

OEIRAS MASTERPLAN: A METHODOLOGY TO APPROACH URBAN DESIGN TO SUSTAINABLE DEVELOPMENT

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ABSTRACT

This paper describes a new methodology for the conception of urban plans in order for them to fit the principles of Sustainable Development. The methodology herein presented makes use of different software for designing, calculations and dynamic modelling of buildings and urban spaces. The results from these assessments are then interpreted and incorporated in the urban design solutions.

This methodology was applied in a case study in Oeiras, Portugal, in the conception phases of the Oeiras Master Plan. The overall objective of the implementation of this process in this case study was to be able to foresee the area's final makeover and predict the impacts of the plan on the context through the integrated use of environmental analysis (ArcGIS), simulations of future scenarios (3dsMax) and 3d modelling studies (Revit, Ecotect).

Factors such as geomorphology, solar exposure, prevailing winds and rail and road traffic noise provided information on how to capitalize all favourable conditions of the site, which is a fundamental base for an appropriate land use transformation.

This methodology contributes to the control of urban design solutions and outcomes, and promotes the creation of an interface between urban planning, landscape and architecture projects. The development of a "City Information Modelling", similar to BIM, which has been successfully applied to Architecture and Engineering projects, is therefore seen as an answer to the new challenges presented by the present and future cities.

This strategy delivers the maximum benefits at all spatial scales by embracing the logic of sustainability so that urban design can be the first tool to optimize future building and infrastructure projects.

KEYWORDS: SUSTAINABLE DEVELOPMENT, METHODOLOGY, SIMULATION, MASTER PLAN

INTRODUCTION

The disarticulation of the urban planning process with the principle of Sustainable Development has led to the construction of urban spaces with low quality and without functionality [1]. The inadequacy of the current planned urban spaces and buildings regarding the use of solar energy, wind and ground use requires that the future interventions be developed with more skill and more concern with the use of natural resources.

In the 1960's all designers had the intention to develop themselves a methodology supported in problem-solving techniques, such as systematic analysis and operational research. In 1970 Christophe Alexander et al. published a new tool for building and planning: "A Pattern Language", which provides a new theory supported in the analysis and application of patterns related to town planning and building. To ensure a successful result of his methodology, considering the great number of patterns identified, he divided all of the patterns into three themes: towns, buildings and construction [2]. Yet all these approaches break down when the problem to solve is too complex.

In the 1980's, with the introduction of environmental concerns in urban planning, the requirements of the design process underwent a transformation towards the use of design directed methods that combined artistic and scientific processes to resolve problems. At the same time, Nicholas Negroponte from MIT Media Lab published an article about the possibilities of CAD and the "New Architecture Machine", which resulted from the partnership between architect and computer [3]. The new capacity provided by the use of CAD systems had a major role in the beginning of the 2000's when the sustainable movement earned a determinant place in all urban planning actions.

In this framework it appears to be necessary to develop a new methodology that provides for effectiveness in the result and that allows for different options to be simulated and evaluated without compromising the duration of the project.

The use of software for design and simulation seems to be the more accurate way to ensure the efficiency of the simulations and evaluations, especially when combined with the technical ability of the team to interpret the results and reflect on their consequent spatial distribution, which will invariably produce different solutions from one architect to another.

METHOD

In 2005 a new process emerged by the name of Sustainable Urban Planning [1], which introduces social, ecological, and solar concerns in all actions related to the territory. This process intends to assume an important role in the stage of land use transformation by ensuring that all actions do not have destructive impacts on the environment. It's a design process that infuses all stages of the planning process with a detailed understanding of the ecological system, the possibilities of solar power use and the concern to ensure public safety in all public spaces.

A dynamic support for these important aspects of the urban planning process can be found in the simulation stage through the modelling of the different scenarios. The plan design simulation is a tool for having control over the proposals and their impacts, especially if associated with the environmental and climatic conditions occurring in the project area.

During the last few years, simulation and analysis software solutions have been continuously developed and improved with notable repercussions on the approach of the design process at different spatial scales. In a few decades we went from hand-drawn blueprints to CAD drawings and since the invention of virtual 3D modelling in the 1980's the design process has changed to catch on with these technologies. Project design is now based on a wide scope of "know-how", obtained either from research or personal experience, and the use of these technologies has become essential for the creation of scenarios and immediate rendering of the solutions.

For this reason it is useful to choose a set of suitable and efficient tools to test all the urban planning parameters and interventions before they come into existence. An innovative contribution to sustainable development could be obtained with the virtual simulation process by defining and adapting it to a list of sustainable principles that take into consideration aspects such as renewable resources, transportation-traffic urban systems, noise emissions and air pollution.

Regarding urban planning, the first goal concerns the interaction between a Master Plan proposal with the urban morphology and future buildings and infrastructure projects. In this way, for instance, it's possible to take advantage of daylight and natural ventilation or to preserve views by simulation of the interplay between the architectural structures and the landscape [5, 6]. The second aim is to get a response that is both an environmental response to each particular climate as well as a cultural, social and economic one.

Having ascertained these basic principles, the next step is to analyse their practical application, which was the objective of the implementation of the Sustainable Urban Planning Process in the Oeiras Master Plan case study. This Master Plan entails a great range of urban transformations including: parks, cycling routes, mixed-use buildings and a recreational harbour on the Tagus river. The site has a large green surrounding area and is crossed by a road with intense traffic that creates problems to the pedestrians crossing and, most of all, breaks the link between the city and the shore.

The proposed methodological approach for the Sustainable Urban Planning Process [1, 5] is supported by five steps, and with a continuous virtual simulation and monitoring at every scale levels (Figure 1). These stages of the process were sequentially applied to the area of the project and depend on each other, since each stage only begins after the evaluation or validation of the previous one.

Many different software were included in all stages of the Sustainable Urban Planning Process [7], allowing to perform a detailed analysis of the Oeiras Master Plan site, taking into account the achievement of the prerequisite environmental, economic and social goals. For a better understanding of the proposed operative process and how the BIM concepts have been included, each stage is described as follows:

Step 1 – Definition of the intervention goals – The first step requires the determination of the strategic goals for urban sustainability that are to be included in the planning process. These goals must take into account the protection and appreciation of the natural environment, the promotion and stimulation of economic activities, and the fulfilment of the needs of the population.

Step 2 – Reference situation analysis – Elaboration of a complete data survey regarding all the process features for Sustainable Development, handling both local data and information concerning to the surrounding area. Thus, environmental, economic, social and urban analysis are part of this stage, as well as the recognition of pertinent restrictions,

potentialities and the definition of criteria for the urban planning process, which constitutes the basis for the plan design stage.

In this stage three main software programs were used: ArcGIS, for the precise analysis of the site, including topography and riverbeds, ecological structure, existing buildings, and solar exposure, biotopes; Excel, to transpose the results of the surveys conducted on site and with the population into tables and graphs, easier to read and compare and therefore more practical; and AutoCAD 2D, to draw the preliminary Master Plan.

Step 3 – Plan design – This step seeks to achieve an urban plan proposal that satisfies the previously defined goals and that, at the same time, assures that the project will help to promote a Sustainable Development.

This step includes seven actions: *Action 1* – survey and review the urban/rural property limits (ArcGIS, AutoCAD 2D); *Action 2* – selection of the restraining elements (geomorphology, solar exposure, indigenous species, existing road networks, public spaces, urban morphology, economic activities, cultural traditions, collective mobility and equipment); *Action 3* – definition of strategic and sustainability factors; *Action 4* – road design (AutoCAD Civil 3D); *Action 5* – buildings plan (AutoCAD 2D-3D); *Action 6* – location of public spaces and facilities (AutoCAD 2D); *Action 7* – conclusion of the plan design proposal.

Step 4 – Plan design proposal simulation – The plan design simulation is made through the modelling of scenarios, which enables to foresee the territorial changes brought by the design implementation. The two-dimensional design proposal developed in step 3 was translated into a precise and complete three-dimensional parametric model. This model gave an updated view of the whole project and the possibility to export individual parts to other simulation software. 3d Studio Max was chosen to create the model and organize the wide range of file formats while Revit was used to make volumetric simulations for the preliminary study of the buildings proposed and to generate elevation sections and terrain profiles working with mass groups imported from 3d Studio Max. Ecotect and Winair were used for lighting and energy analysis and to simulate the shadows and the wind potential of the site for important times of the year. The comparison of the different scenarios formed an information dossier used by all the team members as a technical support for their work (Figures 2, 3, 4 & 5).

Step 5 – Implementation – This step aims to ensure that the urban proposal is efficiently implemented, that its strategic goals are met and that the sustainability principles are respected. The entire implementation process is evaluated in order to make sure that the complete set of measures is correctly executed. The evaluation is detailed with the assistance of implementation technical sheets, formulated for each action, stating the desired goals and defining the priority of different actions.

RESULTS AND DISCUSSION

The results achieved with this new urban planning process, having already been applied in different case studies, have been very positive and, at the moment, it is possible to guarantee not only the efficiency of the whole process but also the good level of the results in every major component of the project.

In this way the results obtained with this methodology also seem to validate the efficiency of advanced virtual technologies, such as the "BIM" systems, when applied to complex urban design problems and their contribution to the sustainable development of the project's site. As this methodology can be supported by a reduced group of dynamic software it also provides a better integration of all teams/information/domains resulting in a correct project without conflicts between specialities.

The main critical aspect to point out is related to the interpretation of the results of the simulation analysis. To overcome this critical point a high level of experience and specialization of the project's team coordinator is highly recommended.

Nonetheless, the implementation of this new methodology has proven to be a powerful tool for urban planning. It provides the architect or urban planner with the opportunity to anticipate the effects of the proposal in a wider scope and helps to reduce the impacts on the environment and in the future urban spaces, by allowing to run systematic simulations that enable quick retrofitting and evaluation of all solutions. Likewise it benefits not only from the possibility to speed up the whole process of urban planning by combining different software efficiently, but also by making the results easier to read and thus easier to work with.

In this way, this methodology also contributes to approach urban planning to the Sustainable Development principles because, even though it is a faster method, the rigor and consistency of the outcome is not only assured but also increased due to the use of BIM-like solutions adapted to urban planning during the various phases and with the continuous integration of all information gathered and developed.

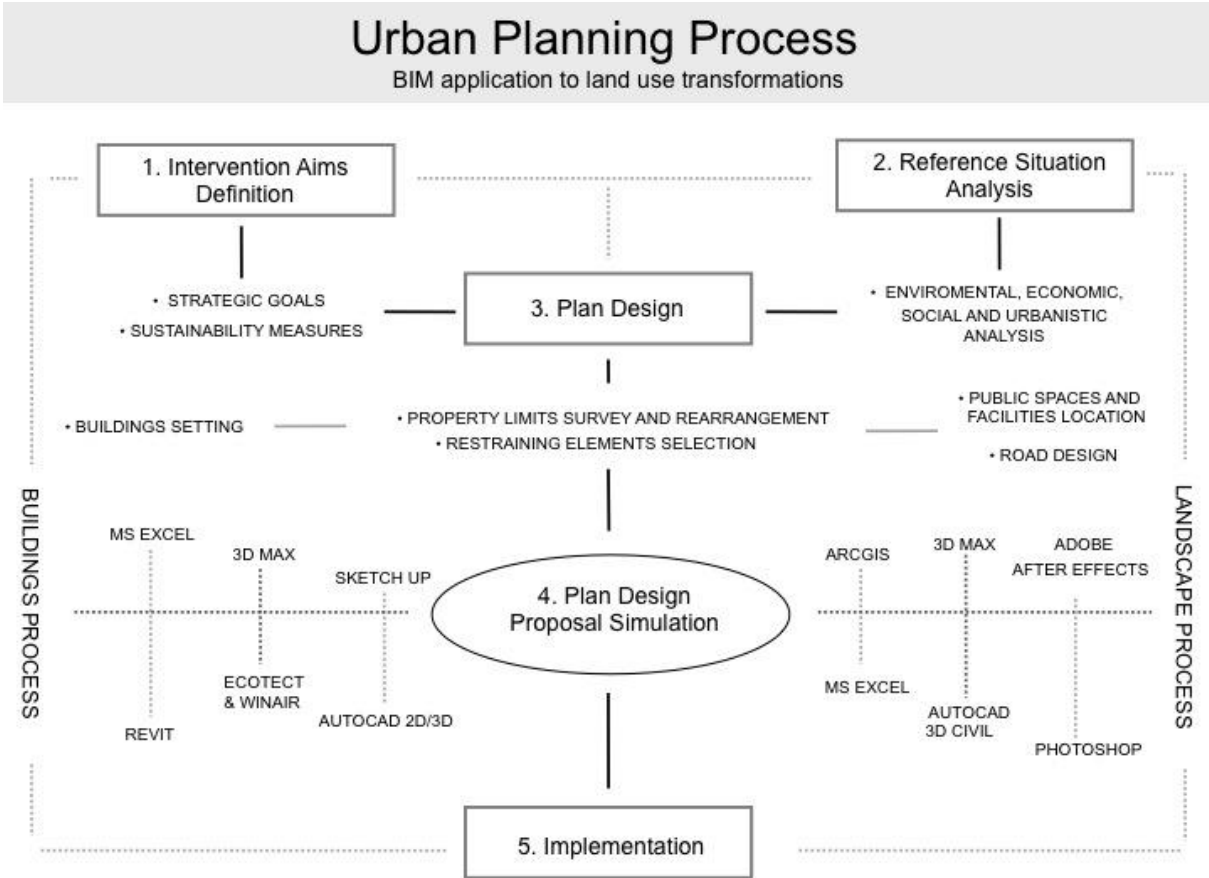


Figure 1: Structure of the Urban Planning Process Methodology

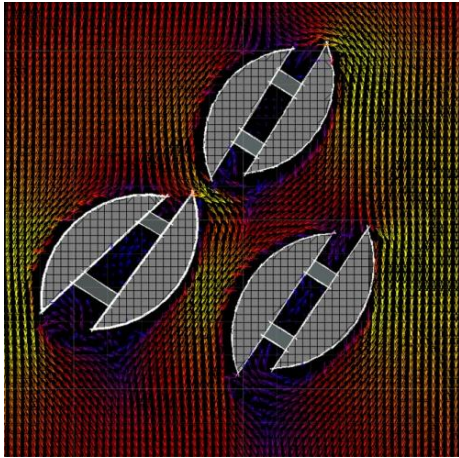


Figure 2: Wind simulation: Ecotect, Winair.

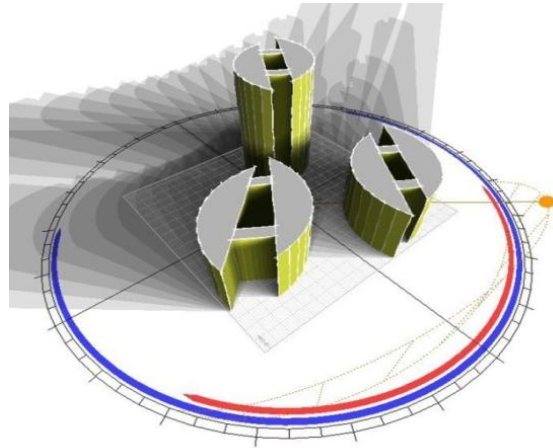


Figure 3: Shadow Study: Ecotect.

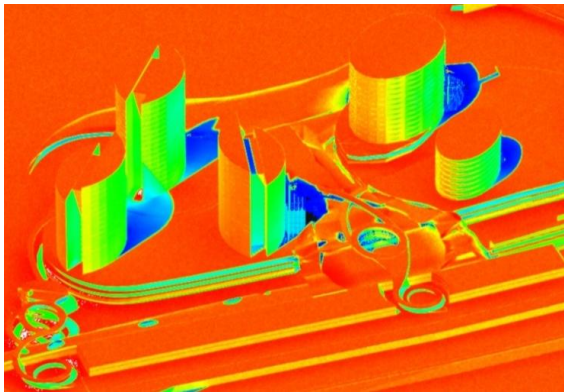


Figure 4: Illuminance Analysis lux_3d Max



Figure 5: Luminance Analysis cd/m2_3d Max

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