DESIGNING A SUSTAINABLE DESERT HOUSE: ARCHITECTURAL CONCEPT AND PASSIVE SYSTEMS

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The U.S. Department of Energy Solar Decathlon is a collegiate competition of 10 contests that challenge student teams to design and build full-size, solar-powered houses. The winner of the competition is the team that best blends design excellence and smart energy production with innovation, market potential, and energy and water efficiency.

Solar Decathlon is more than a competition. It’s an intensive learning experience for consumers and homeowners as they experience the latest technologies and materials in energy-efficient design, clean energy technologies, smart home solutions, water conservation measures, electric vehicles, and sustainable buildings.

The Solar Decathlon provides a hands-on experience and unique training that prepares the competing students to enter the clean energy workforce. This international competition has been a driving force in raising awareness about clean energy since its inception in 2002.
Univerziteti iz celog sveta učestvuju sa svojim projektima u kvalifikacionoj fazi da bi se plasirali među 20 učesnika koji na zadatoj lokaciji grade i testiraju svoje kuće. Naš tim je na ovoj fazi radio u periodu mart-jun 2016.

Solar Decathlon takmičenja se organizuju na reprezentativnim lokacijama i imaju globalni publicitet.
The Solar Decathlon Middle East (SDME) was created through an agreement signed between Dubai Water and Electricity Authority (DEWA) and the Department of Energy of the United States of America, in June 2015, in order to organize a sustainable solar houses competition in Dubai, in 2018 and 2020.

The 2018 edition of this competition is organized by DEWA, in Dubai at the Mohammed bin Rashid Al Maktoum Solar Park. SDME consists of 10 contests that will follow the lines of those in previous editions of the competition, although having the necessary customization to challenge the teams to adapt their designs to the heat, dust & high humidity that we experience in the Middle East. The projects are developed by multidisciplinary teams, giving the students the opportunity to learn about technical issues, teamwork, communication skills, and sustainable lifestyle and socio-economic issues in order to ensure the viability of their project.
SDME 2018 Teams

USA
Team Virginia Tech

FRANCE
Team Bordeaux

NETHERLANDS
Team VirTUE

ITALY
Team Sapienza
Team HAABitalt

Netherlands
Team Twist Box

Serbia
Team Twist Box

KSA
Team KSU

Pakistan
Team Biogreen

Malaysia
Team MizanHome

Oman
Team SoLITE Salalah

Australia
Team UOW

Taiwan
Team TDIS

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Team TDIS
SDME 2018 Numbers

Key Facts:

- 22 teams
- 37 universities
- 4 continents
- 1000+ competitors
- 16 countries
- 10 different contests covering all elements of the sustainable built environment
Naš tim Twist Box je nakon ulaska u finale takmičenja SDME 2018 uspešno odradio 4 faze i učestvovao je na prvoj radionici u Dubaju.

SDME 2018 competition site:
Mohammed bin Rashid Al Maktoum Solar Park near Dubai
10 CONTESTS

- architecture
- engineering and construction
- energy management
- energy efficiency
- comfort conditions
- sustainable transportation
- sustainability
- communication
- innovation
TWIST BOX REPRESENTS ARCHITECTURAL, AMBIENT AND TECHNOLOGICAL DUALITY.

It is conceived as a house that embraces the tradition and culture as a constitutive part of a modern, even futuristic design. The inner skin is transparent, dematerialized in its appearance while the outer skin is forming soft, ever-changing intermediate spaces providing shelter.

Twist box's design meets systems that can be used separately or as a whole, low-tech or high-tech, creating a climate adaptable double skin model for self-sustaining housing that will be a symbol of a greener tomorrow.
**Twist Box**

Designing a sustainable, energy-efficient housing structure is not a mere technical challenge, but requires sensitive, multi-layered approach and deep understanding of local culture and lifestyle, climate, urban and topographical morphology. Students of Faculty of Architecture – University of Belgrade explored all of these factors to create a self-sufficient solution with a goal of changing the way we think and design living spaces and the way they impact not only our lives but the whole planet.

**Objectives**
The project objective is to show the clear connection between bioclimatic design and contemporary technological innovation through the creation of a sustainable housing concept that can be used to promote green design thinking. We aim to make a future home that is both beautiful and functional, technologically advanced and traditional, cheap and environmentally low impact, passive and comfortable, self-sufficient and allows for high quality of living.

**Methods and impact**
TWIST BOX will be a prefabricated structure, easy to assemble, with low embodied energy featuring not only strong passive design solutions but also active sustainable technologies, taking advantage of materials and the environment. The project hopes to set new standards in many different areas of energy-efficient design with systems that can potentially be used separately or as a whole, and create a future model for self-sustaining housing that will be a symbol of a greener tomorrow for all of us.

**Project description**
TWIST BOX is conceived as a house that embraces the tradition and culture as a constitutive part of a modern, even futuristic design. Delicate duality, inspired by perpetual dialogue between the traditional encoding and anticipation of exiting future was a basic design principle, reflected into multiple aspects of a project proposal. The form is dual in its nature: inner volume being hexahedron, while outer volume is a derivative of multiple rotations, twisting its way out of Euclidian geometry. The inner skin is transparent, modern, abstract, dematerialized in its appearance, yet the most rigid element of the house, essential for providing the shelter and protection. The outer skin is soft, perforated, allowing uncompromised privacy and sun protection, dynamically twisting its way around the enclosed box, forming ever-changing intermediate spaces. Double layers of all TWIST BOX elements (façade, roof, base platform) allow for constant airflow that creates a comfortable dwelling experience.

Principal investigator, project director and group leader: doc. mr Nataša Ćuković Ignjatović
CLIMATE

Climate and weather analysis
Dubai climate is a crossover between tropical and humid continental climate. Due to its location close to a large body of water, temperatures changes are not great with 8 months with temperatures above 15°C. What can be expected are really hot summers and winters, with winters having the most of the yearly rainfall, while summers are mostly dry. Humidity is high in the summer making the climate seem more extreme. Global warming gave rise to the average temperatures making the need for clean energy greater. Winds are present in summer with potential sand storms.

Fig. 1 Average temperature in Dubai

Fig. 2 Average humidity in Dubai

Fig. 3 Average sunlight in Dubai

Fig. 4 Yearly wind chart

Extreme weather conditions:
Sand storms - low air pressure in the Dubai area causes strong winds from the north-west picking up sand that covers roads and buildings making protection from it crucial part of the design.
Extreme heat - summers are really hot with temperatures around 40°C. Getting the most out of the solar energy while lowering the cost of cooling is the main strategy.
High humidity - really high humidity percentage in the summer is bad for materials in any construction and making everything dry is one of the top priorities.
BIOCLIMATIC DESIGN
Compact shape of inner volume, providing optimal surface-to-volume ratio
Dynamic Sun control system, avoiding direct exposure of glazed surface
Airflow through roof and floor structure, reducing the heat loads
Openings dimensioned and placed to allow natural ventilation when possible
Outer shell designed to protect the conditioned volume but also to provide comfortable outdoor spaces.

INSULATION
Timber construction - highly insulated floor and ceiling -
Highly insulated walls - triple glazed curtain wall -

SUN SHANDING SYSTEM
Brise soleil - ETFE or epoxy membrane -
Further optimization -

PHOTOVOLTAIC SYSTEM
Self-generating electricity -
AC and DC batteries -

SMART HOUSE SYSTEM
Remote controlling -
Synchronization of energy production and consumption -

HVAC DISTRIBUTION
Heat pump technology -
Inverter technology -
Less electricity consumption -
Temperature and pressure control sensor -

twist BOX
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PASSIVE SYSTEMS

Summer day

Winter day

Summer night

Winter night
PASSIVE SYSTEMS
http://twistbox.ac.rs/

sdme.team.serbia.2018

team.serbia.sdme2018

twistbox_sdme

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