

The information environment of the aesthetic creation of environment-friendly solutions and the application of alternative energy sources in suburban zones

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Abstract

After a period of fascination with the very fact of generating cheap renewable energies we are entering a period of seeking solutions which would not only be useful but would also have an attractive form. The information society sets for the designers the task of ensuring that environment-friendly solutions become aesthetically an integral part of an architectural site or urban layout and do not have an adverse impact on the landscape. Technological progress in the application of digital techniques greatly enhances the architect's tools in this matter as it enables not only the modelling of systems in the virtual space of the computer but also the simulation of processes in a search for optimum solutions, while keeping

control of the form. This research has potential to be a tool conducive to the protection of the cultural and natural landscape. The aim of this paper is to analyze some of the recent achievements in using computer simulation, its usefulness in shaping and controlling the suburban landscape, and in particular solutions that draw energy from the sun. Apart from the role of identification, information and advertising, these signs have also aesthetic significance as well as they are spatial forms of territorial division.

Keywords: information environment; renewable energy; suburbs; aesthetics of technology; landscape protection

Resumen

El entorno de información de la creación estética de soluciones respetuosas con el medio ambiente y la aplicación de fuentes de energía alternativas en zonas suburbanas.

Después de un período de fascinación por el hecho mismo de generar energías renovables baratas, estamos entrando en un período de búsqueda de soluciones que no solo serían útiles sino que también tendrían una forma atractiva. La sociedad de la información establece para los diseñadores la tarea de garantizar que las soluciones respetuosas con el medio ambiente se conviertan en parte estética de un sitio arquitectónico o de diseño urbano y no tengan un impacto adverso en el paisaje. El progreso tecnológico en la aplicación de técnicas digitales mejora en gran medida las herramientas del arquitecto en esta materia, ya que permite no solo el modelado de sistemas en el espacio virtual de la computadora, sino también la simulación de procesos en la búsqueda de soluciones óptimas, mientras mantiene el control del sistema. Esta investigación tiene potencial para ser una herramienta que conduzca a la protección del paisaje cultural y natural. El objetivo de este artículo es analizar algunos de los logros recientes en el uso de la simulación por computadora, su utilidad para moldear y controlar el paisaje suburbano y, en particular, las soluciones que obtienen energía del sol.

Palabras clave: entorno de información; energía renovable; afueras; estética de la tecnología; protección del paisaje

Resum

L'entorn informatiu de la creació estètica de solucions respectuoses amb el medi ambient i l'aplicació de fonts d'energia alternatives a les zones suburbanes

Després d'un període de fascinació pel propi fet de generar energies renovables barates, estem entrant en un període de recerca de solucions que no només serien útils sinó que també tindrien una forma atractiva. La societat de la informació posa a disposició dels dissenyadors la tasca d'assegurar que les solucions respectuoses amb el medi ambient es converteixin estèticament en una part integral d'un emplaçament arquitectònic o d'un traçat urbà i no tinguin un impacte advers sobre el paisatge. El progrés tecnològic en l'aplicació de tècniques digitals millora enormement les eines de l'arquitecte en aquesta matèria, ja que permet no només la modelització de sistemes a l'espai virtual de l'ordinador sinó també la simulació de processos a la recerca de solucions òptimes, mantenint el control del forma. Aquesta investigació pot ser una eina que afavoreixi la protecció del paisatge cultural i natural. L'objectiu d'aquest article és analitzar alguns dels èxits recents en l'ús de la simulació per ordinador, la seva utilitat per configurar i controlar el paisatge suburbà, i en particular les solucions que treuen energia del sol.

Paraules clau: entorn informatiu; energia renovable; afores; estètica de la tecnologia; protecció del paisatge

Introduction

The context of aesthetic creation of pro-ecological solutions in suburban areas is so wide and multithreaded that only selected uses are discussed in this paper: energy generation, and energy efficiency. In this paper we review computer aided architectural design technologies, including parametric modeling and computer simulation, and the possibility of combining pro-ecological technologies with aesthetic values of objects and the resulting benefits.

The beginnings of the third industrial resolution

The scientific and technological revolution that began in the 1950s was a period of significant scientific achievement, resulting in major changes in technology and production. These innovations included computerization, the automation of work processes, improvements in telecommunications and, importantly, the use of new energy sources, which at that time was mainly associated with nuclear energy. It did not take even half a century for these changes initiated in the 1950s to highlight the depletion of natural energy resources and the effect of pollutants emitted into the environment. In 2012, J. Rifkin predicted the merger of internet technologies and renewable energy sources as the causative factor of the third industrial revolution, and which will result in the exchange of energy goods via the internet. Simply put, the owner of a facility, being also a producer of energy, will be able to sell their surplus energy using a global internet network (Rifkin, 2012).

According to studies commissioned by the EU, around 40% of primary energy is currently used in the municipal and housing sector; therefore, increasing the efficiency of this sector is a key priority for EU member states. The declared goal of these activities is the EU 20/20/2020 targets: by 2020, the reduction of greenhouse gases by 20%, the increase in energy efficiency by 20%, and the achievement of a 20% share of renewable energy in the energy balance (Sowa et al., 2017). It is clear that the first two parameters are strictly dependent on the use of renewable energy sources. Despite protests from opponents regarding production instability, high costs including additional ecological ones, and impact on the consumption of fossil fuels, at the beginning of the 21st century investments in renewable energy sources increased exponentially. This resulted, among other factors, from subsidies introduced by many countries for development and application. Research conducted in 2017 indicated that the gravitational energy of water constituted 65.4%, wind energy 18.1%, solar energy 7.1%, and biofuels approx. 6.0%¹. These results may be surprising, as we would expect a larger share of energy production from wind farms in the overall balance, because this sector entered the suburban landscape expansively, often in landscapes of outstanding beauty, becoming its unambiguous aesthetic determinant.

The topic becomes even more controversial when considering the issue of aesthetic

1.- BP Statistical World Energy Review. June 2018. British Petroleum. [Access: 2018-06-14].

sensations in the field of solar energy. Today, solar collectors² and photovoltaic panels³ are almost omnipresent on the roofs of buildings and became a fixture of city and village landscapes.

Some projects for the use of renewable energy have provoked contemporary society to discuss not only economic and formal-legal issues, but also the aesthetic context of the proposed solutions. It is worth noting that the financial support from EU countries, the policy promoting pro-ecological solutions, primarily concerns facilities that already exist. As a result, we more often encounter an existing location “forcibly dressed” in pro-ecological solutions than a new building that meets the NZEB directives (Nearly Zero Energy Building). Historic buildings constitute an exception, because legal protections mean that the introduction of energy-saving solutions can be very difficult. Nevertheless, also in this area, modern technologies are developing greatly and provide broad perspectives.

Computer techniques

Architectural design as a discipline is very quickly adopting new solutions in the field of computer aided design (CAD). The reason for this is its interdisciplinary character and the necessity of multithreaded inference. Over several decades, computer techniques have changed the architect’s work environment. From supporting the process of preparing project documentation drawings in the 1980s through realistic visualizations (so-called renderings), currently the digital environment supports the designer’s work in the field of project analysis, modeling, visualization, teamwork coordination, simulation of technical and utility phenomena, and in activities related to the prototyping, implementation and operation of buildings. Nowadays, a flexible environment of digital techniques makes it possible to assess the consequences of decisions taken on an ongoing basis (Styk, 2012). Observing the rapid changes in architecture resulting from technological possibilities, theoreticians introduced the concept of “information architecture” (Schmitt, 1999). This term means not only the actions in the digital workshop, but also the noticeable impact of technology on the creation of architectural objects in terms of the function, form and construction of objects. Information technologies are not limited to the area of design. The building information modeling (BIM) environment is a philosophy of using digital techniques throughout the entire life cycle of an object: from the analysis, through design, to its implementation, use and end of its life, which is its controlled demolition. Digital techniques have also enacted a revolution in the fields of planning, urban planning and protection of cultural heritage,.

The term “model” is today an inseparable concept in analyzing and searching for the expected solutions; reducing reality to a form that facilitates understanding the problem,

2.- Solar collectors – used to heat utility water – solar thermal energy is transferred to utility water as a heating medium.

3.- Photovoltaic modules – used to obtain electricity from solar radiation using the so-called battery.



modeling has become an optimization tool. In the late twentieth century, a computer three-dimensional model of an object or urban layout described the geometric features of the original and, as such, it usually served to create realistic images. Modeling was based on surface geometric modeling or solid modeling using Boolean algebra. In architectural applications, the so-called iconic model was most popular.

In architectural design – the process of formulating and transferring the design idea – all types of models are used. Starting from the aforementioned iconic model, which reproduces the similarity of appearance, through the analog model, which reflects the similarity of activities, to the symbolic model that describes the principles governing the original, the model becomes a message, i.e. a system of data transferring specific information (Wrona, Miller and Kłós, 1996). It should also be noted that every modeling, as long as it imitates reality, is a simulation: “Model represent reality, simulation imitates it” (Ackoff and Sasieni, 1968). In CAD techniques, model manipulation is, in practice, the use of procedures describing the relations between decision variables. Today this is further reflected in the technique referred to as parametric modeling, consisting in creating a form based on mathematical functions and procedures containing parameterized variables. Thanks to the parameters in procedural models it has become possible not only to create previously unachievable architectural forms, but, above all, to find solutions that meet specific criteria in a collection of possible solutions. These parametric modeling features can be used, for example, in the area of cultural heritage protection: in conservation, revitalization and architectural reconstructions (Kowal et al., 2017).

Parametric simulation of optimal solutions. Their application in shaping the spatial form on an architectural scale

The information society presents designers with the task of making pro-ecological solutions an integral part of an architectural object or urban layout, while not negatively affecting the landscape. Among many pro-ecological solutions, aspects that can noticeably affect their form relate to technologies for collecting wind and sun energy. There is also a difference in the semantic field of concepts: energy acquisition and energy efficiency.

The essence of this difference is explained by the case of a skyscraper in the City of London, designed by Norman Foster: 30 St Mary Axe, known as the Gherkin. This building illustrates the relationship between such concepts as economic calculus, aesthetics and the simulation of optimal solutions. This building is recognized as ecological and is the winner of many awards, but was not created with the thought of ecological energy production; yet this is almost always included in discussions about it. The essence of the problem anticipated in the design phase was the negative impact of wind. It was estimated that a city center building with such a high cubic capacity and height (180 m, 40 floors) would cause a strong air stream (draft) at the base of the building. The designers were afraid that the wind force could cause

people and bicycles to fall over, resulting in health and financial compensation claims. The building was designed using parametric techniques, simulating the influence of wind and its impact on the form and structure. The construction system was optimized and the building's spiral form controls the air flows around it. Thanks to the use of two coatings on the facade of the building, wind energy is used as a factor supporting natural gravitational ventilation. In this way, the insulating efficiency of the building has been improved, protecting it against heating in summer and reducing heat loss in winter. The building is an illustration of a creative and unique approach to ecological issues and economic balance: the wind does not produce energy, but its potentially negative impact has been transformed into a tool to reduce the operating costs of the facility. The relationship between wind farms and the Gherkin building is apparent: although the office building does not produce energy, it works like a turbine and the phenomenon of turbulence is used to support ventilation, insulation, and the overall balance of operating costs and social costs.

Meanwhile, the scope of the means of expression available to designers is illustrated by objects designed from scratch to take into account solar energy. The list of recognizable buildings in this category includes the Further Education Center at Mont-Cernis (Herne, Germany): the exterior facade is a "climatic" coating and consists of glazing and solar modules. This well-thought-out arrangement allows for controlling the flow of light to the interior of the facility, without having to change its layout and additional technical interventions. Inside the building, conditions were obtained comparable to the climate of the Mediterranean region⁴. In turn, the Blue House building at the University of Niederrhein uses a facade that looks as if it is covered with blue glass, but is actually solar panels in this color that rotate toward the sun thanks to the use of intelligent control elements⁵.

Positive examples in Poland include a small office building at Romera Street in Warsaw, which is an illustration of the conscious cooperation of the investor and designers. The building is a showcase of the potential for conscious uses of photovoltaic installations combining both practical and aesthetic benefits. The light design of the roof over the path to the garage does not conceal, and even exposes, the pattern of the modules, whose seemingly superior function is to protect against rain or snow. In addition, the south-east facade, exposed to strong, glaring light, exposes photovoltaic modules instead of the pattern of typical horizontal or vertical window blinds, taking the character of a graphite cuboid – a positive neutral background for the surrounding, attractive park greenery (Figure 1).

4.- Project: HHS Planer + Architekten AG, <https://www.hhs.ag> [Access: 012.11.2018]

5.- Project: Kadawittfeldarchitektur, <http://www.kadawittfeldarchitektur.de> [Access: 02.11.2018]





Figure 1. The roof of the entry ramp uses aesthetic photovoltaic modules in transparent glass-glass technology and also fulfills aesthetic expectations. The south-eastern elevation supports the energy balance of the building in an architecturally considered way. [Photo taken by S. Kowal, 2018.]

In San Francisco (USA), new regulations were passed in 2017 requiring investors to apply solutions that use energy from photovoltaic modules or solar collectors to all newly designed residential and commercial buildings up to ten floors high. This forced architects to change the way of thinking about solar energy.

Similarly, implementation of environmental policy promoting energy-saving solutions in public buildings has begun in Poland at the state level and voivodships or communes. A good example of this is the new headquarters of the Voivodship Fund for Environmental Protection and Water Management in Gdańsk, where pro-ecological solutions have been successfully applied that focus on the reduction of non-renewable energy demand and on rational water management with the use of photovoltaic modules. This minimizes the negative impact of the building on the natural environment and supports the energy balance, achieving architecturally interesting expression at the same time (Figure 2).



Figure 2. The southern wall and roof of the Voivodship Fund for Environmental Protection and Water Management in Gdańsk has been covered with photovoltaic panels. [Photo taken by J. Zdunek-Wielgońska, 2018.]

Renewable energy from the sun and its spatial forms in the suburban landscape

Individual solutions – single-family housing

EU regulations that obligate Poland to optimize energy and implement solutions of this type on a wider scale have resulted primarily in an increasing social awareness in the scope of possibilities and benefits. However, the most effective way to inspire owners to use alternative energy sources is financial incentives, and the most-often used is co-financing to modernize heating systems. In the face of the growing problem of smog in suburban zones, often filled with technologically older single-family buildings heated with coal, opening up to energy from alternative energy sources seems to be a priority. In addition, the expected increases in energy charges will become an additional motivator for change.



Figure 3. Solar and photovoltaic installation on the roof and property of single-family houses in the commune near Warsaw. [Photo taken by J. Zdunek-Wielgołaska, 2018.]

The increasing awareness and widespread use of solutions for obtaining energy from the sun is demonstrated by suburban housing developments, whose roofs are increasingly used for solar panels or photovoltaics. Both technologies are often confused by the uninitiated viewer due to the similarity of form and presence. In both cases, these are usually rectangular panels, placed on roofs facing south-west, at an angle close to 35°. It should be noted that promotion of these solutions using EU and government subsidies takes minimum consideration of aesthetics. As a result, financially supported solutions give the impression of being added to the object, without any care for landscape values (Figure 3).

As a result, aesthetic expectations are growing in the context of shaping and protecting the cultural and historic suburbs landscape in the light of the latest technologies and the need to implement energy-saving solutions. Huge intellectual and creative potential is behind the issue of using solar energy and translating it into aesthetic spatial forms. The market is slowly beginning to respond to this demand. One such proposal is photovoltaic roof tiles, combining the functions of solar panels and roofing. This is evidently a response to the growing aesthetic requirements of the market for these energy solutions. There is a clearly increasing social awareness in this area and a dynamically growing market for energy-efficient single-family housing. Although these are, for the time being, more expensive solutions, in

the future their development and installation costs should become more market friendly due to the increasing number of companies in this area. Photovoltaic roof tiles can also be used on monuments and can preserve the historic value and architectural expression close to the original appearance (thanks to the computer techniques and simulations it will soon be possible to achieve the desired aesthetic effect, both in terms of form and color).

The simplest and the more affordable solution are photovoltaic modules, which do not require any additional load-bearing structures and can be mounted directly on the roof structure. This solution is the most common application for small architecture structures such as arbors or sheds, the geometrically simple form of which is a great excuse to apply such a solution.

Production scale - solar farms

The production of electricity from the sun on an industrial scale enforces the location of such facilities in open suburban and agricultural areas. A typical solar module currently produces approximately 265 W. It is assumed that the efficiency of cells is about 20% (2017). This means that in the Polish conditions an area of about 2 hectares is required to produce 1 MW. Of course, actual performance depends on many factors, ranging from the rotation of the globe and the seasons. For example, in the area of Szczecin, a farm consisting of 3600 modules with a total capacity of about 1 MW occupies an area of less than 1.5 ha. A farm of this size can meet the needs of around 285 families. The development of prosumer energy, i.e. energy for users who become producers at the same time, means that commune local-governments and administrators of public places seek larger-scale photovoltaic technologies.

In the rural landscape, a colorful checkerboard of farmland will assimilate few hectares of blue solar farm easier than a picturesque village whose southern roofs would be decorated with the pattern of rectangular cells, regardless of the architecture of the region, the material of the walls, roofing and their colors. In addition, the roof panel of a medium-sized building will rarely accommodate 15 cells. Observation shows that the roof surface of terraced or semi-detached houses will accommodate a maximum of ten modules, or even fewer if there are roof windows.

The economic calculation and the possibility of making decisions on the scale of a commune or a poviát constitute the logical justification for the implementation of solar farms. The use of even a few hectares of wasteland or degraded areas also seems to be more justified from the perspective of aesthetics and social interest. For example, the first solar farm in Poland is located at a former landfill site in the Ustronie Morskie commune (Zachodniopomorskie voivodeship).

Solar farms are also a solution for historical objects or even those that are in the charge of the conservation of monuments. Architectural values “require” conservators to defend these objects from decorations and foreign forms. Finding a small plot of land nearby to locate even several dozen photovoltaic cells seems to be a more reasonable solution, as long as they will not destroy the landscape values of the area. It seems, therefore, justified or even necessary to conduct proper “energy” communes, in particular, that the local-government’s own tasks include the protection and care of monuments. The relevant regulations included in the study of land use conditions and directions of the commune, and then the introduction of cultural property protection arrangements in the local spatial development plan, seem to be appropriate tools for conducting effective policies that reconcile different interests. For example, the landscape study can indicate areas that should be preserved and determine the methods of permissible interference.

Elements accompanying the technical infrastructure

Considerations on solar farms in the context of protected landscape lead to the reflection on the unused potential of infrastructure related to road traffic. Slopes, acoustic insulation panels, all surface-absorbent parking lots, gas stations and travelers’ rest areas accompanying roads constitute great potential for „energetic” use. Lightweight car parking and gas station canopies can be covered with semitransparent modules (glass-in-glass) to create not only protection from the sun or rain but also energy sources. The same applies to the slopes on highways and expressways. On the sections exposed to the south, their angle of inclination favors the installation of photovoltaic cells, especially as these areas are naturally protected against pedestrians. Similarly, the acoustic panels on kilometers of roads and viaducts can be used as a substructure of solar farms.

Augmented reality in spatial planning

Computer tools that are available today to support the designer’s workshop make it not only possible to simulate in a digital environment the profitability of investments in a given area, but also to analyze each case separately. This is possible thanks to the use of Geographic Information Systems (GIS)⁶, which can model the terrain and objects in the three-dimensional, virtual space of the computer, but also, and perhaps most importantly, collect and process all geographical data. GIS software supports decision-making processes in geodesy and urban planning and, as such, is successfully used in simulations related to the localization of solar farms. GIS systems also allows for storing data on cultural and landscape values. The three-dimensional form of models processed in the digital environment of these systems also enables the creation of photorealistic visualizations, and thus the assessment of aesthetic values of proposed solutions, in particular in the context of protected objects and

6.- Geographic Information System. Information system to collect, process and visualize geographic data supporting decision-making processes in geodesy and urban planning, among other areas.



areas. On this occasion, it is worth highlighting the potential of places whose infrastructural character results from their essence.

The three-dimensional nature of the models processed in the digital GIS environment allows not only the selection of a suitable location for among others solar farms, but also the creation of photorealistic visualizations, and thus, the evaluation of aesthetics of the proposed interference with the suburban landscape. For today's society, a realistic picture or even an animation of the reality of the virtual world are not a surprise. This type of media message, however, does not have the character of an interactive message, which for many modern audiences nowadays seems to be insufficient.

The leading creators of web browsers (Chrome, Firefox, Explorer, Opera) have agreed a standard specification of a universal user interface that allows for interactive observation of the 3D model directly in the browser's window. The main goal of OpenGL is hardware acceleration of graphics, allowing the computer user to interactively observe the model as in computer games, but without the need to have specialized software. Thanks to the above, we can now admire three-dimensional objects directly on websites, freely turn them or even "walk" around a virtual object. The use of OpenGL technology is not very complicated. The digital spatial model, created in almost any CAD system, is transferred to the internet browser using a selected format for recording three-dimensional geometry (e.g., OBJ, 3DS, COLLADA) and is controlled in its environment by Javascript. In this way, cameras, lighting, the textures of materials, etc. is programmatically managed and above all, user's control of the interactive possibilities of controlling the model. In advanced implementations, we can find examples of the use of gravity, the position of the sun and other factors reproducing reality. All components are controlled programmatically, allowing for parameterization of simulation activities. As a result, without specialized software or with the use of open source software, websites are created that become, de facto, a research environment available to the average internet user⁷. Free software, which can be copied, distributed and improved by users, enables the widespread use of parametric technologies in architectural design. Almost every advanced CAD system is equipped with programming tools that allow for the development of supporting tools. In this way, users of programs develop its capabilities by creating so-called plug-ins and thus dozens of programs expanding the capabilities of the base CAD system are created.

The most spectacular examples include the rapidly growing popularity of the Grasshopper plugin⁸ developed for cooperation with the Rhinoceros system. It is in fact a visual programming language whose user interface is so friendly that even those without specialized programming education can create advanced algorithms. As a result, it has become a tool for creating both generative and structural engineering. Grasshopper for Rhinoceros is so popular

7.- OpenGL examples: <https://threejs.org/examples/> [Access 02.11.2018]

8.- Website: <https://www.grasshopper3d.com/> [Access 02.11.2018]



Figure 4. Two buildings with the same floor plan. A typical suburban single-family house (picture on the left). A building optimized in terms of relation with lights and the influence of the sun as an alternative to a typical detached suburban housing development (picture on the right). [Jolanta Szczepanik, „Sustainable development and environment in the context of suburban development”, MA thesis, Faculty of Architecture, Warsaw University of Technology].

that it has become a tool in the didactic process of many universities, including architectural faculties. Thanks to the effort of users so many useful tools are created in Grasshopper, both analytical tools and those related to the creation of modern spatial forms.

Students and other young adepts of architectural design are increasingly able to write algorithms and to implement them in practice into Grasshopper or related environments. As a consequence, it is not only the line of the sun and shading analysis that are analyzed using parametric techniques (Twarowski, 1970). The number of diploma theses is increasing in which this is illustrated with a project developed using programming tools. A good example is the work by J. Szczepanik entitled „The evolution of performative architecture; Sustainable development and environment in the context of suburban development”, which was developed as part of the 2nd degree studies ASK (Architecture For Society of Knowledge) at the Faculty of Architecture, Warsaw University of Technology. Following the considerations of perforation design (Kolarevic and Malkawi, 2005) focused on the broadly understood environmental imperative and complex relations of ecology, culture, technology and architecture, the author conducts a simulation of environmental conditions in the suburban area. As a result of the use of programming tools, catalog house design in the suburban area transforms its form into a system optimized in terms of relationships with light and the influence of the sun (Figure 4).

Another widely discussed issue in modern architecture is the use of modern materials and technological solutions based on biomimetics – a relatively young but rapidly developing scientific discipline. The methods related to the use of new materials and structures in the context of sustainable development and renewable energies refer to the interdisciplinary dialog of scientists, representing a number of disciplines with engineers, in search of “bioinspiration” (Knippers, Speck and Nickel, 2016). Particularly in material engineering, the organic world constitutes the field of observation and research of solutions that meet specific requirements related not only to mechanical strength and thermal insulation, hydro-

protection and frost resistance, but also such properties as: self-cleaning, grip, adhesion and color. The classification of biomaterial properties in the context of their applications in the building industry and architecture include superhydrophobicity and self-cleaning, the ability to lose or accumulate water, mechanical properties, optical properties, and frost resistance. Combining immanent features for the organic world in building industry solutions (paints, coatings, fibers, ceramics, concrete and insulation) creates new, universal and efficient materials suitable for recycling (Pereira, Monteiro and Prazeres, 2015). Organisms synthesize materials in processes that are fundamentally different from the industrial production of synthetic materials. Studies of these processes allow for obtaining materials in laboratory conditions (e.g. composites) with unusual properties and it is only a matter of time before firms find ways of producing them on an industrial scale.

In the last decade, the development of technologies resulting from the transfer of properties of living organisms to the environments associated with architectural design has rapidly expanded and had a significant impact on energy efficiency and optimization of solutions in construction. Innovative solutions, based on understanding specific features found in nature, contribute to solving many problems with the environment related to human interference. This is particularly important, apart from large agglomerations, in suburban areas and protected landscape, where “organic” is one of the most desirable features of such an environment. In this case, parametric modeling also creates a whole range of possibilities. Isolated, in the process of detailed analysis, the characteristics of the living organism, plant or natural phenomenon can be logically ordered according to the adopted key and in the process of inference, written to the form of an algorithm, saved not only as a sequence of clearly defined actions or steps that are to be taken, but even as a “recipe” to be implemented in various programming languages, including the aforementioned Visual Grasshopper language. The process described above is nothing but a characteristic of the stages of the design process: analysis, synthesis, evaluation. The stage of synthesis, i.e. the transformation, acceptance of optimality criteria, and searching for solutions to the problem, is saved into the parameters of functions and procedures of the model being processed, while the evaluation phase is the convergence stage, examining the consequences of the adopted solution (Gasparski, 1988). Thanks to the parameters this research has a simulation character, and thanks to the digital technique used it is even interactive, which creates special opportunities in the process of creating the final form of the project.

Augmented Reality technology

The technology called augmented reality (AR) creates even greater possibilities. It combines elements of the real world with the virtual world. The user’s tool for this reality can be a smartphone or a tablet. This technology uses an image from the camera of such a device and imposes on it in real time an image coming from the virtual world. In this way, the real

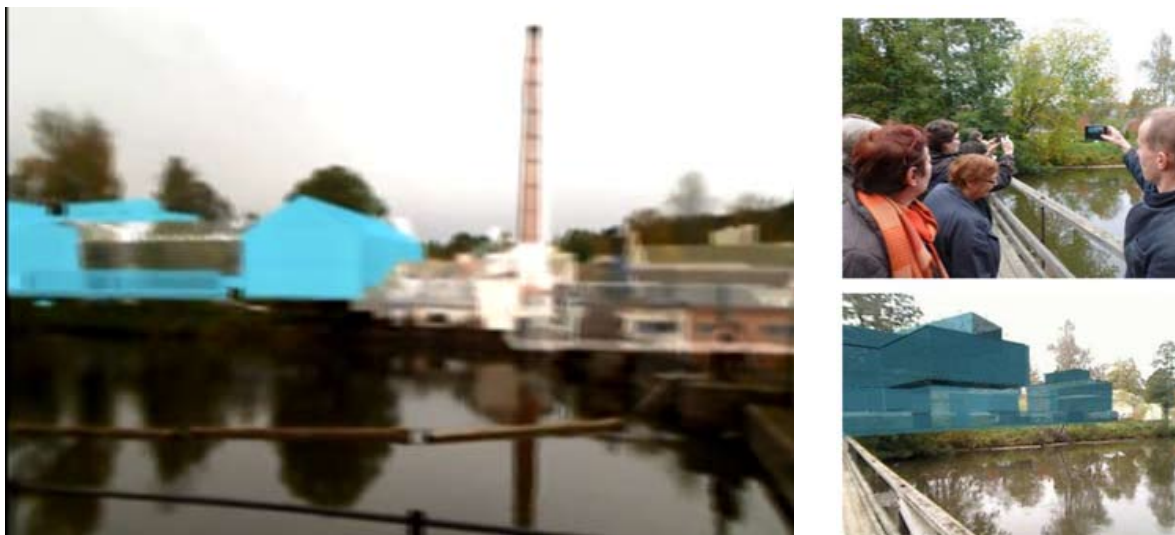


Figure 5. Mobile Augmented Reality visualization of architectural plans. Building of a new hotel complex is being planned at Raseborg town in Finland. Municipal decision makers go on a walking tour at the site and view the 3D plans using N900 mobile phones. [source: <https://www.youtube.com/watch?v=wvSPzG7AqLY>, and: http://virtual.vtt.fi/virtual/proj2/multimedia_old/publications/ECPPM2012_User%20Evaluation%20of%20Mobile%20AR%20in%20Architectural%20Planning-final.pdf]

image captured by the camera is extended with additional information, according to the intention of the creators of the tool. The wide range of applications is limited practically by the imagination of software developers, and the features of augmented reality that distinguishes them is combining real and virtual images, the possibility of real-time interaction and the freedom of movement in three dimensions. AR is currently used in aviation, medicine, motorization, tourism and marketing. Increasingly, it also finds practical application in designing, not only as a tool to strengthen the process, but also as a support for decision-making at the level of local-government actions (spatial planning and urban management) and social participation, including discussions with the local community. Such an attractive technology also increases the involvement of the youngest in society and can be effectively used for their participation in the decision-making process: a smartphone (meaning a GPS locator and camera) is enough to evaluate new proposals for shaping space in the suburban landscape.

The planning activities undertaken in Raseborg, Finland are a good example of the use of AR technology for public consultations and making binding location decisions on culturally protected areas. A large implementation project in the development of legal regulations (the equivalent of the Polish Local Spatial Development Plan) consisted in using the technological possibilities offered by the Technical Research Center of Finland (VTT), in cooperation between Arkval Arkkitehdit OY architectural office and Raseborg authorities, with local community participation. Area of 4.5 ha on the list of National Monuments of History was to be filled with 50 new objects. Participants of the process, who also comprised of residents,

highly rated the use of AR technology as an instrument supporting dialog and facilitating the understanding of plans and projects (Olsson et al., 2012) (Figure 5).

Summary

Computer techniques in assessing the impact on landscape have and may have a wide range of applications. At the meeting point of new technologies that involve them in the essential scope to create a modern reality, they will likely also serve to protect the value of what surrounds us. In the era of globalization and unification, and also in the field of architecture, we lose, often irretrievably, the elements that testify to the identity and values of places. The suburbs of large cities are becoming such an involuntary sacrifice of these dynamic processes of appropriation of space. From this point of view, it seems appropriate to look for technological and aesthetic solutions that will preserve them. The use of computer techniques in various areas of creation, refining and predicting the future of where and how we live, may be a huge support in this area. However, it should be remembered that the program itself will not do all the work of a human being, especially in relation to the determination of cultural and historic values, which in nature are very diverse and require a multi-critical approach. Therefore the human factor should always be part of this process and its reference. The aim should be to raise public awareness in this area by building models of open cities and engaging residents in their affairs with the use of new technologies so that the cultural landscape and natural suburbs can be protected more effectively and more consciously.

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