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A CRITIQUE OF THE DELIVERY OF HOLISTIC SUSTAINABILITY

The research is dedicated to the critical evaluation in terms of holistic sustainable design approach of planning and design issues, environmental factors, economical and social factors as well as barriers and limitations. The case studies are private houses based on the geodesic dome structural scheme and designed by the author. The role of architect in the delivery of holistic sustainability was assessed and investigation of further enhancement was done. The research assists an architect to understand the level of sustainability of the developed projects and helps to develop additional approaches. It is analyzed to what extent the architectural profession can influence the delivery of holistic sustainable solutions and investigates the barriers to deliver them.

Keywords. Holistic sustainability, environmental factors, planning and design issues, economical and social factors, barriers and limitations, geodesic dome, energy efficiency, environmental impact.

Problem statement. This building type is based on the concept of the geodesic sphere which was firstly introduced by architect and engineer R. B. Fuller, who developed the idea of large dome that can be set directly on the ground as a complete structure and the only practical kind of building that has no limiting dimensions [13, 17]. These buildings were considered to be inexpensive and fast to build because they were meant to use prefabricated structural elements, but residential geodesic domes have been unsuccessful (1960-1970) largely because of their complexity and consequent greater construction costs. However, nowadays, this idea is being rediscovered around the world in more contemporary way taking into consideration mistakes of the past and adopting it to the current needs, that's why more and more houses of that type emerge (North America and Europe). This building kind have a potential to deliver a holistic sustainability into the housing sphere by

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reducing the environmental impact and improving the energy-efficiency [1, 5, 14].

Literature review. Foundations for ethics of sustainability were discussed and main ethical principles were presented, including: obligations to future generations, social justice, environmental ethics and sustainable economics. In addition to it translation of these principles into practice was proposed including: the process of decision making, turning ethical decisions into professional practices and personal and planetary sustainability [8]. Built environment surrounds people for 90% their lives and its influence is poorly realized on the environment and people's health. It is shown how to work towards a sustainable environment through socially inclusive processes of placemaking, as well as how to reconcile the apparently incompatible demands of environmental, economic and social sustainability; how to moderate climate to make places of delight [2, 3]. Another researcher explains the philosophy and underpinnings of effective integrative design, addressing systems thinking and building and community design from a whole-living system perspective. Moreover, details how to implement integrative design from the discovery phase to occupancy, supported by process outlines, practice examples and case studies are shown. Furthermore, deeper understanding of integration that is required to transform architectural practice and our role on the planet was explored [11].

Research aims. The idea of the research is to define the role of architect in the delivery of holistic sustainability and to assess and investigate the further possible enhancement. It aims to assists an architect to understand the level of sustainability of the developed projects and to help to develop additional approaches. It has a purpose to analyze to what extent the architectural profession can influence the delivery of holistic sustainable solutions and to investigate the barriers to deliver them.

Research methodology and methods. A qualitative methodology was used for literature review and critical analysis of the completed projects: 1.Literature review. The author searched through scientific journals and books in order to investigate the existing body of knowledge in the field of holistic sustainable design approach. As a result of this

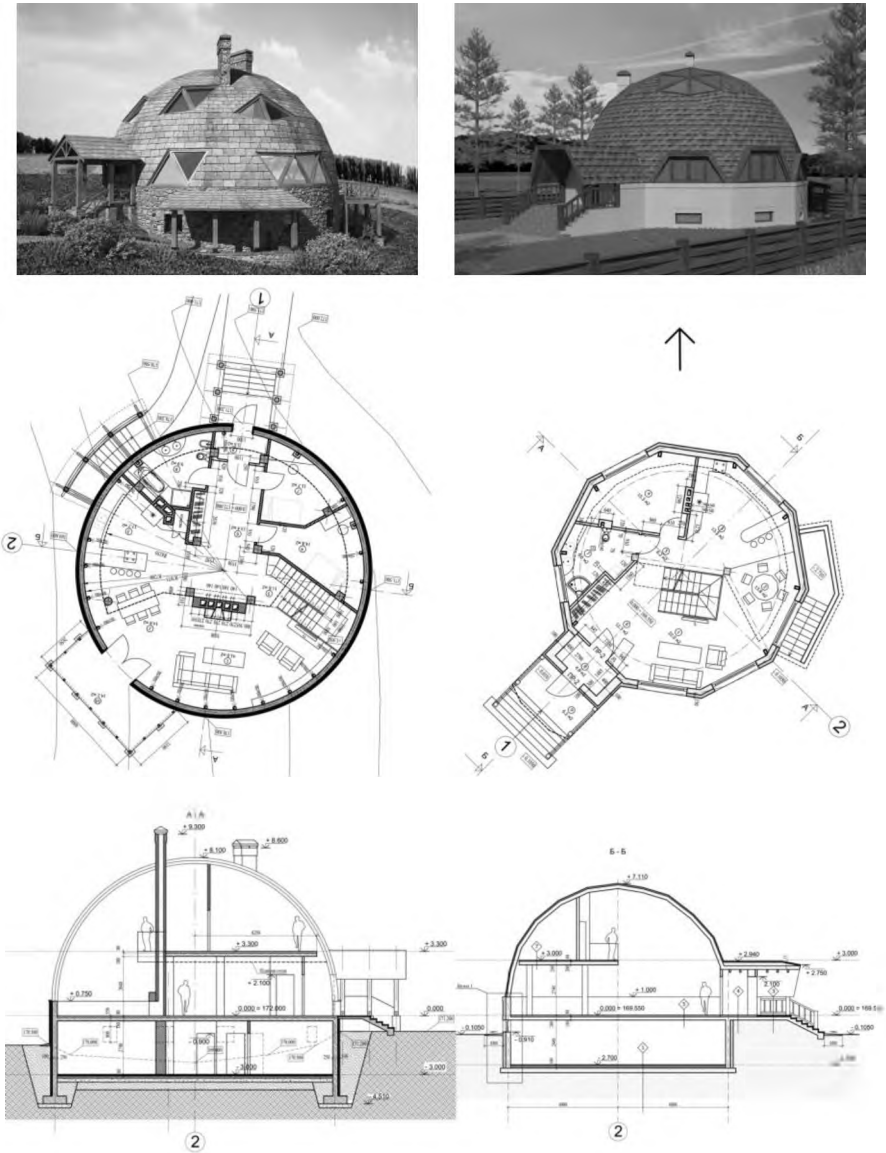

Figure 01. Software: AutoCAD 2017.Private houses based on the concept of the geodesic domes (Kyiv oblast, Ukraine). Architect B. Kutsevych, general views, ground floor plans, section. Source: Author. 2017.

review, the author synthesized the findings and identified the main questions. 2. Critical analysis of the completed projects. The author conducted the analysis of the designed projects where following issues were investigated: planning and design, environmental factors, economical and social factors, barriers and limitations.

Results of the research and discussion. 1. Planning and design issues. Since the dome is a form that is inspired by nature the geodesic houses have the ability to blend with the existing landscape instead of sticking out of it. House 1 is located on the sloped site, so it fitted into its surroundings, which actually contributes to the heating of the house as well, because around 40% of the basement level is covered with the ground. Another sustainable feature of this house is its exact location; the place was chosen in order to minimize the intervention to the existing scenery, as a result only one tree was cut down. As for the typology of these two buildings, they are the private houses with only function to provide full year-round living space for the families. The main task while designing these kinds of building is to have very efficient compact planning with a minimal external surface. Both houses are three-storied (one basement level and two above ground levels), they both have similar planning and parameters. In terms of geometry we can divide the form of the houses into two parts: first part (riser), which is a basement, is a cylinder and the second one, which is placed above the cylinder, is a geodesic dome. So as the result we have extremely compact external envelop with a minimum surface area.

2. Environmental factors. As for the environmental factors that influence the design, form of the buildings needs less energy for heating and cooling, it means that in needs less fossil fuels that prevents resource depletion and CO2 Emissions. According to the design, building is able to consume different kinds of fossil fuels: natural gas, coal and firewood. Firewood is produced locally since area is reach in forests, but natural gas and coal are imported. In addition to the shape of the building, another key factor for the low energy consumption is usage of the insulation materials. Floor, walls and roof are carefully insulated with different mineral materials (foam glass for the basement slab and stone wool for walls and ceilings). Details were carefully designed to avoid thermal

bridges. The idea of using renewable recourses is still under consideration; client is interested to use solar power either to generate electricity or to heat water, especially in the situation when price of electricity is constantly growing. This issue needs further calculation in order to be profitable. Integration of geothermal heat pump into the design was rejected by client due to the need of expensive ground works. Wind power is considered to be inefficient in this particular site due to the house location.

3. Economical and social factors. Turning to the economical factors that shaped the projects it has to be said that the main advantage of this kind of buildings is their cost efficiency which actually comes from their geometry. Buildings that are based on geodesic domes have bigger internal volume with the same amount of floor area to compare to the same buildings based on traditional rectangular schemes. In addition to this, the external surface area of geodesic dome houses including floor, walls and roof is smaller than in rectangular schemes. Depending on the skim, the surface area of this kind of buildings is usually 30% less, which means that these buildings need less energy for heating in winter and for cooling in summer, so clients can save their annual expenditures for these services. It also means that the amount of building materials that is needed for construction of such building is again 30% less than in traditional ones. Despite energy efficiency of this kind of structures, the spherical shape of a geodesic dome provides natural and efficient interior air circulation. In addition to it the natural aerodynamics of the dome means that cold air blows around the home instead of hitting a flat wall and penetrating to the inside. Social factors played significant role in the projects; there were many people who formed teams of professionals from different spheres who contributed to the project. First of all client and client's family, than architect, structural engineer, heating, ventilation and air-conditioning (HVAC) engineer and construction company's team. Client represents recently appearing in Ukraine middle class society. This kind of people mostly live in the big cities, they are usually rather liberal, open for new ideas and challenges, from 30 to 40 years old, with a good education, vast working experience (including international) and constant income. Both clients were enthusiastic about their future houses; they

really wanted to have a house that would be different from ordinary houses in the country (which are usually have nothing to do with sustainability) and not just in terms of form but also in terms of energy efficiency and environmental impact. Both clients were actually very much involved into the design process, contributing a lot to planning and design solutions. Role of the architect in both projects was substantial to influence sustainable decision-making. On the first stage architect proposes the location and orientation for the future building, suggests and proves recommendations with options of building's locations. At this stage architect takes in account and explains to the client different factors, such as: external utilities, safety, security, comfort, accessibility, day lighting, overshadowing and viewpoints. This is the first and most important part when sustainable principles can be implemented into the project. This is the stage when it is possible to save big amount of client's future investments using simple low-tech solutions. Design decisions that are made on this stage will influence the whole project and can define the level of sustainability of it. In order to persuade the client to choose one or another design solution architect should give the confident, clear and economically proven reasons for these solutions, in addition to this, architect can use previous experience to show to a client existing built houses and the sustainable solutions that were implemented there. For instance, in my practice always try to visit previous clients with the new ones, so they can communicate and discuss issues of planning and design together. This kind of strategy helps dramatically to convince the client to make one or another design decision, as well as it creates networking between clients. On the next stage architect produces different options of volumetric studies together with planning solutions that define the interior space. This is the stage when architect makes the decisions that influence thermal performance, natural lighting, and natural air flow through the building. On this stage another professionals are taking part in the project: structural engineer and HVAC engineer, they also able to bring sustainable ideas to the project. It was a role of an architect and structural engineer to convince the client to choose the best material suitable for that particular case. Final decision was proven by economical calculations, as result locally produced timber was selected, which helped to achieve

higher level of sustainability in terms of using renewable material and reducing CO2 emissions for transportation, additionally, it created jobs for local craftsmen. Another example is the HVAC systems, in the beginning client wanted to use traditional heating system with radiators and only natural ventilation. However later on, after consultations with heating engineers, equipment producers and learning new concepts of sustainable heating and ventilation, and particular Passive House experience, client decided to use mechanical air heating system with air exchanger. This decision was made collectively including all members of design team and resulted significant changes of the house design towards the Passive Design approach. On final stage architect concentrates on details and finishing materials, here architect is able to influence healthy living conditions for occupants as well as environmentally friendly solutions of the project. These solutions can be delivered by emphasizing their importance or without any specific references to sustainability; they have to be proven to the client by previous design experience or specific professional knowledge. By the end of this stage client usually selects construction company (CC) for the project, so representatives of the CC start also to influence the design. On this stage architect takes a challenge to persuade both client and representative of the CC to use sustainable design solutions and materials. It is very important on this stage to have the common approach with CC regarding design principles and design values; otherwise it brings to misunderstandings and clashes. Here architect can improve the awareness of the selected CC in sustainable materials and eco-friendly ways of constructions.

4. Barriers of delivery holistic sustainability. According to the author's experience, it can be stated that unfortunately, architects have rather limited influence on the delivery of holistic sustainable solutions to the design. There are many barriers that do not allow architects to implement in real life their sustainable ideas. These barriers can be divided in deferent types:

a) Economical. There are always clashes between desires of the architect to use modern sustainable design solutions and financial possibilities of the client. Generally clients believe that sustainability costs a lot and they don't want to invest money in it. Majority of clients

are only ready to invest into sustainability if they see real economical effect of it. This is a role of an architect to explain to the client that by investing larger amount of money than in traditional houses on construction phase they can significantly reduce their expenditures for building operation and maintenance in future.

b) Social. Usually majority of clients before they invite an architect already have in mind the preliminary idea of their future house. These ideas are based on general beliefs how houses should look like according to the local social preferences and construction market. Clients take conservative position, they do not want to risk and to try new design solutions on themselves, they prefer to build similar things to what their neighbors built, so they simply copy and multiply the house design that they see every day. This social background works as a barrier to deliver new ideas and innovations including sustainable approach. Here architect can take an educational role by raising the awareness of clients in terms of contemporary sustainable design ideas, so clients can shift from locally popular, usually inefficient schemes to up-to-date sustainable building design solutions.

c) Cultural. Different cultures have different rules that people follow from generation to generation. These kinds of rules are also can be addressed to the building industry. People do not want to change their way of living and their way of construction, they got used to live in traditional architecture for ages, but they do not realize that this kind of architecture was formed in the times when fossil fuels were relatively inexpensive and accessible. Nowadays, situation is different and architects together with HVAC engineers can inform clients that it is not appropriate any longer to use traditional energy consuming technologies, but to move towards renewable recourses and sustainability.

d) Technological. Technological development is not on the same level in every country of the world, that's why sometimes architect and client are unable to implement sustainable solutions into the house design. When modern building materials as well as equipment are not available locally architect should find compromises to minimize ecological footprint within existing construction market.

e) Lifestyle. There is a believe among clients especially with very high income that they do not need sustainable design solutions in their houses, because they still can afford to live in luxury, inefficient, high energy consuming buildings. People don't want to change their lifestyles because they value their comfort; however sustainable solutions and holistic sustainability in particular requires some amount of compromise of their luxury lifestyles. In this case architects are forced to follow client's demands, but it is still possible to introduce certain amount of sustainable solutions, minimize the carbon footprint of the building as well as raise client's awareness regarding environmental drivers for sustainability, such us: climate change, air/water pollution, waste production, resource depletion and loss of natural habitats.

'Lifestyle change cannot be imposed, but it can be encouraged by good design' (Edwards 2000).

Conclusions. To sum up the role of architect on the sustainable decision making in planning and design it has to be emphasized that notwithstanding the limitations architects do influence their clients and can cause the increase of the holistic sustainability in the societies. As creative designers, architects should have an underlying objective to maximize the potential of any design scheme, while striving to minimize its environmental impact. Architects have to become the sustainability-conscious designers to take a variety of sustainability measures wherever they can, and wherever it meets client's requirements. Architects need to raise public's awareness and knowledge of effective and affordable sustainable design solutions as well as promoting innovative and practical methods of construction and also to establish strong and successful working relationships with HVAC engineers, structural engineers and environmental consultants. The critical analysis of the case studies that athor chose for this research gave the author broader and clearer understanding of the personal responsibilities of delivering holistic sustainability to the projects that arthor design. It is more evident for the author to see disadvantages in terms of holistic sustainability that were delivered to these projects as an architect; however author is going to use this understanding to deliver more efficient design, to promote the sustainability to the future clients and to overcome the barriers.

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Анотація

Дослідження присвячено критичній оцінці з точки зору сталого розвитку питань планування та проектування, факторів навколишнього середовища, економічних та соціальних факторів, бар'єрів та обмежень на прикладі проектів індивідуальних житлових будинків, заснованих на конструктивній схемі геодезичного купола та розроблених автором. Була оцінена роль архітектора в забезпеченні цілісної сталого розвитку, і проведене дослідження по подальшому її вдосконаленню. Аналіз допомагає архітекторам зрозуміти рівень сталого розвитку розроблених проектів і дає можливість підібрати додаткові підходи. В роботі аналізується, наскільки архітектурна професія може впливати на надання цілісних рішень сталого розвитку та розглядає бар'єри для їх досягнення.

Ключові слова. Цілісне сталий розвиток, фактори навколишнього середовища, питання планування та проектування, економічні та соціальні фактори, бар'єри та обмеження, геодезичний купол, енерго-ефективність, вплив на навколишнє середовище.

Аннотация

Исследование посвящено критической оценке с точки зрения устойчивого развития вопросов планирования и проектирования, факторов окружающей среды, экономических и социальных факторов, барьеров и ограничений на примере проектов индивидуальных жилых домов основанных на конструктивной схеме геодезического купола и разработанных автором. Была оценена роль архитектора в обеспечении целостной устойчивости, и проведено исследование по дальнейшему ее усовершенствованию. Анализ помогает архитекторам понять уровень устойчивого развития разработанных проектов и дает возможность подобрать дополнительные подходы. В работе анализируется, насколько архитектурная профессия может влиять на предоставление целостных решений устойчивого развития и рассматривает барьеры для их достижения.

Ключевые слова. Целостное устойчивое развитие, факторы окружающей среды, вопросы планирования и проектирования, экономические и социальные факторы, барьеры и ограничения, геодезический купол, энерго-эффективность, воздействие на окружающую среду.

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