HelOP – Heliostatic Ornamental Panel

Ana Teresa Ribeiro Vaz; Maria Inês Fernandes Lapa; Rita Francisca Soares Costa
Ana Teresa Coutinho Costa, Gonçalves Pinto & José Manuel Pereira da Silva
COLÉGIO INTERNATO DOS CARVALHOS
Rua do Padrão, 83 – 4415-284 Pedroso
Vila Nova de Gaia – Portugal, helop.project@cic.pt

Abstract. *Nowadays we all agree that population and economic growth put an enormous pressure on the exploitation of natural resources, mainly fossil fuels. The search for higher patterns of quality of life led Man to an unrestrained race for energy whether it is used to extract the same natural resources, food production or simply to ensure its own comfort.*

The HelOP project intends to reduce the consumption of fossil energy and consequent reduction on CO_2 emission and keep the comfort levels that Man has been used to [1]. By resorting to a renewable energy source [2] (the Sun) and to materials originating from abundant natural resources (slate, black schist and sand among others of less significance), without a great consumption of energy on its preparation, ornamental panels can be produced so as to allow the exploitation of solar energy on its four valences: natural light, thermal inertia, thermal collector and photovoltaic generator. The HelOP pieces have been created on the basis of an innovative design and can be applied in any building or architectural work to fully integrate its construction, thus accommodating the new concept of sustainable urban design.

The project has been entirely developed at Secondary School and based upon a Hands-on learning strategy. It is a technological approach to assist the construction of bridges that we need to shorten the distances between science and society.

Keywords. Solar Energy, Sustainable Architecture, Teaching, Urban Design.

1. Introduction

Throughout human history energy has always been a highly “desired” study object by all of those who have contributed to the construction of scientific knowledge. In our days, the installation and setting of equipments for the use of solar energy in public and private buildings often end up being aesthetically aggressive, thus causing a visual/environmental impact which depreciates the architectonic framing of the constructions.

Catch, store and convert the energy made available by the sun in a sustainable design perspective became for us the big challenge that allowed the conception, development and implementation of this project.

The option of turning to the use of raw materials natural resources (slate, black schist), or even other transformed, like for example the glass (sand), well demonstrates our intention of valuing endogenous natural resources abundant in our country. This way we have combined piece design, and all together, the noble purpose of energetic use of solar radiation.

The application of this project results in an increase of energetic efficiency of the buildings with environmental effects in the corresponding reduction of CO_2 emission and natural saving of fossil fuels.

2. Project Methodology Applied

We can describe the methodology used based on the tasks that were followed in every step.

- Bibliographic research into solar radiation and its annual course; thermal characteristics of the materials used in the production of the pieces; energy equivalents; etc.
- Study, conception and production of a piece model for laboratory tests.
- Study and conception of the standard piece with real dimensions.
- Preparation and setting of each type of piece according to its functionality: natural

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light, thermal inertia, thermal collector and photovoltaic generator.

- Study into the integration of the pieces in panels and other components of urban design.
- Setting of panels in the exterior for tests and gathering of experimental data.
- Conclusions and future perspectives.

This Project was developed with secondary school students attending the Scientific-Technological Courses of Chemistry, Environment and Quality and Arts and Graphic Industries from Colégio Internato dos Carvalhos in an extracurricular school atmosphere.

3. The HelOP Project

The first and most important studies produced on optical physics focused on the course of radiation through blades with parallel faces (Figure 1.). These allow demonstrating the deflection of light and the possibility that part of that radiation is retained, producing the greenhouse effect [3].

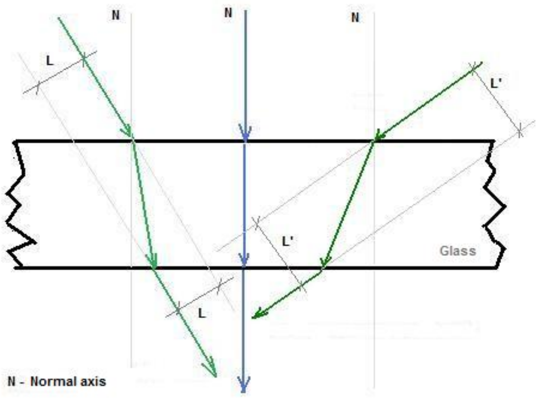


Figure 1. Deflection of Light

Some of the physical characteristics (Table 1.) of the used materials [4], as well as of the solar light were analysed so as to come to a conclusion on the possibility of using the greenhouse effect in the interior of the piece combined with the dark bodies' theory (Stefan-Boltzmann) (Figure 2.). Out of this symbiosis would emerge cooperation for the use of solar energy [5].

Material	$\rho/g.cm^{-3}$	$C/KJ.kg^{-1}.{}^{\circ}C^{-1}$	$\alpha/m.{}^{\circ}C^{-1}$
Slate	2,70	0,837	$8,0 \times 10^{-6}$
Marble	2,70	0,837	$8,0 \times 10^{-6}$
Black Schist	2,70	0,837	$8,4 \times 10^{-6}$
Glass	2,57	0,836	$9,0 \times 10^{-6}$

Table 1. Characteristics of the Materials

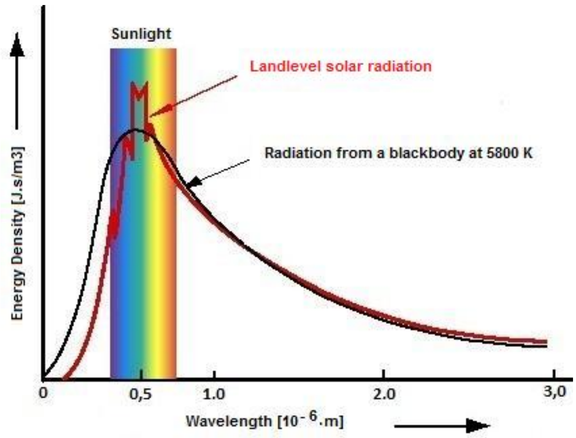


Figure 2. Radiation Overlapping

3.1. Experimental Model

The experimental model was conceived and built in the shape of an equilateral triangular prism with a 60 cm face and 15 cm high. On the exterior face was put glass and on the basis of the box was put a 2 cm thick slate plate (Figure 3.). This model was used to perform the first laboratory tests and allowed to infer the high potentiality of a piece with identical characteristics and the same purposes, allowing a step further on its application.

The tests with the model piece were conducted in the laboratory next to a window directed to the south and during January and February 2010.

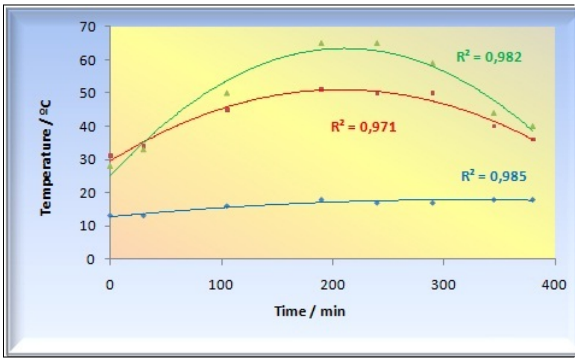
Figure 3. Assembling the experimental Model

Acknowledging that the laboratory temperatures were not the same as the exterior, the valid tests presented appreciable data in the slate temperature capable of encouraging us to continue the project. Table 2. and the Graphic 1. that follow result from data obtained experimentally on the 28th January 2010.

t – Time / Minutes
T1 – Room Temperature / ºC
T2 – Inside HelOP Temperature / ºC
T3 – Slate Temperature / ºC
U – 3 Photovoltaic Cells / V
E – Light Intensity / Lux

HelOP - Study on 28 January 2010 (Clear Sky)						
Time	t / min	T1 / ºC	T2 / ºC	T3 / ºC	U /V	E / Lux
10h30m	0	13	31	28	3,95	2400
11h00m	30	13	34	33	3,95	2450
12h15m	105	16	45	50	3,89	2400
13h40m	190	18	51	65	3,87	2300
14h30m	240	17	50	65	3,86	2350
15h20m	290	17	50	59	3,85	2250
16h15m	345	18	40	44	3,23	2400
16h50m	380	18	36	40	2,19	2400

Table 2. Laboratory Tests

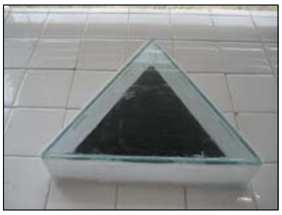


Graphic 1. Temperature Curves

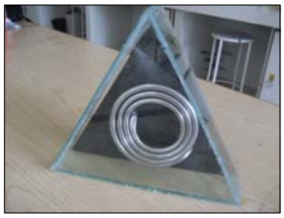
3.2. Original HelOP Element

From the study conducted on the experimental model of higher dimension was conceived the original piece of HelOP {Figure 4. a), b), c) and d)}, built in the shape of an equilateral triangular prism with a 30 cm face and 8 cm high to be applied in different outdoor areas, preferably directed to the south or adapted to the design and/or functions [6].

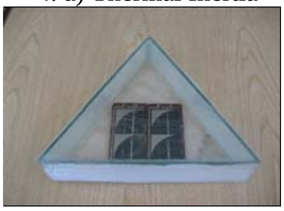
The already mentioned materials were cut, worked and handled in the construction of four different piece models [7]. One piece [4.a)] – glass/slate – or – glass/black schist – that was created with the goal of retaining heat (thermal inertia). Another piece [4.b)] – glass/ copper pipe/slate – that was created as thermal collector used in water heating. A third piece [4.c)] – glass/photovoltaic [8] cell/marble – to the production of electric energy and finally a fourth piece [4.d)] – glass/glass – to natural light.



4. a) Thermal Inertia



4. b) Thermal Collector



4. c) Photovoltaic Cells

4. d) Natural Light

Figure 4. Different HelOP Elements

Of all the created pieces the ones that presented higher difficulties were those that required the fitting of a twisting copper pipe later painted black in the slate basis. These are meant to lower the slate face to fit the pipe (Figure 5.)

Figure 5. Lowering the Slate

The pieces dedicated to the photovoltaic present a white marble in which two small 1V e 500 mA cells were fixed. The future intention is to cover the entire surface basis with photovoltaic material to obtain maximum output. The six units were linked in series so as to allow the charging of a 12 Volts battery. The position of these pieces in panel must be done to avoid the direct exposure to the sun since the cells lose output when they heat.

Of the four different pieces only the one used to natural light, entirely made in glass, offers less construction work. All the pieces were glued using silicon. The faces were covered with a thin skin of white sponge, simulating concrete, to protect its panel union [9].

After building 6 elements for each described function the HelOP pieces were fixed on a support structure for exterior tests (Figure 6.).

Figure 6. HelOP – Exterior Testing Panel

4. Sustainable Urban Design

4.1. Introduction

In the last years many questions have been made regarding environmental conditions, ecological balance and implicitly life quality. Ecological concerns, consumerism and the feeling of economical vulnerability have an impact on the options of design and architecture so as to make them more sustainable [10]. This notion of sustainability in Design [11] (being Design a planed and creative activity that aims to contribute to the improvement and enrichment of the human life) intends to find a balance between the functional, aesthetical, economic, social and cultural dimensions of global development [12].

The growing rises on energy costs and weather changes have been "awakening" people and institutions to the importance of the environmental impact of the anthropogenic activities. Sustainability is no longer seen as an "interesting" option and has become the main goal of any activity [13].

The relation between the principle of planetary sustainability and the concept of eco-efficiency of a product is the main conditioning item on Design of products to the XXI century [14]. So it has become more and more important and urgent that Design may give answers to these new needs and act in a socially responsible way [15].

The design study of the presented panels, in its whole, will be used as the example for a possible application of the studied pieces without neglecting other bolder proposals (Figure 7.).

Imagination is the conducting wire that links creativity and innovation together!

Figure 7. Design Panel Sample

4.2. Applied Design Methodology.

The methodology used with students is part of the contents taught in the school subject Theory of Design – Project Methodology and was seen under the following steps:

1 – Problem definition (identification of aspects and functions).
2 – Synchronic Analysis (competition analysis) and Diachronic Analysis (analysis of the historical evolution of the product).
3 – Development of Ideas (Creative Synthesis).
4 – Evaluation/Discussion of alternatives and ideas presented.
5 – Project Development.
6 – Prototype/Model Development.

4.3. Application in Industrial and Architectural Design Projects

This innovative project is a Redesign based on a covering material – glass brick – that contains aesthetical/ornamental functions and the capacity to let light get through. The HelOP has a major ecologic concern in the creation of panels that present different functions and that promote the sustainability of public or private spaces.

The students presented the study of 3 different applications for the developed materials:

1 – Project of a Multifunctional school sports area. (HelOP application of all valences – Figure 8.)

Figure 8. Multifunctional school sports area

2 – Project of a private house/cottage. (HelOP application of all valences – Figure 9.)

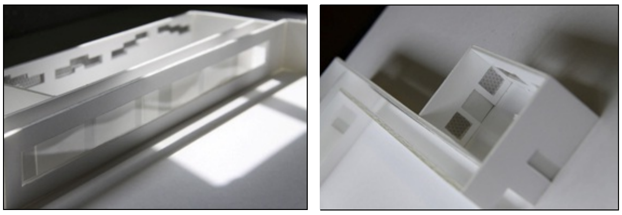


Figure 9. Private house or cottage

3 – Project of a bus stop. (HelOP application of 3 valences – Figure 10.)

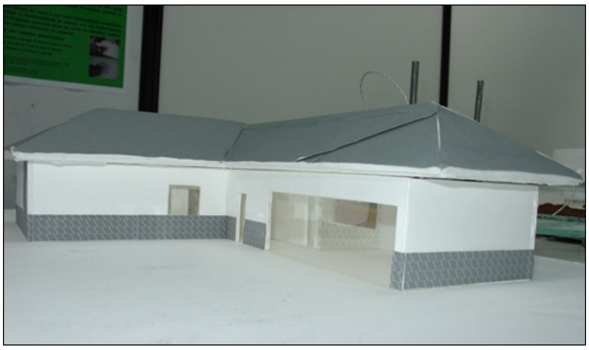


Figure 10. Bus Stop

The use of each panel in the spaces will always take into consideration its synergic potential demonstrated by its higher functionality and profitability together with its aesthetic and ornamental aspects. Being able to combine sustainability of area and its visual shape/impact, both interior and exterior, has been a constant concern regarding the HelOP objectives.

5. Acknowledgements

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