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Daylight as Design Discourse: Representation Strategies in Contemporary Architecture

Keywords

Architectural Design
Architect's Website
Contemporary Houses
Daylight Representation
Grounded Theory

Abstract

This paper introduces a framework for a qualitative study of factors influencing daylight considerations in the architectural design process. Following the Grounded Theory method, a five-step analytical protocol was adopted to first elaborate an abstract diagram of daylight design factors. This diagram was subsequently employed to analyse the architectural representations of thirty houses designed during the first decade of the 21st century. Applying multiple correspondence analysis to the results led to the identification of five distinct groups. Exploring these groups' characteristics enabled the development of a representative model for the studied phenomena. The results reveal that daylight design was largely inspired by local daylight culture, the sites' luminous characteristics, and the opportunities offered by digital mediation. The findings also indicate that the early and mid-decade contexts were marked by a successive evolution in daylight representation. Finally, this research serves as a basis for future studies on daylight in architecture, thereby contributing to the expansion of the knowledge base on qualitative daylight factors in design research.

Introduction

Architecture is nowadays significantly influenced by the use of architects' websites as the primary mediator of architectural production (Paule and Pereira, 2021: 1). These websites typically curate a portfolio of architects' continuous and evolutionary design work (Pramono and Yuninda, 2022: 291; Brügger, 2008: 156). Consequently, the digital mediation of architectural production has introduced a transformative shift in the way contemporary architecture is thought, practiced, and documented (Joklova and Budreyko, 2019: 102). As such, architects' websites serve as a reliable resource for investigating contemporary architectural production (Susetyarto et al., 2023: 5).

The beginning of the 21st century witnessed a growing interest among architects in incorporating daylight throughout their design process (Jiang et al., 2022: 6; Sun et al., 2021: 293). Accordingly, the consideration of daylight has become one of the defining features of contemporary architectural practice (Reveyron, 2020: 201). Despite its importance, studies concerning daylight in architecture usually focus on quantitative indicators such as those associated with daylight metrics (e.g., daylight factor, daylight autonomy, useful daylight illuminance, and annual light exposure) or those based on spatial characteristics (e.g., orientation, window-to-wall ratio, and shading devices) (Jones, 2017: 17; Fang and Cho, 2019: 8). As a result, the existing analytical methods for the evaluation of qualitative daylight indicators in architecture remain notably limited and mostly devoid of a theoretical framework (Gojnik, 2018: 403).

Throughout the various steps of their design work, architects regularly employ diverse modes of representation to articulate their intentions (Ewenstein and Whyte, 2009: 8; Tufano, 2015: 81). Handmade sketches are commonly employed by architects in the initial stages to express their intentions in an abstract way (Derycke, 2012: 154), while orthographic drawings such as plans, sections, elevations, and axonometric projections are used during advanced stages to coordinate technical details (Baudez, 2015: 58). Furthermore, physical models and photography are specifically utilised to integrate the artistic and technical aspects of their design intentions (Pilard, 2014: 3). Ultimately, architectural representation is regarded as a valuable source of data for studying architects' decision-making processes.

The identification of design factors has been consistently recognized as a specific area within architectural design research (Parsaee, Motealleh and Parva, 2016: 328). This is primarily due to the field's capacity to be explored by various scientific disciplines (Marin, Lequay and Bignon, 2009: 12). Early studies primarily sought to differentiate between design factors derived from the arts and those borrowed from the engineering sciences (Simonnot, 2009: 2). Subsequent research emphasized the necessity of implementing theoretical models capable of addressing their inherent complexity (Claeys, 2013: 89). More recently, studies have indicated the need for a methodological framework that can serve as a guideline to analyse architectural design factors across different design stages and situations (Lojanica and Dragišić, 2018: 752).

To address these identified gaps, the present research's main purpose is to propose an analytical framework for investigating daylight design factors, and to test its reliability with a limited corpus of houses. Thus, the adoption of a purely qualitative approach based on the analysis of daylight's visual representation will contribute to complementing the predominant studies typically reliant on quantitative indicators. In light of these considerations, this study proposes the following research questions: (i) What factors primarily influenced the consideration of daylight in architecture at the beginning of the 21st century? (ii) How did these factors interact and impact the visual representation among contemporary architects? (iii) What role did architects' websites play in the choice of representation modes during the design process?

Research Methodology

Grounded Theory

Grounded Theory is an inductive and systematic research method used to reveal patterns in qualitative data, with the aim of developing a theoretical position (Bollo and Collins, 2017: 87; Corbin and Strauss, 2007: 59). The specificity of this method is the emergence of theories from qualitative data rather than from predetermined hypotheses (Charmaz and Bryant, 2010: 409). Adopting Grounded Theory for this research allows for a qualitative study of architects' decision-making processes during their design work. Such a task is achieved through a characterisation, coding and comparison processes that provide a framework for the practical implementation of qualitative indicators. These are identified within architectural representations shared by architects on their websites to describe the role of daylight in the formulation of their design strategy and the choice of representation modes throughout the design stages.

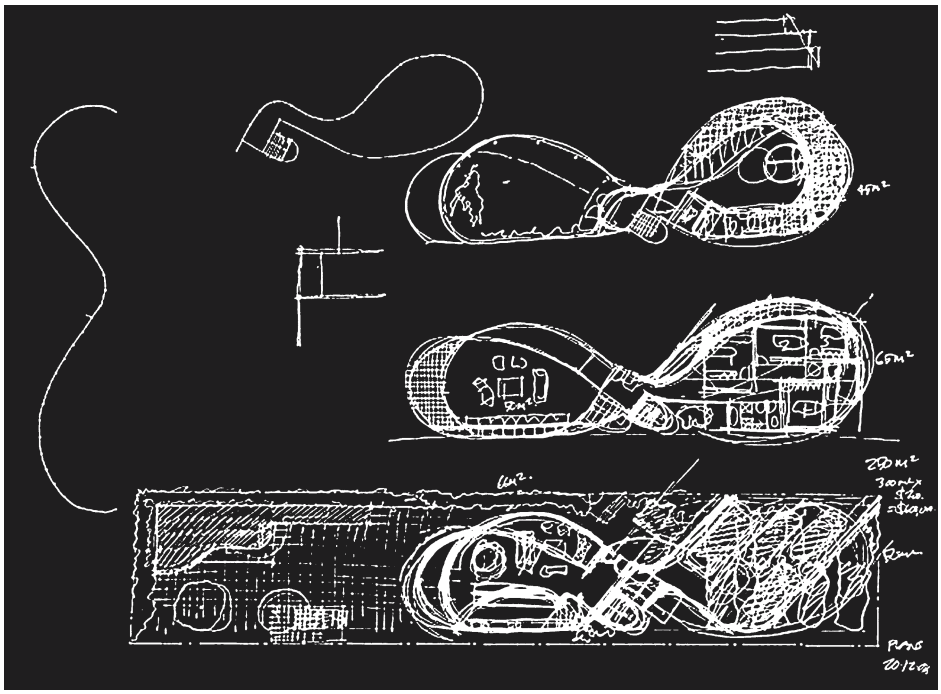


Fig. 1 Sketch edited by Ed Lippmann for the design of Butterfly House: Light in the Feng-Shui principles

Analysis Protocol

Following the Grounded Theory standard workflow, a five-step analytical protocol was developed to investigate how architects consider daylight in their design (Fig. 2). (i) The first step consists of theoretical sampling, which is achieved by fixing a corpus of houses that meet the pre-established selection criteria. The websites of the corresponding architects are then consulted to collect various modes of representation used to present the selected houses. The qualitative data are subsequently characterised according to predetermined criteria. (ii) The second step involves open coding (Karimimoshaver et al., 2020: 2); it is conducted through a content analysis of the architects' textual representations. The extracted concepts are first structured into concept maps and then organized hierarchically into factors, categories, and subcategories using pyramid charts. These charts are eventually integrated into an overall abstract diagram. (iii) The third step implies axial coding (Vassili and Nicolas, 2008: 145); it is operated by using the abstract diagram for the visual analysis of the collected houses' architectural representation. This process enables the generation of analytical diagrams that quantify the factors, categories, and subcategories adopted for the design of each house. (iv) The fourth step involves selective coding (Birks and Mills, 2015: 12); it is based on the identification of similarities that may exist between the obtained analytical diagrams in order to assemble them into distinct groups. These similarities are statistically extracted by means of multiple correspondence analysis (MCA). The coding level results in representative diagrams that characterise each identified group. (v) The final step consists of describing the common trends within the identified groups through a writing-up pro-

Fig. 2 Flowchart of the adopted analytical protocol

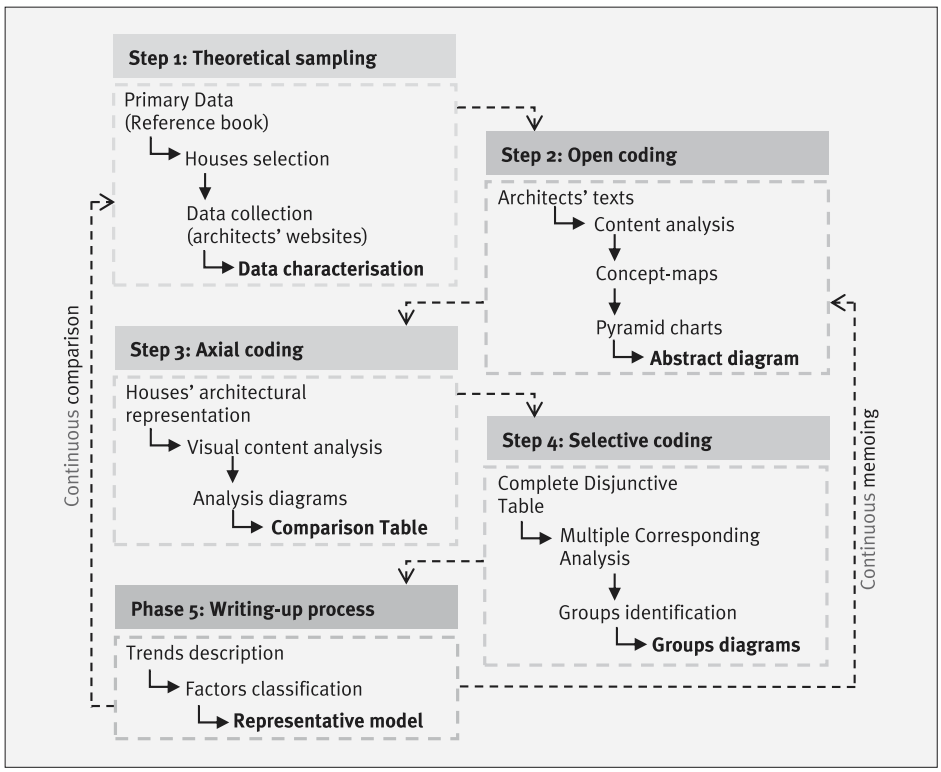


Table I The selected houses and their corresponding architects' websites

N°	House	Architect	Country	Year	Architect's website
01	House 20x20	Assadi Felipe	Chili	2005	www.felipeassadi.com
02	Casa Raveau	Assadi Felipe	Chili	2006	
03	Casa Schmitz	Assadi Felipe	Chili	2001	
04	Casa Serrano	Assadi Felipe	Chili	2006	
05	Glass Shutter House	Ban Shigeru	Japan	2003	www.shigerubanarchitects.com
06	Naked House	Ban Shigeru	Japan	2002	
07	Arkansas House	Blackwell Marlon	United States	2004	www.marlonblackwell.com
08	Tower House	Blackwell Marlon	United States	2000	
09	Asencio House	Baeza Alberto Campo	Spain	2000	www.campobaeza.com
10	Holman Residence	Durbach Block	Australia	2004	www.durbachblockjaggers.com
11	Spry Residence	Durbach Block	Australia	2003	
12	Guesthouse	Kanner Stephen	United States	2006	www.residentialarchitect.com
13	Malibu 3	Kanner Stephen	United States	2004	
14	Butterfly House	Lippmann Associates	Australia	2005	www.lippmann.com.au
15	Pearl Beach House	Lippmann Associates	Australia	2007	
16	Tree House	Lippmann Associates	Australia	2001	
17	Balmoral House	Moore Ian	Australia	2006	www.ianmoorearchitects.com
18	Rose House	Moore Ian	Australia	2000	
19	Cell Brick House	Tekuto Atelier	Japan	2004	www.tekuto.com
20	Lucky Drops House	Tekuto Atelier	Japan	2005	
21	Wafers House	Tekuto Atelier	Japan	2004	
22	Engawa House	Tezuka Architects	Japan	2005	www.tezuka-arch.com
23	Machiya House	Tezuka Architects	Japan	2006	
24	Anthill House	Tezuka Architects	Japan	2001	
25	Canopy House	Tezuka Architects	Japan	2006	
26	Observatory House	Tezuka Architects	Japan	2003	
27	Chicken Point Cabin	Olson Kundig	United States	2002	www.olsonkundig.com
28	Boxenbaum Residence	Steven Ehrlich	United States	2004	www.eyrc.com
29	Leonard Residence	Steven Ehrlich	United States	2000	
30	Webster Residence	Steven Ehrlich	United States	2000	

cess. This is performed by comparing the results of the characterisation and coding processes. The findings are afterwards used to develop a representative model of the studied phenomenon.

Theoretical Sampling

The adopted qualitative data for this research encompass the various modes of architectural representation employed by architects during the design of single-family houses. This choice was based on the fact that the house has historically fostered the experimentation of new architectural approaches (Bell, 2006: 10).

Primary Data

The primary data for this study were drawn from Peter Hyatt's (2007) book, entitled "Master of Light: Designing the Luminous Houses." It was selected as a unique reference due to the significant number of featured architects who are internationally renowned for their numerous architectural awards, including the Pritzker Prize. Furthermore, this book was chosen as the main source for case selection due to the geographical diversity of the presented houses, which are located in Europe, South America, North America, Asia, and Australia. Such a wide selection increases the richness and representativeness of the study corpus, and serves as an additional criterion for a comparative analysis.

Data Selection

The exploration of the content of the reference book was conducted through an initial selection process based on two main criteria. The first criterion considered the project type, which had to be exclusively a single-family house, and the design period, which was restricted to the 21st century. The second selection criterion related to the luminous atmosphere. For this, an overview of the luminous characteristics of each location was carried out to classify the houses according to their dominant sky conditions. The associated data were obtained from the meteorological website www.currentresults.com, which has been validated as a reliable source for scientific research (Herrera et al., 2017). The result is a final selection of thirty houses designed by twelve architects from around the world.

Data Collection

The data collection process was performed by consulting the corresponding architects' websites of the selected houses (Table I). The objective was to gather the diverse architectural representations used to present each case. The collected data were then organized according to the following categories: textual descriptions, handmade sketches, orthogonal drawings (plans, sections, elevations, and axonometries), photography of the building and interior space, and pictures of the physical and digital 3D models.

The obtained corpus does not include any cases from Africa due to the absence of African examples in the reference book, which by no means reflects a voluntary exclusion of the continent. Incorporating supplementary books to include African houses would risk excessively increasing the number of cases and, consequently, further expanding a dataset that is sufficient to test the reliability of the provided methodological framework.

Data Characterisation

A preliminary analysis of the collected data reveals that a half of the selected houses

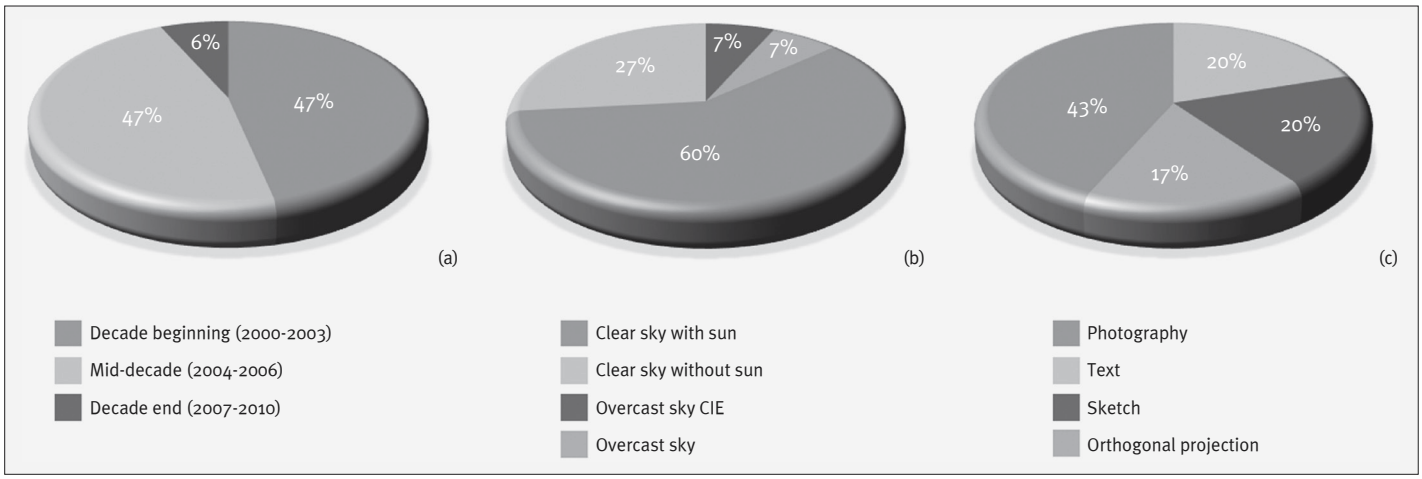


Fig. 3 Data characterisation according to three selection criteria: (a) House design year; (b) Type of sky condition; (c) Representation mode

were designed between 2000 and 2003, while the other half were designed between 2004 and 2006. The end of the decade (2007-2010) is represented by fewer houses (Fig. 3a). Consequently, the study corpus covers the early and mid-decade contexts. It will enable the analysis of the transitional period between the late 20th and early 21st centuries. The analysis also discloses that two-thirds of the houses are located under a clear sky with sun, a quarter are situated under a clear sky without sun, and a fifth are located under an overcast sky (Fig. 3b). The diversity of sky conditions will allow a comparative study between the architects' daylight design and the characteristics of the site's light. The analysis of the representation modes reveals the use of photography in all cases; sketches and texts emerge as the second most employed modes, while orthogonal projections are the least used representation mode (Fig. 3c). Thus, the study will consist of detecting the design stages during which each mode is significantly used.

Coding Processes

In consequence of the insufficient existing research on the subject, the coding process follows J.F. Wong's (2010) work. Furthermore, given the volume of generated diagrams, this section will present only the final diagram obtained for each level of coding.

Open Coding

The first level of coding was conducted by extracting key concepts referring to daylight considerations from the textual representation of the selected architects. The concepts were initially transcribed verbatim and illustrated through concept maps. They were then categorised hierarchically into factors, categories, and subcategories. The criteria for identifying core categories during text analysis were derived from those proposed by Strauss (1987: 36). Consequently, five main factors were defined: (i) The Ideation factor describes the design references that inspired the architects while formulating their daylight intentions. (ii) The Conformation factor addresses the spatial configuration of the luminous atmosphere; it includes daylight typology, representing the daylight system; daylight topology, describing the qualitative specifications of daylight distribution; and daylight morphology, indicating the proportions, positions, and sizes of the daylight system components. (iii) The Representation factor encloses the various modes used by architects to express their daylight considerations, incorporating handmade sketches,

Fig. 4 Overall abstract diagram of daylight design factors

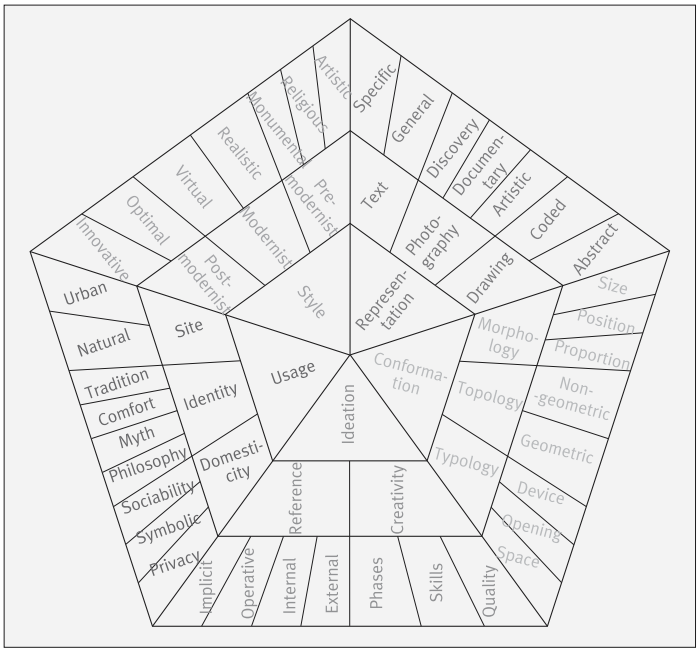


Table II Comparison table summarising the content of the analysis diagrams

Factors	Categories	Sub-categories	House 20x20	Casa Raveau	Casa Schmitz	Casa Serrano	Glass Shutter House	Naked House	Arkansas House	Keenan Tower House	Asencio House	Holman Residence	Spry Residence	Guesthouse	Malibu 3	Butterfly House	Pearl Beach House	Tree House	Balmoral House	Rose House	Cell Brick House	Lucky Drops House	Wafers House	Engawa House	Machiya House	Anthill House	Canopy House	Observatory House	Chicken Point Cabin	Boxenbaum Residence	Leonard Residence	Webster Residence
Ideation	Reference	Implicit	x	✓	✓	✓	x	x	x	x	x	x	x	✓	✓	x	x	x	x	✓	x	x	✓	x	x	✓	✓	✓	✓	x	x	x
		Operative	✓	x	x	x	x	x	x	x	✓	x	x	x	x	✓	✓	✓	✓	x	x	x	x	✓	✓	x	x	x	x	✓	✓	✓
		Internal	x	x	x	x	x	x	x	✓	x	✓	✓	x	x	x	x	x	x	x	x	x	✓	x	x	x	x	x	x	✓	✓	✓
		External	✓	✓	✓	✓	x	x	x	x	x	x	x	✓	✓	x	x	✓	✓	✓	x	x	x	x	x	✓	✓	✓	✓	x	x	x
	Creativity	Phases	x	x	x	x	x	x	x	x	✓	x	x	x	x	✓	x	x	x	x	x	x	✓	✓	✓	✓	x	x	✓	x	x	x
		Skills	x	x	x	x	✓	✓	✓	x	✓	x	x	x	x	✓	✓	x	x	x	✓	✓		✓	✓	x	x	✓	x	x	x	x
		Quality	x	x	x	x	x	x	x	✓	x	✓	✓	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Conformation	Typology	Space	✓	x	x	x	x	x	x	x	✓	x	x	x	x	x	x	x	x	x	x	x	x	✓	✓	x	x	x	x	x	x	x
		Opening	✓	✓	✓	✓	x	x	x	✓	✓	x	x	✓	✓	✓	✓	✓	✓	✓	x	x	✓	x	x	✓	✓	✓	✓	✓	✓	✓
		Devise	x	✓	x	x	✓	✓	✓	✓	x	✓	✓	x	x	x	x	x	✓	x	✓	✓	✓	x	x	✓	✓	x	✓	x	x	x
	Topology	Geometric	x	x	x	x	x	x	x	x	✓	x	x	x	x	✓	✓	x	x	x	x	x	x	✓	✓	x	x	x	x	x	x	x
		Nongeometric	x	x	x	x	x	x	x	✓	x	✓	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Morphology	Proportion	x	✓	✓	✓	x	x	x	x	x	x	x	x	✓	x	x	✓	✓	x	x	x	✓	x	x	✓	✓	✓	✓	x	x	x
		Position	✓	x	x	✓	x	x	x	✓	x	✓	✓	✓	x	✓	x	✓	✓	x	x	x	x	x	x	x	x	✓	✓	x	x	x
		Size	✓	✓	x	x	✓	✓	✓	x	x	x	x	x	x	x	x	x	x	x	✓	✓	✓	x	x	x	x	x	✓	x	x	x
Representation	Drawing	Abstract	x	✓	x	x	x	x	x	x	✓	x	x	x	x	✓	x	x	x	x	x	x	x	✓	✓	x	x	x	✓	x	x	x
		Coded	x	x	x	x	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	x	✓	x	✓	✓	✓	✓	✓	x	x	x	✓	x	x	x
	Photography	Artistic	x	x	x	x	x	x	x	x	✓	x	x	x	x	✓	x	x	x	x	x	x	x	✓	✓	x	x	x	x	x	x	x
		Documentary	✓	✓	✓	✓	✓	✓	✓	x	x	x	x	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	✓
		Discovery	x	x	x	x	x	x	x	✓	x	✓	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Text	General	x	✓	x	x	x	x	x	✓	x	✓	✓	x	x	x	✓	x	✓	x	x	x	✓	x	x	x	x	x	x	✓	✓	✓
		Specific	✓	x	✓	✓	✓	✓	✓	x	✓	x	x	✓	✓	✓	x	✓	x	x	✓	✓	x	✓	✓	✓	✓	✓	✓	x	x	x
Style	Pre-modern	Artistic	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	✓	x	x	x	✓	✓	✓
		Religious	✓	x	x	x	x	x	x	x	x	x	x	x	x	✓	✓	x	✓	x	x	x	x	x	x	✓	x	x	x	x	x	✓
		Monumental	x	x	x	x	x	x	x	x	x	x	x	x	✓	x	x	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Modern	Realistic	✓	✓	✓	✓	✓	✓	✓	x	✓	x	x	✓	x	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓
		Virtual	x	x	x	x	✓	✓	✓	✓	✓	✓	✓	x	x	x	x	x	x	x	✓	✓	x	✓	✓	x	x	x	x	x	x	x
	Post-modern	Optimal	x	x	x	x	x	x	x	x	x	x	x	x	✓	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
		Innovative	x	x	x	x	✓	✓	✓	x	x	x	x	x	x	x	x	x	x	x	✓	✓	x	x	x	x	x	x	✓	x	x	x
Usage	Site	Urban	x	x	x	x	✓	✓	✓	x	x	x	x	x	x	x	x	x	x	x	✓	✓	✓	x	x	✓	x	✓	x	x	x	x
		Natural	✓	✓	✓	✓	x	x	x	x	x	x	x	✓	✓	x	x	✓	✓	✓	x	x	x	x	x	x	✓	x	✓	x	x	x
	Identity	Tradition	✓	x	x	x	x	x	x	x	✓	x	x	x	x	✓	✓	x	x	x	x	x	x	✓	✓	x	x	x	x	x	x	x
		Comfort	x	x	x	x	x	x	x	✓	x	✓	✓	x	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
		Myth	x	x	x	x	x	x	x	x	✓	x	x	x	x	✓	✓	x	x	x	x	x	x	✓	✓	x	x	x	x	x	x	x
		Philosophy	x	✓	x	x	✓	✓	✓	x	x	x	x	x	x	x	x	x	x	x	✓	✓	x	x	x	x	x	x	x	x	x	x
	Domesticity	Sociability	✓	x	x	x	x	x	x	✓	x	✓	✓	x	x	x	x	✓	x	x	x	x	x	x	x	x	✓	x	x	✓	✓	✓
		Symbolic	x	x	x	x	x	x	x	x	✓	x	x	x	x	✓	✓	x	x	✓	x	x	x	✓	✓	x	x	x	x	x	x	x
		Privacy	x	x	x	x	✓	✓	✓	x	x	x	x	x	x	x	x	x	x	x	✓	✓	x	x	x	x	x	x	x	x	x	x

orthographic projections, and photography. (iv) The Style factor classifies the characteristics of daylight representation according to architectural movements. (v) The Usage factor identifies the primary functional features of the architects' design. The next step involved the consolidation of the relevant categories and subcategories constituting each factor into corresponding hierarchical pyramid charts. The five pyramid charts were finally integrated into an overall abstract diagram, in which the factors are situated in the inner ring, the related categories in the middle ring, and the subcategories in the outermost ring (Fig. 4).

Axial Coding

The second level of coding involves applying the previously developed diagram to analyse the selected houses as performed through a visual content analysis of the architectural representations published on the architects' websites to describe the houses design. This process generated thirty individual analysis diagrams corresponding to the number of the houses. The content of the diagrams was then summarised in a comparison table, with rows representing the factors, categories, and subcategories, and columns representing the houses. Colour-coded columns are employed to distinguish between considered and non-considered factors (Table II).

Selective Coding

The third level of coding was performed by subjecting the results of the previous steps to multiple correspondence analysis (MCA). The visual interpretation of the distribution of the thirty analysed houses across the obtained scatter plot graph reveals a clear structuring of daylight consideration into five distinct groups, defined by Dimension 1 (29.55%) and Dimension 2 (12.12%). Dimension 1 (horizontal axis) corresponds to the Representation factor; it acts as the primary differentiator that isolates Group V from the rest of the sample. Dimension 2 (vertical axis) refers to the Ideation factor; it provides a hierarchical classification of the remaining groups (Groups I-IV) and highlights a progressive shift in daylight design intention. Furthermore, the majority of the analysed houses are clustered along the vertical axis (Dimension 1 ≈ 0). This proximity indicates a high level of convergence in adopting daylight in their design, while their vertical dispersion reflects variations in the employed representation modes for expressing the daylight intention, from Group I (negative values) to Group IV (positive values). In contrast, three houses (Group V) are isolated from the rest of the sample along Dimension 1; this indicates a major difference in their features, which do not align with those of the other 27 cases (Fig. 5).

The visual exploration of the houses within each identified group led to the extraction of their main characteristics.

Group I is characterised by the adoption of the site's luminous environment as an implicit reference during the design ideation phase. A second feature is the common spatial conformation of daylight, composed of openings as the daylight typology component and proportions as the daylight morphological descriptor. The third characteristic is the use of photography as the principal mode of daylight representation (Fig. 6a). The realism of the photography aligns with the aesthetic principles of the Modernist style. Finally, the space usage emphasizes the continuity between the interior space and the natural surroundings.

Group II is defined by a design ideation that mixes references and creativity by reinterpreting traditional daylight components of the local culture. The spatial conformation of daylight includes courtyards, openings, and control devices within the daylight typology, as well as the geometric distribution of daylight within the daylight topology. The third attribute is the use of handmade sketches as the primary mode of representation (Fig. 6b). This encompasses both the artistic features

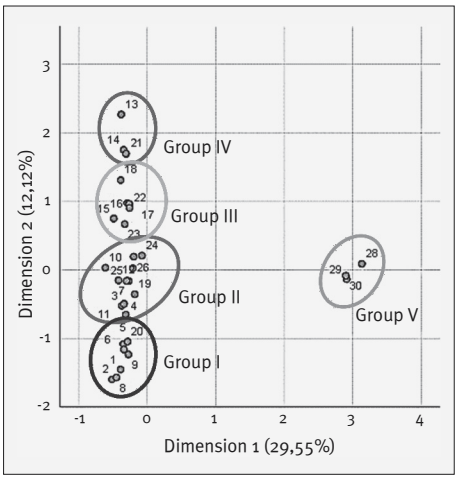
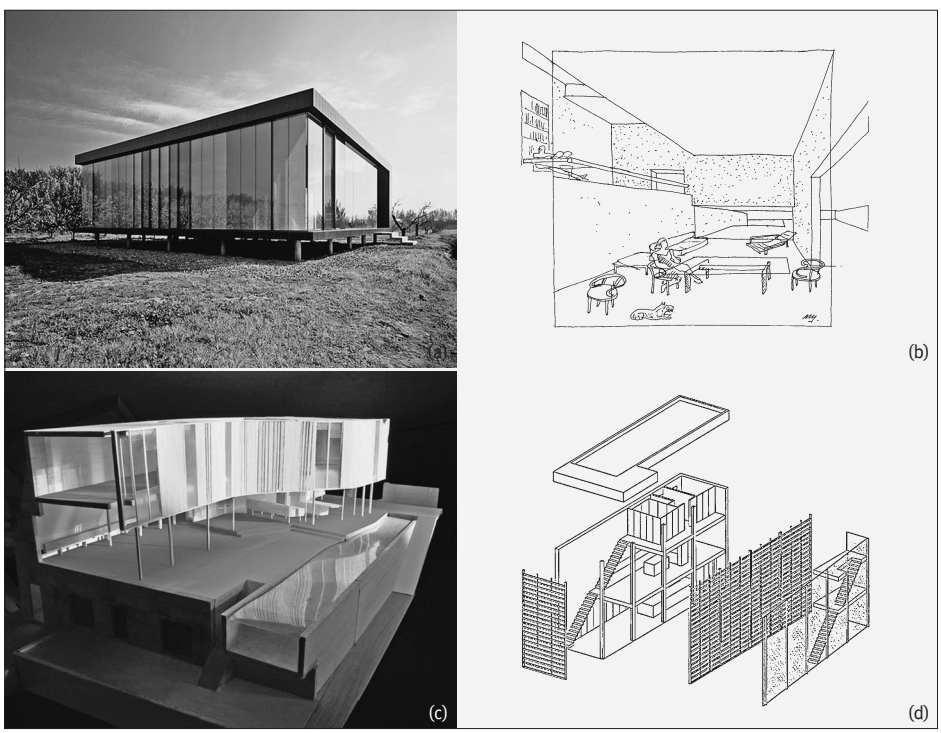


Fig. 5 Scatter plot clustering the thirty analysed houses into five distinct groups

Fig. 6 Architectural representation of the main groups of architects: (a) Photography shared by Felipe Assadi for 20x20 House (listening to the site's light); (b) Sketch edited by Alberto Campo Baeza for Asencio House (Andalusian luminous atmosphere); (c) Model used by Durbach Block Architects during the design of House Spry (light-filled ambience); (d) Axonometry provided by Shigeru Ban for Glass Shutter House (adjustable building skin)



of pre-modern architecture and the virtuality of the Modernist style. Spatial usage accentuates the symbolism of natural light in defining space identity.

Group III is distinguished by an innovative design approach focused on the effect of daylight on the perception of space. The spatial conformation of daylight is defined by a combination of openings and control devices within the daylight typology, and the non-geometric distribution of daylight within the topology. During the houses' design process, the desired daylight effect is tested using physical models (Fig. 6c), which is clearly demonstrated through subsequent photography. These practices align with Modernist architecture. Spatial usage underlines the intended comfort and sociability within the space.

Group IV is identified by the technical manipulation of the daylighting system. Consequently, the spatial conformation of daylight is composed of control devices as the main daylight typology component, and position as the unique morphological descriptor. The third feature is the use of orthogonal drawings, mainly axonometric projections (Fig. 6d), as the primary mode of representation. The adopted aesthetic principles combine the realism of the Modern Movement with the innovation of Postmodern architecture. Spatial usage evokes the relationship with the urban environment while preserving the privacy of the space.

Group V is defined by an explicit declaration of embracing the Modernist architectural style. The spatial conformation of daylight is based exclusively on openings within the daylight typology. Notably, this group is distinguished by the use of textual representation exclusively to express the architect's daylight design strategy. These written descriptions usually reflect the adopted Modernist aesthetic principles. Spatial usage highlights sociability within the space.

A Representative Model of Daylight Design in Architecture

This section constitutes the writing-up step; it discusses the interrelationship between the results of the coding and characterisation processes in an aim to develop a representative model that reflects the main factors of daylight consideration by the studied architects.

Representation modes throughout the design process

The representation of the studied architects is largely impacted by the nature of their design ideation: (i) In contextual design, usually inspired by local daylight culture, the architects employ handmade sketches to express their daylight intentions from the earliest stages of their design process. This practice characterises the work of the Group I architects (Felipe Assadi, Stephen Kanner, Olson Kundig and Ian Moore Architects); similarly, it defined the work of the Group II architects (Alberto Campo Baeza, Lippmann Associates and Tezuka Architects). (ii) In creative design, mostly characterised by the manipulation of the building skin, architects use axonometric projections and physical models during the intermediate stages. This practice identifies the work of the Group III architects (Durbach Block and Marlon Blackwell Architects) as well as the work of Group IV architects (Shigeru Ban and Atelier Tekuto). (iii) In cases where the design is entirely inspired by a specific architectural style, architects use text and photography as the only modes to describe the luminous atmosphere during the advanced stages of their design process. This practice is evident in the work of Group V, represented by Steven Ehrlich.

The site's light as tangible design ingredient

The luminous attributes of the site are considered by the studied architects to be an essential element that determines their design choices regarding the daylight system components: (i) Under a clear sky without sun, the daylight system is based on shaping openings. This practice characterises the houses of Groups I and II, where large windows are conceived to establish a direct connection between the building and its surroundings. (ii) Under an overcast sky, the adopted daylight system focuses on the control elements. This strategy is frequently adopted for the houses of Group III, where daylight design typically incorporates multiple layers of the building envelope to provide views to the outside while maintaining privacy within the space. (iii) Under a clear sky with sun, the daylight system comprises various components, including courtyards, windows, and control devices. This sky condition constrains architects' choices, often leading them to draw on traditional local daylight strategies to reproduce the qualitative characteristics of a typical luminous atmosphere.

The evolution of daylight representation over the decade

The representation of daylight by architects on their websites underwent significant changes throughout the first decade of the

21st century. This evolution was largely driven by the opportunities offered by digital sharing, which encouraged them to express diverse aspects of their daylight considerations throughout the design process: (i) At the beginning of the decade, the architectural representations shared on architects' websites consisted primarily of handmade sketches describing the incorporation of cultural background into daylight design. (ii) The mid-decade context was marked by significant progress in the handling of new daylighting techniques. As a result, the architectural representations shared on architects' websites shifted to include physical models and orthogonal drawings for explaining the components of the innovative daylight systems. (iii) The end of the decade was characterised by sharing photography and texts to reveal the architects' intentions and the quality of the resulting luminous atmosphere.

The linking of the obtained results from the whole steps led to the elaboration of a representative model of daylight design and representation by the studied architects (Fig. 7).

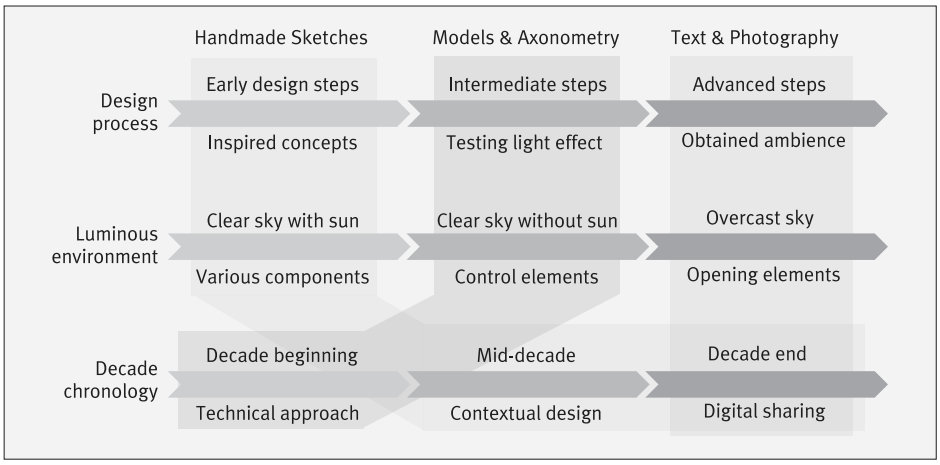


Fig. 7 Representative model of daylight design at the onset of the 21st century

Conclusions

This paper presents the results of a study that employs a grounded theory methodology to establish an initial analytical framework for evaluating qualitative daylight indicators within the design process of contemporary architects. To this aim, the architectural representations of thirty houses designed during the first decade of the 21st century were investigated via a five-step analytical protocol.

The study's findings indicate that the early and mid-decade contexts were a key period for daylight consideration in architecture, which has evolved from the paper version to a digital sharing of their graphic representations. This shift was notably driven by the emergence of websites as a primary mediator for the architects' work. The use of these platforms allowed architects to share various modes of daylight representation corresponding to the different stages of their design process. Moreover, this period was marked by a significant evolution in the role of daylight in formulating the architects design ideation, largely inspired by local daylight cultures, the sites' luminous characteristics, and the new opportunities afforded by digital sharing.

The main advancement of this research consists in the establishment of an abstract diagram which will serve as a conceptual model for future studies to analyse a broader range of architects and case studies. Likewise, the developed representative model should serve as a reference for comparing future research findings, thereby contributing to the expansion of the database on qualitative daylight factors in design research.

However, the primary limitation of this research, which affects its representativity, is the restricted number of reference books and, consequently, the limited number of studied cases. This was due to the study's main objective, which was to test the reliability of the proposed analytical framework rather than the generalisability of the findings. For this reason, further studies are required to incorporate a larger selection of reference books and a broader corpus of architects and houses, aiming toward the development of an integrative framework for daylight design within contemporary architectural practice.

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Illustration sources

Fig. 1	Derived from: https://www.lippmann.com.au/project/butterfly-house [Accessed 23 May 2024].
Figs. 2-5	Authors.
Fig. 6a)	Derived from: https://www.felipeassadi.com/casa-20x20 [Accessed 16 June 2024].
Fig. 6b)	Derived from: http://www.campobaeza.com/asencio-house/ [Accessed 20 June 2024].
Fig. 6c)	Derived from: https://durbachblockjaggers.com/projects/residential/house-spry [Accessed 10 July 2024].
Fig. 6d)	Derived from: https://shigerubanarchitects.com/works/hh/glass-shutter-house/ [Accessed 18 June 2024].
Fig. 7	Authors.
Tables I, II	Authors.

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