FELSCH LIGHTING DESIGN

THE **CHACRACTER** OF LIGHT

What Expresses the Characteristics of Hard and Soft Light?

MAKING THE CHARACTER OF LIGHT **MEASURABLE**

How can the properties of hard and soft light be quantitatively described? This question is known to all lighting designers. In practice, this topic has been solved by experience and imagination up to now, but it could not be determined sufficiently with measurable parameters and thus made reproducible. A new approach is offered by the method for determining the Light Hardness.

CONTENT

Academic consideration of the topic of "light" has increased greatly in recent years. The reason for this is the continuously growing interest in better understanding the effects of artificial and natural light and being able to plan specifically.

In Germany, the TU Ilmenau and the KIT, Karlsruhe, are among the leading institutions in the field of lighting technology. The TU Berlin, with its department of lighting technology, is very active in the field of investigating the effects of light. In the field of lighting design (lighting design in architecture), the University of Applied Sciences in Wismar (master's degree course) and the HAWK in Hildesheim with its courses in lighting design play an important role in further developing knowledge about light.

Every day, many lighting designers work with a medium that they barely or at best only partially understand in its physical nature. What they all have in common, however, is an understanding of the visual effect, the perception that a planned light gives. In order to be able to describe and grasp the forming effect of light, the state of the art describes a number of photometric parameters such as illuminance, luminance, contrast ratios and glare. One significant parameter has not yet been named in the past: the Hardness of Light. The Light Hardness(HgF) describes the ratio of diffuse to directed light components of a lighting situation.

We all know the different effects and emotional evaluation of clear sunlight (directional) and an overcast daylight atmosphere (diffuse light). In planning, these properties are currently used according to personal experience. Until now, there has been no way to technically describe this important

THE PROJECT "Church of Silence" shows quite clearly the power of light.

parameter and thus to achieve reproducibility of a lighting situation. In addition, it has not been possible until now to empirically investigate the visual and physiological effects exhaustively.

The method for determining the Light Hardness

With the process registered for a European patent in 2019 by Felsch Lighting Design, we can determine the value of the Light Hardness (HgF). For this purpose, a standard shadow is generated on a projection surface (CCD chip). The resulting shadow image is digitally evaluated. By analysing the ratio of the fully exposed area, the penumbra and the core shadow, the HgF can be determined. The smaller the spatial transition from penumbra to core shadow, the steeper the graph. If the gradient of the graph is approximately 90° (corresponds to HgF=100 %) almost completely directed light is present. The softer (more diffuse) the light becomes, the wider the penumbra and the flatter the slope of the graph becomes. At approximately 180° (corresponds to HgF=0 %) almost completely diffuse light is present.

For the first time, a lighting designer can use the values determined to describe the achieved or planned lighting situation technically precise and thus more complete than before, and hence make it reproducible. The knowledge and research of the HgF effects will enable the targeted and conscious use of this light parameter in the future.

HARDNESS OF LIGHT (HgF)

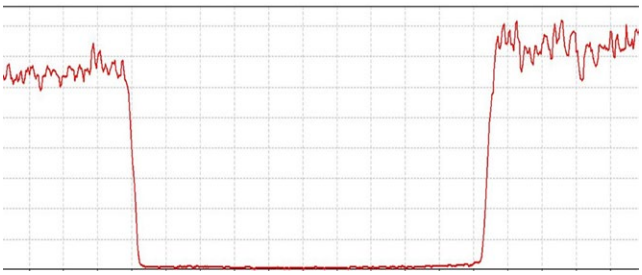
- New photometric parameter
- Is indicated in percent
- 100 % means fully directional light
- 0 % describes completely diffuse light
- The physical quantity is lm / cm (luminous flux / distance)

DIRECTED AND DIFFUSE lighting situations inevitably trigger different emotions and sensations. This becomes particularly clear in daylight situations or the transition between them.

EVALUATION OF THE IMAGING PROCEDURE

DIRECTIONAL LIGHT

The HgF is given in percent (%) and is determined by an imaging procedure. The shadow image of a strongly directed light is shown here.This light situation corresponds to an HgF of about 90 %. The gradient of the graph approaches 82°. The ratio of slope to percent (HgF) corresponds to approx. 1° to 1.11 % HgF.

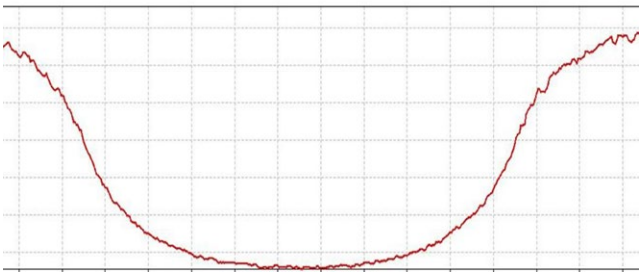


FALSE-COLOUR DEPICTION of the luminance distribution in the measuring device: The light entering the measuring device and the resulting standard shadow is recorded by a dense grid of measuring points and processed by software. In this way an luminous flux curve (lm / cm) can be determined, from the data of which the gradient of the graph and thus the HgF can be determined.

BACKGROUND KNOWLEDGE

DIFFUSE LIGHT

Under diffuse lighting conditions, the method works according to the same parameters as described above for directed light.
This partially diffuse light results in an HgF of about 60 %. The gradient of the graph approaches 55°.



FALSE-COLOR REPRESENTATION of the luminance distribution in the measuring device: The transition from the bright areas shown in yellow to the dark areas shown in blue is significantly wider than in the measurement of directed light.

HARD OR SOFT LIGHT
RENDERING OF THE BODY

Hard light creates hard shadows. The spatial distance from a fully illuminated area to a core shadow is very short. It creates a high contrast in a very small space. Soft light produces lower contrasts. The transition from a fully illuminated area to a core shadow is longer and thus perceived as a gradient. The HgF decreases from hard to soft.

> "The interplay of light and shadow creates the contrast in which the message is revealed".

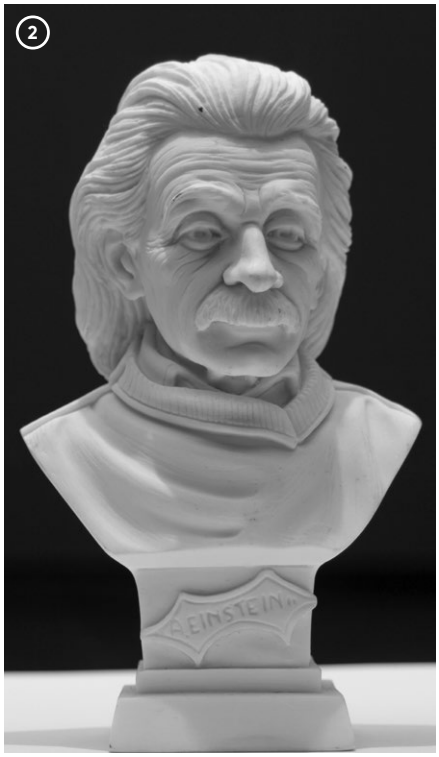
Usually, both extremes rarely occur in artificial and daylight planning. The aim is to understand the evolutionary formed expectations of the visual perception system of most people regarding the lighting situation. Only then can we take this into account in our planning and fulfil this expectation, or design against the expectation in particularly staged situations.

The effect of the perception of contrast on the perception of object shape and surface properties can be seen very clearly in these images. It is these criteria that, in addition to, for example, adequate illuminance and glare reduction, determine the quality of lighting. With a measurable HgF value, the respective light hardnesses can be reliably reproduced.

FIG. 1 shows the bust of Albert Einstein in a very hard, directional light – HgF value approx. 80 %.

FIG. 2 ... in a mixed light – HgF value approx. 50 %.

FIG. 3 ... in a very soft light – HgF value approx. 20 %.



APPLICATION EXAMPLE: NGG

Upgrading the working environment at the Food, Catering and Luxury Food Workers' Union

The trade union NGG from Hamburg can look back on a history of 155 years. As the oldest interest group in Germany, it currently represents approximately 220,000 members from various sectors.

The well-being of its employees is particularly important to NGG. For this reason, the engineering office Felsch Lighting Design GmbH has been commissioned to develop a lighting solution that goes beyond the current standard of office lighting but can be realised at no extra cost. Such an approach to design is called "Human-Centered Design", HCD, or just related to lighting, HCL, "Human Centric Lighting".

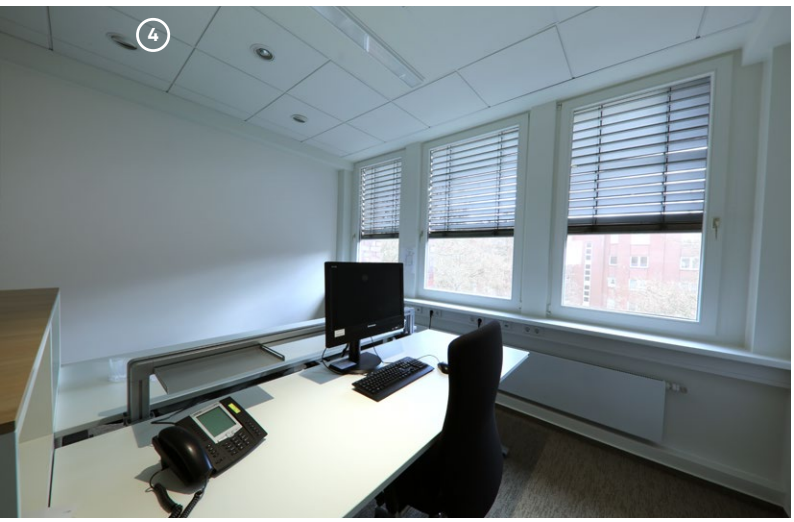
IN THE OFFICES, employees now have access to selectable variants of the lighting situation at the workplace:

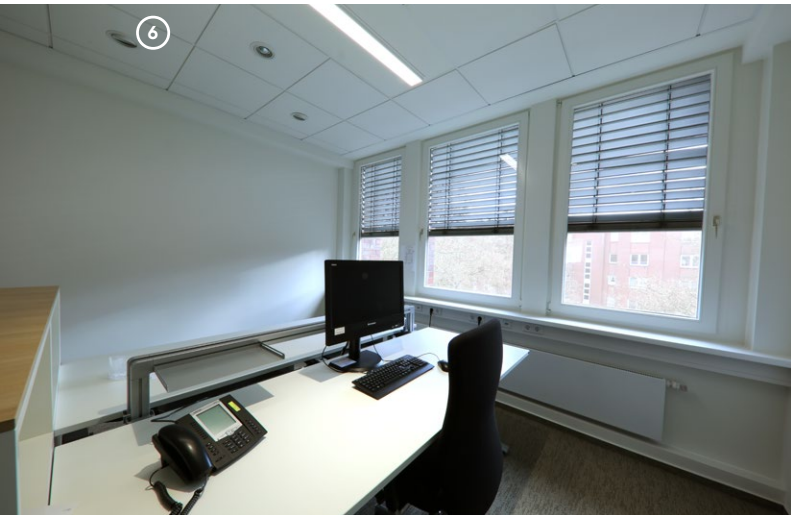
FIG. 4: Directional light only

FIG. 5: Directional light plus wall illumination

FIG. 6: Directional and diffuse light

FIG. 7: Diffuse light only





In the state of the art, this involves changing the brightness (luminance / illuminance) and colour temperature of a luminaire. For us as planners, it means incorporating as many aspects of visual perception as possible into the design. First and foremost this is the character of light, whether it is soft or hard. Then the choice of illuminated surfaces is important for perception. In addition, zoning and contrasts are important for perfect lighting design. Since workplaces are concerned, the design must also meet the requirements of the ASR and DIN.

With the lighting concept for NGG, the employees have the possibility to change the location of the leading brightness centre in the room. They can individually illuminate wall surfaces in relation to their seating position and control their own workplace lighting in intensity and degree of hardness. This is a novelty in office workplace lighting.

From our discussions with NGG employees, we were able to ascertain an extremely high level of user satisfaction among employees with the new lighting situation. Most of the respondents became accustomed to the individual setting options and active use within the first week. In the meantime, the use of the flexible lighting options has become a natural part of daily office work.

For us as planners, one of the highest goals is to ensure that the planned and installed lighting system is used in the a very natural way. Lighting should not be an "issue" among employees. These positive experiences motivate us to further develop the subject of light hardness measurement and dynamic workplace lighting. Another project planned according to this design approach will soon be implemented in Hamburg's Speicherstadt (UNESCO World Heritage Site).

The Benefits of Light Hardness Measurement

The introduction of the photometric parameter Light Hardness (HgF) makes it possible to plan future lighting situations more specifically and successfully. Especially the increasing use of artificial intelligence (AI) in lighting design makes an extended qualitative description of lighting situations by means of quantitative parameters indispensable. A second important aspect that speaks for the establishment of HgF is the qualitative analysis of already existing lighting situations. With these analyses and additional exemplary mock-ups (research projects), the visual effects of light can be investigated more precisely and the psychological effects of a design can be better predicted.

IN THE CENTRAL MEETING ROOM, the lighting situation can be changed as required:

FIG. 8: Directional light only

FIG. 9: Direct and indirect / diffuse light

FIG. 10: Only indirect / diffuse light

OFFICE WITH APPEAL AND CHARACTER: **"Dahler und Company", the real estate agents specialising in exclusive properties, express their personal values – quality, appeal and character – by designing their company headquarters in HafenCity Hamburg.**

FIG. 11: The lobby planned by Davide Rizzo is the house's showcase. The sharp light of the spotlights emphasises the three-dimensional structures of the wall cladding.

FIG. 12: 300 individually made glass spheres of Murano glass together form an inviting gesture. 100 of the glass spheres are partly equipped with spotlights to project the structure of the glass onto the walls.

FIG. 13: Hard and soft lighting moods alternate in the office. Flowing forms and clear light contrasts are style-forming elements.

I would like to know more about the topic of light hardness.

THIS WAY

THE AUTHOR

MARKUS FELSCH

Year of birth	Birthplace	Profession
1972	Berg. Gladbach	Lighting Designer (Dipl.-Ing.)

Markus Felsch has been involved in lighting design since the age of 16. Initially in the context of event lighting, then in the course of training as a power system electronics engineer with the technical aspects and finally during his lighting design studies at the HAWK in Hildesheim with the architectural aspects of lighting design. Parallel to the design work with his office Felsch Lighting Design GmbH, he researches and teaches at the HAW Hamburg in the department of event technology on the subjects of lighting design and lighting technology. In the winter semester 2020 / 21 and summer semester 2021 Mr. Felsch will take on a teaching position as an administrative professor at the HAWK.

Imprint

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