Light and Function: An Approach to the Concept of Space in Pharaonic Architecture

Pierre Zignani

Dieser Beitrag fasst die Hauptergebnisse der Bauforschung zu den Belichtungsöffnungen im Hathor-Tempel von Dendara zusammen. Er stellt einen antiken geometrischen Entwurfsansatz vor, bei dem die Parameter Raum, Funktion und Licht in unmittelbarer Abhängigkeit von einander zu denken sind. Der sparsame Gebrauch von Fenstern lässt darauf schließen, dass das Licht im Innenraum eine vollkommen andere Bedeutung hatte, die nichts zu tun hat mit sonstigen dichotomistischen Vorstellungen von einem Licht, das über die Dunkelheit siegt. Jenseits von solchen Bedeutungsebenen, die mit dem Licht verbunden werden, liefert die Lichtkonzeption des Hathor Tempels den Beleg, dass hier dem Bau eine akkurate, dreidimensionale Planung vorangegangen ist.

STATE OF THINGS

The western feeling about the natural light in the space of Egyptian temples is often close to mysticism or a romantic emotion. In this sense, it has also been magnified by the movie industry of Hollywood (e.g. »The Raiders of the Lost Ark« from Steven Spielberg, 1981) and many people are only expecting relationships between the sun's rays and an image of Pharaoh or God. Two cases are well known through the touristic literature. Some scholar's publications also mentioned them as examples of »atmosphere inside the Egyptian temple«. However this last comment cannot be regarded as a scientific caution.

The first, and most famous, example is, certainly, the great temple of Abu Simbel where the sun rays light, twice a year, the divine statues. It has already been reported since the 19th century¹. It happens in late winter and early autumn, but does not coincide with the equinox. The phenomenon has never been object of study and, in fact, it does not reflect the ancient mind where the Egyptian temple nucleus was a private divine residency, beyond the human world. The design of this nucleus was very protective and was not thought to be open towards the outside (fig. 1). The privacy of these most sacred spaces excluded human beings. Only Pharaoh, due to his divine role, was allowed to enter and perform the daily cult. In reality, higher priests acting as Pharaoh's deputies were, all over the country, in duty of the cult to sustain the divine energy and keep the Pharaonic society balance. The Pharaonic temple is not a structure to accommodate a public cult; it is literally the Mansion of Goda and its design models the cosmos of the mythical time of the ideal origin. Its architecture refers to an entirely different concept of environmental relationships that the ones shaped by our cultural heritage. It requires perfection and purity that must be protected from the chaos which can always come from the outside². Thus it is almost impossible to imagine a major Egyptian sanctuary with all its axial doors opened at the same time (fig. 2). Our modern perception where the cella is seen in a central perspective does not reflect the ancient design. The central axis was closed permanently by heavy doors, which were opened and shut, one after the other, only when the God (its statue) moved towards the human environment³.

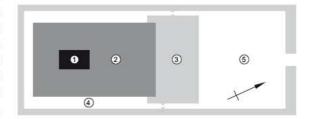


Fig. 1 Units of composition according the temple of Hathor at Dendara. (1) cella inside the naos (2), (3) pronaos, (4) stone enclosure wall, (5) court and pylon (foundations)

- 1 Edwards 1982, 303 f. The 1st edition was in 1877.
- 2 Zignani 2008, 21-28.
- 3 On the design of the central axis, see Zignani 2008, 97-100.

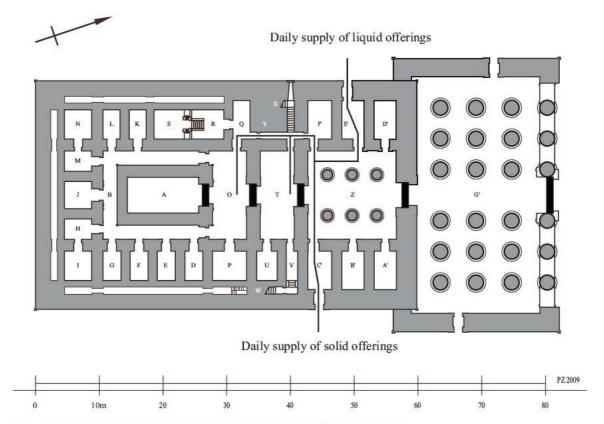


Fig. 2 Plan of the temple of Hathor with all the axial doors closed and the way of the daily worship

The second example is the sanctuary of Ptah inside the precinct of the temple of Amun-Ra at Karnak. There, people come from all over the world to see, in the southern lateral chapel, the re-erected statue of Sekhmet just below a small orifice, through which sunlight - or moonlight on certain nights - filters on the statue (fig. 3). In the central chapel, one can observe also at noon during the summer solstice that the sun's ray light directly the statue of kneeling Pharaoh (only the legs are preserved) in front of the god Ptah (fig. 4). Unfortunately for the atmosphere-lovers, the slabs directly above the two statues are a modern reconstruction with openings invented for the circumstances4.

In general, it is difficult to find precise data on the lighting and aeration in Pharaonic religious architecture in studies published hitherto⁵. We usually read that light supply in the Egyptian temple decreases with the gradual reduction of room size towards the sanctuary, however, as was contended in the above paragraphs, such movement does not reflect the ancient Egyptian way of thinking about space. Looking at the so-called sfirst stone architectures, the work of Imhotep for Djoser at Saggara (c. 2650-2575 BC), it seems obvious that with the beginning of the stone masonry, builders experimented the geometrical impact of the sun on the surfaces of the architecture and its dark spaces (fig. 5).

PRELIMINARY LEARNING FROM THE HATHOR TEMPLE OF DENDARA

This sanctuary, dedicated to the goddess Hathor, is the last reconstruction of the main temple of an antique regional capital in Upper Egypt, which is known since the Old Kingdom. It is also the last major Pharaonic temple of Ancient Egypt. Today, the temple consists in two parts, the naos and the pronaos (fig. 1, 2, and 6). A stone enclosure wall was begun but never achieved. The work of a forecourt and a pylon was stopped at the layers of the foundation. The construction of the naos began at the end of the reign of Ptolemy XII (in July 54 BC) and the pronaos should have been built a bit later at the beginning of the Roman rule.

Zignani 2008, 102 fig. 3. 35.

Haeny 1977, 168 f.; Aubourg - Zignani 2000, 47-49.



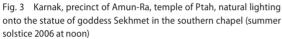




Fig. 4 Temple of Ptah, sun's rays onto the kneeling Pharaoh in front of the god Ptah (summer solstice 2006 at noon)

From the outside, the naos and the pronaos present elementary shapes, which do not express the complexity of the internal organization.

Taking advantage of the quasi-perfect stage of preservation of the building, the observations done during the survey made possible to develop studies on the way of designing the temple, of course from a technical point of view, but also from a spatial point of view. Our method of surveying has a five millimetres tolerance, this for a rather large construction of eighty meters long by forty meters wide, which has several levels and an elevation of nearly eighteen meters. The survey showed that all the spaces and the elements of control, like the numerous and different types of axes, were realized exactly with the same tolerance of ours, or even better6. That means that the builders of this period worked with an absolute accuracy, of which we are often quite far in our modern traditional building activity.

The state of preservation of the Hathor temple of Dendara allowed the documentation of 61 windows. They



Fig. 5 Saqqara, funerary complex of Djoser, impact of the light inside the colonnade entry at midday during the winter solstice



Fig. 6 Dendara, temple of Hathor, general view of the western side of the pronaos (left) and the naos (right)

could be classified into two groups according to the position of the opening:

- the zenithal elements, whereby the source of light is coming from surfaces of the roof (fig. 7).
- the lateral elements, which despite their high position under the ceiling slab, have a vertical opening and thus constitute a lateral supply of light (fig. 8).

The size of these windows varies originally from 200 to 800 cm², a rather small opening especially when considering the important thickness of the outside walls or slabs. With such conditions, we cannot consider the windows as elements opening the inside towards the outside, but only as a minimal contribution of lighting. It is significant to note that certain types of window can be common to different rooms in size and in hierarchy. In addition to this kind of standardization, all the openings were conceived with a symmetrical shape, thus contributing further to an obvious effort of abstraction between the lighting and the spaces. An accurate survey of window types allowed us to model their incidences in every room. All measurements were translated into the ancient cubit used by the builders of the temple. Two relations were taken into account according to simple geometrical principles, which could be observed during Pharaonic times (fig. 9)7:

- the projection of the geometry of the prismatic opening into the space.
- the projection of the cone of light defined by the geometry of the opening.

Some details show that the ancient designers were conscious of the reflection of the surfaces in terms of luminosity8. But its intensity was not quantifiable for them and this effect was ignored in the framework of the research. In a preliminary test, the direct impact of the sun was also considered regarding the dates of the temple construction9. The importance of such an effect could be only factual because of the mobility of the sun during the year and the day. The point is, of course, that the latitude of Dendara near the tropic results in the illumination of a surface just below the zenithal opening at the time of the summer solstice and at solar noon. Except for this short moment when the sun penetrates to the heart of the spaces on a surface hardly bigger than that of the opening, the investigations on a correlation between a special date and an opening, for example, which projected light onto a divine figure or a particular place, gave no results.

The most representative results of the zenithal openings pertain to the type 1, which is located in the chapels around the sanctuary, and in some rooms, which are in the continuation of their spatial alignment (fig. 7). In the

All the types are detailed in the forthcoming publication: Zignani (in press).

Like the accessory wall above the southern lateral window of the offering room of the Hathor Temple: Aubourg - Zignani 2000, 72-76.

Aubourg - Zignani 2000, 55. 57. 69-71.

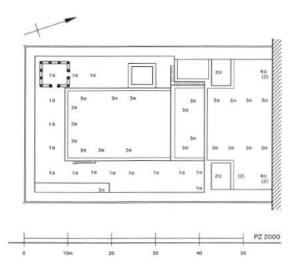


Fig. 7 Dendara, temple of Hathor: zenithal opening types of lighting of the naos roof

axial chapel, the most important of all these rooms (fig. 2), we noticed that the geometrical projection of the light cone meets the plan exactly at floor level at the levelling course of the wall (the surface of the upper course of the foundation which is equivalent to the toichobate of the Hellenistic architecture) (fig. 10). Such a result shows a correlation between the plan, the height and the lighting of the space. We can assert that there is a geometrical play between the three dimensions of this chapel and the prismatic shape of the opening. The intelligence behind the connection between light and space, observable in the main chapel, has in the meantime been confirmed by another play on geometry. This time the relation is with the most important group of rooms of the same size. In this case, we observe that the projection of the geometry of the prism on the ground corresponds exactly to the width of four chapels (D to G), which open onto the eastern side of the ambulatory around the sanctuary (fig. 2 and 11).

Proportionality being in the heart of Egyptian arithmetic by the use of fractional forms, we notice that the geometrical mechanisms developed to obtain such results are an application of the Thales' Theorem. The concomitance of these two spatial relations for the same light opening excludes that it is pure coincidence. Thus this minimal lighting reflects a geometrically aware approach that was subject to a hierarchy (the most important chapel and the biggest group of chapels with the same dimensions) in the sizing of the space. It clearly demonstrates a planning and a building process in three dimensions 10. At this point

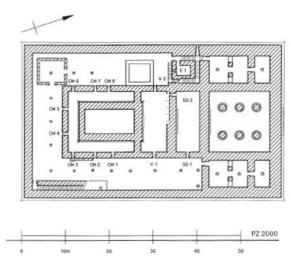


Fig. 8 Dendara, temple of Hathor: lateral openings between the different terraces of the naos roof

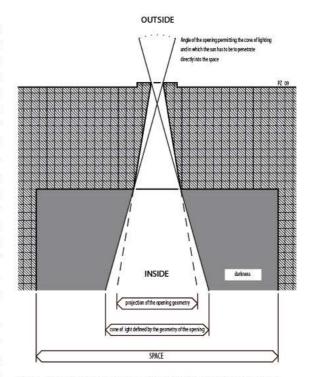


Fig. 9 Geometrical principles of the light into the space (section)

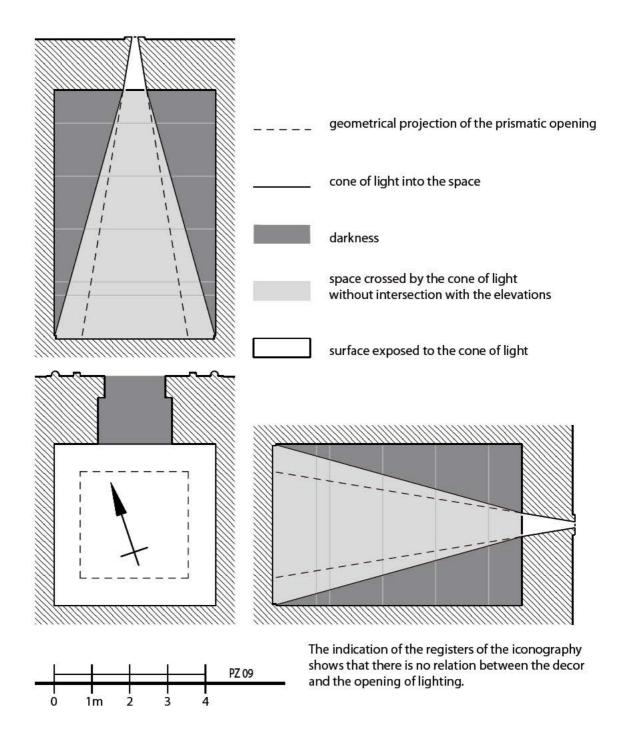


Fig. 10 Zenithal lighting, type 1. Projections into the axial chapel (J)

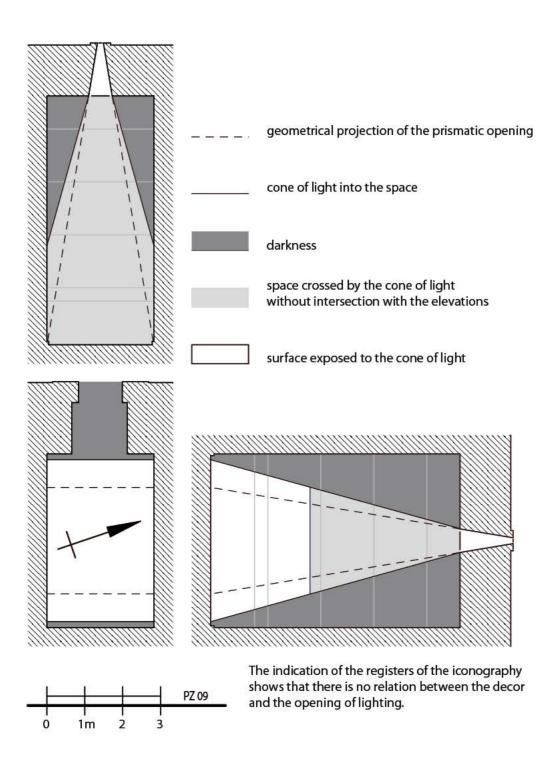
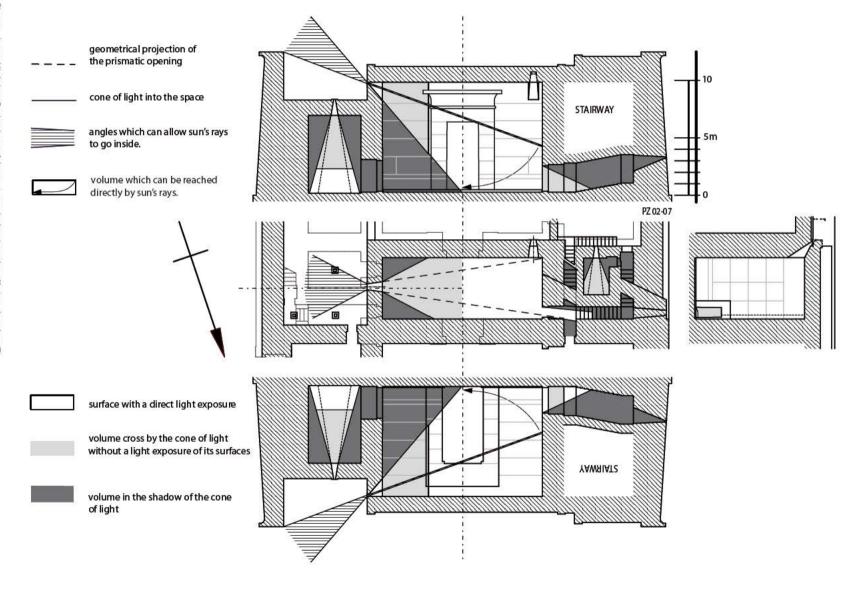


Fig. 11 Zenithal lighting, type 1. Projections into the axial chapels (D, E, F, G)



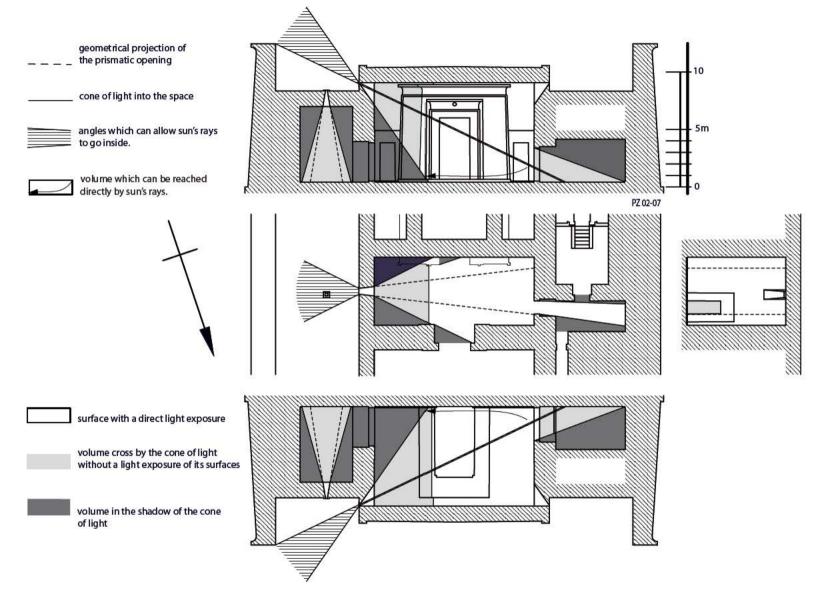




Fig. 14 Dendara, effect of the lateral openings illuminating the cornice of the outside cella elevation (corridor B, west side)

and from a westerner's point of view, it is quite a formal relationship.

The results of the lateral openings are rather different as these windows served clearly functional purposes. They are found in two different contexts. Most of these windows are on the central part of the naos, taking advantage of the different levels between the roof terraces. They are not visible from the outside. In the second case, the openings are on the western facade and allowed a minimal natural lighting through an elaborate geometry in order to use the helical staircase without artificial illumination¹¹.

The lateral windows located around the central part of the naos roof terraces are used differently. In the surrounding corridor of the cella, eight lateral windows have been added to nine zenithal openings. They obviously have a fixed purpose in a space, which is already well lit. They bring light only at the top of the outside elevations of the cella. Like the lighting of the angle torus-moulding, the contribution of these windows underlining the detail of the cornice of the cella serves to express the independence of this architectural unity, i.e. a temple inside a temple (fig. 12). The negative architectural joint between the cornice and the slabs of the ceiling tries to reinforce the independence of the holiest space of the temple. Thus the stars of the sky on the ceiling decoration are supposed to continue very high above the sanctuary. In this case the lateral lighting was used to bring more emphasis to an essential expression of this architecture. In this sense, it is also a functional necessity.

The eastern openings of the offering chamber (T) and the vestibule (O) in front of the sanctuary reveal another character of the work of the designers¹². In section, the geometry of these openings confines the distribution of the light cone with the projection of the lower sloping surface of the opening. In the offering chamber it reaches the longitudinal axis (fig. 13). This invites us to come back, as for the zenithal lighting, to the idea of a conception of the lighting in connection with the main geometry of the space. In the vestibule (O) the projections come at the foot of the doorframe of the cella façade suggesting that the lighting, in section, was focused on this most sacred door (fig. 14). Extremely interesting is that both openings have a horizontal projection, which channels the light to the angle of the corridor used for the daily cult (fig. 15). In the vestibule (O), it is particularly important to notice that the window located in the transversal axis of space conditioned opposite the position of the door. To respect this geometric design, it was necessary to reduce the thickness of the south wall of the space (Q) in order to have a door recess (fig. 16). It has enough space to move the position of the door northward and this would have avoided the transgression of the linearity of the structural shape. Such solution should need to move the opening implanted on the transverse axis of space (O). The respect of the axis being possible, it was privileged to the simplicity of the structure.

The learning of this latest relation is great: a window determined the position of a door eight and a half metres below at ground level and fifteen metres away. Such geometric conception in the space leaves no doubt that it was conceptualized in three dimensions, and this clearly

¹¹ Zignani 2008, 110-112.

¹² Zignani 2008, 116-119.

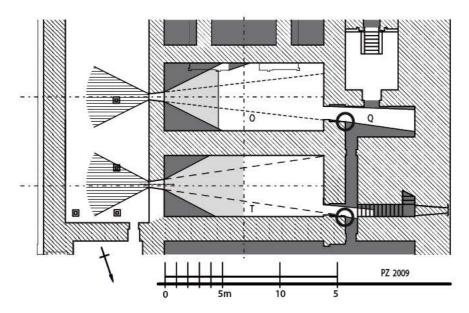


Fig. 15 Projection of the eastern openings of the offering chamber (T) and the vestibule (O) according to the arrival of daily worship

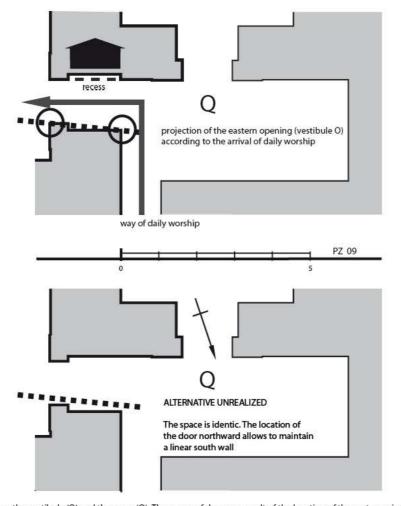


Fig. 16 Door between the vestibule (O) and the room (Q). The recess of door as a result of the location of the eastern window on the roof terrace according the transversal axis

before the work. This shows an optimization of a geometrical relationship between the size of the space, the shape of the openings, and the position of the doors determined by the necessary access through the system of corridors for the daily cult. If the main aim of these two windows seems to offer a minimal contribution of light for the dailycult access, a question remains open: are such openings related to the human condition of the priests, or was the light supposed to underline the cult?

CONCLUSION

This approach on the openings shows that the sizing of the elements of lighting is dependent on their spaces. The Pharaonic temple architecture was not reduced to a standard form but to a design that integrates complex parameters of a minimum level of lighting, playing on the main guiding lines of the geometry, the spatial hierarchy, the emphasis on a significant detail of architecture, and the daily activity of human beings authorized in the temple. As is the case with all the constituents of Pharaonic architectural design, the natural lighting interacts with of functions and the use of geometry did not result from superfluous aspects. We are also very far from any western allegory, e.g. according to the philosophy of the Age of Enlightenment, of a victorious light in the darkness. The parsimonious use of the openings for lighting does not allow us, like the historian of modern architecture Siegfried Giedion, to deny Pharaonic architects of the skill of using light in the expression of the internal space¹³. Conversely, the lighting techniques demonstrate high degrees of intelligence and rigor in the relationship between space and function, which required a global and preliminary conception before the construction. In its cosmographic aspect, the architecture designed for Hathor at Dendara may demonstrate better than in the classical temple, an idea shared by the Greek philosophers who proposed the existence of a divine cosmos with an underlying mathematic order¹⁴.

Address: Dr. Pierre Zignani, Centre franco-égyptien d'étude des temples de Karnak, CNRS Karnak, AmbaFrance Caire, S/C Valise Diplomatique, 13 rue Louveau, F-92438 Chatillon Cedex, e-mail: pzignani@bluewin.ch.

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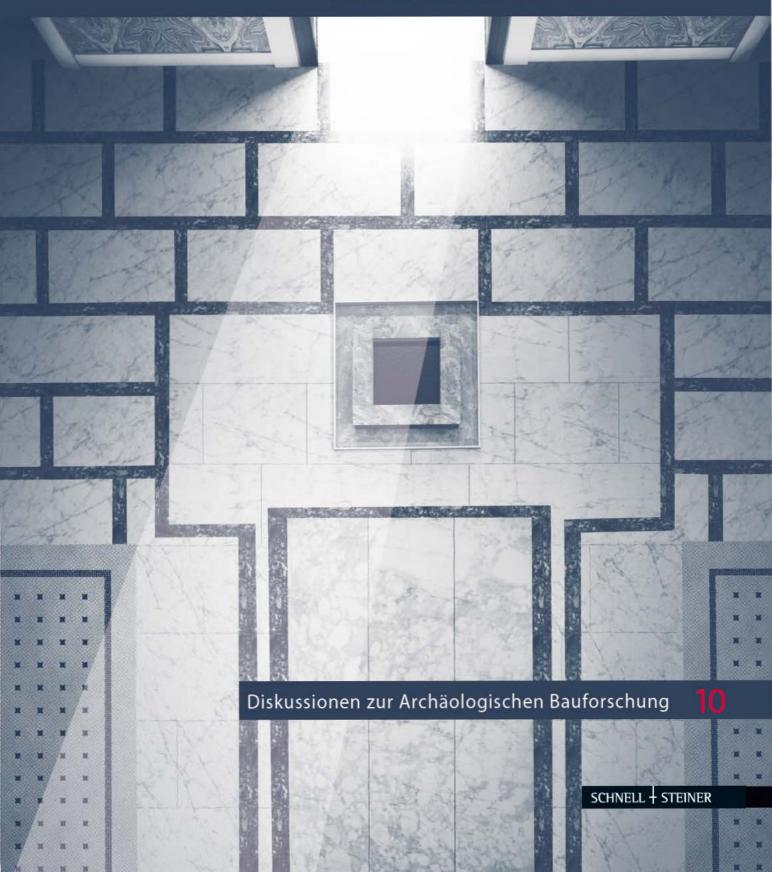
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¹³ Giedion 1964, 523.

¹⁴ Green 1990, 454-456.

Licht – Konzepte

in der vormodernen Architektur



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Deutsches Archäologisches Institut Architekturreferat



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Licht – Konzepte in der vormodernen Architektur

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Zusammenfassung

Licht ist ein ebenso grundlegendes wie symbolisch aufgeladenes Phänomen der sinnlich erfahrbaren Welt – es ist die Voraussetzung für jede visuelle Wahrnehmung, es beeinflusst das subjektive Empfinden und vermag so auch starke emotionale Wirkungen hervorzurufen. In vielen Kulturen ist es deswegen mit metaphorischen und symbolischen Konnotationen verbunden. Auch in der Architektur ist Licht die Grundvoraussetzung jeder visuell räumlichen Erfahrung: Es ermöglicht Orientierung, kann die Funktionalität bestimmen, die Raumwahrnehmung nachhaltig prägen und als Energieträger das Raumklima erheblich beeinflussen. Mit Hilfe von Licht und Schatten werden Körper im Raum, seien es gebaute Räume, Stadträume oder Landschaftsräume, strukturiert und in ihrer Plastizität moduliert.

Obwohl jede räumliche Gestaltung unausweichlich von dem Medium Licht beeinflusst wird und entsprechende Berücksichtigung bei der Planung erfahren muss, ist dem Licht als Element der Gestaltung in der vormodernen Architektur bislang wenig Beachtung von seiten der historischen Bauforschung geschenkt worden.

Im Band 10 der Diskussionen zur Archäologischen Bauforschung wird anhand von 30 Beiträgen versucht, einen Beitrag zur Schließung dieser Forschungslücke zu leisten. Es wird der Einsatz von Licht zur Gestaltung von Architektur und zur bewussten Inszenierung von räumlichen Effekten facettenreich diskutiert. Das zeitliche Spektrum reicht dabei von der Prähistorie bis in die Romantik mit einem Schwerpunkt in der Antike. Es werden Beleuchtungskonzepte unterschiedlicher Kulturen nicht nur für den Sakral- und den Hausbau, sondern auch für Höhlen und einfache Werkstätten vorgestellt. Der breite zeitliche und inhaltliche Bogen ermöglicht es dabei auch, Fragen nach Kontinuitäten und Brüchen zwischen den verschiedenen Epochen hinsichtlich des Umgangs mit Beleuchtung und Licht nachzugehen.