The Nationalmuseum Lighting Lab

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Alexander Roslin (1718–1793), The Artist and his Wife Marie Suzanne Giroust Portraying Henrik Wilhelm Peill, 1767. Oil on canvas, 131 x 98.5 cm. Donated by the Friends of the Nationalmuseum, Sophia Giesecke Fund, Axel Hirsch Fund and Mr Stefan Persson and Mrs Denise Persson. Nationalmuseum, NM 7141.

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Fig. 1 The Nationalmuseum Lighting Lab.
A new lighting programme is being designed for the Nationalmuseum in connection with the refurbishment. The programme considers how we want visitors to experience the art and the museum building, also bearing in mind our visitors’ comfort and enjoyment. Other important aspects concern preservation and the potential of the 19th-century building with regard to its historic qualities and installation technology. The solution we opt for will contribute to making the Nationalmuseum a “green museum”; moreover, the installations we execute to handle natural and artificial light should be sustainable, cost-effective and easy to use.

The Nationalmuseum building was created with the idea that the experience of art is enhanced when the works communicate with the surrounding space. Originally, the museum comprised galleries that varied in size, decoration, colour and light – different kinds of galleries for different kinds of presentations and art. Over the years, the building changed, and the galleries became more uniform in appearance. Windows were covered and partition walls erected, blocking out daylight and views of Stockholm. In our vision of a renovated Nationalmuseum building, daylight is let in and diversity of style, colour and ornamentation will be reinstated. The varied environments can be utilised to create a more multifaceted art experience.

The Nationalmuseum specifies the requirements and describes to the property owner, the National Property Board, how
we want the building to be used and experienced. Solutions will then be designed together with specialists in various fields of technology, and especially in collaboration with Wingårdhs Arkitektkontor and Kardorff Ingenieure Lichtplanung. The Museum has extensive practical and theoretical expertise, but now that the refurbishment opens up for new solutions, along with exciting new developments in lighting, we realised there is a need to experiment and learn more. The Nationalmuseum’s Light Lab is one example of our efforts to build a Nationalmuseum for the future.¹

The original purpose of the Light Lab was to serve as a tool for specifying the Nationalmuseum’s requirements on a control system for the new lighting. We wanted to launch a pilot experiment, with a trial installation in one of the exhibition spaces. However, in order to assess the control system we wanted the lighting scenarios to be relevant to our exhibition activities. In that way, the experiment had multiple aims. We were able to learn more about the capacity we wanted the new control system to have, and could also test and assess how art is perceived in different qualities of light. By making the lab public, we could also involve our visitors. We were able to inform the public about the ongoing refurbishment project, and exemplify what we were doing to create the future museum. We also gave visitors opportunities to learn more about Solid State Lighting (SSL) and to test different kinds of lighting and consider how light and colour influence what we see.

Light is crucial to how we experience art, and there are important questions about what will be required of the Nationalmuseum’s new light sources. What qualities should the light have in order to offer museum visitors rewarding experiences of art? How can we minimize the detrimental effects of illumination on light-sensitive objects?

Technical progress is swift. SSL lighting has developed into one of the most interesting options for illumination today. As the qualities of SSL differ from traditional lighting, we must gather information about the new possibilities of this light source.

Thus we designed an experiment where we tested how paintings are experienced under SSL where white light has different warm or cool tones. We explored the effects of light on paintings with different subjects and characteristics. 17th-century paintings...
of exteriors with many shades of red and brown were compared to landscapes and plein-air paintings from the 19th century with bright-blue skies and fresh green hues. To introduce still another dimension, we also tested how the experience changed depending on whether the paintings were hung on a white or grey wall.

The visitors’ experience is crucial, but in order to protect light-sensitive pigments and materials we are also looking for lighting that exposes works to the least possible risk. We want light that is free from damaging infrared and ultraviolet rays. So as to further protect the artworks, the brightness and duration of light-exposure should be limited. There are many SSL lights to choose from today, with new varieties popping up all the time.

The light quality is essential to minimising the damaging effects of SSL light. In our search for suitable museum lighting, therefore, we performed both technical and visual studies. A survey was carried out in consultation with the Getty Conservation Institute in Los Angeles, and the Kunstakademiets Konservatorskole in Copenhagen.

Based on our description, the Stockholm-based company Transpond created an installation, a control programme and a control interface that made it easy to adjust colour temperature (Kelvin) of the SSL lighting via an iPad. Visitors could adjust the lighting themselves, choosing between three scenarios (Figs. 1 and 2). In scenario A, the works and the surrounding walls were illuminated with a fairly warm light (3200 K). In scenario B, the light was somewhat colder (4000 K), while scenario C simulated daylight (5600 K). The paintings were exposed to light corresponding to 200 lux.

Visitors were invited to activate scenarios A, B or C via a touch screen, and to note how the lighting temperature and wall colour affected their experience of the work of art. They were asked, among other things, how the colours, contours and volumes appeared in warm and cold light. We also asked them whether they thought the 17th-century interiors looked better in one lighting and the landscapes in another. Moreover, they were requested to consider whether the wall colour influenced the impression.

Workshops were organised for staff and colleagues from other institutions. The first workshop was held when the lab was inaugurated during the Nationalmuseum’s two-day conference and workshop *The Future’s Bright: Managing Colour Change in Light Sensitive Collections* (Fig. 3). Workshops were subsequently held with the Nationalmuseum’s curators, educators and conservators, and with the Friends of the Nationalmuseum and groups of colleagues from other museums in Stockholm.

All workshop participants were requested to fill out a questionnaire relating to the three lighting scenarios (Fig. 4). Unfortunately, we were unable to let all museum visitors answer the questionnaire, but 145 people who took part in guided workshops replied in writing. Although this is not a huge statistical base, the data nevertheless gives some guidance. Everyone who

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Fig. 4 The questionnaire was a simplified version of questionnaires used in assessments at the Getty Conservation Institute, Los Angeles, which we were able to participate in thanks to GCI senior scientist James Druzik’s generosity and commitment to our project. Each scenario was followed by the questions above. Participants were also able to add free-text comments to each question.
responded either works with art or frequently looks at art. Ages varied from 25 to 84.

The majority of respondents preferred 3200 K, saying that colours and details were clearer at that strength. 4000 K and 5600 K were perceived as more acceptable lighting for art hung against a grey wall section. The alternative that scored the lowest was art hung on a white wall with lighting set to 5600 K. The white wall looked blue in the cold light, and this had an unfavourable effect on how the colours were experienced.

The survey results clearly indicated that the viewer experience was affected more by the wall colour than by the colour of the light. Paler paintings were to their advantage against a light wall. Darker paintings looked better against a dark wall. The 17th-century interior with a black frame looked veritably lifeless against a white wall. The contrast between the painting and the wall was too stark. Rather than being revolutionary or astonishing, the survey results confirmed long-established colour theories. To refine our results, we could proceed by examining how age, profession and personal opinions on development and change have influenced the answers.

Choosing to install SSL lighting with a fixed colour temperature is one alternative. Having a lighting engineer choose and manually set the lighting using individual lights with a range of fixed settings is another. But today it is also technically possible to use tunable lights that are all individually adjustable via the control system, and thus optimizing the settings for each indivi-

Fig. 5 Interface for advanced lab functions accessible only to Nationalmuseum staff demonstrating the lab in connection with workshops. These functions were locked for visitors who did not participate in a guided presentation of the lab.
dual work of art. Our question was whether such a system would be viable for us. In order to evaluate and learn more about how light affects the experience of art, we organised another, more advanced, workshop.

One question we asked ourselves was if a plein-air painting made in the cold light of Sweden’s northern latitudes would benefit from colder lighting. Another question was if an interior painted in warm hues would appear more appealing in warm lighting resembling that of wax candles and halogen. For this evaluation, we commissioned Transpond to design a more advanced programme and interface than in the three scenarios described above. The SSL lighting we tested was tunable white, and the workshop participants were able to control individual spotlights and wall washers. The colour temperature and brightness were more or less infinitely adjustable. The colour temperature could be varied from 2700 K to 5600 K. Brightness was between 0 and 200 lux (Fig. 5).

Participants concluded that the green landscape with a very blue sky was benefited particularly from colder light. It was also interesting how the perception of the time of day depicted in the painting was influenced and seemed to change. At 3200 K, Edvard Bergh’s painting *Summer Landscape* (Fig. 6) was seen to portray a scene on a hot summer’s day at noon. In colder light, it suggested early morning before full sunrise, or the “blue hour” at dusk. In a painting by Anders Zorn, *By Lake Siljan* (Fig. 7, hung on a wall not shown in the image of the laboratory), representing a nude woman just before or after bathing, the lighting was even more crucial. At 3200 K, the bare skin seemed warmed by sunlight at lunchtime, when the sun is at its zenith. In colder light, the scene could be interpreted as a morning or evening swim.

![Fig. 6 Edvard Bergh (1828–1880), Summer Landscape, 1875. Oil on canvas, 60 x 90 cm. Nationalmuseum, NM 3084.](image)
Studying Gustaf Rydberg’s painting *Spring in Skåne* (Fig. 8) provided further insights. It would appear that we who live in the north, and who long for sunlight for large parts of the year, have a highly-developed sensitivity to variations in daylight. This is probably accompanied by a well-developed understanding of different kinds of snow. In cold light, Rydberg’s spring landscape awoke a lively sensation of ice melting and the first warm rays of sunshine in spring. In warmer light, the scene was perceived as a lifeless, dirty landscape without any spring feeling.

Our conclusion was that it can be interesting to enhance various moods by means of colour temperatures. Nevertheless, we find it hard to envision how tunable white could be used throughout the Museum. Technically, it would be possible. However, as we see it today, such a system would be expensive and not particularly user-friendly. It may, however, be viable and interesting for showing art in specialised presentations in smaller exhibition spaces. It could also be used for enhancing artefacts in display cases, for instance by using warmer light for gold objects, and colder light for silver.

For more complex displays in large galleries, however, with many art works hung in tiers on the walls and with sculpture and display cases standing on the floor, a uniform colour temperatu-
re would be preferable. We have not yet decided which Kelvin degree to use. Until we have made this decision, we are monitoring developments closely, focusing especially on ongoing or completed projects in other museums around the world. In addition, we have to evaluate the best alternative for combining artificial light with daylight. It will also be essential to choose wall colours that harmonise both with the architect Friedrich August Stüler’s 19th-century building and with the Nationalmuseum collection. One of the objectives of the refurbishment is to create a modern museum where architecture and art interact to offer a powerful art experience. Our experiences from the Nationalmuseum Lighting Lab have brought us closer to achieving that goal.

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