

Sensual Technologies: Embodied experience and visualisation of scientific data

Michael Hohl

'Sometimes I think; and sometimes I am.' Paul Valéry

Abstract

In this text I set out to discuss the relationship between a selection of four works which bring together the sciences, natural processes, the body and sensorial perception. These works are, Ned Kahn's 'Seismic Sea', Luke Jerram's 'Tide', Hugo Kükelhaus 'Strudel, Wirbel, Spirale' and Antenna Theater's 'Sands of Time'. These works blur boundaries as it is difficult to categorise them. They could be seen in science centres visualising scientific principles, in art exhibitions for their aesthetic qualities or possibly function as types of scientific instruments in their own right. They have in common that they use natural processes or environments as a medium of visualisation or as an interface for action and reflection. Within each work the human body plays an essential role in stimulating the imagination through aesthetic experience. These particular examples have been selected for their usefulness to discuss the potentially transformative role of bodily experience in works that emerge from art and science collaborations. The text aims to show a genre of evocative works that not so much depend on technology than on investigations into phenomenology and contemporary research into neuro-plasticity. Their primary goal though is not to create new knowledge but to make curious and to delight. A critical reflection as a result of curiosity may follow later.

Introduction

The emergence of such works coincides with the public debate around climate change, sustainability and ecological literacy. In their timely combination they contribute to a public awareness of environmental issues and sustainability. We can see this in recent exhibitions, with several examples of art and science collaborations, such as 'Radical Nature' at the Barbican and 'eARTh' at the Royal Academy of the Arts, both in London, in 2009, and 'sensing nature' in Tokyo in 2010.

Vindicating the importance of the role of the human body, sensual perception and physical activity in a type of learning experience, is largely based on two texts: Hugo Kükelhaus' 'Inhuman Architecture' originally published in 1972, and Andreas Lüscher's 'Experience Field for the Development of the Senses: Hugo Kükelhaus' Phenomenology of Consciousness.'

Kükelhaus (1900-1984) was a German artist and philosopher. His writing and practice were dedicated to demonstrate the importance of reconnecting with our bodies and the senses through actively perceiving natural phenomena, especially in respect to child development. Modern life, he argued was restraining the human body and limiting exposure to sensorial varieties, for example, such as hot and cold, darkness and light. Kükelhaus argued that experiencing sensorial varieties was essential during the developmental phases of children for their nervous system and sensory organs to develop their full potential.

In his reasoning, this also had consequences for the development of consciousness. The emphasis of modern life, he argued, was on abstraction and largely deprived of the multifarious sensual experience necessary for the full development of consciousness, of consciously perceiving the world and one's body. According to his framework, action and reflection were not opposites but complementaries feeding on each other and a requirement for fully becoming aware of the world. He argued that simply perceiving phenomena of natural processes (such as a water vortex or a burning fire) not only supported the development the senses but also strengthened them.

Swinging on a swing, so Kùkelhaus, would allow us to realise how opposites have a renewing quality. Falling produces rising and vice versa. And at the same time becoming aware that this primordial symmetrical motion of 'back and forth' was forming a unity. For Kùkelhaus the experience of nature and natural processes was an essential condition of engaging and developing the sensory organs and as a result developing human consciousness. This theory is supported by contemporary research into neuro-plasticity, which discovered that the brain changes continuously through the way it is used. In childhood there are critical periods (Doidge, 2007, 47-49), phases during which the brain is most sensitive, for example, for acquiring language. Once such a critical period has passed certain nuances of pronunciation cannot be distinguished by the brain. Merely seeing physical laws in action resonates with intrinsic pre-verbal knowledge but may also, as a result, make the underlying science less abstract and more accessible.

'Kùkelhaus' understanding of science is especially useful for the developing science of consciousness where the phenomena of lived experience comprise the very field of study. In stressing the relation of theory to praxis and taking the continuity of experience and nature as revealed through the outcome of directed action as the starting-point for reflection, [...].' (Lüscher, 2006)

While this text is concerned with interdisciplinary collaborations between art and science its focus of reflection lies on two distinct properties: Knowledge and experience. The relationship between a natural process, its scientific interpretation informing a visualisation, and the role of the human body and the senses in this process. Or, to put it another way: The balance between abstract and actual; intellectual and physical; between conceptual content and aesthetic qualities. The text suggests that a combination of these could play a crucial role in transformative scientific art experiences. The paper concludes that scientific visualisations may have more impact when they not only are intellectually stimulating, but also have sensual qualities or even involve a hands-on experience. An aesthetic quality of interaction. Why is this important? Because these types of aesthetic experiences can lead to fundamental learning experiences regarding our perception of the world, of ourselves and of ecology.

Scientific impact on public perception

Originally, photography in early space flight was technical photography and was largely considered a recreational exercise for astronauts by NASA (Kitmacher, 2010). When the US space program NASA returned the first images from their visit to the moon, paradoxically it was the image of the planet earth that had the most unexpected and profound impact. This 'blue marble' image became an iconic view in the following years. 'We went to explore the Moon, and in fact discovered the Earth.' reflected astronaut Eugene Cernan. (Krausse, 1998) One simple image led to an infectious shift in public perception. It enabled everybody to see the earth as a small, vulnerable and limited island in empty space and triggered the foundation of the environmental movement and gave impetus to emerging ideas of ecology and sustainability. These technical images, a result of a scientific undertaking, resulted in transforming the public imagination more than abstract rational conceptions, such as Rachel Carson's book 'Silent Spring' from 1962, had achieved. It allows us to realise that one technical photograph, can over time, fundamentally affect human consciousness. Scientific knowledge about the world and ourselves increases rapidly. At the same time, this knowledge is abstract, complex, and not very accessible to other people than experts. It would be interesting to see some of this revolutionary knowledge about genetics, biology, optics or physics 'visualised' in similar comprehensible ways, leading to new shifts in public perception of the world and ourselves. Such works hold the capability to capture public imagination, by transporting science from the laboratory into the art gallery, thus increasing public accessibility and impact of scientific knowledge.

Data visualisation beyond the screen

Most of us will be familiar with data visualisation in the form of graphs, charts or diagrams. These have a long tradition of depicting mathematical formulas and figures in a graphical manner,

conveying information within the data and its relationships in a clear and visual style. In short, they transform 'raw' data into information that is easier to comprehend than abstract figures themselves. Traditionally printed visualisations use contrast, scale and colour, to structure information, often combining text with graphics. In recent years, screen-based information visualisations have become increasingly popular in the form of animated or interactive graphics. For example, showing flight patterns of planes (Aaron Kobelin, 2005), or the 10,850 litres of 'embedded water' in a pair of blue jeans (Black, 2010) depicted by 73 bathtubs. While these two examples convey information for a general audience, others transform scientific data from cellular-biology or radio-astronomy, to be analysed and interpreted by scientists.

While these visualisations mostly take place on the screen or in print, the focus of this discussion is on 'visualisations' that take place beyond the two-dimensional plane, in space and extending beyond the visual sense to other sensorial modalities such as sound or touch. The focus of such works is often less about an accurate depiction of complex or large data-sets, but instead, emphasises the aesthetic experience. Other qualities may be playfulness, engaging the traditionally passive visitor, and a physical experience - as opposed to a more passive, intellectual one. As such, these works emerge from different disciplines following different rationales and have different conceptual goals. While some works (not discussed here) simply employ sound or water as alternatives to conventional displays, for others the choice of media is intrinsically linked to the conceptual content. The work 'Tide', described below, for example, uses water to symbolise water, 'Sands of Time' uses sand and distance to symbolise time. Both approaches share an experiential quality, which I shall go to discuss, that extends beyond the visual sense and are perceived in a different manner.

Ned Kahn's *Seismic Sea*, 2009, Transforming bodily motion into visual feedback

The San Francisco-based artist Ned Kahn has a long tradition of creating works that engage with natural elements such as water, fog or sand. His first piece, created in 1991 for the science centre 'Exploratorium' in San Francisco, is called 'Tornado'. The work consists of a round knee-high platform covered in perforated steel-mesh through which a cloud of white fog slowly emerges. While the fog slowly revolves, its centre begins to rise building up in a narrow column towards the ceiling, forming the shape of a typical tornado, although indoors. This structure is very fragile and will collapse through a brief gust of air. Kahn writes: '[My] work [is] inspired by atmospheric physics, geology, astronomy and fluid motion. I strive to create artworks that enable viewers to observe and interact with natural processes. I am less interested in creating an alternative reality than I am in capturing, through my art, the mysteriousness of the world around us.' (Kahn, 2007) From the large number of pieces Kahn has produced since 1991 I want to describe one work in closer detail for its role of showing processes of the human body.

Ned Kahn's 'Seismic Sea' was created in 2009 for the Pasadena Museum of California Art. In it, a small amount of water is sealed in a transparent acrylic dish and mounted on top of a steel pole. This pole again is fixed upon a steel base plate which sits on hundreds of springs that allow the plate to vibrate as people walk on it. The vibrations caused from people's motion are transferred up the pole and create waves and ripples on the surface of the body of water. The piece can be used indoors or outdoors. Either the sunlight refracts intricate patterns of water ripples onto the floor around the steel plate, or the water surface reflects light towards the ceiling. Kahn writes that the system was sensitive enough to reveal the heartbeat of a person standing still on the base plate.

The piece invites different types of activity. It is attractive for children creating vigorous visual effects but also allows for more contemplative interaction. Its functional simplicity does not distract from the vibrant visual reflections that take place around it. The simple element water in combination with bodily movement and light, becomes the medium that transforms motion into complex iridescent patterns and can make visible invisible bodily processes. The visitor can learn that even when passively sitting, her presence can have an effect and through this process of bio-feedback she can become aware of her own heartbeat or breath visualised as lightful ripples around her. Technically, the work is easy to understand through simple examination, as no

sophisticated technology is used in this piece. In the next work water also plays a central role, but it is used as a source of sound and as a medium to visualise changes of gravity.

Luke Jerram's *Tide*, 2001, Transforming gravity into sound

Luke Jerram's work 'Tide' was created in 2001 in collaboration with specialists in astrophysics, geophysics, the history of music, glass design and vulcanology. 'Tide' presents the effect of the moon's gravity upon sea levels in the English city of Bristol, using three large rotating glass spheres, similar to oversized wine glasses, filled with water. A gravimeter, measuring changes in gravity, controls the amount of water in each of the three spheres. As planet earth and moon move during the course of a day, gravity changes as well, a process that we are unaware of, as our senses are unable to detect such minute differences. Synchronous to these changes of gravity, the tide is affecting the Bristol channel where the difference between flow tide and ebb tide can reach almost 20 Meters. On the rim of each rotating glass sphere sits a friction device that makes it 'sing' in resonating overtones. As gravity changes over the course of a day, so do the water levels in the glasses and as a result the quality of the sound resonating within the space. For visitors entering the exhibition space, these sounds create a visceral corporeal experience, and an awareness of the continuous changes of gravity throughout the day that are imperceptible to their senses.

Jerram's work involves sophisticated technology, yet the relationship between gravity, alternating water levels and the resulting sound is direct and clear. Felicitous has been the clear mapping in which water is used both as a medium to visualise rising and sinking sea levels and also as the medium that creates the sound. In this work, technology translates the gravimeter's abstract scientific data into a very direct and actual experience otherwise imperceptible to the human senses. As our ears are much more susceptible to minute changes of sound than our perception of gravity, this experience reminds us of synaesthesia, a neurological phenomenon that links sensorial modalities. Individuals suffering from synaesthesia can, for example, perceive colours also as different tastes. By transforming gravity into sound, 'Tide' extends the human senses and creates an awareness of the changing invisible natural forces that surround us yet of which we are not consciously aware. Central to the work is a vivid bodily awareness that focusses on the process of hearing and the resonating overtones that fill the exhibition space. As no direct interaction is involved, 'Tide' is about contemplation, acute listening and becoming aware of cosmic forces that extend over astronomical distances. The experience stimulates the imagination through the human body and sensory perception.

Hugo Kükelhaus' *Strudel Wirbel Spirale*, 1967-68 (Vortex Turbulence Spiral)

A related process of involving the visual sense is taking place in 'Vortex Turbulence Spiral' by Hugo Kükelhaus from 1967 which originally was created in collaboration with physicist Otto Hahn. A model consists of a large glass cylinder measuring 30 cm x 190 cm filled with water. At the bottom of this cylinder are two stirring devices that rotate in opposite directions when a crank handle is turned. As the handle is turned, one can see the body of water slowly beginning to rotate and rising up against the glass walls, while in its centre, a vortex begins to form, extending from the water surface down to the stirring device. Kükelhaus had experimented with smaller models and determined that scale was important, as a large body of water in whirling motion would more easily have the power to captivate the attention, resonate with the nervous system, and literally draw people into this state in combination with the physical activity. Kükelhaus observed that when we marvel at such processes we do not ask, 'What can I do with it?' or, 'What is it good for?' It simply was enough to be immersed in the phenomenon.

This installation was an embodiment for his larger phenomenological framework of developing consciousness by fully and actively stimulating the senses. His intention was to bring young people in direct sensual contact with natural phenomena to challenge and activate their senses' functional possibilities. His reasoning was that this was necessary as through over-intellectualisation and the sensorially deprived modern lifestyle, we had lost the sense for perceiving the connectedness of

processes, that all phenomena were connected in one. For him, it was more important that young people first would experience the 'large phenomena' of nature directly, and thus become aware and curious while learning the abstract theory could follow later. During the 1960s, he created about 40 different installations of this kind that allowed to explore experiences of symmetry, balance, resonance and gravitation, among others, twelve of which were exhibited at the 1967 EXPO in Montreal, Canada. (Lüscher, 2006)

Chris Hardman and Antenna Theater, Sands of Time, 1998, 2002

'Sands of Time' was a temporary installation exhibited at several locations in California between 1998 and 2002. It was organised by the artist group Antenna Theater, based in San Francisco. The 2002 version was installed on Rodeo Beach near Sausalito and was 1,300 feet long and 13 feet wide (an earlier version had been over 4 km long). The sand along this stretch of beach along the Pacific Ocean was shaped into patterns, grooves and sculptures similar to an expansive Zen garden that visitors could walk through. The intention of the work was to create an awareness of deep time, or billions of years, staged as a narrative of the history of the universe from its origins to today. The stretch of beach represented the theoretical 13 billion-years of age of the universe, each billion of years indicated by an iron tower with a burning flame on top. Visitors wore headphones with a narrative spoken by science writer Timothy Ferris. They would begin their walk at one end of the installation, symbolising the beginning of time with the big bang, walking along the beach while the history of the universe unfolded in the narrative of the audio guide and in the raked and structured sand around them. The audio narrative described how matter formed, how stars ignited and elements were created, how galaxies formed, how 4.5 billion years ago our solar system was born, the earth cooled down, asteroids hit our planet, life emerged, from single cellular organisms to plants and dinosaurs, to the present day. At the end of their walk, the audio track invites participants to pick up a single grain of sand. As they hold it in the palm of their hand, they learn that compared to the entire walk along the beach this grain of sand represented 2,000 years.

Symbolic for this work is the choice of location, a beach along the Pacific Ocean. Not only is sand often used as a metaphor for the infinite, but located outdoors visitors experience the natural forces around them such as the wind, the sea and the sun (or moon) which heightens the sensuality of the experience. It would be perceived entirely different in an urban setting such as a public square. The vast ocean and sand support the reflective nature of the audio tour regarding deep time and a sense of long-term thinking in relation to the short amount of human history. Through the headphones, participants are less likely to be distracted and can focus upon the narrative and its meaning. As a result listening to the audio track is a highly immersive experience that may draw participants easier into the narrative and resonate with its imaginative message. The combination of sensual experience, together with intellectual stimulation, appears highly original in this piece. Being exposed to the elements by the ocean, walking and listening to the thought-provoking narrative may result in an intense experience. Also of interest is the ephemeral nature of the piece as it mostly consists of raked sand and is exposed to the tide and elements. Another fact enhancing the experience may be the knowledge that work will not last and is ephemeral only. This emphasises the uniqueness of the experience.

Organiser Hardman says about 'Sands of Time': 'I think the human race could learn a lot by understanding that both in space and time, we are not the major players in the Universe,' 'We're not the owners; we're just the visitors here, ... in a very long process.' (Lubick, 2002) and understand 'the idea that we're part of a large, unfolding story. It has the potential for leaving culturally based homocentric thinking behind.' (Cole, 2000)

Discussion: What is the relevance of these works?

Distinctive in all works is a focus upon the sciences and an aesthetic emphasis of involving the human body and the senses in original ways. The encounters are both intellectual as well as highly sensual. Also significant is most works' departure from the passive role of an art observer to that of an involved participant actively engaging with the work. All the works have in common that they stimulate sensory perception in original ways and possibly create a curiosity in science by

visualising a natural process, while at the same time being playful, and can simply be enjoyed as such. 'Sands of Time' provides enough redundant visual information to be enjoyed without listening to the narrative. At the heart of all selected works are not science or technology, but the human body and a focus upon the natural world that surrounds us. As the sound of gravity resonates, a silent heartbeat is reflected in light, or as we create and watch a spinning vortex or relate a walk along a beach to the cosmos and deep time we do this in a state of heightened sensory awareness. All of them result, to varying degrees, in 'learning experiences'. Participants know more about the world and themselves as a result of the experience and have internalised this knowledge much less rationally, than as an imaginative sensual experience in relation to their own body's intuition and feeling.

Experiences such as these can have a lasting impact upon our brains, creating new connections or reinforcing existing ones. Similar to the NASA photograph they may potentially create paradigm shifts in people's perception of the planet or their bodies and their relationship to it. Contemporary neuro-scientists argue that the brain takes on the form of how it is used.

Neuro-scientist Gerald Hüther writes in that respect:

'Most [...] deficiencies have become solidly anchored in the brain through repetition of previously adopted strategies of perceiving, thinking, feeling, and behaving that either have been regarded as right or that have never been seriously questioned. There is only one way to get your brain back to the point where you can [...] smell as well as hear, dance as well as play music, and think rationally as well as sense things intuitively. This way, which has been known to us human beings for thousands of years, is expressed in an ancient Chinese proverb: 'Not where you have already attained mastery should you exert yourself further, but there where such mastery has still yet to appear.' (Hüther, 1997)

In that sense, the selected works teach us new ways of seeing and perceiving, and encourage us to feel and to think. I believe we can learn from these examples that technology is not necessarily the key to capture the visitor's imagination, but the conceptual idea that informs a work and its aesthetic quality, especially how it involves the senses through physical interaction. In recent years, information art has seen a steep rise, although these works are mostly screen-based. This is largely a result of open data formats, open platforms and the availability of this data via the Internet. Through this, various kinds of live streaming data from radio-telescopes and satellites have become easily available. With the effects of climate change increasing, it is likely that we will see more works in the near future created from live weather data.

'We do not know yet what kind of art-making will best help us transform our cultural relationship to climate, but I believe it will involve artists' work using scientific data with instruments for artistic purposes.' (Malina, 2010)

In that respect Kükelhaus suggests that *'One should actually surround oneself with all kinds of phenomena and constructions in which universal laws become visible. Why do I suggest this? Because then we can produce, whenever we like, the phenomenon which conveys a bodily experience of the correspondence between the inner and the outer world.'* (Kükelhaus, 2007)

Another way of viewing the experience of such works could be that they are a process of learning. Future experiences will be affected by the thoughts and experiences that we encountered with them and they are linked to embodied experience as well.

'[L]earning of a living organism [...] takes place in an oscillation between certainty and uncertainty, contraction and expansion, attraction and repulsion - above all, in processes that are not characterised by the fixation of information. Or, to be more precise: just as there is no direct link between the cause of the stimulus and its processing in the living organism, there is no link relating to information in a verbal nature. [...] it is not the brain or any other single receptive field [...] that learns, but the human being as a whole. And it is the human being as something transcending the mere sum of its components that absorbs information.' (Kükelhaus, 2007)

Although open-data formats and open platforms have been around for several years now, we rarely see works that combine scientific data in combination with sensual aesthetics. What could be the reason for that? Gabriele Gramelsberger conducted research in 2004-2005 about the use of

interactive media at science centres.

She concludes: *'The presentation and use of new technologies can offer a huge potential to science centers which isn't being used widely today. A reason for this may be the lack of communication between researchers and exhibition makers but also the experience that prototypes are not robust enough for everyday exhibition practices.'* (Gramelsberger, 2005)

Clearly a didactic experience requires a different design than a more ambiguous open-ended artistic experience that is guided by individual exploration and curiosity. Yet, all the above pieces could be imagined in science centers as well in art galleries.

In this text, I used a number of case studies to demonstrate the relevance of an intellectual experience in combination with an embodied experience for exhibits that involve art and science collaboration. It also attempts to provide convincing examples and rationale that such scientifically informed visualisations are stimulating in their own right without necessarily having to convey a significant intellectual payload in the form of learning outcomes. First we want to people to have an aesthetic experience. It is later when they may want to understand and investigate its cause. This I tried to express this with the choice of the Paul Valery quote at the beginning of this text. It poignantly makes us aware that thinking and experiencing do have mutually exclusive dimensions, that thought can be detrimental to 'being in the moment'.

This text presented new avenues of research and of practice which require interdisciplinary collaboration among the arts, design and the sciences to create a new body of engaging and sensual works. Some of these works may contribute to the public understanding of science or emphasise the invisible natural and unnatural forces that surround us, while others may focus on sensuality and aesthetics. Together, they may emphasise our connectedness with the cosmos and thus may have a profound impact on the human psyche.

Figures:

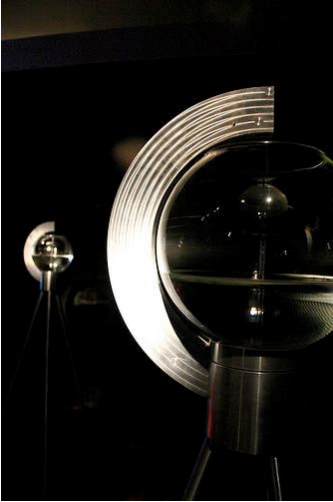


a)



b)

a) Hugo Kükelhaus' *Vortex, Turbulence, Spiral*. Used with permission by MEKU Erich Pollähne GmbH. b) Used with permission by Pädagogische Aktion für OÖ.



Luke Jerram's *Tide*. Copyright by Spinster. Creative Commons licence, at <http://www.flickr.com/photos/spinster/1539718/sizes/m/in/photostream/>



Sands of Time, Used with permission by Chris Hardman and Antenna Theater.



Ned Kahn, *Seismic Sea* used with permission by Ned Kahn Studios.

References:

Black, Richard (2010) 'Embedded Water' for BBC with data from UNESCO/TWENTE, <http://news.bbc.co.uk/1/hi/sci/tech/8628832.stm> accessed October 15th, 2010

Cole, K.C. (2000), "Earth Day 'Tour Through Time' to Be Sculpted on Beach", Los Angeles Times, 13/04/2000

Gramelsberger, Gabriele (2005) 'Science Center - Places for Informal Education,' Free University Berlin, supplementary material for television documentary, available at <http://www.huettinger.de/v3/exhibeng/downloads/publications/ScienceCenter-informal%20education.pdf> accessed October 15th, 2010

Hüther, Gerald (2006) 'The Compassionate Brain: How Empathy Creates Intelligence,' Shambhala Publications, Boston, USA

Kahn, Ned (2010), 'Artist Statement' available at <http://nedkahn.com/statement.html> accessed October 15th, 2010

Kitmacher, Gary H. (2010), "Astronaut Still Photography During Apollo", available at http://history.nasa.gov/printFriendly/apollo_photo.html accessed October 15th, 2010.

Kobelin, Aaron (2005) 'Flight Patterns' <http://users.design.ucla.edu/~akoblin/work/faa/> accessed October 15th, 2010

Kükelhaus, Hugo (2007) 'Inhuman Architecture: From Animal Battery to Information Factory', Studio Naqshbandi, Auroville, India. German original from 1972.

Lubik, Naomi, (2002), 'Beach walk through time', published in Geo Times, 24/10/2002

Malina, Roger (2009) 'RETHINKING ART AS INTIMATE SCIENCE: CLIMATE ART AS A HARD HUMANITY', accessed at <http://www.rethinkclimate.org/debat/rethink-art/?show=far>

Lüscher, Andreas (2006) 'Experience Field for the Development of the Senses: Hugo Kükelhaus' Phenomenology of Consciousness' in International Journal of Art & Design Education, Vol. 25, Issue 1, pages 67–73, John Wiley & Sons, Ltd

Valéry, Paul (1969), 'Analects', Collected Works XIV, Princeton University Press, USA

Michael Hohl is a designer and researcher working in digital media. He likes making things, thinking about things, how we do them and what they mean to us. Currently he is exploring telematic technologies, calm technologies and ambient displays. A main interest is to understand how technology changes us, while we think we are doing something with technology. His work is about consciousness, perception and experiences of presence and connectedness among physically remote people connecting via the web: mh@hohlwelt.com