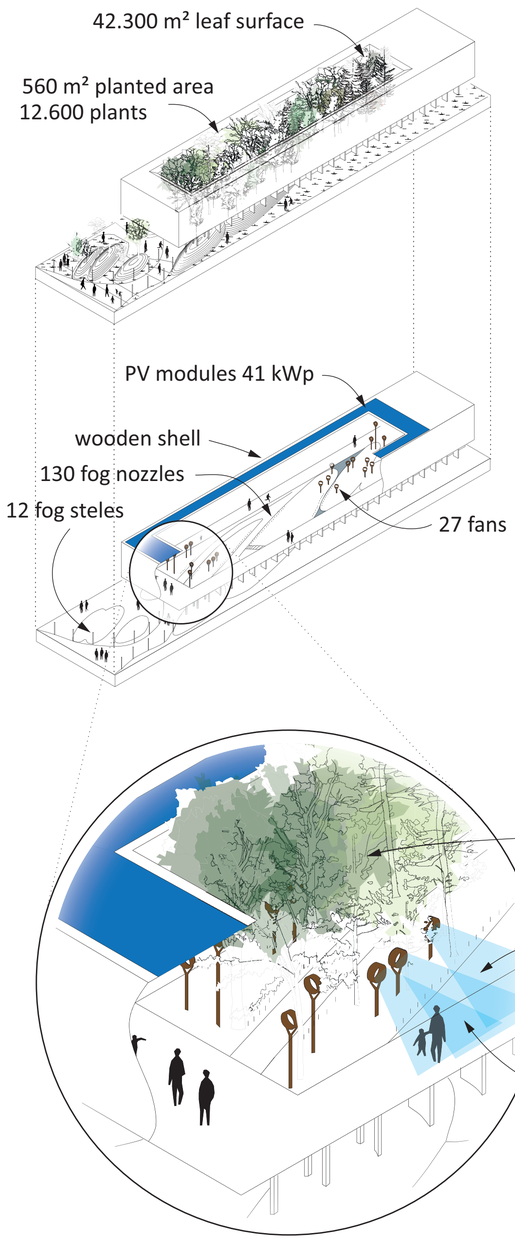
THE EXPO 2015 PAVILION: BREATHE AUSTRIA
OUTDOOR COMFORT IN THE CITY

PLEA '15
Architecture in (R)Evolution
Bologna, 9-11 September

IDEA



VEGETATION

Large and dense trees can provide excellent shade. If well irrigated, leave surface temperatures will remain close to ambient air temperatures even when exposed to intense solar radiation. Rich vegetation will keep the Mean Radiant Temperature (MRT) significantly lower as typical building materials. Also air temperature will be lower.

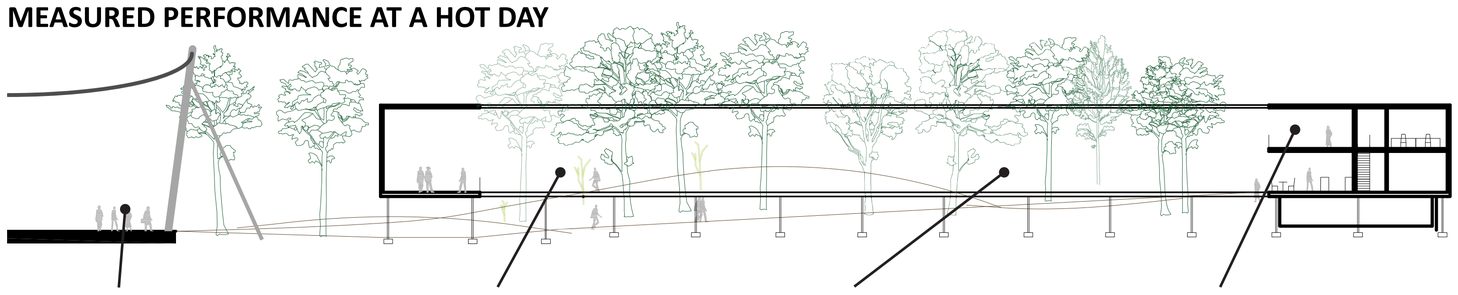
TECHNOLOGY

Fans in combination with a high pressure misting system can provide efficient adiabatic cooling effects perceived at the position of human beings.

OUTDOOR COMFORT

The combined effects can provide excellent outdoor comfort even in hot and humid environments.

MEASURED PERFORMANCE AT A HOT DAY

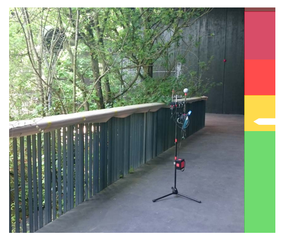


UTCI 36.2 °C

Shade, EXPO Pathway

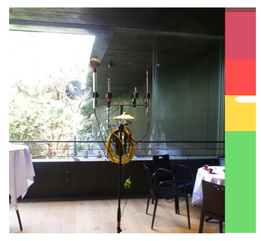
UTCI 33.4 °C

Shade, Vegetation



UTCI 27.8 °C

Shade, Dry Mist Fans



UTCI 31.4 °C

VIP-Lounge

	Shade, EXPO Pathway	Shade, Vegetation	Shade, Dry Mist Fans	VIP-Lounge
Air temperature:	34.5 °C	32.5 °C	27.0 °C	31.0 °C
Relative humidity:	44.0%	50.0%	74.0%	61.0%
Mean Radiant Temperature:	38.4 °C	32.5 °C	34.3 °C	31.0 °C
Air velocity:	0.3 m/s	0.3 m/s	2.6 m/s	1.8 m/s

HUMAN RESPONSE TO IMPROVED OUTDOOR COMFORT

WOLFGANG KESSLING, Transsolar, Munich, Germany

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ALEXANDER GREISING, Transsolar, Germany

DESIGN SAFE, COMFORTABLE AND HEALTHY ENVIRONMENT
NEW TECHNIQUES AND HIGH PERFORMANCE PRODUCTS
TOOLS DEVELOPMENT

BUILDING

CHANGES IN LIFESTYLES AND PEOPLE NEEDS
ENERGY AND WATER EXPENDITURES
URBAN HEAT ISLANDS

OUTDOOR COMFORT IN THE CITY

Evapotranspiration is one of the (probably underestimated) elements to mitigate urban heat island effect. Well watered green areas can reduce ambient air and radiant temperatures. For outdoor conditions, elevated air speeds can be combined with Dry Mist Technology to create human comfort. This is showcased at the Austrian Pavilion at the EXPO 2015 in Milan, Italy from May to October 2015.
The pavilion by Team.Breathe.Austria is designed as simple wooden frame built on a slender concrete plinth creating an open enclosure for a miniature forest of 560 m². All electrical energy required for the operation of the pavilion is provided by a PV system on the roof. There are no mechanical cooling systems installed.

IDEA

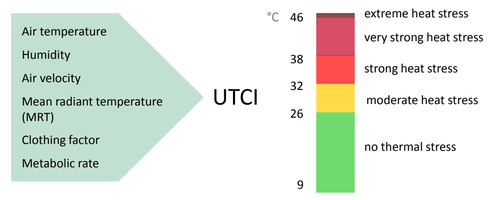
The general idea for this pavilion was to create the cool and comfortable sensation of a rich Austrian forest within the hot and humid summer conditions in Milan. Large and dense trees provide excellent shade. The rich and well-watered vegetation keeps the Mean Radiant Temperatures significantly lower compared to hard surfaces exposed to solar gains. This comfortable radiant environment is combined with fans with Dry Mist Technology, a high pressure misting system that provides effective adiabatic cooling without spraying water droplets at people. The combined effect creates excellent outdoor comfort even in hot and humid environments. In 2014 the systems have also been successfully tested in the hot and humid conditions of Singapore.

MEASURED PERFORMANCE AT A HOT DAY

The improvement of outdoor comfort is highlighted with an example measured at a hot but partially cloudy day in July 2015, Milan. Ambient air temperatures are about 34 to 35 °C. Being under the membrane roof in the street feels like 36 °C UTCI. Upon entering the pavilion - through a path in the forest - visitors perceive a reduction of about 3 °C UTCI because of good shade and dense vegetation. Walking through the pavilion visitors pass by a total of 27 Dry Mist Fans. Exposure to these fans means that temperatures drop to about 27.8 °C UTCI. In outdoor environments this change is perceived as a substantial comfort improvement. Comfort at the VIP area on the second floor is enhanced with the same concept. The North facing glass façade can be fully opened to the canopy level of the vegetation. Dedicated Dry Mist Fans are in place to improve comfort to about 31.4 °C UTCI. Further to the Dry Mist Fans 9 fogging loops with a total of 130 nozzles are installed. All systems are controlled automatically to create different visitor experiences. With higher ambient temperatures the building control is intensifying the system operation to improve outdoor comfort for visitors.

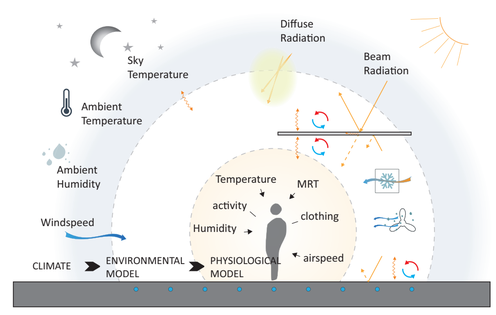
PREDICTING HUMAN PHYSIOLOGICAL RESPONSE

The Universal Thermal Climate Index (UTCI) is used to characterize thermal outdoor conditions for human comfort. The index includes the combined effects of solar and heat radiation, air temperature and humidity, air speed, activity and clothing of the person.
An UTCI in the range of 26 to 32 °C is rated as excellent in hot and humid climates.



MODELING ENVIRONMENTAL PARAMETERS

An dynamical simulation model was developed to predict all relevant environmental parameters and resulting human outdoor comfort. Effects of evapo-transpiration can be modelled with estimation of the Mean Radiant Temperature (MRT) of the vegetation and the impact of adiabatic cooling. The model was verified against detailed modeling with TRNSYS and compared to measurements.



DRY MIST TECHNOLOGY

The Dry Mist Technology fans have been developed by Transsolar. The fans for the EXPO are optimized for the Mediterranean climate to create an adiabatic cooling effect of 4 to 6 °C with a noisel evel < 30 dBA at a typical distance of 3 m. Each fan has an adiabatic cooling capacity of about 3.5 kW. The combination of elevated air speed and adiabatic cooling is energy efficient; the coefficient of performance of 20 is high compared to 4 of conventional air cooling technologies.

References

1. Blazejczyk, K., Jendritzky, G. Bröde, P., Fiala, D. Havenith, G., Epstein, Y. Psikute, A. and Kampmann, B. 2013. An Introduction to the Universal Thermal Climate Index (UTCI). Geographia Polonica. Vol 86. Issue pp 5-10.
2. Campbell, G.S., Norman, J.M. 1998. An Introduction to Environmental Biophysics. Springer. ISBN 978-0-387-94937-6.
3. Gill, S.E. Handley J.F., Ennos, A.R. and Pauleit,S. 2007. Adapting Cities for Climate Change: The Role of the Green Infrastructure BUILT ENVIRONMENT Vol 33.