Cultures of light : contemporary trends in museum exhibition

Katzberg, L.M.

Publication date
2009

Chapter Three
Blacklight Boundaries: Exposing Ultraviolet-Induced Visible Fluorescence

> Under special cultural conditions light enters the scene of art as an active agent [….] (303)
> Rudolf Arnheim, *Art and Visual Perception*

Precipitated by the current advancements in lighting technology, at no other point in history has light been more actively deployed in museum exhibitions than in recent years. In *Art and Visual Perception* Rudolph Arnheim argues that light is an "active agent", which is the motivational phrase for this chapter. The phenomenon of light, its intensity or absence, is an active part of all museum exhibitions. I argue that the application of various wavelengths of light enhances the viewer's sensorial experience. Without light, museum viewers would be unable to see the artefacts on display, yet with the proper lighting conditions viewers can have an unimpaired, stimulating multisensory experience. In short, light is the primary tool of visibility. This chapter takes a specific angle on this truism by dealing with blacklight, which is a part of the *in*visible electromagnetic spectrum but nevertheless contributes to visibility. Blacklight is increasingly being used in many museum exhibitions for a variety of purposes. Through discourse analysis I will consider three recent exhibitions that employ blacklight as an active agent: *Fluorescent Minerals from the Permanent Collection*, a major new permanent display at the University of Richmond Museums established in 2004; *Night Owls*, a 2005-06 temporary solo exhibition at the Centrum Kunstlicht in de Kunst in Eindhoven, The Netherlands; and *Piet Mondriaan: The Transatlantic Paintings* at Harvard University's Busch-Reisinger Museum in 2001. My discussion of the application and effects of blacklight upon the objects in these exhibitions will assist me in uncovering the active agency of various specific wavelengths of light.

Within the museum environment, blacklight is a useful tool that goes beyond its already understood functions.[1] It is a special lamp source emitting both visible and invisible light energy that cloaks its environment with an unusual tinge of violet

[1] In this chapter I have chosen the word "tool" over "medium", which I used in the first chapter, in order to emphasize my notion that light is used calculatedly to further the programmatic goals of the exhibition and its designers.

colour. Blacklight as such can thus be compared to paint or to other malleable artistic media. It is a type of light that exposes hidden aspects of objects. It is not light in the usual sense of the word because it emits little luminous intensity in the visible range (hence its name). Instead, it makes objects visible selectively.

Not only does blacklight make certain aspects of objects visible while obscuring others, but it also "colours" our viewing experience. It can change the colour of a mineral specimen, uncover long-hidden details of a painting or alter our perception of space. Therefore, I would like to suggest that blacklight acts as a permeable and unstable mediator between the artefact and viewer. I consider blacklight not merely as a utilitarian tool, but rather as a mode of expression employed during the informative and creative activity of exhibiting objects and artefacts in museums. In that sense, blacklight can be seen as what Susan Star and James Griesemer have called a "boundary object" (392-93). As Star and Griesemer explain in "Institutional Ecology, 'Translations' and Boundary Objects", boundary objects have at their core the ability to communicate and translate between different communities of practice. They consider as a community of practice the social learning that occurs when people who have a common interest in some subject or problem collaborate over extended periods and/or distances to share ideas, build innovations and find solutions.

I suggest that blacklight can be considered a boundary object because it likewise assists what I call communities of practice to communicate not only amongst themselves, but also, through the use of blacklight as a boundary object, to translate their ideas between different communities of practice. In this chapter I maintain that a case can indeed be made that the phenomenon of blacklight fluorescence is a conceptual boundary object in the sense of Star and Griesemer, that is, as a communication tool.[2] I would like to stress here that blacklight functions within the museum at different levels of knowledge. It acts as a pedagogical tool in exhibition spaces and as a forensic instrument in the conservation and research areas. Through the analysis of my three case studies, I will substantiate my assertions and hypothesize on the usefulness of considering blacklight as a boundary object.

Firstly, I elucidate the phenomenon of blacklight fluorescence, from its discovery through to its current museological use, after which I proceed to explore the three aforementioned cases where artists and museum staff deploy the effects of the tool of blacklight in pursuit of various goals. Secondly, I will discuss and define the

[2] Sunlight, or daylight, as it is termed in the museum lighting profession, might also be considered a boundary object when used for specific illumination tasks, but this is not the focus here.

notion of a boundary object in terms of its applicability to blacklight and its ability to communicate and translate between various communities of practice. Finally, I will conclude with some remarks about the usefulness of blacklight as a boundary object in a museological context.

What's in a Name?

On his deathbed, Victor Hugo uttered the enigmatic words "I see black light".[3] What he could have possibly meant by this remains obscure, as the word "blacklight" is an oxymoron, a contradiction in terms, because the first half of the word refers to darkness and the second to lightness, two meanings that can cancel each other out. The presence of light makes objects observable and darkness obscures them, therefore rendering the word and concept paradoxical. *The Oxford English Dictionary* defines the compound word blacklight as "light-rays beyond the two ends of the visible spectrum; invisible ultra-violet or infra-red light". Blacklight is a generic term related to the two specific physical phenomena of ultraviolet (UV) and infrared radiation (IR). In this chapter I will focus exclusively on the former. Therefore, I will henceforth use the more specific term "ultraviolet light". A fluorescent tube is the form of ultraviolet light we are most familiar with, as it is frequently experienced in nightclubs or amusement parks, and increasingly now in museums. These tubes emit large quantities of ultraviolet radiation and, at the same time, block out virtually all visible light above 400 nanometres (nm), emitting a small amount of light in the visible violet range. The word "light" in this context is therefore problematic; it is a misnomer. By definition, ultraviolet is beyond the visible spectrum and therefore not visible to the naked eye.

In 1801, German physicist Johann Ritter (1776-1810) discovered ultraviolet radiation using silver chloride, a light-sensitive compound, to show that there was a type of invisible "light" beyond violet, which he called chemical rays. In his weblog David Bryson describes Ritter's discovery as follows:

> [Ritter] covered paper with damp freshly prepared silver chloride and let the solar spectrum act on it in a darkroom, he saw that the action began first beyond the ultraviolet and only then proceeded towards the violet. He also noted that silver chloride paper already exposed to diffused daylight that had turned slightly dark had become darker in the violet end of the spectrum but lighter in the in the red end. This observation first pointed to the antagonism of the chemical effect of violet and red light.[4]

[3] Last words (22.05.1885); quoted in *Olympio, ou la vie de Victor Hugo* by André Maurois (1954).
[4] Bryson, D. "What is Fluorescence?" Accessed 20 May 2006. <http://www.cladonia.co.uk/what-is-fluorescence.html>.

At that time, many scientists, including Ritter, thought that light was composed of three separate components: an oxidising or calorific component that we now call infrared, an illuminating component (visible light), and a reducing or hydrogenating component that we label ultraviolet. The unity of the different parts of the spectrum was not understood until about 1842 with the work of Macedonio Melloni (1798-1854), who is notable for demonstrating that radiant heat has similar physical properties to those of light, and Alexandre-Edmond Becquerel (1820-1891), who discovered the photoelectric effect, a phenomenon in which electrons are emitted from matter after the absorption of energy from electromagnetic radiation such as light. During that time, ultraviolet radiation was also called "actinic radiation".

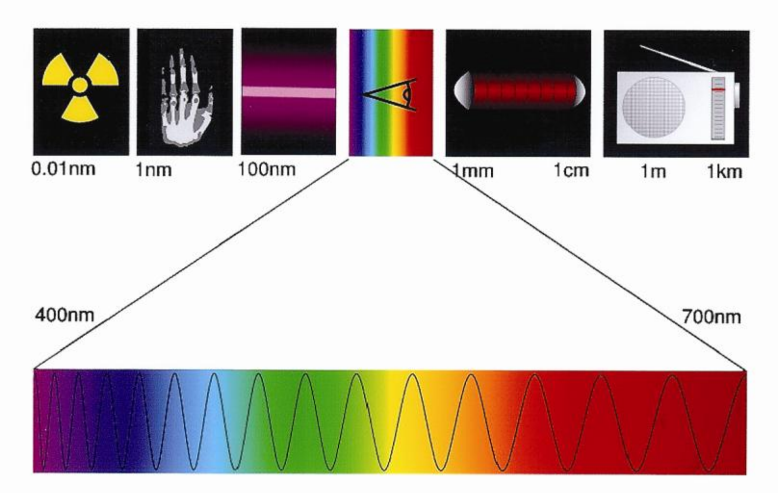

Figure 3.1. Two views of the Electromagnetic Spectrum depicting wavelength distances (below) and icons (above). Wikimedia Commons. Copyright free.

During the last quarter of the nineteenth century the electromagnetic spectrum was codified into the scale used today. Figure 3.1 illustrates the different parts of the electromagnetic spectrum in relation to their wavelength. A more precise examination of the wave model of light provides information necessary for a more complete understanding of ultraviolet light. The length of its wave differentiates the parts of the electromagnetic spectrum. The sine wave diagram, shown in the lower part of figure 3.1, gives visual form to this description of electromagnetic energy. Best-practice handbooks such as *Light and Ultraviolet Radiation* (2000) prepared by the Australian Heritage Collections Council put forward that:

> Energy in the diagram is travelling horizontally. As it travels, it moves in a wave motion passing through peaks and troughs. The distance between the peaks of the waves is called the "wavelength" and is measured in nanometres. There is a mathematical relationship between the amount of energy transmitted and the wavelength of the radiant energy – namely, they are inversely proportional. In other words, the longer the wavelength the less energy transmitted, and the shorter the wavelength the more energy transmitted. (10)

Radio and microwave radiation have relatively long distances between the peaks of their oscillating energy waves, while infrared and visible spectrum radiation reside in the middle region of the continuum. Ultraviolet, x-rays and gamma rays have very short distances between peaks and hence short wavelengths. The behaviour of electromagnetic radiation depends upon its wavelength, with shorter wavelengths carrying more energy. This is why prolonged exposure to light in general and ultraviolet light in particular, damages certain types of sensitive museum artefacts, as evidenced by the fading of textile and paint pigments. Ultraviolet light has visible effects on physical objects, which are sometimes detrimental. That is, its effects affect objects. Garry Thomson, author of the industry-standard textbook *The Museum Environment* (1986), argues "that all organic material is at risk under light" (2). The extent of the damage is contingent upon the length of the exposure time and the specific wavelength of the light.

Visible light radiates at wavelengths between 400 and 700 nanometres and is further categorized into a spectrum of red, orange, yellow, green, blue, indigo, and violet light. "We see these distinct colours because the different wavelengths have different energies, and so affect our eyes differently" (11). However, ultraviolet light radiates at shorter wavelengths, between 10 and 380 nanometres. The ultraviolet portion of the electromagnetic spectrum is further sub-divided into three divisions according to their wavelength region: UV-A (380-315 nm), UV-B (315-280 nm) and UV-C (< 280 nm). According to the US National Park Service (2000) and others, UV-A and UV-C are the most useful for examining museum objects. Specific wavelengths are also useful for other exhibitionary purposes.

In order to articulate the effects of ultraviolet light, there are a few more terms that need clarification. In much literature the three terms *luminescence*, *phosphorescence* and *fluorescence* are often used indiscriminately; this can lead to confusion and it is therefore useful to clarify them here. Both fluorescence and luminescence refer to the emission of visible light from a substance when exposed to visible or invisible radiation. Luminescence is usually associated with infrared radiation and will therefore not be addressed here. According to the Thomas S. Warren Museum of

Fluorescence in Ogdensburg, New Jersey, phosphorescence refers to the continued emission of visible light from a substance after being irradiated with ultraviolet light. A well-known but often misunderstood example of this is the common fluorescent tube, which is internally coated with phosphors. A phosphor is a substance that exhibits the phenomenon of phosphorescence. Phosphors are transition metal compounds such as mercury, or rare earth compounds that emit visible light under certain conditions.

As I discussed in chapter one, a fluorescent lamp is a type of lamp that uses electricity to excite mercury vapour in argon or neon gas resulting in a plasma that produces ultraviolet radiation. In this respect, fluorescent tube lamps are similar to neon tube lamps used for building signs and also employed by a relatively small group of neon-artists such as Bruce Nauman (1941-), Christian Herdeg (1942-) and Jeffry Chiplis (1952-), who salvages and recycles neon which has acquired what he calls a "patina of time".[5] The radiation then causes a phosphor to fluoresce, producing visible light. Fluorescent ultraviolet lamps are typically manufactured in the same fashion as normal fluorescent lamps except that only one phosphor is used and the normally clear glass envelope of the cylinder is replaced with Wood's glass, a deep bluish-purple nickel oxide, cobalt oxide-doped glass which blocks virtually all visible light above 400 nanometres. Robert W. Wood devised this type of glass in 1903. In exhibition spaces fluorescent tubes are often used because of their liner configuration, omni-directional dispersion characteristics and ease of installation. But in the investigative environment of the conservation laboratory, the fluorescent tube is less-often used, in favour of two more accurate emission devices that emit UV-A and UV-C wavelengths within a range of precise parameters. This range is important, because it clearly illustrates the plasticity of ultraviolet light. In other words, ultraviolet light is not a fixed commodity. It occurs along a continuum and has affective properties at different points along that continuum. Various materials fluoresce differently at different wavelengths, as can be observed in figure 3.2. In this display materials exposed to ultraviolet light fluoresce in a wide variety of colours according to their physical composition. Thus, the concept of fluorescence is of primary importance to this chapter.

[5] For an extensive list of artists employing neon light see http://www.neonshop.com/museneon.html. Personal correspondence with J. Chipless on 24 Mar. 2009.

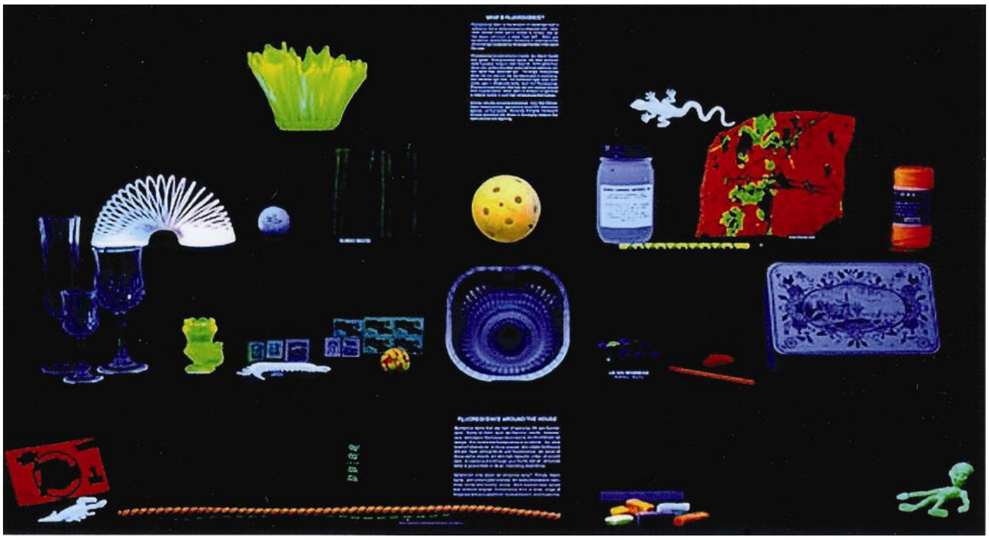

Figure 3.2. Artefacts fluorescing under ultraviolet light. Image © 2001, Tema Hecht, Thomas S. Warren Museum of Fluorescence.

Induced fluorescence is coloured visible light produced by the direct action of the properties of ultraviolet light. The deliberate inducing of fluorescence, it can be argued, is one way museum agents make ultraviolet light an active ingredient in exhibitions. According to the University of Richmond Museum, the phenomenon of fluorescence has been observed for more than a thousand years, yet it was not until the 1850s that George Stokes, a professor of mathematics and physics at Cambridge University, coined the term "fluorescence" after the mineral fluorite that sometimes glows blue in unfiltered direct sunlight. In lay terms, when something fluoresces it is said to "glow from within". All fluorescence involves the addition of energy by some means to a substance, artefact or object, and the reemission of part of that energy as visible light. The schematic molecular-level diagram in figure 3.3 illustrates this sequence of action of ultraviolet light on a substance. Beginning from a normal or resting state, an electron firstly absorbs light energy. This absorption excites the electron and precipitates its move to a higher energy level. When the electron returns to its normal energy level, visible light is emitted and can be seen with the naked eye. This diagram graphically illustrates the process whereby objects are induced to fluoresce, whose aesthetic outcome is dramatically and colourfully illustrated in the display in figure 3.2. Aesthetically speaking, the visual effect of fluorescence upon various artefact materials is what makes the exhibit visually stimulating, but it also creates knowledge in the mind of the viewer by aiding the interpretive process.

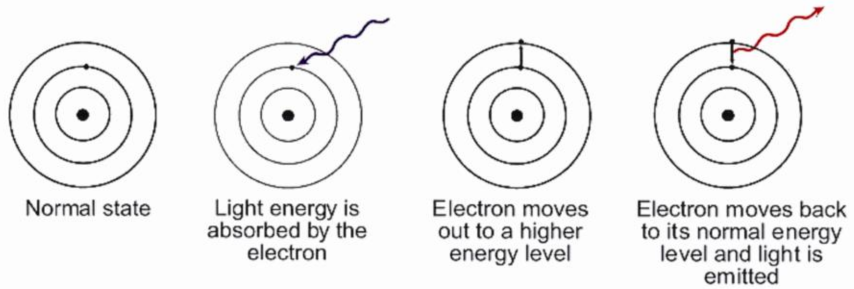

Figure 3.3. Diagram showing the sequence of the action of ultraviolet light on a substance. © D. Bryson.

Figure 3.2 displays different objects including plastic, glass, paper, porcelain and textiles seen under the effects of ultraviolet light. That is, they are emitting different spectra of visible light energy rendered in different colours. Because many synthetic and natural materials transform ultraviolet radiation into a specific colour of visible light, it is useful for the examination and exhibition of museum artefacts. "Ultraviolet-Induced Visible Fluorescence" is the term used by museum professionals to denote the practice of using ultraviolet light as a pedagogical, exhibitionary and investigative tool. This induced fluorescence is the unifying feature of the three case studies included in this chapter as well as the core of my argument that ultraviolet light constitutes a conceptual boundary object. Fluorescence has been induced, albeit in different ways and for different reasons, in each of the three cases I analyze in this chapter.

The cases are presented here in terms of their sites of production (the gallery, the vitrine and the website), while paying particular attention to the technological modalities occurring at these sites. Let me also make clear at the outset that I am working with images that only partially represent whole exhibitions. They depict, respectively, a collection of specimens, an artwork installation and a photograph of an irradiated oil painting. Earlier I suggested that ultraviolet light is being used as a pedagogical, exhibitionary and investigative tool. In my analyses below, I will follow these avenues of inquiry in order to uncover to what extent ultraviolet fluorescence affects museum viewers at various sites of production.

Revealing Ultraviolet

The first site of production is a display vitrine in an exhibition mounted by the University of Richmond Museums entitled *Fluorescent Minerals from the Permanent Collection*. In the Lora Robins Gallery of Design by Nature there is a geological exhibition taking place enclosed in six newly reinstalled vitrines containing mineral specimens from the Franklin-Sterling Hill district of northern New Jersey. In this region collectors have discovered at least eighty varieties of fluorescent minerals. This is more than any other site in the world. With a flip of a switch, more than 350 mineralogical specimens fluoresce revealing brilliant green, red, purple and chartreuse colours (fig. 3.4). In this exhibition the minerals are exposed to both long- and short-wave ultraviolet radiation in order to bring out different colours, on occasion in the same specimen. Laura McGlasson-Robbins and S. A. Dulany-Hunter donated the collection of minerals to the museum in two allotments in 1977 and 1982.

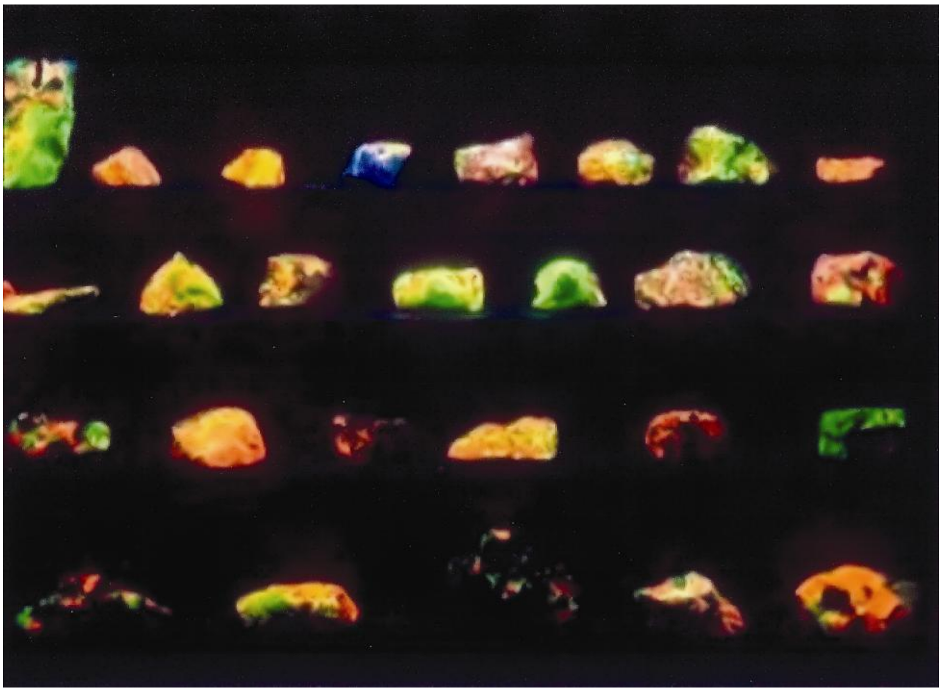

Figure 3.4. Mineral specimens exhibiting fluorescence under short- and long-wavelength UV light, 2003. © University of Richmond Museums.

The current exhibition was co-curated by assistant director N. Elizabeth Schlatter and research fellow Michael Reimer. When certain minerals are exposed to different spectra of radiation, electrons within their atomic structure absorb some of the energy and become excited. To return to their original state, these atoms eject this newly acquired energy as photons of visible light, which results in the unusual colours that are not visible under ordinary daylight conditions.

This exhibition belongs to a select group of specially illuminated geological exhibitions where various wavelengths of light are deployed to illustrate scientific principles in a visually stimulating mode. The technological modality of ultraviolet light has been used here as a visual channel of communication to translate the scientific principles of mineral fluorescence to museum viewers. The physical principle of fluorescence is transformed from an unseen phenomenon to an observable and visually stimulating experience that instructs the viewer.

For my study, the pivotal point of this exhibition is that knowledge is produced by this visible experience. This knowledge production is made possible primarily by the inducement of ultraviolet light. The colours and shapes of the specimens teach the viewer about the molecular composition and structure of various elements and compounds. Because elements are unique substances, which are organized by the periodic table of the elements, they fluoresce with a specific colour. In figure 3.4 specimens that are purer fluoresce with a (more or less) single colour. In distinction to elements, compounds are combined from different elements. They exhibit different visual properties when fluorescence is induced. The specimens that exhibit multiple colours are interpreted by the viewer as compounds. Thus, this display illustrates the conceptual difference between compounds and pure elements with the aid of ultraviolet light. This concept is mapped onto the specimens by ultraviolet light. Therefore, ultraviolet light, I suggest, is a pedagogical tool that teaches by showing us different "faces" of an object, previously unseen. We learn that when specific minerals absorb invisible energy, visible light is produced. The colour and intensity of the fluorescence is directly related to the specific mineral or compound, and the wavelength of the ultraviolet light. The light thus instructs us in the physical interaction of light, energy and organic elements and compounds.

FLY BY NIGHT

At the second site of production, Eindhoven, the celebrated city of lighting research and manufacture which is home to the Koninklijke Philips Electronics Corporation and the Centrum Kunstlicht in de Kunst (Centre for Artificial Light in Art), the issue of exhibition illumination arises. This issue comes up, in particular, as the issue of lighting an exhibition space exclusively with the medium of ultraviolet light. This mode of lighting is distinguished from the use of ultraviolet light as a pedagogical tool that I analysed in the previous section. Here, in a darkened space, ultraviolet light is employed as an exhibitionary tool and agent. Two types or categories of objects are on display – the artwork itself and the illumination tool as such. A violet "haze" pervades the exhibition space. It gives the impression that there is a fusion between the exposed and the exposing agent. Ultraviolet light penetrates the surface of the object, unleashing a vibrant display of colours, while at the same time skewing our visual perception.

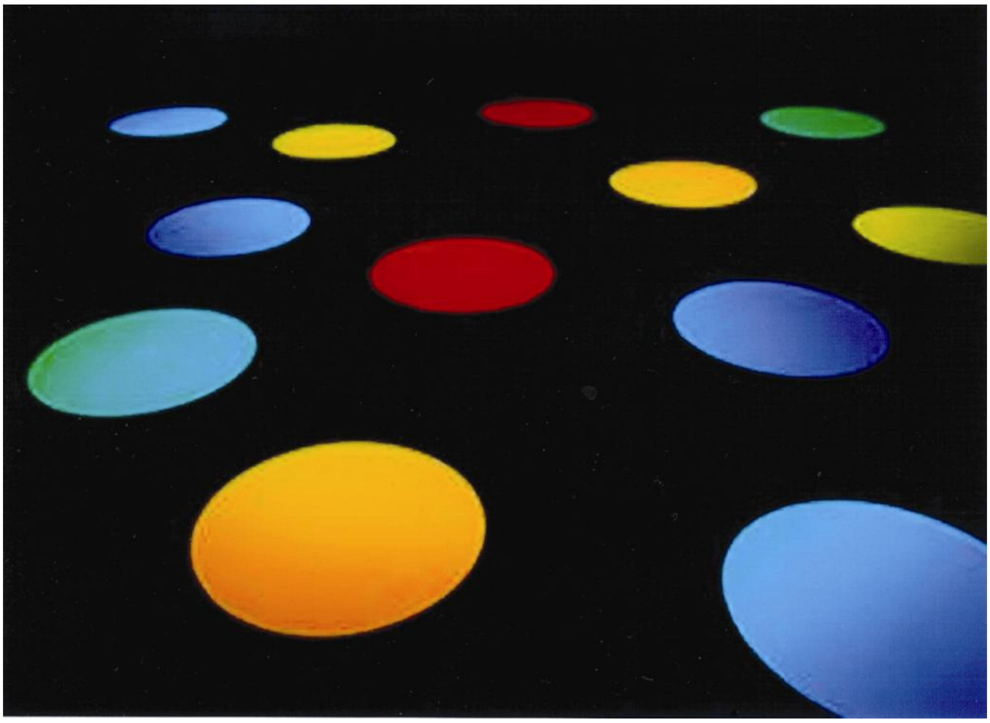

Figure 3.5. Regine Schumann. *Nachtschwärmer*. Centrum Kunstlicht in de Kunst, 2005.

Night Owls is a solo exhibition of the works of German artist Regine Schumann (1961-). In her work Schumann often uses materials that fluoresce under ultraviolet illumination. At this particular site of production, Schumann has created artworks and installation pieces that require ultraviolet light to achieve the desired artistic effect and at the same time affect the viewer's perception. Figure 3.5 is an installation shot of the work entitled *Nachtschwärmer* (*Night Butterfly*), which is installed in a large gallery lit exclusively by ultraviolet light. Forty (almost) flat discs measuring 80 centimetres in diameter are dispersed around the black-carpeted gallery floor. The discs are comprised of a plastic material that – under daylight conditions – is an unremarkable whitish colour. However, when illuminated by ultraviolet light they fluoresce brightly in many of the primary colours comprising the visible spectrum. In this disconcerting "landscape of light and colour" viewers are encouraged to move the discs around so that the *Nachtschwärmer* metonymically moves through the "night" of the gallery.[6]

Figure 3.5 is somewhat confounding and so was the installation. The artwork affects our equilibrium to a great degree by throwing the viewer slightly off balance when first entering the gallery. This spatial incongruity occurs because the discs are shallowly convex on their underside, creating a small, but perceptible space between the brightly fluorescing disc and the matte black floor, which makes the discs appear to float in an empty space whose dimensions cannot be easily assessed. The spatial incongruity affects the viewers' perception of the artwork. Perception, or the process of becoming aware through the senses, influences the visitors' reception of the artwork. If the discs were completely flat, viewers would perceive the installation differently. If this were the case, viewers would experience an installation piece with clear boundaries that would not throw them off balance and upset their equilibrium; the installation would affect them to a lesser degree. Additionally, I argue that it would not be so successful or visually stimulating. Because of the time necessary for human ocular acclimation and the high contrast between the fluorescing object and dark floor, the viewer is initially hesitant to meander through the gallery for fear of falling through the black hole suggested by the interstices between the discs. Because of the perceived spatial discontinuity between the discs and the floor, viewers are overcome by a feeling of disassociation or separation from their surroundings. This sensation lends another dimension to this installation, namely that of *dis*orientation. It is therefore crucial for the discs to be elevated from the floor as much as for the exhibition space to be illuminated by ultraviolet light.

This exhibition also belongs to the group of exhibitions I mentioned before that use ultraviolet light as a primary exhibition illumination tool. Light as tool is pedagogical, it teaches us; in this case that our vision is not completely reliable. Therefore, it compels us to tread lightly because our equilibrium has been thrown off to a great extent. The title of the exhibition, *Night Owls*, alludes to the notion of acute

[6] See: http://www.kunstlichtkunst.nl for a description of the *Night Owls* exhibition, primarily in Dutch.

perception in a darkened environment. The noun "night" denotes the period of darkness occurring between one day and the next, as well as corresponding to the virtual darkness of the exhibition. Owls are nocturnal creatures that have the innate ability to see extremely well at night. Viewers are also "night owls" in this exhibition space. Through the tool of ultraviolet light they are extended the ability to see the objects on display and be physically affected by them during the course of an embodied experience. This effect is primarily achieved by exposing the objects on display in literally a different light.

Penetrating Mondriaan

In the 2001 exhibition at Harvard University's Busch-Reisinger Museum entitled *Piet Mondriaan: The Transatlantic Paintings*, two sites of production solicit my interest in ultraviolet light: the conservation laboratory and the online exhibition. Various wavelengths of ultraviolet light were used as one of the primary investigative tools deployed to uncover long-forgotten or undocumented evidentiary information about this famous group of paintings. After an extensive investigation lasting several years, two types of exhibitions were created, a gallery exhibition and a virtual (online) exhibition. At both sites ultraviolet light was used as an investigative and interpretative tool.

The transatlantic paintings are a particular group of works by the early-modernist Dutch painter Piet Mondriaan (1872-1944). The exhibition of these paintings became an "analytical tour de force" write Ron Spronk and Harry Cooper in their introduction to the accompanying exhibition catalogue with the same title. Cooper explains that the transatlantic paintings are the seventeen identified works that Mondriaan started (and in some cases finished) in Paris in 1935-38 and London in 1938-40, and then finished (or else refinished) after his arrival in New York in preparation for a solo exhibition. Mondriaan arrived in New York on October 3, 1940 and in December of the same year the first shipment of his European works appeared on American shores. The works are termed "transatlantic" not just because they crossed the ocean during Mondriaan's lifetime, but because he worked on them in both Europe and the United States of America. [7]

Before work on the gallery and online exhibitions could proceed, investigative work needed to be concluded elsewhere. In the conservation laboratory, ultraviolet

[7] The phrase "transatlantic paintings" is not self-explanatory. Cooper explains the origin of the term in his catalogue essay, "Looking Into the Transatlantic Paintings" as follows: "The term 'transatlantic paintings' was coined by Kermit Champa in *Mondrian Studies* (1985) and endorsed as an 'apt term' by Carel Blotkamp in *Mondrian: The Art of Destruction* (1994)".

light was used to reveal elaborate revisions undertaken by Mondriaan in the bi-continental works. During the investigation process, executed by three staff curators, ultraviolet light was a primary tool used in conducting, what one curator called, "forensic art history". Already by the late-1920s, the usefulness of ultraviolet light for examining artworks and artefacts was known to museum professionals. In 1931 James J. Rorimer, the then assistant director of New York's Metropolitan Museum of Art, published a seminal book entitled *Ultra-Violet Rays and Their Use in the Examination of Works of Art* (1931) wherein he set out best-practice guidelines on how artworks were to be examined and what the findings might be. Ultraviolet light, he revealed, assisted in identifying pigments through induced fluorescence. For example, Zoe Ingalls remarks in "Seeing the Hidden History of a Great Painter's Work" that "the cadmium yellow that Mondriaan used in Europe fluoresces orange-red, but the yellow he used in New York does not" (3). This has allowed conservationists to chronologically map the alterations to Mondriaan's work. Visible light, infrared light, X-radiography and ultraviolet light assisted in revealing the sub-surface topography where Mondriaan removed existing paint when he added blocks of colour or repositioned some of his trademark shiny black lines. The figures below illustrate various states and views of composition *No. 4*, one of the paintings extensively examined during the investigation leading up to the exhibitions.

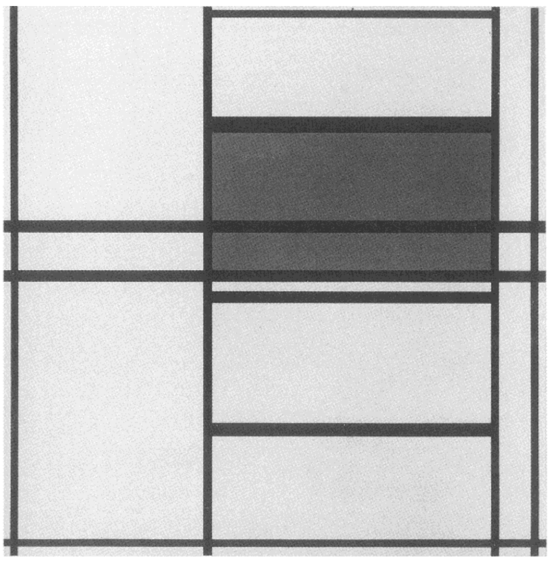

Figure 3.6. Piet Mondriaan. *No. 4*. 1938-42. First state 1939, B/W photograph. Photograph 2001 © Joop Joosten and the Busch-Reisinger Museum.

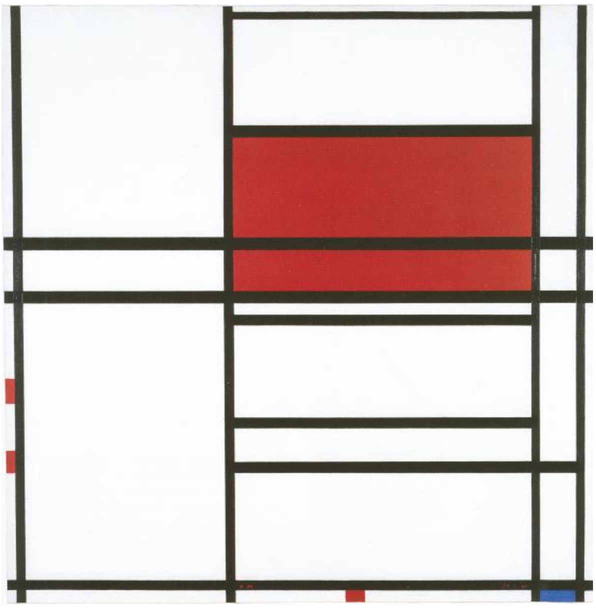

Figure 3.7. Piet Mondriaan. *No. 4*. 1938-42. Final state 1942. Photograph 2001 © The Saint Louis Art Museum and the Busch-Reisinger Museum.

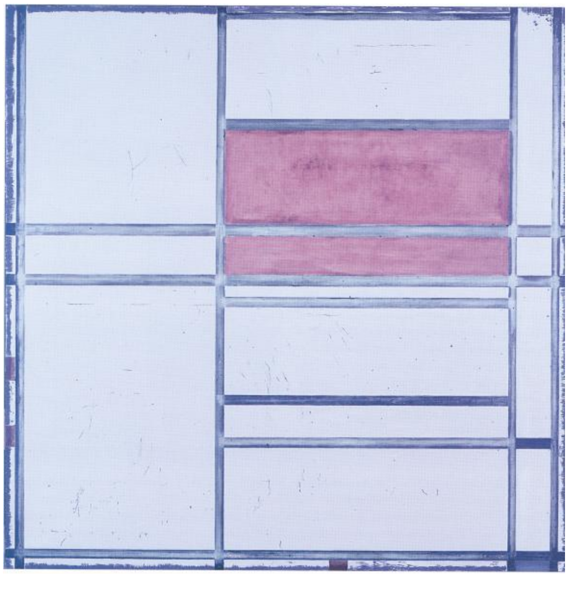

Figure 3.8. Piet Mondriaan. *No. 4*. 1938-42. Photograph under ultraviolet light. Photograph 2001 © The Saint Louis Art Museum and the Busch-Reisinger Museum.

In figures 3.6 through 3.8 three different images of the same large-format composition *No. 4* (100.3 x 99.1 cm.) are illustrated. Figure 3.6 depicts the first state of the oil on canvas work in a circa 1939 black and white photograph. Figure 3.7 depicts the artwork after 1942 in its final form, now in the possession of the St. Louis Art Museum. Figure 3.8 illustrates a photograph of composition *No. 4* illuminated by ultraviolet light taken during its examination preceding the exhibitions. The section of the accompanying catalogue essay for this work (Catalogue 9) concerning ultraviolet light describes *No. 4* in detail and is useful for understanding what ultraviolet light can expose.

> Under UV light […] a continuous, nonfluorescing (dark) strip of black paint was observed at the edges of some lines, indicating areas where white paint was scraped away and black paint was added relatively late. The second vertical from the right, for example, which was shifted to the left, has a dark strip on its left edge under UV light. [….] The far left and far right verticals have dark, narrow strips seen under UV light at their left and right edges, respectively, indicating that the widening of the left vertical occurred toward the left edge of the canvas and that of the right vertical toward the right. (175)

Ultraviolet light reveals changes made to the surface of the painting by both artist and conservator. It exposes, for example, where inpainting (retouching by conservators) has been carried out during a restoration treatment. Figure 3.8 shows areas of inpainting visible at the perimeter of the work. In the ultraviolet photograph the white paint appears dark due to the formulation and elemental composition of the particular paint used by Mondriaan. The white fields are exceptionally smooth, compared to other transatlantic paintings. It was well known at the time that the painter was concerned about the surface appearance of his works. This non-reworking of the white fields could be related to time constraints or the relatively large size of the canvas. From this investigation, curators concluded that Mondriaan added a horizontal line (the third from the bottom) and extended the line below rightward, among others. Under ultraviolet lighting conditions, both changes appear darker because they absorb more light than the other lines; however, curators are not aware why this occurs.

All three of the images are included in the online exhibition where ultraviolet photography plays a major interpretive role.[8] The website exhibition, or the second site of production, is also one of knowledge production. Ultraviolet-induced visible

[8] See <http://www.artmuseums.harvard.edu/mondrian/> for the complete online exhibition. See the accompanying exhibition catalogue for scientific descriptions of all 17 transatlantic paintings.

fluorescence was employed to make the invisible visible to virtual website viewers. The online exhibition, professionally designed and executed to accompany the gallery exhibition, pays particular attention to the investigative techniques employed before the exhibition opened. Not only does this site allow its virtual viewers to explore the depth and breadth of the artworks on display in both the Busch-Reisinger Museum and the Saint Louis Art Museum galleries, but it also facilitates different ways of knowing. That is, getting to know information about the artworks and becoming more familiar with them and the investigation techniques used in their exhibition. This function of the website was particularly important since not all seventeen paintings considered to be in the transatlantic group were included in the gallery exhibition, due to poor condition and their inability to travel.

The group of 17 "schizoid" paintings have a kind of split personality, since they can be said to have been "made" twice. Firstly, Mondriaan inscribed two different dates on many of them, stating emphatically that he intended to show the disjuncture in time and place of conception, creation and completion. Secondly, and just as importantly, this disjuncture was brought to light by investigative techniques employing, among others, ultraviolet light, creating a double exhibition of the paintings. The online site of production is comprised of 4 main divisions with up to 23 nested pages under each main heading. The framing question is: What changes did Mondriaan make? Ultraviolet light was instrumental in answering this question. On the site, Mondriaan's transatlantic works are laid out in terms of change, putting the change of physical location in relation to the changes he made to the artworks after having arrived in New York. This exhibition employs the discourse of scientific investigation with illuminating interpretation through the mediator of ultraviolet light, in order to "speak back" to its virtual and visceral visitors. The light emitted by the computer screen further emphasizes how scientific investigation generates knowledge about the artwork and empowers the hidden layers of paint, now exposed by light, to tell the painting's own story, as opposed to the narrative of the painter.

Exploring Boundaries

Museum professionals have an inherent need to communicate during all phases of the exhibition design process.[9] Communication processes are not only facilitated by physical or linguistic tools, but by conceptual tools as well. In 1989 philosophers of science Star and Griesemer coined the term "boundary object" in their article "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and

[9] For an excellent source on exhibition planning and execution, including a section on "Light", see Lord and Lord (2002).

Professionals in Berkeley's Museum of Vertebrate Zoology". They deploy this concept to understand how museum workers of different backgrounds and specializations can "maximize communication" (404). They define boundary objects as follows:

> Boundary objects are objects which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use. These objects may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation. (393)

Later in the article, they specify:

> In natural history work, boundary objects are produced when sponsors, theorists, and amateurs collaborate to produce representations of nature. [….] Their boundary nature is reflected by the fact that they are simultaneously concrete and abstract, specific and general, conventional and customized. (408)

In this article, Star and Griesemer distinguish between four kinds of boundary objects. The first kind is the *repository* where ordered "piles" of objects are "indexed in a standardized fashion" and includes libraries and museums (410). The museum itself is thus also always a boundary object. The second kind is the *ideal type*, which is an object such as a diagram that does not accurately describe the details of one thing, but serves as a means of communicating symbolically. The third kind is a *coincident boundary*, common objects that have the "same boundaries but different internal contents" (410-11). The example Star and Griesemer use is the outline of the state of California. Maps created by different communities of practice used the same outline of the state but contained different research information such as campsites and trails on one map and abstract ecologically-based life zones on another. The fourth kind of boundary object is the *standardised form*, which is a method "of communication across dispersed work groups" (411).[10]

Since its publication, the article has been widely cited in a number of different fields such as computer science, management, and sociology. Geoffrey Bowker and Star (1999) issued a revised definition of the boundary object, wherein the revisions are relatively superficial and predominantly clarifying in nature, but the following

[10] In 2001 Michael Briers and Wai Fong Chua added a fifth kind of boundary object named the *visionary* boundary object.

passage succinctly defines their status. The importance of this second definition lays in its inclusion of the phrase "communities of practice".

> Boundary objects are those objects that both inhabit several communities of practice and satisfy the informational requirements of each of them. Boundary objects are thus both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use and become strongly structured in individual-site use. These objects may be abstract or concrete […]. Such objects have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation. The creation and management of boundary objects is a key process in developing and maintaining coherence across intersecting communities. (297)

This definition expands the concept so it can be understood as a somewhat flexible bridge between different communities of practice, along which information flows. This understanding of the term "boundary object" was initially formulated in response to sociologists Bruno Latour, Michel Callon, and John Law's concept of "interessement" included in their Actor Network Theory which maps relations that are simultaneously material and semiotic. The term interessement can be understood as a process of getting the actors interested and negotiating the terms of their involvement. The primary actor exerts himself to convince the other actors that the roles he has defined for them are acceptable.[11] Boundary objects are a response to interessement that proceeds through acts of stabilization and methods of standardization, where information becomes consistent and standardized.

Such acts can take the form of the creation of a map or the use of a specific wavelength of ultraviolet light. For example, the curatorial researchers of the Mondriaan exhibition sought to identify changes to the artist's work, and through consistent use of specific wavelengths of ultraviolet light they standardized their practice, which in turn enabled other researchers to employ the same methods for other research projects. But it is the additional articulation of boundary objects provided by Wolff-Michael Roth and Michelle McGinn (1998) that is most germane to my formulation of ultraviolet light as boundary object. Roth and McGinn make an argument in their article to support the theoretical concept of inscriptions as a boundary object. According to them "[i]nscriptions are signs that are materially embodied in some medium" such as a diagram or photograph (37). They explain

[11] See, for example, Latour (2005), Callon (1986) and Law and Hassard (1999).

boundary objects as interfaces between multiple social worlds and as facilitating "the flow of resources (information, concepts, skills, materials) among multiple social actors" (42), while noting a distinction between face-to-face boundary objects and distant boundary objects. Canadian writer George Goodall describes the distinction in his weblog *Facetation* as follows:

> Face-to-face objects mediate direct communication between individuals and are available to both parties. Roth and McGinn describe boundary objects as a medium with which "to think with, coordinate […] actions, and translate initially different understandings of inscription-relevant issues". (2004: 3)

Distant boundary objects operate "[w]hen participants in a collective task are not copresent (temporally or physically)" (Roth and McGinn 1998: 43). With distant boundary objects, Goodall notes, "there is an inherent power relation between the individuals that may introduce bias into the interpretation of the object" (2004: 3).

I suggest that ultraviolet light can be both a face-to-face and distant boundary object, contingent upon the required translations, that is, the translation task it is invoked to achieve. When in use, ultraviolet light is an object because it is presented to the senses and is indirectly received by the eyes. This object is also a tool, in the sense that it is an aid to a means of expression and communication by allowing curatorial staff at other institutions to duplicate the research or exhibition practices at another site. By employing ultraviolet light artists and curators use this object as a mode of expression in a creative or artistic activity, whether creating artworks or exhibitions. When employed by the curatorial researcher, ultraviolet light is a means of translation and communication deployed to inform other museum professionals about their artefact of study.

Boundary objects have, at their core, the ability to translate and produce representations. Ultraviolet light, and the various wavelengths that comprises it, allows the curator to produce different representations. The conceptual boundary object nature of ultraviolet light is reflected in its simultaneously robust and plastic nature. It retains a common identity across great distances but also adapts to local needs. These are the primary identifying factors with which Star and Griesemer define boundary objects. The tool of ultraviolet light is robust, because it is a reproducible quantifiable commodity and it is plastic, because it occurs across a range of useful wavelengths, while retaining its ability to make other material fluoresce.

On the basis of these analyses, I propose to consider ultraviolet light as a tool through which translations take place between multiple social worlds. Star and Griesemer point out that museum work encompasses a range of very different visions "stemming from the intersection of participating social worlds" and that "[a]mong these were amateur naturalists, professional biologists, the general public, philanthropists […] and even the animals" (396). Significant for me are the "professional biologists" and the "general public" because these are equivalent to our modern day curators and viewers, the *de facto* subjects of my study. Social worlds are socially differentiated environments or spheres of influence such as academia or the popular world. The curator translates researched information for museum viewers through the active and deliberate act of exhibiting. The choice to employ the effects of ultraviolet light is an active and conscious choice made by curators and artists. Does it make a difference whether it is used by the artist as part of the artwork or is used by the curator to expose the artwork? In both cases, I see ultraviolet light as a boundary object because when both artists and curators invoke its use, they transform artefacts visually and communicate their ideas to a wider audience through the exhibitionary process.

In the case of the *Fluorescent Minerals from the Permanent Collection* at the University of Richmond, curators assembled specimens in such a way that Nature (with a capital "N") is represented in an educational light. Knowledge about physical properties of minerals is transmitted through the tool of ultraviolet light. The cause of fluorescence is translated to students and other viewers through the conceptual ultraviolet boundary object. As we know, elementary school students and curators inhabit different, but often intersecting social worlds. Ultraviolet light means one thing to the curators (a tool with which to work) but to the school children the unseen source makes the mineralogical specimens glow, seem visually stimulating and hopefully stimulate knowledge acquisition. This exhibitionary encounter teaches the school children about the physical properties of mineral fluorescence when they ask the question: Why do the rocks glow? The plasticity of the blacklight boundary object is illustrated by the use of short- and long-wave ultraviolet sources, as some compounds spectacularly fluoresce with different colours at different wavelengths. Nature, under the effects of the ultraviolet boundary object, has been represented, mapped and translated.

In the case of the *Night Owls* exhibition, ultraviolet light was employed by the artist as the primary exhibitionary illumination tool to generate the visual and physical impact of the artworks. The use of ultraviolet light brings Schumann's work to conceptual fruition and allows the viewers to experience the full force of an embodied encounter with altered perception. For, without the ultraviolet illumination of the gallery space, the artworks would remain unremarkable and, in the *Nachtschwärmer* work, the installation would lose the spatial incongruity effect I described. Because the ultraviolet light is part of the artwork, it could not be displayed without it. This does not mean, however, that it is not a boundary object, for ultraviolet light is a tool of illumination and a boundary object whether used by the artist or curator. In this case, the ultraviolet boundary object is able to translate Schumann's (trans)formation of a natural creature into an abstracted artistic representation of that creature.

In the case of *Piet Mondriaan: The Transatlantic Paintings*, ultraviolet-induced visible fluorescence was employed to penetrate the famously prepared surfaces of Mondriaan's bi-continental works. It was also deployed to peer into the hitherto unseen depths of his canvases and into the working practices of the artist himself. Ultraviolet-induced visible fluorescence enabled curators to translate, visually render and inscribe the changes made by an artist to his work over time. By the use of inscriptions (ultraviolet photographs), both printed in the catalogue and included in the online exhibition, curators were able to use ultraviolet light as an interface between different social worlds. The use of the ultraviolet boundary object has mediated the "space" between academic curator and the viewing public, enabling and fostering communication between different communities of practice and different social worlds, in this case in an expanded sense because of the use of the internet.

Also on the basis of these analyses, I would like to suggest that ultraviolet light, understood as boundary object, allows artists and curators to translate and transmit artistic or scientific meaning to the museum viewer in such a way that people of different social worlds or communities of practice can understand and visualize the representation or the discourse being articulated through the act of exhibiting. As I stressed in the introduction to this chapter, I have made a clear distinction about how ultraviolet light functions at different "levels" of knowledge. In the conclusion to this study, I add another level by investigating how the deployment of ultraviolet light can also have a formative function. There, I analyse the way one particular artist exposes knowledge about herself and by extension, the whole human race, with the use of ultraviolet light. But first, it is necessary to discuss the absence of light, or darkness, not only because this is a necessary ingredient for exhibitions involving ultraviolet light, but also because darkness is inevitably tied to any consideration of light and its exhibitionary capacities.