

REFLECTION

Luminous Minds:
enhancing cognitive performance and knowledge acquisition
in future libraries through the lighting landscape

AR3AH115

Graduation Studio - Revitalising Heritage

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INTRODUCTION

For this graduation project Revitalising Heritage, the focus lies on the redevelopment of heritage architecture. Within this project the case study of the Koninklijke Bibliotheek (Royal Library) in The Hague. During the initial site visit and walkthrough, one observation immediately stood out: the building suffers from a profound lack of natural lighting (see Figure 1). Normally, this is not the first thing I would notice when entering a space, yet here it dominated the entire experience. I identified this as the building's most critical shortcoming, which led to the central research question: How can the lighting landscape be designed to stimulate user-driven knowledge acquisition and cognitive performance in the 'Future Library'?

This question evolved further as the research progressed. I discovered that not only (natural) lighting, but also the quality of view plays a vital role in enhancing cognitive performance and knowledge acquisition. Both aspects are severely lacking in the current building, particularly in the reading room areas, which informed the core concept and design direction of my proposal for the library's redevelopment.

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Figure 1: Current Reading Room KB (Mooren,2025)

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RESEARCH

The research aimed to bridge a clear gap in the existing discourse: the absence of a strong connection between the neurological effects of the lighting landscape and its architectural role in libraries. The goal was to explore how lighting strategies can be designed to enhance cognitive performance and support user-driven knowledge acquisition.

The findings confirmed the initial hypotheses: lighting is not merely a visual phenomenon, but a neurological stimulant that influences emotional and cognitive states through both visual and non-visual pathways. Natural light impacts the circadian system, which in turn regulates hormonal activity, metabolism, body temperature and sleep wake cycles, all of which directly influence cognitive performance and knowledge acquisition. Figure 2 illustrates this physiological process.

The architectural implication is crucial: the way light is integrated spatially determines how users experience it, and therefore how effectively it stimulates cognitive performance and knowledge acquisition. Moreover, research revealed that access to 'high-quality views' can provide up to ten times more circadian stimulus than natural lighting alone. A finding that significantly shaped the design concept for the redevelopment of the Koninklijke Bibliotheek.

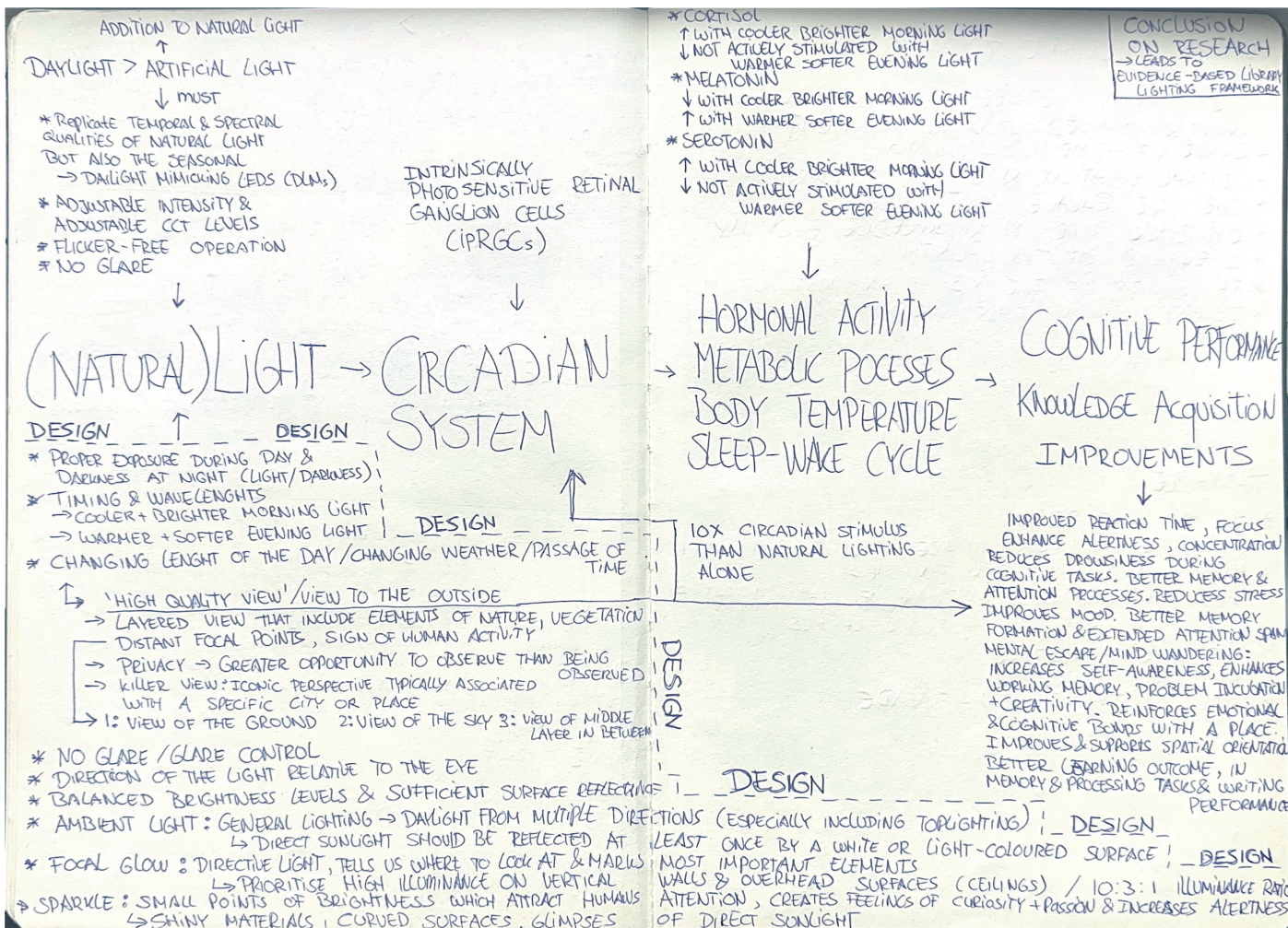


Figure 2: Synthesis of the research on the impact of (natural)light on cognitive performance and knowledge acquisition (Mooren,2025)

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RESEARCH TO DESIGN

To translate these insights into design, I developed an Evidence-Based Library Lighting Framework (see Figures 3 and 4). This framework comprises five hierarchical themes based on their importance:

- Orientation, Form & Shape
- Building Openings
- Daylight Controls
- Artificial Lighting
- Lighting Control Systems

These were used sequentially to guide the design process. From the large-scale spatial configuration to the finer aspects of lighting control (which at the moment is not researched and designed yet). For example, the framework emphasises that elongated, narrow floor plans with ample perimeter exposure are optimal for daylight penetration. The existing library, however, follows a deep-plan layout, which severely restricts daylight integration. The concept therefore restructured the plan into three smaller, elongated volumes, using the central core as a reflective element between them. (see Figure 5). This configuration significantly improves the distribution of diffuse daylight throughout the building.

One insight that emerged later in the process, and that I initially overlooked, was the influence of surrounding obstructions. Analysing these proved essential, as external context can dramatically alter daylight access. Recognising this gap strengthened the framework's practical value and confirmed its relevance and my own understanding of how contextual analysis should precede any form-related design decision. I have come to realise that choices regarding orientation, form, and shape exert such a decisive influence on the success of a design that they must always be considered first. In future projects, particularly new-built ones, I intend to make these decisions far more consciously and systematically.

Beyond this specific example, the framework has served as a directional guide, helping me as a designer to understand where to look in order to develop a strong conceptual foundation. Although it does not prescribe explicit design solutions, it provides a clear structure for identifying which spatial and environmental factors deserve priority. This characteristic enhances its transferability, as the framework can be applied not only to heritage or library buildings, but to almost any architectural typology in which daylight quality is crucial.

However, I have also learned that the framework should not be followed too literally. During the design phase, for instance, I focused on implementing dynamic or user-controlled daylight systems, since these were ranked highly within the framework. Yet, through mentor feedback, I learned that such systems can be impractical and even counterproductive in certain contexts, where static solutions may perform more reliably. This experience taught me that the framework should be interpreted as a guiding tool rather than a prescriptive step-by-step manual. Its strength lies in offering direction and awareness, not rigid rules.

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Evidence-Based Library Lighting Framework

A comprehensive design tool that visualises key spatial lighting strategies for sustainable future libraries. In this framework, lighting is not treated as a mere technical add-on, but leveraged as a spatial and cognitive asset that enhances both users' knowledge acquisition and cognitive performance.

An effective library lighting strategy begins with a strong conceptual foundation. Richard Kelly's framework, grounded in **ambient light, focal glow and sparkle**, offers essential principles that shape spatial experience and enrich visual engagement, forming the basis for all further design.

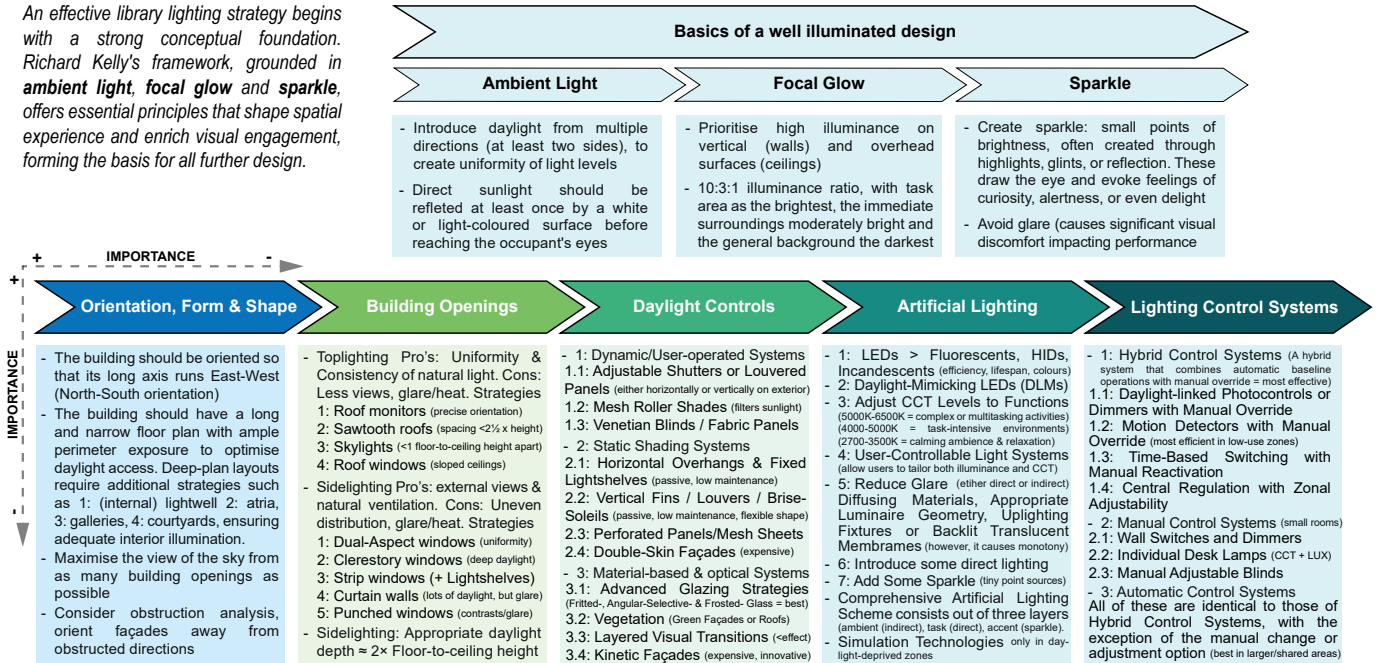


Figure 3: Evidence-Based Library Lighting Framework (Mooren, 2025)

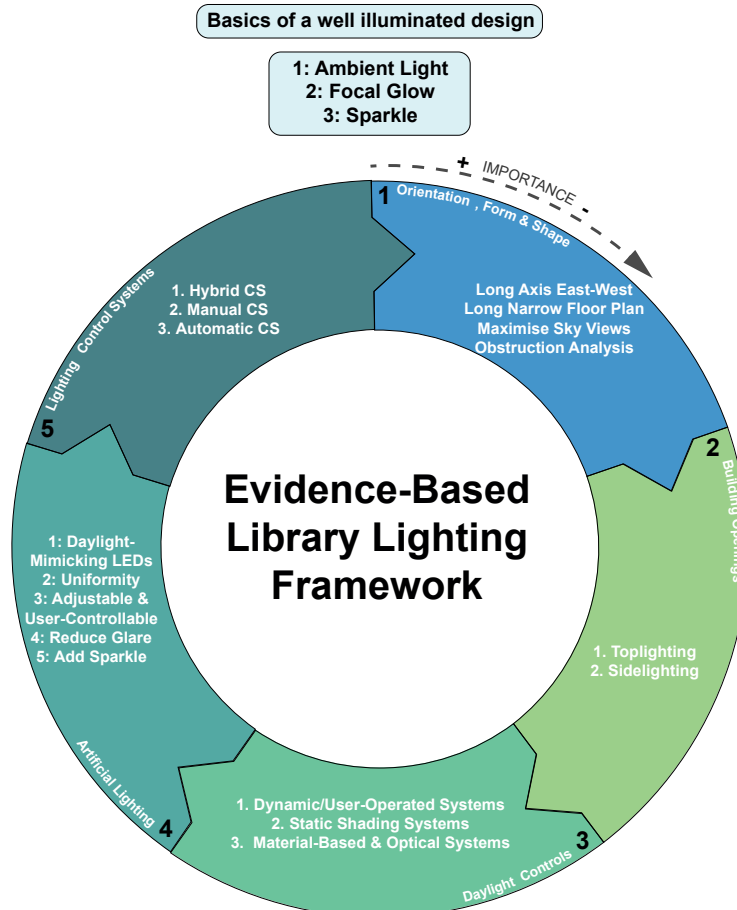


Figure 4: Evidence-Based Library Lighting Framework (Mooren, 2025)

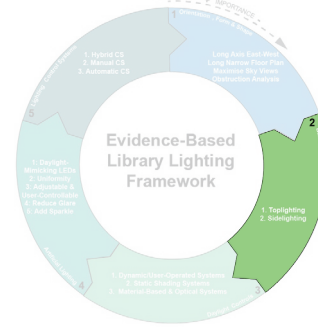
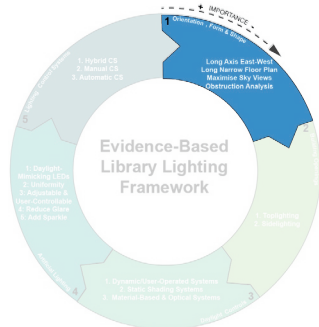
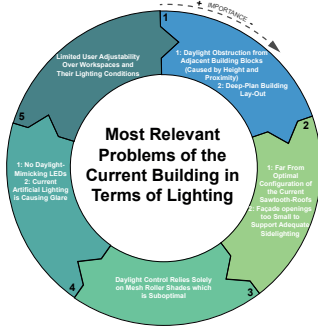
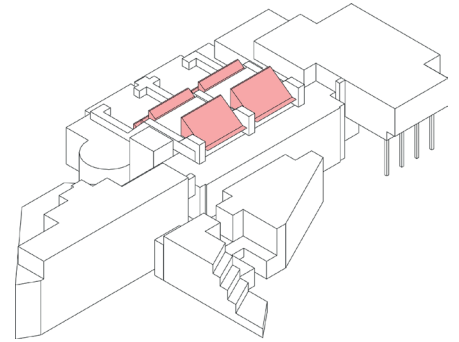
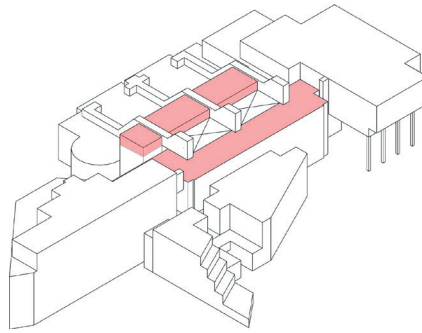
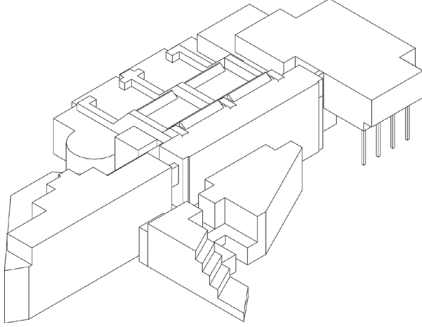
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Design Concept

Create Long Narrow Floor Plans With a Higher Volume in the Middle Acting As a Reflective Core

Improving Existing Sawtooth-Roofs Structures

Current Building (Problematic Lighting Mainly Because of Its Form)



Maximize Sky Views & Remove Obstructions

Connect Within Urban Scale and Combine With (Natural) Daylight Controls

Improve Most Important Facades for Better Lighting and Less Glare Issues

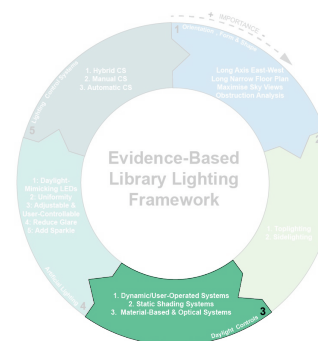
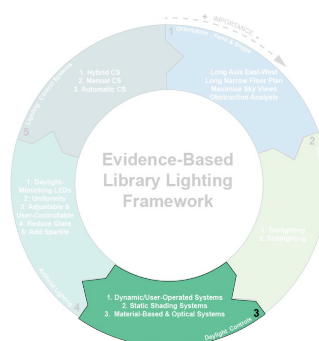
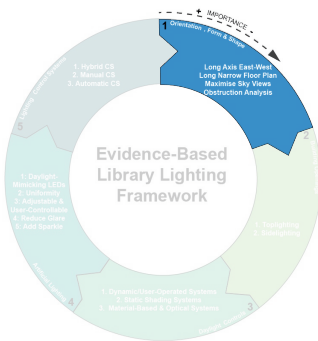
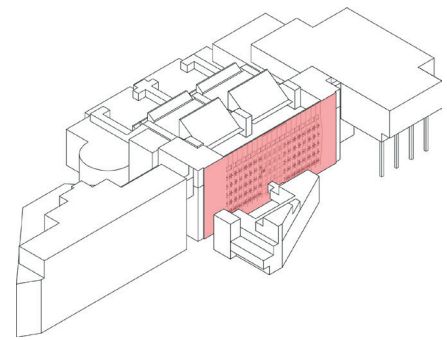
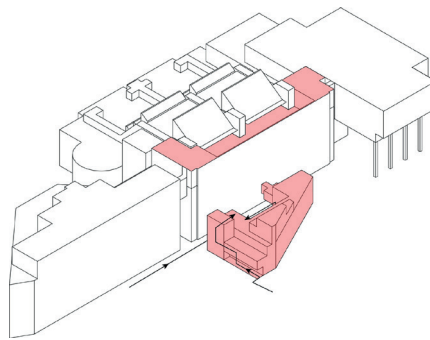
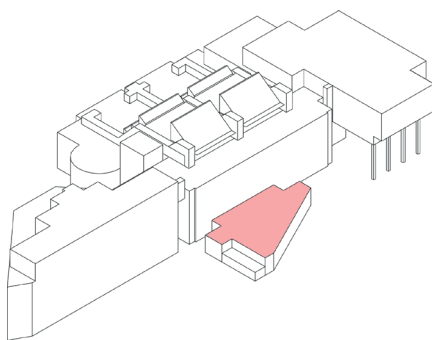


Figure 5: Concept Idea (Mooren,2025)

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DESIGN MATURATION: : FROM HEAVY-HANDED INTERVENTIONS TO CONTROLLED SUBTLETY

Throughout this project I became increasingly aware of the need to understand the actual added value of every design decision. Early in the process I often proposed interventions that were far too heavy for the context: large, expressive gestures whose underlying idea might have been valid, but whose impact on the existing building was difficult to justify. Following a process of continuous feedback and critical reassessment, it became apparent that not every ambitious concept requires a radical transformation to be effective. In many cases, a more subtle approach has been shown to achieve the same objective with greater clarity, precisely because it allows the heritage to remain present rather than overwhelmed (see figure 6 and 7).

At the same time, this experience showed me that rigorous interventions are not inherently wrong. There are situations where a bold spatial move genuinely strengthens the design and opens up possibilities that more delicate adjustments simply cannot offer. The challenge lies in recognising when such an intervention truly contributes something meaningful, and when it risks becoming architectural noise. Understanding this distinction forced me to look more carefully at the context: the value of the existing structure, the scale and rhythm of the building, the user experience, and the wider urban setting.

This project became a continuous exercise in weighing impact against necessity, and ambition against appropriateness. It taught me to question why a particular move was needed, what it added, and whether the result justified the intervention. Through that process I have developed a sharper awareness that strong architecture does not emerge from accumulating ideas, but from knowing what each gesture contributes and when restraint is the more powerful choice. This is something I will carry into future work, as it enables me to design with intent rather than excess, and to ensure that every decision is both contextually grounded and architecturally justified.

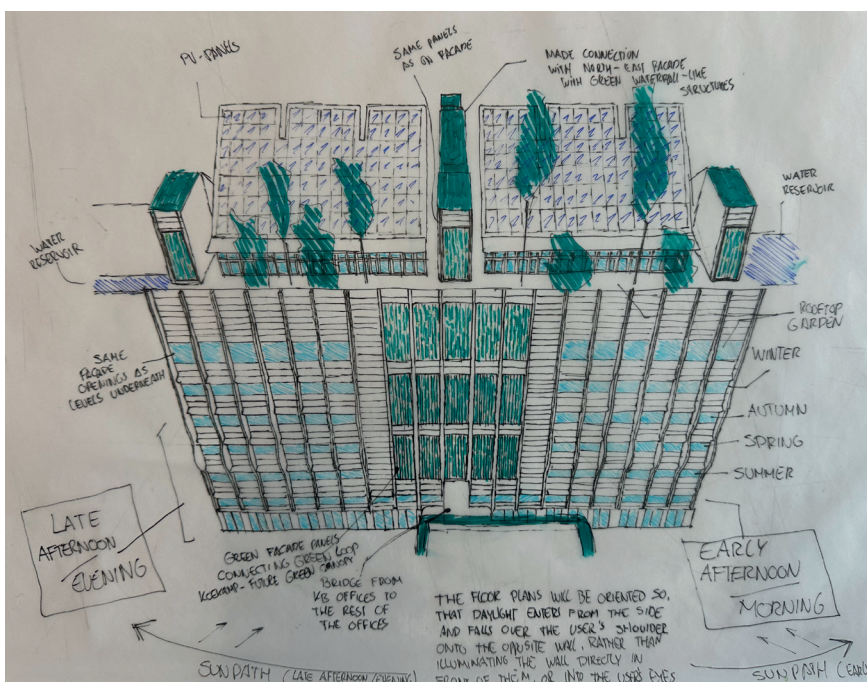


Figure 6: Initial Façade Concept with Overly Drastic Green Rotating Panels (Mooren,2025)

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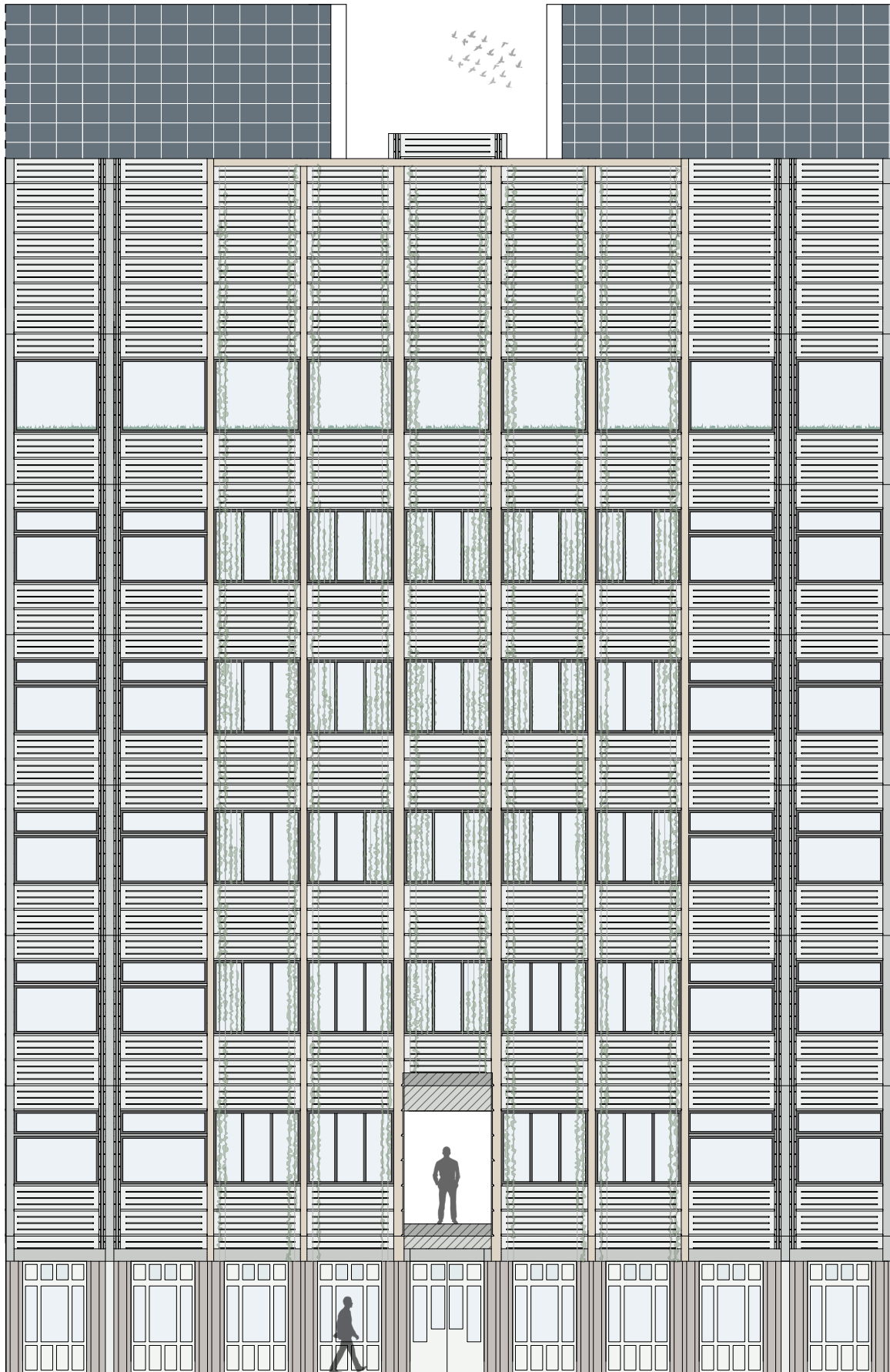


Figure 7: Refined Façade Design Showing a More Subtle Integration of Greenery.(Mooren,2025)

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THE VALUE OF AN EVIDENCE-INFORMED DESIGN APPROACH

Reflecting on my design process, I have come to recognise the significant value of this approach to working. My knowledge of the scientific mechanisms surrounding (natural) lighting, and high-quality views has improved greatly. As a result, I am now able to make more effective design decisions that truly make a difference. Instead of relying on intuition alone, I was able to base each spatial intervention on evidence, which not only clarified the project's concepts but also allowed me to explain how specific choices contribute to cognitive performance and knowledge acquisition.

During the initial design phase, whenever I encountered a period of uncertainty or encountered difficulties in progressing my ideas, the framework provided a stabilising influence. Returning to its themes enabled me to reassess the problem from multiple angles and identify alternative strategies that aligned with the project's ambition. A clear example of this occurred when I struggled to determine meaningful options for integrating both sidelighting and toplighting into the design. By revisiting the framework, new directions within these themes were identified (see Figure 8), demonstrating the feasibility of incorporating and evaluating each lighting strategy within the evolving concept.

This iterative movement between research and design helped me regain direction each time the process threatened to stall. In that sense, the framework did not constrain creativity; instead, it expanded it by providing a structured set of lenses through which design possibilities could be reconsidered.

This experience has demonstrated the productivity and reassurance that can be derived from working with a research-based design methodology. The ability to justify design decisions based on underlying scientific principles is becoming increasingly important to me, and I aim to carry this approach into my future professional practice.

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RELATIONSHIP BETWEEN THE GRADUATION PROJECT AND THE MSc AUBS PROGRAM

This project aligns strongly with the aims of the MSc Architecture, Urbanism and Building Sciences programme, particularly in its ambition to develop architecture that enhances human experience and performance within the design. By proposing an evidence-based design framework, this research contributes to the field of neuroarchitecture, connecting architectural design decisions to measurable human outcomes.

This project's integration of research and design reflects the programme's emphasis on bridging scientific inquiry and architectural practice. It helps with my personal ambition to create architecture that goes beyond aesthetic quality, by creating architecture that genuinely improves the users' capacity to perform and learn better.

ACADEMIC AND SOCIETAL VALUE, SCOPE, IMPLICATIONS (INCLUDING ETHICS)

From a societal perspective, the project underlines the responsibility of architects to design buildings that genuinely support human health, well-being and productivity. By aligning the built environment with peoples' natural circadian rhythm, architecture enhances users' comfort, cognition and health. Therefore this approach goes beyond aesthetics but it also redefines buildings as active contributors to human well-being. Healthy and cognitively supportive environments should not be preserved for privileged users but should become a baseline quality in all public buildings. Architects and policymakers must treat visual comfort such as daylight and view not as luxuries but as essential components of design.

Beyond its broader societal implications, the project demonstrates that well-being and cognitive performance can be placed at the heart of architectural decision-making without relying on drastic or overly expressive design gestures. The proposal demonstrates that subtle spatial adjustments, when guided by a clear understanding of how people perceive and respond to their environment, can meaningfully elevate the everyday experience of a building's users. This is particularly evident in the transformed reading room environment, as illustrated in Figure 9, which demonstrates how such targeted spatial adjustments can translate into a noticeably improved user experience. This approach treats the enhancement of human comfort and performance not as an optional layer, but as an ethical responsibility embedded within the design itself.

In this sense, the project aligns with the principles of SDG 3 (Good Health and Well-Being), as it aims to create environments that support physiological balance and mental clarity, rather than contributing to stress or fatigue. Furthermore, it aligns with SDG 4 (Quality Education) by demonstrating how thoughtfully designed study environments can strengthen learning conditions and make knowledge more accessible. Taken together, these considerations emphasise the academic and societal value of the work: the creation of a built environment that strengthens human potential while respecting its architectural context, and that demonstrates how responsible design can quietly but powerfully contribute to a healthier and more equitable public realm.

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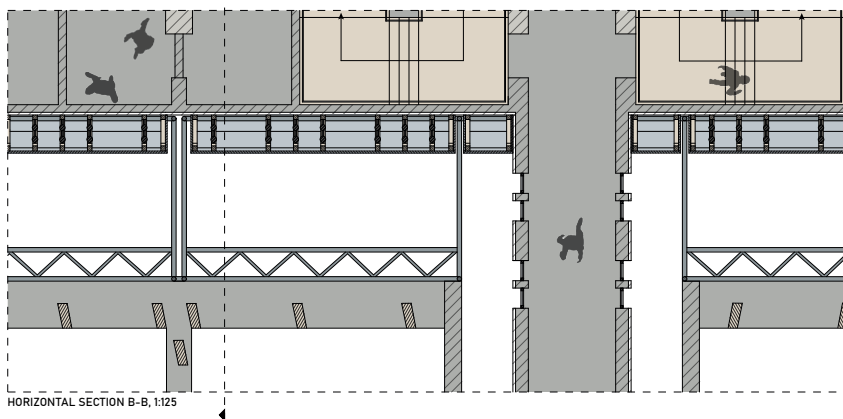
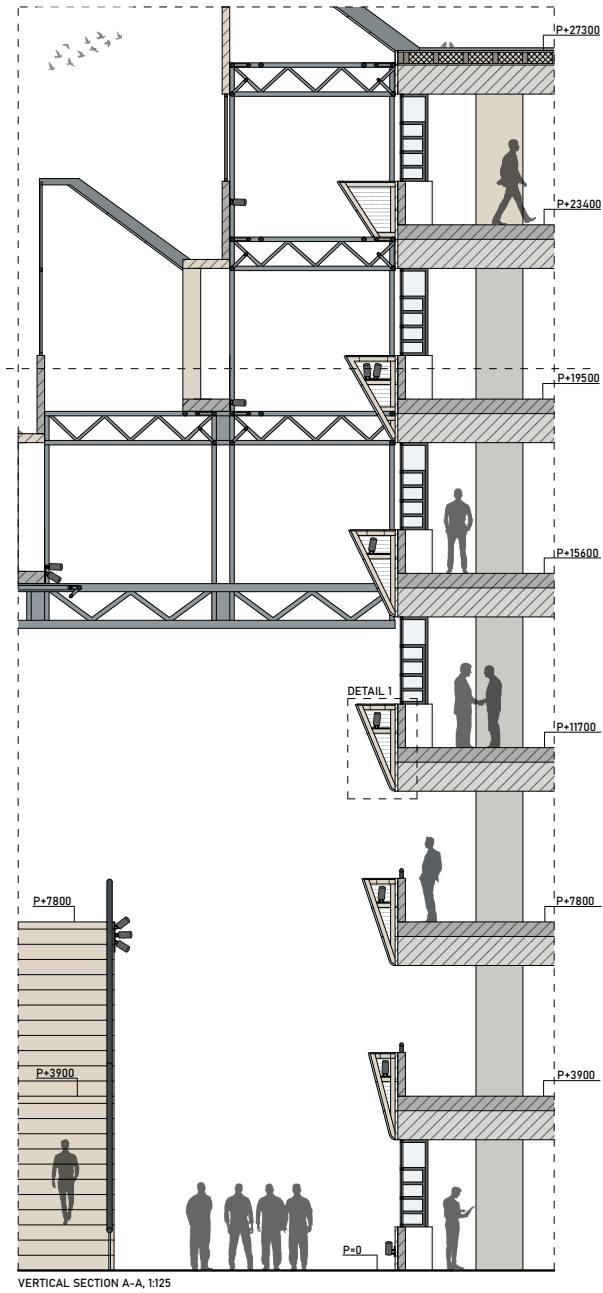
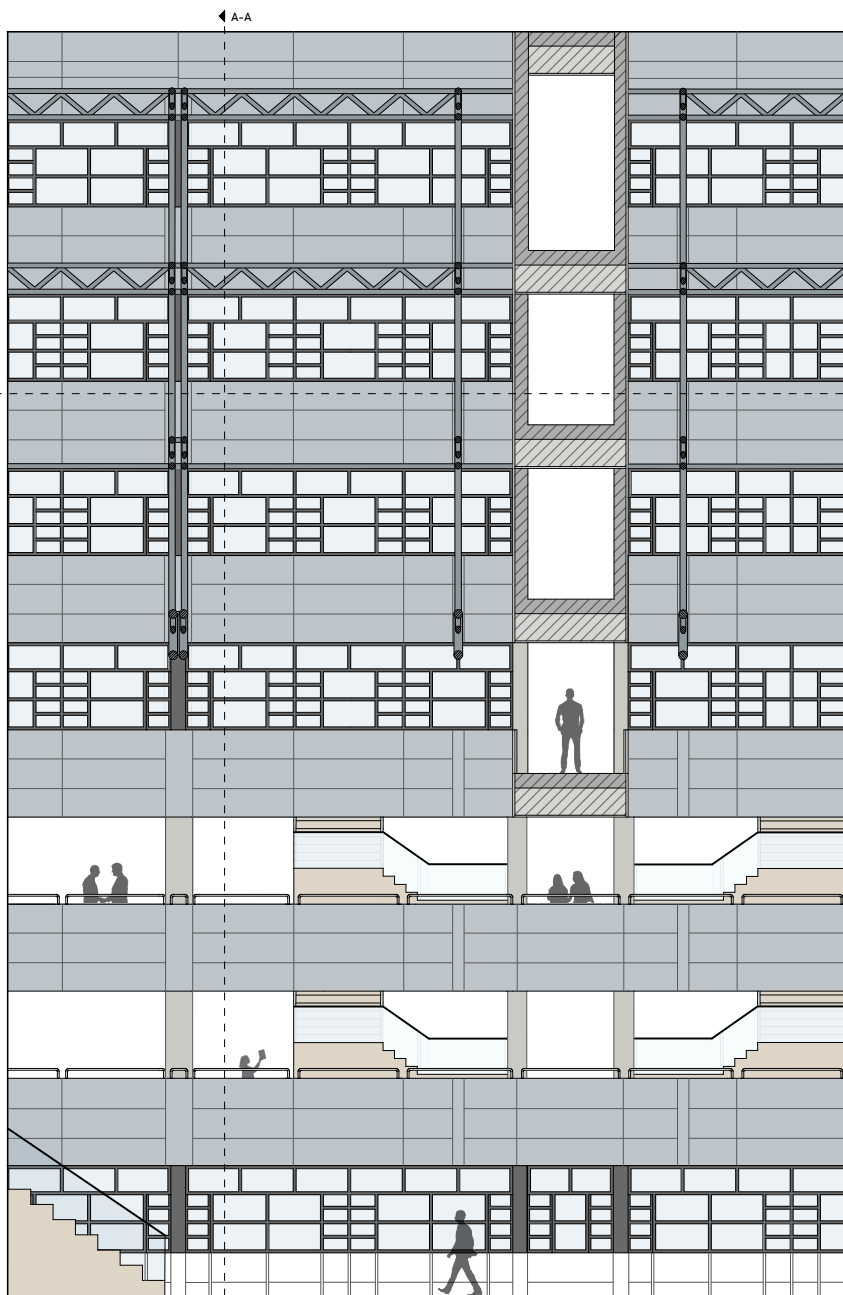


Figure 9: Conceptual Façade Fragment of the Redesigned KB Reading Room (Mooren,2025)

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LOOKING TO P5

In anticipation of the P5 phase, the emphasis will be placed on the refinement and elaboration of the design, ensuring that the fundamental spatial and lighting interventions are thoroughly resolved. The development of a physical scale model is also intended, with the purpose of clearly illustrating the most essential transformations of the proposal. This model will facilitate the communication of the core design ideas and their impact on the user experience in a precise and tangible way.

HOW I WOULD REFINE MY PROJECT IN A FOLLOW-UP STUDY?

Conducting this research and design project within a single graduation year has been both ambitious and challenging. The developed framework represents an important first step, yet it is far from a final or fully optimised model. In a follow-up study, I would aim to expand and refine the framework, particularly by quantifying the neurological and behavioural effects of specific lighting configurations through empirical testing or post-occupancy studies. Time constraints meant that several design assumptions were based on literature synthesis mainly, rather than on-site performance data. Ideally, future work would involve (natural) light and circadian simulations calibrated against real user data. Despite these limitations, the project establishes a foundation for a measurable and adaptable design methodology that can evolve with further research.

In what ways can empirical data, such as circadian simulations or user studies, be integrated earlier in the design phase to validate or challenge conceptual lighting strategies?

This question is relevant because, although my design process was strongly rooted in scientific literature, the project did not include any empirical testing to see how users would actually respond to the proposed lighting strategies. The cognitive and circadian principles I worked with remained theoretical within the context of the Koninklijke Bibliotheek. Incorporating simulations or user observations in a future project would make it possible to assess whether the intended effects truly manifest in practice. It would add a layer of verification that goes beyond conceptual reasoning and helps evaluate the architectural performance of specific design choices. Therefore, understanding how to integrate this empirical dimension earlier on is an important step in strengthening an evidence-informed design approach.

What is the most effective method of determining when a large, expressive architectural gesture is justified, and when a more subtle, heritage-sensitive approach will deliver a stronger outcome?

This question is relevant because a recurring challenge in this project was understanding how far an intervention should reach within a heritage setting. While several bold gestures ultimately proved too heavy for the context, they were not wasted exercises; they opened up new perspectives, unlocked unexpected spatial possibilities and allowed me to explore the concept with far more creative freedom than a subtle approach would have offered at the start. Conversely, many of the most effective outcomes emerged only after these ideas were refined into more restrained, heritage-sensitive interventions. Finding the balance between expressive ambition and contextual responsibility is not a fixed rule, but rather an ongoing design judgement. It is important to understand when each mode of working is most effective, as both approaches can contribute meaningfully to a project when used with purpose.

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