Urban Ecodesign in the City of Barcelona

Designing sustainable cities seems to be the best solution for facing the global environmental problems that our society has created. With this aim, new approaches and tools for improved urban design and planning are necessary. In this context, ecodesign presents itself as one of the key tools in the move towards more sustainable cities. This article presents three case studies of how it has been applied in Barcelona: a street light; a waste collection point and an entire neighbourhood.

Urban areas and environments are expanding worldwide. Statistics of urban population share reach figures of 70% in Europe, America and Oceania and 50% globally. This ever-increasing urban population is likely to grow even more. With this unprecedented growth in urbanisation, global sustainability is increasingly linked to urban sustainability. This is especially so considering the impact that people living in cities have on the rest of the globe and the sustainability of life in the cities themselves. Despite representing only 2.7% of the world’s surface area, the world’s cities are responsible for 75% of the world’s energy consumption and 80% of greenhouse gas emissions. Therefore, it is essential to improve the environmental performance of urban systems.

In this article, we adapt and apply product ecodesign methodology to urban elements at different levels:

—Urban element: urban furniture, street light
—Building: public facility, waste collection point
—Neighbourhood: newly designed neighbourhood

The ecodesign of urban environments at different spatial scales is an emerging topic fostered by the research on ecodesign and urban sustainability.

“The ecodesign strategies were evaluated from technological, economic and social standpoints”

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FOR THE PEOPLE
SPACE
—MINIMIZING SPACE FOR PRIVATE VEHICLES.
—ENVIRONMENTAL HEALTH, REDUCING ATMOSPHERIC AND ACOUSTIC POLLUTION.
PARTICIPATION
—ENVIRONMENTAL EDUCATION.
—PARTICIPATIVE PROCESSES.

Table 1: Strategies for urban sustainability

<table>
<thead>
<tr>
<th>Strategies for urban sustainability</th>
<th>Tools for urban transition towards sustainability</th>
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</table>
| The most important strategies for fostering urban sustainability are listed in Table 1. | During recent years, cities in general (and Barcelona in particular) have applied environmental assessment tools such as environmental audits or planning tools such as Agenda 21. Currently, Barcelona has signed the Covenant of Mayors, committing itself to reduce 20% of greenhouse gas emissions by 2020. However, experience with more innovative tools such as Life Cycle Assessment (LCA) or eco-design is more limited. In spite of this, these tools are eliciting a great deal of interest from cities.

CIRCULAR FLOWS
CLOSING ENERGY, WATER AND MATERIAL FLOWS WITHIN NEIGHBOURHOODS.
CREATING SYNERGIES.
PREVENTING ENVIRONMENTAL IMPACTS.
INTRODUCING ENVIRONMENTAL CRITERIA IN PUBLIC SERVICES.

MIX OF USES + BIODIVERSITY
INTEGRATE AGRICULTURE, INDUSTRY, SERVICES AND HOUSING ORDER TO REDUCE ENVIRONMENTAL LOADS.
VERTICAL MIXITY OF USES.
MULTIFUNCTIONAL SPACES.
PROTECTING LOCAL BIODIVERSITY.
CREATING NEW SPACES FOR BIODIVERSITY.

Methodology overview
Ecodesign
Ecodesign consists of the consideration of environmental criteria in the development of a product, process or service. The aim of ecodesign is to use the minimum amount of resources and generate the least possible emissions along the life cycle of the product. It can be defined as "the systematic incorporation of life cycle considerations into the design of products, processes or services". Actually, it is one of the most valid tools to reduce the inherent environmental drawbacks associated with products. The ecodesign methodology is shown in Table 2.

Table 2: General stages of a process of ecodesign, applicable to the case studies presented

1. CREATION OF MULTIDISCIPLINARY ECO-DESIGN TEAM
2. DEFINITION OF THE VARIABLE WHICH DEFINE THE MOST REPRESENTATIVE PRODUCTS
3. SIMPLIFIED LCA OF THE SELECTED PRODUCTS
4. ECO-BRIEFING AND ECO-DESIGN STRATEGIES
5. CONCEPTUAL DEVELOPMENT OF ECO-DESIGN
6. ENVIRONMENTAL ASSESSMENT OF THE ECO-DESIGN OF THE PRODUCT
7. MANUFACTURE OF A PROTOTYPE ECO-DESIGNED PRODUCT

The interdisciplinary team which works on the environmental aspects in this type of design is key for enhancing product stages: production materials, process, transport, packing, installation, use, maintenance, dismantling and end of life. The team is aware that these initial decisions have a consequence on the whole life cycle.

Ecodesign of a street light
Artificial lighting accounts for 19% of the world’s electricity consumption, so the first case study focused on designing an environmentally friendly street light. Table 4 presents the main characteristics of the case study.

The results of the market study show that the most widely-used materials for manufacturing the streetlight body are galvanized steel and cast aluminum, although some models are still manufactured using reinforced concrete. The streetlight bases involve the construction, in situ, of concrete supports. The most widely used lamps are Compact Fluorescents, High or Low Pressure Sodium Vapour lamps, which are more energy efficient than Mercury Vapour Lamps, with an installed power of between 50 and 70 W, and luminance of between 20 and 30lx. All the streetlights analysed in the market study are designed for a useful life of 20 years.

The simplified LCA of the selected streetlights in the market study shows that the main impact is concentrated in the Use stage, which represents over 84% of the total environmental impact. The environmental impact of the Material Extraction and Processing stage of the light element and base represents over 15% of the total.

In order to make it easier to subsequently compare the environmental impact of the traditional streetlight with the ecodesigned unit, a scenario was proposed in which lighting was adjusted to the 15lx indicated in the functional unit. In this scenario, the impact of the Use stage was reduced to 77% of the total, and to 37% with respect to the current use stage.

The results of the simplified LCA indicate that the eco-briefing should focus on the stages of Use and Material Extraction and Processing as indicated in Table 3.

The ecodesign strategies were evaluated from technological, economic and social standpoints. The strategies that proved most viable were the use of high efficiency lamps, the application of a photovoltaic system, and the design of the streetlight in modules and bases which were easily installed and dismantled.

The proposed ecodesign streetlight comprises three basic elements: support, light, and a panel supporting the light. For the People: Space — minimizing space for private vehicles, environmental health, reducing atmospheric and acoustic pollution. Participation — environmental education, participative processes. The strategies that proved most viable were the use of high efficiency lamps, the application of a photovoltaic system, and the design of the streetlight in modules and bases which were easily installed and dismantled. The proposed ecodesign streetlight comprises three basic elements: support, light, and a panel supporting the light.
The streetlight’s electric components are high-efficiency lamps, a photovoltaic module, battery, wiring, and a photoelectric regulator. The lights are attached at the top of the support in clusters of long-life high-efficiency lamps. There is a storage space under the top of the support in the form of a panel to hold a photovoltaic module. These elements port the photovoltaic module. The lights are attached at the top in the form of a panel to hold a photovoltaic module. The lights are attached at the top of the support in clusters of long-life high-efficiency lamps. There is a storage space under the streetlight for hiding the battery. The light given off by the elements, consisting of six “trees” (each made of a column holding the crossbars that support the roof) supporting in turn each of the planes that make up the “tree-covered” WCP, a nature metaphor.

The key points of the WCP are functionality, sustainability, management and communication.

In terms of functionality, the WCP enhances a clear and intuitive operation – both for operators and users –, a clear separation of WCP inputs (the waste brought by users) and outputs (perimeter area for waste collection, not accessible to users), and the multifunctionality of the space to accommodate different uses beyond collection such as classroom, exhibitions, events, and neighborhood activities. In addition, the WCP is based on a few basic and flexible elements that make it possible for it to adapt to different needs and uses. Its strength in terms of sustainable self-sufficiency is its exploitation of endogenous local resources (water and sunlight). It collects and stores rainwater for use in cleaning the facility, toilets and watering of the green areas. Sunlight is harnessed to illuminate the WCP, and solar thermal technology heats the water. The WCP is also designed for its dematerialisation, optimizing the use of materials and prioritizing those of lower environmental impact. Vegetation has been integrated into the perimeter fence to better control weather conditions in the area and absorb CO₂.

### Ecodesign of a building: a waste collection point

A waste collection point (WCP) is a facility where people can dispose of the waste fractions that are not collected on a regular basis from street containers (i.e., glass, packaging, carton and cardboard, organic waste and residual waste). Fractions that are collected in WCPs include used cooking oils, textiles, electric and electronic waste, fluorescent chemicals, batteries, etc. Currently, Barcelona has a network of 37 WCPs (eight of which are mobile units), that collect 20 tons of waste, the units have over half million users per year.

The goal of the project was to design a new WCP model designed to satisfy the needs of a neighborhood. The process started with an interdisciplinary team that covered the required knowledge areas: architects, communicators, environmentalists, etc. The first action was to analyse different WCPs. This enabled the team to determine the problematic issues (social, environmental, financial) of WCPs and the strategies needed to define the WCP described below.

Besides being easy to use and functional, the ecodesigned WCP has an attractive appearance and features didactic elements. It is also able to communicate to society the needs and strengths related to waste management.

The main components of the ecodesigned WCP are:

- The desks. A modular element identifies the different types of waste while avoiding direct view of the containers. At the same time, the desks create two separate spaces: one in the central area for depositing waste and the other in the perimeter area for collection.
- Two prefabricated and transportable modules. The first is used as a fully equipped reception office and the second as a classroom or multipurpose space.
- A lightweight cover that protects the site from the elements, consisting of six “trees” (each made of a column holding the crossbars that support the roof) supporting in turn each of the planes that make up the “tree-covered” WCP, a nature metaphor.
- Finally, a perimeter fence naturalized with climbing plants helps blend the WCP into its environment.

The main features of the streetlight project are:

| TEAM | SOSTENIPRA (ICTA-UAB) AND JULI CAPELLA & STEPHANIE HERR |
| FINANCING | PILOT PROJECT FOR THE ECODESIGN OF URBAN FURNITURE |
| CONTEXT | CEMA. GOVERNMENT OF CATALONIA |
| IMPROVEMENTS ACHIEVED | USE OF A HIGHLY EFFICIENT LIGHT BULB & PHOTOVOLTAIC ENERGY SYSTEM (7% REDUCTION OF ENVIRONMENTAL IMPACTS) |
| | DEMATERIALIZATION OF AERIAL STRUCTURE |
| | USE OF RECYCLED CONCRETE FOR THE BASE |
| | DEMATERIALIZATION OF URBAN SETTING |
| | ADDRESSING ENVIRONMENTAL ASPECTS TO STREET LIGHTING |
| | REDUCTION OF LIGHT POLLUTION |
The waste management system is designed to facilitate and encourage public involvement. Communication to users is essential to guide them to deposit the waste easily and without confusion.

In terms of communication, the WCP is itself an educational, environmental communication and interactive project, promoting the values of waste prevention and recycling and reuse among the general public.

Table 5 highlights the main characteristics of this case study, which followed the same ecodesign process than the first case.

The first WCP of this kind will be installed the first half of 2012 in the Barceloneta, Ciutat Vella district of Barcelona. This neighbourhood will house 2,000 dwellings. The area lacks urban continuity and features many structural deficiencies as well as isolation from the rest of the city. Currently it is almost completely surrounded by natural and artificial barriers: the Besòs River and several roads, highways and railways.

Environmental aspects have been incorporated since the conceptualization of the neighbourhood and considering the intrinsic determining factors of the landscape. The methodology followed throughout the Vallbona design and planning process is an adaptation of the methodology followed in the previous sections, fully developed in Transition towards sustainable cities: opportunities, constraints and strategies in planning. A neighbourhood eco-design case study in Barcelona (Spain).

The table 6 presents the basic features of this case study.

**Eco-design of a neighbourhood**

The city council of Barcelona unanimously approved, in October 2008, to establish sustainability as the driving force for the urban planning of the last section of its territory to be urbanised. This new neighbourhood will be located in an area called Vallbona located in the northern part of Barcelona. It stretches over 32.6 Ha and is currently mainly devoted to agricultural land uses.

This neighbourhood will house 2,000 dwellings. The area lacks urban continuity and features many structural deficiencies as well as isolation from the rest of the city. Currently it is almost completely surrounded by natural and artificial barriers: the Besós River and several roads, highways and railways.

Environmental aspects have been incorporated since the conceptualization of the neighbourhood and considering the intrinsic determining factors of the landscape. The methodology followed throughout the Vallbona design and planning process is an adaptation of the methodology followed in the previous sections, fully developed in Transition towards sustainable cities: opportunities, constraints and strategies in planning. A neighbourhood eco-design case study in Barcelona (Spain).

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**Table 6. Main characteristics of the Vallbona project**

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<thead>
<tr>
<th>TEAM</th>
<th>BARCELONA REGIONAL AND SOSTENIPRA (ICTA-UB)</th>
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<tbody>
<tr>
<td>ENTITY</td>
<td>BARCELONA CITY COUNCIL</td>
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<tr>
<td>CONTEXT</td>
<td>ECO-DESIGN OF THE LAST NEIGHBOURHOOD TO BE URBANISED IN BARCELONA</td>
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<tr>
<td>IMPROVEMENTS ACHIEVED</td>
<td>MAIN STRATEGIC ACTIONS:</td>
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<tr>
<td></td>
<td>—MINIMIZATION OF BUILDINGS’ ENERGY DEMAND</td>
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<td></td>
<td>—USE OF LOCAL RENEWABLE ENERGY SOURCES AND A DISTRICT-WIDE HEATING NETWORK</td>
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<td></td>
<td>—PROTECTION OF THE AREA’S AGRICULTURAL MOSAIC</td>
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<td></td>
<td>—DIVERSIFICATION OF WATER SOURCES, ADAPTING THE QUALITY OF WATER TO ITS USES</td>
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<td></td>
<td>—LOCAL RESOURCES MANAGER THAT WOULD PROFICIENTLY MANAGE ENDogenous RENEWABLE RESOURCES</td>
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<tr>
<th>TEAM</th>
<th>SOSTENIPRA (ICTA-UB &amp; INEDIT), PICH AGUILERA ARCHITECTS, SOLANAS, GERONA GROUP</th>
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<tr>
<td>FINANCING</td>
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<tr>
<td>CONTEXT</td>
<td>ECO-DESIGN OF A NEW MODEL OF WASTE COLLECTION POINT</td>
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<tr>
<td>IMPROVEMENTS ACHIEVED</td>
<td>—USE OF LOCAL ENDogenous RESOURCES (RAINWATER, SOLAR ENERGY), AIMING AT SELF-SUFFICIENCY</td>
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<td>—USE OF RECYCLABLE MATERIALS</td>
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<td>—PASSIVE ENERGY SYSTEMS</td>
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<td>—INTEGRATED WITH THE URBAN ENVIRONMENT</td>
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<td></td>
<td>—Didactic function</td>
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<td></td>
<td>—More user-friendly, accessible and simple</td>
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<td></td>
<td>—Interactive with users</td>
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**Conclusions**

The ecodesign methodology has been applied to the design of urban environments at different spatial scales in the city of Barcelona. This process differs from a conventional one mostly in that it takes into account environmental criteria throughout the entire lifecycle of the designed products and involves highly interdisciplinary teams. Considering environmental issues is of particular relevance since the incorporation of the lifecycle approach in the early design of a product/facility encourages prevention of urban environmental impacts and guarantees that sustainability goals will be reached.

Three urban ecodesign case studies have been considered (a streetlight, a waste collection point, and a neighbourhood) as examples of the potential of applying ecodesign in urban systems. This approach can help reduce environmental impacts and bring social (educational, functional, etc.) and financial (efficient use of resources) improvements.

**Acknowledgments**

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