

_lightscape

an exploration in interactive lighting
nds caad 2004 individual thesis alexandre kappelos

ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

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1.0 IDEA

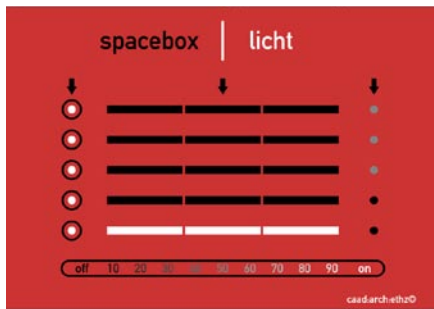
This paper describes an experiment/investigation undertaken at the Chair for CAAD of the Swiss Federal Institute of Technology in Zürich. It concludes one year of postgraduate studies in computer aided architectural design.

The aim was to provide a theoretical approach to the lighting project undertaken for the xCube group work. The nds2004 students had decided to build an interactive, computer-optimised structure as their final project, where lights, sensors and textured surfaces were to create an interactive experience for the visitor. For various reasons the interactive aspect was abandoned.

The idea to work on a light(-ing) object came up when I discovered a little device called the Barionet™. This device allows you to control an on/off switch remotely, through a web interface or through programming. That was it! The ip_lamp (...its first name): a small object that has its own IP address, and therefore can be accessed via the internet. Turn it on or off...

This evolved into the _lightscape where 2 interacting lights send each other data about the other (distance from a wall or number of people for example). The atmosphere of a room becomes dependant of what is going on in another...

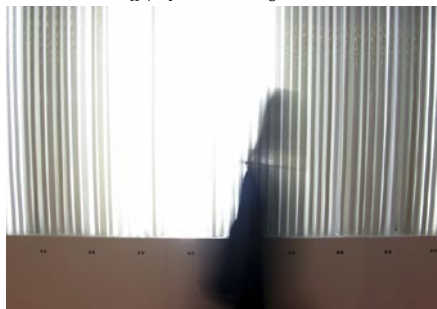
This work is also an attempt to develop a pluridisciplinary approach to an architectural project by making use of the many tools available to the postgraduate students: programming a simulation in Flash, experimenting with different hardware interfaces or rapidly manufacturing a light box on the 3-axis mill. A cross-over project in a (modest) way.



illustr. 6.1 redhell: flash interface



illustr. 6.2 redhell environment (top)
illustr. 6.3 room access interface (above)



illustr. 6.4 leuchstoff project: reactive light

2.0 UN TOUR D'HORIZON...

2.1 Chair for CAAD

Research on interactive devices has already been undertaken at the Chair for CAAD at the ETH in Zürich. Some examples:

The *Building IP* (illustr. 6.3) project researches possible application of interactive and internet controlled devices in living or working situations: remotely controlled installations, lights, access control. More precisely "...the Chair serves as laboratory. The idea is the maximal integration of today's and future devices and services into a economical, scalable and more importantly user-friendly system. By the intelligent networking of a multiplicity of physical and organizational components new service possibilities are created."¹

Red Hell (illustr. 6.1 & 6.2) is an installation found in the department of architecture. It is an interactive and immersive environment whose environment (light, sound) is controlled through a programmable web based interface (flash and xml). A variety of moods and atmosphere can be created, and a movement detector allows the installation to "adapt" or interact with users, in real time.

Leuchtstoff (illustr. 6.4) is a student project elaborated as a *diplomwahlfach*. A series of fluorescent tubes are controlled by sensors, varying the intensity of each light bulb as people interact with the object. approaching it or moving away. Various scenarios are also implemented as the installation goes into sleep mode.



illustr. 8.1 weather forecast beacon by Ambient Devices

illustr. 8.2 Active Light by ZumtobelStaff



2.2 Commercial products

A number of products are readily available from various companies. Some of the products act as interfaces to data, some are purely cosmetic...

Ambient Devices² manufactures two products that are of interest. The Weather Forecast Beacon (illustr. 8.1) collects meteorological data from the internet and represents it in a chromatic way (temperature, humidity, etc), whereas with the Stock Orb colour shifts according to the (monetary) value of your stock portfolio. In both cases, the object acts as an interface to digital information.

“Your weather is just a glance away, a quiet interface that avoids the buzzing of cellphones and the complicated interfaces of computers. Design and technology blend [...]. Ambient Devices provides a complete solution to offer wireless products to consumers that make tangible interfaces to digital information.”

Two devices/installations by ZumtobelStaff³ work in similar directions. The Active Light Wall (illustr. 8.2) is a “homogenous uniform light with powerful lighting effects [that] can be changed in terms of colour and intensity, purposefully controlled by intelligent Luxmate lightning management systems, to create lighting scenes and attract attention. [...] The coloured light is

² www.ambientdevices.com

³ www.zumtobelstaff.ch



illustr. 10.1 PHAOS™ lighting system by ZumtobelStaff



illustr. 10.2 James Turrell, *Afrum-Proto*

distributed evenly over the whole surface and reaches right into every corner. [...] Purposefully controlled changes in the intensity, colour and direction of the lighting make it more dynamic. Ever-changing lighting sceneries producing subtle effects replace the static concepts of lighting and, according to requirements, provide stimulation, motivation, activation, relaxation or calm, creating the required room atmospheres and making the lighting a separate, important factor of design which provides for a more sustainable effect of architecture and spaces.”⁴

The PHAOS™ light system (illustr. 10.1) is made up of red, green and blue LEDs, electronically controlled and housed in an aluminium case. Based on the mixture of these 3 colours, 16.7 millions colours can be implemented. The inner surface of the glass is composed of prisms which diffuse the light evenly, assuring the smoothness of the color on the overall surface.

2.3 Art installations

Light has always played an important role in defining architectural space and various artists have incorporated it into their work.

James Turrell's *Afrum-Proto* (illustr. 10.2) is the first of several “corner projection” installations developed during the 1960s. Made by aiming the light from a slide projector through a template, the resulting projection is a floating optical effect in the corner of a room. Seen from an optimal point of view the rectangle of light resembles a three-dimensional white cube. As one approaches the corner, the cube is transformed back into an ordinary projection of light.

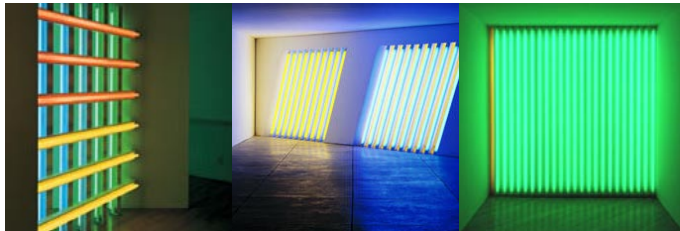
In other works, Turrell was interested in the various ways that we experience light, using a

⁴ <http://www.zumtobelstaff.com/com/en/2748.htm>

illustr. 12.1 James Turrell



television as the light source in this work. He discovered that different types of programming, such as the news, sports or cartoons, emit different kinds of light. He also uses light to dramatise architectural space, as it can be seen in his installation at the Zug railway station.



illustr. 13.1 Dan Flavin, *Untitled*

Another artist, Dan Flavin, also used light as a *mise-en-scene* for architectural space, modifying our perception of it. With the use of fluorescent light, Flavin “[...] explored a new sense of space that, in his words, “could be disrupted and played with by careful, thorough compositions of light. [...]”. Using standard electrical fluorescent tubes, in various combinations of size and color, he “[...] investigated the dichotomy between the concrete, revealing the actual tubes and fixtures, and the ethereal, capturing the indefinable dimension of light in space.”

3.0 _lightscape

3.1 Flash simulation

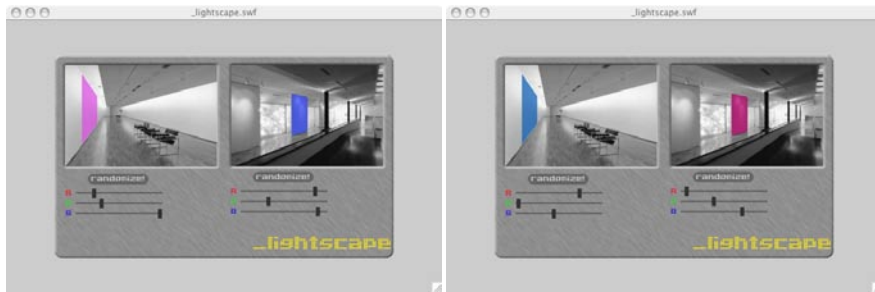
A specific colour is determined by the amount of red, green and blue it contains. In the 1/1 simulation model, the colour of the light will be obtained in the same way: each colour tube will be dimmed or increased accordingly. To illustrate this, a simulation was created in Flash. Two light walls are incorporated into two different environments. Sliders simulate the sensors that would modify the RGB values of each tube according to movement or position.



Illustr. 15.1 the _lightscape simulator with all RGB values set to zero

From the programming aspect implementing the simulation is not different from the real model. In Flash, a colour is defined by its quantity of red, green and blue, each of which has a value between 0 at 255. This value is given by each slider, and this gives 16'581'375 possible colours (255 x 255 x255). For example the following combinations give the following colours:

<i>black</i>		<i>red</i>		<i>green</i>	
red	0	red	255	red	0
green	0	green	0	green	255
blue	0	blue	0	blue	0
<i>blue</i>		<i>grey</i>		<i>white</i>	
red	0	red	122	red	255
green	0	green	122	green	255
blue	255	blue	122	blue	255



The idea here is to simulate the `_lightscape` idea: sensors in one room affect the colour of a light box in another room and vice versa.

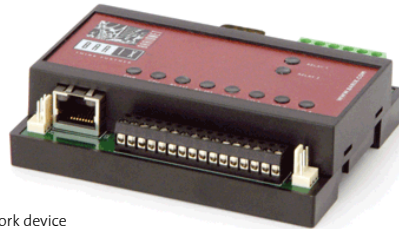


illustr. 16.1, 16.2 & 17.1 three different scenarios of the `_lightscape`, each time the distinct red, green and blue values are different, resulting in a different overall colour. the `_lightscape.swf` file can be found on the accompanying cd-rom.

3.2 Barix Barionet®

The Barionet is a “network enabled automation interface” (a sophisticated switch) with its own ip address and 10/100MBit Ethernet connectivity, making accessible from anywhere via a web browser. On screen the user can toggle between *on* and *off*. These functions can also be programmed, in Flash (via cgi, XML) for example and accessed from a web interface.

The Barionet also offers other possibilities: as optional temperature and humidity sensors to



illustr. 18.1 Barix Barionet© network device

monitor environments, digital and analog input, digital output, relays to activate bells, door strikes, etc.

The simplicity of this device is very appealing, a type of *plug'n'play*, just slightly more advanced. An Ethernet cable connects the Barionet to the computer and a 12V adapter powers it. It then has to be configured and given an IP address (a simple procedure). For it to be able to switch on and off the light bulb, one of the two cables has to pass through the Barionet. That's it.

Step 2 in the project was to set up a basic web interface is created in Flash, allowing a user

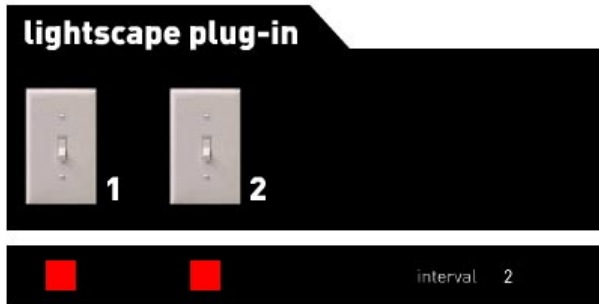
illustr.19.1 the Barionet triggered the idea for an ip_lamp, which was to become the _lightscape



to toggle from on to off and back, and create a blinking sequence (see illustration 20.1). Sending commands via Actionscript is very simple (illustr. 19.2): one line of code containing a cgi command. But rapidly the maximum potential of the device is reached, since the Barionet does not send feedback, interaction is limited. The result is a rather expensive remote controlled lamp. The Barionet does not seem adapted for complex interactive applications...

```
on (release) {  
    loadVariables("http://129.132.32.185/rc.cgi?o=2,999", "_level10", "GET");  
}
```

illustr.19.2 a small actionsript that sends the signal to the Barionet



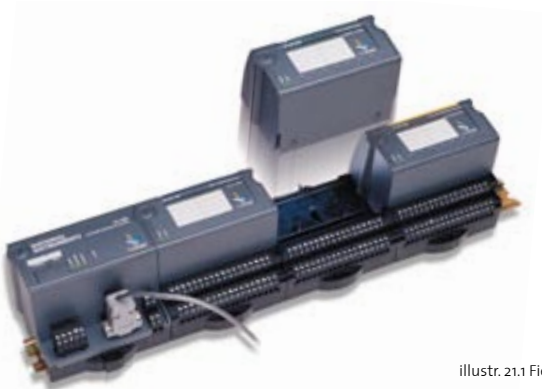
illustr. 20.1 _lightscape v1.0 flash interface

3.3 National Instruments LabVIEW

LabVIEW is a graphical development environment, a type of programming language, for signal acquisition, measurement analysis, and data presentation. FieldPoint is a modular input/output system made up of a variety of analog and digital I/O modules, terminal bases, network modules that connect I/O modules to networks and high-level software tools.

The two work together, the software sending the instructions to the hardware. It resembles a programming language because it also works with conditions (if... then...), loops, variables... The first step consists of setting up the project in LabVIEW, defining the inputs and outputs, the different possible scenarios.

The set up for the _lightscape project was relatively straight forward. Data is collected through the distance sensors according to the distance detected: the closer the object is to the sensors, the higher the voltage (in the range of 0 to 3V). It is this data that is sent to the FieldPoint analog



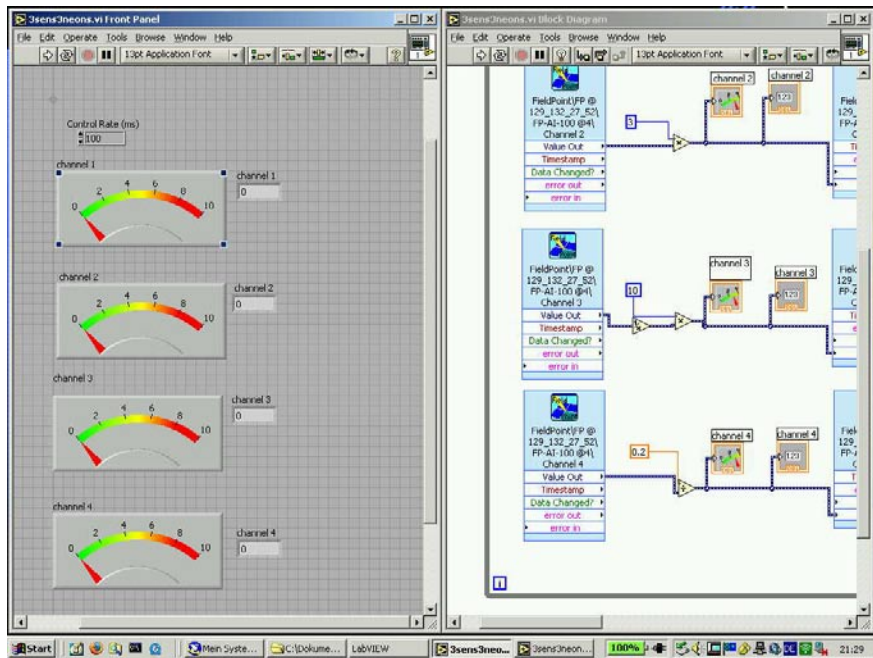
illustr. 21.1 FieldPoint modules & Sharp distance sensor

input module, FP-AI-100 (see illustration 25.1) .

RGB fluorescent tubes connected to electronic dimmers are the output devices. The dimmers receive a varying voltage (from 0 to 10V) from the FieldPoint analog output module FP-AO-210. Because this varying voltage is generated by the sensors (0 to 3V), it has to be amplified 3x and the dimmer requires a 0 to 10V range.

The advantage of the LabView set up over the Barionet is obvious. LabView has greater flexibility. The FieldPoint modules are truly programmable, making scenarios possible. Unlike the Barionet which, basically, only had an on and off state, LabView allows for conditions to be added to the set up. For example, if no signal is detected by the sensors for X minutes, a subroutine is executed, putting the system into “idle” mode. Another advantage with LabVIEW is that one can work in simulation mode, none of the hardware has to be plugged in. Signal acquisition can be simulated and the different outcomes explored.

On the downside, the hardware is considerable in size, unlike the Barionet, and rather heavy.

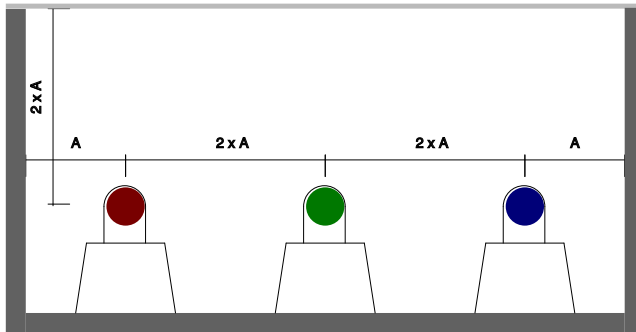


illustr. 22.1 LabVIEW 7.1 screenshot. On the left, the Front Panel (or interface) and on the right, the Block Diagram

3.4 1/1 Model & Simulation

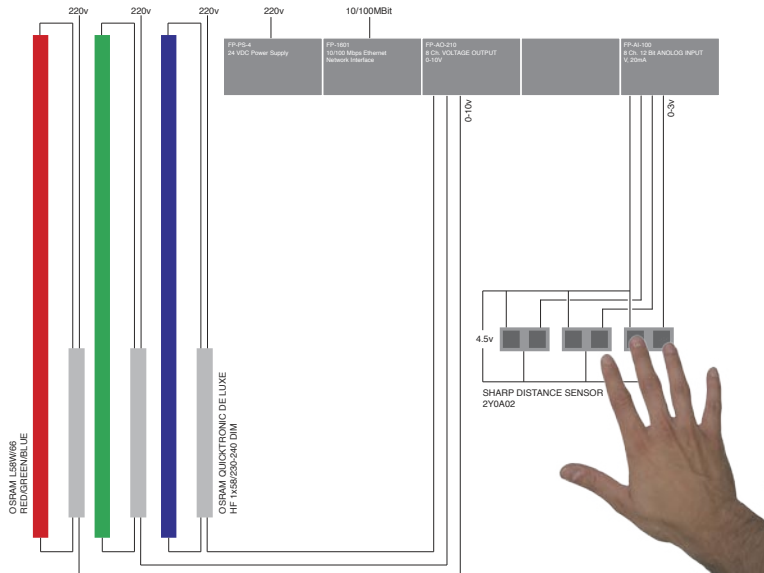
Once the technical aspects were more or less solved, a 1/1 scale model was constructed. An 18cm x 38cm x 168cm wood case was constructed. For economical and practical reasons (weight) the light box was to be made up of only 3 fluorescent tubes, one of each colour. The inside of the box was covered with white adhesive paper for maximum reflection.

For an even distribution of the light, the following rules have to be applied: the distance between each fluorescent tube has to be twice the distance from the edge of the box to the first fluorescent tube (A). Also, the distance between each tube must be the same as the distance from the tube to the film.

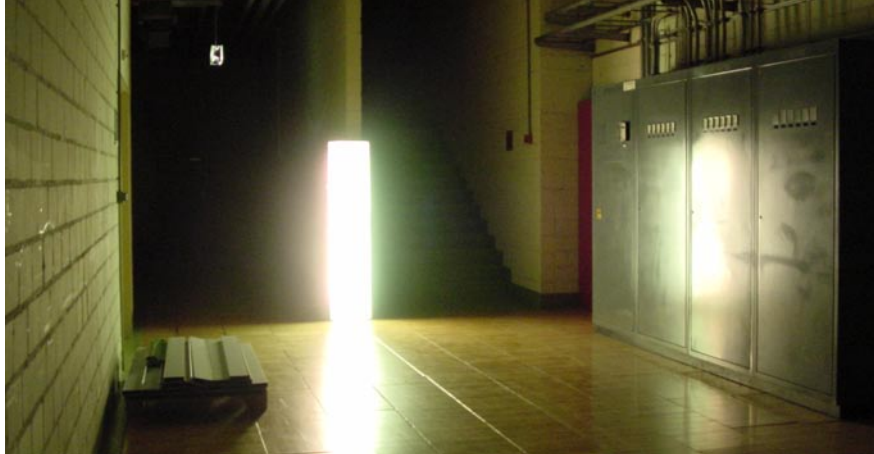
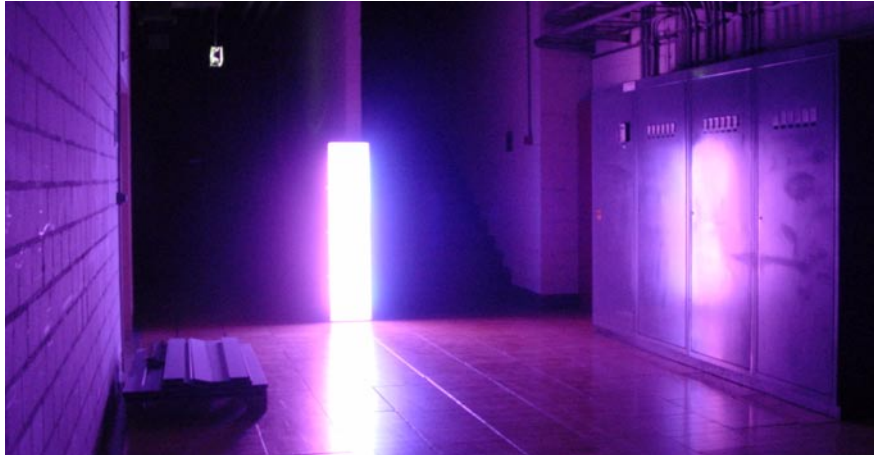


illustr. 23.1 position of the tubes inside the light box.

In practice, it isn't that simple. Working with one tube per colour, the result isn't even, as tests later showed. With 3 tubes, A represents about 16% of the lighten surface, whereas with say 6 tubes this drops down to 8%, with 9 tubes to 5.5%... More tubes would have been better.



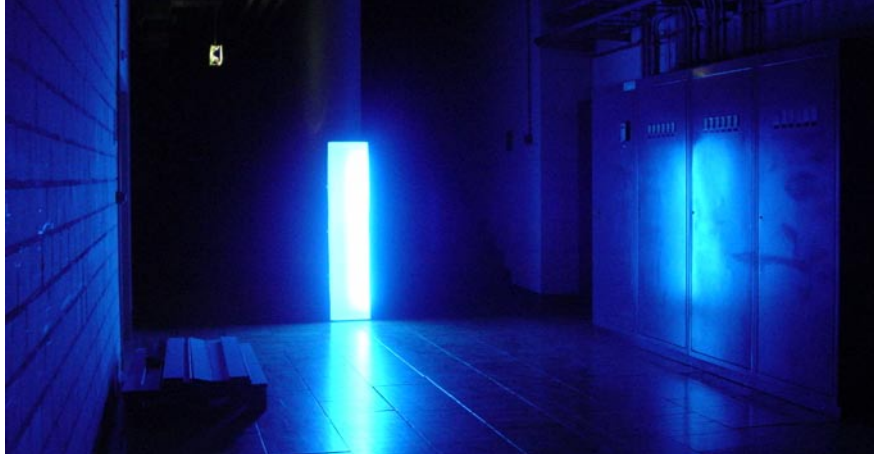
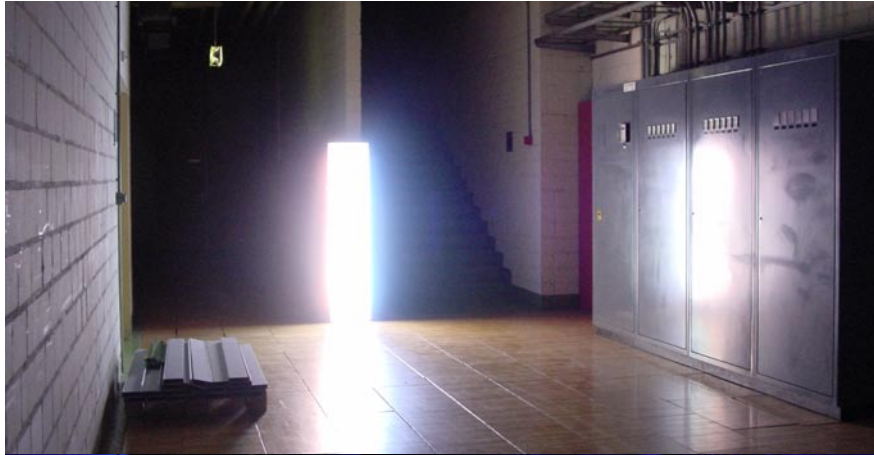
illustr. 25.1 _lightscape set-up

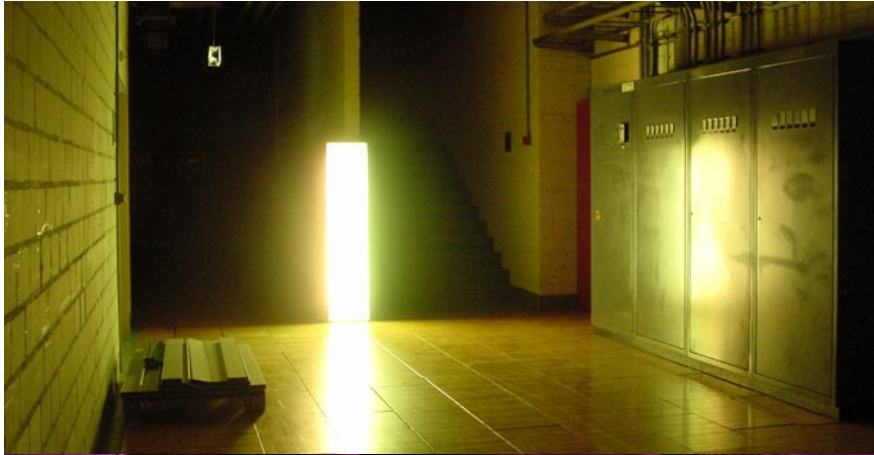


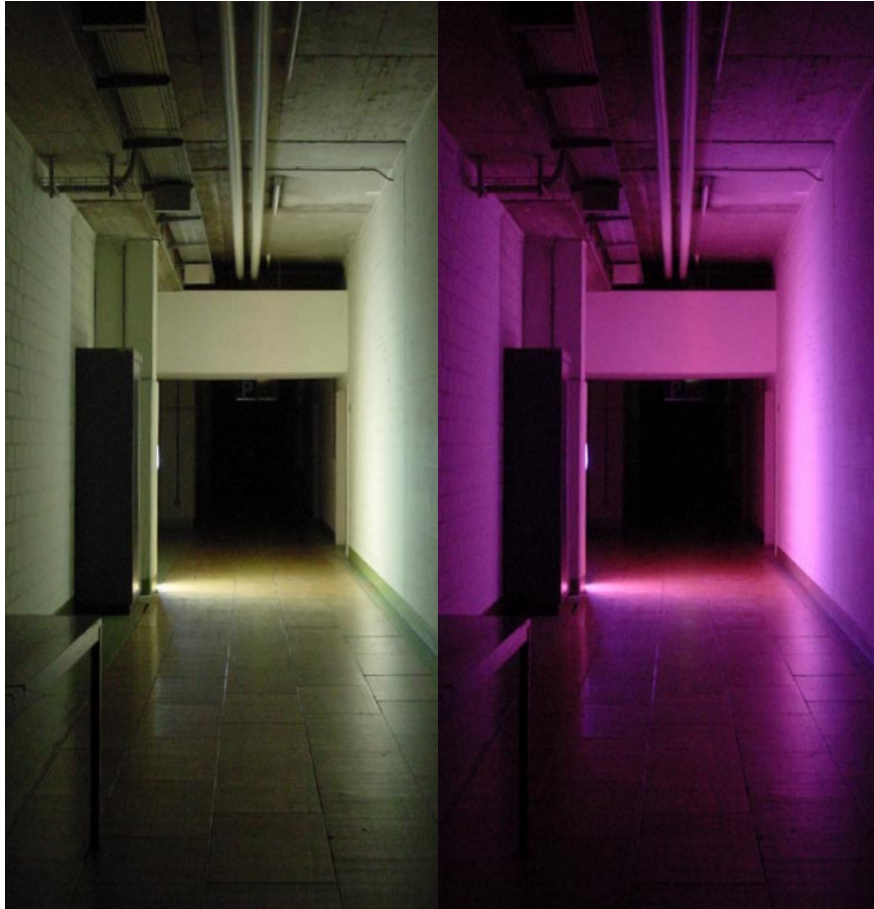
4.0 THE REAL THING | BACK TO ANALOG

So... does it work? Last minute and inherent problems made simulations difficult. Connecting to the Fieldpoint modules on the CAAD subnet always proved dodgy. It was definitely the case during the last days of this project: laptop problems, network problems...

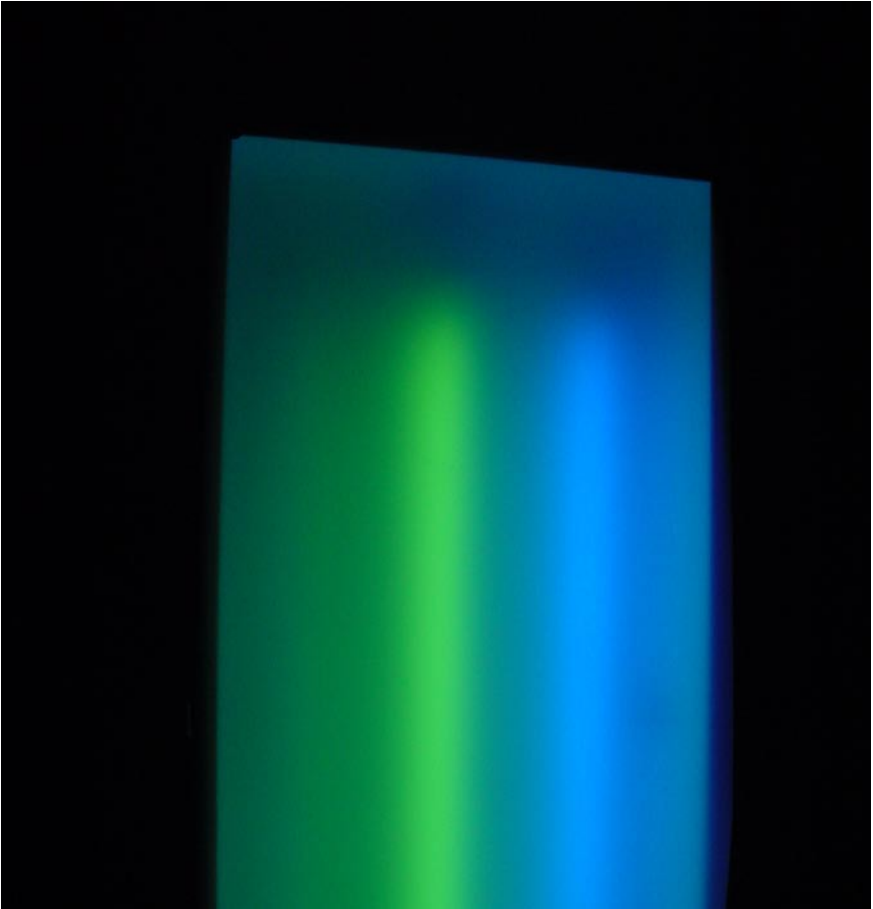
But more importantly, the set up was not very portable, being dependant on a network connection to function. For simplicity's sake, the distance sensors were replaced by standard analog dimmer connected directly to the fluorescent tube and manually dimmed. In the following pages are photographs of the _lightscape in context. Each time one or more of the tubes is dimmed, modifying the colour of the whole.







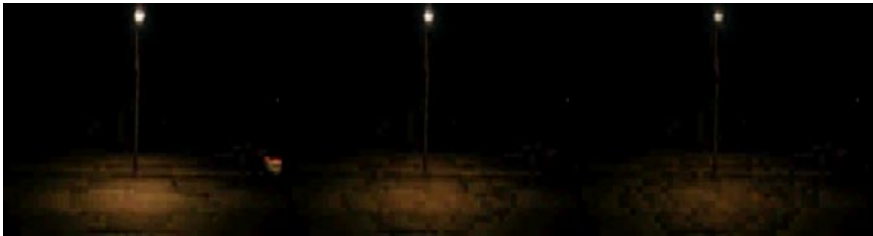






left: Exerts from the Honda IMA hybrid car commercial

4.0 ANNEX: Some inspiration...





top: a colour-changing ambient device seen at the imm köln furniture fair 2005
left: exerts from the Honda IMA hybrid car commercial





top: light boxes at the imm köln furniture fair 2005
left: a colour-changing ambient device seen at the imm köln furniture fair 2005



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<http://www.barix.com/>

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