Experiencing the non-sensuous
On measurement, representation and conception in urban art installations.

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ABSTRACT
In this paper we discuss the conflict between a scientific and an artistic approach to interface design in an urban experience-oriented installation, we designed for the Hopenhagen LIVE activities in Copenhagen during the COP15 climate summit meeting in December 2009. The installation called “Atmosphere – the sound and sight of CO2” converted data from CO2 measurements to sound and visuals presented through headphones and on a 2-meter high, quadrant sculpture that functioned as a transparent, low resolution LED screen. Hereby a normally non-sensuous phenomenon became visible and audible giving the public sensuous access to the symbolic villain of climate change: Carbon dioxide. What the sound and visuals actually represented, how it was conceived and to what degree it concerned climate change, is a rather complex question that is fundamental to the artistic concept and of epistemological concern for this paper.

Keywords
Visualization, sonification, interface design, representation, measurement and epistemology.

INTRODUCTION
At COP15 we were invited to be part of Hopenhagen LIVE, a public oriented festival at the City Hall Square with exhibitions, NGO activities, art installations and concerts. Our commission was to design an artistic and experience-oriented installation dealing with climate change. Inspired by “Informative Art” i.e. working with information displays as aesthetic objects that dynamically reflect information of their environment, giving way to moments of concentration and reflection [1], we chose to create an audiovisual interface that allowed the public to follow and compare variations of CO2 in the air, at three different locations in Copenhagen. Due to the ambition of creating an artistic and experience-oriented installation, we decided to avoid conventional forms of visualization like graphs and diagrams, since they, in our opinion, would bias the installation towards a scientific approach. Instead we used more abstract forms of expression. Looking back this decision shows, how we from an early stage on felt court in the dilemma of creating an installation that on one hand expressed a truth of the reality being measured (what we here call a scientific approach) and on the other hand could function on artistic premises alone, i.e. be an interesting audiovisual expression in itself. In the remaining part of the paper we will diagnose on which levels in our design process the so-called scientific and artistic approaches have collided, and reflect upon, how that has influenced the design and the conception of our installation, in order to benefit from this reflection in future design practices.

HOW IT WORKS
Basically, the installation physically consists of two parts: the CO2 meters (Figaro TGS 4160/CDM 4160-L00) [2] and the audiovisual sculpture.

CO2 meters
The CO2 meters were individually connected to wireless WIFI-routers through Arduino boards [3], installed in impact resistant boxes and placed at three different locations in Copenhagen: In front of 1) the City Hall, 2) The National Art Gallery and 3) the School of Fine Arts. From the meters the data was uploaded to PACHUBE [4] a server for storing and sharing real time sensor data.
The sculpture
From PACHUBE the data were streamed and mapped to a sonic and visual output through a software program written in MaxMSP. The visuals were displayed on a monolithic, quadrant sculpture made of four 1x2-meter high low-resolution LED-screens, placed in a pavilion at the City Hall Square. Next to the sculpture headphones were available for listening to the corresponding sounds. See Fig. 1

![Fig. 1. The sculpture seen from outside of the pavilion.](image)

The experience
Each of the three locations was assigned an individual colour: red for the City Hall, green for the School of Fine Arts and blue for the National Art Gallery. The overall experienced colour of the sculpture resulted from a combination of the colours from the two sites, where the measured concentrations of CO2, at a given moment in time, were highest. See figure 2.

![Figure 2. A map of Copenhagen showing the locations of the CO2 meters and the assigned colours of the sites.](image)

Also, the sculpture was subdivided in a top, middle and lower part each representing one of the three locations. The subdivisions would individually blink with a rhythmic pulse due to the concentration of CO2 at the corresponding site. So a fast blinking pulse in the upper part of the sculpture would indicate a relative high concentration at the City Hall. Likewise a relative low concentration at the School of Fine Arts resulted in a slow, blinking pulse in the middle part of the sculpture etc. See figure 3.

![Fig 3. The sculpture was visually subdivided in 3, each part representing one of the three sites.](image)

The same principle was applied to the sound, which was composed in the genre of electronic glitch music [5]. The overall frequency range was divided into three frequency bands with the high frequencies representing the City Hall, the mid-range the School of Fine Arts and the bass frequencies the National Art Gallery. When the level of CO2 changed at one of the three locations it affected the pitch of the corresponding frequency band respectively as well as the tempo of beating pulses. Furthermore, each time a CO2 value changed, a short audio and visual glitch, displaying the actual ppm value, emerged as a contrast to the repetitive pulsating drones. Imagine the amount of CO2 evolve from a low to a high concentration at each location. Then you would experience a similar evolving visual and audible pulsation at a constantly higher pace. In short, the higher concentration of CO2, the faster the visual and audible pulse. At what pace the overall colour would shift depended on the relative variations of CO2 at the three locations. So the shift of colour would not follow the logic of “more is more”.
The information
One thing is what to experience, another the information the experience represents. In our case the information that could be drawn from the installation was: 1) The ongoing relative variations of CO2 in the air at the three chosen locations, i.e. was the concentration rising or falling, designated by the visual and audible pulsations of the sculpture, 2) an indication of the site at which the concentration of CO2 was highest, i.e. is the overall color mainly red, green or blue?

DISCUSSION
In the design of the installation it became clear that the scientific and artistic approaches collided on three levels: 1) at the level of measurement, 2) at the level of representation and 3) at the level of conception. As a scientific approach we understand the installation to be informative and with the ambition of being true of reality in a precise and unambiguous way, while an artistic approach although informative not necessarily is true or precise, but e.g. critical, tentative, ambiguous and with strong aesthetic focus. This is of course a caricatured opposition that could easily be criticised from a “Latourian” perspective, holding that technology of science – the apparatus itself - is part of the construction of the picture of reality [6]. In this paper we will bypass this larger cultural and philosophical discussion of science technology studies since we only want to point out what we experienced as inherited problems in designing an installation that needed to be both informative/scientific and artistic.

Measurement
The concentration of CO2 in the atmosphere is measured in parts per million (ppm). According to NOAA [7] the average ppm is of 2010, 391.06 ppm per volume. The concentration of ppm varies seasonally and is of course locally dependent on a number of regional factors. In urban areas the concentration is normally higher. In our measurements the concentration varied from approximately 400 ppm (which was the lowest ppm value we were able to register, due to the construction of the meter) and up to 600 ppm, but only occasionally. Most of the time during a 24-hour cycle the value would fluctuate within a maximum of 100 ppm and with large differences between the individual meters. This probably had to do with the chosen locations and with the exact position of the meters. For instance how close they were placed to the ground, and to the city traffic.

From a scientific point of view it is reasonable to doubt the precise validity of our measurements, but it is fair to say that they reflect the tendency of the variation throughout the day due to e.g. traffic density, humidity etc. However from an artistic point of view the scale of fluctuations were rather small. In order to visualize and sonify the fluctuations so that people would notify and observe the variation, we therefore changed the scale, letting even a small variation in the actual data result in a larger variation of the visual and sonic expression. This was the first encounter of the scientific and artistic approach.

Representation
At the level of representation, we as designers choose how to map the measured data into sound and visuals. In scientific visualizations we often see representations of diagrammatic origin that in the semiotic theory of Charles S. Pierce is a subset of the icon, a sign or a representation that works by resemblance. In the case of the diagram it resembles its object in so far that it illustrate internal relations. So in our case a simple bar chart to illustrate the relative concentration of CO2 at each site would have been an example of a diagrammatic representation. For reasons already mentioned, we chose to avoid diagrams and hereby an iconic representation in favour of another class of signs often seen in artistic forms of representation – the symbol. The symbol represents its object not by virtue of resemblance but by convention. For us the symbolic representation offered a larger palette of expressiveness, but it also resulted in a more abstract form of representation that as a convention needs to be learned, before one can understand the relation between the aesthetic expression of the installation and the information it provides. The point is, that the readability of the information depends of the choice of
representation, but so do the expressiveness although not in a linear way. What we as designers need to balance in the choice of representation are e.g. 1) the readability in relation to the expressiveness, 2) whether the choice of representations conflict with already established semiotic conventions e.g. that the colour of red in many cultures is a distress signal and 3) whether the context supports the necessary learning-time for establishing the proposed convention. Although not exclusive to the encounter of scientific and artistic design approaches, these aspects are however clearly outlined in this relation.

**Conception**

Although we did not carry out any systematic analysis of the way the installation was conceived we did however perform a few informal talks, interviews and observations of people’s reaction to the installation. This brings us to the following observation. First, the physical context – a pavilion on a public square, did not provide the right setting for reflecting on and learning the symbolic relation between the aesthetic expression of the installation and the reality being measured. In that sense the mapping were too complex for an immediate conception. Besides the context the choice of a symbolic representation might also have contributed to the complexity. Second, the symbolic use of the colours red green and blue collided with already established conventions. We observed, how the overall colour of green sometimes were interpreted as indicating a healthy environment i.e. a low concentration of CO2, probably because green is often a symbol of nature. What it really indicated was that the concentration of CO2 was clearly highest at the School of Fine Arts. But even more often when the sculpture suddenly turned all red, meaning that the concentration of CO2 was clearly higher at the City Hall, it was interpreted as a distress signal and leading to comments like “Ohh, I did not realize it was that bad” as an observed elderly woman concluded. Examples like this show us, how an artistic expression chosen for a certain state (a relative high concentration at one site), were wrongly interpreted as truthful information of reality.

**CONCLUSION**

To conclude we can say that designing an experience-oriented installation in the context of COP15 has made clear to us the fine balance between scientific information and artistic expression. We have exemplified the dilemma of this balance on three levels: measurement, representation and conception. On the level of measurement the dilemma concerned the scale of measurement versus the scale of expression. On the level of representation it concerned the choice of semiotic encoding. Favouring a symbolic representation for an iconic (diagrammatic) in order to work with a more open, abstract tentative and in our understanding artistic expression, than often seen in scientific forms of representation might in this case have contributed to the complexity of perception and to peoples misunderstanding of the information conceived. This of course is something we need to address in future design practices of this kind.

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**REFERENCES**


