A Didactic Concept for Training Architects and Interior Decorators

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Abstract

The 20th year anniversary of the *Lichtlabor* is used as an opportunity to look back. Two decades in a period of rapid technological development is a long time, during which furnishings pass or fail their trial period. The organizational structure of the *Lichtlabor* which includes lay-out and appliances has continually expanded since 1977 although the theoretical approach has not changed. Even the ideational structure of the *Lichtlabor*, without which an organizational structure would be worthless, has proved to be workable and effective as a didactic concept. This concept is based on the interdisciplinary midpoint between a technically (basic) understanding of light – a combination of abstract knowledge and experience gained – and its design-related application.

Introduction

Design-related application inevitably assumes an analysis of the subject. Interior design today can no longer be confined to the principles of the historical influences of stylistic models, but has to look for elements which appeal to the senses, namely the criteria of lay-out and perception. Spatial lay-out and spatial perception are corresponding terms which are mutually dependent. Spatial lay-out means that a volume must be metrically defined and enclosed. The enclosure or shell is usually substantial and contained. But even open confinements, such as alleys and glades are perceived as spaces, at least from an appropriate line of vision. Activated by experience, the inborn ability of dimensional imagery which flows to the three information levels enables us to complete missing ideation. Thus, contour antecedents, light and color contrasts which are linked in a real spatial situation, also rouse dimensional associations in their own right. Line systems, light-dark patterns and color sequences are unconsciously understood in dimensions as soon as they are visible. A volume filled with light does not require a rigid shell to be recognized as a space of light. A sufficient number of the finest particles or dust particles are adequate if they are only illuminated. Therefore, light is a necessary medium for perception, starting with a metrically defined volume, continuing through to the texture of the shell and ending up as an architectural space which can be enjoyed.

The didactic concept of the *Lichtlabor* blends with a dualistic method of procedure. On the one hand, a receptive antecedent should reveal an insight and convey methods. On the other hand, a constructive conclusion must arouse that slumbers and cultivate beginnings which have been found. The moment when dealing with light begins to fascinate lies between the antecedent and the conclusion. A report on the dualistic method of procedure can be found in this contribution.

Spatial Organization

During my study period as assistant professor at Professor Johannes Ludwig's Chair for Architectural Drawing and Interior Design at Munich University of Technology, I had the opportunity to analyze the design and illumination of large interior spaces, mostly churches. The topic of my doctoral thesis *Light Direction in the Architectural Area* [1], derived from this experience, caused me to carry out experimental lighting engineering investigations which I first carried out on abstract space models and then on concrete space models. In a black box, which I was able to convert to a white box of the same volume, and using the artificial calotte sky room of the Keller company in Wallisellen near Zurich, I studied the light incidence through a window opening which I orientated towards significant points of the hemisphere. I fitted this quadratic window opening with attributes like, window sill, window reveal and deflectors also encouraged by measures I had seen in Alvar Aalto's buildings. In this way, I discovered typically formed light distribution bodies and investigated their effect in the white box. Here, I let the light distribution body collide with a fixed space shell and imagined that the shell could, like a living cell, envelop through contraction or make way through expansion and so give the light volume less or more space.

In 1976, when the opportunity arose to realize a *light laboratory* in approx. 160 m^2 of space in a new building of the Fachhochschule Lippe (Abteilung Detmold) situated in the Bielefelder street, I was immediately in a position to specify the spatial divisions and functions. Specifications which I have not changed since: a multi-use *daylight room* of approx. 50 m^2 with a through-going fenestration on one side, a *white room* of approx. 25 m^2 and an adjacent *black room* of identical size, a *light measuring track* approx. 16 m^2 long, an *artificial mirror sky* of approx. 12 m^2 and a room for equipment and own working space are the significant rooms which were able to be expanded with a *fore-zone* with exhibition possibilities (see figure 1).

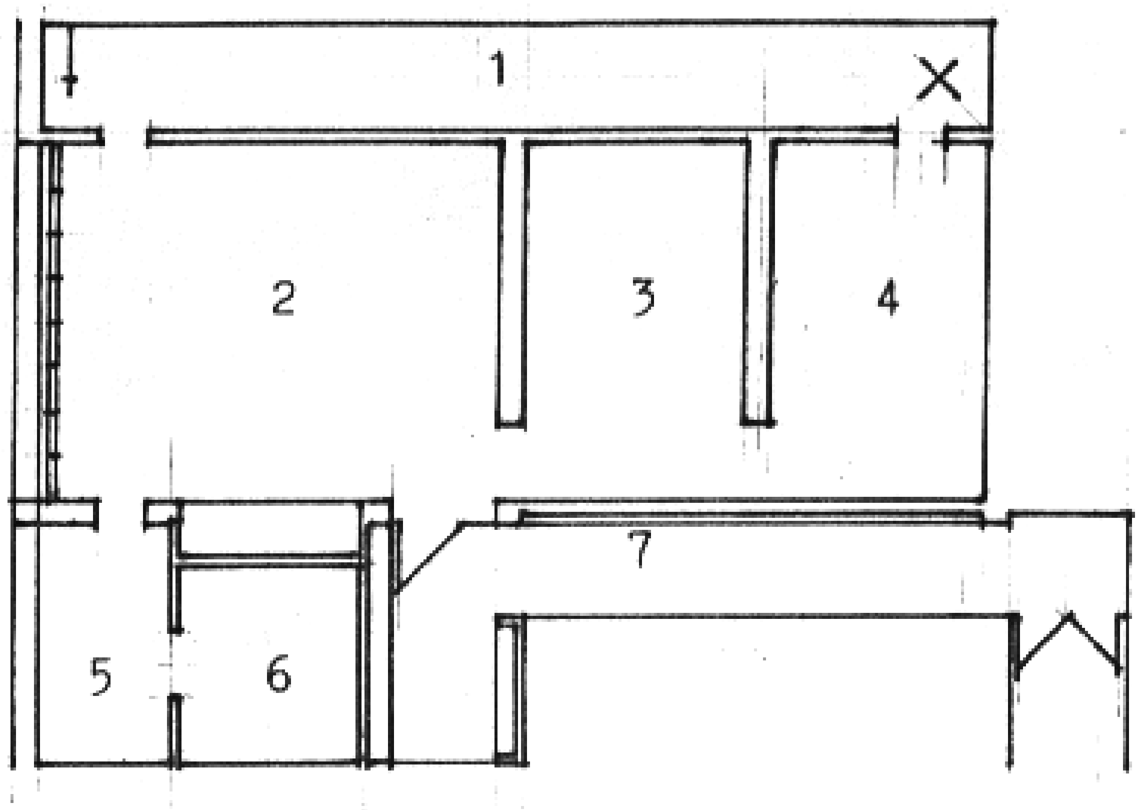

Fig. 1 Ground-floor Plan (#1 Light Measuring Track / #2 Daylight Room / #3 White Room / #4 Black Room / #5 Working Room / #6 Artificial Sky / #7 Fore-zone).

The window in the *daylight room* is fitted with a grille having quadratic fields which can be partially closed by flaps until the room is completely darkened. The boxes integrated in the grille permit the demonstration of the illuminant chromaticity of artificial illuminants which can be compared with the daylight. A built-in display window situation which can be used in isolation or in competition with the daylight is located at a side wall of the daylight room. Further built-in demonstration facilities demonstrate the influence illumination intensity has on a body color, the change in object effect through the surroundings and the modeling of a surface which shows differently formed stereometric projections and hollows by diffused and directed illumination. The *white room* and the *black room* have the same metric dimensioning. The ceilings of both rooms are fitted with similar spot, line and area-shaped ceiling lights.The *measuring track* which originally had a manually-moved pivot carriage now has an automated version so that the measurement data can be stored and evaluated with software programs. In the *artificial mirror sky* which has an effective useful area of approx. 9 m^2 at a height of 2.75 m there is a centrally located lifting table for the positioning of space models. An artificial sun which, in line with the third generation of my designs is a parabolic reflector guided along a fixed arc to automatically travel all possible sun paths, provides parallel directed light.

Receptive Phase of the Study Period

Although every study-starter reflects on a life period in which he has grown up with the nature of light and has had time to consciously question his impressions, he has usually not done so. When you ask him to sketch an illumination situation, this will usually show a window through which the sun projects a memorable pattern and not the image of a space modeled by light. It is first necessary to open the eyes to all the phenomena important for dealing with light: generation, characteristics, spreading, reflection, transmission, all type of effects and finally also the photometric detectibility. Light is a medium which transports information but, as an energy form, is just not visible.

Working in Natural Scales

The *daylight room* is suitable for studying the effects of window sizes, window shapes and window arrangements. For the latter, the position can be high, at eye level or low as well as vertical or horizontal bands. For each fenestration situation, the associated horizontal illuminance values can be demonstrated for each measuring grid and for each measuring time point - and also compared with calculated values. The visibility requirements and sensitivity can be assessed for each fenestration situation: certainty or irritation through cast shadows, reflections, reflected glare, surface and color identifiability and readability of print and patterns at different room positions.

This wakes the interest in the modeling strength of the light which has always been valued in painter studios and strived to newly exploit when building photography studios around 1900 by including generously dimensioned side windows and skylights with shadowing, distribution and reflection measures in combination with ingenious background constructions. Even a small obstacle like an upright pencil supplies a wealth of information about the illumination conditions: the modeling of vertical surfaces becomes recognizable from the nuances of the shaft facets and from the own-shadow. And what does the cast shadow which envelops the light flux lee with the own-shadow tell us? The number of shadows is equal to the number of effective light sources. The various colors of the shadows are caused by the different illuminant chromaticity of the participating light sources. The shape of the shadows reveal the shape of the light sources. The length of the shadows indicate the height of the light sources and, with reference to a single light source, we even obtain information about the illuminance conditions of the side and ceiling areas.

In the illuminant chromaticity comparison boxes integrated in the window grille, it is possible to demonstrate the illuminant chromaticity of the installed artificial illuminants and the respective color rendering of inserted material or color samples; and to make a comparison with daylight which, although as we well know does not represent any constants, is for us historically a reference light source. Especially interesting and amazing are the changes in the metameric color patterns which can fall apart. The most similar color temperature of light sources can be measured. It is an important assignment quantity for the illumination level. Also important from a psychophysical point of view is the determination of whether the light source has a continuous spectrum or a band spectrum. A glimpse through an interference graded filter provides the answer.

The display window situation is suitable for merchandise presentation. This window is equipped with a variety of illumination types: spot, line and area-shape light sources produce their effects from the top, from the bottom and from the sides - with diffused and narrow beam light distribution characteristics. The front sliding glass plate illustrates the problem superimposition of mirror images creates for visual requirements. Position, noticeability and luminance in comparison to accidental light source can be defined. The glass plate also serves as virtual expansion of the daylight room.

The *white room* and the *black room* are similarly intended for the studying of the handling of artificial light. An elementary experience which every viewer should be familiar with but is rarely conscious of, is recalled as soon as we stand in the separating wall area of the two rooms and simultaneously look into these: the same volumes filled with identical light quantities from identical lamp positions result in fundamentally different effects. With the large difference in reflectance of 0.80 to 0.04 there is also little chance of realizing a visual compensation of the surface effects - e.g. through increasing the light quantity in the *black room*. The measurement of the illuminance distributions on the room shells permits objective comparisons. The subtraction of corresponding values produces the respective indirect percentages.

An analysis of the systematically measured illuminances provides the basis for all terms relevant for a lighting calculation, e.g. scalar illuminance (utilization method), point illuminance (point-by-point method), utilization coefficient, efficiency factor and lamp operating efficiency, - after prior measuring or determination of the lamp light flux -, reflection coefficient and luminance. Also informative is the comparison of isolux lines in the *white room* and *black room*. Observation of a sheet of paper moved along isolux lines of identical order in the mentioned rooms shows that identical illuminances and identical luminances do not need to give the same visual effects: surroundings luminances and light direction distributions are fundamentally different.

The modeling of a sphere can also show different results when only the illuminance distribution is defined on its surface. What about the surface itself, the light direction composition and the surroundings determining the adaptation? Just as in acoustics where the audibility of a tone is dependent on the prevailing noise level, the difference sensitivity respectively the visual perceptibility of contrasts, is dependent on the adaptation level to which our eyes have adjusted themselves. My visibility model which I have been working on in the framework of my dissertation is aimed at visual requirements, predominantly defined by luminosity contrasts and less by color contrasts.

The *black room* is indispensable for the following experiments: measuring the light intensity distribution of small light sources, verifying the cos spherical illuminance distribution around a point in space, verifying the illumination through a secondary spot and measuring the reflection indicatrix of surfaces having different color and smoothness. The *measuring track* serves for the measurement of more dispersed lights. As it is accessible and can be viewed from the *black room*, a measuring sequence can be followed with even a large seminar group. In this context, it is also possible to practically explain the significance and relationships of the basic quantities of light engineering.

The mentioned rooms also serve for different areas like the demonstration of the spectral breakdown of the light, the additive color mixture and the color perception, the simultaneous contrast, the light generation, the operating mode and the performance of lamps, the dimmability and the waviness. The mentioned rooms are also suitable for simulating spatial situations and providing work positions at which, for example, the relationship between reflected glare and contrast rendering should be demonstrated. It is also possible to test the suitability of lamp designs produced by project work.

Working in Scale Models

Working in scale models is obligatory for large dimensioned spaces. This manner of working is, however, also important for small-volume projects because models are practical, can be easily altered and are even challenging for influencing. In contrast to acoustic investigations, the model scale can be freely chosen for light investigations. Every miniaturization is possible when dimensional accuracy and surface relationship are observed: the wavelengths of the visible spectrum are extremely small in comparison to what we can see with the naked eye. When working with a scale model, a decision must first be made about which surroundings conditions appear favorable: white, metallic or black backgrounds, and whether or not these projected images should be used. The suitable space can then be chosen. Available as light sources are all fixed lights and all types of movable lights. Particularly popular is a lighting apparatus which transports the light into the model via optical conductors whereby the light can be color filtered, closely or widely bundled or dimmed. Useful is everything that was already employed in the early days of photography: masks, screens, diffusion disks, reflectors and backgrounds.

A simulation of a daylight situation can, as before, be carried out outdoors. However, the *artificial sky* is recommendable for comparison observations under standardized and reproducible conditions. It offers the luminance distribution of a completely covered sky increasable in three switching stages to an outdoor illuminance of max. 7,000 lux. and an artificial sun which automatically travels all sun paths for any location in the world. In simpler cases, the initial orientation using light boxes with uniform diffused light from all sides can also be practical.

In addition to the visual observation of the model, the documentation with the aid of photography and video technology, the latter especially for dynamic sequences is particularly important. In contrast to the observation in the model, which for dimension reasons usually needs to be carried out one-eyed and not always optimally adapted, the mentioned methods have an advantage: psychological uncoupling from the model scale so as if the picture was taken in real space. A trick that is also used by film studios. Large-format projections of the shots on areas reaching as far as the floor, as is possible in the *white room*, increase the impression of reality which can only be further optimized through the three-dimensionality of stereo-shots. The use of endoscopy is recommendable for very small model spaces and spatial areas which are difficult to reach. This conveys surprisingly realistic impressions when viewed directly and is also suitable for photographic documentation.

Receptive-constructive Phase of the Study Period

Just as we can analyze historical building, we should also not deny the roots of modern building. What appears to be new is usually an original combination of solutions which we have copied from nature and which have already often played a role in the history of mankind. In the new context, they receive a new relevance to the present and new acceptance - perhaps they have also only recently become technically achievable. It is therefore sensible to replicate, analyze and vary spaces which have been built. By experiencing that which is foreign to us, we can also discover that which belongs to us - or recognize without doubt the brilliance of a solution. For example, we take the model of the lobby of the IG-Farben company by Peter Behrens in Hoechst, gut the space to its quadratic outer shell, replace the supports and circling galleries, cover these through the fenestrated inner shell, then place on these the prismatic pilaster strips and then, finally, cover these with the original colors. After attaining the actual-state, we reverse the color sequence on the pilaster strips so that the dark colors reach upwards to the light and the light colors reach downwards into the twilight or we turn the prismatic pilaster strips so that they do not project upwards and envelop the light but, like gravity, form a projecting stable foot at the bottom. Although the mentioned variations in no way dispense with the logic, the fascination of the built solution would be lost in both cases.

An alternative exercise could involve the replication of a space by appropriately co-ordinating the spot-shaped, line-shaped, area-shaped and body elements of the target on its virtual shell. By adding or removing elements, it would be possible to interpret, negate or counterpoint the spatial effect, i.e. emphasize, mask or accompany the metrical dimensions. Changes to the arrangement and the shape of the light sources would have similar design significance. The perception of contours would be aided or the weights in the space displaced - perhaps also the formation of the fenestration given independence.

Variations in the illumination effect can also be practised on drawings of projected spaces, such as the hall of the Königswart Hotel by Joseph Maria Olbrich or on images of existing or already demolished buildings of historic importance such as: the Rabe House in Zwenkau near Leipzig, the Ernst Ludwig Studio House in Darmstadt, the Große Kunstschau in Worpswede, Bruno Taut's Glass House in Cologne, the Panaromas Mesdag in The Hague, the Titania cinema in Berlin, the Art Collection NW in Dusseldorf, the Bagsvaerd Church in Copenhagen and many others.

Constructive Phase of the Study Period

However valuable and indispensable the collected knowledge in the areas of light engineering and the design of spaces is, it remains unused until the moment in which the synthesis of the preceding analytical stages has taken place. The synthesis is the special intellectual performance of a design. This intellectual performance, also called creativity, is performed unconsciously but can be consciously performed when powers of memory, combination talent and imagination are trained.

Abstract Spaces

Utilization ideas easily tempt to the making of associations which are orientated to casually known similarly used spaces without their qualities having been questioned. Spatial ideas can be developed more easily when we use elementary spaces and illuminate these with the aim of entering these or spending time in them. Such elementary spaces consist of cubes, rectangular parallelepipeds, prisms, barrels, cylinders, ellipsoids and nestings and spatial sequences derived from these. The light can seep through the shell material or fall through slots and protrusions or intrusions. Desirable is that the light openings, individually or in total, are given an independent character, for example through the design of the reveals or subdivisions and by ensuring that an assignment quality exists between the light openings and the closed parts of the shell which can be compared with that of an ornament.

When the approach is correct, a spatial idea which was intuitively found or consciously sought will be readable: the articulation of the contours of the upper or lower room-half, of a light corridor or the sequence of spatial sections. Space can radiate tranquility or dynamically point a path. The desire for activation of the light wealth, for moderate light incidence or secretive darkening will be recognizable. The impression space gives also depends on whether or not the contrasts included in the design, such as large - small, long - short, straight - round, vertical - inclined, convergent - divergent, colorful - uncolorful, come into play. It is also very tempting to explore the extent to which the shell of a volume must be obvious or whether it could permit several interpretations. The latter can be achieved with the use of layered shells whereby the shells show different translucence and coloring. Just as interesting is the experimenting with mirrors that can create virtual lengthening, widening, heightening, deepening or anamorphoses. It is possible to work with entirely virtual spaces, like in a kaleidoscope. A technique which has already been employed in the Baroque period to simulate large garden and park facilities.

Concrete Spaces

In reality, we will predominantly deal with concrete spaces intended for a defined usage. It is possible to optimize and test spatial ideas, measure light engineering values in a model, track sunlight times and sequences in the model, check the effectiveness of antisun and shading measures, activate light transportation and light steering and discover further variations. In the majority of cases we will assume several approaches, respectively, a series of preliminary designs. The multiple solutions for static problems are brought to mind here: there is not just one bridge design with which we can cross a specific span. Similarly, there are also several ways to fulfil functions and find suitable illumination solutions for the concrete design of space.

The confidence for being able to design spaces which enrich architecture and not just fade into ordinariness will awake slumbering forces in us. And regardless of whether the spaces are representative or more ordinary spaces like, hallways, wardrobes or wet units. The key to success will be the understanding that the spatial quality will not be guaranteed solely by the attractive ground plan shape and the intended volumes, not until the texture and especially the shape-giving force of the light have been integrated. Could we not also characterize Alvar Aalto in this way? Influenced in the early years by the clarity of classicism, later captivated by innovative design and finally fascinated by the uniqueness of human faculties, sight, hearing, touch, feeling, smell and taste, he found a personal and epoch-making trademark as an answer to the challenge of modern building.

Conclusions

A shortened developmental summary which describes the perception and design of space may make it easier to classify the *lighting laboratory* institution as a didactic concept: deriving from the building tradition and trying out were the common methods of historical building. A calculable number of building tasks, modest sequences of the building events and the use of the familiar daylight as the dominating light source, not only permitted these methods but produced so fully developed and visually consistent solutions which are still a part of our repertoire today. The intellectual conflict with the laws of perspective, as they flowered in the Renaissance and Baroque periods, demanded the exact study of shadow casting and the modeling of objects and spaces. This knowledge was the basis for the design of space and his nature-true presentation as it was nursed as the ideal situation until the beginning of this century.

At the end of the 19th century, the pointillistic painting around Paul Signac brought new impulses. The possibility of partitive color mixture and the image creation through the addition of small color areas fascinated. The laws of vision and color vision were rethought. Photography, as a technology which also produced image effects by way of differentiation of small spots, joined around the same time: first supplementing the painting world as a tool, then competing with painting during the phase of increased perfection and finally displacing the naturalistic painting. There was an interest in photographically effective results and the exact looking was left to the camera.

The possibilities offered by electronic data processing and the projection on a monitor represented a new revolutionizing of the visualization and of the presentation technology which now competes with photography. The efforts to perfect the monitor/video technology raises a new the question: How do we see, what do we see, what do we know from what we have seen and what is decisive for a spatial impression? Legions of pixels are waiting to be so accurately directed that the results are photo-realistic images; incidentally, usually images of spaces which have never existed and only appear virtually before our mind's eyes.

Is it still necessary to build these spaces or is the actual experience the gaping at their simulation? This newly stimulated research into viewing delivers a by-product, this being that seeing is an information flow which unconsciously controls the entire organism and thus also has an influence on our mental equilibrium. It is not until the information has reached the vision centre for evaluation that we finally become image conscious. To be derived from this is that when viewing in a real space - and into a model space - we not only obtain a visual impression but also a feeling which in the coupling of all faculty impressions leads to a real experience. Attempts to replace the complex interplay of sensations and perceptions through computers or instruments will remain unfinished unless someone wanted to withdraw into the world of monitor reality. Even under inclusion of all possibilities which the computer media today offer (and we should of course use), the need to develop concepts for the illumination of space will remain. Concepts which only strive quantitatively for equalization of the visual performance at all spatial locations will remain design fragments despite computer precision.

Design requires visual comfort. Visual comfort only exists when a qualitative differentiation, a hierarchy of the visual requirements, is wanted, because not everything has the same level of importance to us. The determination of priorities, the discovery of pre-opinion, the avoidance of errors, all these become possible through experimentation and analysis of real and simulated situations. The *light laboratory* will thus in no way become redundant through the surprising technological developments, instead it will maintain its relative importance as a place of spontaneous experience and controlling. PR, lectures and external contacts, like on Open Day, will additionally ensure updating. [2]

References

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