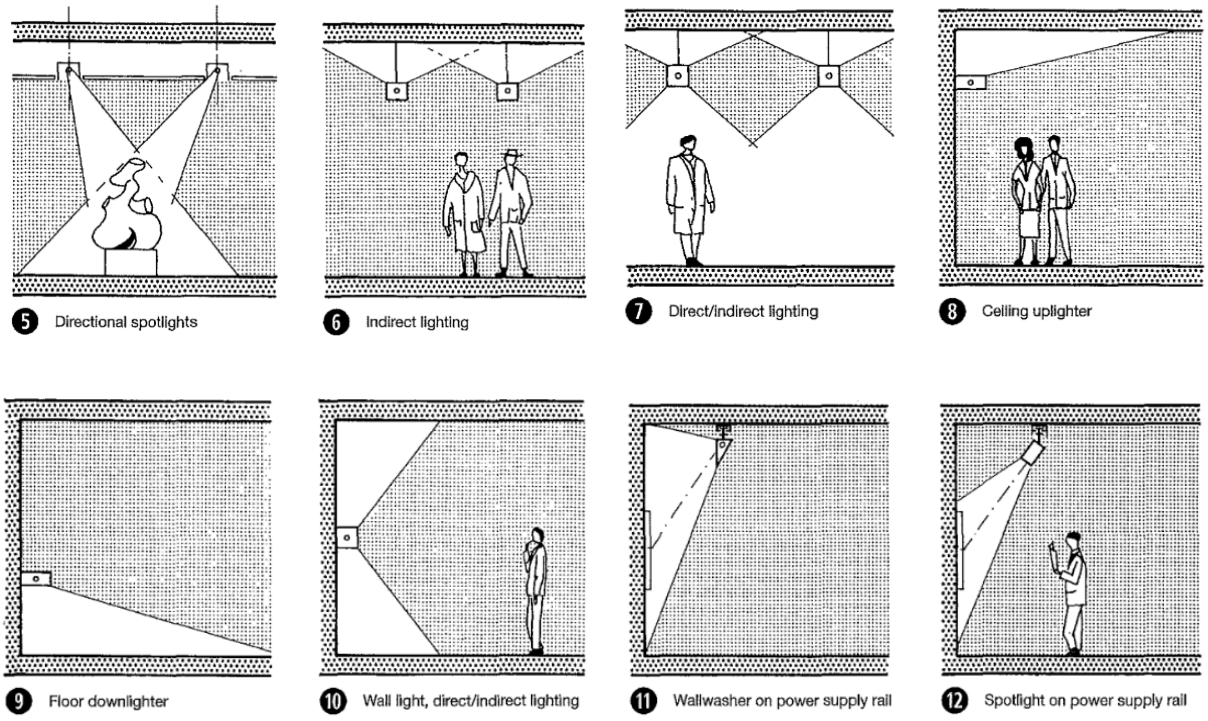

Figure 2.22: Artificial Lighting strategies in museum

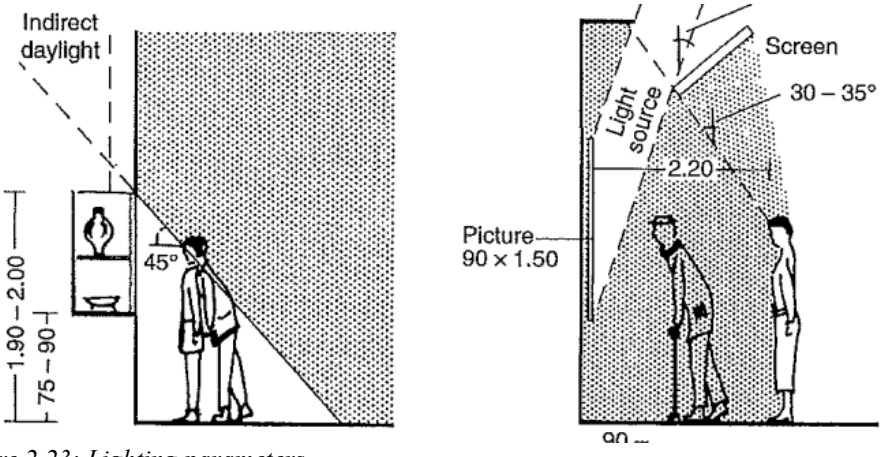

Figure 2.23: Lighting parameters

Source (for fig 2.22, 2.23): Neufert, E., & Neufert, P. (2012). Architects' data (4th ed.). Wiley-Blackwell.

2.8.3 Lighting Cases

1. External Lighting – Uses glass tops for illumination but may cause heat buildup, glare, and shadows due to slanting light.

2. Integral Lighting – Light boxes separated by diffusing glass or louvres; fluorescent for even lighting, tungsten for highlights.

3. Lighting from Below – Reduces shadows and illuminates undersides; requires masked light sources, usually louvres.

4. Backlighting – Fluorescent tubes behind diffusing material (e.g., opal Perspex) with dimmers for brightness control.

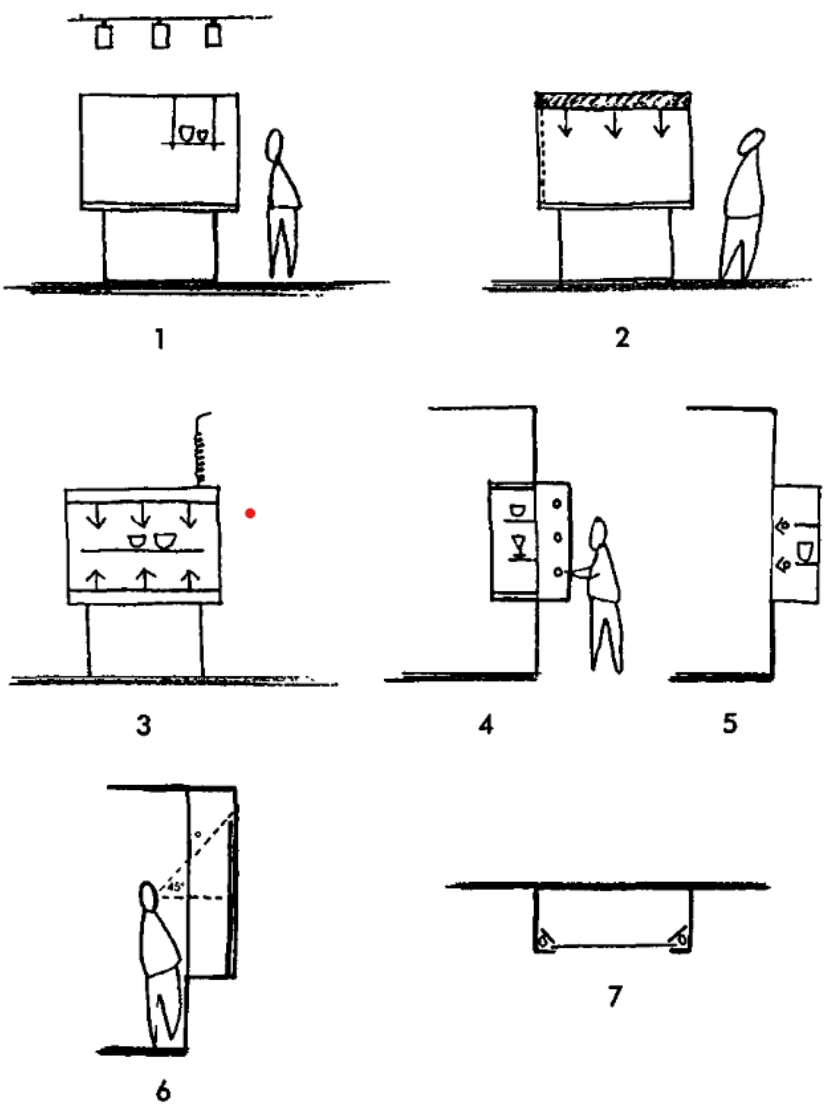

Figure 2.24: Lighting strategies inside display case

Source: Pickard, Q. (Ed.). (2002). The architects' handbook. Blackwell Science.

5. Strip Lighting – Fluorescent or tungsten lights attached to shelf ends, illuminating objects above and below.

6. Fluorescent Fascia Lighting – Positioned behind case fascia without diffusing panels; needs careful angle calculation to prevent glare.

7. Vertical Lighting – Slim fluorescent tubes in case corners, forming light columns suitable for wall cases.

2.9 Circulation Strategies

Circulation in a museum refers to the movement and flow of visitors through the museum space, guiding them from one exhibit to another in an organized and efficient manner. It encompasses the design of pathways, corridors, and areas that allow for easy access to and engagement with the exhibits while ensuring comfort, safety, and accessibility. The goal of effective circulation is to create a seamless and enjoyable visitor experience, maintaining logical routes, clear sight lines, and well-defined zones within the museum. It also includes the consideration of emergency exits, seating areas, and accessibility features. In terms of internal circulation there are two main types: horizontal circulation and vertical circulation.

2.9.1 Horizontal Circulation:

It refers to the movement of people in spaces on the same level. It is simply moving of visitors along walkways, corridors, and paths connecting different galleries or exhibition areas. It ensures easy and uninterrupted access between galleries, allowing for flexible flow across the same floor.

2.9.2 Vertical Circulation:

It is the movement of visitors between different levels or floors of the museum, typically involving stairs, ramps, or elevators. It is simply connecting different floors or sections of the museum, such as galleries on multiple levels, auditoriums, or special exhibition areas. It helps to maximize the use of space, allowing for multi-story designs and more varied exhibitions. The location of the corridors, staircase and its design, width and slope have to be considered within the overall design steps because they affects the visitors perception of space and level of visitors satisfaction.

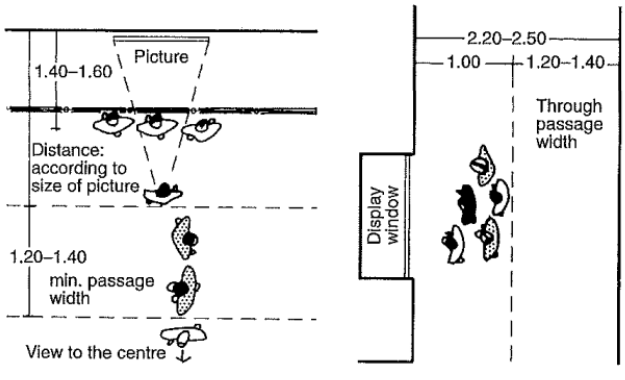

Figure 2.26: Space required around display areas

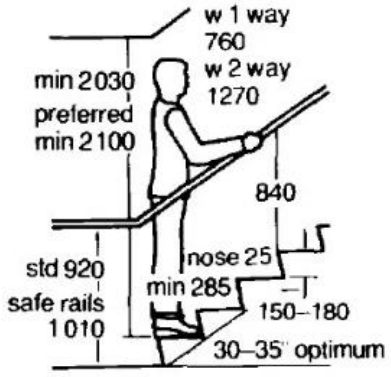

Figure 2.25: Staircase Dimension

Source: Neufert, E., & Neufert, P. (2012). Architects' data (4th ed.). Wiley-Blackwell.

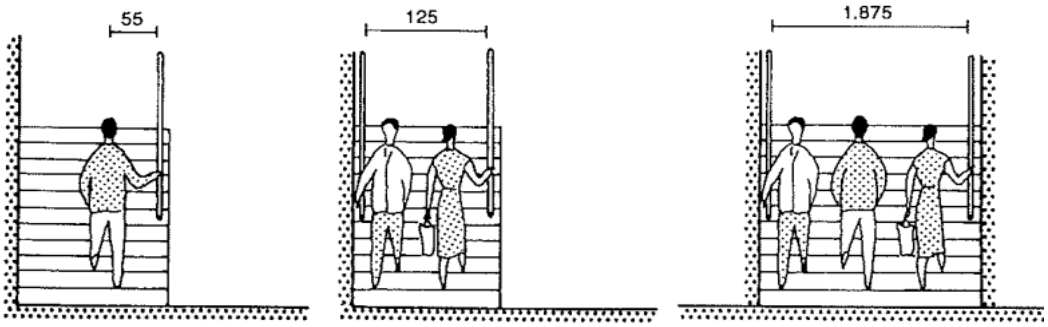

Figure 2.27 Staircase width for one, two and three people respectively

Source: Neufert, E., & Neufert, P. (2012). Architects' data (4th ed.). Wiley-Blackwell.

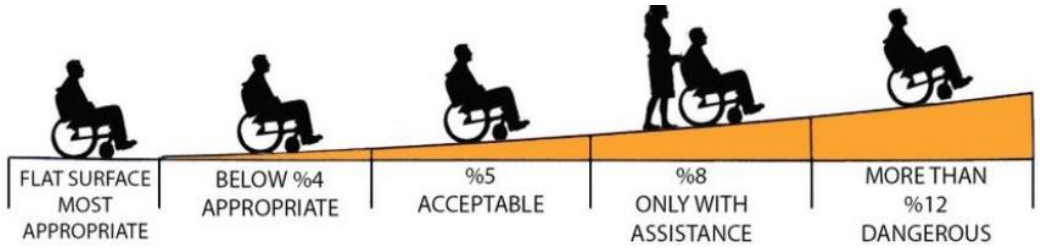

Figure 2.28: Ramp incline for universal design

Source: Alharbi F, Alshammari A, Almoshaogeh M, Jamal A, Haider H. User Perception-Based Optimal Route Selection for Vehicles of Disabled Persons in Urban Centers of Saudi Arabia. Applied Sciences.

2.10 Natural History Museum

2.10.1 Understanding Natural History

Natural history is the study of the Earth, life forms, and natural events. It covers topics like how the universe began, how the Earth formed, and how plants, animals, and humans have changed over time.

A natural history museum helps people explore these subjects in one place. It also helps raise awareness about the natural world and the need to protect it. For Nepal, a museum like this is important because it can present the country's rich geological past, biodiversity, and environmental changes in an engaging and educational way.

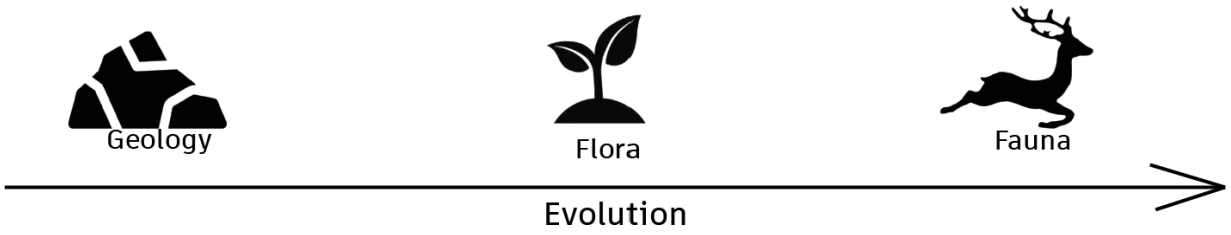

Figure 2. 29 : Diagram showing geology, flora and fauna

2.10.2 Natural History in the Context of Nepal

Nepal has a very special natural story shaped by its location between two major tectonic plates, the Indian Plate and the Eurasian Plate. This powerful geological movement created the Himalayas, one of the youngest and tallest mountain ranges in the world. These mountains tell the story of Earth's huge changes over millions of years. Fossils found here show that ancient oceans once covered this land, revealing a fascinating hidden history.

Besides its geology, Nepal is home to many plants and animals because of its varied climate and wide range of heights. From snow leopards in the high mountains to Bengal tigers in the low forests, and many other rare species, Nepal is a center of rich biodiversity. Protecting these animals and their homes is very important for Nepal's natural heritage.

This museum aims to share the story of Nepal's natural world, its rocks, ecosystems, and living creatures, and explain how these things have shaped both the land and the culture. The exhibits will focus on Nepal's unique natural history while also connecting it to the bigger story of Earth's evolution.

3. Chapter 3: Case Studies

3.1 Natural History Museum, Swayambhu

3.1.1 General Information

Location: Swayambhu Stupa, West Hillock

Total Land Area: 21.5 Ropanies (11,000 sq.m)

Ground Coverage: 40% of allowable buildable space (12 Ropanies)

Number of Blocks: 3

Land Type: Contoured

Construction: RCC

Visitors: Tourists visiting Swayambhu Stupa and students

Building Usage: Initially a hostel, later converted into a museum

3.1.2 Introduction

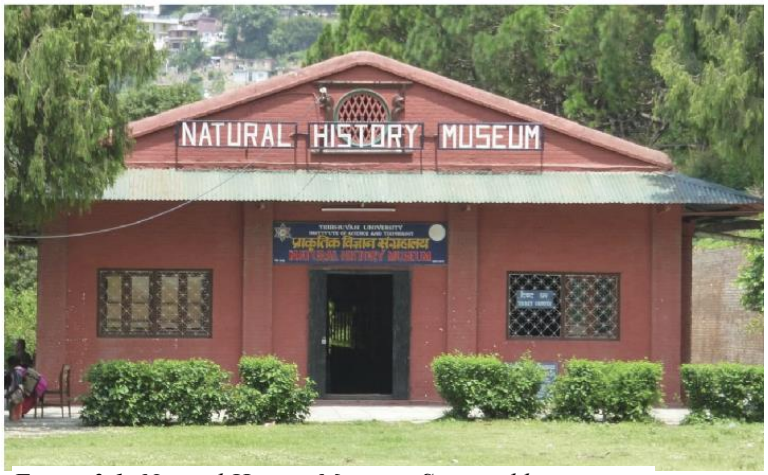

Figure 3.1: Natural History Museum, Swayambhu

The Natural History Museum (NHM) in Swayambhunath is Nepal's only museum dedicated to natural history. Established in 1975, it is managed under Tribhuvan University's Rector's office and sits on the former Ananda Kuti campus.

The museum, located within the Swayambhunath World Heritage Site, covers 21.5 ropanies. It houses a vast collection of over 40,000 zoological specimens, 7,000 botanical specimens, 400 fossils, and 100 skeletons. The museum serves as a research and educational center for both local and international scientists, students, and teachers.

NHM actively organizes exhibitions, mobile displays, and educational programs to engage the public and expand its collection.

3.1.3 Background Study

The NHM is located within the protected monument zone of Swayambhunath, making it easily accessible via public transport. As part of a World Heritage Zone, the museum attracts students, researchers, and tourists seeking educational experience. However, being situated at the foot of a hillock, it is exposed to city traffic, noise, and air pollution, though the environment remains generally peaceful.

Figure 3.2: Satellite of the location map

3.1.4 Collections

The museum contains over 55,000 specimens from nearly 60 districts of Nepal, covering tropical lowlands to alpine highlands:

Fauna: 4,500 specimens

Flora: 9,500 specimens

Paleontology, minerals, and meteoroids: 500 specimens

3.1.5 Presentation and Display

The museum uses various display methods across its exhibition galleries:

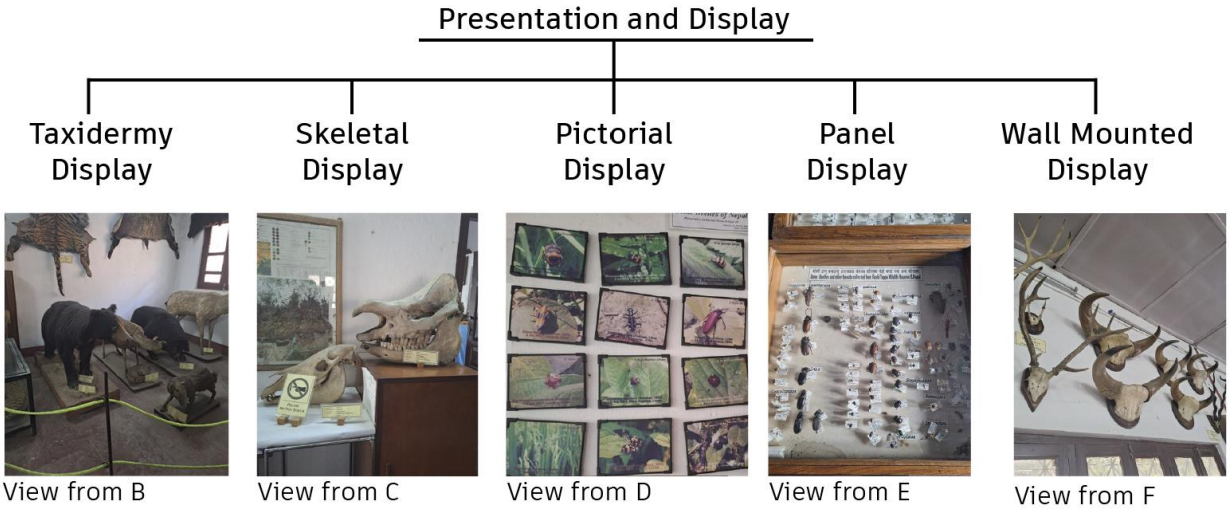

Figure 3.3: Visual representation of presentation type

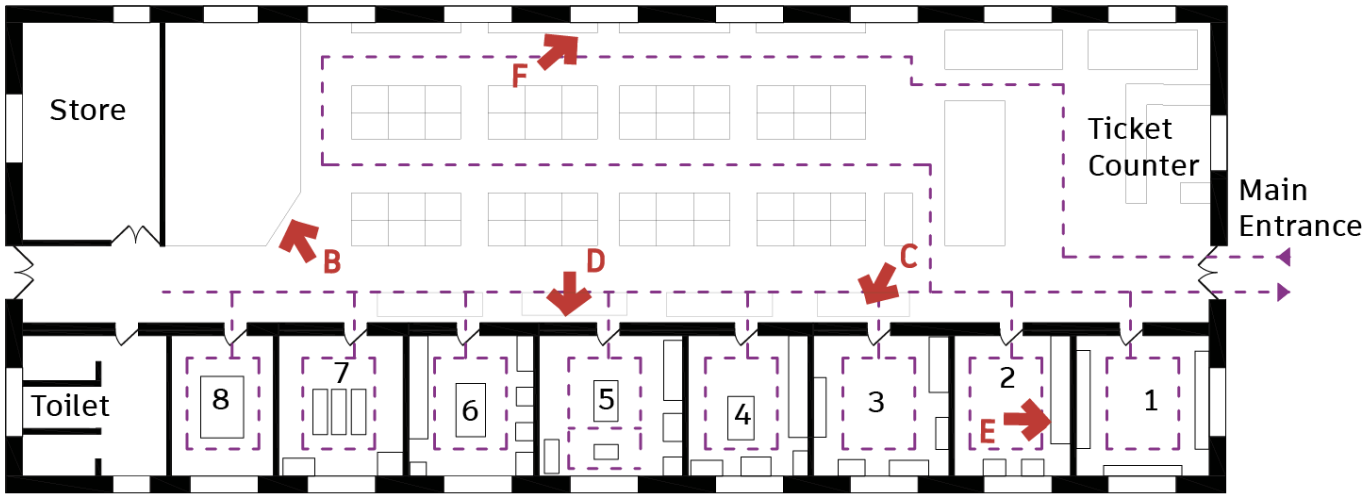

Figure 3.4: Ground floor plan of natural history museum

3.1.6 Analysis and Observations

Functional Analysis

- Separate entrances for staff and visitors improve circulation.
- Each space has external exposure, enhancing natural light
- Public and staff areas are poorly connected, leading to limited communication.
- The exhibition area is not visible from the administration, reducing supervision.
- Spaces are arranged linearly but lack an intermediate transition zone.

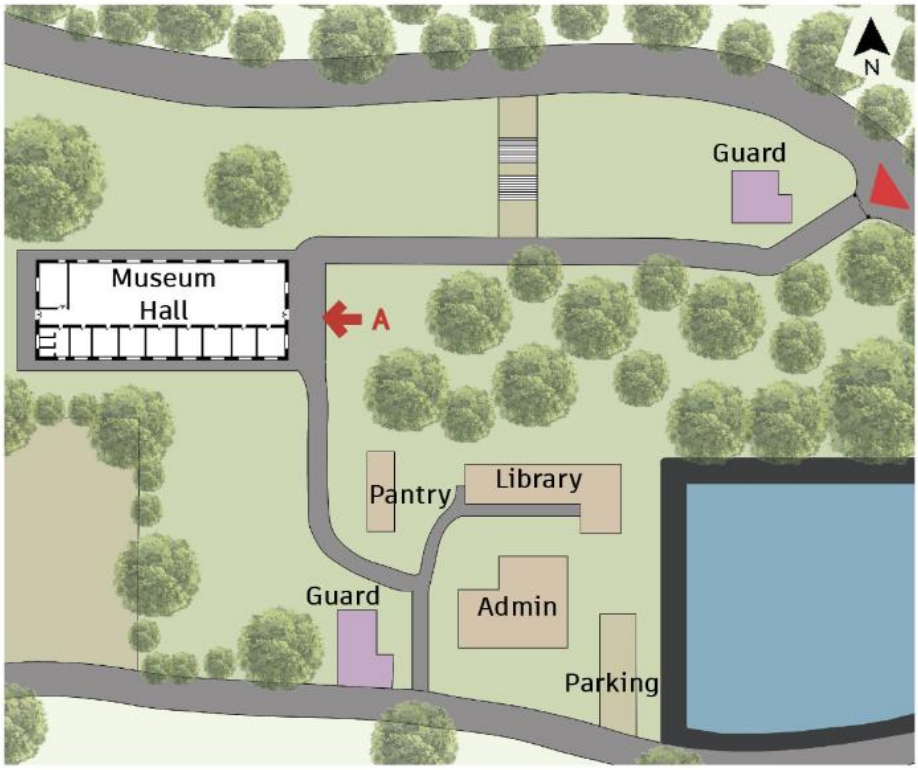

Figure 3.5: Masterplan of Natural History Museum

a. Spatial Organization

Exhibition galleries are arranged in a linear sequence without interactive zones or resting spaces.

b. Area Analysis

Space allocation for different sections:

Botany Section: 60 sq.m (medicinal plants)

Zoology Section:

Invertebrates: 60 sq.m

Pisces/Amphibians/Reptiles: 50 sq.m

Aves (Birds): 90 sq.m

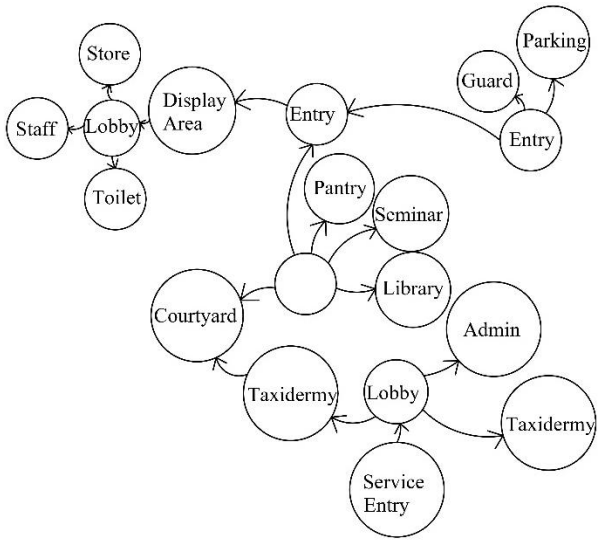

Figure 3.6: Bubble diagram of master plan, Natural History Museum

Mammals: 60 sq.m

Casting & Molding: 40 sq.m

Paleontology Section: Fossils/Rocks: 20 sq.m

CITES Information Section: 30 sq.m (Flora & Fauna)

Research Section: 30 sq.m (Research cabins/depository)

Other Facilities: Reception, toilets, storage (30 sq.m)

3.1.7 Issues

a. No dedicated public parking area.
b. Public toilets are unavailable.
c. The ticket counter was repurposed as a storage area, forcing visitors to walk long distances to the reception.
d. 60% of the site is landscaped, featuring live botanical species.

3.1.8 Ventilation

Ventilation is provided by windows, ceiling fans, and exhaust fans.

3.1.9 Lighting

Natural Light: Provided through windows at a 900mm sill level, but glare and reflections are issues.

Figure 3.7: Ventilation through windows, ceiling fan and exhaust fan

Artificial Light: Fluorescent and incandescent lamps are used, but glare is a frequent complaint among visitors.

3.1.10 Security

Security guards protect the exhibits during **operating hours**, and the museum is locked after closing.

Windows are secured with **grilles**.

Figure 3.8: Security through window grills and channel gate

3.1.11 Inferences

Since the museum was originally designed as a dormitory, it has several limitations in terms of lighting, ventilation, circulation, and gallery arrangement. The specimens are displayed more like stored items than curated exhibits. Key takeaways for improvement include:

- Public and private spaces should be better segregated.
- Exhibition areas should be under direct supervision from the administration.
- Lighting issues should be addressed to reduce glare.
- Educational spaces such as a library, research rooms, and interactive zones should be added.
- Facilities like a seminar hall, auditorium, temporary exhibition galleries, and cafeteria would enhance visitor experience.
- Replacing existing windows with ribbon windows can help reduce glare.

3.2 Nepal National Museum

3.2.1 General Information

Location: Chhauni, Kathmandu, Nepal

Site Area: 39 Ropanies (20,000 sq.m)

Architectural Style: Neo-classical, Malla residence

Ownership: Government of Nepal

3.2.2 Introduction

The National Museum of Nepal is the country's largest museum, preserving and showcasing Nepal's rich history, culture, art, and military heritage. It serves as an important educational center, offering insights into Nepal's artistic evolution and traditions.

The museum comprises three main buildings, each with a unique focus:

1. Juddha Jatiya Kalashala – Traditional and contemporary Nepalese art
2. Buddhist Art Gallery – Buddhist artifacts, paintings, and sculptures
3. Main Historic Building – Military history, natural science, stamps, and coins

Originally built in 1824 by Prime Minister Bhimsen Thapa as an arsenal, the building was later expanded by Prime Minister Chandra Shamsher in 1926 and renamed Silkhana Museum.

3.2.3 Museum Sections

The museum has three main sections: Juddha Jatiya Kalashala, showcasing paubha paintings, ancient sculptures, and contemporary Nepalese art; the Buddhist Art Gallery, featuring Buddhist paintings, ritual objects, and regional artifacts; and the Main Historic Building, which includes galleries on natural science, military history, stamps, and coins. The museum attracts about 63,750 visitors annually, including tourists and students.

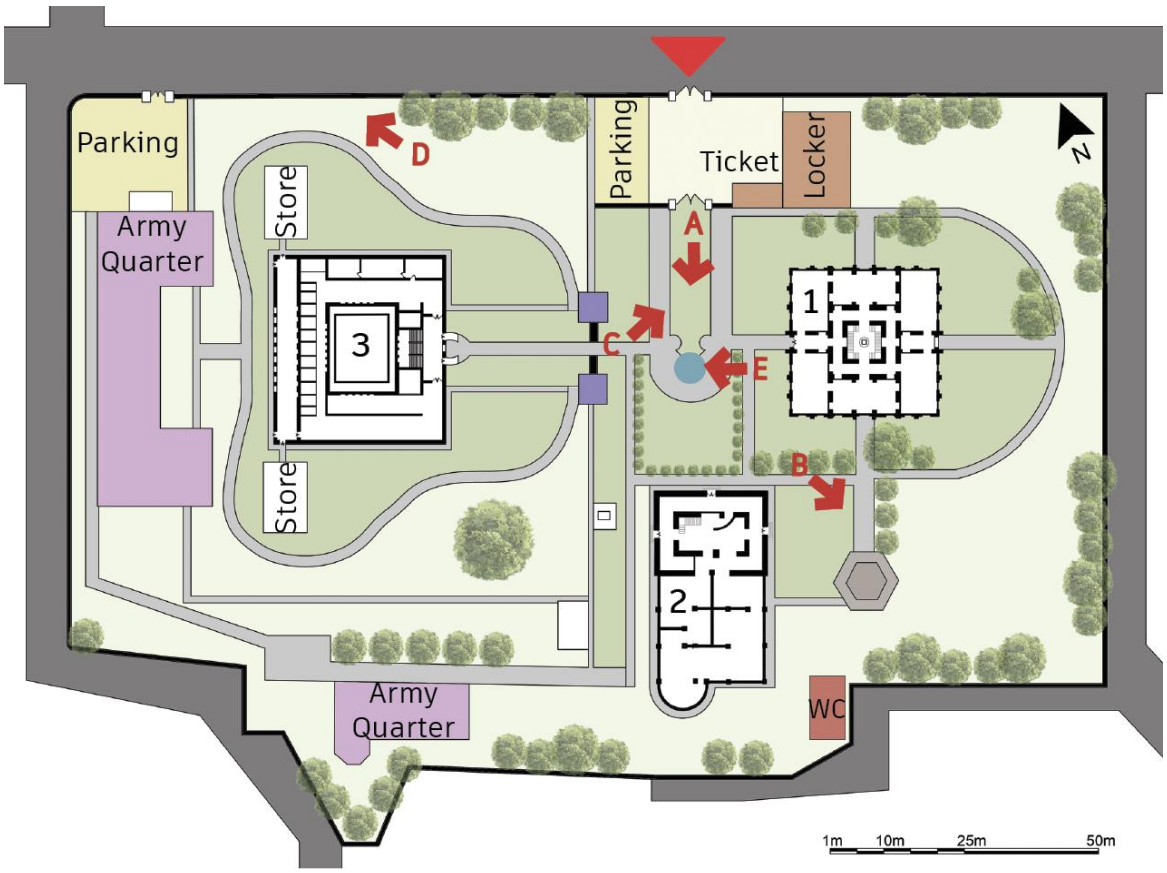

Figure 3.9: Master plan of Nepal National Museum

View From A

View From B

View From C

View From D

View From E

Figure 3.10: Landscape view of the master plan

3.2.4 Architectural Design and Planning

The National Museum complex covers a 20,000 sq.m site and consists of three main buildings:

1. Juddha Jatiya Kalashala
2. The Buddhist Gallery
3. The Main Historic Building

These buildings are arranged in two mutually perpendicular directions relative to the main entrance. This layout enhances visitor orientation, as all three blocks are clearly visible from the central courtyard. The courtyard also serves as a hub, directing visitors to the museum shop, parking area, and canteen.

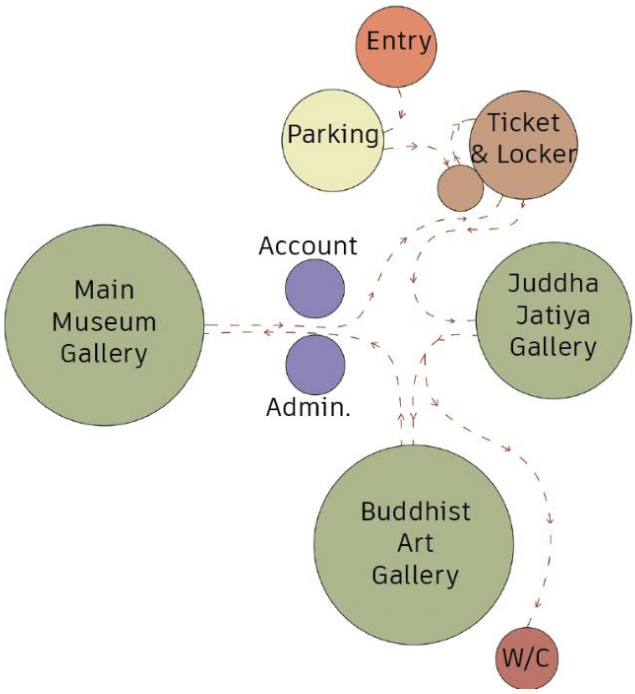

Figure 3.11: Flow of visitors in the museum.

The placement of public zones around the courtyard creates a clear circulation pattern and allows visitors to choose their paths through the museum. However, there are some functional challenges:

- The restrooms are located at the rear end of the site, making them difficult to access.
- The museum lacks adequate parking facilities, especially during peak visitor hours.

3.2.5 Juddha Jatiya Kalashala

Juddha Jatiya Kalashala was the first museum building, established in 1999-2000 B.C. by Prime Minister Juddha Shumsher. The building's design blends traditional Nepalese architecture, Post-Victorian elements, and Indian architectural influences.

Figure 3.12: Juddha Jatiya Kalashala front view

Architectural Features:

- Rectilinear plan with a symmetrical layout
- Entry inspired by the Sanchi Stupa, located on the western side
- Central circulation and stair hall, with galleries arranged around the perimeter

a. Circulation

The circulation within the museum is analyzed based on horizontal and vertical movement patterns.

Horizontal Circulation

The museum follows a structured room-to-room flow, moving in a clockwise direction. Upon entry:

- Visitors encounter the stone gallery on the left and an old painting collection on the right.
- They naturally move left, guided by instinct and staff assistance.
- Displays are positioned along the left-hand side, ensuring a structured viewing experience.

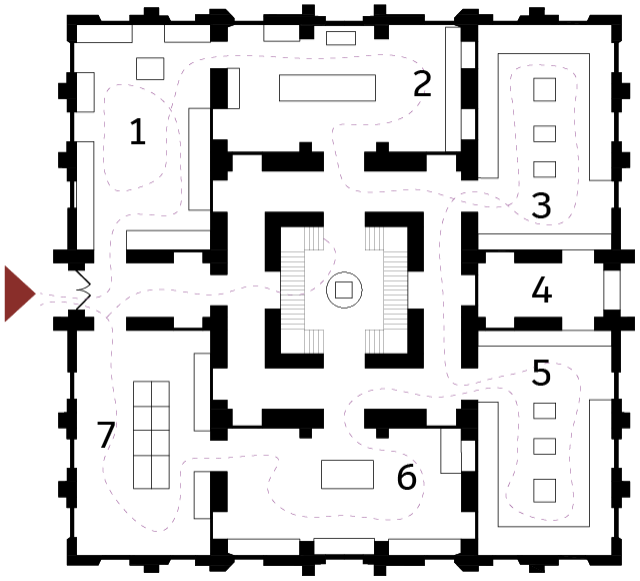

Figure 3.13: Ground floor plan of the museum

To address this:

- A winding circulation path around the central hall is used.
- A stone staircase connects all exhibits within Juddha Jatiya Kalashala.

Circulation widths:

- Galleries: 1.7 meters
- Hallways: 2.7 meters (This ensures comfortable movement for visitors.)

On the upper floor:

- Displays are arranged in the central hall and circumambulatory spaces.
- A central exhibit acts as a focal point, visible from all directions.
- The clockwise movement continues, maintaining an organized flow.

Vertical Circulation

- The museum features a central staircase with separate sections for ascending and descending.
- It consists of 27 risers, each 190 cm high, leading to the double-story hall with a 4-meter ceiling height, adding a sense of grandness to the space.

b. Lighting

The museum's high ceilings allow for an interplay of natural and artificial lighting, enhancing the display and circulation areas.

- **Natural Light:**
  - Integrated through high perforated windows, allowing diffused daylight into the interiors.
- **Artificial Light:**
  - Cool lighting is used in display areas to highlight exhibits.
  - Warm lighting is applied in central circulation spaces for a comfortable ambiance.
  - Focus lights are installed on suspended metal supports to illuminate display objects. Display cases incorporate built-in diffused lighting to enhance visibility without glare.

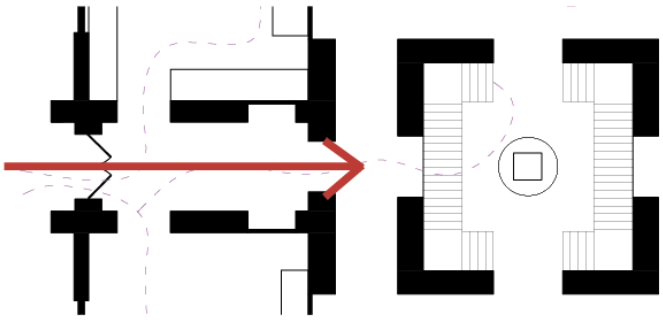

Figure 3.15: Entrance highlight shown in plan

Figure 3.14: Juddha Shamsher statue

c. Ventilation

The museum relies on natural ventilation due to the absence of mechanical systems. High-perforated windows facilitate cross-ventilation, ensuring fresh air circulation throughout the building.

3.2.6 The Buddhist Gallery

The Buddhist Art Gallery, funded by Japan in 1997, was designed to meet modern museum standards. Originally, it housed the private collections of the Rana and Shah families, but after Nepal's democratic transition in 2048 B.S., it was converted into a dedicated Buddhist gallery.

Figure 3.16: The Buddhist Gallery front view

Exhibits & Functions

- The gallery showcases Buddhist reliefs, paintings, and ritual artifacts from Nepal's Terai, Hill, and Mountain regions.
- The upper floor is reserved for temporary exhibitions, displaying historical Nepalese artifacts acquired from foreign nations.
- It includes an audio-visual area and a lecture hall, enhancing visitor engagement.

Design & Circulation

- Designed as a modern exhibition space, it features spacious galleries and structured layouts.
- The linear circulation pattern ensures a smooth visitor flow.
- Partitions and exhibits are strategically placed to guide visitors while maintaining unobstructed views.

a. Circulation

The gallery follows a unidirectional flow, guiding visitors from the left of the entrance through a continuous path along the exhibits. Partitions create an interactive experience, while brick and wooden carvings enhance the traditional Nepali aesthetic.

At the end of the gallery, an audio-visual room features a projector and seating. A staircase nearby leads to the upper floor, which hosts temporary exhibitions displaying recovered stolen artifacts.

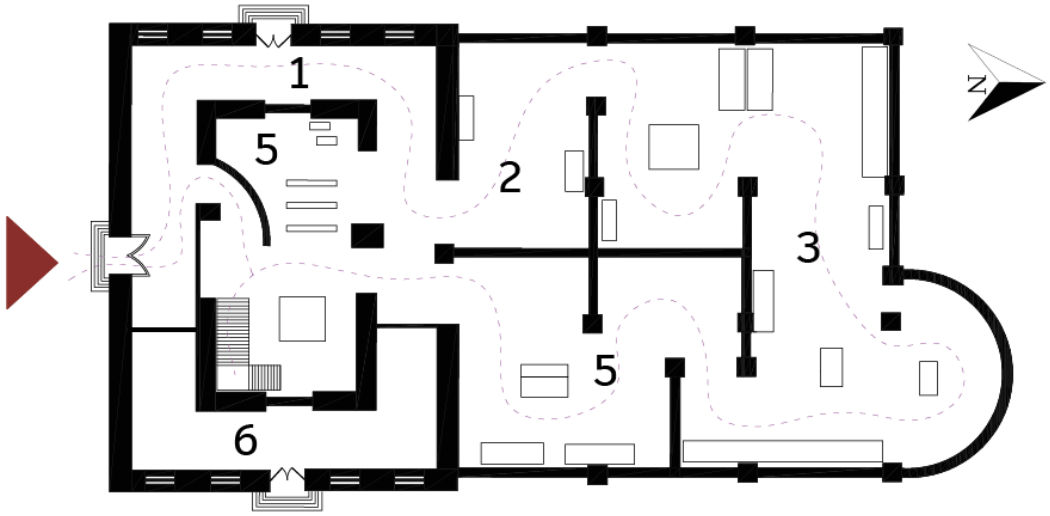

Figure 3.17: Ground floor plan of the buddhist gallery

b. Lighting

The gallery primarily relies on artificial lighting, as natural light from the windows is filtered through screens to prevent glare. CFL and focus lights illuminate the display areas. Encased diffused lighting is installed with screens to soften shadows and distribute light evenly.

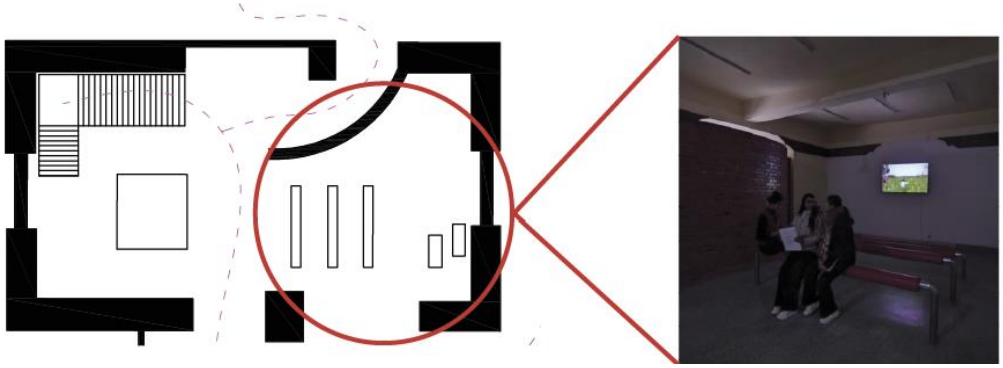

Figure 3.18: End of circulation features audio visual room.

3.3 Shanghai Natural History Museum

3.3.1 Introduction/ Background

Project Name: Shanghai Natural History Museum

Architects: Perkins&Willd

Type of Museum: Natural History

Area: 44517 m²

Year: 2015

Purpose of the Museum: To provide immersive experience exploring the natural world through extensive exhibits, interactive displays, and educational programs, showcasing over 10,000 artifacts from all seven continents.

Figure 3.19: Ariel view of the museum

Living wall (View from A)

Main Entrance (View from B)

Figure 3.20: Front and side elevation from the ariel view

Source: ArchDaily. (2015, April 23). Shanghai Natural History Museum / Perkins+Will.

3.3.2 Location

a. Site Location: Jing'an Sculpture Park, Jing'an District, Shanghai, China

b. Connectivity:

- **Roads:** Accessible via major city roads; nearby bus stops include Shimen Second Road Shanghaiguan Road.
- **Public Transport:** Served by multiple bus routes (41, 104, 109, 301, 324, 927, 955) and the Shanghai Metro Line 13 at Natural History Museum Station.

c. Distance from City Center: Located in downtown Shanghai, the museum is centrally situated, making it easily accessible from various parts of the city.

d. Ease of Entry:

- **Ticketing:** Tickets can be purchased on-site; the entrance fee is RMB 30.

- **Queuing:** During peak times, visitors may experience queues; the museum has measures in place to manage large crowds.

3.3.3 Climate/ Topography

a. **Climate Type:** Shanghai experiences a humid subtropical climate with four distinct seasons, including hot summers and cool winters.

b. **Topographical Features:** The site is predominantly flat, situated within an urban park setting.

3.3.4 Zoning

a. The major zones identified are:

- Exhibition Areas
- Administrative Offices
- Visitor Services
- Public Amenities
- Educational Spaces

Figure 3.21: Central wall from the garden

Source: ArchDaily. (2015, April 23). Shanghai Natural History Museum / Perkins+Will.

b. **Spatial Organization:** The museum features a centralized layout inspired by the nautilus shell, with a spiraling design that guides visitors through the exhibits.

c. **Key Spatial Relationships:** Exhibition spaces are interconnected, allowing for continuous visitor experience, while administrative and service areas are strategically separated to maintain operational efficiency.

d. **Orientation & Environmental Considerations:** The building's design incorporates intelligent skin that maximizes natural daylight while minimizing solar gain. An oval courtyard pond provides evaporative cooling, and a geothermal system regulates the building's temperature.

3.3.5 Circulation and movement

a. **Visitor Flow:** The spiraling design facilitates a free-flow visitor movement, allowing guests to explore exhibits in a guided yet flexible manner.

b. **Entry & Exit Points:** Main entrance through the striking glass wall inspired by cellular structures; exits are clearly marked and lead visitors back to the central atrium.

3.3.6 Architectural Expression

a. **Form & Volume:** The building's form is inspired by the nautilus shell, symbolizing the purity of natural geometric forms.

b. **Façade Treatment & Materials:** Features include a central cell wall representing cellular structures, a living wall signifying vegetation, and a stone wall suggesting tectonic plates. Materials used are sustainable and reflect natural elements.

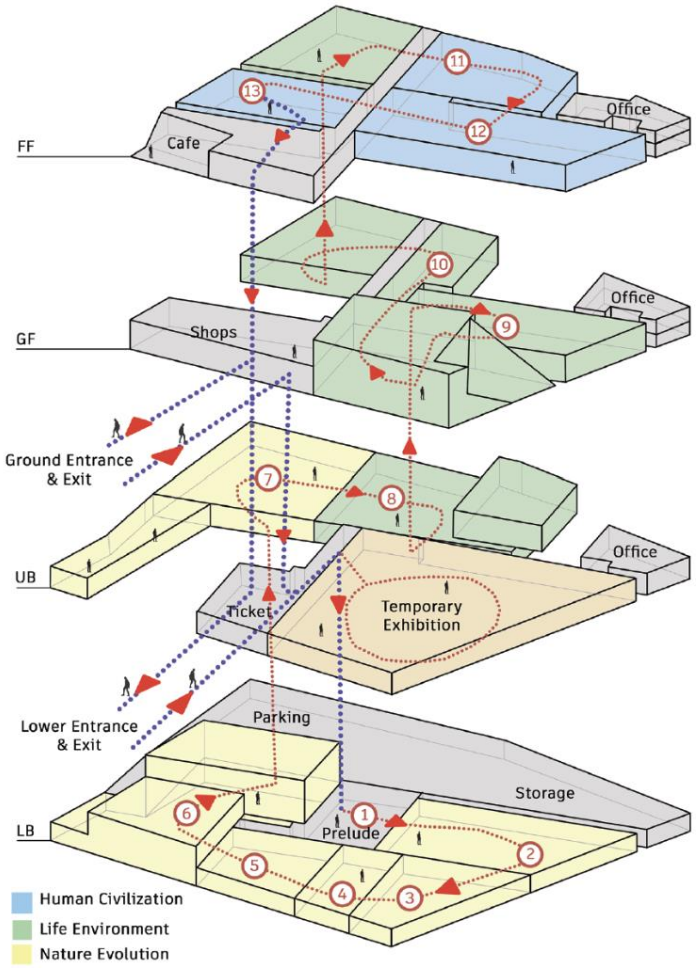

Figure 3.22: Vertical Circulation of Sanghai Natural History Museum

Source: ArchDaily. (2015, April 23). Shanghai Natural History Museum / Perkins+Will.

c. **Construction Techniques:** Incorporation of bioclimatic design principles, intelligent building skin, geothermal systems, and rainwater harvesting techniques.

3.3.7 Pedestrian and Vehicular Movement

a. **Pedestrian Access:**

Main pedestrian access is through the Jing'an Sculpture Park, seamlessly integrating the museum with its natural surroundings. Wide pathways lead to the entrance, ensuring smooth visitor movement.

b. **Vehicular Access & Parking:**

Limited on-site parking: visitors are encouraged to use public transport. Drop-off points for buses and taxis are available near the entrance.

3.3.8 Sustainability & Environmental Strategies

- North-facing glass façade maximizes daylight without excessive heat gain.
- Courtyard pond aids natural cooling through evaporation.
- The green roof and living walls improve insulation and air quality.

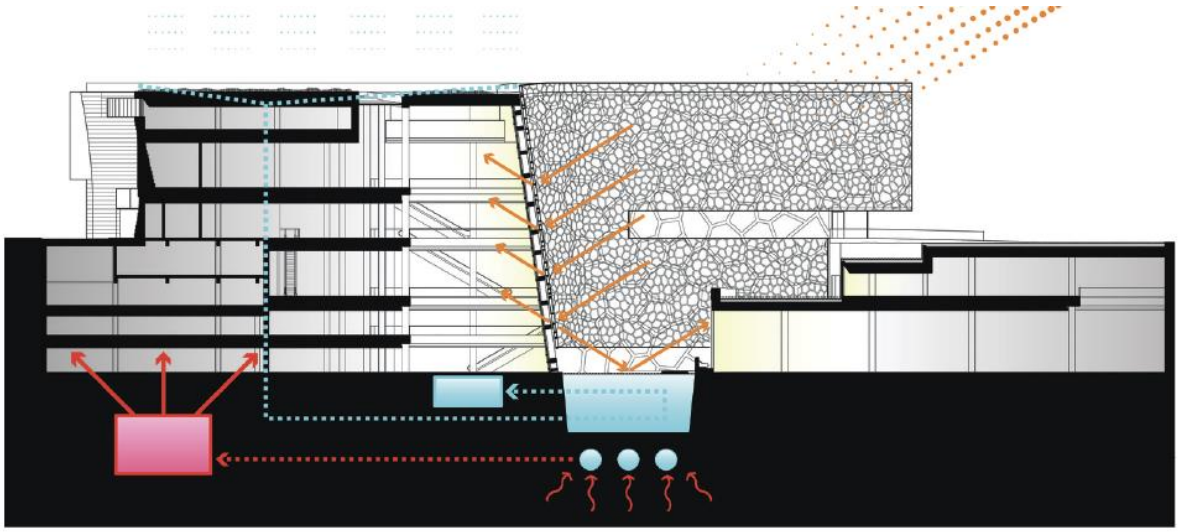

Figure 3.23: Section showing passive energy strategy

Source: ArchDaily. (2015, April 23). Shanghai Natural History Museum / Perkins+Will.

3.4 California Academy of Sciences

3.4.1 General Information

- **Location:** Golden Gate Park, San Francisco, California, USA
- **Architect:** Renzo Piano (lead architect)
- **Opened:** September 2008 (after major renovation and expansion)
- **Function:** A museum of natural history, planetarium, aquarium, and research institution.
- **Size:** Approximately 400,000 square feet (37,161 m²).
- **Mission:** To explore, explain, and protect the natural world through science, education, and sustainability.

3.4.2 Concept

Figure 3.24: "Seven hills of California" drawn by Renzo Piano

Source: ArchDaily. (2008, September 16). California Academy of Sciences / Renzo Piano Building Workshop + Stantec Architecture.

3.4.3 Site and Location

a. Location: The CAS is located within Golden Gate Park, a large urban park that spans over 1,000 acres in the heart of San Francisco. The park provides an ideal setting for the museum's purpose of educating the public about nature and conservation.

b. Surrounding Features:

- Located near major cultural and recreational institutions, including the de Young Museum, the Japanese Tea Garden, and the San Francisco Botanical Garden.

- Public Transport Access: The museum is well-connected by public transit, including Muni buses and Metro lines, which stops near the park. The nearest metro station is the Golden Gate Park Station.
- The site is easily accessible by car, bike, and on foot, thanks to its location in the middle of one of San Francisco's busiest parks.

3.4.4 Design and Development

a. Architectural Concept:

- The museum was designed by Renzo Piano, and its design focuses on sustainability, integration with nature, and creating a harmonious relationship between the building and its surroundings.
- The building's green roof, which spans over 2.5 acres, is one of the key architectural features. It functions as an ecological habitat and reduces the building's energy consumption while blending the structure into its environment.

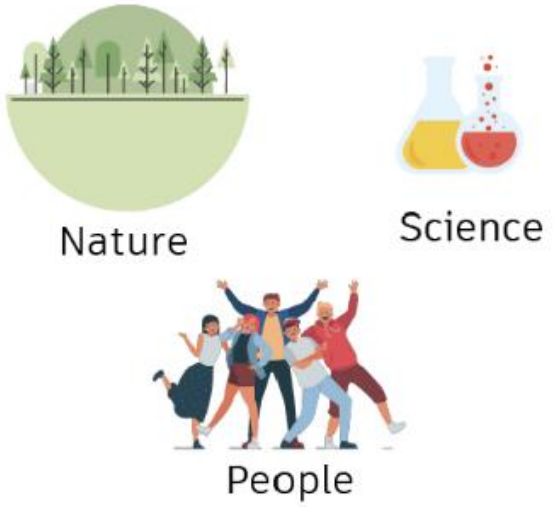

Figure 3.25: Objective of CAS being people, nature and science

Source: ArchDaily. (2008, September 16). California Academy of Sciences / Renzo Piano Building Workshop + Stantec Architecture.

- The glass canopy of the Rainforest exhibit is another iconic feature, providing natural light to the museum and offering visitors a view of the lush plants inside.

b. Building Composition:

- **Rainforest Exhibit**: A four-story vertical rainforest that replicates a tropical ecosystem. The exhibit includes live animals, birds, reptiles, and plant life native to tropical rainforests.
- **Aquarium**: Features underwater exhibits showcasing aquatic life from around the world, including ecosystems such as coral reefs and kelp forests.

- **Planetarium**: Offers immersive experiences for visitors to learn about astronomy and space exploration.
- **Natural History Exhibits**: Explore themes such as evolution, ecosystems, geology, and more, featuring scientific exhibits on the Earth's biodiversity.
- **Sustainability Features**: Solar panels, energy-efficient building systems, rainwater harvesting, and other green technologies contribute to the museum's environmental responsibility.

3.4.5 Circulation and Flow

a. Visitor Flow:

The museum is designed to offer a fluid visitor experience, with clear pathways guiding guests through exhibits while maintaining an open and airy atmosphere. The Rainforest exhibit is a central feature, with a wide-open space that visitors can explore vertically. The circulation pathways are designed around the central waterfall, allowing visitors to move between different levels and experience the rainforest in multiple dimensions.

b. Vertical Circulation:

Elevators and staircases are strategically placed throughout the building, especially near major exhibit spaces, facilitating easy vertical circulation across multiple floors, particularly in the Rainforest exhibit.

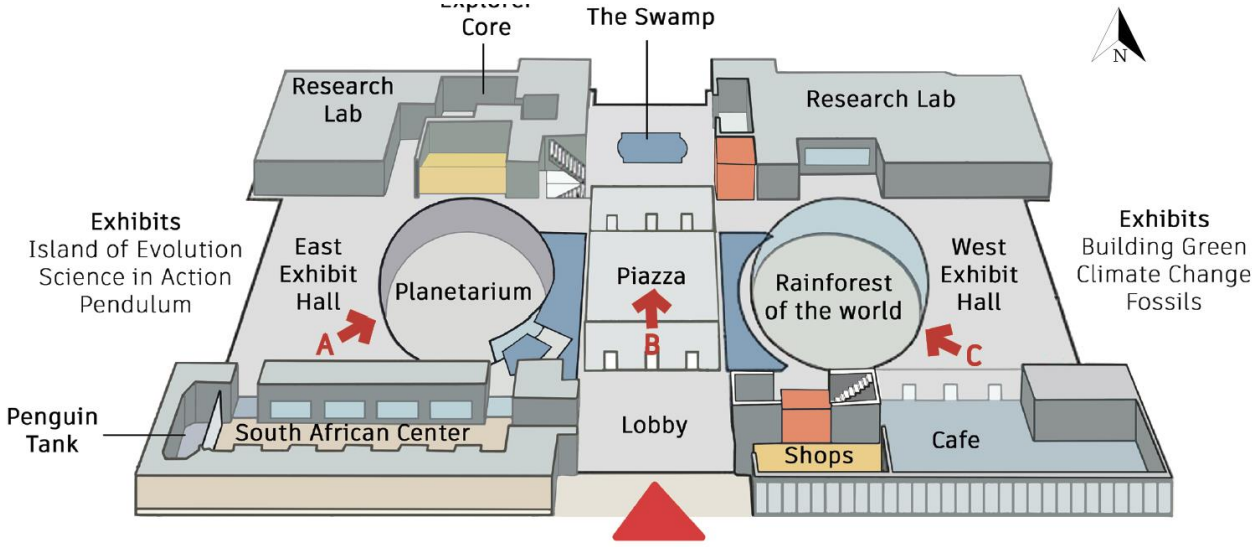

Figure 3.26: Circulation and exhibits in ground floor of CAS

Figure 3.27: Views of different programs in CAS

Source: ArchDaily. (2008, September 16). California Academy of Sciences / Renzo Piano Building Workshop + Stantec Architecture.

3.4.6 Parking and Accessibility

a. Parking:

The museum has an underground parking garage with designated parking spaces for museum visitors. It can accommodate a significant number of vehicles, ensuring that visitors can easily access the museum by car. The museum encourages visitors to bike and provides bike racks near the entrance to accommodate cyclists.

b. Accessibility:

The building is designed to be fully accessible, with wheelchair-friendly entrances, ramps, and elevators. The layout ensures that visitors with disabilities can easily navigate the museum.

3.4.7. Sustainability Features

Green Roof: The building is topped with a living roof that supports native plants and provides insulation for the building, reducing energy consumption. The museum uses solar panels to generate renewable energy. The museum has a rainwater collection system, which helps in reducing water consumption by using harvested rainwater for irrigation and other non-potable uses.

Comparative Table

Table 3. 1: Comparative table of case studies

S.N	Criteria	Natural History Museum, Swayambhu	Nepal National Museum, Chhauni	Shanghai Natural History Museum, China	California Academy of Sciences, USA
1	**Architectural Style**	Simple, rectangular form	Traditional Nepali, symmetrical	Organic, nautilus-inspired form	Futuristic, sustainable, green roof
3	**Structure**	Brick masonry, load-bearing walls	Masonry, wooden beams	Steel + RC frame, large spans	Concrete + steel trusses, large spans
4	**Materials**	Brick, concrete, plaster	Brick, timber elements	Glass, steel, concrete	Glass, steel, recycled materials
5	**Roof Design**	Sloped truss roof	Traditional sloped roof	Undulating green roof, atrium	Green roof, skylights
6	**Facilities**	Basic exhibition halls	Galleries, shop	4D theater, classrooms, garden	Aquarium, rainforest, planetarium
7	**Entry**	One public, one staff entrance	Single ticketed entrance	Grand plaza, ticketed	Central piazza, seamless access
8	**Spatial Layout**	Linear, basic zoning	Thematic wings	Radial with central atrium	Courtyard-based, fluid spaces
9	**Lighting**	Artificial, small windows	Natural + artificial	Atrium and glass facade	Skylights + controlled lighting
13	**Living Exhibits**	None	None	Insect & plant habitats	Rainforest, aquarium, green roof
16	**Sustainability**	None	None	Green walls, daylighting	PV panels, rainwater, passive cooling
17	**Visitors/Day**	100 - 200	300 - 500	2,000 - 3,000	4,000 - 5,000

4. Chapter 4: Site Analysis

4.1 Introduction

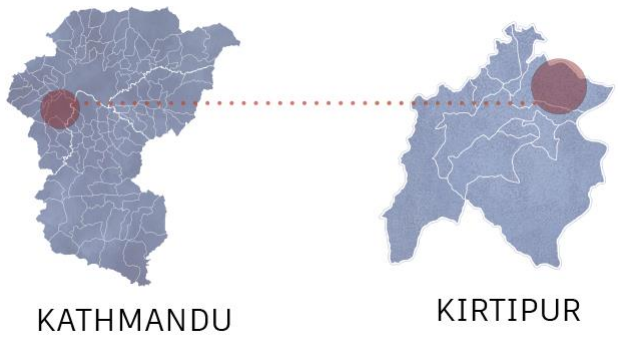

Figure 4.1: Map of Kathmandu and Kirtipur

Location: Tribhuvan University Premises, Kirtipur, Kathmandu, Nepal

Area: 22 Ropanies (Approx. 11,220 sq.m)

Latitude: 27°40'40.9" N

Longitude: 85°17'13.7" E

Altitude: 1,327 meters above sea level

Land Use Type: Institutional / Educational Zone

Access: Direct access from the T.U. main road, near Kirtipur Tinkune junction

4.2 Sociocultural Factors

The site for the proposed Natural History Museum is located in Kirtipur, a historic town in the Kathmandu Valley known for its rich culture, traditional architecture, and educational environment. The location holds strong social and cultural value, which adds meaning to the design and purpose of the museum.

One of the most important sociocultural aspects of the site is its close connection to education and knowledge-sharing. The land is owned by Tribhuvan University, the oldest and largest university in Nepal. Being near TU means the site is surrounded by academic institutions, students, teachers, and researchers. This makes the location naturally suited for a museum that aims to educate people about Nepal's natural history. The museum can work closely with the university community and become a hub for learning and research.

Socially, the site is already active due to nearby residential areas, student housing, and public spaces. This allows the museum to become part of the local lifestyle, encouraging casual visits, learning trips, and public events. By designing outdoor courtyards and open areas, the museum can become a welcoming space for all types of visitors, from school groups to local families.

4.3 Neighbourhood Study

4.3.1 Figure Ground Study

The figure-ground analysis highlights a stark contrast between the dense, built-up areas outside the Tribhuvan University (T.U.) premises and the more open, scattered development within.

Outside the boundary, buildings are tightly packed, indicating high urban density. Inside, structures are spread out with irregular shapes and orientations, showing a lack of rigid planning regulations.

4.3.2 Open Space Analysis

The site benefits from a significant green buffer in the form of the Coronation Garden, a large protected open space located to its north. Densely vegetated with mature trees, this garden ensures a constant presence of nature near the site. It not only enhances the microclimate but also provides a serene backdrop, reinforcing the museum's connection to natural history.

4.3.3 Road Network Analysis

The site is strategically located along the TU Major Road, with direct access from the TU-Tinkune Road, ensuring smooth vehicular and pedestrian connectivity. It lies within a well-connected institutional zone with multiple approach roads.

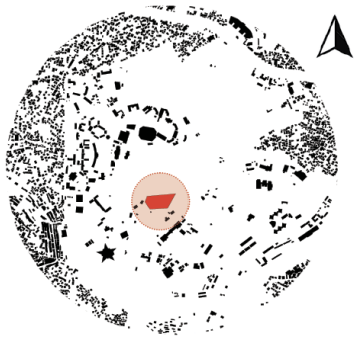

Figure 4.2: Figure ground diagram

Figure 4.4: Open space analysis diagram

Figure 4.3: Road network analysis diagram

4.4 Site Photographs

Figure 4.6: Site Photograph from T.U. road

Figure 4.5: Site photograph of the slight contour

4.5 Surrounding Study

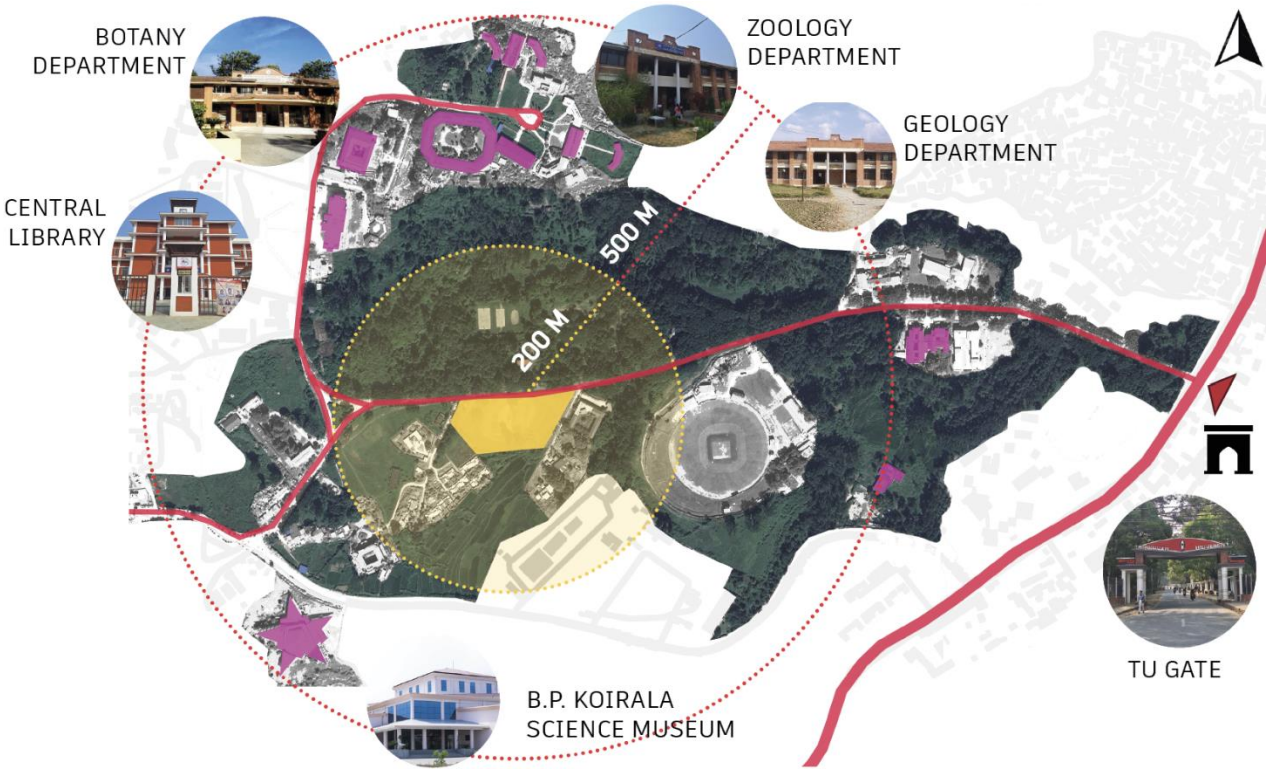

Figure 4.7: Site surrounding study with approximate distance

The site is ideally located within the Tribhuvan University (TU) premises, surrounded by key academic faculties such as Botany, Geology, and Zoology, making it highly contextual for a natural history museum. It is easily accessible from the main TU gate, approximately 800 meters away, and lies close to the Central Library and Research Institutes, fostering opportunities for academic collaboration and frequent student visitation. The institutional character of the area supports educational and research-based engagement.

4.6 Views from Site

The site offers serene and expansive views, with minimal visual interruption from buildings. Surrounded by dense greenery and mature trees within the TU premises, it provides a calm, nature-rich environment. In the distance, layers of hills can be seen, reinforcing a strong visual connection to the natural landscape, an ideal setting for a museum celebrating nature and history.

Figure 4.9: View of East from Site

Figure 4.11: View of West from Site

Figure 4.8: View of North from Site

Figure 4.10: View of South from Site

4.7 Solar Analysis Diagram

a. Orientation and Surroundings:

The site is positioned with the main road running along its northern edge, beyond which lies the Coronation Garden, a large protected open space filled with trees. This green buffer helps moderate the local microclimate by providing shade and cooling effects near the site. The northern road frontage also limits direct harsh sunlight exposure, creating a comfortable environment for visitors and the building facade.

b. Solar Angles and Sunlight: In summer, the sun reaches a high angle of about 80°, meaning the sunlight is mostly overhead, which can cause strong heat gain on flat roofs and upper facades. In winter, the sun angle drops to around 34°, creating longer shadows but also offering opportunities for passive solar heating, especially on south-facing surfaces. Designing the building with appropriate shading devices on the south side will help balance heat gain throughout the year.

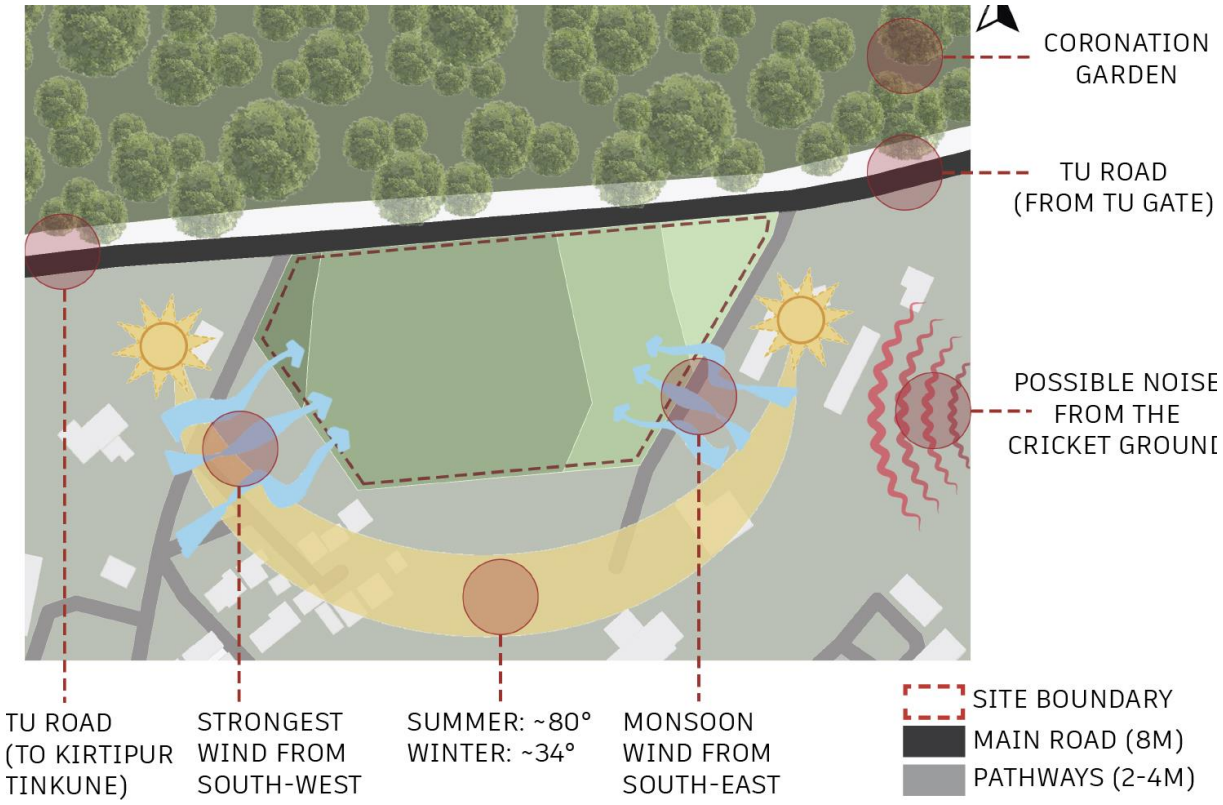

Figure 4.12: Solar Path Diagram

c. Wind and Ventilation:

The dominant wind direction comes from the southwest, which can be used advantageously for natural ventilation. Orienting windows, openings, and courtyards towards this wind direction will help promote airflow and cooling inside the museum spaces. This natural breeze, combined with the nearby green spaces, enhances thermal comfort and reduces reliance on mechanical cooling systems.

4.8 Climate Analysis

The site experiences warm summers with temperatures around 30°C and cool winters averaging near 3°C. This seasonal variation requires the design to accommodate both cooling needs in the hotter months and warmth during the colder periods. Heavy monsoon

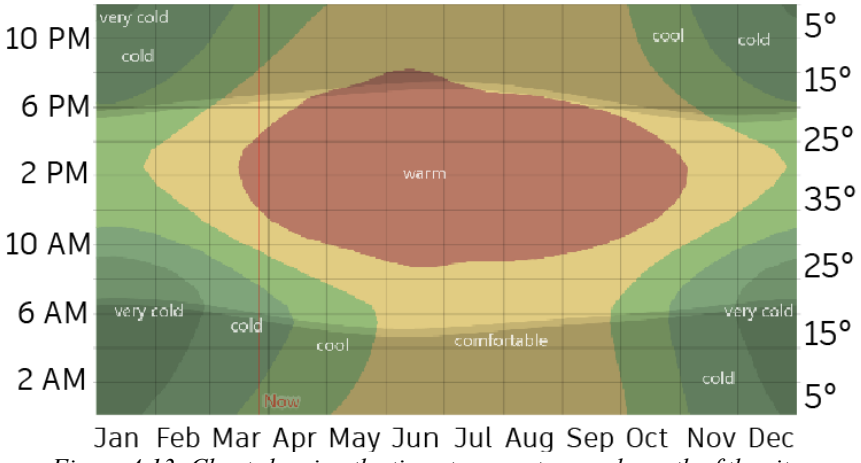

Figure 4.13: Chart showing the time, temperature and month of the site

rains occur from June to September, bringing high humidity, while the winters remain dry with moderate humidity levels.

The site experiences warm summers with temperatures around 30°C and cool winters averaging near 3°C. This seasonal variation requires the design to accommodate both cooling needs in the hotter months and warmth during the colder periods. Heavy monsoon rains occur from June to September, bringing high humidity, while the winters remain dry with moderate humidity levels.

Prevailing winds primarily come from the west and southwest, accompanied by afternoon breezes that provide natural ventilation opportunities. Designing the museum to capture these breezes can enhance indoor comfort, especially during the warmer months. Proper rainwater management will also be essential due to the intense monsoon season.

4.9 Bye-Laws

- **Zoning:** Institutional

The site falls under the institutional land use category, aligning with the academic and public nature of the museum.

- **Building Type:** Educational

As a knowledge-based public facility, the museum is classified under the educational building type.

- **Ground Coverage:** 40%

A maximum of 40% of the total plot area can be occupied by the building footprint, allowing adequate open space for landscaping and courtyards.

- **Setback:** 3 meters from the Right of Way (ROW)

A minimum 3-meter setback is to be maintained from the road boundary, ensuring safety, privacy, and ease of access.

- **Floor Area Ratio (FAR):** 2.5

The total permissible built-up area is 2.5 times the total plot area, allowing for multi-level development if required.

- **Minimum Ceiling Height:** 2.4 meters (for habitable rooms)

To ensure adequate ventilation and comfort, habitable spaces must maintain a minimum clear ceiling height of 2.4 meters.

4.11 SWOT Analysis

Strengths

- Ample natural light and ventilation throughout the site.
- Easy road access from three sides, enhancing connectivity.
- Availability of all essential infrastructure such as water, electricity, and drainage.

Weaknesses

- Lack of existing natural shading elements like trees.
- Sloping terrain requires cut-and-fill, increasing construction complexity.
- The site is exposed to dust and traffic from nearby roads.

Opportunities

- Potential for academic and research collaboration with Tribhuvan University.
- Scope to implement passive solar design strategies for energy efficiency.
- Opportunity to design harmoniously with natural elements like topography and views.

Threats

- Rapid urban development around the area may affect site context.
- Noise pollution from the nearby stadium can disrupt user experience.

5. Chapter 5: Program Formulation

The program formulation for the Natural History Museum serves as the foundation for defining spatial requirements, functions, and relationships essential to achieving the museum's purpose education, preservation, and public engagement with Nepal's rich natural heritage. It aims to provide a well-organized layout that balances exhibition, research, and administrative functions while enhancing visitor experience through efficient circulation, zoning, and support services. This formulation is informed by precedent studies, user needs, site context, and the thematic narrative of Nepal's biodiversity and geodiversity.

5.1 Estimated Daily Visitors

The estimated daily visitor count for the proposed Natural History Museum is expected to peak around 400 individuals per day. On regular weekdays, the museum is likely to attract approximately 200 visitors, including students, researchers, faculty members, and the local community from nearby Tribhuvan University.

This estimation is based on visitor data from the existing Natural History Museum at Swayambhu and has been adjusted to reflect the enhanced facilities, larger exhibition spaces, and the museum's strategic location. The following key points summarize the visitor projections:

- **Weekday visitors:** Approximately 200 per day
- **Weekend/holiday visitors:** Peak of 400 per day (maximum manageable capacity)
- **Visitor profile:** Students, academic staff, researchers, local community, and tourists
- **Basis of estimate:** Adjusted from the current Swayambhu Museum visitor data

5.1.1 Museum Operation

Museum Opening Hours: **7 hours/day** (for example, 10 AM to 5 PM)

Total visitors per day: **400 visitors**

5.1.2 Hourly Catering Capacity of the Museum

Table 5.1: Day-part breaks down of the museum catering requirement

Day Part	Hours	% of Visitors (approx.)	Visitors in that period	Visitors per hour (avg.)
Morning	10 AM - 12 PM (2 hours)	20%	80 visitors	40 per hour
Midday / Afternoon	12 PM - 3 PM (3 hours)	40%	160 visitors	53 per hour
Late afternoon	3 PM - 6 PM (3 hours)	40%	160 visitors	53 per hour

5.2 Parking

The museum provides a dedicated parking area to accommodate visitors, staff, and service vehicles. Designed for efficient access and circulation.

Table 5. 2: Parking area calculation

S.N.	Description	Area	Units	Quantity	Occupancy	Total Area
1.	Car	12.5	Sq.m	24	-	300
2.	Bike	2.5	Sq.m	105	-	260
3.	Bus	50	Sq.m	2	-	150
4.	Mini truck	36	Sq.m	2	-	72
	Total			**128**		**780** Sq.m

Total Area for Parking Vehicles: 780 Sq.m

Vehicular Road (Inside Site): 1195 Sq.m

Total Parking Area: 2095 Sq.m, which is 18%

(Minimum of 15% parking required by Byelaws)

5.3 Entrance of museum

The entrance of the museum serves as the primary threshold between the external world and the immersive experience within. Designed to be welcoming and intuitive, it guides visitors into the central lobby while offering a glimpse of the museum's thematic essence through architectural expression and signage.

Table 5.3: Entrance area calculation

S.N.	Description	Area	Units	Quantity	Occupancy	Total Area
1.	Guard House	15	Sq.m	1	2	15
2.	Lobby	285	Sq.m	1	150	285
3.	Ticket Counter	52	Sq.m	1	4	52
4.	Locker Room	52	Sq.m	1	30, (130 locker)	52
5.	Toilet	72	Sq.m	3	10	216
	Total					**1024** Sq.m

5.4 Exhibition Gallery

The Exhibition Gallery serves as the core public space of the Natural History Museum, designed to showcase diverse natural history specimens including flora, fauna and geology. It provides visitors with an engaging and educational experience through thoughtfully curated displays, interactive exhibits, and immersive environments.

The gallery is organized to facilitate intuitive visitor flow, ensuring easy navigation between thematic zones while maintaining a balanced circulation pattern. Natural and artificial lighting strategies are employed to highlight exhibits while preserving sensitive materials. The design also prioritizes flexibility, allowing for periodic updates and special exhibitions.

Table 5. 4: Exhibition gallery area calculations

S.N.	Description	Area	Units	Quantity	Occupancy	Total Area
A.	**Geology Block**					
1.	Hall of Earths Formation	144	Sq.m	1	40	144

2.	Hall of Collision and The Lost Sea	144	Sq.m	1	40	144
3.	Hall of Fossils	288	Sq.m	1	80	288
4.	Courtyard of Fossils	216			60	215
5.	Hall of Rocks and Minerals	180	Sq.m	1	50	180
	Total					**970** Sq.m
B.	**Flora Block**					
1.	Green House	140	Sq.m	1	38	140
2.	Covered Plants	260	Sq.m	1	72	260
	Total					**400** Sq.m
C.	**Fauna Block**					
1.	Hall of Invertebrates	216	Sq.m	1	60	216
2.	Aquarium	216	Sq.m	1	30	216
3.	Hall of Amphibian and Reptiles	180	Sq.m	1	50	180
4.	Hall of Birds	180	Sq.m	1	50	180
5.	Hall of Herbivores	216	Sq.m	1	60	216
6.	Hall of Domestic Mammals	252	Sq.m	1	70	252
7.	Hall of Carnivores	252	Sq.m	1	70	252
8.	Hall of Human Evolution	216	Sq.m	1	60	216

9	Hall of Climate Change	180	Sq.m	1	50	180
10	Courtyard of Fauna	295	Sq.m	1	80	295
	Total					**2200** Sq.m
	Grand Total					**3570** Sq.m

5.5 Educational Spaces

As part of the museum's broader mission to inform and inspire, educational spaces are a vital component of the design. These areas are intended to facilitate learning, research, and deeper engagement with the subjects presented in the galleries.

Table 5.5: Educational spaces area calculation

S.N.	Description	Area	Units	Quantity	Occupancy	Total Area
1.	Library	288	Sq.m	1	-	286
2.	Lecture Theatre	144	Sq.m	1	128	144
	Total					**432** Sq.m

5.6 Technical and Workspaces

These are the behind-the-scenes areas that help the museum run smoothly. They include staff offices, storage rooms, labs for research and conservation, and utility spaces. Though not open to the public, these workspaces are important for managing collections, preparing exhibits, and supporting the daily operations of the museum.

Table 5.6: Technical and workspace area calculation

S.N.	Description	Area	Units	Quantity	Occupancy	Total Area
1.	Depository Room	72	Sq.m	1	1	72
2.	Taxidermy Workstation	72	Sq.m	2	8	144

3.	Chemistry Lab	36	Sq.m	1	4	36
4.	Biology Room	36	Sq.m	1	4	36
5.	IT Room	36	Sq.m	1	2	36
6.	Preservation Room	72	Sq.m	1	2	72
	Total					**396** Sq.m

5.7 Administration

The administration area is the core of the museum's management and coordination. It includes offices for directors, curators, and support staff, along with meeting rooms and basic amenities. This space ensures the smooth planning, communication, and day-to-day running of the museum, helping all departments stay organized and efficient.

Table 5.7: Administration area calculation

S.N.	Description	Area	Units	Quantity	Occupancy	Total Area
1.	Director's Room	36	Sq.m	1	1	36
2.	Curator's Room	36	Sq.m	1	1	36
3.	Staff Lounge	72	Sq.m	1	4	72
4.	Publication Room	36	Sq.m	1	4	36
5.	Meeting Hall	36	Sq.m	1	10	36
	Total					**216** Sq.m

5.8 Recreational Zone

The Recreational Zone of the museum serves as a relaxed, welcoming space where visitors can unwind after their journey through the exhibits. Located near the exit, it includes a cozy café offering light refreshments and a souvenir store. This area enhances the visitor experience by providing a moment of leisure and reflection before departure.

Table 5.8: Recreational area calculation

S.N.	Description	Area	Units	Quantity	Occupancy	Total Area
1.	Cafeteria	216	Sq.m	1	1	216

2.	Souvenir Store	72	Sq.m	1	1	72
	Total					**288** Sq.m

5.9 Circulation

Table 5.9: Circulation area calculations

S.N.	Description	Area	Units	Quantity	Occupancy	Total Area
1.	Horizontal Circulation	-	Sq.m	-	-	1265
2.	Staircase	30	Sq.m	3	-	30
3.	Elevator	15	Sq.m	2	6	15
	Total					**1310** Sq.m

Total Site Area: 11220 Sq.m (22 Ropani)

Ground Coverage: 4180 Sq.m (37%)

Total Build Up Area: 9250 Sq.m

6. Chapter 6: Concept and Development

6.1 Concept: "Interpreting Nature Through Spatial Narrative"

The main concept for this museum is **"Interpreting Nature Through Spatial Narrative."** This means architecture itself will tell the story of nature, its history, processes, and diversity, through the way spaces are arranged and experienced.

Visitors will move through a sequence of spaces designed to guide them on a journey, helping them understand natural history not just through exhibits but through how the building interacts with light, materials, and the landscape. Each space will represent different themes of Nepal's natural heritage, making the learning experience immersive and meaningful.

The design aims to use spatial storytelling as a tool to connect visitors emotionally and intellectually to nature, showing how architecture can interpret and celebrate the environment.

6.2 Objective of The Museum

The main goal of this project is to design a museum that helps people learn about nature, with a special focus on Nepal's natural environment. The space will allow visitors to explore and understand the country's geology, plants, animals, and ecosystems through well-designed, intuitive, and engaging exhibits.

Flexibility and functionality will be key design priorities, allowing the museum to host a range of exhibitions, programs, and educational activities over time.

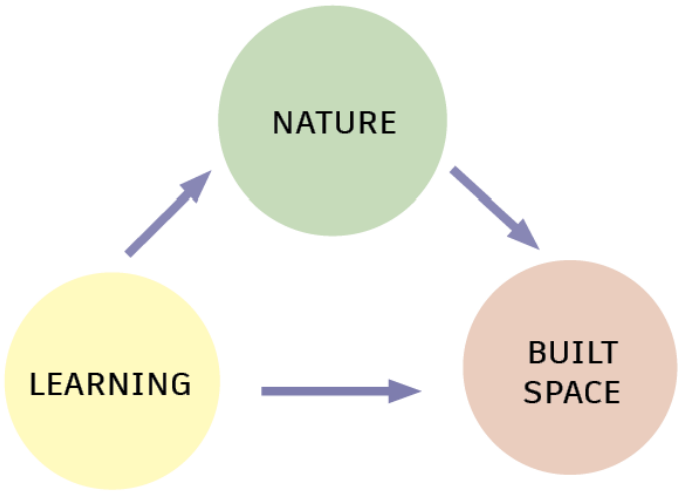

Figure 6.1: Objective of museum is being a built space that encourages learning about nature

To enhance the learning experience, the design will also integrate AR (Augmented Reality) and VR (Virtual Reality) technologies. These tools will offer immersive and interactive ways to engage with topics such as prehistoric life, geological changes, or natural habitats making abstract or ancient phenomena more accessible and memorable for visitors of all ages

6.3 Public and Private Zoning

In the museum design, spaces are divided into public and private areas to serve different needs. **Public spaces** are where visitors spend most of their time. These include exhibition halls, visitor lounges, courtyards, and educational areas. These spaces are open, welcoming, and easy to navigate. They encourage learning, exploration, and social interaction. **Private spaces** are meant for staff and operations. These include offices, storage rooms, workshops, and service areas. These areas are usually restricted to ensure smooth running of the museum without disturbing visitors.

By clearly separating public and private spaces, the design supports both an engaging visitor experience and efficient management of the museum.

6.6 Visitors Movement

The movement of visitors through the museum is carefully planned to create a smooth and enjoyable experience. The layout guides visitors naturally from one exhibition space to another without confusion or backtracking. Parking is located right near the entrance for easy access, leading directly to a welcoming entrance garden that sets the tone for a nature-focused experience. From here, visitors enter a large, stepped foyer that acts as a transition space, offering views into the landscape and organizing movement into the museum.

The spatial sequence of the built structures follows the narrative of natural history, starting with geology, moving into flora, and ending with fauna. Each zone is supported by landscaped open spaces that not only enhance the environment but also give visitors moments to pause and reflect. Near the main exit, a cafeteria and souvenir store are placed for convenience and visitor engagement. The exit route brings visitors back through the garden, completing the loop and reconnecting them with the outdoor setting.

The circulation design separates incoming and outgoing flows where possible to avoid crowding. Wide corridors and open courtyards allow visitors to move comfortably, even during busy times. Rest areas and viewing points are placed strategically to give visitors moments to relax and appreciate the exhibits.

6.7 Site and Massing

The zoning of the museum is carefully designed to create a smooth and engaging journey for visitors.

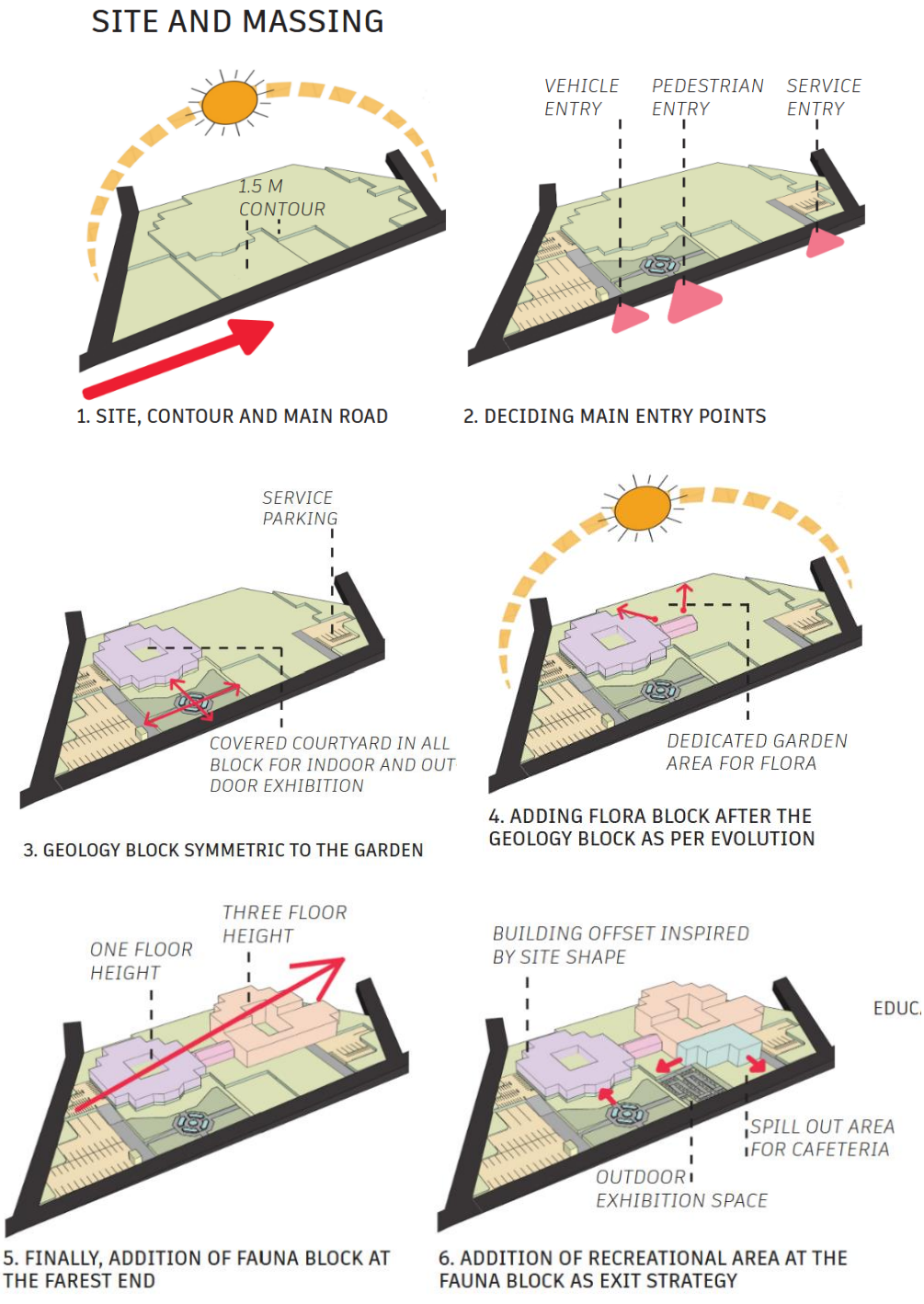

Figure 6.2: Site and Massing of the museum

7. Chapter 7: Conclusion

This project aims to create a Natural History Museum that not only showcases Nepal's rich natural heritage but also provides an engaging and meaningful experience through thoughtful architectural design. By carefully considering the unique geology, biodiversity, and cultural significance of Nepal, the design connects visitors to the stories of the Earth and their surroundings.

The integration of public and private spaces, along with well-planned visitor movement, ensures the museum is both functional and welcoming. Sustainability and local context guide the design choices to create a building that respects its environment and community.

Overall, this museum will serve as a valuable space for education and conservation, inspiring visitors to appreciate and protect Nepal's natural history for generations to come.

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