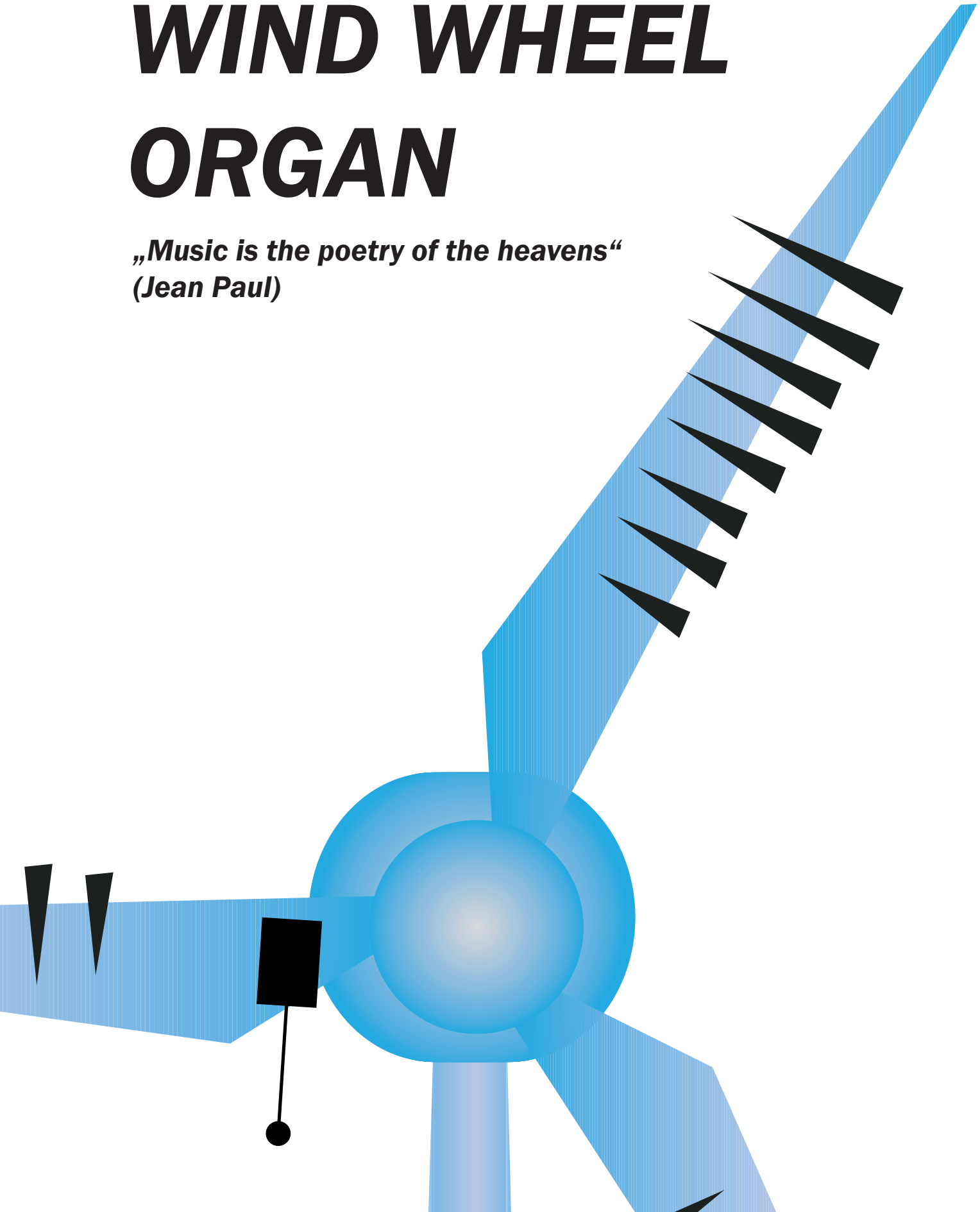
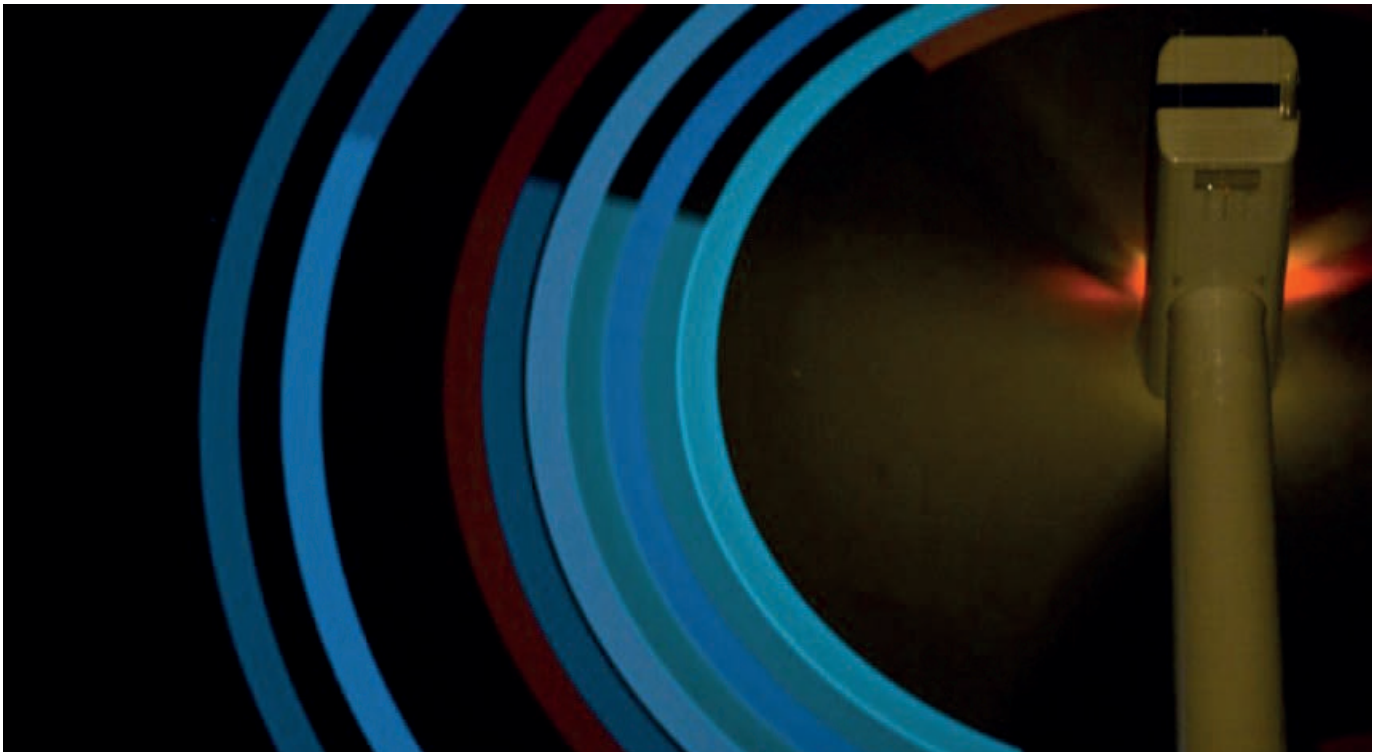
The
WIND WHEEL ORGAN

„Music is the poetry of the heavens“
(Jean Paul)





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Wind Wheels to be used not only for Climate Protection but also as Musical Instrument

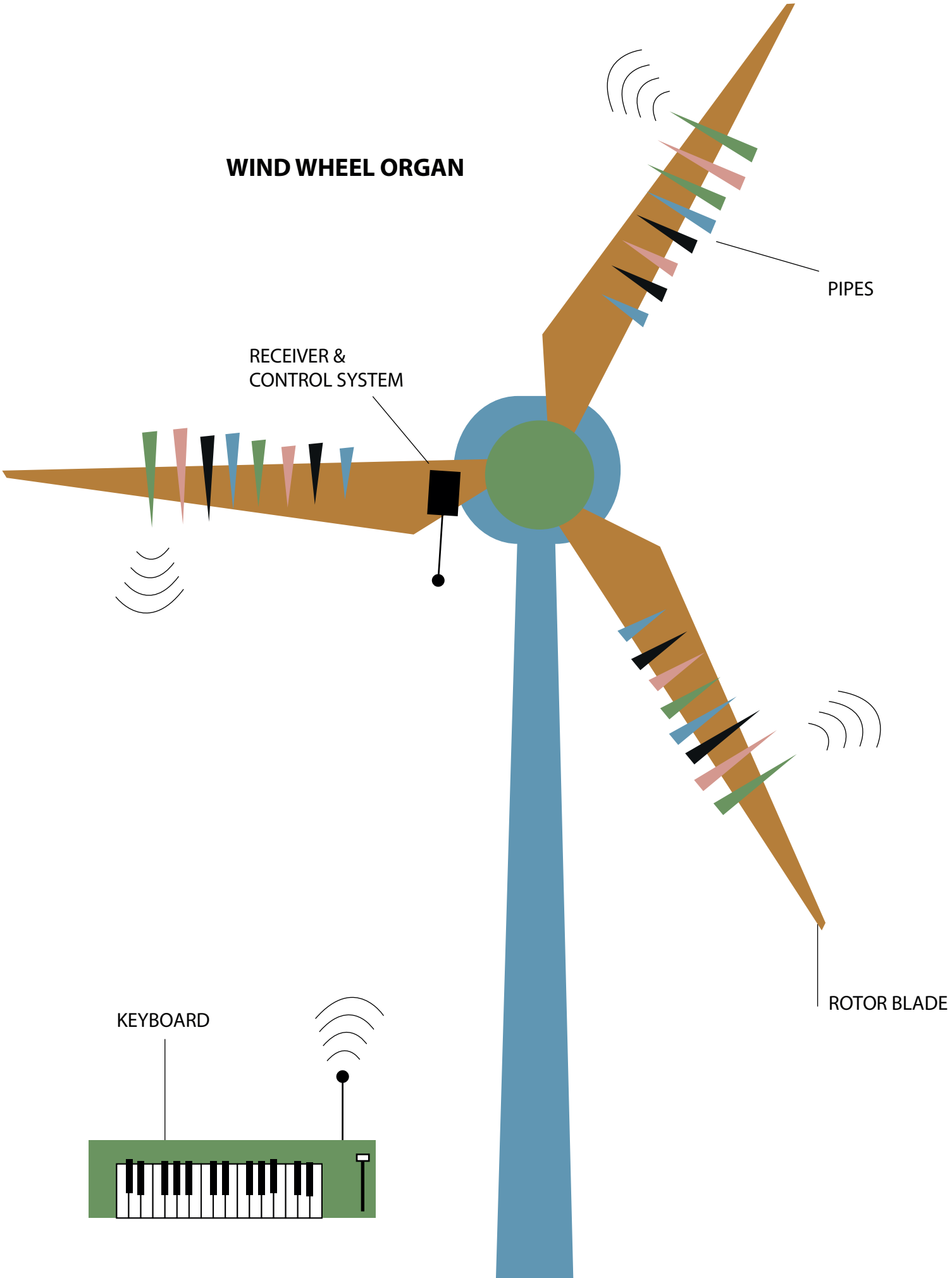
The cost-benefit analysis of large wind wheels is still considered to be negative. People are annoyed about the “destroyed” landscape and think that noise pollution is worse for local residents than the benefits of renewable energy generated by wind wheels. This attitude makes a more efficient use of wind energy difficult in order to meet the requirements of climate protection.

Yet, wind wheels can be used as musical instruments: the wind wheel organ. It is suited for big open-air concerts. For music fans who reject wind wheels as inconvenience, this fact may create a positive approach to the topic of wind wheels.

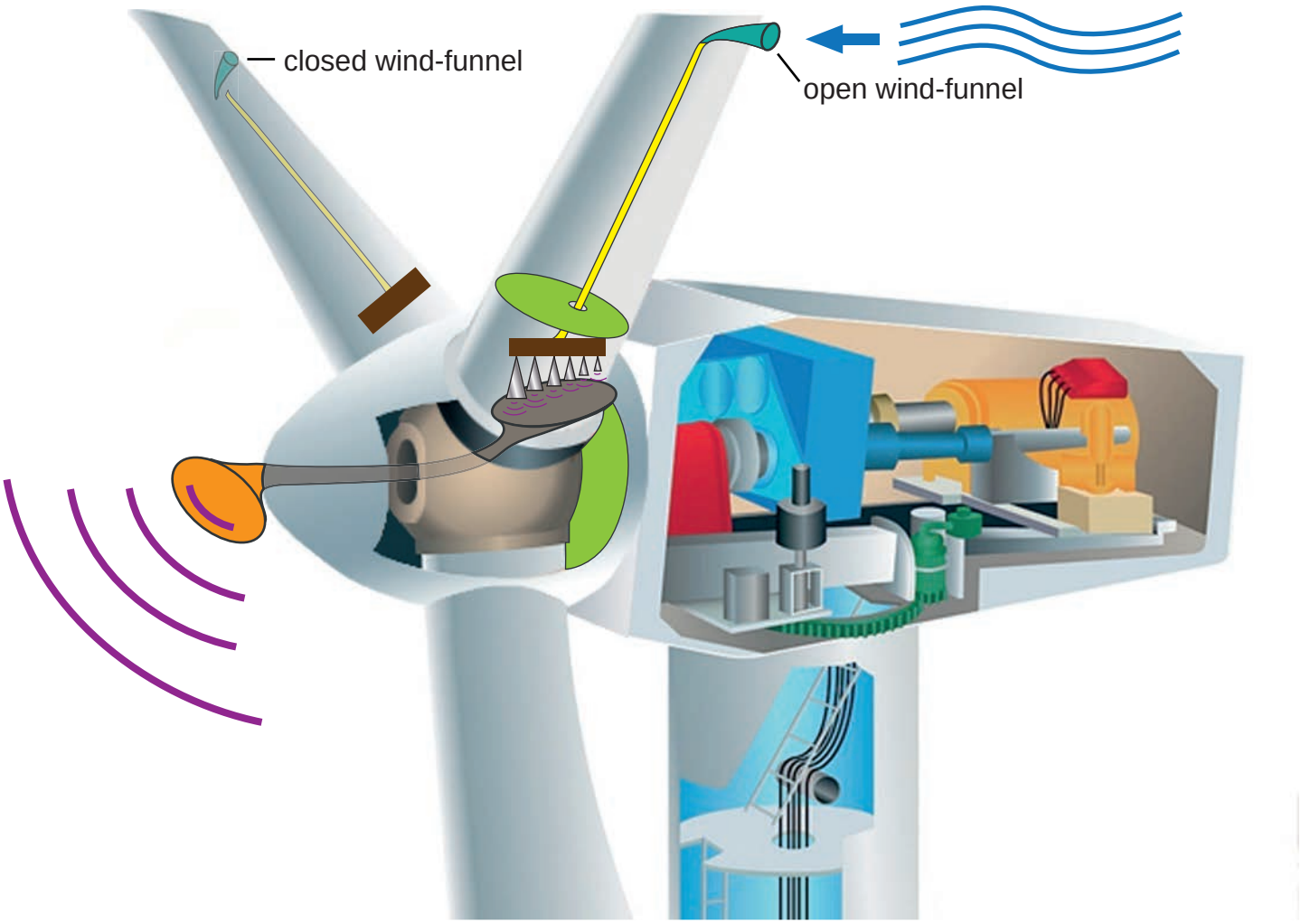
Wind farms may become public centers of attraction due to the additional use of wind wheels for open-air concerts. This is especially important for tourist centers with favorable wind conditions, e.g. in coastal areas and in the mountains or in urban parks and parking areas in front of sports arenas, from where the music of the wind wheel organ can be transmitted into the arena.

Wind wheels with wind wheel organs can be of significant importance for amusement centers integrating the topics of energy turnaround and sustainability to their event program. Wind wheel organs can also be installed in minarets and church spires to generate renewable energy for these places of worship and to play wind wheel organ music for the services there.

Graphic 1: Wind Wheel Organ - organ pipes outside rotor blades



Graphic 2: Wind Wheel Organ - organ pipes inside rotor blades



Wind - Wind
Funnel – (Stau-)Trichter
Feed-pipe - Druckleitung
Closed Wall - geschlossene Wand
Wind chest - Windlade
Organ-pipes – (Orgel-)Pfeifen
Sound-pipe - Schallrohr
Horn - Horn
Sound - Schall

Mode of Operation

In case of traditional pipe organs, air pressure generating the sound in the pipes is produced by means of the wind chest. The wind pressure is generally between 600 and 1000 Pascal.

In case of the wind wheel organ, the air pressure is generated by means of the rotational speed of the wind wheel.

At standard speed of a large wind wheel a velocity of up to 300 km/h is achieved in the outer section of the rotor blades.

The velocity in the centre section of the rotor blades is between 100 and 150 km/h.
A dynamic pressure of 1800 Pascal can be expected here, in the outer area the air pressure may rise up to 3.000 Pascal. I.e. a very much louder sound of the pipes will be generated in comparison to church organs.

There are two possibilities to install the organ-pipes. They can be mounted externally onto the rotor blades (see graphic 1) or inside the rotor blades (see graphic 2). The wind will be collected in the outer area of the rotor blades by a funnel and will be transmitted to the organ-pipes, respectively the wind chest, through a feed-pipe.

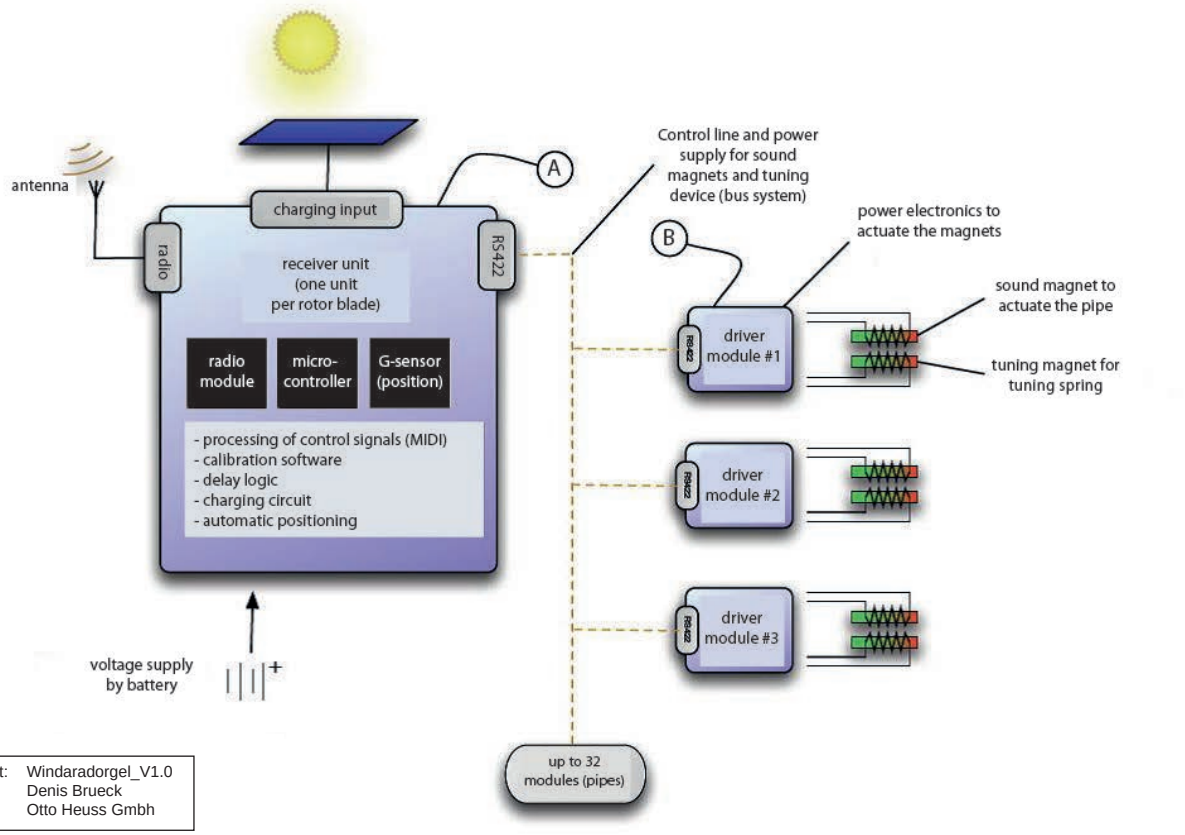
If the organ-pipes are inside the rotor blades the sounds of the organ-pipes have to be channelled through sound pipes to the rotor hub of the wind wheel.

From there the sounds will be spread by a horn or several horns.

The organ pipes are switched on and off by means of an electro-magnetic mechanism. This mechanism is operated by remote control by radio and by means of a MIDI control module. Thus, the pipes can be operated by an external keyboard, i.e. can be played like an organ or piano (see graphic 3).

The wind wheel organ can be permantly installed or temporarily for concerts.

Graphic 3: Conception of the configuration of a control system for wind wheel organs



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Feasibility

Dr. Judit Angster, head of the research group of Musical Acoustics of the Fraunhofer Institute for Building Physics in Stuttgart (IBP) verified the feasibility of the wind wheel organ in cooperation with the organ builder Karl-Martin Haap, Organ Building Company Muehleisen plc (Werkstätte für Orgelbau Mühleisen GmbH), the expert of wind wheel technology Dipl. Ing. Jan Liersch, Keywind plc (GmbH), and the experts of electronic control technology of organs Denis Brueck, Julian and Stefan O. Heuss, Otto Heuss plc (GmbH).

The study is financed by the Federal Ministry for the Environment. Pipes were identified by tests in the wind channel which fulfill the necessary criteria: stability of tone frequency under dynamic condition of air pressure, high sound power for open-air concerts and sound quality even with lightweight construction by means of glass fiber reinforced plastic (GRP). Due to the high centrifugal forces at the rotor blades lightweight pipes are necessary.

The low energy demand of the wind wheel organ allows an „autonomous“ energy supply by means of small solar-powered rechargeable batteries and thus has only a minimum adverse effect on the energy performance of the wind wheel. In order to not reduce the energy yield under normal operation of the wind wheel, the wind wheel organ is designed to allow short-term mounting and rapid dismantling of the rotor blades before and after a concert. Therefore, there is a multitude of applications of the wind wheel organ in various wind farms for concerts, if required.

A risk for concerts is calm. The solution to this problem is to install a small electric motor in the generator nacelle which accelerates the wind wheel by means of a strip to a velocity required for playing music. This means: open-air concerts can be organized independent of current wind conditions even in hot summers with occasional calms.

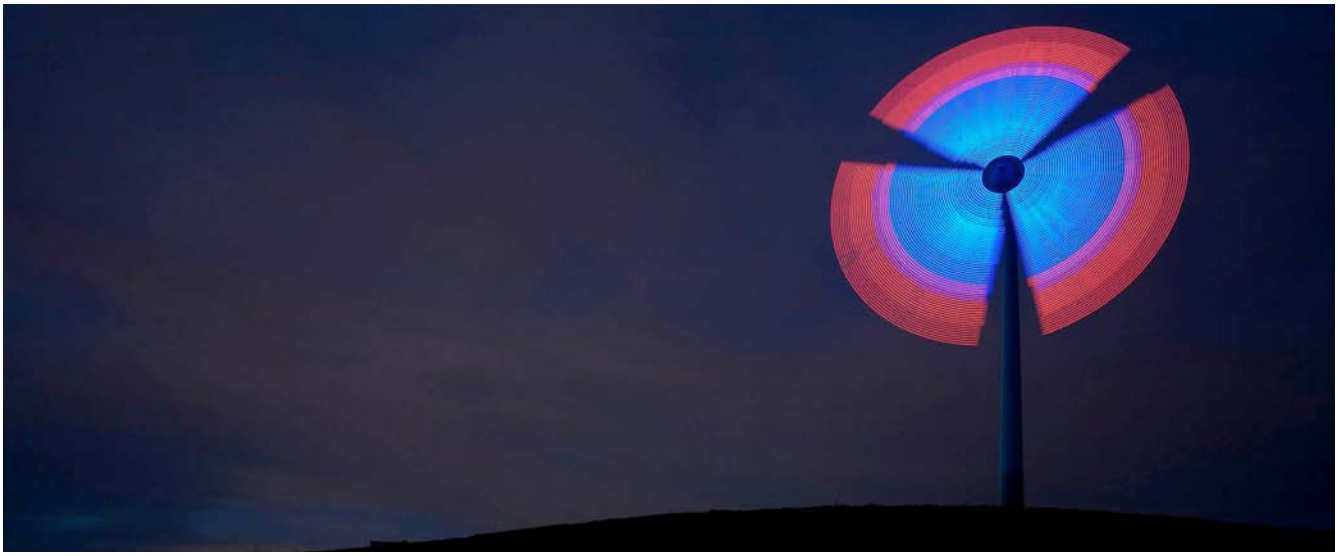
Extension of the tonal range: The number of pipes to be mounted on or inside the rotor blades is limited due to weight. The number of octaves can be increased by means of the repetition method so that the tonal range of the wind wheel organ allows playing like a piano.

Microphones can be installed in the pipes or in the horn on the rotor hub and can be connected to a PA system. Thereby the sound volume can be varied or raised especially for large auditoria, if necessary. Acoustic problems like the Doppler effects or the problem of phase difference, when sound from various positions of the rotor blades arrives at the audience, can be optimized by a PA system. These effects don‘t occur, if the wind wheel organ is installed inside the rotor blades.

IBP

Fraunhofer Institut Bauphysik

Music and Light Effects



The wind wheel organ can be used like an organ or piano as solo musical instrument or accompanying instrument for numerous other instruments or orchestras.

Connected to a PA system the wind wheel organ is suited to interpret all existing musical styles from classical music to jazz and pop. The innovative sounds of the wind wheel organ due to the Doppler effects among other things will stimulate new musical styles.

Wind wheel organ music can be combined with light effects in LED technology, developed by Windmove (www.windmove.de) and Siemens AG, to become a „light echo“ of music at the wind wheels of a wind farm.

A special attraction can be playing music on traditional instruments of various cultures, if they are suited to be amplified by PA systems, e.g. the West African harp kora or Asiatic string instruments, the „finger piano“ Mbira or Marimba. Within a short period of time, wind energy will become popular in this way.

The first wind mills were developed in Persia and China. They did not rotate around a horizontal but a vertical axis. This technology could be applied in minarets and church spires to make wind wheel organs in churches and in mosques sound.

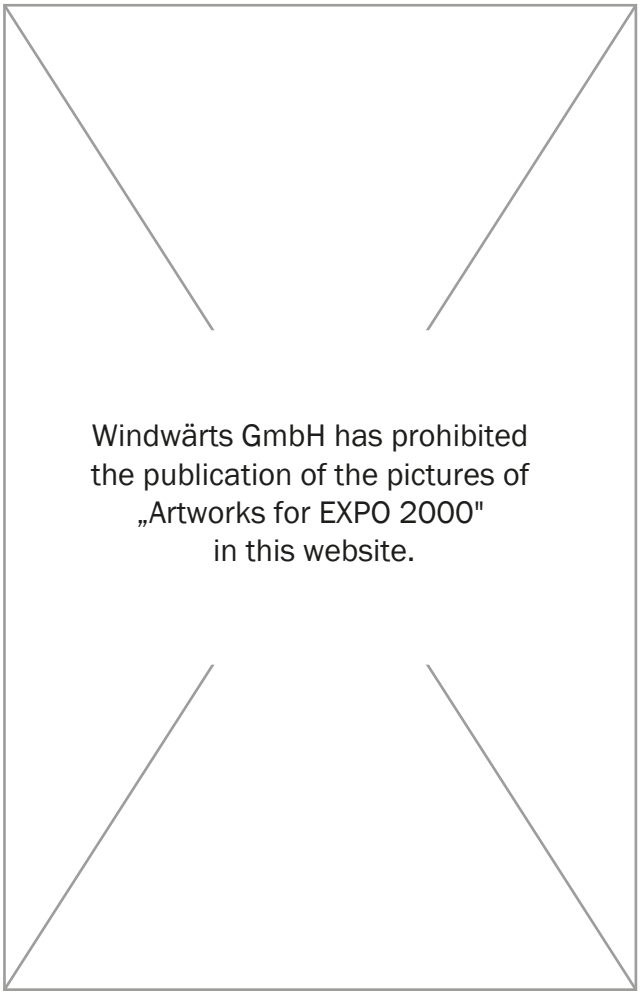
Ecological Mosque Project Norderstedt

Wind Farms for Open-Air Concerts and as Art Parks

Many wind farms are suited for open-air concerts. Some of them can even establish regular festivals with wind wheel organs. Some wind farms are located or planned in spectacular landscapes, e.g. the wind farm on the Sattelberg at Brenner Pass in the Alps at a height of 2.100 m with the panorama of the Zillertal and Stubai glacial mountains. Wind farms in tourist centers do not deter people from coming but can even be an attraction, if they do not only generate clean energy but are also used for wind wheel organ concerts and as art parks.

A competition for artists of Expo 2000 in Hannover delivered first incitements for art park concepts (www.windwaerts.de). There are three aspects of using parking areas in front of sports arenas: as parking lot, as wind farms to generate wind energy and to play wind wheel organ music on the occasion of concerts in the arenas.

From a wind wheel on the landfill deposal mountain of Fröttmaning near Munich for example wind wheel organ music can be played and transmitted to the nearby „Allianz Arena“ (soccer stadium of the soccer clubs of Bayern München as well as 1860 München). On the occasion of the World Climate Summit in Copenhagen in December 2009 the Siemens AG presented the light show „Stern des Suedens“ (star of the south) by means of a wind wheel (http://www.siemens.com/press/en/events/corporate/2009-11-29.php). This could be restaged as the echo of wind wheel organ music. Parks or open spaces within cities such as the former airport Tempelhof in Berlin can be further developed into wind farms with wind wheel organ music and art.



Artworks for EXPO 2000

Climate Protection and Energy Turnaround as an Event

Amusement parks throughout the world enjoy great popularity with hundreds of millions of visitors each year. They should make the energy turnaround an event as a contibution to create a broad public conscience for climate protection and sustainability by means of the wind wheel organ as special highlight. „Ghost trains“ can demonstrate the horror of climatic and environmental disasters.

Aeolists developed various wind toys which do not only fascinate children, for example wind harps and kites with Aeolian flutes. On the occasion of kites festivals experts show artistic kite art. Nighttime shows use dramatic and poetic light effects and music which can be played by the wind wheel organ in future times. The event program should be completed by an educational program on the topics of climate protection and renewable energies.

Khmer Kite „Kleng Ek“ (Music Kite)

Sources of Inspiration: Heron's Organ, Singing Wind Mills, Bamboo Wind Organs, Sea Organ and Salvador Dali's Tramontane Organ

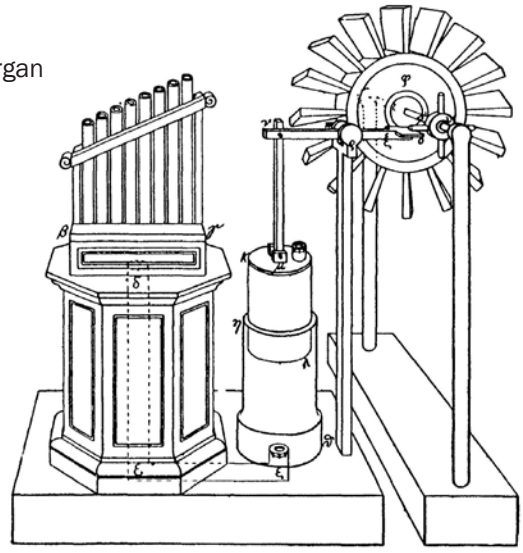
Ktebesios of Alexandria invented the first organ probably in the third century before Christ. It was operated by a wind wheel and could be played like an organ. The Greek inventor Heron (first century after Christ) described this organ and therefore it was named Heron's Organ. It was a very popular instrument in the Roman Age for music-making in the homes of rich Romans or as background music for gladiatorial combats.

Wind pipes were developed and used in many cultures. But they could not be switched on and off by means of a keyboard meaning that they could not be played like an organ or a piano. A few examples:

The Singing Wind Mills have an ancient tradition in Portugal. They were developed there centuries ago to warn millers of storms which could destroy their wind mills. The mills use vanes covered by canvas which work like the sails of a sailing boat.

If the wind is too strong, the sails must be unrigged. Pipes made of pumpkin or clay mounted to the vanes make the danger point audible by making a tonal leap at a certain wind velocity and wind pressure and thus sound an octave higher.

Heron's Organ



Singing Windmill in Portugal

Pigeon Whistle

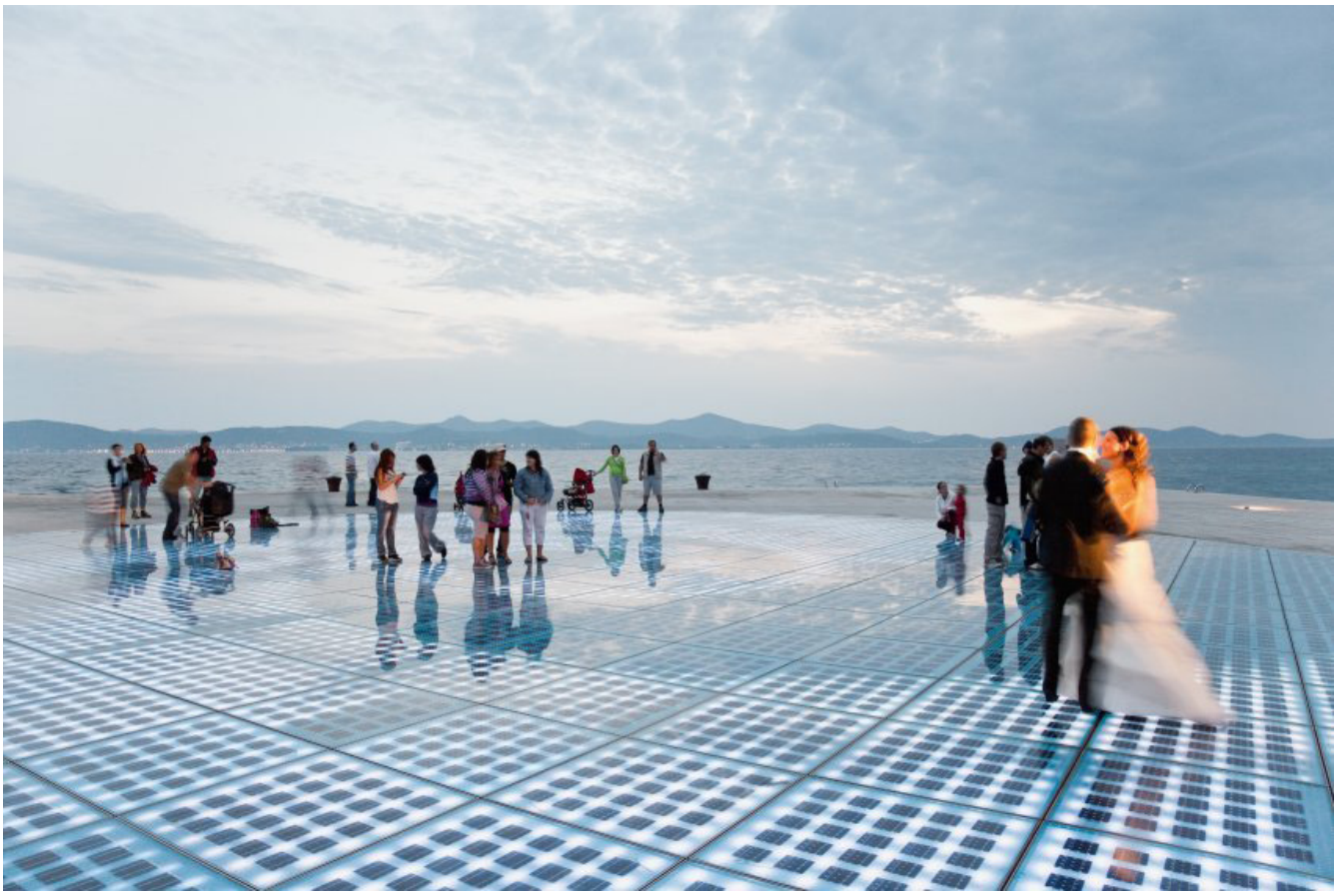
Pigeon Whistles made of featherweight calabashes developed in China and Indonesia have a similar function. They were stuck to carrier pigeons to repulse raptors and foxes by the sound produced, allowing farmers to raise free-range chicken, ducks and geese safely.

„Bamboo Wind Organs" were developed in South East Asia and used for religious ceremonies and to mark jungle trails.

Salvador Dali had the idea of a Tramontane Wind Organ. It was designed to use the strong wind blowing from the Alps and Pyrenees to the south. The surrealist artist intended to buy the legendary Castell de Quermanco at the Costa Brava in the 1960s and have a wind organ installed there. The project failed due to the purchase price of the castle. In 2003/4, physicists of the University of Barcelona and the organ builder Albert Blancafort tried to realize Dali's idea with pipes, but failed because of the resistance of the population against the permanent acoustic irradiation caused by the pipes. The artist Oriol Ruis was also inspired by Dali's idea and created the sculpture "Organ for the Tramontane" in 1993.

Organ of the Tramontane by Oriol Ruis inspired by the idea of Salvador Dali

In 2005, the architect Nicola Bašić built a sea organ in Zadar (Croatia). It consists of 35 tubes of a length of approx. 70 m installed in a stepped concrete sea front. Water flowing in and out generates sounds in these tubes, which resonate the waves. All tonal sounds of most diverse pitches come through small openings up to the boardwalk as well as through the lateral openings in the steps towards the water. Unique sound characteristics are generated in this way which can be heard day and night. The sounds have a very calming effect and are very popular with numerous visitors. Similar constructions are to be found in San Francisco, California (wave organ) and in Blackpool, UK (Blackpool High Tide Organ).



Zadar Sea Organ

Development of a Prototype

The research group of Musical Acoustics at the Fraunhofer Institute for Building Physics (IBP) has a long experience in the field of musical instrument research, organ research in particular (http://www.ibp.fraunhofer.de/Kompetenzen/akustik/musikalische-akustik).

The „research organ for organ research“ installed at the end of 2011 allows the performance of experiments (http://idw-online.de/pages/de/news456951 and http://www.ibp.fraunhofer.de). The IBP as well as the other participating expert enterprises have carried out a feasibility study and have the know-how and capacities to develop and construct a prototype of the wind wheel organ. The estimate of costs amounts to € 350.000 € and the time frame of the project is supposed to be two years. The project sponsor is the gemeinnützige Verein zur Förderung von Bildung und Publizistik zu Umwelt und Entwicklung e.V „Solidarisch Leben Lernen“ (non-profit association to promote education and journalism on environment and development “Learning to live in solidarity”).

Research Pipe Organ
of the Fraunhofer Institute
for Building Physics (IBP)

Measurement of the Velocity
of a Reed Pipe’s Tongue with
the Help of a Laservibrometer

Siemens AG Munich - lights up the world's biggest revolving Christmas star

Development:

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