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# Rethinking The Performance of Envelopes in Architecture

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*The paper's objective is to propose a redefinition of the notion of 'envelope' in architecture that goes beyond the common definitions of 'building skin' or 'façade.' The intention is to ground the notion of 'envelope', within the context of contemporary discourse on 'performance' in architecture, as an extended threshold that affects humans' experience of architectural space. This is done through four thematic sections: [a] discussion of selected conceptual approaches to the notion of envelopes based on literature study; [b] a proposed taxonomy of envelope types based on an analysis of built and unbuilt projects; [c] research-by-design inquiry by way of designing performative envelopes, and [d] formulation of a resulting position including a synthesized conceptual and methodological approach for the purpose of further development. The aim is to initiate a design approach that intensifies the interrelation between interior and exterior through specific performance foci.*

*Keywords: Architectural Envelopes, Performance-Oriented Design, Taxonomy of Envelopes, Architectural Envelopes' Inhabitation, In-Between Spaces*

## 1 Introduction

Contemporary architectural discourse frequently focuses on the tension between globally uniform architectures and their lack of response to local conditions and circumstances, and the constraints that this places on approaches to sustainability. Many of today's attempts for creating sustainable architecture using strategies like zero-energy buildings, green architectures, or efficient and controlled interiors fall short when considering the capacities of envelopes. These approaches treat building envelopes as a layer of control and insulation against climate and exterior environment, and thus as independent of their local surroundings. By doing so, these approaches underestimate the capacities of envelopes as a threshold that provides the necessary sheltered space by attuning to its interior and exterior environments and creating modes of adaptation and change by its constructs. However, these constructs are the first architectural body that the inhabitant experiences when moving from the exterior environment to the enclosed interior. It is therefore of great value to revisit the notion of the building's outermost covering to explore and define guiding factors, within the envelope design process, that should be considered in the way an envelope meets its local context and affects its inhabitants' experience of interiority and exteriority.

Before proceeding to clarify the scope of performance in this research, it is useful to redefine the notion of 'envelope', in order to set it apart from other notions such as 'building skin' or 'façade,' that continue to assert the separation of architecture from its setting by rendering it discrete. This research defines these notions based on their spatial reality. Façades are the two-dimensional representation of architecture, defining a material boundary for the enclosed space, setting apart the interior from the exterior. Building skins are the three-dimensional representation of architecture, with higher complexity, that respond to

features of the surrounding environments by conducting specific operations. These operations are mostly orchestrated using today's technological advancements and intelligent systems. This research therefore proposes the following definition for the notion of architectural envelope: unlike the building skin, which is the operative or static material division of exterior and interior, an envelope is a spatial zone, engaged in and affected by the interactions between the outside and the inside of the built form (Figure 1).

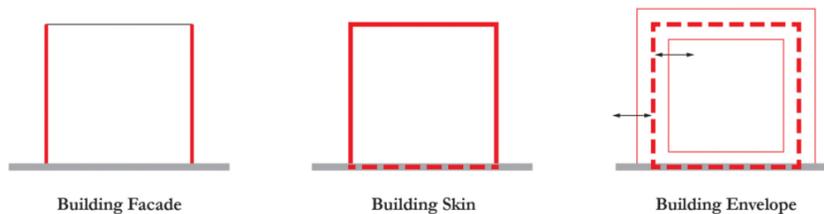


Figure 1 Diagrammatic Representation of Research Definition of Building Facades, Building Skins, and Building Envelopes, produced by Sareh Saeidi, spring 2016

Defining envelopes as spatial zones thus incorporates the traits and attributes of the notion of building skins and façades, as well as transcending them by including architectural performance and experience foci in their design. It is a threshold that can be experienced, and by creating a sensible relationship between its interior and exterior spaces, it also possesses a character. Through this, the envelope becomes unique and claims its distinct character not through its effects, but by its affective encounter with its inhabitants and surrounding environment: a dialectics in which matters and souls, substances and subjects, spaces and emotions sublimate.

To frame the aforementioned relationships, the research focuses on performance aspects that contain studies of climatic design, spatial experience, and the notion of agency in envelopes to establish ways of conditioning the interior by relating to the building's milieu. This investigation refers to these interactions, conditions, and their mutual correspondences as active agency,<sup>1</sup> including various actants<sup>2</sup> ranging from micro- to macro-scales, and from objects in an architectural space to climatic factors. The role of material and spatial organization in creating in-between spaces is a key factor by which these studies seek to clarify the position of architectural envelope as a space that affects its inhabitants through its atmospheres. The research presented in this article attempts to outline a design approach of the aforementioned focuses by examining the research's tailored methods within the design studies of a series of workshops conducted at master level studios.

## 2 Literature Review

According to Gottfried Semper, the building's covering is one of the oldest architectural elements. It is what defines the enclosures, the building's identity, and its spatial and climatic aspects. In "Four Elements of Architecture", Semper describes the enclosure through the wall, the role of which he divides

<sup>1</sup> The notion of agency and its passive and active role in envelope's performance will be discussed again later in this section.

<sup>2</sup> Bruno Latour defines actant as: "anything that does modify a state of affairs by making a difference is an actor –or, if it has no figuration yet, an actant" [12].

into two distinct parts: structural, i.e. primary and more permanent, and covering, i.e. secondary and more temporal [30]. Apart from clarifying the relationship of the human body and the built through this systematic division, he defines the boundary's role as symbolic as well as functional representations of human purposes. Semper's focus in this study is the temporal element of the wall; he refers to the nomadic tent structures as an exemplary argument that the primary need of humans was not essentially the solidity and permanence of the built form, but providing the enclosure and shelter created by a materialized boundary. Semper emphasized that the same temporal structure, when used as cladding or a secondary covering, is a way of self-expression and representation, or perhaps a sign of power [30]. Taking this discussion further, one may argue that the human desire for expression and beauty, by using the outer stance of architecture as a representative device, is one reason for the emergence of architectural styles. And as such, façades become operative tools for architectural styles, reflecting shared assumptions and expectations that result from the conventional face-to-face encounters and interpretations, through which the building gains identification and significance within its context [17]. The emphasis on architecture's representational features can lead to approaches with a focus on the object position of buildings that might result in fragmentation and the disaffiliation of the built form from its surrounding environment. These attempts lead to the emphasis on surface architecture that focus primarily on the representational features of buildings' stance, and thus, typically fail to sustain a local identity for the built space.

Technological advances, changes in values, attitudes and actions for standardization that started the international style in the 20th century led towards globalization in architectural design. The emphasis on rectilinear forms and use of glass and steel superseded the use of local materials for construction. Such tendencies foreground efficiency and insulation in designs and reinforce the emergence of sealed spaces that are incapable of integrating with their local environment. As a result, the exterior walls of the built form became a boundary to exclude and isolate the interior. These structures mostly focus on the object stance of architectural design that is governed by dominating mechanical and electrical setups, thus, blurring the possibilities that can unfold through the latent use of the space. The continuum of this approach towards standardization in today's culture and the prevalent technological advancements have resulted in the production of synthetic, identical environments with similar features and characteristics. By becoming independent of their local climate, culture, traditions, and regional building materials, these built forms are "reducing architecture to the provision of aesthetic skin" [4] and transforming it into fully controlled mechanisms and constructs. The outermost covering of a building is, as a result, defined as a boundary that excludes any direct or indirect interaction between architecture's outer and inner environments. In this way, buildings turn into either expressive devices that are politically charged [35]; or operative boundaries of insulation that become a spatial support for structural, mechanical, and electrical systems, thus leading to what Farshid Moussavi calls blank envelopes [19]. In this investigation, these types of architectures are regarded as discrete, due to their intentional focus on the object stance of architecture.

In contrast to approaches to creating highly immune environments and efficiency preoccupation, another discourse has emerged that places emphasis on questions of performance; in short, the locally specific interaction between architectures and their settings. This approach includes the inhabitants, environmental factors, and local conditions within its constitution and defines them equally as 'active agents' with

reference to Actor Network Theory [12]. The interaction between architectures and their settings opens up the possibility of redefining aspects of both – not by way of separation, but as a continuum, resulting in non-discrete architectures [10]. Non-discrete architecture represents built forms that integrate with, and correspond to, their local conditions and surrounding environments through their design strategies and considerations. These structures perform by implementing and utilizing factors from their local environment to build their design features and attributes. By doing so, architecture creates a character for the space that is enacted by an intricate network of human and non-human relations with and within the space. According to Hensel, the basis of performance-oriented design is to understand how architecture unfolds its performative capacity “by being embedded in nested orders of complexity and auxiliary to numerous conditions and processes” [10]. This view points towards a definition of architectural performance that would foreground architecture itself rather than its technical add-ons and which is in the scope of this investigation. The tendency to define performance through advances in electrical and mechanical systems and their efficiency optimization accentuates the object stance of the built form rather than attuning it to its local conditions. Criticizing the current emphasis on the object in contemporary practices of architecture, in his book “Anti-Object” Kengo Kuma uses examples of his projects to propose an alternative view that disperses the object in a wider spatial field of architectural design. He illustrates, instead, a substitute design approach that engages architecture with its milieu.<sup>3</sup> Kuma emphasizes relationships and involvements of architectures that create meaning, balance, and harmony through their eminent awareness of occupying a location, their tectonics and material presence, their inherent force/counterforce relations, and spatial orders [11]. The research presented in this paper focuses on one such aspect, namely the interrelation and interaction between exterior and interior across a threshold defined by architecture: the performative envelope.

As Antoine Picon stated, architecture today is expected to perform at various levels, similar to the performing arts, “from an ecological footprint to the realm of affects” [24]. Architecture thus requires an integrated approach, constructed from a variety of concepts and methods, to systematically enable it to address performance foci and experiential aspects. According to Hensel, “performance-oriented architecture requires an overarching and inclusive theoretical framework together with integrated and instrumental concepts, design strategies and methods” [10]. A clear thematic classification of performance is required to redefine the envelope as an essential element of conceiving non-discrete architecture constructed upon a synergy of complex relations. These thematic categories are addressed in three ways<sup>4</sup>: Environmental conditioning and climatic design consideration to position interiority and exteriority; Conscious and unconscious architectural experience; Co-authoring performance through design provisions and flexibility.

There is a large body of knowledge in recent discussions on addressing environmental, technological, and

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<sup>3</sup> Marcellin Berthelot (1827-1907) referred to milieu as the “element surrounding a given body”; however, Auguste Comte (1798-1857) expanded it to “the total ensemble of exterior circumstances [...] upon which the existence of a given organism depends” [32] including both the organism’s surrounding physical world and the external conditions essential to its existence.

<sup>4</sup> These three categories are explicitly and individually discussed within the body of the article; in the following paragraph they are introduced as a whole as part of an overall description.

structural performances in architecture. One of these includes discussions of contemporary approaches in defining architectural performance through a series of case studies, collected in the book “Performatism” by Yasha J. Grobman and Eran Neuman [8]. In this book, approaches to the notion of performance within architecture and today’s architectural digital interface are discussed. Emphasis is placed on professional practice and how various aspects of performance can be developed within a synergetic design process. Other potent references on the performance foci, especially regarding environmental studies, are local traditions in architecture that provide a significant body of knowledge on climatic design of different climatic zones. In vernacular architecture, the outermost wall of an enclosed space was not regarded as the divorcing boundary that isolated the human body from the exteriority of the building, but as the mediating element that attuned the needs of the human body to its local climate and environment. Architectural elements such as windcatchers, Mashrabiya, also called Islamic sunscreens, or design strategies in spatial planning like Persian courtyard arrangements and Iwans, are mediators of an inclusive approach in which architecture derives its character and identity through an active integration with its context. In addition to this, such built forms operate effectively by attuning to climate and utilizing the climatic restraints in favour of creating additive and novel qualities provided for interiors’ climatic comfort. Hassan Fathy’s studies of vernacular architecture and climatic considerations in arid regions illustrate how climatic designs strategies can result in architectures that respect and attune to both their surrounding environment and inhabitants by ways of adaptation [2,3]. He argues that a climatic element like heat, as a force, creates different formal expressions than cold, and highlights how climatic design considerations exhibit designs that are formally and spatially specific to their local context [27]. Vahid Ghobadian’s analysis of local design traditions and material specifications in different climatic zones of Iran is another explicit reference. Within his systemized studies, Ghobadian organizes knowledge about traditions and regional elements of Persian architecture, spatial arrangements, and choices of materials, as well as elaborating on cultural expressions in different regions [6]. This investigation attempts to build an understanding of local climatic designs that are focused on developing spatial strategies and principles to interrelate the interior and exterior of a built form.

Traditional buildings emerge and grow spontaneously from the interaction of landscape, soil, climate, and type of culture, and in doing so create a synergy of physical conditions and psychological needs that form the ultimate balance within a built form [22]. Aligned with approaching the climatic design by extracting knowledge from traditions of architecture, this research looks into an approach that addresses interior thermal comfort through human adaptation and programmatic considerations. Free-running buildings is a method that provides a variety of indoor climates through the joint necessity of non-discrete architectures with the inhabitants’ adaptation abilities. It includes design strategies that implement concepts such as inhabitants’ acceptance, adaptive capacities, and expectations within architectural designs by attuning clothing, activity, and spatial arrangements [20]. Addressing the potentials of envelope design for providing flexible systems and provisions of adaptation, these studies also aim to define the role of inhabitants in modifying designated qualities of space. This systematic flexibility and adaptation determines the envelope design’s capacity for interacting and responding to various foreseen and unforeseen needs of its inhabitants and programmes. The objective of this investigation is to open discussions regarding the repositioning of inhabitants’ subjectivity in the co-authoring of spatial characteristics along with the design’s provisions. The built form creates certain spatial qualities with its

elements' organization, and an integrated network of correlations and correspondences between these architectural components and inhabitants of the space can affect and change the space's conditions, resulting in the co-authoring of the spatial characteristics. As David Leatherbarrow says, the task of architecture will be lacking and has been misunderstood if the building's requirements are only associated to the physicality of architecture and discard human praxis [13]. Human praxis includes the inhabitants' efforts, interactions, and living in architecture that has been actuated according to their preference and deliberate choice rather than on purely technical and functional operations and labours [5]. This Investigation thereby positions the potential actions of human in the building envelopes.

Apart from discussions on environmental and technological performance, there are other discourses that concentrate on phenomenological aspects of architectural envelopes in creating distinct atmospheric features beyond their design considerations. These include phenomenological debates on spatial and material experience [26]; spatial design provisions and effects [13]; and the role of multi-sensory experience and the body's memory in human perception [22,23]. The underlined importance of envelopes in creating distinct spatial qualities is how architecture affects the memory and experience of space and moves<sup>5</sup> its inhabitant. By defining functions of architectural forms and elements, Leatherbarrow attempts to highlight the role of the latent design provisions in creating additive effects and qualities to the bare necessities of the architectural spaces. These provisions create a disposition or mood in the space and develop a character for the built form, and by doing so, make the architectural experience lasting in one's memory [13]. The character of architectural space is produced by, and can perhaps be identified as, the embodiment of human interactions. This character is not a thing-in-itself, but rather emerges from the intersection of an intricate network of human relations with, and within, the space. It includes both corporeal and incorporeal interactions of the inhabitants, besides their perceptual intakes of these relations within the space. The character of architecture is what Rasmussen calls poise, representing the way through which the built form is directly experienced; i.e. seen, heard, or felt [26].

In his architectural essays on Sensing, Pallasmaa uses the metaphor of the body to expand on how the interrelations and correspondences between elements of architecture form a unified whole to foster the sensations of their spectator's experience [22]. In regards to human corporeal experience, in his book "Experiencing Architecture" Rasmussen also attempts to elaborate on the notion of architectural experience through perceptual accounts of various architectural elements and expressions. These include concepts such as the contrasting effects of solids and cavities that create an active observation in the spectator of architectural forms. Additionally, he elaborates on how various characteristics of materials of architecture such as surface's finish, materials' thickness or organization affect the process of spatial perception. He amplifies these features by exemplifying built works that represent design considerations on scale and proportion, materials' finish, textual expressions, and how concepts per se empower or forbid certain sensations in the space. Through detailed analysis of rhythmic compositions of elements like windows, vaults, or columns, he discusses their affecting sensation of stability or motion, and how they define the architectural presence of a built form. His studies open up for discussions on how

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<sup>5</sup> Zumthor defines architectural quality as the ability of architecture to move its spectator. He lists three points to define this moment: [1] when architecture becomes part of people's lives, [2] when it creates a coherent whole by interrelations of its individual parts, and [3] when beside these it also creates a beautiful form [36].

architectural designs can be heard, seen, and felt through interacting with an inhabitant or spectator [26].

Architecture then turns into a synthesizing system in and through which the envelope becomes the curator of a desired character and identity, created by its milieu and inhabitants. This is the domain of envelope's performance within which this research positions itself. As such, the envelope develops an integrated network in which the way the building works is dependent on complex interrelations and correlations of design provisions. How the building works includes both the operative and functional aspects of architecture, in addition to its atmospheric characteristics and effects.

This research seeks to redefine the notion of envelopes in architecture through the chosen methodological approach. This attempt is closely related to both passive and active agencies of envelope design to present an integrated system within which various actors and actants work as a unified whole to expound the built form. Actor Network Theory defines actors as participants that modify a state within a system by performing an action, while actants are the participants in a course of action that are waiting to be given a figuration [12]. Therefore, both actors and actants need to be integrated within a system for the action to occur. To put this in the context of architectural character and experience, one could say that experiencing architecture not only requires the human being, i.e. the one through whom we define it, but also the non-human constructs that actively participate in shaping the process of perception and experience. Non-human constructs include architectural elements and their tectonics, as well as the surrounding natural environment. Active agents, in this investigation, are defined as actors who directly affect and modify a state through physical operations, while passive agents are defined by material properties and design strategies, such as the thermal capacity of materials, or spatial organization.

The investigation does not strive to explore optimization and efficiency in the envelope design process. Instead, it aims to pursue an approach, leading to an effective design model that function as a guideline for approaching envelope designs. Optimization either limits the design to the manipulation of elements predetermined by the imperatives of production, or results in superficial masking and compensatory façades [4]. Revisiting envelope designs with effectiveness, however, directs the design process into an exploratory mode, in which provisions of use can be utilized for unplanned conditions. Unplanned conditions curate spatial flexibilities that are unveiled through inhabitation and latent use of space. In the scope of this research, effectiveness, includes design considerations and strategies that address both functional and atmospheric conditions by enabling ranges of adjustments and adaptation patterns. Flexible patterns of use and climatic conditions as such enable the design with latent possibilities that emerge in the course of the building's life. The investigation's developed approach pursues envelope concepts, taxonomy, and design experiments within a mixed method mode of inquiry consisting of quantitative and qualitative studies. Design experiments follow an iterative logic and include digital simulation, evaluation, and data collection that support an informed mode of exploration and feedback. The simulation and analysis benefit from the implementation of the informed non-standard approach through which context-specific and real-time datasets are integrated to inform the computational design process [31]. An example of these datasets is climatic measurements, collected through sensor-based electronic setups that directly stream the data to digital models and provide real-time feedbacks. The application of this method equips the design process with an informed mode of reflective thinking, decision-making, and real-time design modifications.

### **3 Research Objectives**

The design process for envelopes can be presented as a systematic approach, addressing inhabitation patterns, atmospheric effects, climatic and spatial context, and material elements of architecture within an integrated system. This research seeks to find ways on how the envelopes' design process can be approached to result in nuanced architecture and environmental interactions through the envelope's overall scheme, by which the performative aspects of the built form can also be defined. This includes questions on how to design envelopes as inhabitable spaces with a flexible construct that provide heterogeneous spaces for adapting the use of space to individual preferences. It is therefore relevant to pursue the design of envelopes as an early step in an integrated design process that includes a strong focus on environmental and experiential aspects of envelopes.

The investigation aims to initiate a design approach, both conceptually and methodologically, in which the synchronization of specific environmental inputs and ranges of flexibility within the envelope design creates and defines the extents of spatial experience and performance. The approach investigates various concepts, design strategies, and scenarios to find the most effective patterns (regarding the design's intended performance) within a flexible design through close interrelations of both human and non-human agencies. The investigation aims to provide a guideline for the envelope design process by which envelopes' various performance and design aspects can be adequately addressed, assessed, measured, and actuated. The research thus bases its objective on existing knowledge while developing its distinct approach to envelope design to pursue it further by redefining this notion through a systematic evaluation and analysis.

### **4 Methodology and Design Studies**

The investigation is organized into four thematic sections: [a] discussion of selected conceptual approaches to the notion of envelopes based on a literature study; [b] a proposed taxonomy of envelope types based on an analysis of built and unbuilt projects by various architects; [c] research-by-design inquiry by way of designing performative envelopes, addressing both qualitative and quantitative aspects within the performance foci; and [d] formulation of a resulting position, including a synthesized conceptual and methodological approach for the purpose of further inquiry and development.

The first two themes initiate the theoretical basis of the investigation by creating operative tools within which the research-by-design inquiry explores and evaluates the actualization of various design scenarios for performative envelopes. Assessing and operating the experiments within this approach allows for an iterative process that can both meet the aims and challenge the hypotheses of each design research. The cross-connections and overlaps between various themes and concepts provide the possibilities of choosing, juxtaposing, or integrating them with one another. This in turn empowers the design process to achieve the targeted performance foci. These progressive tools substantiate the experimental projects' framework by providing validated, operating concepts as initiatives of the design. Therefore, the method equips the research by generating a precise definition of the approaches to the project, as well as by building its arguments on a grounded premise. Another advantage of the method is that it enables the examination of different approaches that can potentially create an ingrained mode of practice in which the

synergy of various approaches form the initial design parameters. Criticism of operating through and within the mentioned approach is the subjective observation and reflection, which is derived from a specific point of view and unchallenged by alternative possibilities. While this argument is valid and concerns a relevant deficiency of the method, the advantage of research-by-design mode of practice enables the “reflecting on and in action” [29] that allows for effective development and exploration of the investigation in other aspects. The design process can start from sets of principles or established disciplines that can be altered or revised upon further elaboration of the design in an iterative process to meet the aims of the project and its contextual demands of locality. According to Schön, the process of reflection-in-action is an effective design process in which the designer chooses strategies for action or models of phenomena implicitly, through reflection-in-action on the construction of the problem. He elaborates on how the designer’s domains of language are affected by the decisions within the process, or how reflecting on and in action during the design process provides systems of implications that constitute a discipline or break an initially established one. This stimulates shifts in the designer’s stance and, therefore, the whole design process makes the thought-experiment manageable [29].

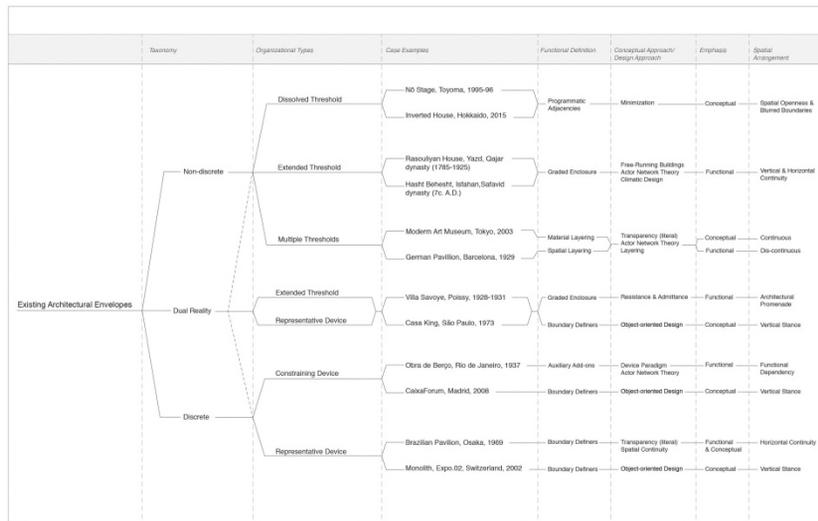


Figure 2 Phylogenetic tree of the existing envelopes' taxonomy, produced by Sareh Saecidi, spring 2016 (progressive document)

The research’s envelope taxonomy functions not only as a reflective map of the prevailing approaches to envelopes within architecture, but also as a guide to envelope types that are used by design investigations for facilitating the re-examination of design scenarios. This progressive document, while providing a good understanding of the current shortcomings and strengths of the envelope designs, constitutes one of the main tools that will be developed further during the author’s research. Figure 2 represents the envelope’s taxonomy, produced by the author as part of this investigation.

This document, based on how the built form relates to its exterior surrounding, classifies three types of envelopes: discrete; non-discrete; and envelopes with a dual reality. Discrete envelopes refer to the object-focus of the built form, as explained earlier in the text, and the iconic stance of architecture. Non-

discrete envelopes identifies built forms that are embedded in their surrounding contexts in such a way that the separation from their surroundings disrupts their architectural means and functions. Envelopes with a dual reality represent built forms that are more open to subjective interpretations and possess characteristics of both mentioned types, with different magnitudes. This taxonomy uses built case examples for each type to clarify each category by the author's reflections on properties, architectonics, and conceptual emphasis of these buildings.

An iterative research-by-design inquiry provides a framework in which the investigation can develop its theoretical basis through a design-based experiment, benefiting from causality [33] within both digitally and physically simulated environments. As such, the researcher can establish a cause-effect relationship throughout the experimental research design process by various features such as outcome measures, unit of assignment, and control or comparison groups [7]. This ascertains the relevance of the designs' hypotheses by examining the experiments in two ways: by testing designs through digital simulation and data analysis of parametric models, in which the iterative process of design provides immediate, real-time feedbacks, and by qualitative analysis of physically collected data and measurements that can be used either as data streams for the digital simulations, or as observational feedback to reflect upon. The application of this methodology benefits the design process by enabling iterations to extract the working ideas and actuate design hypotheses through systematic experiments and database analyses. The approach illustrates how theory and practice can be systematically integrated to form an active, informed design process.

Within this framework, two workshops were conducted as an integral part of the research of the author, which is entitled: 'Inhabiting the Architectural Envelopes: A Design-based Approach for Performative Envelopes', to assess the methodological approach of the investigation. The workshops were organized at the Advanced Computational Design Laboratory (ACDL) studio at the Oslo School of Architecture and Design (AHO). Within both workshops, the designs aim at establishing a strong relation between the built form and its milieu by integrating various performance foci and defining active and passive agencies within the design concepts. The objective of the first workshop, entitled "Performative Envelopes", was to design envelope systems that approach the notion of performance for creating heterogeneous spaces through multiple building envelopes in which the outermost layer was supposed to be a membrane structure. The envelope design was expected to offer ranges of the enclosure and environmental modulation for different kinds of activities related to the building programmes. The second workshop, entitled "Interactive Envelopes", aimed at emphasizing the position of the envelope as a spatial zone ascribed with human or non-human agency. The envelope system was expected to utilize light in accordance with the programmes in the building, and include provisions for ranges of adaptation in relation to the programme.

In both workshops, a few conceptual approaches were addressed by all projects. These shared concepts establish a common ground, and a framework for the performance foci, including the themes milieu, climatic considerations, and agency.<sup>6</sup> The topics have been approached in various ways within the workshops by each envelope design specifications. In the workshops, students were asked to initially

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<sup>6</sup> The concepts will be discussed further in the following pages.

approach their envelope designs by choosing Multiple Envelopes as their envelope typology. Multiple envelopes represent layers of envelopes that are arranged and positioned concerning one another to fulfil different demands of the built environment, from providing enclosure and achieving spatial effects to acting as insulation. This approach provides a convenient flexibility for designing and examining different materials and spatial compositions by creating in-between spaces. The interstitial spaces can inherently equip the designs with distinct spatial qualities and programme distribution. Therefore, the choice of multiple envelopes initially provides the design with enough flexibility for testing different design concepts, while allowing the design to switch between other alternative taxonomies upon further design requirements. These interstitial spaces also addressed the climatic design and free-running building approaches in individual projects.

To establish a strong connection between the interior and exterior, the building must respond to and address its milieu through various design concepts and approaches. These include focuses on different performative aspects of architectural experience and consciousness, human and non-human agencies, and climatic design considerations. The chosen literature studies of this investigation were therefore directly derived from these performance foci to demonstrate possible approaches to developing the abovementioned relationship through the envelope's threshold. These themes resulted in a list of conceptual and design approaches. This list was then narrowed down into shorter divergent or collective lists to correspond to the workshops' frameworks and individual projects' aims. Each workshop's selected conceptual approaches are implemented through projects' aims, and are then evaluated and assessed throughout the process. The mapped conceptual approaches are applied in design experiments along with the research classification on taxonomy and types of envelopes to create the necessary coherence for the design studies and experiments. Figure 3 illustrates the workshops' design methodology and the interrelations and dependencies of its various components.

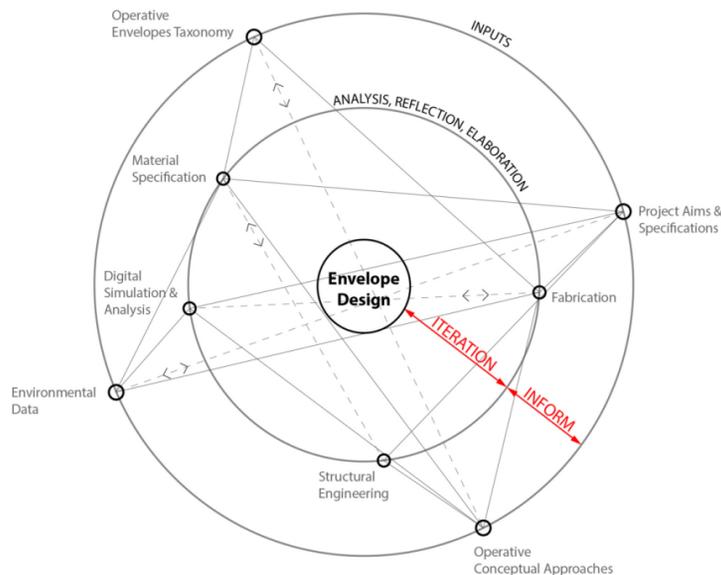


Figure 3 Envelope Design Methodology, produced by Sareh Saeidi, spring 2016

The primary focus of the investigation within the framework of the workshops was to distinguish key conceptual approaches according to each workshop’s focus. Therefore, apart from the main design criteria in the workshops, several concepts were chosen to test how consistent ideas and themes can be implemented and addressed as different designs’ strategies. The selected concepts were: spatial organization, permeability, spatial continuity, proximity, dynamic environments, particlization, and transparency.<sup>7</sup> Figure 4 illustrates the chosen concepts and design approaches of the literature studies, and how they have been approached by the workshops’ design projects.

The selected concepts are focused on the three themes agency, climatic design, and architectural experience that define the research’s notion of performance. These concepts were approached in various ways by different projects within the workshops. Some concepts were addressed in almost all projects; others were shared in some but approached at different levels; and other concepts were considered and applied only in individual projects. The choice of application was highly dependent on each envelope design system’s aims and specific configurations to intensify the relationship between the project and its local conditions.

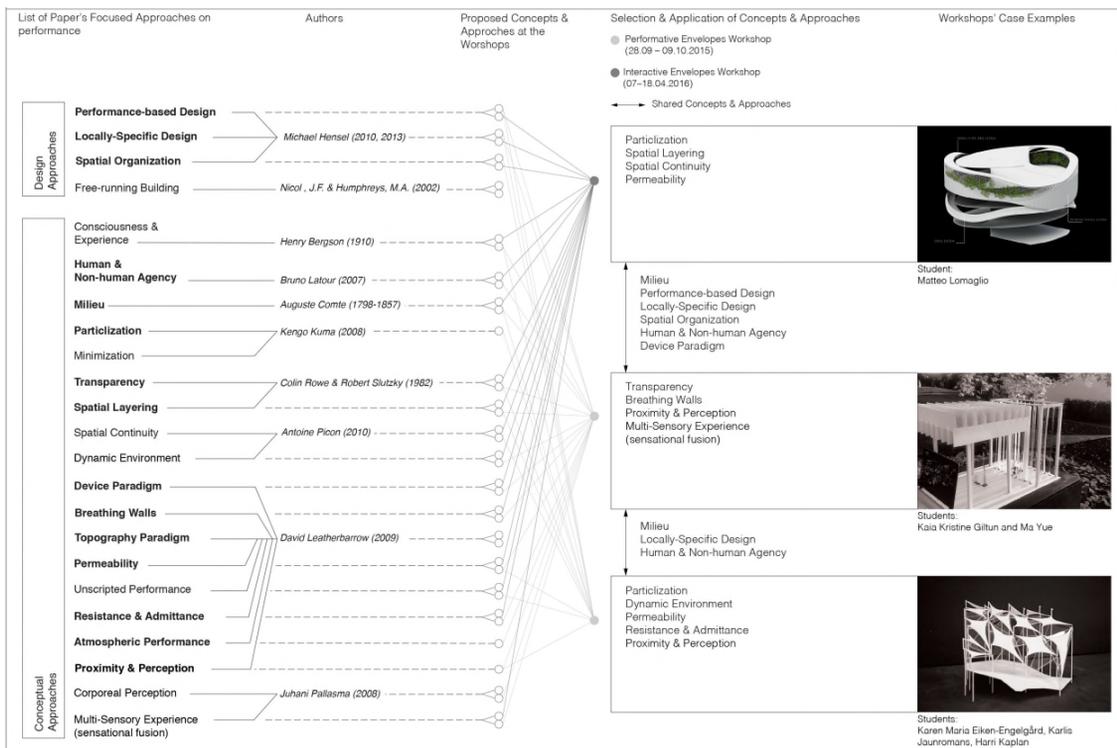


Figure 4 List of Envelopes Conceptual Approaches, collected through the research’s literature studies, and applied in the workshops conducted by Sareh Saeidi at Advanced Computational Design Laboratory (ACDL). The Oslo School of Architecture and Design (AHO) respectively in fall 2015 and spring 2016. The illustration is produced by Sareh Saeidi, fall 2015

<sup>7</sup> These concepts will be discussed further later in this article.

Nevertheless, in both workshops, the most significant conceptual focus in creating a strong relationship between the interior and exterior was designing with daylight through the permeability of envelopes. This discussion led to concepts such as breathing walls [13] and particlization [11] that utilize strategies of surface treatment to determine degrees of air and light penetration along with desired spatial qualities. All projects within the workshops address structure, scaling, spacing and proximity as design considerations and input for coordinating the relationship between the interior and exterior. Nevertheless, the main leading concepts addressed were milieu and topography paradigm.

One of the main objectives of a built work is to generate a new identity, not only for the site at which it is located, but also for its surrounding context. In creating this character, the built form must relate to, and establish a strong relationship with its surrounding environment or milieu. The French term milieu was extended by Auguste Comte (1798-1857) to address not only the physical environment that surrounds an organism, but also the external conditions required for its existence [32]. It should be noted that in this paper, the notion of milieu does not refer to the sole causality through which an organism is shaped and affected by its milieu, but rather, the “relationship and coexistence between the two” [34]. Through design, the built form allows its milieu to exist not only outside, but also within it. Thus, the building discovers and adds to the existing conditions through its design configurations, and in doing so creates productive architecture [13]. In the Breathing Walls chapter of his book “Architecture Oriented Otherwise”, David Leatherbarrow defines productivity as the performances through which the building operates in a more particular way. He refers to productivity as the alteration and adjustment of the phenomena, which milieu provides the built form with, and which is not necessarily sufficient. Or as Leatherbarrow said; it is the adjunctive or adjectival modification of what the built form inherits from its surrounding environment [13]. A tangible example of a productive façade element is Mashrabiya, or Islamic sunscreens, that in addition to equipping the built forms with means to minimize the effects of the intense sunlight and reduce heat through radiation, they also provide fresh air and privacy.

Another aspect that was part of these common design strategies is the notion of orientation and topography.<sup>8</sup> David Leatherbarrow refers to the milieu in which architectural performance unfolds as topography, indicating both the built and the unbuilt. He elaborates this notion by how performance-oriented design approach should exclude strategies that are built on device paradigm, and rather include strategies that entail a topography paradigm. The topography paradigm is what he defines as the capacity of architecture in responding to ambient conditions through its force-counterforce relationships that result in ranges of alteration in the building’s physical body [13]. Device paradigm includes designs that are dependent on either manual, electrical, or mechanical systems to perform an action initiated by human or environmental prompts. In these designs, the ranges of positions and movements of the movable mechanisms script the device performance [14]. In the workshops, although students were exposed to both approaches, the design experiments results relate closely to the device paradigm approach.

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<sup>8</sup> For further reading on Topography, refer to references on Leatherbarrow’s 2000, 2010, and 2015, cited in this article’s bibliography.

#### **4.1 Performative Envelopes Workshop**

The workshop was conducted from 5<sup>th</sup> to 15<sup>th</sup> October 2015 and aimed at formulating a coherent definition of the performative aspects of envelopes in each team's projects. The design process started by developing concepts and approaches that address spatial performance of the research's mappings with the focus of establishing a strong relationship between the interior and exterior. This stage included considerations on the context, project, and material specifications. The development of design concepts consisted of various stages – such as explorations of material properties, fabrication process findings, structural engineering, and digital simulation and analysis – that are tightly interwoven and form a synergetic system. The results and outputs within each stage and their interrelations informed the further modifications and adjustments during the design processes to achieve a specific performance within envelope systems. In the Performative Envelopes workshop, the joint necessity and integration of different conceptual approaches within the context of a design project seemed crucial for forming an effective system.

The designs were examined in an iterative process by working with multiple design criteria tightly framed by specific performance foci and feedbacks from physical and digital models. The teams formulated their conceptual approaches, such as proximity and distancing, as operative criteria to develop performative aspects of light; either atmospheric or functional. The achieved qualities, and their modifications during the process were addressed differently by moving between and testing various concepts attuned with spatial and material organizations. The designs used a systematic organization of envelopes' architectural elements in relation to the surrounding environmental factors that were directly affecting and supervising the design. The concepts of envelope organization were examined within an iterative design process of evaluation and reflection in and on action. The benefits of this design approach are: the design parameters are easily controlled and adjusted to test various conditions and inquiries, each test's variables are inert during the test process and therefore remain consistent and allow accurate measurements, the outcomes are explicit and therefore enable the research for further possible iterations, precise demonstration, and documentation.

The theme of the RCAT/ACDL studio in the fall semester 2015 was “Performative Envelopes - Rethinking Architecture from its Boundaries”, and comprised the task of designing a pavilion with two different uses and locations. In the first location, the project was to serve as a pavilion for the Oslo Architectural Triennial 2016 in a central location in Oslo. Subsequently, the project was to be relocated to an island in the Oslo Fjord with a large waste landfill area, where it would serve as a small environmental research laboratory. The project consisted of approximately 100 m<sup>2</sup> of fully enclosed spaces and 50-100 m<sup>2</sup> of transitional spaces. The different zones of the pavilion, including enclosed and open spaces and dark and light areas were to be articulated by the building envelopes that organize the space. Environmental modulation was supposed to be following the specific activities housed by the project, which was fully aligned with a free-running building design approach. The inhabitants' relation to the park as the pavilion's surrounding environment revealed interesting perspectives on drawing new relationships between the built form and its surrounding environment both conceptually and climatically. These had been considered in the process – not only from the initial design configurations, but also as an emerging quality enriched by the design process itself. The students were asked to choose either the

overall envelope system, or a selected room of the pavilion to develop further during the weeklong workshop. The following paragraphs present and reflect on two selected projects from this workshop to expand on how each design team applied and developed their chosen design concepts methodologically through their design process.

Team one<sup>9</sup> chose one room of their pavilion design for which to develop a performative envelope system. The pavilion itself followed a programmatic layout, designed as a journey through the project. It emphasized the way in which the visitor moves in sequence through different rooms and encounters various degrees of enclosure and spatial qualities that correlate with each room's intended programme. The portion selected for the design project is a workshop and reading space area, intended to provide the brightest zone within the project, that includes reading screens, workshop tables, and sitting areas. The envelope layers are positioned in such a manner that they correspond to the programmatic needs of different zones of the room. For instance, the screened reading zone is surrounded by translucent glass to prevent glare and the reflection of light. The distance between the arrays of glass louvers results in a multiple envelope system as a layered space in which the aesthetic and functional properties of the in-between spaces are varied. The relation between static and kinetic louvers generates these varied conditions and specifies different functional zones in the space. The configuration of the louvers' position, mobility, and degree of transparency creates a vivid, atmospheric effect in which the designed daylight is the driver of the mood in the space.

The pavilion provides nuanced and changing light modulation and embraces an existing tree as part of its multiple envelopes. The primary structure defines the roof of the room, while the secondary structure forms the enclosing walls. The combination of the diffracted softened light that penetrates from the ceiling and the transparent glass louvers of the multi-layered walls gives the room a sense of layered, regulated visibility that is affected by the seasonal change and degrees of enclosure. The arrangement, distancing, and depth of the roof's louvers provide direct ventilation and an ambient light condition in the room. The students chose David Leatherbarrow's notion of breathing walls to define the performative aspects of their envelope design. Breathing walls as a concept articulates how architectural elements can simultaneously operate in three different ways: technically, practically, and symbolically [13]. The louvers abstractly represent Oslo Triennial 2016's theme, "After Belonging", by challenging the inhabitants' presence through a spatial boundary between inside and outside that results from the layered louvers' transparency variations. On an abstract level, this is a metaphoric interpretation of participation in society. The pavilion thus attempts to create a space in which the condition of space adjusts to the presence and needs of its inhabitants. The composition practically structures the events and arrangements in the room through modulating light and wind by the louvers' interactions. This aspect includes in itself technical needs of the emerging space in which the notion of device Paradigm [13] is actuated by what the louvers do. This includes movable elements and scripted operational behaviours of architectural elements. On the operative basis, the concept of the device paradigm provides active engagement of the inhabitant by the labour of sensors and mechanical apparatuses. This envelope setup creates the means for the conceptual approach of the project while emphasizing the role of envelope's permeability in creating spatial relations and climatic variations.

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<sup>9</sup> The students in team one were Kaia Kristine Giltun and Ma Yue.

The first array of sensor-based louvers, which constitutes the outermost layer of the envelope, is made of single-sided mirrored glass plates that provide different light exposures within the pavilion in conjunction with the second layer of louvers. They are therefore scripted to adjust mechanically according to the direction of the sunlight during the day within the rooms. The inner louvers enclosing the room are constructed in smart glass with various degrees of transparency. They interact with the presence of the visitors, according to their proximity, by changing their levels of transparency. The spatial qualities experienced by the visitors through the changes of visibility and the light's intensity create a unique character for the room. The spacing between the louvers is sufficient for the visitors to cross the thresholds when they are fully open – a state in which the border between inside and outside is dissolved. The spacing of the arrayed louver layers provides the design with interstitial spaces and in-between climatic conditions dependent on their distance and orientation. The spacing and degrees of translucency of the louvers were determined experimentally throughout the iterative process of data-driven design and physical data analysis (Figure 5).

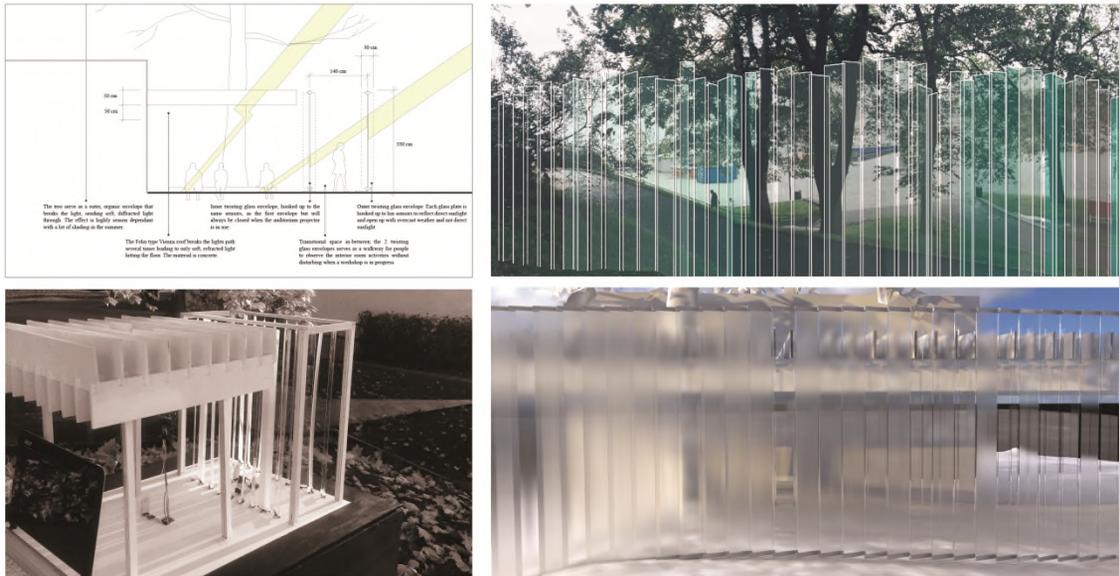


Figure 5 Team One's Envelope Design Documentations. Performative Envelopes Workshop, conducted by Sareh Saedi, Advanced Computational Design Laboratory (ACDL) studio, The Oslo School of Architecture and Design (AHO), fall 2015. The students in team one: Kaia Kristine Giltun and Ma Yue

As flexible design elements, louvers could easily be rearranged and modified. They have the potential to be explored further through their formal arrangement and orientation to fine-tune the design intentions and local specifications of the project. For instance, the formal expression of the project could be further elaborated and assessed by a geometrical expression that could potentially provide pockets of distinguishable climatic zones for the project. Aspects such as these seem to be an area where the project falls short of addressing and developing further. Figure 6 illustrates the findings of physical and digital analysis of the conducted tests on the envelope's design system.

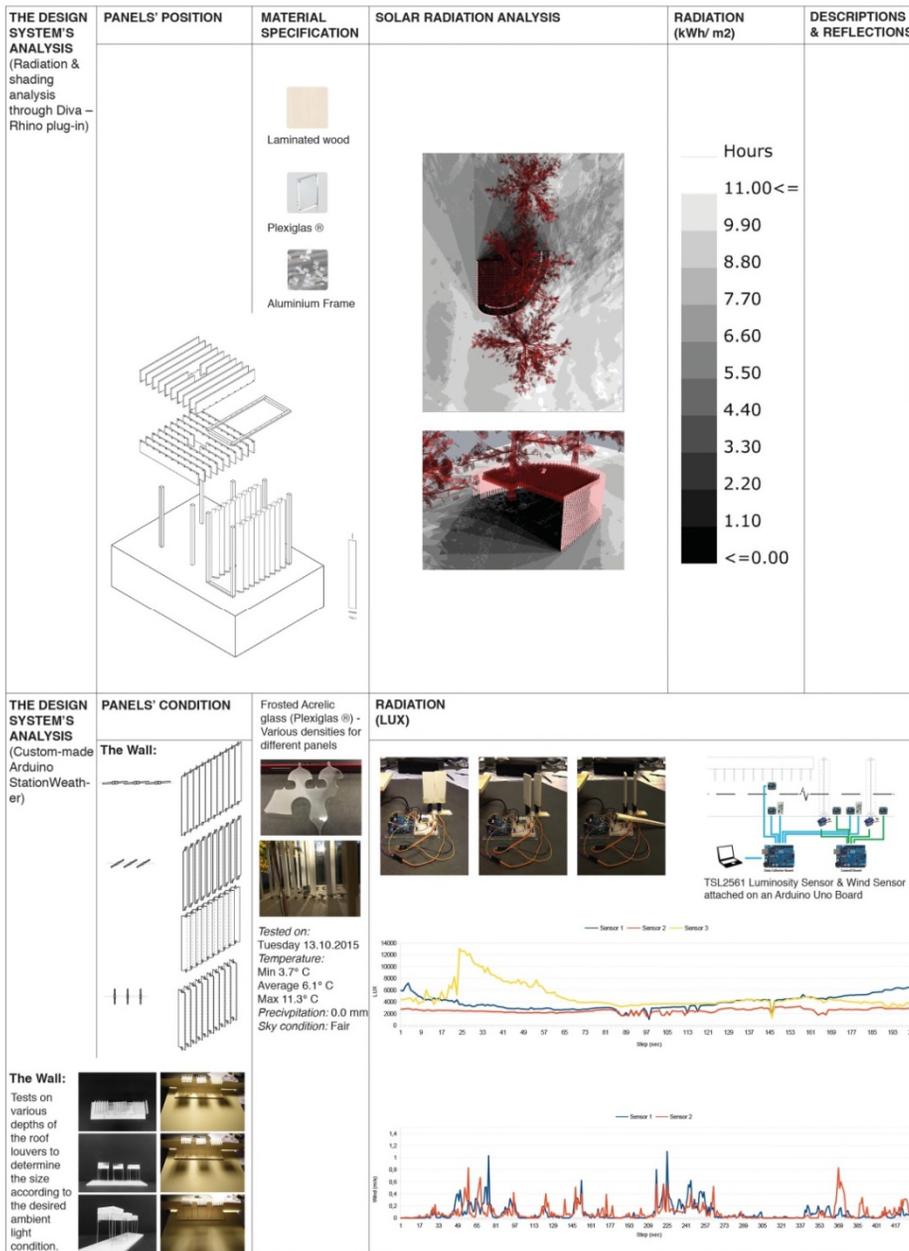


Figure 6 Team One's Envelope's Design System Simulation and Light Analysis. Performative Envelopes Workshop, conducted by Sareh Saeidi, Advanced Computational Design Laboratory (ACDL) studio, The Oslo School of Architecture and Design (AHO), fall 2015. The students in team one: Kaia Kristine Giltun and Ma Yue

On a conceptual level, the project addresses transparency as its main design characteristic. The ambient presence of the pavilion, its formal expression through the mirrored glass, and reflections of light in defining levels of transparency are characteristics that define the pavilion's presence. Transparency as a conceptual design approach was also considered in other design projects of the workshop. However, the approach of this project to transparency in comparison to the other projects in the workshop is significant and different due to the design's considerations of the participation and presence of the inhabitants experiencing the envelope. The setup defines a boundary of change that not only reacts to its surrounding environment, but also to its inhabitants. By creating various layers of envelope, transparency turns into a phenomenon of gradual literacy of space. Once one is outside, in-between, or inside the envelope setup, depending on the light conditions and distance, the perception of the space and layers of envelopes differ. Transparency as a conceptual approach has therefore been used to define various degrees of privacy, light regulation, and spatial mood. It affects, and to some extent controls, the inhabitant's spatial perception and experience, in addition to its environmental regulations for providing a semi-sheltered space.

Team two<sup>10</sup> approached the pavilion design as a continuous space and therefore developed an overall design for its multiple envelopes system. The design of this pavilion was developed through an experiment-based, reflective thinking process of testing ideas substantiated early in the process by immediate feedback through digital and physical scaled model studies. The pavilion design is shaped through two elevated membrane systems with a series of columns as the supporting structure. The pavilion standing on the site resembles a dense forest covered in snow, like an early morning fog that lingers among the trees before it is dissipated by the heat of the sun.

The membrane systems articulate the floor of the pavilion, which is formed by a reinforced membrane system, and the roof structure consists of a grid of both adjustable and static membrane patches. The organization of these membrane systems and the structure's elevated floor provide it with various degrees of spatial privacy. The ground level space is a sheltered, yet public area that is open to passersby. The room above is a semi-public, semi-closed space for the exhibitions with a grid-based roof structure that provides it with ambient light throughout the day.

At the ground level, the passersby experience walking among the series of thin columns within a continuous landscape at the horizon, and in the distance, seeing the city's active life framed by the columns and experienced by the limits of the pavilion's scales. Besides providing a preliminary space for the exhibition entrance, this level also serves as a public passage. Nevertheless, it potentially engages and arouses the curiosity of passersby due to the membrane's properties and effects that enable them to see the shades and hear the ongoing events in the exhibition level above. The entrance to the exhibition is almost at the centre of the pavilion at this level. Conceptually, the pavilion tries to create a structural impression that resembles a continuum of the trees of the park. The columns are laid out as a base grid to support and define different layers of envelopes and interstitial spaces. This grid also provides the possibility of creating new enclosed spaces by wrapping series of columns with additional layers of textile. The white steel columns, the PTFE-coated glass fibre fabric, and frosted Plexiglas® shadings and enclosures give the pavilion an integrated unity.

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<sup>10</sup> The students in team two were Karen Maria Eiken-Engelgård, Karlis Jaunromans, Harri Kaplan.

By elevating the pavilion, the design activates the terrain of the project as an inhabitable space, and also has a minimal footprint. The considerations of distancing and proximity of the multiple envelope layers enable the design, establishing relations between the project's membranes and the terrain. These fluctuations, especially concerning raumplan structure of the pavilion, result in an intriguing spatial flow and disparity. One can discern raumplan as the established relationship of the main living areas (entrance hall, living hall, dining room, study) in a fixed scheme, in which, rooms are not primarily separated by walls, but by their situations at (slightly) different levels [18]. The openings in the membranes help the visitors to orient themselves continuously throughout their walk. The adjustable membrane roof modules enable ranges of enclosure, thus allowing for modifications of the intensity and airflow. Through this, the design provides time-based conditions that adjust to the various spatial and programmatic needs of the room. Nevertheless, this setup provides a semi-closed space and therefore opens up discussions on degrees of climatic control and insulation for various exhibition conditions. The designed system also provides potentials for the application of sensor-based mechanical systems that define degrees of enclosure and light penetration (Figure 7).

The team realized and tested arrays of a single patch logic within an assemblage and explored how scaling and distancing affect both collective and individual behaviours in its overall system. The tested physical and digital models and the light analysis informed the final choice of materials and degrees of roof patches' enclosure in correspondence to the zone and programme distribution of the pavilion. Figure 8 illustrates the analysis and results of the digital and physical studies of the project's envelope design system.

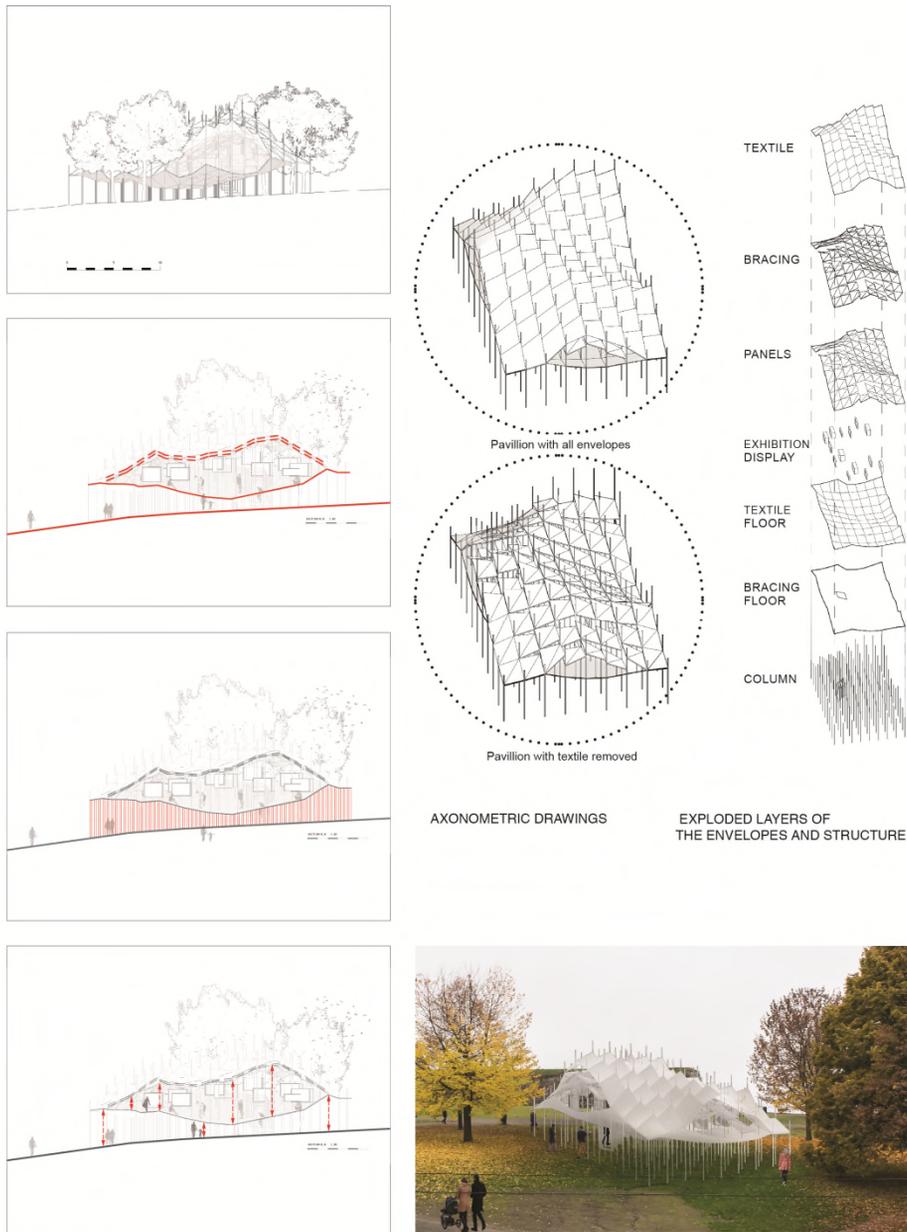


Figure 7 Team Two's Envelope Design Documentations. Performative Envelopes Workshop, conducted by Sareh Saeidi, Advanced Computational Design Laboratory (ACDL) studio, The Oslo School of Architecture and Design (AHO), fall 2015. The students in team two: Karen Maria Eiken-Engelgård, Karlis Jaunromans and Harri Kaplan

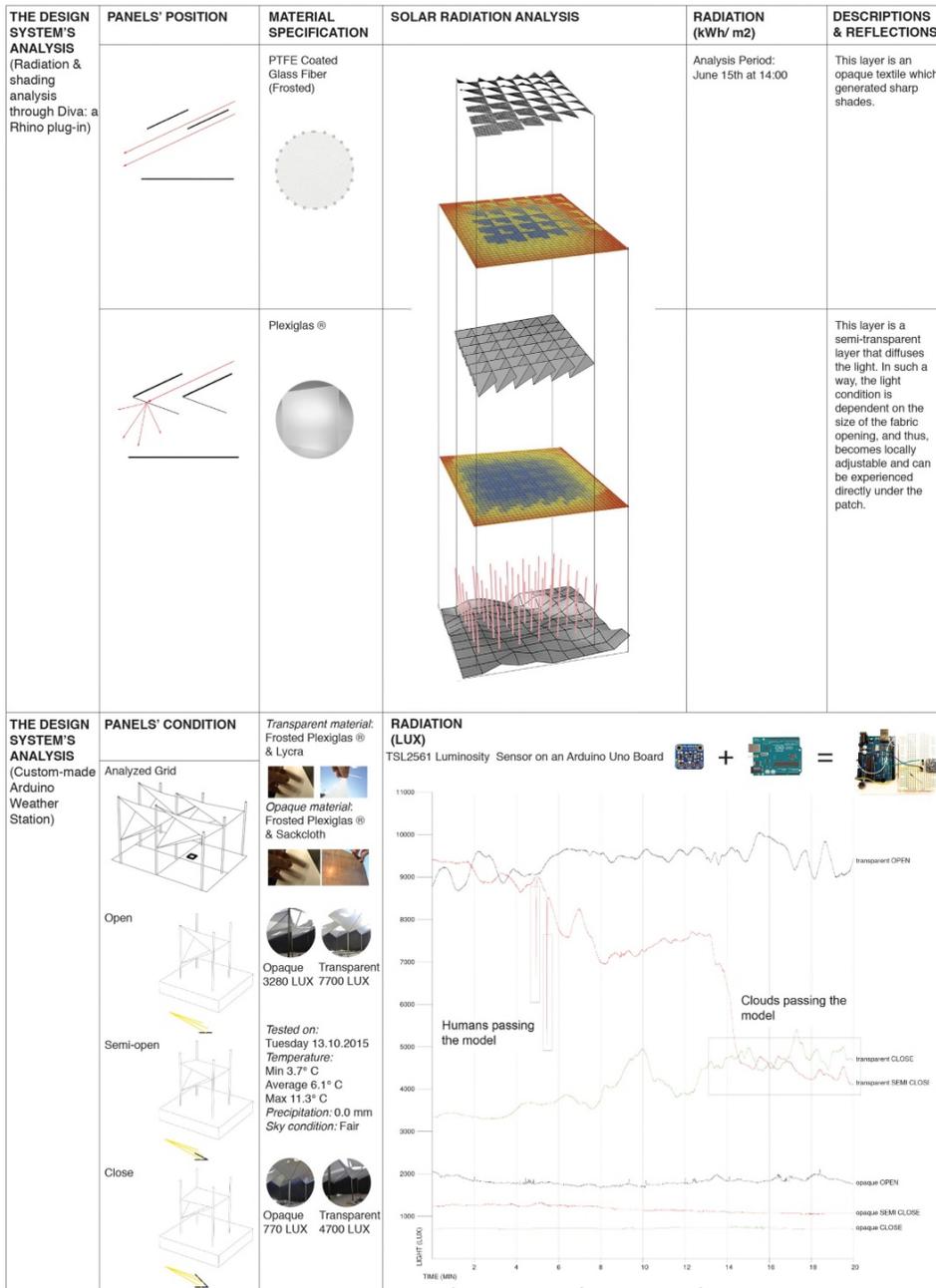


Figure 8 Team Two's Envelope's Design System Simulation and Light Analysis. Performative Envelopes Workshop, conducted by Sareh Saeidi, Advanced Computational Design Laboratory (ACDL) studio, The Oslo School of Architecture and Design (AHO), fall 2015. The students in team one: Karen Maria Eiken-Engelgård, Karlis Jaunromans and Harri Kaplan

## 4.2 Interactive Envelopes Workshop

The 24-hour Oslo studio brief asked for a multiple-use, 24-hour building of circa 400 m<sup>2</sup> that addresses the demographic changes of the population of Oslo. The project was to take into account and respond to adjacent actors, activities, and programmes, as well as those that are further afield but linked to the site. The Interactive Envelopes workshop aimed at developing the envelope designs of studio projects. The workshop proceeded with a week of design, parametric modelling, digital simulation and analysis, and building scaled models followed by two days of climatic data collection and analysis with custom-made Arduino weather stations. On a conceptual level, the workshop dealt with societal and cultural themes in relation to the visitors of the space and related issues of envelope design and its adaptation to changing programmatic requirements. On the technical level, focus was placed on how to reflect on and inform the design with the collected digital and analogue data.

All projects sought to address spatial and programmatic needs by emphasizing conceptual and environmental mediation to create productive buildings [13] and atmospheres through the envelope's design by way of providing an extended threshold between the interior and the exterior. In order to address non-discrete architecture, the students framed their designs within the concepts of: transparency [28], particlization [11], layering, and kinetic systems. The designs were expected to address the role of envelopes in creating heterogeneous spaces while providing the visitors authorship through modifying conditions of daylight in accordance to their spatial needs. The envelope systems thus provided interactive mechanisms with integrated sensor-based operations or physical interaction.

Defining interactivity through agency requires theories around the subject in which the correlations of various elements and concepts of architecture are engaged. For this reason, the conceptual approaches to the notion of envelopes within the workshop included environmental, programmatic, and material considerations. The selected design project<sup>11</sup> presented here focuses on creating an adaptive building programme that corresponds to the envelopes' reactions to light conditions and seasonal change, while defining the notion of public and private realms through its envelope's organization and enclosure. The project in question is located at Slottsparken, a public park surrounding the Royal Palace in the centre of Oslo. As the initial stage of the design process, the programmes and activities in the area were mapped to inform the approach to the 24-hour programming of the building. The site analysis included the site's accessibility, sports activities, modes of transportation, neighbouring touristic attractions, adjacent buildings' programmes and functions, and distances between the public hubs in the area. The juxtaposition of mapped data informed the choice of location for positioning the building and decision-making related to the programme's distribution. Through its organizational strategies, the project decisively arranges a graded transition both in terms of its degrees of enclosure and climatic control, and transitions from public to private realms. In this project, the common practice for – or rather, traditional way of – addressing private and public realms through the defined border of envelope is revisited and redefined. The envelope systems not only affect the interior space conditions in terms of climatic comfort, light modulation, and degree of privacy, but also its urban surroundings.

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<sup>11</sup> This project was designed and developed by Matteo Lomaglio during the spring semester 2016 at ACDL studio, the Oslo School of Architecture and Design.

The design consists of two continuous surfaces that form a spherical building. One of these continuous surfaces constitutes the core of the building and is surrounded by the other surface that supports the three envelope systems. The envelope systems consist of a metal mesh, a kinetic louver façade, and an open structure that surround the building's innermost, fully enclosed glass core. Each of these envelope systems provides different degrees of enclosure and various climatic, daylight conditions. The metal mesh creates a zone that houses vegetation, providing spaces with seasonal features and changing degrees of climatic conditions. The opening in the envelope creates a semi-sheltered space that is exposed to its surrounding environment, and mostly accommodates the public areas of the building. The kinetic louver system equips the spaces with adjustable degrees of enclosure and exposure. The degree of enclosure of these systems and their orientation were determined upon climatic analysis and environmental assessments of the project's analytical mappings. The envelope surface's porosity defines the daylight penetration and sunlight exposure of the enclosed spaces, along with the climatic conditioning of the in-between spaces they create. The inner and outer layers provide various spatial depths of interstitial spaces corresponding to the programme and spatial needs. Together, the building systems fulfil the varying needs of the 24-hour programme of the schemes in correspondence with the changes in its diurnal and season-specific conditions and milieu. The spherical envelope types often contain gradients of publicness within themselves, and as such, they go beyond defining only a border between private and public through the surface treatment. Being open to the public at its ground floor and oriented at this cross-connection, the project therefore engages the passersby by providing an opportunity for social interactions and coffee pauses, while fulfilling its 24-hour building programmes (Figure 9).

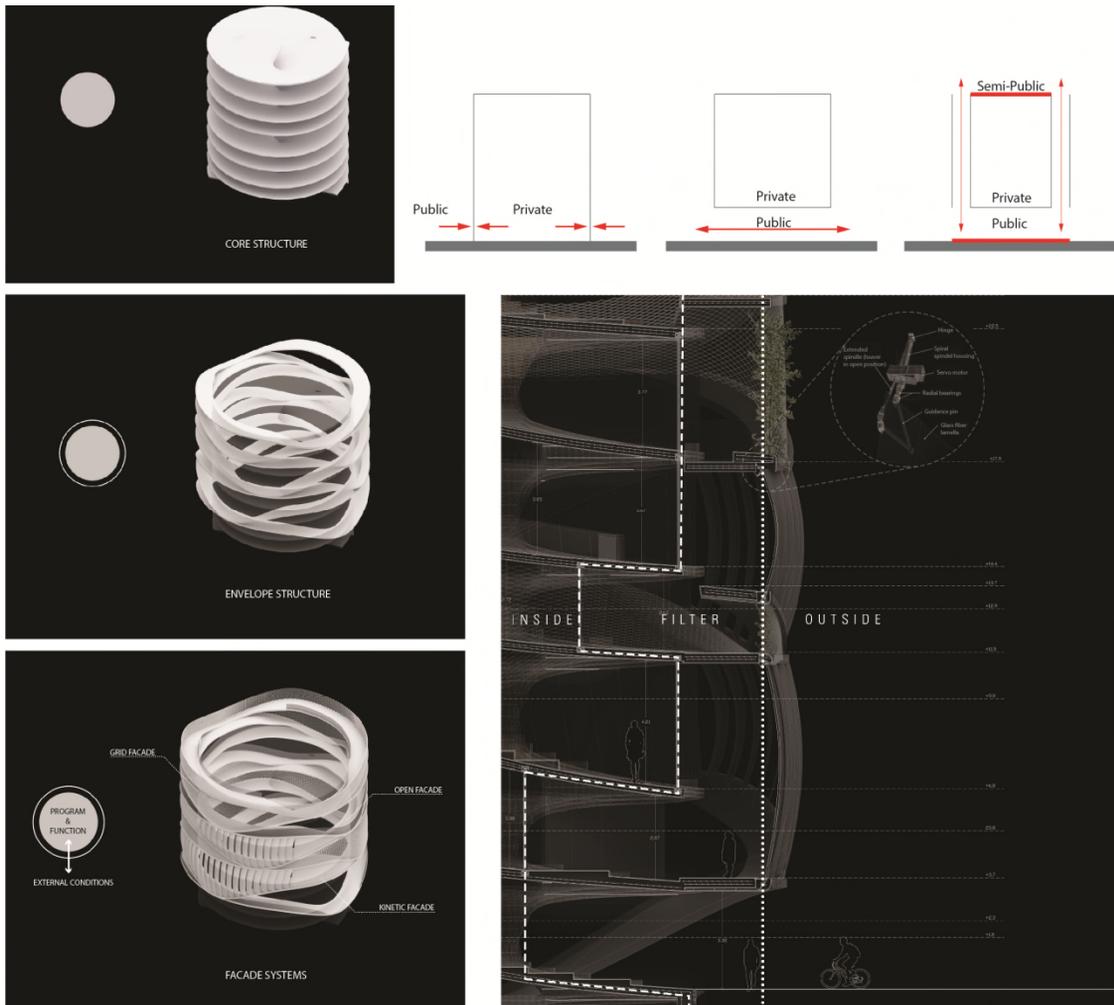


Figure 9 The Selected Envelope's Design Documentation of Interactive Envelopes Workshop, conducted by Sareh Saeidi, Advanced Computational Design Laboratory (ACDL), The Oslo School of Architecture and Design (AHO), spring 2016. This project was designed and developed by Matteo Lomaglio

The continuous ramp of the building, which is located at the outer ring of the project, provides an in-between space that allows public access to the roof garden through which the visitors can catch a glimpse of what's happening in the interior spaces as they pass by. The project thus consists of transitions between public and private spaces by addressing the ground floor as the public space, the roof garden as the semi-public space, connected by the continuous ramp that accommodates the envelope systems, and the private rooms in the core of the building. By defining a different degree of privacy through movement, the project creates a flexible zone, a new topography [13] that moves between the public and private zones by distancing from the innermost layer with full enclosure, or penetrating it and constituting new access points to the semi-private zones (Figure 10).



Figure 10 Rendered View of The Selected Project designed at Interactive Envelopes Workshop, conducted by Sareh Saeidi, Advanced Computational Design Laboratory (ACDL), The Oslo School of Architecture and Design (AHO), spring 2016. This project was designed and developed by Matteo Lomaglio

In his book “Anti-Object” Kengo Kuma exemplifies different conceptual approaches that he had developed for various projects. One of these approaches is particlization, which he describes as attempts to create similar effects as fine particles of reflected light on a water surface by breaking up the surfaces of the projects. Doing so, he believes, creates a distinct spatial effect, while maintaining the surface’s overall identity [11]. The mesh surfaces of the project create a constant spatial quality throughout different seasons while changing the density of the patterned light that penetrates through the plants during summer, or the exposed mesh surfaces during the cold seasons when there is no foliage. The kinetic envelope system uses a sensor-based setup that is mechanically controlled to provide modifiable ranges of openness in response to time-specific programmatic requirements. The setup allows the inhabitant to control light penetration and the degrees of spatial enclosure, in addition to its potentials of being mechanically programmed for a responsive sensor-based system. All three of the project’s envelope systems define conditions of interactivity within the interior by creating an active relationship between the inhabitant and the exterior conditions. The overall building design, therefore, creates heterogeneous spaces that are continuously varied in terms of their functional and atmospheric conditions. Figure 11 illustrates the digital structural and climatic analysis of the model, and physical model’s measurements on degrees of light penetration at various intervals and ranges of openness in the kinetic panel.

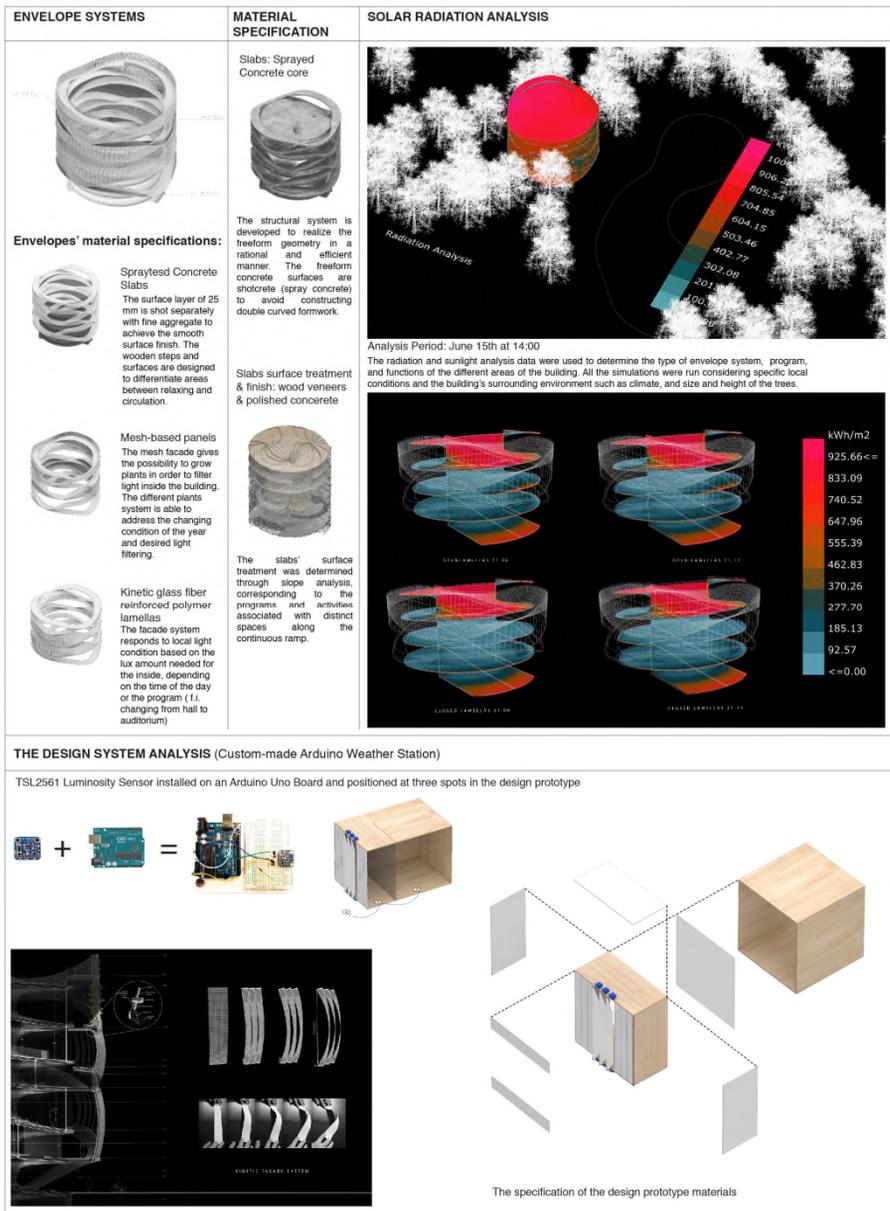


Figure 11 The Selected Envelope's Design System Simulation and Light Analysis, Interactive Envelopes Workshop conducted by Sareh Saedi, Advanced Computational Design Laboratory (ACDL), The Oslo School of Architecture and Design (AHO), spring 2016. This project was designed and developed by Matteo Lomaglio

The physical model of the design was evaluated by a custom-made Arduino measure station.

The design was based on an iterative process. The various design parameters and related analyses that were considered as criteria in this process included: [a] slope analysis and surface treatment of the slabs;

[b] height differentiation; [c] structural analysis; [d] bracing structure and its stress and displacement analysis; and [e] material definitions and programmatic layout in relation to these analyses. Figure 12 illustrates the correlation between the design parameters.

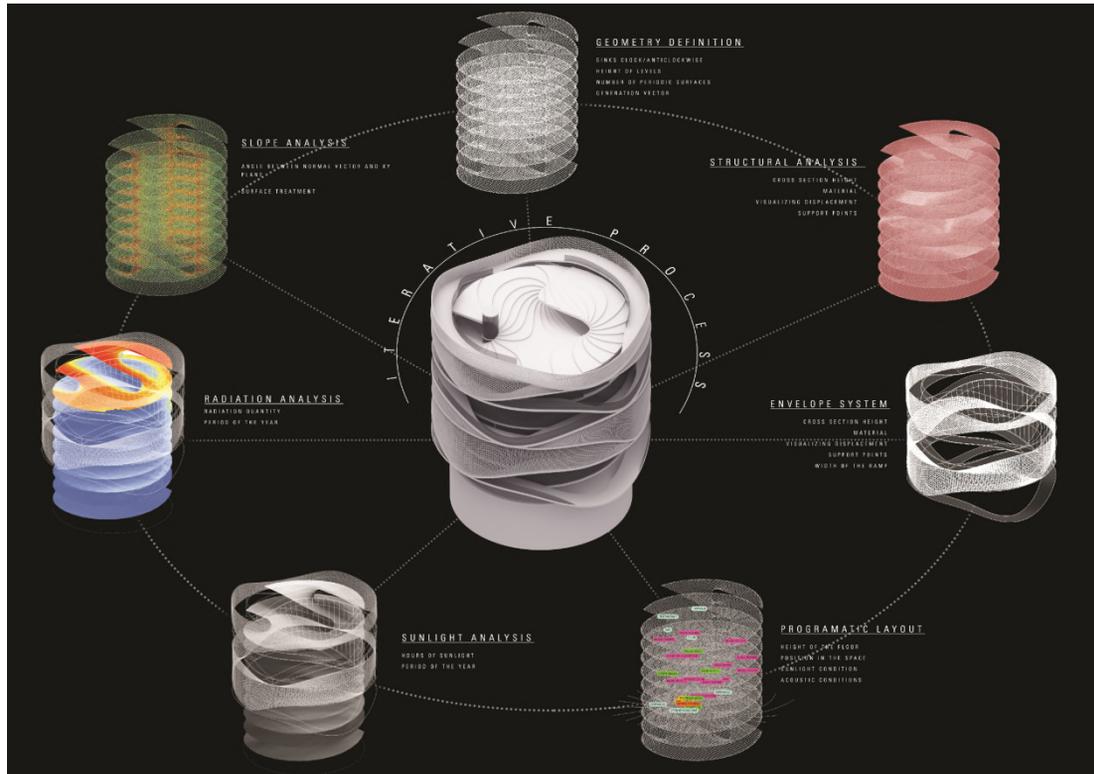


Figure 12 The Iterative Design Process and Analysis Diagram of The Selected Project designed at Interactive Envelopes Workshop, conducted by Sareh Saeidi, Advanced Computational Design Laboratory (ACDL), The Oslo School of Architecture and Design (AHO), spring 2016. This project was designed and developed by Matteo Lomaglio

The process included digital and analogue analyses to assess the design iteratively through direct feedback and modification.

## 5 Discussion and conclusion

The envelope of a building defines and conditions a given space. Interiority is created by a material boundary that defines the enclosure, either by abstracted and minimized constructs or by massive structures. The importance of the role of façades has been the focus of various discussions within the architectural discourse. These arguments can be classified into four thematic approaches: structural and static; expressive and representational; socio-political and economical; and environmental discussions and issues of sustainability. This investigation focuses on the lattermost theme to approach a redefinition of envelopes with the focus on local specificity in architectural design through specific performances and design concepts. The research tries to find ways through which envelopes are the author, or governing

threshold, of the strong relationship between built forms and their milieus. It therefore reveals the problem of today's architectural envelopes by elaborating on how the dominant approaches in current practices lead to objectification of architectures that are independent of their surrounding environments. It also shows how within this approach, the building's outermost layer is treated mostly as a materialized boundary. The aim of the investigation is to redefine the notion of the envelope as a spatial zone that creates heterogeneous in-between spaces. Heterogeneous spaces include and enable various types of inhabitation, climatic adjustability, and programmatic flexibility within a sheltered zone. The investigation therefore selectively utilizes some of the current focuses on performance in the architectural discipline to establish an operative approach to envelope designs. The performance's emphasis is constructed through the notions of agency, architectural atmospheres, and environmental conditioning.

The outcomes of two workshops conducted at the Advanced Computational Design Laboratory (ACDL) studio at the Oslo School of Architecture and Design (AHO) in the fall 2015 and the spring 2016 semesters helped the investigation to reflect, realize, and position its arguments on the applied methods and conceptual approaches. They included questions on how and what should be addressed and examined during the design process to arrive at a result that fulfils its objectives and can be described by its design approach and process. The workshops' design experiments highlighted the necessity of narrowing down the mappings of the research to work through a few conceptual approaches leading to non-discrete architecture by their envelope design. The experiments made it evident that approaching non-discrete architecture requires an acute emphasis on designing transitional spaces. They manifested that the constructs of an envelope, as a spatial zone, are dependent on the gradient and articulation of spaces in correspondence to its exterior and interior demands. The New Oxford American Dictionary defines 'transition' as: [a] the process or a period of changing from one state or condition to another, and [b] a passage in a piece of writing that smoothly connects two topics or sections to each other. It defines 'transitional' as: relating to or characteristic of a process or period of transition. Similar to the definition of transition in the literary works, a transitional space is one that connects two different spaces through a smooth gradient of change. This specific change is embedded in both atmospheric and climatic conditions that affect the architectural experience.

To correspond to the emphasis on transitional spaces, the research's selected concepts need to be focused according to their conceptual importance in facilitating concepts around designing transitional spaces. The conceptual approaches listed previously in this article include: spatial organization, permeability, spatial continuity, proximity, agency, dynamic environments, particlization, and transparency as the main concepts within the design experiments. Therefore, the concepts can be grouped into three categories. One of these consists of approaches that build the spatial notion of envelopes, and the second consists of concepts on its surface treatment and material organization. The third group includes post-inhabitation readings and provisions of design, taking into account notions of active agency mentioned earlier in this article. The first group incorporates spatial organization, layering, adjacency, and continuity, as design approaches that can be worked through at the initial stage of the design process to constitute the necessary spatial gradient and articulation of the envelope. The second group includes concepts such as particlization, transparency, and permeability. These concepts address design provisions for envelopes in creating heterogeneous interstitial spaces that, through locally specific design, affect the inhabitants' experience and perception of envelopes.

The research's methodology helped the delimitation of conceptual mapping towards framed concepts that could be easily applied and evaluated within the design process. In the experiments conducted, a need became evident for greater elaboration of defining ways to approaching flexibility and provisions of change in envelope designs. This includes questions and considerations on change and how it affects the experience of envelopes. Change, in the scope of this research, is the ability of the envelope design to meet and include the effects of its both interior and exterior surroundings in time and space. Time and seasons had a greater presence in historical traditions of architecture; one of the reasons for this is their close relation to climatic design considerations. The organization of materials and space can be utilized to engage closely, and demonstrate, the factor of time, seasons and climate to create specific spatial character and modes of inhabitation. It can provide possibilities for creating ranges of enclosure and shelter, resulting in different degrees of public-ness, climatic comfort, and programmatic flexibility. In addition, material and spatial organization of the envelopes can provide the design with post-inhabitation-provisions. Two examples of this can be named as spatial considerations that are mindful of vegetative growth or programmatic adaptation of the envelope's interior and exterior environments.

The paper seeks to introduce the research's approach to facilitating a discussion regarding the validity of the design approach, and to position the investigation within contemporary envelope design research in architectural practice. The application of analytical and iterative approaches based on design studies and the systemization of the existing knowledge provide the design with the instant feedback necessary for the reflective thinking and modification within an iterative process. Through the conducted experiments and methods, and upon their further development, the research seeks to establish an operative design approach that can be utilized within both architectural practice and academy. The mapped conceptual approaches initiate a guideline for envelope design that, along with the envelope taxonomy, establishes the notion of performative envelopes and their inhabitation capacities by designing in-between spaces. These semi-sheltered and in-between spaces provide greater chances of interaction between interior and exterior or private and public environments. On that account, the inhabitable building envelopes elevate the common design tendencies of surface treatments in architecture to a higher level that also engages discussions on social interactions and climatic designs. The research's guideline on how to provide spaces with various microclimates and multiple patterns of use through building envelopes' articulation, benefits the academy and practice by providing an adaptable systematic approach that can be evaluated upon application and modified based on various designs' specific inquiries.

The developed approach will be examined and investigated further through design experiments that are sharply focused around contemplations on ranges of inhabitants' experience and the process of change within the constructs of performative envelopes. It would therefore appear necessary for the studies to specify the effects of envelope's design on its adjacent environments through demonstrating various ways of inhabiting the envelope and experiencing it. This includes phenomenological aspects such as human consciousness, intentionality, and sensory fusions, in addition to defining the role of non-human agencies in affecting inhabitants' spatial perception and moods within a space.

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## **International Journal of Design Sciences and Technology**

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