Windscapes

A radio feature by Andreas Bick

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In the July 1993 issue of "Nature" magazine, John Maddox described the research carried out by two Japanese scientists under the poetic title "Endless ripples on the sands of time". They had managed to define the formation of dunes and sand ripples with the aid of non-linear differential equations. Hiraku Nishimori and Noriyuki Ouchi used a mathematical model to simulate how wind carries desert sand, grain by grain, and arranges it into complex patterns. After a certain wind strength is reached, macroscopically ordered structures begin forming spontaneously as a result of collective processes on the microscopic level, i.e. at the sand grain level. The most basic laws of physics and merely the parameters of wind, sand and gravity are sufficient to generate an infinite variety of shapes. Although the process can be simulated using supercomputers, it cannot really be calculated or even predicted. The formation of dunes and creation of ripple marks on dune surfaces involve dynamic systems. These dynamic systems are continuously renewing themselves due to processes of self-organisation, thus leading to the creation of recurrently similar shapes and structures. These pattern formation processes are quite common in nature. The coloured patterns on marine mussels, the markings in the fur of various animals, electroconvection in liquid crystals, neuronal activity and even social processes can be described in terms of non-linear dynamics. In the previous sound compositions *sono taxis* and *dripping*, similar phenomena were discovered in the interaction patterns of frogs and grasshoppers and in the patterns created by droplets falling from water outlets linked to the same water supply. The *windscapes* piece rounds off a triptych of radio features on the theme of non-linear dynamics.

At first you hear a faint, delicate trickling. Sand runs through an hourglass focussing the listener's attention and conjuring up images in the mind: the wind swells, rattling gusting sounds then begin to build up and gradually the whole spectrum of conceivable wind sounds roars through the hourglass before the storm suddenly quells and the listener finds himself back in a parched saltpan in the midst of a desert in which gentle flurries play with the odd grain of sand.

The desert, a landscape reduced to the most fundamental and primordial components, a place for introspection, is the starting point of *windscapes*. In all its breathtaking beauty and simplicity, the desert represents the epitome of a landscape sculpted by the wind. The sea of dunes and the aeolian modulation of the sand remind us of the empty vastness of the ocean, whose silent waves of sand are continually being shaped by the wind to create sheer infinite diversity. The flowing shapes and patterns of sand seem to go on endlessly like time – which itself has been measured using sand since time immemorial.

Wind is defined by various characteristics such as its original direction, temperature and humidity, duration and seasonal occurrence. The winds forming over the Sahara were given names even in ancient times, such as the buran, harmattan, sirocco and simoom. The various characteristics of the wind correspond in *windscapes* with sound-generating desert landscapes, which can only be experienced acoustically by the very presence of wind. The backdrops to the six locations experienced in *windscapes* are provided by sandy, rocky and mountainous deserts – which make up the largest part of the Earth's arid regions – and dune-covered ghost towns. The Vlei, a parched saltpan with cracked shards of dried mud and eroded clay soil; gnarled desert vegetation, its desiccated branches rattling in the wind; a deserted house in which smashed glass fragments clink in the window frames and loose hinges knock about in the wind; a mountain cave and pipe-like chambers whistling in the wind; a diamond mining town buried beneath sand dunes in which the clanking of metal huts and wire can be heard and the sounds of flowing sands build up to the phenomenon of the humming dunes; finally, there is the rocky desert in which rock formations crack open under the intensity of the sun and the wind tosses little stones over the eroded rocks. In each of these sonic locations, the wind toys with objects, it sweeps over the ground, carries off sand, causes various bodies to resonate in the stream of air and makes it possible for us to imagine the shapes of an archaic landscape and its physical structures. The typical whistling and wailing sounds of the wind give the listener the impression that the different soundscapes of each location have their own acoustic atmospheres and characteristic resonances, and that the wind is finding its way amongst the spatial arrangement of resounding objects.

In addition to the real-world soundscapes, two types of sound installation were responsible for generating the basic material used to compose *windscapes*. One involved a 20 to 30 metre long string made to resonate by the wind, the other involved the translation of sand ripple photographs into rhythmic sand sounds with the help of contact loudspeakers, known as "bodyshakers", which can be used to transfer sound vibrations to solid bodies. The long wire forms a closed system, which creates tonal and rhythmic effects solely through its interaction with the wind and is related to the macroscopic structures of the dunes. The sand sounds represent an acoustic translation of the microscopic sand-ripple structures, whose rhythmical behaviour was synchronized with the rhythmic behaviour of the long string.

The discovery of the rhythmic acoustic characteristics of various long strings originates from Uli Wahl of Weinheim, Germany, and is presented here for the first time to the broader public. A 20 to 30 meter long piece of metal wire or a flat twisted wire is stretched out against the wind, which, depending on the wind strength, makes the string produce a series of natural harmonic overtones. The distinctive feature involved in this setup is that the long wire is coupled with a second shorter and thin thread. This thin thread is tied to the long string near its suspension point and is connected to a resonator and soundboard. The second wire also produces its own sound at a different pitch and includes a range of harmonic overtones. The interaction of the two strings causes the overtones to build up to polyphonic sound structures as the wind strength increases. These sound structures move back and forth along the long string like an echo, thus leading to a pulse-like behaviour. The speed of the pulse depends on the length of the wire – the longer it is the slower the echo. The sounds are recorded using a piezo microphone located directly inside the resonator, which acts as an amplifier and at the same time shields the microphone from the wind. All the sounds produced with the long string that were used in *windscapes* are original recordings by Uli Wahl – no technical tricks or effects were used. The clear, penetrating sounds of the long string can be interpreted as the blazing light from the desert sun, whilst the slow rising and subsiding of the harmonic overtones conjures up an image of the endless interwoven lines produced by the expanse of dune crests.

Analogous to the flowing contours of the dunes, the sand ripples on the dune surfaces represent, as it were, the original embryonic state of the dunes, since the little ripples already display the macroscopic structures of the dune and exhibit a predisposition to dune formation. The aeolian modulation of the sand traces out paths created by the wind that run perpendicular to the predominant wind direction. Depending on the shape of the dunes and the changing wind direction, these paths continuously split and merge or are superimposed by patterns of other frequency and amplitude. At the same time, the little ripple marks are continuously inching their way over the ridge of the dune. Translating this slow progression of the sand ripples into something acoustically perceivable was another challenge. The approach used here was to imagine that the sand waves were breaking against spatially distributed resonating bodies, which act like acoustic detectors to record the staggered impact of the ripple marks over time. Typical patterns were selected for this from various sand ripple photographs, whereby transitions involving a high occurrence of branching off points (bifurcation) were of particular interest. These photographs were transferred to a computer, which was then used to assign a particular sound to individual sand ripple lines. The time window of a music program was made to pass over the image of the patterns several times. With each pass, the section to be analysed was moved forwards parallel to the predominant direction of the ripple lines. The analysis allowed trigger information to be gleaned from the photographs for each sand ripple. This trigger information then enabled the changes over time – i.e. the bifurcation, diverging and merging of the ripple marks – to be made audible and moulded into a rhythmic sequence.

Since wind transports sand in the desert either by "creep" or "saltation" (short movements through the air), suitable acoustic analogies had to be found for both modes of transportation. To acoustically simulate the creeping movement of the sand, sheets of paper, metal and glass were mounted horizontally in elastic suspension devices. The trigger information for the ripple patterns was then applied to these suspension devices by means of bodyshakers. Low-frequency pulses caused the sand that was placed on the resonant surfaces to move to the rhythm of the ripple lines. Furthermore, by applying various grain sizes, a different timbre could be assigned to each rhythmic pattern. The low-frequency trigger pulses were later filtered out of the signal since that frequency range was not relevant to the sound being produced by the creeping sand. Astonishingly enough, the sand on the vibrating resonant surfaces often spontaneously merged into dune-like formations. Slight inclinations would cause them to move like accelerated wandering dunes. The phenomenon reminds us of the research carried out by Ernst Chladni around 1780. He created geometric patterns by sprinkling sand on sheets of glass and metal and then drawing a violin bow across the sheets' edges. The "Chladni figures", however, only form on square or circular sheets. If any other shaped sheet is used or even if rhythmic information is used instead of a constant tone, the resulting behaviour of the sand appears to be mysteriously related to the pattern-forming processes that are also responsible for the formation of the dunes and sand ripples.

For the motion of sand through the air, countless individual recordings were made of wind-blown sand grains flying against various resonating bodies. The sound of the sand grains could then be assigned to the relevant time-related trigger information. To ensure a natural organic sound sequence, it was important to record various sand grain sizes and wind gusts, and for the resonating bodies to be struck with sand at different positions. The objects used were made from wood, stone, glass and metal, and their sounds were then used in combination with the sounds of the creeping sand. Wind sounds made by whirled-around plastic pipes known as "whirlies" and short blowing sounds on bamboo flutes and bottlenecks were also used.

As in the previous sound compositions *sono taxis* and *dripping*, the "drifting pattern" composition technique was also used in *windscapes* in some of the rhythmic passages. This looping technique makes use of the inherent dynamism of non-linear processes. The processes evolve and are repeated with a certain degree of imprecision. The sound loop moves along the rhythmic pulse of the sand ripple pattern and is continuously offset by a tiny amount along the time axis. This means that the material constantly develops a new rhythmic emphasis. If we imagine this in visual terms, the "drifting pattern" method is analogous to the technique in which a certain vertical section is cut out of several copies of a picture – each section covers an area that is continuously shifted by a certain amount to the right. If these individual sections are then lined up alongside one another, a horizontally stretched picture is produced. As a result, rhythmic sequences are produced whose pulses move towards one another like in a kaleidoscope due to the constant shifting. Rhythmic emphases or beats become blurred and a hypnotic pattern is created.

The subtle changes and imperfections in the "blurred" rhythms portray the idea of nature as an interwoven network of rhythms and time scales in which only similar but not identical processes can be observed. According to L. Klages, a beat is repeated but a rhythm constantly renews itself. This puts forward the idea that the beat has mechanical qualities, whilst the rhythm exhibits organic characteristics. The combination of repetition and slight changes in the sand ripple patterns alludes to a cyclical perception of time: a movement away from the linear progression of time by freezing moments in time in continuously self-renewing repetitions, which – like the endless ripples on the sands of time – move towards the horizon sand grain by sand grain.