Structural Sustainability - Heuristic Approach

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Abstract. Nowadays, we are faced with a challenge of having to join building structures with elements of nature, which seems to be the paradigm of modern planning and design. The questions arise, however, with reference to the following categories: the leading idea, the relation between elements of nature and buildings, the features of a structure combining such elements and, finally, our perception of this structure. If we consider both the overwhelming globalization and our attempts to preserve local values, the only reasonable solution is to develop naturalistic greenery. It can add its uniqueness to any building and to any developed area. Our holistic model, presented in this paper, contains the above mentioned categories within the scope of naturalism. The model is divided into principles, actions related, and possible effects to be obtained. It provides a useful tool for determining the ways and priorities of our design. Although it is not possible to consider all possible actions and solutions in order to support sustainability in any particular design, we can choose, however, a proper mode for our design according to the local conditions by turning to the heuristic method, which helps to choose priorities and targets. Our approach is an attempt to follow the ways of nature as in the natural environment it is optimal solutions that appear and survive, idealism being the domain of mankind only. We try to describe various natural processes in a manner comprehensible to us, which is always a generalization. Such definitions, however, called artificial by naturalists, are presented as art or the current state of knowledge by artists and engineers. Reality, in fact, is always more complicated than its definitions. The heuristic method demonstrates the way how to optimize our design. It requires that all possible information about the local environment should be gathered, as the more is known, the fewer mistakes are made. Following the unquestionable principles, we can choose the related actions. As there is no need and, probably, no possibility to implement all of them in a particular case, we must find our own way. The holistic model shows the effects of our actions and thus enabling us to compare them with our own targets. Following the method will help us to make conscious decisions, but not to implement all possible tasks in our program. In nature, every species has its own capabilities to adjust and creates its habitat accordingly, disregarding the universal idea of taking all possible benefits offered by nature. In order to follow the principles of sustainability we have to act similarly. When designing we should rather try to approach perfection than create ideal solutions, because what is perceived as ideal at the present state of knowledge, will always be imperfect. The paper describes three case studies of the heuristic approach in landscape design. They are all located in Silesia, Poland. The first is GPP Business Park in Katowice, whose building and its surrounding with the greenery designed according to the discussed method received the Outstanding BREEAM Certification. The second is the recreation area of Rybczówka near Strzelce Opolskie, whose redeveloping design won the highest rating in a government competition for the ecological fund investments. The third is Row Rudzki - an ecological area in the center of an industrial city.
1. Introduction

Architecture should be treated jointly with a landscape, as this medium of design has an astonishing feature, with every object inserted having the capacity to change it. Thus, accents visible from a distance will affect our perception. The question arises if the principle will apply also in the opposite direction, namely, if it is possible to adjust a landscape so that the quality of the building could be changed. If all the elements of the available space and the relations between them are treated like one structure, this should reveal a possibility of a dialog between designers and their medium of creativity. Humans, being part of nature, tend to perceive it in their own way, which could manifest an everlasting challenge of how to reconcile nature with our lifestyle. It is possible to design the holistic model of the naturalistic approach to creating a landscape in order to protect or even enrich the natural environment [1]. This model describes the cultural context of nature and emphasizes the use of native plants, as well as the natural processes and patterns formed by nature. Thus, it serves as a special way to support the uniqueness of a designed object by letting the landscape shape the form of the building. However, this model does not have to be applied in every case equally effectively because there might be also other conditions and targets to be achieved. The environment itself is a sufficiently complicated structure which, combined with the cultural demands, will become a highly unpredictable medium. Fortunately, the holistic model will provide designers with the possible effects of the undertaken actions. As mentioned above, not all targets could be realized in a particular case, so designers should make a conscious choice of the most relevant ones and the appropriate way of their implementation.

2. Material and methods

The holistic model is the result of detailed studies in various fields: first, the historical evolution of views on the place of the human being in the environment; second, the international law principles defining the desirable relations between the human being and the environment supporting sustainability; third, defining the functional model to describe the proper environmental conditions both sustained and human friendly; fourth, nature aesthetics; and last, environment perception and caring for its spatial legibility, attractiveness and provision of information. The holistic model could be used as a matrix for the heuristic method. The term "heuristic" was introduced by Herbert A. Simon and Allen Newell [2] and developed later by J. Clifford Shaw [3]. They claim that problem solving is an intuitive, speculative procedure where the hypothesis should be formulated first, before the procedure algorithm. In reference to a landscape, the algorithm must analyse an enormous amount of data, so the procedure is slow and unable to consider all the relevant information. It is also difficult to assess the information properly, which affects the outcome critically. On the other hand, in the heuristic method research is conducted highly selectively because its relevance is decided according to the hypothesis, which is crucial when obtaining the results. We should be fully aware of all the elements of the holistic model, but we must decide which track to choose for our design, so as not to try to implement all the possible ones. It is best described in a slogan of Local Agenda 21 - "Think globally - act locally". We must guess, make potentially correct hypotheses and reject all irrelevant data. As the hypothesis should not be formulated blindly, the holistic model can provide help by limiting potential mistakes, although not absolutely. The alternative is obvious: losing a lot of time when conducting research of no effect or taking a risk and choosing the way which seems to be the best, however not always successfully as neither the model nor our way of thinking are ideal. Nature seems to reach compromise by creating optimal solutions, not ideal ones. The same applies to the heuristic method with, on the one hand, the local conditions and natural processes of greenery spontaneous growth, and, on the other hand, with people's expectations concerning space – its usefulness, clarity, maintenance and safety. However, the effects of these two attitudes lead to entropy. The natural way with limited human touch ends up with wilderness perceived as a neglected and abandoned area. A thickly built-up place demands expensive maintaining. The funds are always inadequate and, as a result, the area will soon begin to look neglected. Sustainability brings us to that vague boundary between the natural and artificial solutions, where placing our design is very tricky.
The holistic model provides principles, related actions and their implied effects. The heuristic method, based on its principles, shows the designer the appropriate actions and demands to choose the most adequate of them. By assessing the potential effects, we can change the way of the project implementation and undertake other actions. It is better, however, to conduct this analysis when working on the project before the final construction. The actions and effects are described in two forms: positive and negative ones. The project can be approached either in a purely utilitarian way or in a thought-provoking manner, which will, undoubtedly, be more expensive for the investor.

Here are some examples of the use of the table presented above. First, if the design is to prove the correctness of the idea of sustainable development, it could be accomplished by an experimental open space laboratory for invasive plants treatment, which may support the legal aspects of open space maintaining regulations. Second, if one wants to support the idea that all human actions do harm to nature, some post-industrial contaminated plots could be left as the evidence of such destruction.

### Table 1. Holistic model

| a) Principles                  | Actions                          | Effects                                                                 |
|--------------------------------|----------------------------------|-------------------------------------------------------------------------|
| 1. Naturalism as an idea       | searching for harmony between nature and culture | influence on legal regulations                                          |
|                                | promoting the living world       | formal creation manifestations treated as expression of artificiality and stagnation |
|                                | imitating natural laws           | building structures based on nature and accepting it                    |
|                                | searching for justification in nature of human actions as a negative idea | treating human actions as nature manifestation leading to robbing nature of its resources |
| 2. Naturalism manifestations in culture | juxtaposing nature with culture | greenery closer to natural, not clearly bound to buildings              |
|                                | creating structures combining nature and culture | structures binding greenery formally to buildings, tamed nature          |
|                                | creating naturalistic built-up area | buildings as an organic consequence of natural forms, buildings placed in natural greenery |
|                                | creating structures referring to natural ones | minimizing energy needed for construction and maintaining              |
|                                | creating structures              | developing optimal conditions for functioning based on self-regulation |
|                                | referred to natural ones         | development of nature protection active methods                        |
|                                | referring to natural plant communities | promoting native flora                                                 |
|                                | referring to natural plant communities | using wastelands for reconstructing local natural values                |
|                                | referring to natural plant communities | referring to natural plant communities stressing the local uniqueness and identity |
|                                | referring to natural plant communities | using the predictable psychosomatic influence of natural communities |
|                                | sustainable development          | synergy of building elements and greenery                              |
|                                | sustaining natural processes     | easing conflicts                                                        |
|                                | hierarchy and diversity          | sustaining natural processes                                           |
|                                | development of legal regulations | development of legal regulations                                        |
|                                | education in distinguishing and appreciating natural communities | education in distinguishing and appreciating natural communities |
b) Principles | Actions | Effects
--- | --- | ---
3. Naturalistic structure | building harmony of hierarchic wholeness | structure with a diverse force of accents at various levels of scale
 | optimal size | functionality
 | free composition | problem of spatial coordination, naturalness impression
 | spatial relations based on the golden ratio and fractal structures | using space optimally, adjusting to human perception
 | added geometrical elements | stressing important places, artistic content message
 | using material and intuitive elements | message affecting various senses, narration
 | securing the organic character of relations | harmony with habitat conditions, changeability in time, transience, complexity, free arrangement, border fluidity, form dynamism, subtle accents

4. Perception of naturalistic structures | the field of observation is formed by a streak of looks, with the scene determined by the accent, and not by the frame | composition built with spatial objects, their context and background
 | minimal visual tensions | lack of uncomfortable sense involvement, dissimilarity from everyday effort habitat, sense of freedom
 | vague, implicit and complex forms | affecting all senses, causing and controlling reactions
 | using meanings associated with archetypes or symbols | narration with references to native nature
 | following the hierarchy of human needs | optimal functionality

Third, if the aim is to demonstrate that the existence of natural and artificial structures is the consequence of the co-existence of the human being and nature, it could be realized in the form of geometrical sewage tanks where the process of purifying water and producing bio-gas helps to maintain colonies of bacteria and chosen littoral plants. Fourth, if we want to show the organic character of those relations, our design could comprise the natural succession of native plants. Fifth, if the design is to analyse our perception, paradoxically, minimal visual tensions could be provided by a varied naturalistic meadow composed of many xeric species. Such a "xeriscaping" garden reveals colourful aspects periodically, however most of the time it remains in the state of green mass with accents hard to define. A similar effect could be obtained by means of a naturalistic wood with a mixture of native trees and shrubs, although with too many accents, or too weak to be distinguished by an observer. These examples present only chosen single-aimed tracks, however, the heuristic approach puts forward a hypothesis that it is possible to create an efficient ecological structure with a few parallel actions and effects of anticipated values (Figure 1). During the designing process, certain solutions could be adopted and their common relations examined, namely, which effects will be most visible, which ones should be supported or diminished. The final structure could be always reached by several parallel tracks. Some of them could be noticed only after establishing the full conception, at the moment for the possible revision of targets. We present below a few selected projects using the heuristic method with the indication of the characteristic assumptions according to the holistic model.
3. GPP Business Park in Katowice - a case study
Implementation of sustainable development very often manifests itself in combining the energy-saving technologies and nature protection with support for the local biodiversity [4]. In the case of GPP Business Park in Katowice, the investment plan of the year 2011 aimed to achieve the BREEAM Certification of Outstanding level, which succeeded. The requirements for greeneries were to enrich the local biodiversity, prove the rise of native species quantity and show evidence of plant habitats similar to the natural ones. The assessment referred to the maintaining of the local plant communities and their evolutionary changes. Most of them represented special forms typical of calamine heaps. Some areas had also other habitats characteristic of grasslands and forest edges. The easiest solution would have been to cover the area with a common soil cover for ornamental plants to grow there. That scenario did not meet the certification requirements, so a decision was taken to leave some evidence of the smeltery on the border of the area in the form of a spoil heap scrap covered with spontaneous vegetation. However, such plants may pose a risk for health by gathering heavy metals. For this reason, a special design surrounding the office building was created, consisting of meadow plants typical of the local region and found in the neighbourhood. Both the building and the open space have a modern appearance designed by the GroupArch office. Leaving the casual grassland was not appropriate for the representative goals of the investors, though. In order to combine the native species with the geometry of architecture, there were designed patterns of herbs and grasses separated with lawn patches, which creates the impression of good maintenance (Figure 2). Besides, some native species of trees were used, with their ornamental forms with narrow tree crown, in the building proximity. The design assumed the possibility for natural succession on the herb spots. The realized greenery concept met the BREEAM requirements. Owing to the heuristic approach, the designing process considered the use of natural plant communities in order to stress the local identity. The geometric patterns did not have a negative influence on the local species composition or their capacity to succession. The office building, of a common form, gained a unique character, whereas the area became attached to the local history and bound to the local environment. Also, other sustainable values were met and not by chance.
Figure 2. The perennial spots made of native plants in GPP Business Park, Katowice

Figure 3. Geometry penetrated by perennial plantations in Rybachowka, Strzelce Opolskie
4. Rybaczowka - recreation area in Strzelce Opolskie - a case study

Rybaczowka, an area for fishing, jogging, and strolling, has two ponds, a beach, tennis courts and a limited area of meadow and wood being remnant of an oak-hornbeam plant community. The most important targets for the project were indicated according to the heuristic method: first, to increase the number of native plants; second, to enlarge the area covered by perennials and shrubs; third, to make the greenery cooperate with the local ecological system. The terrain relief was slightly modified. A high dike made of sand retrieved from the bottom of the ponds had to be transformed because the equally-grainy sand prevented the stabilization of its slopes. Thus, the design involved the creation of low mounds covered with xeric plants on the top and the south side, and perennials characteristic of wood border on the north side. The latter ones were also used to create cover in the shade under the old oaks. The concept designed in the Domel Office in 2015 introduced a geometrical road system. Some free line forms, however, were created by the perennial plantations (Figure 3). Trees were planted in geometrical patterns and curves. It could be said that the geometry of the city park was penetrated by a free plant composition adjusted to the local habitats. The overall idea was to introduce new elements capable of a natural succession and to combine them with the existing waterside habitats in order to create a stable ecosystem, despite the visible geometry of the architectural forms. Also, some foreign ornamental plants were added as accents. The complexity of the response to the environment demands met the requirements of a government competition for the ecological national funding.

5. Row Rudzki - ecological area in Ruda Śląska

The area is an enclave of a riparian wood with an oak-hornbeam community on the slopes of a valley. It has also some ponds and stream habitats for plants, fish and amphibians. There is no evidence of a large number of rare species, but in the context of an urbanized industrial city, the area is of an exceptional value (Figure 4). The local authorities formulated the following expectations regarding the area development: first, to support the local biodiversity; second, to protect the existing natural values; third, to build a safe path with educational elements. Consistently, the design solutions made use of the
natural conditions in the path location with benches placed in nature observing points. The path is to gather pedestrian movement and protect the animals nesting around from contacts with people. There is, of course, free access into the wilderness but not really comfortable and discouraging from unnecessary penetrating. The design plans the construction of a new retention pond as well as the creation of native plant spots whose aim is to become dispersion centres of seeds for the future succession (Figure 5). The trees, native species, are planted freely, but are placed so as to make accents supporting a complex landscape structure. It is important to limit or try to destroy all spots of the invasive Asian knotweed (Reynoutria spicata) by means of brush mode chemicals application and frequent mowing. All the greenery should refer to the local nature with as few as possible anthropogenic influences. Also, new native species are put in the undergrowth on the wooded slopes. Thus, the hierarchy and diversity of the semi natural wood should be supported. On some trees, there are placed birthhouses and batboxes, the latter in groups, whereas shelters for owls a long distance from those for little birds. Thus, the design solutions create structures referring to the natural ones by gaining harmony with the habitat conditions. They give the impression of naturalness and adjust to human perception.

![Design supporting biodiversity in Row Rudzki, Ruda Śląska](image)

**Figure 5.** Design supporting biodiversity in Row Rudzki, Ruda Śląska

6. Discussions

The essential issue, from the perspective of culture created in the context of naturalism, is to find its elements in nature aesthetics. An important contribution to the creation of the holistic model was made by the German philosopher Gernot Böhme [5]. Defining the effects of action in this model was possible owing to the works on determining the requirements of a biologically active surface [6], on creating habitats [7]; [8]; [9]; [10]; [11]; and on the practical aspects of remediation and transformation of postindustrial areas [12]. The author made an attempt to combine those issues and demonstrate a method of applying the experience of those specialties which refer to sustainability and culture in its broad meaning, particularly nature aesthetics. The heuristic method describes a decision-making process characteristic of human reasoning, namely being based on the choice of the targets and factors considered as essential, and omitting the less important data. Those mental processes are described by various psychologists, e.g. Herbert A. Simon and Allen Newell [2].
7. Conclusions
The effectiveness of the method seems to be proven by obtaining funds for the implementation of projects designed by means of the heuristic method and by receiving BREEAM certificates (only one of them is mentioned in this paper). Besides favouring nature, the method meets people's expectations. The holistic model attempts to define designing within the context of nature and sustainability, being a frame of reference to its essential elements. By focusing on the most important targets to realize our project effectively, the heuristic method allows us to omit a lot of less important data. The examples show that the heuristic method is successful and does not depend on the local conditions or the level of urbanization. It is applicable to almost natural woods and to artificial, urbanized conditions of office buildings located on contaminated spoil heaps.

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