The implementation of installations and energy-saving systems in the design and construction of the Spanish Pavilion at the International Expo 2008 in Zaragoza

[1]Martín Gómez, C.

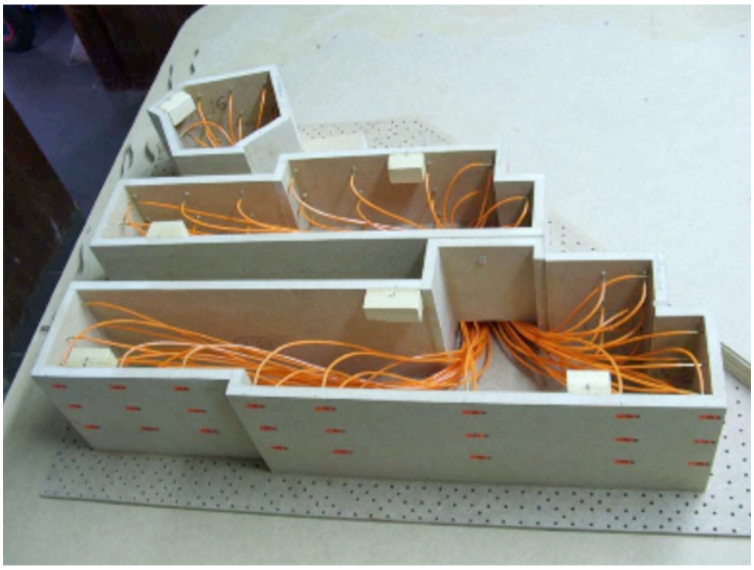
[1]Sección Instalaciones. Escuela de Arquitectura.
Universidad de Navarra. 31080 Pamplona.
e-mail: cmargom@unav.es

ABSTRACT

'Architect Magazine' rated the Spanish Pavilion at the International Expo 2008 in Zaragoza among the top five best buildings of 2008, comparing it favourably in terms of quality with the National Stadium in Beijing and the Opera House in Oslo [1].
This public recognition was based primarily on the Pavilion's architectonic spaces; however, the presentation centres on a description of the research undertaken as part of the implementation of the energy-saving systems in the construction of the building, as well as in the design of the active installation systems, which were key criteria in the original tendering process for the project.

The role of interdisciplinary cooperation among a number of professional experts in relation to a wide variety areas including the choice of construction materials, the initial drafting of the installations plan, and the monitoring of consumption is outlined. Architects, industrial engineers, aeronautical engineers (fig.1 – fig.2) and chemists played a part: the different perspectives they drew on enriched the technical development of the project.

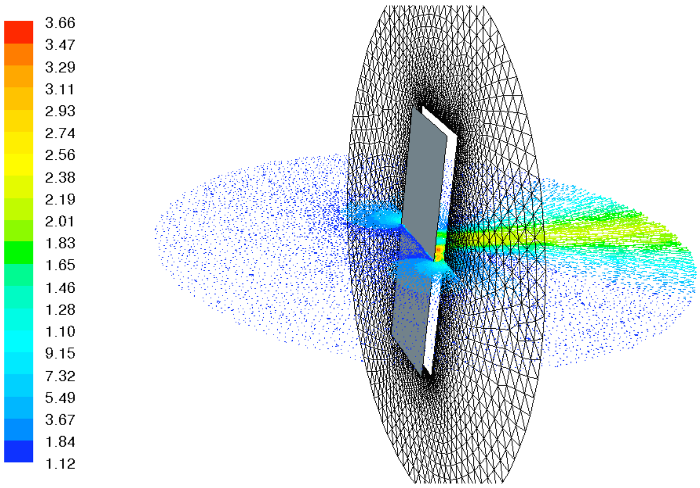
(fig. 1. Pavilion model in the Wind Tunnel at the Instituto Universitario de Microgravedad "Ignacio Da Riva", Universidad Politécnica de Madrid)



(fig. 2. View of the ducts connecting the pressure probes with the mesure instrumentation)

The success of their work is underscored by reference to the relevant data: a description of the installations; the solutions implemented; and, in particular, the technical innovations involved in the Pavilion's design and construction. Briefly, because this paper must be a concise explanation of the main exposition at the Congress, we can explain the following points.
A series of measures were undertaken in order to reduce the high thermal loads foreseen for the Expo:

- A layer of water along the perimeter moderates temperature oscillations around the Pavilion.
- A large roof provides the Pavilion and the surrounding outdoor areas with shade.
- The density of the columns is increased on the west facade to avoid harsh direct sunlight from this side during the summer.
- Motorized windows on the opposite facades permit ventilation at night and thus reduce the amount of energy needed to cool the building the following day (fig.3 – fig.4).



(fig. 3. CFD simulation of the motorized windows. Source: Fundación CENER-CIEMAT).

(fig. 4. Motorized window opens during the Expo)

After reducing the initial energy demand with physical architecture, the facilities system was designed to work with high efficiency and to achieve a low level of consumption. Two concepts guided the implementation of this system: the container of the roof and the energetic membrane of the structure (fig.5) [2].

(fig. 5. Construction of the energetic membrane)

Production and extraction of heat does not occur in the Pavilion proper, but in a thermal power station that supplies the whole Expo grounds, and which gives energy through the heat exchangers located on the semi-basement floor. Furthermore, the air treatment units have a system for the recovery of enthalpic heat and motorized hatches to use free-cooling when the outdoor conditions so allow (fig.6).

(fig. 6. AHUs with heat recovery in the container of the roof)

Aside from this active energy-saving, this centralized control system permits, aside from operating the different installations, monitoring the energy consumed in real time (fig.7).

(fig. 7. An ‘Energetic Mirror’ is used for show to the public the consumed energy and water in real time)

On water management, rain is collected on the roof by means of drain pipes inside some of the pillars, and is directed to the tanks that provide water to the pavilion's ponds. This accumulated rain water can also provide the water necessary for the functioning of the "Generating Supports of Microclimates" (GSM) [3], which are minor elements when compared to the whole, but one of the elements that has had more media impact. Evaporative cooling is the origin of the solution used for these supports. This is an effect that has been used to lower room temperature for centuries in climates with dry summers, and was used to alleviate outdoor spaces from the heat, for example, at the Expo in Seville. In this case, at the International Expo, with water as its main theme, the pavilion shows, the air conditioning possibilities of the liquid, occurring here as air movement with water is forced on the inside of several of the pillars located in the entrance area (fig.8 – fig.9).

(fig. 8. Upper connection -built in two parts- of the GSMs)

(fig. 9. Operational test of the GSMs)

The conclusions drawn from the Pavilion project experience may be extrapolated to the day-to-day work of other construction industry professionals.
It must necessary to consider that the main contribution of the Pavilion is not an element or a solution, but the understanding of the architecture process as a complex research procedure that needs the collaboration of different professionals under the architect's management.

REFERENCES

[1] Williams Golhagen, S. (2008), Spanish Pavilion. *Architect Magazine.* December 2008.
[2] Martín Gómez, C. (2008). Las instalaciones: investigación energética. *Pabellón de España. Expo Zaragoza 2008.* Edition by Arquitectura Viva / Luis Fernández – Galiano, 1st edition, pp. 70-75, Madrid.
[3] Lanceta. D. - Manteca. F. - Martín Gómez. C. - Martínez D. - Serna F. (2007), Cooling of outdoor spaces by means of evaporative-cooling ceramic pillars. En *AIVC 28th Conference and Palenc 2nd Conference: Building Low Energy Cooling and Ventilation Technologies in the 21st Century*, Crete Island, Greece.

ACKNOWLEDGMENT

Architect Francisco J. Mangado.