TRANSITION OF THE PASSIVE FEATURES FORM THE BIG LOW-ENERGY BUILDINGS INTO THE INDIVIDUAL HOUSES DESIGN

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Summary
In order to facilitate the problem of transfer of the passive energy solutions, methods of the complex systems analysis has been presented. Through the utilization of these tools, a better understanding of the systems complexity has been obtained. Multidimensional analysis of the individual house as a system, helps in the design process organization.

Keywords: passive house, complex system, heuristic, problem analysis.

INTRODUCTION

The subject of the passive design has been recently well developed for the benefit of big buildings, high buildings and buildings serving special purposes. Buildings with wide implementation of passive solutions are usually well known for it. This is one reason why investors want to use such solutions, the other, the more important one, is that they are designed to use the energy with the high efficiency. This refers not only to the energy consumption but mainly to its absorption.

In this document the other challenge has been undertaken, the problem of the transfer of the passive solutions from the big buildings to the individual houses design. What kind of problems will have to be solved, how to deal with such problems, how to deal with changes in the structure of the complex system like an individual house.

PRESENTATION OF THE PROBLEM

Transition of the passive solutions form large buildings to the individual house is not just a simple scaling down. Passive resolutions are mainly arranged in the structure of the building, where as in big buildings, designer takes a great advantage of the vast space, comparing to the individual house.

In order to propose basic methods to deal with the problem, few transferable passive solutions have been chosen. These solutions are well recognized in big buildings and might bring a significant advantage to the energy balance of the individual house design. Chosen passive solutions are as follow: double façade, atrium, heat storing wall, green roof, sun well.

Analysis and practical application of the solutions is performed, and further solutions are proposed, basing on the design of the "ecological individual house" designed by Mr. Piotr Kuczia.

This paper doesn't have an intention to solve problems, the aim is to present a few methods for the problem analysis for better understanding of the system and in order to facilitate the process of the solution research.

METHODS

Set of methods presented below is designed for complex system analysis. These methods may be utilized one by one or together, and then they give a better system recognition. [1,2]

Since an individual house is recognized as a complex system, there are the methods to describe it, in time and space frames, in structure and environment.

OPERATIONAL ZONE (OZ)

Operational zone is a physical border which separates the system from the nearest super-system. This border has to be set in order to draw the line between the area where the problem exists and where it doesn't. Using this frame the super-system is also described at the same time.

Operational zone includes all indoor environment of the individual house. The first border is the building's envelope, precisely, the outside surface of the walls, roof, etc. This limit may be considered as an envelope for the heat energy balance calculation. This is a general approach, OZ should be described individually for each problem case and then will be strictly limited to the system where problem occurs.

OPERATIONAL TIME (OT)

Operational time limits the time frames of the system, describing when the problem exists and when it doesn't. For the general purpose of the problem existing in the individual house, a few OT may be found. OT_1 - operational time may be defined for the indoor conditions, which should be maintained on the satisfactory level when inhabitants are present, and is not necessary to maintain during the time when inhabitants are not present, although some furnishing and other equipment, plants etc. may need to have some of the conditions still kept within certain range. OT_2 - operational time may be defined for outdoor conditions, so in fact for the energy inflow/outflow rates required to maintain the indoor comfort. There are periods when there is a need to remove energy outside and periods when there is a need to bring it in. OT_3 - considering the utilization of passive energy solutions, periods of their availability, quantity and efficiency may serve as OT limits too.

SUBSTANCE FIELD RESOURCES (SFR)

Resources of the system may be defined in two different ways, as substances and as fields of influence. Example of the substance resources: brick, timber, air, thermal insulation, etc. for field resources following fields may be considered: magnetic field, electricity, radiation, air flow. SFR description should be arranged individually for the problem case. Following this schema, the resources of the nearest super-system and subsystem should be recognized, e.g.: it has been revealed that the slope of the site goes down perpendicular to the south wall the terrain is covered with the light sand – this will effect in the reinforced sun light reflection towards the house.

MULTI SCREEN SCHEME

Multi Screen Scheme is a tool which helps in organizing the structure of the system in the shape of sub- and super-systems around the main system. Sub-, super-system structure describes relations vertically. Horizontal axis represents the time of the system's operation, Figure 1. Complete scheme shows on its screens the structure of the system and its changes in time, before the problem occurs and after its action.

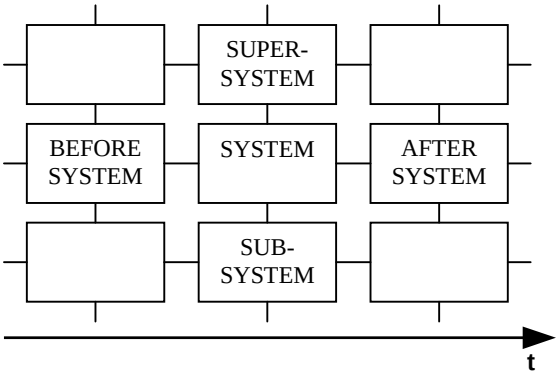

Figure 1. Multi Screen Scheme

Example analysis of the system of the glass façade in the individual house, with the utilization of Multi Screen Scheme, is featured in the Figure 2.

PARTICULAR SITUATION CONDITIONS

On the "area" of possible solution, two restriction lines can be drawn. The first one represents the objective laws of nature, second one shows the specific situation restrictions. These imaginary lines narrow the "area" where the possible powerful solution may be found. Objective laws of nature are usually known and

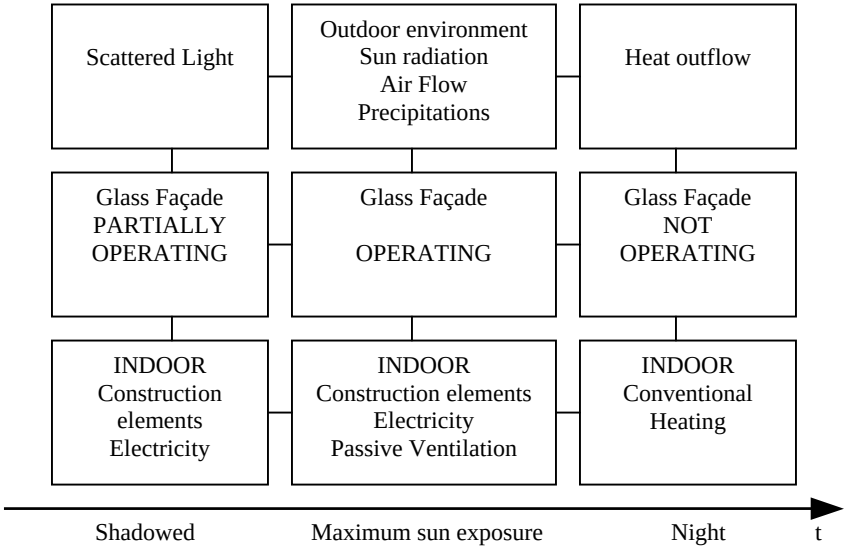

Figure 2. Multi Screen Scheme – Glass Façade case study

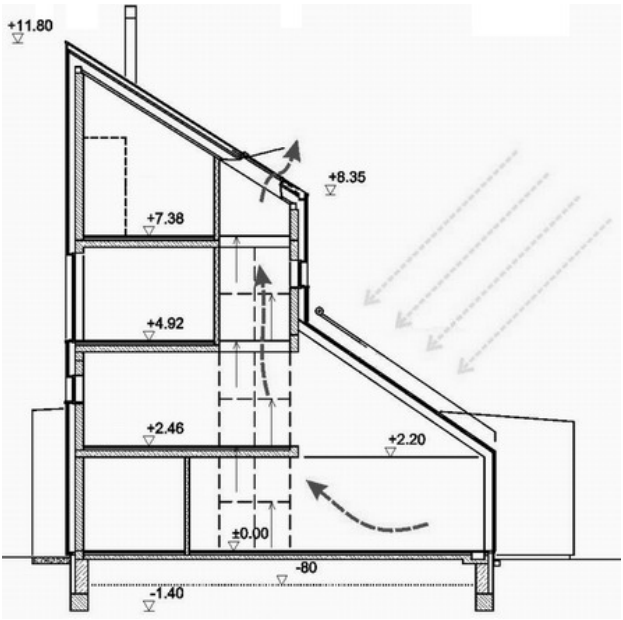

Figure 3. Ecological house – schematic cross section (designed by P. Kuczia)

taken into the consideration by engineers working on the house design, however these laws should be described with the measurable values to give a clear limit.

The best way to disclose particular situation conditions, is working with the integrated design principles, what involves the cooperation between investor, architect and building service engineer. As a result of this cooperation a set of restrictions should be gathered, which will guide each of designers to the efficient solution within their domains toward the creation of the harmonic and efficient design.

Some of the particular situation conditions may be described here using for the example the case study of the "ecological house", designed by Mr. P. Kuczia, Figure 3. Particular conditions may be presented in the form of needs: view on the lake, ecological idea, service less solutions (passive energy solutions), other restrictions: terrain slope, local law restrictions, local conditions (risk of break in). These conditions have a significant influence on the shape of the building and also on the decision for great number of passive features utilization.

ANALYSIS OF THE PASSIVE ENERGY SOLUTIONS

Following passive energy solutions have been chosen for the example analysis of the "ecological individual house" case study. For each of the solutions, the technical alternative for the individual house has been proposed. [3,4]

Double Façade – in the individual house this construction takes shape of the glass façade, a glass-house integrated into the building, or in the modified form, as the French window (double glassing with space in-between; in the shape of one window frame). The French window, with additional devices, acts in fact as the miniaturized double façade.

Atrium – this solution refers to the large window openings in the south façade, connected with the large space, indoor. Then, correctly arranged spatial layout (subsystem SFR), enables the utilization of accumulated sun radiation (super-system SFR) to enhance the buoyancy force and then passive ventilation occurs.

Heat storing wall – in the classic construction, for the high efficiency it needs the night screen mechanism for the heat loss reduction. Particular situation restriction excludes solutions which need a service. However the solution of the heat storing wall has been introduced into the "ecologic individual house" with some modification. It has been put as an indoor wall, localized in the *"atrium"* area and exposed to the sunlight. It is activated by sun in the afternoon. It redirects the accumulated heat on both sides, directly to the rooms. Additionally it is made of clay there so it balances the air humidity too.

Grass roof – utilization of the super-system SFR, precipitation, sunlight, to take an advantage of appearance, heat energy flow balancing, with free maintenance. Currently offered solutions suppressed all previous faults like: cracks of the roof construction, high load problem, fire risk, maintenance service. Utilization of grass roofs has been included into the urban policy e.g. in the city

of Tokyo where for medium-size buildings it is required to have 20% of the roof designed as a garden.[5]

Solar well – solution in structure of indoor spatial layout brings daylight into rooms with insufficient natural lighting. This solution transferred to the individual house design, has a significant influence on the building shape as on its economy. It has been revealed that introduction of natural daylighting in the commercial buildings saves approximately 80% in energy consumption. [3,4]

INTEGRATED APPROACH

Case study of the "ecological individual house" Figure 3., is certainly a good example for the successfully designed building with the wide utilization of passive energy features. Project manager efficiently handled all needs of design process participants. Great number of restrictions has been taken into account. All featured methods for the system's analysis give a powerful guideline to the design process and help in the better understanding of applied solutions and their role in the system. Finally, this design achieved a harmonic combination of ergonomic solutions for individual houses and energy efficient passive solutions, with the significant application of "ecology" aspect (the main idea of investor), still it is going along with the objective laws of nature and local limitations.

CONCLUSION

Presented methods for the analysis of the complex system of the individual house, help in the introduction of new solutions. Since the system is well described, many passive energy solutions may be successfully transferred to the individual house design. Analysis of the system and its peripheries with the structure of subsystems and super-systems, facilitate the work of the designer who is going to solve problems involving many actors of the system.

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