THE METEOROLOGICAL ARCHITECTURE OF PHILIPPE RAHM

We may have experienced various concepts that aim to become new practice in this century and bring the modern society closer to what is ultimate goal of sustainability. Some of these ideas are perhaps radical now but their roots are natural and the final outcome always pushes forward architecture in a new direction towards better future. It is not an optimistic approach. It is a research based and design demanding practice that is in favour of sustainable development, heat insulation, climate condition, the use of renewable energies and whole life cycle of materials, etc.

Taking into account that nearly 50% of greenhouse gas emissions comes from energy used to heat or cool dwellings, Rahm creates architecture that treats the interior climate of the space as a new architectural language, a language for architecture rethought with meteorology in mind. All known phenomena such as convection, conduction or evaporation for example are new tools for architectural composition. This is the architecture where vapour, heat or light become the new bricks of contemporary construction.

"Climate change is forcing us to rethink architecture radically, to shift our focus away from a purely visual and functional approach towards one that is more sensitive, more attentive to the invisible, climate-related aspects of space. Slipping from the solid to the void, from the visible to the invisible, from metric composition to thermal composition, architecture as meteorology opens up additional, more sensual, more variable dimensions in which limits fade away and solids evaporate."

Philippe Rahm is architect, principal in the office of Philippe Rahm architectes, based in Paris, France. His work, which extends the field of architecture from the physiological to the meteorological, has received an international audience in the context of sustainability. In 2002, he was chosen to represent Switzerland at the 8th Architecture Biennale in Venice, and was one of the 25 Manifesto's Architects of Aaron Betsky's 2008 Architectural Venice Biennale. He was nominee in 2009 for the Ordos Prize in China and in 2008 and 2010 for the International Chernikov Prize in Moscow where he was ranked in the top ten. He has participated in a number of exhibitions worldwide (Archilab, Orleans, France 2000; SF-MoMA 2001; CCA Kitakyushu 2004; Centre Pompidou, Paris, 2003-2006 and 2007; Manifesta 7, 2008; Louisiana museum, Denmark, 2009; Guggenheim Museum, New-York 2010). In 2007, he had a personal exhibition at the Canadian Centre for Architecture in Montreal.

Rahm was a resident at the Villa Medici in Rome (2000).

He was Headmaster at the AA School in London in 2005-2006, Visiting professor at the Mendrisio Academy of Architecture in Switzerland in 2004 and 2005, at the ETH Lausanne in 2006 and 2007, at the School of Architecture of the Royal Danish Academy of Fine Arts of Copenhagen in 2009-2010, in Oslo at the AHO in 2010-2011. From 2010 to 2012, he held the Jean Labatut Professorship in Princeton University, USA. He has lectured widely, including at Harvard School of Design, Cooper Union, UCLA and the ETH Zurich.

VIEWS ON THE MATTER

In your works we can recognize evaporation and other methods used to create the internal climate of the building. What about the external climate, and the building envelope? How do you treat that part of the project?

Philippe Rahm: We have to think in a different category. The first question refers to the building envelope, the shape and the form of the building. For example, we made a project where we considered wind, sun and orientation, which is something quite common in green architecture. But also, there is another aspect the question of the colour or the material and I think it is quite interesting, because depending on the colour of the material it could absorb more or less heat. Therefore, in my view the question of the colour of the building, which is more related to the aesthetic choice or some cultural choice, is an interesting challenge today. However, deciding on the colour of the building is more challenging if you consider climatic choice. It could be a new way of perceiving the appearance of the building. Also, we have to consider the public space and roads more like an interior because it is like an envelope – the façade of the building is like the interior of the street. Thus, we made the proposal were the 'colour' black is used for the floor of the street because the project was in a cold climate country. Black floor absorbs more heat from the sunlight and then creates warmer microclimate in the street. Meanwhile, the higher parts of the buildings are in lighter colours, so they reflect the sunlight back to the walkways and increase the heat quality and maybe also the noise quality by using some absorbing material (like concrete that acts like a catalyst). Therefore, in my opinion we can challenge the shapes and the materials through the same climate issues.

What is the main reason for choosing these methods in your designing process?

Philippe Rahm: The reason why we need the building is to create a pocket of different climate within another, larger one. The main fundamental reason is to shelter us from the rain, cold etc. Therefore, I tried to make a comeback to this very primitive idea of architecture. As it is dealing with climate we have to decide on the interior and the protected space using climatic parameters, and afterwards make a decision and try to imagine depending on the program what would be the most important aspect of the space.

Is this decision your personal one or is it a conclusion of the analysis?

Philippe Rahm: No, it is not my personal decision, it is a product of the analysis and it depends on the program. For example: we just finished a competition in which we made a storage for art work. Of course, it was intended to have different temperatures in different storage facilities as well as different humidity levels. Therefore, it was quite simple to focus on the principles. I think if we focused on one element, it could increase quality of the space. Likewise, in traditional architecture you focus on the columns, the structure of the building or the wall structure or try to define the quality of the space through a structural choice or material choice. However, in this project we tried to give increase quality through some climate figures.

Do you believe that certification is a good way to promote green architecture or do you prefer more individual case studies, analyses and research as a more adequate way?

Philippe Rahm: I think that the regulations and rules for buildings were never set / made by architects. In 2005, when we started to deal with these regulations, the general community of the architects was not interested in green buildings at all. It was more like a business or a political approach, which in our view was wrong and therefore, we tried to get more involved in this topic. As the architects were missing, the result was that someone 'out of profession' decided what the relevant regulations are. Therefore, it is in a certain way the responsibility of the architect to know that these rules do exist and what they are. This is the reason why architects always have to be more up to date with what is happening and not to allow themselves to be lost in a course of change and to suffer the consequences of not knowing new rules. I do think that we have to be always avantgarde and to do research, in order to avoid receiving a set of rules and just following them.

However, rules can sometimes be stimulating as they force you to think differently and also develop your imagination.

What is the response to your methods from the clients, the building officials and colleagues?

Philippe Rahm: When I started to talk about this topic I was quite alone but I was sure that it was something interesting. You always have to wait a little bit, maybe a few years, before anything new and interesting takes hold. I think this is one of the most important challenges for the architecture today. Also, I think that the question of energy and ecology will transform deeply the architecture and the future. Therefore, the response to these methods will then become better.

What is more challenging for the design process: when you apply your principles in architecture or in urban planning?

Philippe Rahm: Both are challenging. I usually start with the architectural scale or the room scale, then apply it to the architecture and afterwards to the urban design. All scales are interesting but maybe the architectural scale was quite new when I started and it was a new technique as it was linked to workflow and the airflow. The room scale was something more linked to the 70's, like green buildings from this period or solar buildings. Therefore, I did not find something really new, but after I started to work on an urban scale, like the project we did in Taiwan, it was becoming more evident and new to find solutions for the urban scale. However, I think that the focus in the beginning was more on the interior and on the architectural scale.

Philippe Rahm is working on several private and public projects in France, Taiwan, Italy and Germany. His recent work includes in 2011 the first prize for the 69ha Taichung Gateway Park in Taiwan; An office building of 13000 m2 in La Defense in France for the EPADESA; A convective condominium for the IBA in Hamburg, Germany; The white geology, a stage design for contemporary art in the Grand-Palais on the Champs-Elysees in Paris in 2009 and a studio house for the artist Dominique Gonzalez-Foerster in 2008.

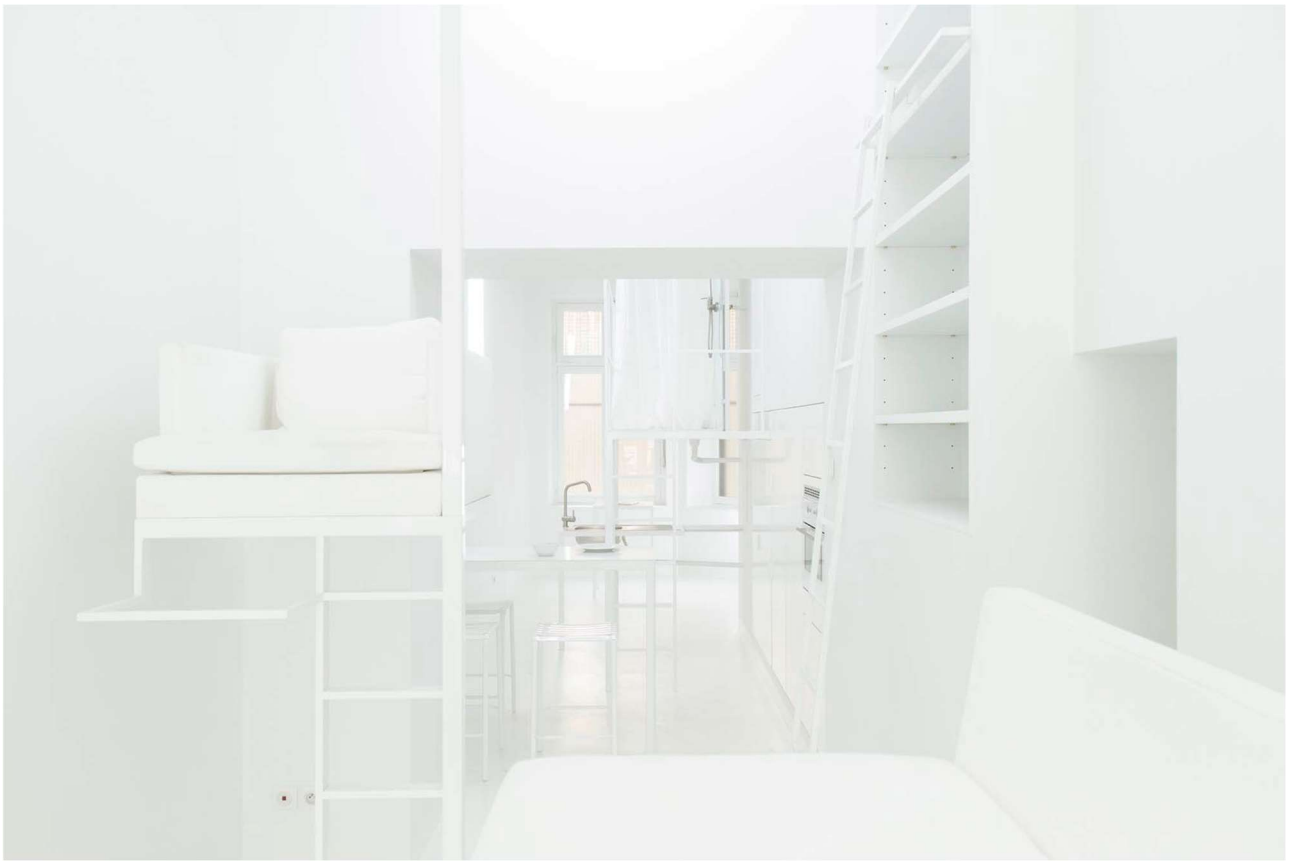
Monographic books include Physiological architecture published by Birkhauser in 2002, Distortions, published by HYX in 2005, Environ(ne)ment: Approaches for Tomorrow, published by Skira in 2006 and Architecture meteorologique published by Archibooks in 2009.

The Lyon Residence – The Thermal Coexistence of Space and User

In the architectural world in the last decade the works of French architect Philippe Rahm are recognized as projects of a new wave that takes the practice and sustainable issues to the next level. This talented architect incorporates basic elements of comfort and atmosphere as his concept and builds his ideas around different perspective of the ambient. When he started putting his ideas to the practice with the turn of the century it was very difficult and yet over the years he earned respect and numerous recognitions for breaking projects that distinguish him from the other contemporary artists. Inclusion of thermal characteristics of the air, moisture and demands for energy, etc. into the method named meteorological architecture became his new building blocks of his architectural creations, weather it is an apartment, building or public park.

It is a matter of sense and sensual connection between the space and its' users. The connection is based on physical and biological aspect of comfort that needs to be achieved in space. Imagine that you do no longer occupy the space horizontally but you live and use your ambient spatially. Imagine using the evaporation,

Insight in the Apartment
Source: Philippe Rahm architects



Insight in the Apartment
Source: Philippe Rahm architects

thermal and moisture gradients, airflow or other natural components of comfort to compose the program of space without boundaries.

The meteorological architecture has no longer the task to build images and functions but to open up climates and interpretations. At the large scale, meteorological architecture explores the atmospheric and poetic potential of new construction techniques for ventilation, heating, dual-flow air renewal and insulation. At the microscopic level, it plumbs novel domains of perception through skin contact, smell and hormones.

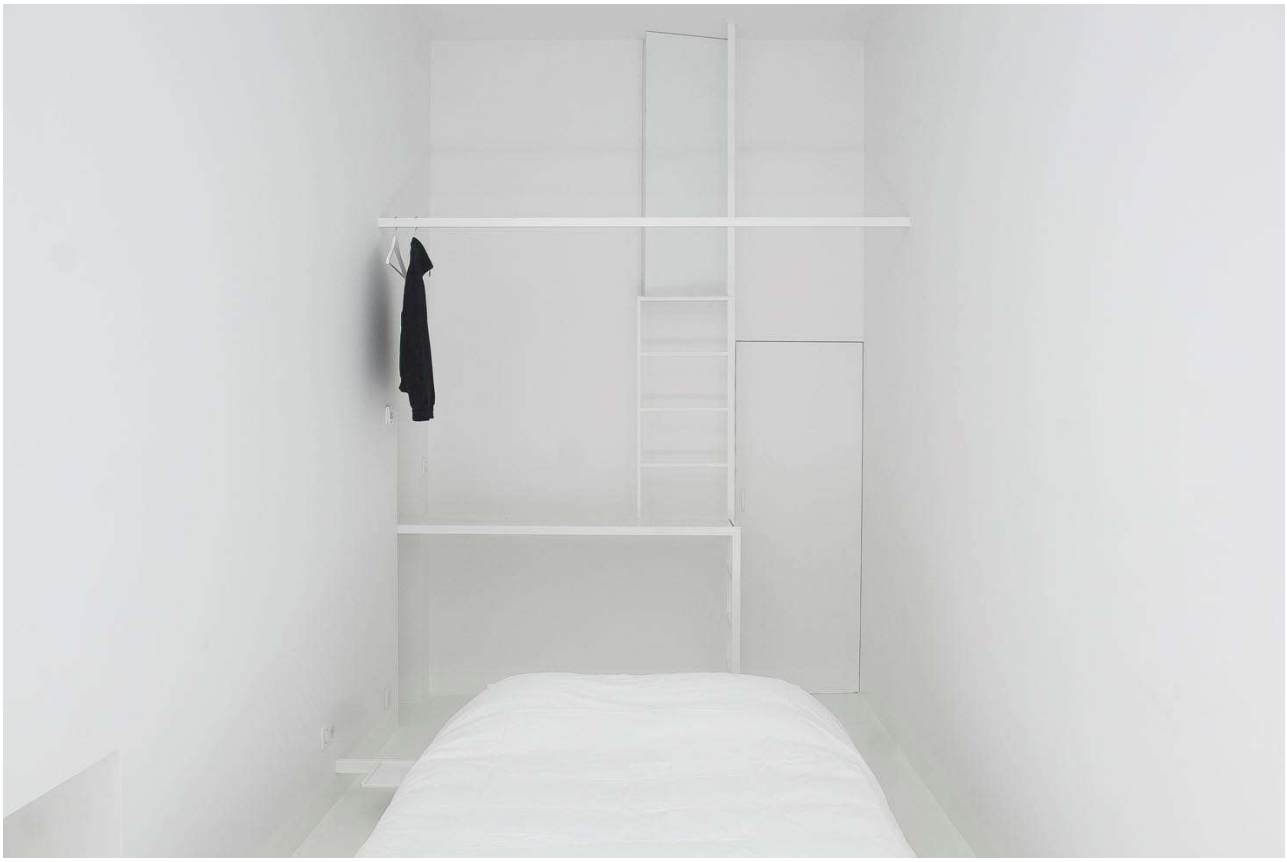
One of his latest projects is the Evaporated Rooms – An apartment for a young doctor in Lyon, France. This 70 m2 floor area was completed in January 2012 as a white open space interior with conventional home spaces (bedroom, bathroom, kitchen, living room, etc.) that are fused in a single living unit in a very unconventional way.

In every ambient the level of present energy emitted by the users and the equipment within represents the unused amount of kWh/m2 that are usually wasted and released into the outdoor space. Therefore, in this particular case, the author analysed the outdoor conditions and provided a new approach to architectural design. This magical ambient has spatial disposition of functions based on thermal analysis of each unit of the apartment. It is a liquid space where all necessary utilities are present and connected with each other by the level of temperature in particular point created by the materials, users and activities.

> *"For this apartment in Lyon, we used the most recent recommendations for domestic internal temperatures to reduce environmental energy consumption in the built environment. This approach caused us to shift from working in plan to composing in section based on atmospheric gradations."* – Philippe Rahm

The interior design indicates the importance of the relationship between the users, space and heat energy in creating comfortable interior conditions. Space is a result of observation of temperature curves and air saturation with water vapour, i.e. its relative humidity. Observation of the temperature curves, i.e. comfortable temperature, and air temperature ranging between 16 and 21°C defined the horizontal and vertical layout of the space functions. Allowing architect Philipe Rahm to spatially define apartments' functions. The cross-section of the space with temperature curves clearly shows the idea of elevating the zones within the space.

Insight in the Apartment
Source: Philippe Rahm architects



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Based on prescribed temperatures of spaces (kitchen – 18°C; living room – 20°C or bedroom – 16°C), airflow, laws of physics and the level of activity in particular space (generating or demanding certain amount of heat) as well as the dress code, the author made a spatial composition of apartment that follows these standards in order to reduce energy consumption within the space. Deserting the need physically to separate the different rooms, each with its own function, by using walls and closed doors and to prevent air from rooms at different temperatures to mix, Rahm rather used sections and thermal analysis to decide how to organize the contemporary open-space residential unit.

> *"The free plan and spatial continuity was achieved by working in section on the intrinsic physical behaviour of air when it is elevated and hot or when it is cold and closer to the ground. We can start composing rooms and spaces; or rather begin dividing programs in space, without the use of walls, which delineate the contours of the parts. We can compose using only the spatial distribution of temperatures and luminosities in the air to divide program. The goal is no longer to design the plan but rather to design an atmosphere, with its various weather gradations through which one moves to find a certain temperature or a certain light."* – Philippe Rahm

Another aspect presents the dependence of the functions on the percentage of relative humidity of the indoor air. Analysis of dry and moist zones provided results on the space quality in terms of water vapour concentrations. Space without walls, i.e. physical barriers or partitions becomes a unique atmosphere defined only by different functions within single volume.

The architect's proposition was not to create rooms and spaces, but instead to situate the furniture and the

furniture's usages at particular heights, temperatures and light intensities. This methodology makes an atmosphere of the interior similar to a natural landscape, providing the user with shelter for rain or perhaps the shade from heat. Thus, the sit alone chair is positioned in the highest point in the upper warmer air, same as the shower based on dress code. The sofa, on the other hand, that represents more social and interactive activities, is situated somewhat lower, as its temperature will rise due to the increase of warmth that each individual produce. The kitchen floor would be placed lower still, reducing its temperature, while the bed is in the coldest part of the house, on ground.

Referring to the users of the space as a "live matter" and to find answers to the question – what type of the space and how would it look like, led the author to develop specific solution, presented in this project. The Lyon residence is a unique space that emphasizes the coexistence of users and ambient based on natural laws. This project goes beyond the physical or psychological connection as it re-establishes the components – the occupant, the material and the volume in a single living organism.

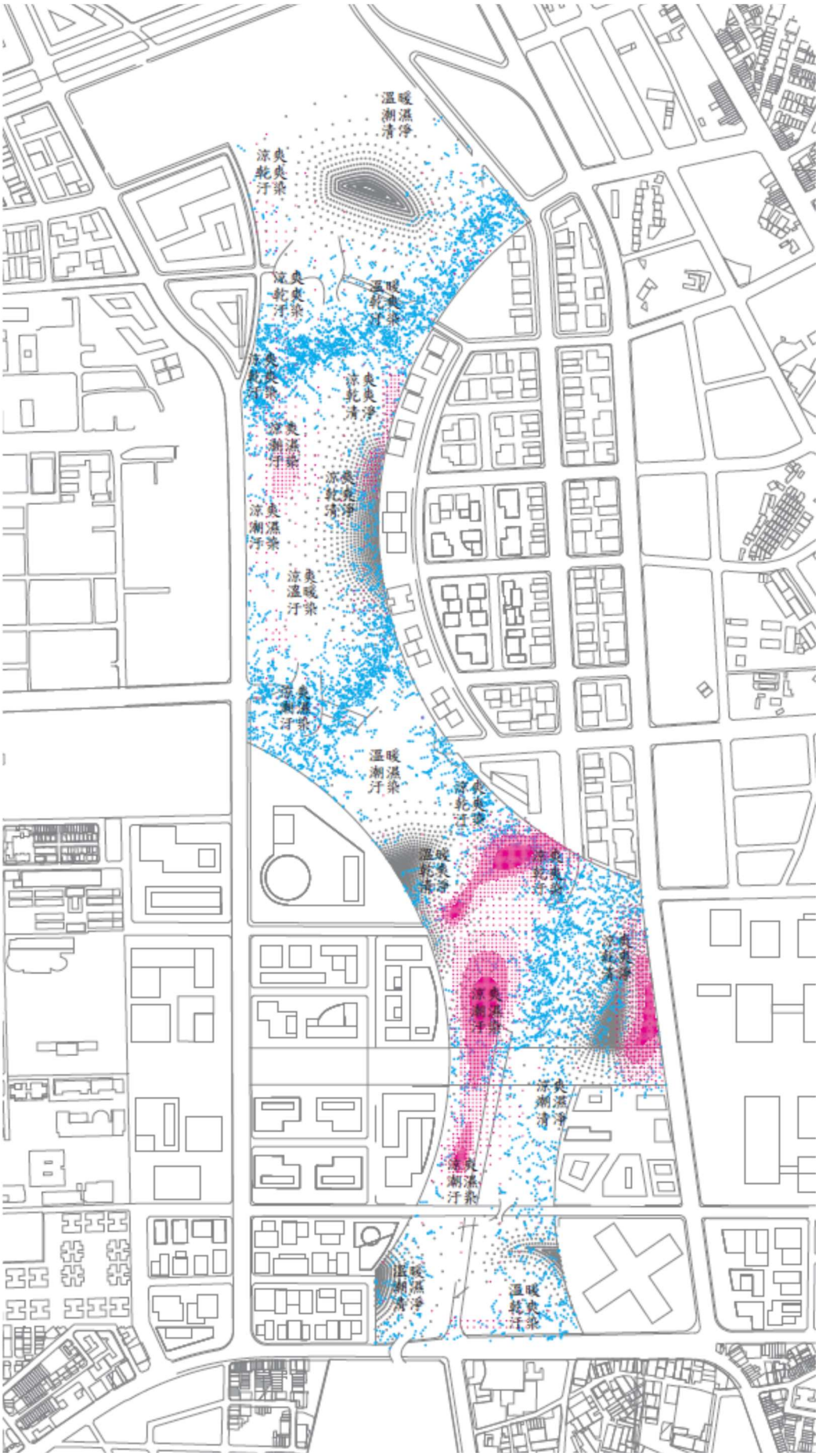
> *"Between the infinitely small of the physiological and the infinitely vast of the meteorological, architecture must build sensual exchanges between body and space and invent there new aesthetical philosophies approaches capable of making long-term changes to the form and the way we will inhabit buildings tomorrow."* – Philippe Rahm

Thermal section of the Apartment
Source: Philippe Rahm architects

The Jade Meteo Park – Colourful Symphony of Senses

The public urban spaces were always the subject of special treatment in a matter of architectural design and construction. Beside the difference in scale, the reconstruction of public green areas provide creative comfortability for designers who can take their step forward in the field of design, composition and mixture of functions. They are like a raw material that stands in front of the sculptor ready to be turned into a beautiful statue. If we examine the past and remember some of the well-known projects like Parc de la Villette in Paris, or recent the High Line – the liner Park in New York, we will discover that all of these areas become the golden examples of architectural virtuoso that changed the image of modern cities forever. The public character of these projects intrigues the designer to create the hybrid space that will nurture socialisation, communication, playfulness and reconnection with the nature.

One of the examples of successful contemporary redesign of urban space is the project for new urban park called Jade Meteo Park. It was designed by Philippe Rahm architects along with Mosbach paysagistes and Ricky Liu & Associates for the city of Taichung in Taiwan. The design team won the First prize on the International competition that was held back in 2011 with their proposal that used meteorological architecture in urban scale. Since then the authors worked on detail projects and other documentation so that the completion of the entire project is expected in July 2015. The city authorities dedicated a budget of 90 million US$ for transformation of airport site into the welcoming exterior spaces where the excesses of the subtropical warm and humid climate of Taichung are lessened.



Jade Eco Park
micro – climate
Source:
Philippe Rahm architects

Park view
Source: Philippe Rahm architects

This is the project, which beautifully demonstrates the methods of architecture that treats climate as a building tool and use advantages of the site so that the new urban park becomes pleasant green area in the middle of a busy and polluted Asian city. The exterior climate of the park is thus modulated so to propose spaces that are: less hot by inserting more cold segments and shade; less humid by lowering humid air, sheltered from the rain and flood; and less polluted by adding filtered air from gases and particle matters pollution. The green oasis is also less noisy and less mosquito presence because of unique design principle that embraces the climate and nature rather than to counteract.

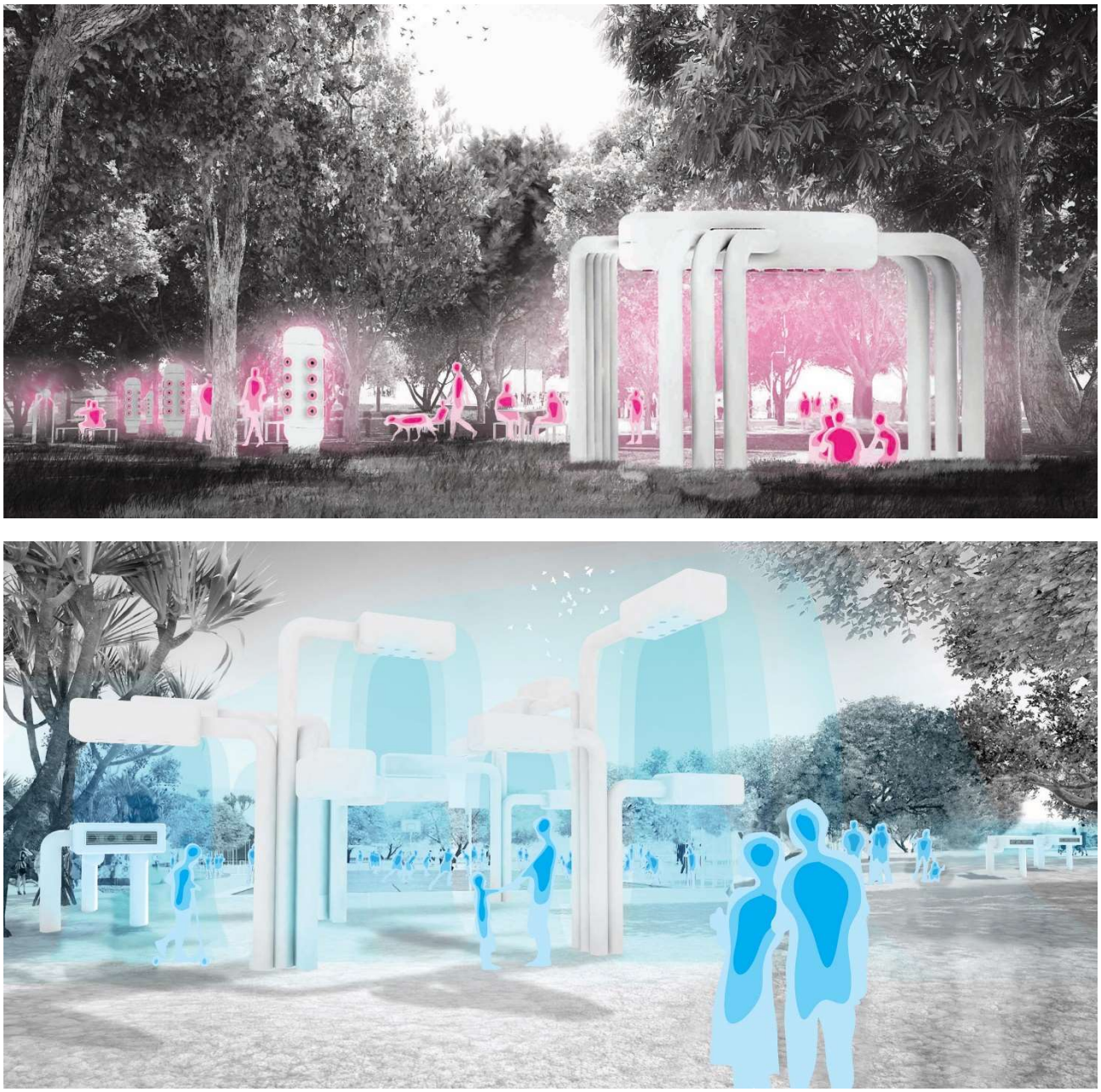
This massive urban park will be a new meeting place for more than 2.6 million inhabitants of the Taichung city. The project included several new features of the park: vegetation and topography, rain maintenance, park furniture and climatic devices, architectural buildings, and facilities buildings. The subject of the project was a new landscape and architectural design for a new park stretching on more than 70 hectares located on the site of the previous airport. The proposal included facilities for leisure, sport, family and tourist activities, a 1500 m² visitor centre, maintenance centre, urban regulation for the construction of a new museum and the Taiwan tower.

Park view
Source: Philippe Rahm architects

DESIGN PRINCIPLES

> *"The ambition of our project is to give back the outdoors to the inhabitants and visitors by proposing to create exterior spaces where the excesses of the subtropical warm and humid climate of Taichung are lessened."*
> – Philippe Rahm

The "Taichung Jade MeteoPark" project is based on specific design principles that incorporated Computational Fluid Dynamics (CFD) simulation to achieve necessary climatic variations through the space. The design team mapped several areas of the park that are naturally warmer, more humid and more polluted or areas that are opposite to them as naturally colder, dryer and cleaner. The results have shown the differences of microclimates on the location that demanded change and upgrade in order to create more comfortable spaces for the visitors. Based on the existing climatic conditions of location and dominant direction of cold winds coming from the north; or southeast wind bringing the humidity of the see in the air; and the distance from the roads, all of these inputs were carefully analysed and recognised as the starting points of the design concept.



Influences
Source: Philippe Rahm architects

This had a consequence of defining three gradation climatic maps that followed the results of three CFD simulations. Each map specifically corresponds to a particular atmospheric parameter and its' variation of intensity thought out the park. The first map corresponds to variation of the heat on the site, the second one describes the variations in humidity in the air and the third one the intensity of the atmospheric pollution. These maps keep certain areas within the park from reaching out the excessive natural conditions and allow comfortable climate changes between the upgraded segments. Visitors can freely move thought the space and since the three maps intersect and overlap randomly in specific points it provides visitors different sensual experience of internal microclimates of the park.

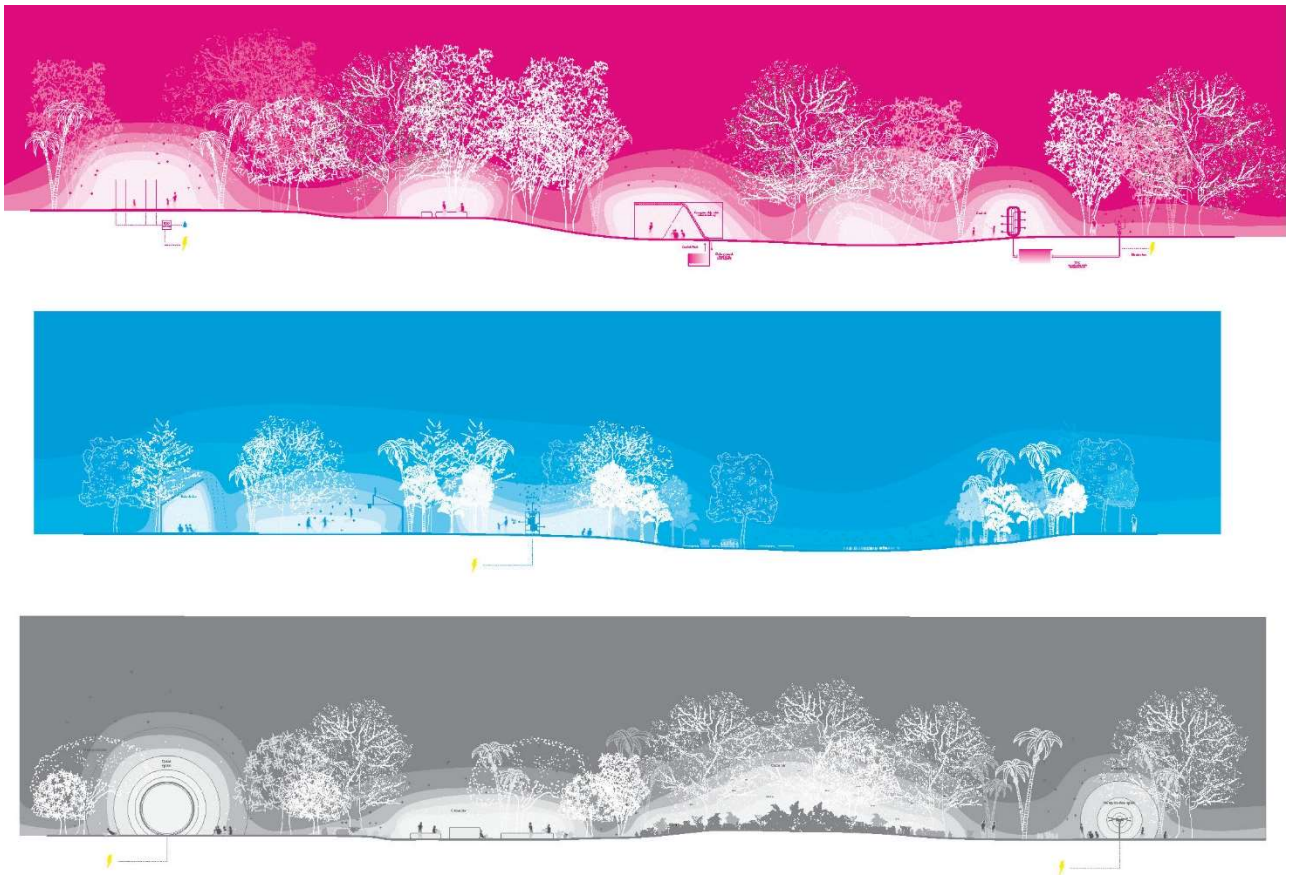
The Climatic Lands represent special places inside the park that are the result of the CFD simulation as places of the coldest, the driest, and the cleanest areas of the park. The most comfortable areas are denominated Coolia, Dryia and Clearia by their specific climatic character. The Climatic Lands contain all the activities and programmes and they are all linked together by the three Climatic Paths.

Coolia – This is a colder area of the park that houses most of the cooling devices and trees. There are four Cooling Lands named Northern Coolia, Western Coolia, Middle Coolia and Southern Coolia. They represent zones where people can enjoy favourable climate and air temperatures.

Dryia – It represents a zone for recreation, or more precisely, this is the area where majority of sports facilities is located. Here, relative humidity is reduced, ranging between 60 and 70%. This area is divided into three zones: Northern Dryia, Eastern Dryia and Middle Dryia.

Clearia – This area offers conditions for comfortable family rest. The aim was to create the space with insignificant amount of air pollutants. The result was four zones, which the author named Northern Clearia, Eastern Clearia, Middle Clearia and Southern Clearia.

The climatic maps vary within a gradation, which ranges from a maximal uncomfortable ambient (maximum value of pollution, maximum rate of humidity, maximum heat) to areas that are more comfortable (optimal values of the heat, the humidity and the pollution). For the materialization of these climatic maps design team invented a catalogue of climatic devices (natural and artificial) that reinforce areas that are already more comfortable by lowering, reducing, inverting, and



Sections
Source: Philippe Rahm architects

diminishing the heat, humidity and pollution. These devices are classified in three categories: the cooling devices, the drying devices, and the depolluting devices.

The natural protective (cooling, drying and depolluting) devices are trees that create heavy shadows, or white flowers and waxy white leaves that reflect the warm sun rays, or trees that produce a strong evaporation that cools the air around; trees with capability to absorb oxides of nitrogen and other aerosols, to make effective sound barriers and reduce the presence of mosquitoes. The other, i.e. the artificial cooling devices are apparatus that uses convection, conduction, evaporation or reflection in order to cool the air or the human body; or drying climatic devices which objectives are to protect the body from the rain and to reduce the excess of humidity in the air that amplify the displeasure by blocking perspiration; or the depolluting climatic devices that reduce the pollution in the air, the excess of the noise etc. All of these artificial devices contribute to the total variety of climate inside the park making special ambient with specific atmosphere which users can choose and enjoy.

Cooling Devices

System-based and targeted cooling of the park is a result of an analysis of the microclimate and meteorological phenomena that have been causing overheating of the park. These phenomena include wind movements, i.e. its frequency in certain zones of the park and solar radiation. Besides, the project also observed reactions of the human body to different outdoor temperatures, which in the end resulted in five different cooling devices**.**

Anticyclone – Based on the analysis of energy movements (radiation, convection and conduction) the author created an innovative device for blowing cool air into the outdoor space, which he named Anticyclone. The purpose of the device is to create a colder zone with a radius of 11m and maximum temperature of 29.4°C in relation to the surrounding zone with the temperature of 34.5°C. The device blows cool air into the atmosphere, and cools the human body by means of conduction and convection. There are four devices of this type and they are located in the coldest parts of the park, which are determined by the analysis of its hot and cold areas.

Cumulus Cloud – Was created to provide better microclimate (lower temperature and reflection of excess solar radiation). The author designed a perforated pillar to disperse mist or droplets to cool down the surrounding air temperature by creating an artificial cloud around the device. Water droplets cool the surrounding area and reflect 90% of the solar radiation into the atmosphere. In total, two such devices have been installed in colder areas of the park.

Night Light – This device uses radiation and conduction to cool the human body. It was inspired by the phenomenon that during hot nights the excess heat is re-emitted into the atmosphere. It is a curved tube with cold water (from the city water supply system, at temperature of 27°C. The structure provides protection from the solar radiation and offers refreshment at the temperature not higher than 32°C (mean value 27–37°C). The effects on the human body include less dizziness, less vasodilation, less imbalance of electrolytes, and fewer risks of heat stroke. The two such devices are installed around the location of the park.

Long Wave Filter – It is the result of analysis of the solar radiation spectrum that brought up an idea to reflect the sunrays with the highest solar energy concentration (650–750nm) in the spectrum of 450nm–1mm into the atmosphere to reduce the direct solar radiation on the users of the park, i.e. to initiate the process of natural cooling. In this specific case, a glass filter (green, cyan and blue acrylic glass filter) reflects 83% of the heat energy – it releases on the low-energy short waves. Eight such devices found its habitat in colder areas of the park.

Cooling Devices location plan
Source: Philippe Rahm architects

Cold Light – Similar approach was used in this shelter to provide sun protection. Here, a violet shade of glass coated with infrared blocking film was used to enable the glass to absorb almost all visible and infrared radiation and allow penetration of only the violet light, which is the coldest light (390–450nm) in the visible spectrum of the sunlight.

Drying Devices

South-west winds bring more humidity into the city, which causes over-saturation of the park with water vapour. Therefore, it was necessary to analyse the park areas to provide specific drying solutions. Dry, i.e. less humid park areas depend directly on the south-west wind that brings humid air from the sea.

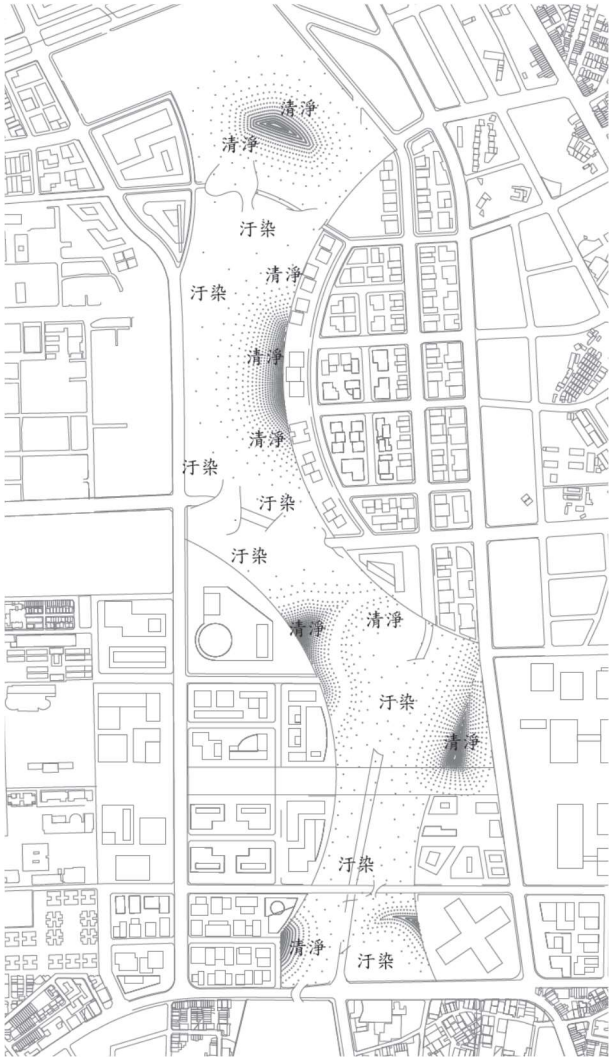
Dry Cloud – If the air is oversaturated, it cannot absorb more moisture, and thus it blocks perspiration. This is made possible by the Dry Cloud device, which absorbs water vapour by means of the silicate gel. Bags filled with this gel absorb the air from the park, dry it and emit it back into the atmosphere by means of fans. Dry Cloud has positive effects on the human body. It enables more efficient cooling of the body, perspiration, less overheating and dehydration, inflammation of the respiratory system, reduce high blood pressure, etc. Six devices are installed in the driest parts of the park.

Crepuscular Rays – This device provides shelter from monsoon rains, and at the same time, its acrylic glass enables the sun to reach the users of the park. The heaviest rain season is from May to August, when relative air humidity is very high. In total, 15 devices are installed in dry areas of the park.

Depolluting Devices

As in most urban areas, the biggest air pollutants are harmful gasses from traffic and industries. Active and passive depollution systems are installed in the park, in the areas with less polluted air.

Dehumidifying Devices location plan
Source: Philippe Rahm architects



Depolluting Devices location plan
Source: Philippe Rahm architects

Devices for cooling, drying and depolluting
Source: Philippe Rahm architects

Ozone Eclipse – In total the 15 devices has been installed to absorb aerosols (SOx), nitrogen oxides (NOx) and ozone (O_3) through various catalytic and plasma filters. The air is depolluted in areas far from the traffic zones and other pollutants.

Pre–Industrial Draught – This device filters the air using water. As air is lighter than water, a mechanical force pushes it through the water, depolluting it in that way. Heavy pollutants sink to the bottom from where they can be easily removed. The device eliminates PM_{10} and$PM_{2.5}$ particles from the air, which may cause breathing difficulties.

Beside the specific devices installed and design through the park, it is important to emphasize that energy savings and efficiency was also a matter of the design. So, all of the above devices are powered by electricity generated from photovoltaic systems, built to meet the energy demands of the park and to reduce CO_2 emission down to zero.

ARCHITECTURE OF THE JADE ECO PARK

> *"In order to change the external environment, the architecture works on two levels: the first level is the building envelope as filtration of the outdoor climate. The second level is by conditioning the inside air as an artificial increase of the filtration effects. Constructing a building is actually to build a space pocket whose inner climatic characteristics are each more or less different from those outside. The building envelope has a mission to filter more or less intensely natural outdoor meteorological parameters which are then more or less artificially increased or reduced according to the interior comfort sought."* – Philippe Rahm

Beside special constructions and devices located through the park the project included also few new buildings. The architect has decided to take different path in creating the objects by applying the same principles of the meteorological architecture from the design of the park to every aspect of the buildings that were planned for the same area, and even to the structure of the building envelope. This is an essential example of how do architects learn and work with the environment itself by carefully designing not only the structure or function of the future building but also its envelope – the element that is the first to come in contact with the surroundings.

The traditional wall construction (i.e. stone, wood, brick or glass) represents a single element – a single layer that served as a major, straightforward filter for all of the external climatic forces towards the building. This is a solo, closed plane and boundary between an outer uncomfortable exterior and a comfortable interior. This situation is opposite to the modern construction that tends to distinct layers; use multiple materials and thickness to create optimal joined filters for each exterior condition that can be separated by the intermediate spaces. Buildings of the Jade Eco Park replay to dissociation of an individual building envelope into a wall of multitude layers, each with a specific climate priority. These layers join together and separate from each other in order to develop habitable interstices that heats up, cools down or cleans the inner climate in its own way. Taking the principle of climate as a priority Rahm designed his structures by the level of occupancy, exterior climate conditions and demands for certain interior climatic values. There are four types of buildings throughout the park that follows this same principle of unique functions and building envelop.

Climatorium – This building assembles several functions each with different set of its envelope depending on the conditions needed inside for the users to operate in the particular space. The maximum level of the envelope layers are four and they are applied in a concentric gradation from the outside to the innermost, from a single one to a group of four. Each layer is different material and it protects in a specific way, has its' own mission for climatic filtration.

The first layer (grid of white aluminium) creates physical and solar barrier for visitors representing: the first outline of the interiority; the first element of envelope with open and closed fields of material that meets the wind, rain and heat; the space like outdoor terrace for various activities. The second layer is a thin skin (tight polymer) that stands as a filter for moisture, rain and air. It runs together with first one and yet sometime it shrinks inward to open the space allowing the users to stand underneath when it rains. The third layer (insulating layer consisting of sheep wool coated with a cotton textile) is reserved for more comfortable spaces such as corridors, toilets and storage – the places where users do not spend too much of their time to experience interior discomfort. Inside the insulation are the most comfortable spaces: info centre, café and offices, and these spaces have maximum insulation and are conditioned because users spent most of their time here. In the centre of the building are the three artificial climatoriums – three envelope layer, concrete constructed ambient with ideal conditions of cold, dry and clean climate against the typical Taichung climate (hot, humid and polluted). These "oasis" are a kind of shelters, a refuge for the visitors that are designed for sensual experience. They are the structures of atmosphere (built climates) immersed bodily and sensory.

The Coolium is one of the climate constructions for a cool atmosphere that uses conduction and convection. It replicates the climate of the Jade Mountain, located in the middle of the Taiwan Island. In the base, this room reproduces in real-time the subtropical highland climate of the village Alishan located at 2190 meters above sea level with temperatures from 6°C in winter and 15°C in summer. At the top of the space, the visitor will experience the climate from 3000 meters altitude, where the visual effect of sunlight is reflecting off the snow by a grid of white fluorescent lights just as it is at the peak of the Jade Mountain covered by snow and shines like a stainless jade. A translucent transparent acrylic covers floor allowing visitors to walk in the light, as on snow. For better reflection of the light the walls and ceiling are white semi-satin as a white day in the mountain. To simulate the mountain condition a light sensors are installed on the mountain and monitored from Coolium's technical room that control the emission of light from fluorescent tubes in a real-time dimming of the sun.

The Dryium is the spatial construction of a less humid climate that represents the day of November 21st in Taichung that is recognized as the day with the best possible climatic conditions during the whole yearlong of a high humidity. This date is taken as the driest day of the year and replicated in the interior of the Dryium as climate condition on every day. The Authors monitored and recorded a variation of the humidity and temperature during the whole day of the November 21st so that this data can be transmitted by a computer controlled creator of the interior climate. This oasis is completely white and divided in middle by a glass floor line representing the upper (the air above) and lower levels of the Taichung city (the soil below). The fluorescent tubes stretching on walls and ceilings mimic the path of the sun during the same day so the amount of active lights (noon – five lights on the ceiling, midnight – five light on the floor) directly depends on the exact time during the 24-hour sequence.

Dryium
Source: Philippe Rahm architects

The Clearium is the final atmospheric construction with unpolluted indoor environment. This room replicates the climate of the Taichung from the year 1832 before the industrialisation and motor vehicles that erects each year tons of toxic gases and particles that jeopardize human health and before the increase of the temperature due to the global warming. The constant clean air is secured by filtering the air by two different filters: molecular filter for nitrogen oxides (NOx), ozone (O_3), and sulphur dioxide (SO_2) and another filter that traps harmful particulates. The air is also cooled by 2°C air to reincarnate in total the air before the global warming. The thick layer of circulating mist caps the open roof of the Clearium to reveal the natural sky of the Taichung. The only alteration is done by modifying the level of humidity to create more clouds just like it was before the increase of the temperature with the turn of the 20th century.

Clearium
Source: Philippe Rahm architects

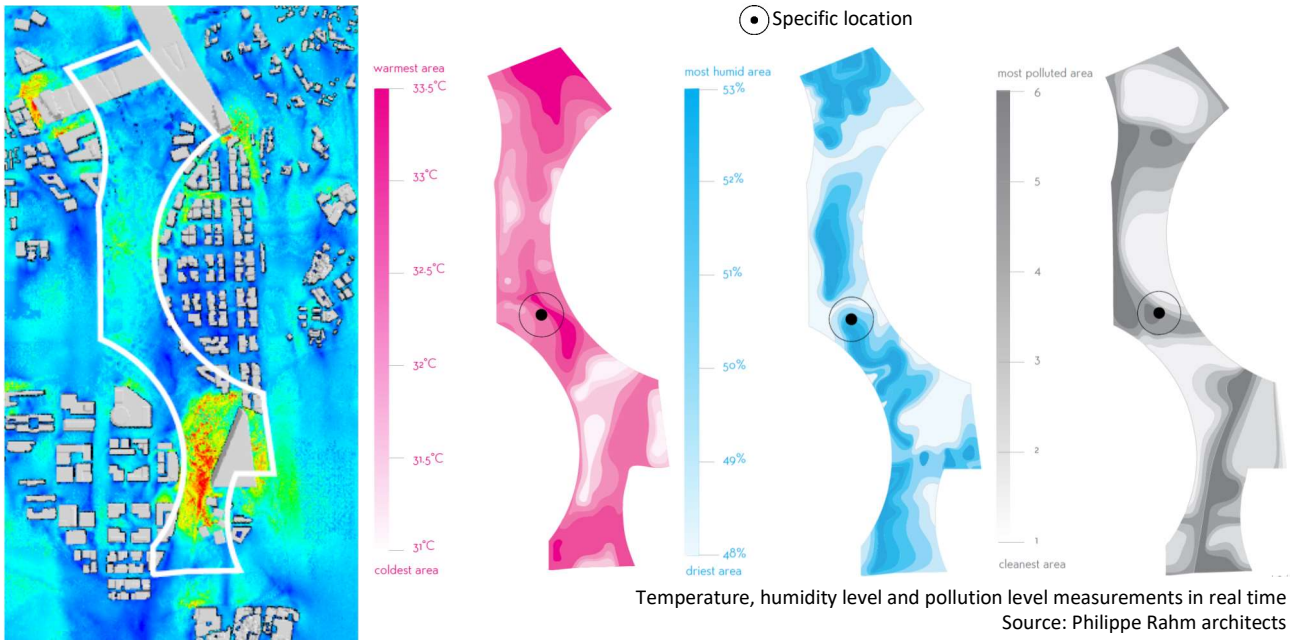
Jade Meteo Park
Source: Philippe Rahm architects

The project of Jade Meteo Park represents a result of past analyses of the subject location and a proposal from a new millennium. This design and its final outcome will contribute to the city of Taichung on so many different levels and it will improve the life quality of its inhabitants. The project also re-assesses some of the basic principles of climate and environment in a single location that are treated according to its roots and natural inhabitant. The authors used benefits of the location and tame other less positive aspects of the site. The design principles and the buildings are all done with the applications of the same – climate driven method that recreates the best possible scenarios for group of different ambient inside the 70 hectare area. It allows the visitors of the park to relax and reconnect with the nature and experience it on a very basic, more sensual level that is less present in other parts of the built environment. This project is a true symphony of senses gathered around the unique wish for quality, smart and green oases in the middle of the busy metropolis.

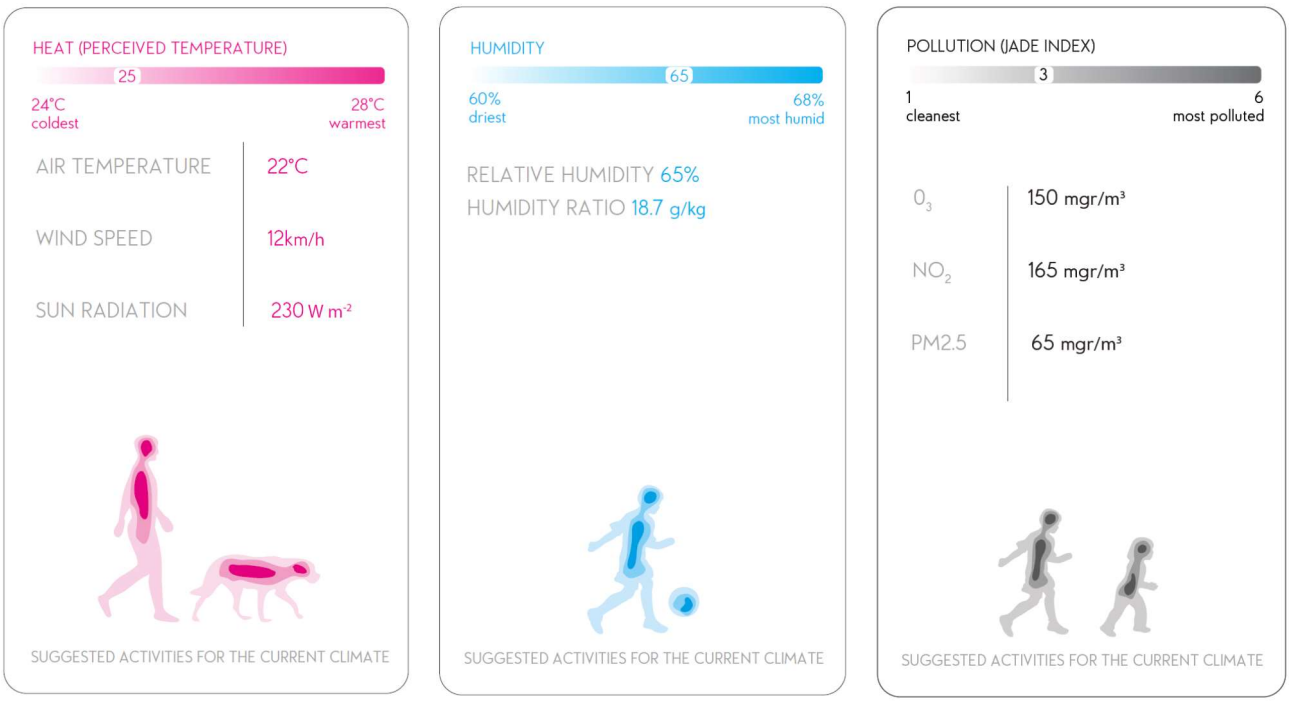
Jade Meteo Park
Source: Philippe Rahm architects

- Name of the project: Jade Meteo Park
- Location: Taichung, Taiwan
- Authors: Philippe Rahm architectes, Mosbach paysagistes, Ricky Liu & Associates
- New urban park
- Dates: 2011–2015. First prize of the International competition in 2011 / Preliminary design completed in December 2012 / Detailed design completed in June 2013 / Tender design completed in December 2013 / Construction started in January 2014 / Completion in July 2015
- Size: 70 hectares
- Park (vegetation and topography, rain maintenance), park furniture and climatic devices, architectural buildings, facilities buildings
- Public client: Taichung City Government
- Budget: 90 million US$

APPLICATION FOR THE JADE METEO PARK



Temperature, humidity level and pollution level measurements in real time
Source: Philippe Rahm architects



Climate data of temperature, humidity and pollution for the specific location
Source: Philippe Rahm architects

Interview: Mirjana Uzelac Filipendin
Text: Mirjana Uzelac Filipendin and Haris Bradić