Light and Humans

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"Turn your head toward the light, and the shadows will fall behind you"

- Maori Proverb heard in New Zealand, Christmas day 2010

Register

We learn to trust our eyes at an early age, that a picture says more than a thousand words is a well known saying, and only blind people can really make use of audible information other than speech. Still the mind is easily fooled, we interpret the world the way we are used to, often missing seemingly obvious things. Illusions are all around us, whether natural or man made. Light plays a bit part in this, changing environments and twisting our perception.

To me RGB used to mean rött, gult, blått, that is red, yellow, blue in Swedish. The three primary colours that you can mix into any colour of your choice. First time that I found out about additive colour mixing in light was like a whole new world opened up, and I knew I had to know more. This book documents not only facts brought up in lectures at the lighting laboratory, but just as much my own thoughts, findings and experiences.

One question that I have thought about for years, is why we see purple as a mixture between red and blue? Physically blue is close to purple, but red is as different as possible within visible light, so why is our perception twisting the linear order of wavelengths in light into the circular spectrum of colours that we see? After having asked many people whithout reciving any kind of complete answer, nor been able to find any information on the subject myself , I have realized that finding this out will take quite a bit of further researching.

Hence I am still to figure that out, so for now, on the following pages, you are welcome to join me in the exploration of some other phenomenons in light.

A B C

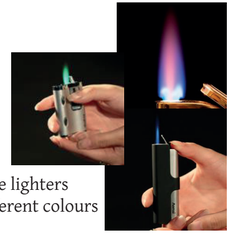
What do you see?

Mood Lamp Indubitably

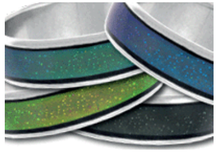
"Mood lamps are lighting devices that are used to establish a particular feeling or mood within a room."
www.wisegeek.com/what-is-a-mood-lamp.htm

As my favourite light I imagine one that is "alive", swaying with the tiniest gust of wind, like the open flame of a candle.

Reminiscing of the safety of the campfire it will provide further comfort by changing its colour appropriate to one's mood - to suit or to endorse positive change.



Butane lighters
in different colours



"The Mood Ring is nothing but an interesting thermometer. Sort of! It's colour changing is due to your body temperature."
http://www.jewelry-secrets.com/Jewelry/What-Are-Mood-Rings/Do-Mood-Rings-Work.html

"The candle's flame has always been a metaphor for the soul. It possesses a tranquil and almost hypnotic atmosphere to those who allow its power to take them to a very special place. (...) It burns as a reminder and symbol of our desires."
http://www.candlehome.com/Reasons-Uses/

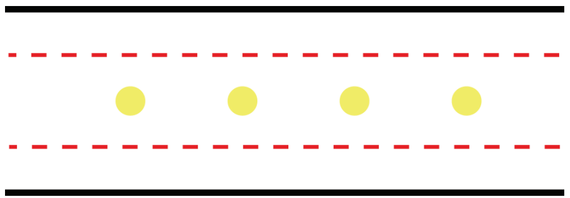
Our perception of light - from lecture “Light and humans 1” with Jan Ejhed

There is an almost endless amount of definitions and discussions of what light actually is, but the most widely accepted one must be Newtons “light is the visible impression of radiation”. As radiation in it self is never visible it needs to hit an object before we experience it as light. When different objects are hit by light they absorb some wavelengths and reflect others, thus we see them as different colours. For an object to show up in its natural colour the initial light must contain that specific wavelength, as sunlight contains the whole visible spectrum we are able to see all colours, while everything turns yellow in the glow of a low-pressure sodium lamp with only yellow light. The initial light source being sunlight does however not always guarantee correct rendering of all colours if the light is filtered through something, water is the most obvious example of this and I will get back to that on the next spread.

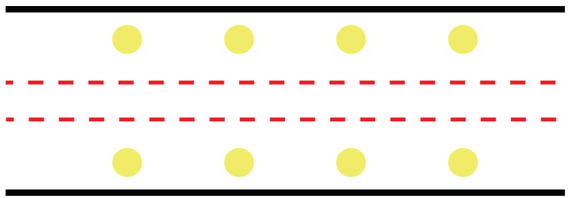
The same amount and colour of light can also give very different impressions under different circumstances. Imagine driving into a well lit tunnel from a dark road at night... Now imagine getting into that same tunnel at 1 pm on a sunny day, indubitably you would experience the light very differently under those two conditions.

This is because we see things not as statics, but as contrasts, and our eyes are constantly adjusting to the surrounding light level. While our eyes have the ability to adjust between dark and light scenes, what we see does need to contain contrasts in light and shadow for us to make out the scene properly.

While we do need contrasts in our field of view to see good, we tend to prefer remaining in the middlepoint between light and darkness. Below are two examples of a corridor with different lighting, the red lines mark where people will usually tend to walk. This concept can be used to direct people in desired directions without putting up actual signs.



example 1: corridor with lights in the middle. *[p1]*



example 2: corridor with two rows of lights close to the wall. *[p1]*

Different materials react differently to varying light, while some keep pretty much the same colour throughout the day, others can change drastically with the movement of the sun. Ularu (to the right) in central Australia turns to a famous bright orange colour just before sunset due to the high iron content of the rock.

Time is essential to our perception of light, on a still picture it would be hard to tell whether a sunset is pictured in Sweden our Spain. The impression of the special nordic light comes from how slow the sun actually sets here in summer, letting us experience the gradual changes in colour. Likewise Ularu would unlikely have been talked about as suddenly lighting up unless the sun there went down so quick.

Rainbows are a special and much appreciated light phenomena, that works a bit like a prism when light hits tiny water drops in the air. “The end of the rainbow” is often associated with mystery and fairy tales as this is a place we can never reach, we have to be in the middle of the rainbow to actually see it. If earth did not get in the way, we would see all rainbows in their full form as circles, halos.

At rare occasions we are able to see two rainbows, the outer one will then always be paler than the main one, and have inverted colours due to the way the light bounces.

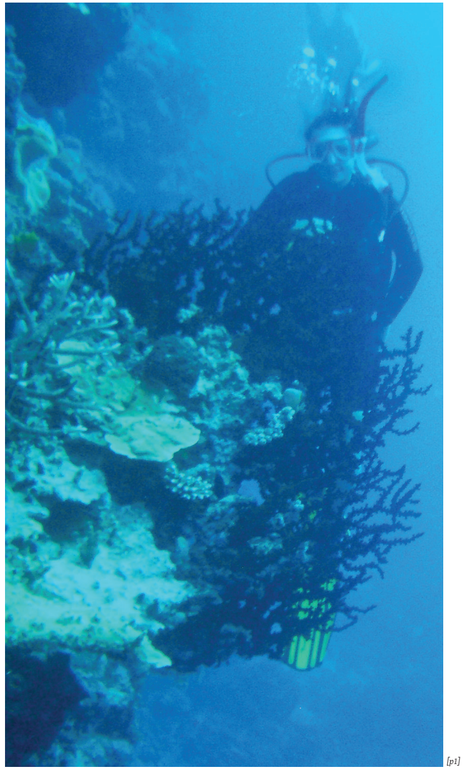
Double rainbow *[p6]*

Halo close to the top of Eagles Peak, Costa Rica *[p5]*

18:00 *[p1]*

18:10 *[p1]*

18:23 *[p1]*



[p1]

Light under water

As we dive down colours gradually disappear, starting with red and continuing through the spectrum to the shorter wavelengths. Most of the red is gone by the time we get to 5 meters, this is why people who go only to see brightly coloured reefs often end up enjoying snorkelling more than diving.

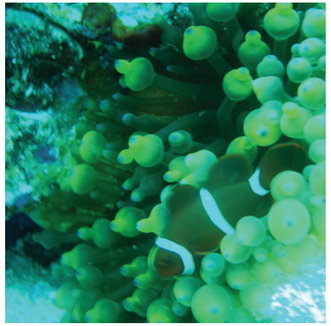
Theoretically everything should become more and more violet as we go deeper under water as this would be the last visible colour to disappear, but we tend to experience the surroundings turning more and more blue. However some deep-divers do claim that everything does turn from blue to violet for a few meters before going completely black as you descend.

The photograph on the left is taken at a depth of about 25 meters, and you would probably never have guessed that the tip of my snorkel had a bright red colour. As most of the yellow wavelengths do not reach past 15 meters, there is no yellow to see in the coral either.

My fins on the other hand have not lost any of their bright neon yellow. This is due to the fact that neon colours fluoresce when hit by uv light invisible to the human eye, and thus do not lose their tone in the same way as spectrum colours do. As ultraviolet has even shorter wavelengths than violet it can reach down to extreme depths.

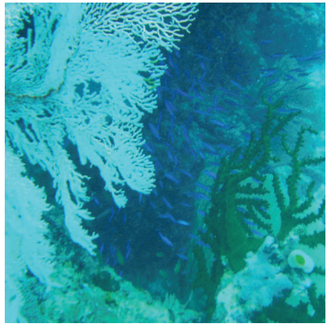
A lot of people, me included, are simply amazed the first time they do a night dive as colours not seen before suddenly appear in the light of the torch. Obviously the darkness around the lit-up area does add to the experience, but doing a few night dives on trips has made me realise I should get my own torch that I could bring on dives in daylight as well.

On the right are some examples of how things appear different under water. The golden rule of diving, not to touch anything, does become crystal clear when realizing how expecting to easily notice a brightly coloured lion fish (middle) at depth could become a fatal mistake.

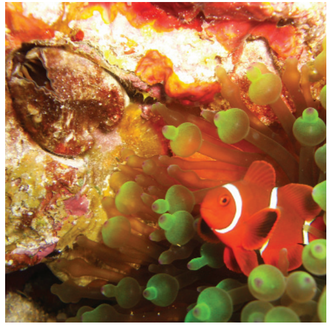


To get a good picture of Nemo at a depth of 20 meters... [p1]

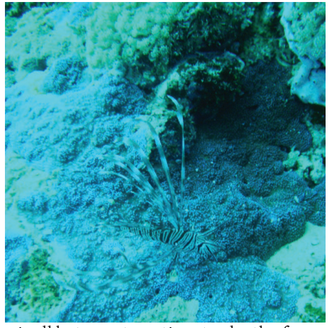
One of the oceans most poisonous fish... [p1]



Depth can sometimes be useful in photography, above, the blue fish do not have to compete with the reds and yellows of the coral. [p1]



...one needs to use the flash. [p1]



...is all but easy to notice at a depth of 30 meters. [p1]

Snorkelling in about a meter of water, all colours are preserved. [p1]

Vesa Honkonen - Freedom

"Your freedom might be my jail"

Vesas lecture focused on the concept of freedom, and was very inspiring, but really hard to pin down. I have therefore decided to just recite some of my favourite quotes from the afternoon.

"There is always a door hidden in our culture that stops us to [sic] *see what really is"*

When making street lighting for Heinola, Vesa decided to use his freedom to completely ignore the surroundings, that he found ugly. Instead he designed his luminaires to be beautiful, taking no inspiration from what was around them.

At Nacka Strand, he worked with light integrated in the ground and benches, to preserve the openness of the space. After the lecture we went to Nacka Strand for the Osram event and passed by Vesas project. Surely it was not as impressive a cloudy afternoon, as it would be when lit up at night, but it was still fun to see.

Street lights in Heinola [p25]

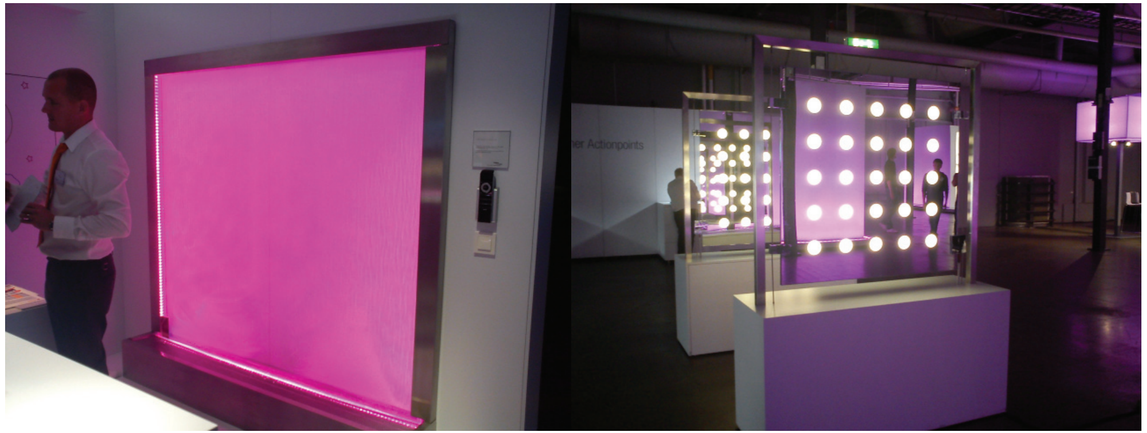
Nacka strand at night [p25]

Visiting Nacka Strand [p1]

Osram event

Osrams fair was all about LEDs, and they seem to have LEDs for any given purpose. One product they have recently developed is a white light that is not made up by all of the spectrum colours, but by red and mint green only. The thought is to enhance the colour rendering of red, which has typically been a problem in LED lighting, using the complimentary colour green to produce actually white light. The red clothes they were exhibiting looked r eally good in that light, but I can not help but wonder if that really goes for all colours.

I really liked the glass sheets that are printed with dots so you can send light through them and make the whole surface light up, below is an example of one that has been used to make a waterfall, but my favourite of the evening was definitely the OLED. I had never heard of them before, and ultra-thin panels that do not need a luminaire to produce light and can be either of transparent, reflective or opaque, feels a bit space-age and really starts of ones imagination.



[p1]

OLED [p1]

Vision basics - from lecture “Light and humans 2” with Jan Ejhed

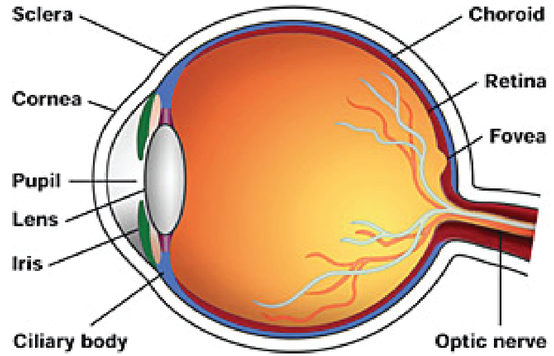
The retina inside our eyes is filled with millions of light sensitive receptors of three types, the cones, the rods, and the third receptor. At the connection of the optical nerve there are no receptors, but as our brain interprets what we see as a whole we are normally not aware of this blind spot.

The cones make up about 4,5 million of the receptors in one eye and give us our colour vision. There are three different types of cones, one type each for seeing red, green and blue. A person who is red or green colour deficient lacks cones to perceive that colour, but has double the amount of receptors for green or red respectively instead, and thus have a hard time telling the difference between red and green. Blue colour deficiency is extremely rare.

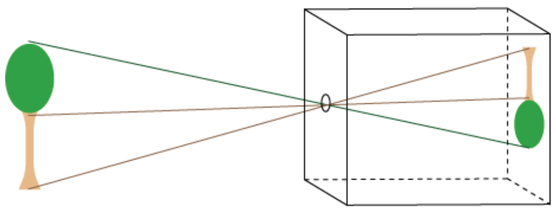
There are far more rods than cones in an eye, about 90 million. They are much more sensitive to light than the cones, and let us see contrasts in light levels clearly as well as give us our night vision.

The third receptor was only discovered in 2002 and is normally referred to by that exact name. It is a non visual receptor that has been found to have an important connection to our circadian rhythm.

A camera obscura was often used by painters to project an image onto the canvas while painting, when light hits our eyes the image gets projected much like this, upside down. It is then our brain that turns the picture around, as well as gives us the impression of a fully focused visual field although we can actually only focus on a tiny point with our central vision while the surrounding foveal vision is blurry.



The eye [p7]



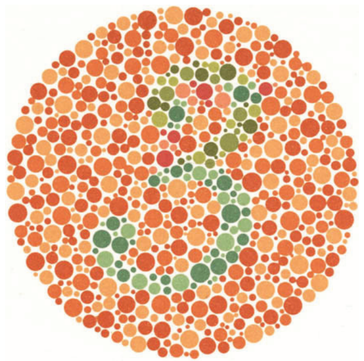
How an image is transformed in a camera obscura [p8]

The left picture below is part of a colour deficiency test, what do you see? Most people will see the number three, while people with a red/green colour deficiency will see a five.

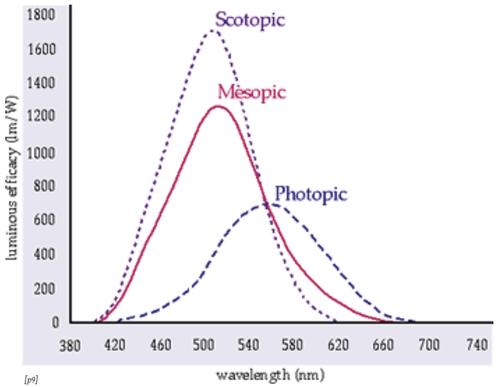
The colour rendering we normally talk about is true for our Photopic vision, that is active at light levels of more than about 3 lux. We are then most sensitive to yellow light, you can see how efficient different wavelengths of light are in the diagram below.

Between 0 and 1 lux we use our Scotopic vision, at this point no cones are active and we see in black and white. The wavelengths of light still matter however, as the Scotopic vision is most sensitive to blue light.

There is no exact curve of sensitivity for the Mesopic vision, the one below is just an example of a possible one, but it will always fall in between the other two. The Mesopic vision is used around between 1 and 3 lux, although the cones are still activated they do not react as strongly as with the Photopic vision, why we can not make out colours as clearly as in a brighter scene.



What do you see? [p11]



[p9]

[p10]

Natalie Bell - Lighting design experience

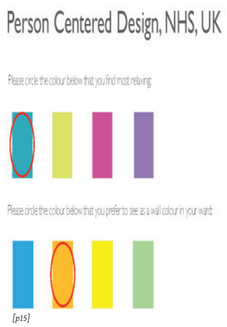
Natalie talked a lot about that it is important to use your own personality as a designer, and about that we should find out, not presume, the assets and problems of a place before making a design.

I found it really interesting when she told us about a colour questionnaire in hospitals (bottom left picture shows part of it) where patients got to evaluate what colours they prefer for different reasons. Most people having chosen a blue tone as the most relaxing colour, is in line with previous colour research. That the bright orange has became the colour most people chose as one they would like to have on the walls in their ward gives an indication of that a relaxing atmosphere might not always be the best for people who spend 24 hours a day in bed relaxing.

Natalie also showed us many different projects she has worked on, my two favourite ones are very different, and herein lies part of my fascination with lighting, that there are just so may different things to work with.

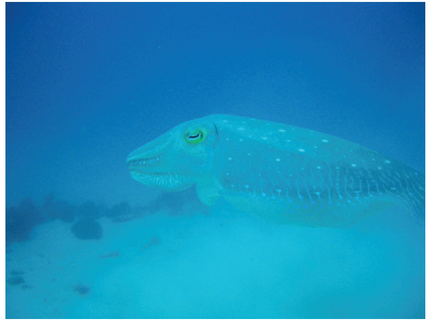
The Inverleith park light event was made to draw attention to what the inhabitants wanted the place to be, and try to save it from being developed. The concept for the United Tower was to make it look like a swimming cuttlefish, and I found it to be a great translation of this beautiful animal into a play of lights, unfortunately the client decided to go for a cheaper alternative.

Concept, United Tower, Kuwait *[p15]*



[p15]

Community Design, Save Inverleith Park *[p15]*



Cuttlefish outside Port Douglas, Australia *[p1]*

Rodrigo Muro - Lighting design experience

Rodrigo talked about that we should appreciate and make use of the lighting knowledge that does exist today, although there is still much left to discover.

But at least we have gotten a long way from ancient Greece, where as he told us, people apparently believed that light came out of our eyes, and then bounced back so we could see. I guess they were half-right though as we do see through light bouncing of objects into our eyes. I would really like to know how they explained no, or less, light coming out of our eyes at night though.

Rodrigo also talked about that many different experiences can be useful for a lighting designer, drawing examples from his own background as an architect, interior designer, and industrial designer. I definitely agree with this, I mean, by now it has probably not eluded anyone that a big part of the pictures in this book are taken during the last year, which I spent in Australia, many, more specifically while diving.

As a final point Rodrigo mentioned that good lighting does not always have to be expensive as long as it is well thought through, partly by quoting Poul Henningsen and leaving us with the exhortation; “Let there be light”.

[p16]

—It doesn’t cost money to light a room correctly, but it does require culture.”
- Poul Henningsen

Light qualities and quantities - lecture with Federico Favero

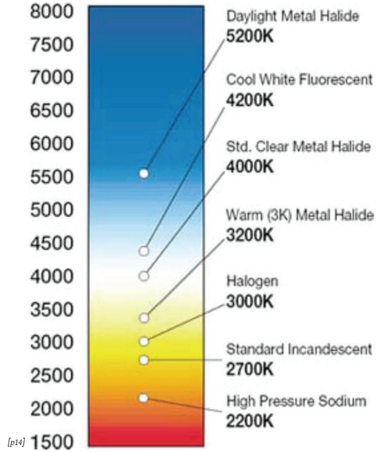
Light gives us visual impressions, but it also has a big psychological impact, and is crucial to our circadian rhythm. Our visual sense mainly focuses on contrasts and variation, but what we notice is also largely dependant on previous experiences of the perceiver.

As I have mentioned earlier, the sunset is much faster in northern Australia than in Sweden (pg. 7). I went up to Port Douglas for the first time in December 2010, and on the afternoon of the first day we decided to follow a track through the rainforest. About half an hour into the woods we were faced with the choice of going back or continuing on a circular track that would be about an hour longer to walk. We did not have a watch, and suspected that it was pretty late. But the strong sun rays, shining playfully through the trees, assured us it would be ages until darkness fell. An hour later it was pitch black. We realized what was happening about half-way through, but running across huge roots, and then spending forty minutes tracking the last few hundred meters back to the car on a track we could not see, only imagining what could be lurking around us, surely stays as a vivid reminder of that although our senses can usually lead us correct by instinct, we should stop to consider how valid our previous experience is in new situations.

We get crucial information through the intensity, the colour, and the direction of light, and have different associations with different lighting conditions. The top right picture shows the colour temperature of some common light sources, the numbers represent the (theoretical) colour a black metal body would turn to when heated up to x°K.

Fluorescent lamps often have codes like 840 or 930 on them, the two second numbers represent the colour temperature of the lamp with 840 shining at 4000 Kelvin, 930 at 3000, and so on. The first number is about colour rendering, where an 8 means 80-89% and a 9 90-99%.

Colour rendering describes how well we see colours in a certain light compared to daylight (100%). This has lately been questioned though as the whole concept is based on only the 8 colours of Ra8, at one point is was suggested to expand the colours to 14, adding some brighter ones, but this has never been done. Knowing this it is not much of a surprise that “good” LED lamps are often accused of having a insufficient rendering of red.



[p14]

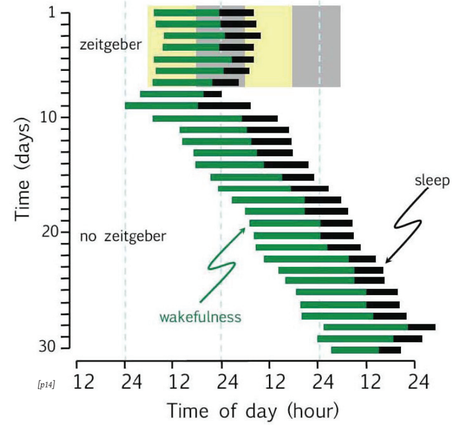
Test colours for Ra8			
R_1	Old rose	R_5	Turquoise
R_2	Mustard yellow	R_6	Sky blue
R_3	Yellow-green	R_7	Violet
R_4	Light green	R_8	Lilac
Additional test colours with saturated colours (Ra14)			
R_9	Red	R_{12}	Blue
R_{10}	Yellow	R_{13}	Skin tone
R_{11}	Green	R_{14}	Leaf green

[p14]

Circadian rhythm

In 2007 neuroscientist Pasquale Montagna said that “Circadian rhythms exist in all living beings. They are therefore an intrinsic property of living matter”. The rhythm exists within us, although bright light starts chemical reactions that make us feel awake and active while darkness promotes the production of among other the sleep-hormone melatonin, even without changing light conditions this rhythm would exist, although distorted.

In 1972 Wever and Aschoff made a famous experiment with keeping a group of college students in a room where they could not be aware of the daylight outside. The experiment lasted for 30 days, but the first 7 were spent in normal lighting condition for comparison of measurements. The result can be see to the right.



[p14]

Experiments like this have made room for claims that we have a intrinsic circadian rhythm that is slightly longer than 24 hours, explaining why so many people have a hard time both going to sleep and waking up in todays society where electrical lighting has made our exposure to the changes of daylight less obvious.

Later experiments with school children have shown that study results increased drastically if the first lesson was pushed from 8am to 10am, while the teachers on the contrary had a harder time coping with lessons later into the afternoon. Those experiments did not go on for any longer period of time, so for arguments sake lets assume that those effects would wear off after x days when the daily extension of a day and night would have caught up with the 2 hour shift.

The interesting point I find here is that the children, like the students in the Wever and Aschoff - experiment seem to have a circadian rhythm of more than 24 hours, while their older teachers do not. So my final questions are; Are we born with a circadian rhythm longer than 24 hours, that later adjusts itself to prevailing light conditions? And if so, does the constantly lit environment of today counteract this adjustment, so it takes longer time than in earlier days?

There have been a lot of studies on circadian rhythms in different land-living animals, but to this day we know almost nothing about how it works in deep-sea creatures. A few ideas on the whale-sharks, that I had the opportunity to snorkel with in august, will be communicated on the next page.

The whaleshark is the biggest living fish today. We know very lite about those amazing giants, as unlike whales, they do not need to come up to the surface to breath. They have been recorded to dive deeper than 1800m, and seem to spend the larger part of the year so deep that we can not track them. Also, unlike many other fish they have not been found to pursue any pray specially found in shallow waters or use the shallows for mating or rasing their young.

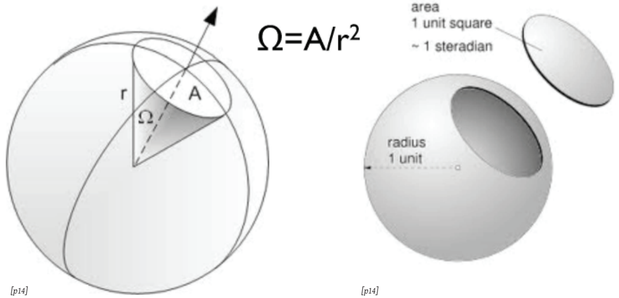
Still, every year between may and august they do come to the surface so regularly that commercial charters can guarantie in-water sightings on their trips. Are the sharks maybe coming for the sunlight, choosing the winter months when it is not quite as strong?

9 meter long Whale Shark outside Exmouth, Australia [p1]

Radiometry

Radiometry deals with detection and measurement of electromagnetic energy, below is a table of what the different units measure. Hence a 60w lamp emits 60w energy, this however tells nothing about how much of the energy is actually emitted as visible light, therefore the brightness of different lamps based on their amount of watt can only be made between those of the same type. The picture (bottom right) shows how a steradian (sr) is measured, this is then used to measure Radiance, energy emitted in a direction per surface area.

Description	Quantity	Unit
Energy per time	Power	W
In a specific direction	Intensity	W/sr
Incident on a surface	Irradiance	W/m2
Emitted in a direction per surface area	Radiance	W/(m2 sr)



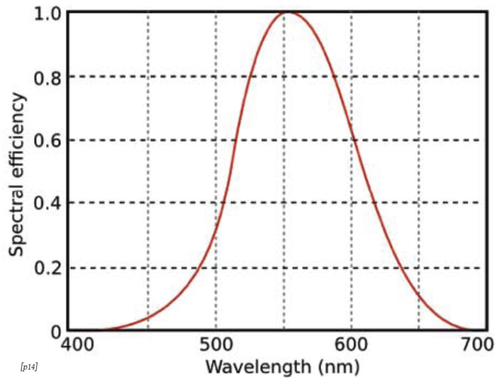
[p14] [p14]

Photometry

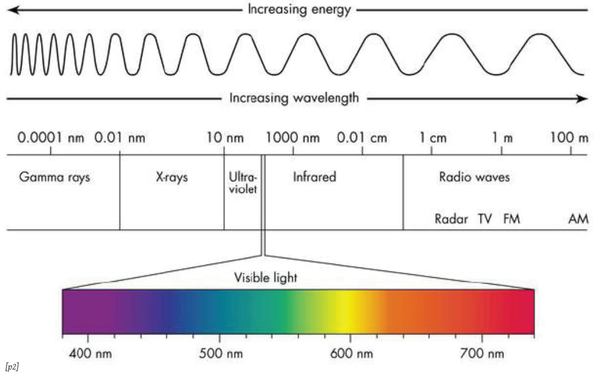
CIE defines light as “radiant energy weighted by the photopic luminous efficiency function, v (λ) (lambda)”, thus accounting for that we do not experience all wavelengths of light at the same strength. Below is the lambda-curve, showing at what intensity we do experience the different wavelengths with our photopic vision. Although many people, including Anders Liljefors, question the validity of this curve, it is today used throughout the l ighting industry.

In the table to the right Luminance is usually the most interesting as it shows how much light we will actually experience bouncing back from a surface. However, Illuminance is more often specified as it is much easier to measure.

Description	Quantity	Unit
Light	Luminous Flux	Lumen lm
In a particular direction (Luminous)	Intensity	Lumen/sr candela cd
Incident on a surface	Illuminance	Lumen/m2 Lux lx
Emitted in a direction per surface area	Luminance	Lumen/(m2 sr) cd/m2



[p14]



[p2]

Lecture with Per Nylén

Visual ergonomics

We adapt to our vision, not the other way around! If our vision gets impaired for some reason, the “position change reflex” kicks in, and we might find ourselves crouched up in a all but natural body posture without ever thinking about it. Thus visual ergonomics are important to avoid not only tired eyes, but a tired body as well.

Apart from just not seeing good enough, flicker has been a problem since the introduction of the first fluorescent lamps as it can disturb normal brain functions in some people. But with newer fluorescent lamps that actually flicker less than the traditional light bulb, this is a disappearing issue.

[p12]

Light adaptation

It is commonly known that our pupils enlarge in a dark room to allow for more light to pass, and shrink when we go out into the sunlight, but this actually only accounts for 10 x of our possible 10 000 000 000 x light adaptation.

1 000 000 x comes from a process called pigment bleaching. Photo receptors which signal to the visual cortex have to states, one light-sensitive, and one light-insensitive, they still pick up information in their light-insensitive state, but the more receptors are turned into their light-sensitive state, the less light wee need to see. To lessen sensitivity the activated receptors emit energy, and let us adapt quickly to bright light. When we need to adapt back to darkness however, the receptors need to receive a photon hit to return to their activated state, this process takes time, and it can take up to half-an-hour until we have adjusted our vision properly back to dark conditions.

The last 1000 x in light adaptation are due to neuronal inhibition, changes in chemical signal substances between nerve cells. This is a fairly quick process that, together with pupil size, serves for quick adaptation between only slightly varying light conditions.

Chromatic Aberration

Why do we see only such a small part of the spectrum? Would it not have been helpful to for example see infra-waves and thus easily make a pray or an enemy approaching? So why did we develop this way?

The answer is believed to be a phenomena caller chromatic aberration, due to differing wavelengths the different colours will hit the eye slightly differently. Below is an example of what happens when we focus on something green, while the green wavelengths hit the retina perfectly, red and blue get their focus slightly behind and in front respectively, thus showing up as slightly out of focus. When are focusing on red or blue, the other one of them does become even more blurred, but those variations are still small enough that our brain can compensate for them reasonably well and give us the illusion of our whole field of view being in focus.

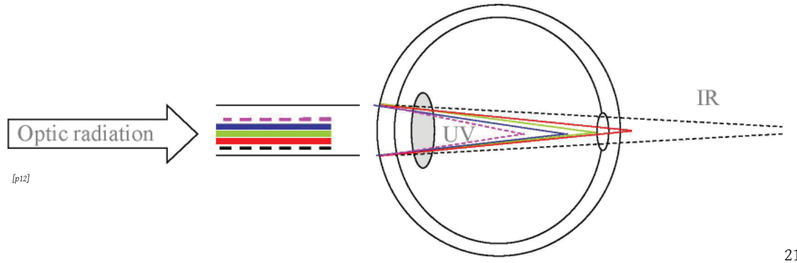
If we on the other hand could see infra-red and ultra-violet as well, the variations of the lights breaking points would probably make us see nothing but a blur. Having that said, there are animals that have a different visual-range than us. The most famous example of this must be bees, as they can se ultra-violet, they are drawn to certain flowers in a way we can hardly imagine,. With this though, goes the fact that they can not see reds as far up in the spectrum as us, and are often looking for the ultra-violet in flowers we see as red.

Although some creatures do have a pretty different vision than us, it usually does not differ too much in choice of visible wavelengths. This has to do with the fact that our colour spectrum is focused around the area where sunlight is strongest, thus giving us as much usable information as possible.

bee vision

human vision

[p13]



[p12]

Colour therapy and hearing aids made of light at Monocrom

I found out about Karl Rydbergs company just after I realized what RGB stands for, and thought that colour therapy sounded really interesting. At first, I did actually think it would be a bit like light therapy for different applications, winter depression - have some white light, just generally sad - here's some orange, hyper - look at a bit of blue, or something like that.

Obviously it is not that easy, as humans are more complex than that. Instead you get to lie in a Ganzfeld sphere where the purest possible spectrum colours are projected all around, ranging from infra-red to ultra-violet. You control the change in colours yourself, and the thought is to relax and get your mind going for the following therapy-session.

The original sphere was one where the patient went inside, but a more compact version that only covers the head has later been developed. I got to try the smaller on a couple of years ago, and it really is amazing how many thoughts, you never knew you had, surface after being exposed to those bright colours for ten minutes.

On the 10th of september I was at Monocroms office at Kungsholmen again, to have a look at two new products. The light mask is a further development of the sphere designed for easier transport, although the colours in it were still really clear, I do prefer the sphere where you completely loose track of distances. The second product was more surprising as I had never imagined something like that being possible, a hearing-aid that send out infra-red light into the ears, increasing the blood circulation through heath, and thus improving hearing.

The different devises I have mentioned can be seen below in chronological order.

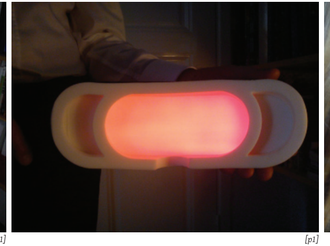
A hearing-aid driven by light [p1]

Looking into the ear-piece [p1]

[p1]

[p1]

[p1]



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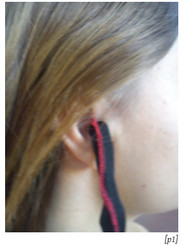


[p1]

Light sources seminar - with Federico Favero

Incandescent lamps have a tungsten wire that heats up an glows. They give of a much bigger part of their energy as heath than as light, but work well in high temperatures. A black patch can often be seen on the inside of a burnt-out incandescent lamp, this is evaporated tungsten. A halogen light has less resistance than a traditional incandescent light bulb, and can therefor double both the life span and the lm/w efficacy. It is also constructed so that tungsten evaporating while the lamp is in operation is able to partly settle back on the wire when the lamp cools down, adding further to the life span.

Discharge lamps work through radiation being transmitted through a gas and then different filters to give the desired glow. There are many different types of fluorescent lamps, and although the first ones had very questionable colour rendering abilities, some fairly good ones have later been developed.

The newest up and coming light source is the light emitting diode, with LED's we can choose exactly what wavelengths we want, and many people believe that we will soon have LED lighting in which we can not possibly tell the difference from a traditional light bulb. A big problem with LED's is the cooling, although they do not heath up as much as an incandescent light, they need to be cooled down as high temperatures will significantly shorten their life span.

What is white? is an interesting question. Although daylight has a pretty cold colour temperature, many people experience equivalent of the warmer glow from a candle or incandescent light as more natural in artificial lighting. There is currently no standard within the lighting industry about what is actually white, although most manufacturers give their different colour temperatures names like; warm white, white, cold white, and daylight, on the left picture below you can see how different 10 "white" lights can look when put beside each other.

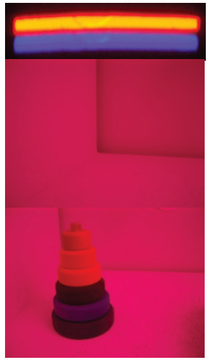
The following ten lights are all considered to be white. [p1]

A comparison of those 10 lamps can be seen on the next spread. [p1]

Hi-pressure sodium

Discharge lamp
35 w
2400 lm
100-130 lm/w
CRI 20
2000°K
requires ballast
does not require transformer
not dimmable
expected life span: 16 000 h
release year: 1962
time to switch on/off: 3 sec

RGB led colorblast,
colour kinetics, philips



LED
12 w
1700 lm
17 lm/w
CRI not applicable
colour changing
requires ballast
does not require transformer
dimmable
expected life span: 100 000 h
release year: 2010
time to switch on/off: < 1 sec

Fluorescent tubular T5

Discharge lamp
24 w
2900 lm
81 lm/w
CRI > 90
4000 °K
requires ballast
does not require transformer
not dimmable
expected life span: 20 000 h
release year: 1939
time to switch on/off: < 1 sec

CFL TC-DEL

Discharge lamp
24 w
1500 lm
65 lm/w
CRI 82
3000 °K
requires ballast
does not require transformer
dimmable
expected life span: 15 000 h
release year: 1976
time to switch on/off: < 1 sec

Halogen incandescent 12V

Incandescent
50 w
9000 cd
23 lm /w
CRI 100
3000 °K
does not require ballast
requires transformer
dimmable
expected life span: 9000 h
release year: 1959
time to switch on/off: < 1 sec

[p1] (all photos on this spread)

MST-CRI
Hi-pressure sodium, enriched

Discharge lamp
50 w
2400 lm
44 lm /w
CRI 81
2700 °K
requires ballast
does not require transformer
not dimmable
expected life span: 7000 h
release year: 1986
time to switch on/off: 60 sec

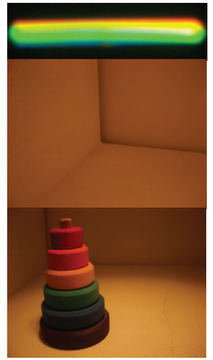
Metal halide HIT-TC 830

Discharge lamp
35 w
4000 lm
102 lm /w
CRI 81
3000 °K
requires ballast
requires transformer
not dimmable
expected life span: 10 000 h
release year: 1960
time to switch on/off: 180 sec

Philips Activivia 17000K

Discharge lamp
24 w
3700 lm
94 lm/w
CRI 82
17000 °K
requires ballast
requires transformer
not dimmable
expected life span: 24 000 h
release year. 2002
time to switch on/off: < 1 sec

Metal halide HIT-TC 930



Discharge lamp
35 w
4000 lm
98 lm / w
CRI > 90
3000 °K
requires ballast
requires transformer
not dimmable
expected life span: 15 000 h
release year: 1962
time to switch on/off: 180 sec

LED Philips

LED
12 w
420 Lm
28 lm / w
CRI 85
4000 °K
requires ballast
does not require transformer
dimmable
expected life span. 85 000 h
release year: 2009
time to switch on/off: 2 sec

See Colour

James Turrell has made several installations at the “See Colour” exhibition in Järna, including Tall Glass, Darkspace and a Ganzfeld. They all focus on experiencing light, giving us different impressions, without ever explaining what is actually going on. The exhibition also hosts pictures of Turrells crater in Arizona, and models of some of the installations he has made there.

I had previously heard about a James Turrell installation in darkness where hundreds of stars gradually appeared as your eyes adjusted, so I was a bit disappointed that the only thing you were supposed to see after 10 minutes in Darkspace was a reddish spot, that I noticed as soon as we walked in. It was pretty impressive being in an almost pitch black room though.

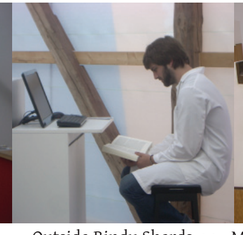
The Tall Glass reminded me a bit of Dawning at Magasin 3, and I really like the play of perspectives in both those installations. My favourite thing in Järna was however Bindu Shards, a piece that has been borrowed from Gagosian Gallery in London. Basically you lie inside a sphere watching a light show, that at times gets so intense that it feels like the picture leaves the screen, coming closer and closer, to finally pass the surface of your eyes and stop at a level of about the middle of your head, but somehow you can still see it. That is the best explanation I can give, it was a weird, but really cool feeling. Also for some reason the flashing dots kept looking like open laptops to me, my theory is that the computer outside the sphere might have been the last sensible shape I looked at before going in.

The answers to the questions on the right can be found on pg. 29.

What am I holding? [p1]
a. A soft ball
b. A piece of sky
c. My hand in front of a painting

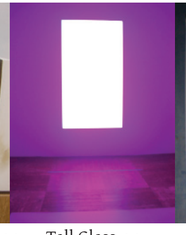
What am I doing? [p1]
a. Throwing a leaf into a reflecting puddle
b. Throwing a leaf up towards the sky
c. Waving my hand in front of a painting

Bindu Shards [p1]

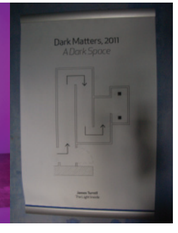


Outside Bindu Shards [p1]

Model of installation in Roden Crater [p1]

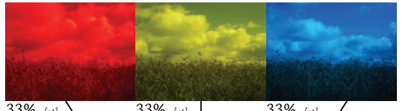


Tall Glass [p1]



[p1]

[p1]



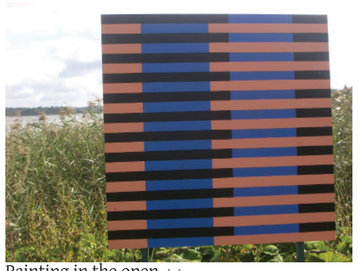
33% [p1] 33% [p1] 33% [p1]

[p1]

The exhibit also offers an open-air exhibition, consisting mainly of paintings that express different colour phenomenons. Their separate intention is never foretold, but I assume that the purpose of the specific one here on the right is to show how the same colour, in this case blue, can look different when the background changes.

The path leading between the paintings meanders through beautiful parklands in a shore side environment and passes several beautiful dams, with sparkling water and adorable little piers, that are just screaming for you to jump in.

Along the path there is also a little house with three rooms that have different coloured windows. I took a picture through each one of those and later overlaid them in photoshop with 33% opacity, you can see the result on the bottom left picture. Obviously I can get it to look more realistic with different adjustments, but I was amazed at how close to the picture, taken with no glass in the way (top left), I got just by the overlaying.



Painting in the open [p1]

One of the dams [p1]

Did you feel like jumping into the mini-lake on the previous page? Then have a look at the sign below (bottom left), which was very (un?)strategically placed after the dam. For those of you not speaking swedish I will translate; *"Please observe! Even if it is tempting for children to play with the water, this is not appropriate as the dams contain sewerage water."* There were no signs at all in english, and I can not help to think that this was on purpose, I mean, James Turrell likes to play with our perception of things in his installations, so why not make use of this as well?

Apart from James installations, there are also many colour experiments, paintings and sketches on display. I really like Himla af Klints Altar Painting, and how it gives the illusion of a three dimensional shape by only simple fields of colour.

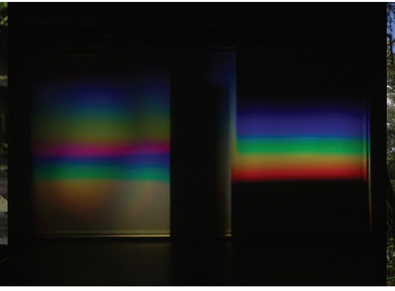
In the afternoon we had a lecture and a walk through the colour experiment rooms with Bent Åhlin, this was the part of the exhibition that convinced me that I definitely need to come back and spend more time here as there was just an array of things on display that I previously could not even imagine. At the end of the walk Bengt asked what I had liked most during the day, I said the rainbows he had created by holding up black and white papers while we were looking through prisms. He looked at me for a long time and seemed to finally assume I was joking, but to me it does make sense. I mean, of course all the big installations were impressive, but it is one thing to make things out of who knows how many hidden parts, and a totally different to find something eye catching in the tinniest piece of plastic. And I was really amazed on how the rainbow could be inverted, putting purple in the middle.

The answer is b for both questions on pg. 26, and both pictures are taken looking up into the Skyspace.

Hilma af Klint - Altar Painting [p1]

Reflections [p1]

Sign by the dams in Ytterjärna [p1]



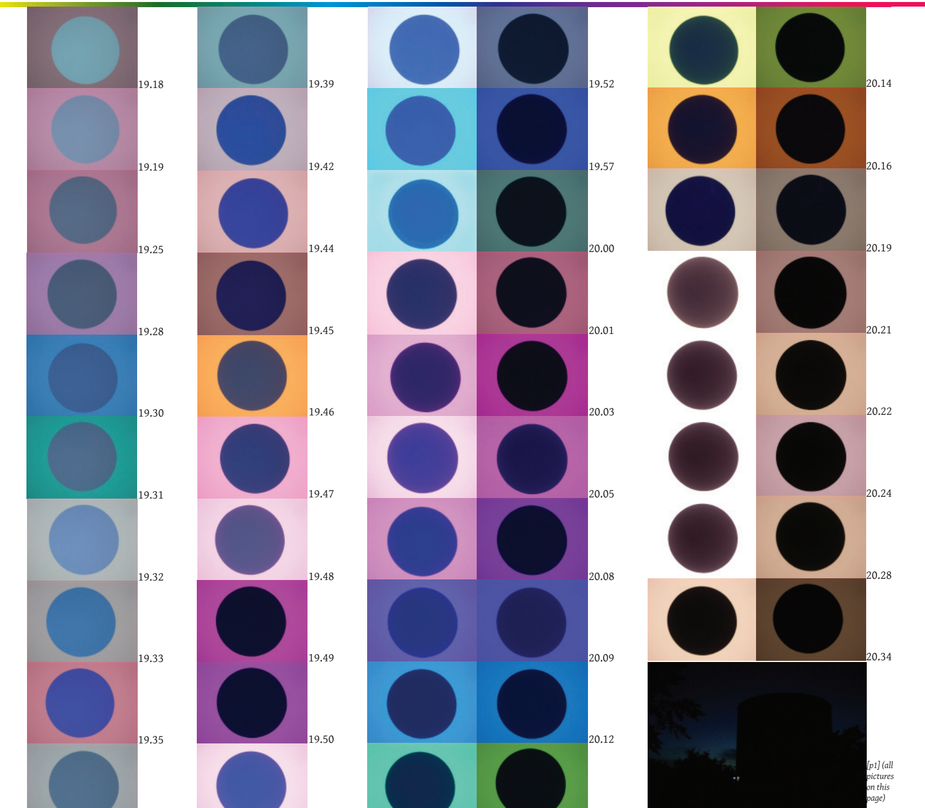
Rainbows where darkness meets light [p1]

Skyspace in daylight [p1]

The skyspace will be kept as a permanent installation and shows a light show at sunrise and sunset. It is also quite fun to see in daylight though, and gives opportunity for a bit of cameraplay like the two pictures on pg. 26, and the one of Natalie to the left with her sun glasses giving a double reflection of the sky.

Once the light started changing the thing that amazed me most was how I was convinced that it had gotten close to completely dark at 19.45, just to experience the illusion of the sky becoming lighter again as the colour inside changed.

As my camera does not have a manual light setting I kept taking double pictures, measuring of the sky and of the ceiling. For the first 30 minutes they were identical, but then they started to differ. I have presented the later ones as pairs, with the darker ones (measured of the ceiling) being closer to what I was seeing with my eyes.



[p1] (all pictures on this page)

COMFORTABLE?

Dashboards in Volkswagen cars - old and new

Driving home tired from Ytterjärna in dads car I suddenly noticed the colours on the dashboard - blue and red, those two Per Nylén had previously mentioned we could not possibly focus on at the same time. So after stopping I tried, and just like that it was quite obvious that I could not see both the numbers and the arrow clearly at once. My first thought was, well, it's not really a big problem, as it had never bothered me until this night, but thinking further it did seem all but optimal.

Sure I could see how fast I was driving, but would my eyes get tired faster when driving a longer distance than they would with a not so extreme dashboard? And if I had to see something on the display fast, could there be a situation where that millisecond longer, it would probably take, would be of importance? Could I get distracted from what was happening around me while having to focus too much on the dashboard? I don't know, but I have a feeling that the answer to at least some of those questions is yes.

Dropping the keys of I asked my dad if he had ever had a problem with the light on the dashboard; "I found it quite annoying in the beginning, but now it doesn't bother me, and it does look really cool... why?" was his answer. When I told him that we can not watch blue and red at perfect sharpness at the same time, he instantly replied that we get used to it, thus it would be just fine. "Well of course we get used to it..." was my answer, "...but the fact that we do not see the picture perfectly still stands".

Now I had gotten his attention, and got a tip about having a look at the dashboard in mums car, as he believed that Volkswagen had had the blue and red colours as part of their branding for a long time, but recently had changed to a more neutral palette.

This was the case. In mums three years newer car, all blue dashboard lights had been replaced with white, giving it a much more harmonic look. Since those two cars, apart from being manufactured in different years, were also different models, I now of course wanted to know what the Dashboard in a Volkswagen golf Variant manufactured in 2011 would look like, and a few days later made my way to Volkswagens store in Akalla.

Dashboard - VW Golf Variant '08 [p1]

Dashboard - VW Passat '11 [p1]

Dashboard - VW Golf Variant '11 [p1]

The staff were quite happy answering my questions and letting me turn the car on to take pictures of the dashboard - that was until I told them what I was actually looking at. Now it went quiet, I did get to see a few more cars and could thus pin down that the change of colours had occurred in 2009, but every question was now answered with a variation of "It's just a design thing, nothing important".

I have tried to contact the main office of Volkswagen for a comment, without any luck, and I can not help but wonder if the change from their well-established design came due to someone having the same realisation as I had a few days ago.

I mean, contrary to what the salesman at the store was trying to imply, design is after all not only about making things look good, but at least as much about designing things that work well for people.

"It is the goal of the [Volkswagen] Group to offer attractive, safe and environmentally sound vehicles [...]"
- from the international website

COMFORTABLE.

Daylight study at Skansen

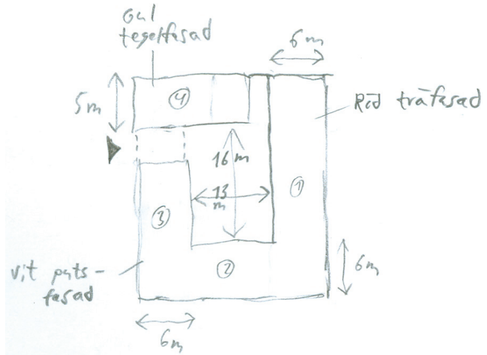
The first thing I noticed about light when we got to Skånegården was how different the lighting conditions were in the different wings of the building, and I made a few mood sketches of those.

Nr 1 is the residential part of the building built in the early 1800s, it has quite big windows, and as there are a lot walls dividing the space into smaller rooms, light comes from several different directions and creates many levels of light and darkness.

Nr 2 was used for keeping animals and has no light at all accept what sneaks in through tiny cracks in the wooden wallboards. Nr 3 is not much different, but does have two small cross-shaped openings. Because of their size and the thickness of the walls, you do not really experience them as windows, but more like small glowing things on the wall, almost like luminaires. Both those wings where built at the same time as the residential block.

Nr 4 is also a place for animals, but was re-built in the early 1900s. At this point, knowledge of that animals also need light, started to be widespread, and the block was equipped with fair sized windows. I experienced the light level here to be about the same as in the residential part, but the character of light being totally different. The still smaller windows in the newer block do take in less light, but as the space is open light is not stopped be walls, but spread quite evenly around the space.

[p1]



[p1]

[p1]

[p1]

[p1]

[p1]

11:30am (sunny) [p26]

11:35am (cloudy) [p26]

1:35pm (half-sunny) [p26]

Model - representation of sunny weather [p1]

Model - representation of cloudy weather [p1]

We also looked at shadows in a specific room, behind the oven. They were very defined in the morning when it was sunny, and more blurry under a cloudy sky. They also became more diffused later in the day due to the angle of light coming through the window. This is what we chose to represent in our model.

Hess event

The Hess event focused on street lighting, and I found it quite surprising that LED luminaires that are strong enough to be used on big motorways are available already today. Hess has four types of main luminaires for roads, ranging from strong ones for really big roads, to ones that are adapted to fit into a historical environment.

Francisco Ramos held a lecture for us during the event, and mentioned that in the beginning Hess had been focusing on cold white LEDs as those are more energy efficient. But as there was a big demand from the market for a light more similar to the traditional light bulb, they have later added warm white to their range. I guess next time someone asks why I keep buying lamps with such a cold temperature for my apartment, I can just say they use less energy instead of trying to explain that I do actually prefer a more daylight-like light.

We also got to see Hess solution for sending light through glass, emdelight®, that seems to be quite similar to the Osram one. Below are a few nice buildings that make use of the emdelight®-glass.

The Sera LED road light [p24]

Villingen-Schwenningen, Germany [p24]

Barwa Commercial Avenue, Doha, Quatar [p24]

Yoshi Ohno - Solid state lighting measurement and Colour quality research at NIST

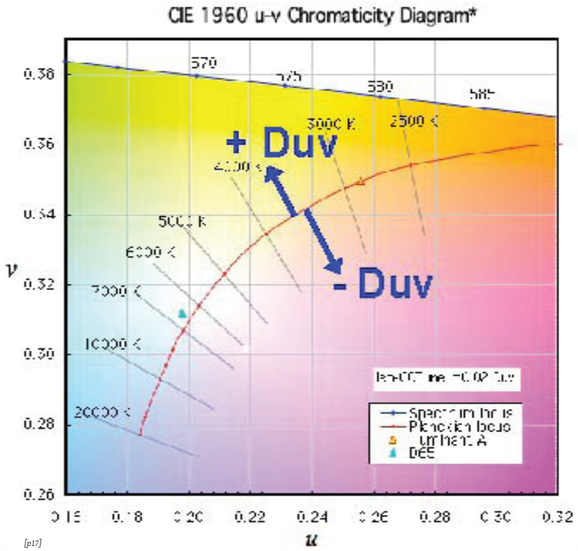
This was the first lecture we went to outside school with my class from the lighting laboratory, and hence the first one that was not targeted towards students who have just begun to learn about lighting, but towards lighting professionals.

The first part of the lecture, that focused on new techniques for light measurement, was at a very high technical level and I was lost after about the second slide, it was however nice to once again strengthen my impression of that there is just so much more to find out about lighting.

The second part, about Colour Quality, was way more understandable, and really interesting as it pinned down flaws in definitions commonly accepted throughout the lighting industry. On the right you can see CIEs cure for white light, lights that differ too much sideways from the curve are not accepted.

New testing at the National Institute of Standards and Technology in Gaithersburg, Maryland, USA, has shown that people often prefer lights that are slightly colour enhanced, today those are being highly penalized by the current equation, and thus often seen as not acceptable. At the same time lights that have a good average between test colours, but render one (often red) extremely bad will on paper give the impression of being really good.

Thus Yoshi Ohno and his colleagues have been working on a new way to rate light sources, one that is closer to our perception of the lights. But as the current definition is so widely spread today, the new one will most likely be published alongside an update of the current one.



[p17]

Willem van der Sluis - Concepts in design

It was nice to hear a lecture from the person who designed the Philips Living Colours luminaire, because this lamp is really funny; I have one at home, and it is my favourite luminaire. I love it dearly. I love it because I can change the colour to whatever I want. I never change the colour.

Ok, this is not 100% true, at the very rare occasion, I will lay down just watching the roof, changing the colour manually to get a tiny bit of the same effect as in the Monocrom globe (pg. 22), but then it is back to white. And seriously, the promotion pictures are beautiful, but who is ever going to have dinner under a green light?

The fascination about this lamp is not about what you do with it, but what you can do. It is not a functional luminaire, I mean, the white light, in at least the first model that I have, is not even that good. But if I want to play techno music in a purple nightclub-like environment, I can, and enjoying a fake pink sunset is just a click of a button away if I want to, I do not, but that is beside the point.

This luminaire makes me think back on Vesa Honkanens lecture about freedom, because that is what it is all about to me, knowing that I have the freedom to choose any colour I want, and choosing not to care.

If I'm going to turn more towards talking about the actual lecture, of all the projects Willem described, there were two that really caught my attention; The Sportdomes and the Luceplan Aircon Luminaire.

The Aircon was Willems first luminaire, and won a dutch design award. I really like the look of it, the way it is mostly pictured all over the web, as a decorative solitaire. So I was quite surprised to hear, that its original intention was to change office lighting from the straight lines of light we see today, to a more varied light distribution. He did not mention it ever actually being used in an office, although the concept of how it would work was really convincing. And he did say that he was not completely happy with it, as it ended up giving of way to much glare for its intended purpose. This touches on an aspect of design that is really interesting to me, that we can never be completely sure of what our designs will turn out to be in the end, despite our best efforts.

Philips Living colours [p20]

I sure hope they are not having meat... [p21]

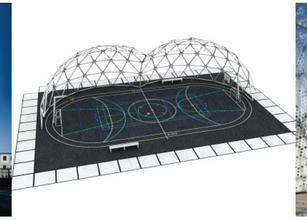
Sportdomes is a design Willem made for a holding facility for illegal immigrants waiting to be deported. A demand was that noone should be able to see who was inside the cage, but at the same time Willem wanted to preserve the feeling of being outside. Thereof comes the pattern, that is quite closed close to the ground to only let silhouettes shine through, but opens up higher to give a view of the sky.

My first thought when I saw the pictures was, "why not make the roof closeable so the poor people do not have to be stuck getting wet when it rains". Apparently, I was not the only one to wonder. Willem told us that the first time he had gone to look at the previous facility, the sporting fields consisted of open fields with wired fencing around them, he asked why they had not put a roof on them. The prison warder answered that feeling the elements, getting wet in the rain, is a privilege for people who are locked up inside during the rest of the day. Thinking about it, of course it makes sense.

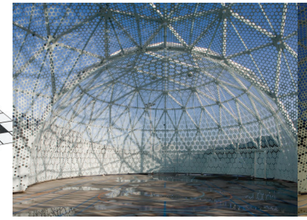
Another interesting feature of the domes is the lighting at night. Originally, the floor was supposed to be pitch black, and that is what the amount of light was planed for. The late change to a pale concrete makes the room extremely bright, but since the domes are not used at night, this is not really a big problem. And Willem concluded with how he does like that the strong light will hopefully draw attention to structure, and further spark the discussion of how the people there are held in prison like criminals before they are to be sent of.

Aircon luminaire [p19]

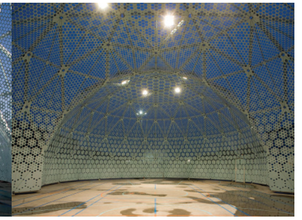
Sportdomes [p18]



The basis of the form [p18]



Rain is seen as a privilege [p18]



Strong lighting at night [p18]

Illusion

After Yoshi Ohnos lecture at Norra Real I found the bathrooms of the place to have a quite interesting plan. From where you normally walk, it seems like there are squares with the actual booths, that you could walk all the way around, just placed inside the large room. This makes the space feel huge, but going closer to the window (below) instantly breaks the illusion.

[p1]

[p1]

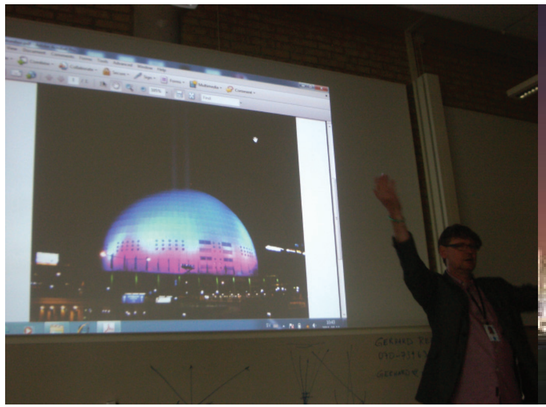
"You are already hooked with lighting, it is to late anyway!" - Gerhard Rehm

Gerhard Rehm - Lighting design experience

Gerhard definitely had an unique way to start his lecture, with writing his email and mobile number on the board, promptly saying "you *will* need this", and then going on to telling us how he ended up in Sweden because of love.

He later talked about that he had not originally intended to work with lighting, but in his projects as an interior designer it just kept coming up. He then gave us a word of warning, saying that as soon as you learn about lighting, everyone will start throwing their lighting issues at you, but soon took it back, noting that since we were sitting in that room it was to late for all of us anyway. Well, I can not say I neither mind or am surprised, as I had heard no talk about lighting at all in three and a half years at architecture school.

The project Gerhard showed us was a lighting installation he made on Globen. He had initially intended to put one skycracker at every entrance, thus having a circle of light beams coming up, but soon realized the effect would be much to weak. Instead he used them four and four to create two light beams. He also mentioned that at the memorial by ground zero, they have used eighty skycrackers to represent each of the towers.



Gerhard Rehm shows his installation on Globen. [p1]

"Tribute in Light" memorial near the ground zero site. [p23]

[p1] (all photos on this page)

Lighting Machine - workshop

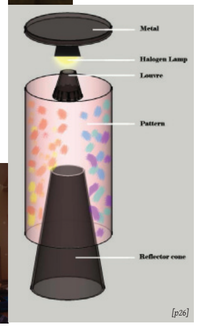
The task for the workshop was to make a lighting machine for some space at school with either a circular fluorescent light or a halogen spot, so we started of with going around looking, trying to open every door and peak around every corner, to find places we had not seen before.

Out choice fell on a corner at the bottom level, under a stair where almost noone ever walks. When we found the space if was filled with everything from garbage to mattresses that looked like they had not been moved for years, but being so secluded and quiet we definitely believed that the space had potential. It was fun to later hear Jan Ejhed mention that in his 10 years working at the school, he had not previously been to our little hideout.

As there are already many nice spaces in school with a lot of daylight, we were not looking to make a space that has lots of light, but more a contrast to that, provide a change of atmosphere, a place for new ideas. We also wanted it to be a place where you can choose to read a magazine under a focused light while enjoying the dimmed atmosphere around, or curl up and relax in a warm, soft light under the stairs.

Our process contained a lot of testing with both lights, different material, louvres, diffusers, colour, holes in different sizes, and reflectors. It was great to play with how all those things can be used in different way.

We decided to call our final construction “DFR”, distraction from reality. It is made up by a halogen spot, an outer shell that sends coloured light onto the walls, and an inner cone, with louvres inside, that focuses the downlight and minimizes glare.



[p26]

 [p1]

DFR - Final result [p1]

Sources of information

Most of the content in this book is based on lectures and seminars at the Lighting Laboratory, KTH, during august through september 2011, lecture notes from those, and my own experiences.

Where it does draw from specific conversations and occurrences, this has been stated within the text, the rest are thoughts and understandings that have become clear to me during a longer period of time.

The few additional sources I have chosen to use when deciding on content for the book are listed below in no particular order;

http://www.deep-six.com/page77.htm

http://www.osram.com/osram_com/LED/OLED_Lighting/index.html

http://www.volkswagen.com

Picture credits

[p1] My own pictures
[p2] http://www.antonine-education.co.uk/physics_gcse/Unit_1/Topic_5/topic_5_what_are_the_uses_and_ha.htm
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[p12] From pdf of Per Nyléns lecture, 1/9 - 11
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[p24] From pdf of lecture at the Hess event, 7/9 - 11
[p25] http://www.vharc.com/
[p26] From our group presentations

The sun is the role model for our luminaires, enjoy it. [p1]

A B C

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What do you see now?