Beyond the Construction, Design and Planning Scenarios of Eco-Buildings

Bogdan Cioruța\textsuperscript{1,2*} and Mirela Coman\textsuperscript{2}

\textsuperscript{1}Office for IT and Communication, Technical University of Cluj-Napoca - North University Centre of Baia Mare, Victor Babeș 62A, 430083, Baia Mare, Romania.
\textsuperscript{2}Faculty of Engineering, Technical University of Cluj-Napoca - North University Centre of Baia Mare, Victor Babeș 62A, 430083, Baia Mare, Romania.

Authors’ contributions

This work was carried out in collaboration between both authors. Author BC designed and wrote the study, performed the structure analysis and wrote the first draft of the manuscript. Author MC managed the literature searches and the final analyses of the study. Both authors read and approved the final manuscript.

ABSTRACT

Lately, even in Romania, the interest in ecological homes has begun to take on proportions. Hugged by curiosity, but especially by reorienting towards a (more) healthier lifestyle, people seek to find out as much detail as possible about them - thus capturing the outline and the present work. Although eco-house construction is simple and eliminates many of the heavy stages of a classical construction, future homeowners omit, due to lack of information, this option, especially in the context in which we do not have a good filter of information about this subject, which will give us the real benefits we have.

Ecologic houses seem to be a trend with strong growth, because the shapes that they can wear are extremely varied. The great variety, low price and promise of ecological housing is likely to convince people to completely change their lifestyle. How well are we prepared for sustainable
development? How do we meet the demands of today’s society? What does a green house look like, how does it behave in time, and how much does it cost? What are the trends in designing a green house? These are just a few questions that we will answer during the work.

Keywords: Ecological houses; green design; sustainable planning; healthier lifestyle.

1. INTRODUCTION

The term "ecologic" has expanded so that we by ecologic, green or sustainable architecture understand in harmony with the environment and the community [1]. The man viewed through ecology is directly involved and even responsible for his integration and harmony in a healthy natural environment [2], from which the notion of an ecological house, as a result of the concept of a healthy home, cannot be missed.

The ecologic house is a dream of each of us, but it does take longer to become reality. As far as the modern home is concerned, this is in a closer relationship with the alienation home (impersonal, simple depository of objects, ignoring our emotional needs), an ecologically blind house, a home in which the sickness syndrome is more than just pregnant [2].

Before we talk about the ecological home, we must not overlook the fact that our place of living, which the dwelling houses, derives from our own unique identity, the house being often perceived as a living organism with its own metabolism, a "third skin of man".

Our home, before it is an ecological bill, must provide health for the body, peace of mind and consonance with the environment. It is only in these circumstances that we can speak of the notion of ecological sweet home [3].

"Green houses" or "ecological houses" are those buildings made primarily from natural materials and designed to efficiently use the power, water and other resources. The green house principles are closely related to the energy performance of buildings, renewable energy use and construction waste management (Fig. 1) [4,5].

As a definition, a green building is any project that involves a construction or renovation done with particular attention to minimising the impact that design, construction and renovation work may have on the environment [5]. "Organic or natural-made buildings" are another concept of ecological construction, which makes natural materials (wood, stone, bamboo, clay, straw, reed, earth) [6] or non-toxic, renewable or recycled. Organic houses also include passive houses - without energy consumption - and those with a very low consumption of heat. Through this system, winter and summer cooling costs are reduced by 50-58%. The notion of organic house has two aspects: the built house and the environmentally friendly house.

The "ecologically-built house" involves the use of 100% natural or partially processed materials, including finishing materials. Organic materials:
• for the skeleton, the basic structure can be used: wood, stone, straw, reed, earth, clay, sludge bricks, slurry, some metals;
• for roofing: sieve, shingle, reed, straw, slate, tile, olane;
• for finishing: stone, limestone, marble, cousin, gypsum, gravel, glass, some metals, natural pigment paints based on natural solvents, wood;
• for decoration: wood, stone, clay, ceramics, paper, cardboard, reed, bamboo, natural fibre fabrics.

The "functional-ecological house" is perceived as an organism, as an open system to the environment. When we say "open" we refer to the fact that it takes the matter and energy from the environment, "burns" it and releases it in the form of scraps, waste of various types.

Below, inspired from [2], are some of the rules to obey in the construction of the future house which brings one closer to having an ecological home.

• Choose the ideal terrain! - To save money during construction, it is important to work with local materials. The most important aspect remains the water supply. We must not forget the opening of the terrain and the orientation towards the cardinal points.
• Take care to "breathe" your walls! - the expression does not refer to the circulation of air through the walls. In the case of masonry made of natural materials, finely finished with plaster, there is a slow circulation of vapours from the inside to the outside. We recommend natural materials that allow vapour diffusion.
• Thermo-insulate your house very well - to save money! Wood, stone, clay, sand form a thermal mass and have excellent thermal insulation qualities.
• Maintains the building materials moisture and excessive outdoor moisture - the number one enemy of ecological constructions - within a well-defined range. Design your home with "high boots" and a "hat" (wide eyelid), so keep the walls of rain.
• Do not pollute the environment and do not harm your health! - Many contemporary building materials are detrimental to health due to formaldehyde, which is present in every synthetic building material.

2. METHODS OF CONSTRUCTION AND TYPES OF HOUSES

Given the decline in the monetary system and the current state of the economy [2], we should focus on designing and building dwellings to bring us closer to both ourselves and ourselves by combining technological knowledge with the protection requirements of the current environment (Fig. 2).

There are many types of ecological houses that can be built with very little material resources, are very practical and attractive. Here are some types [2,7]:

2.1 "EarthBag" Houses

Building with earth-filled bags is both old and new. Sandbags have long been used, especially by the military, to create strong barriers to protect or control floods. The same reasons that make them good for the listed applications make them good for homebuilding. Considering that the walls made with earthbags are so massive, they resist all types of natural disasters (earthquakes, floods) [2].

Buildings as in Fig. 3 can be quickly picked up, especially if using the materials available in the near area. Many kinds of bags can be used [8], starting from natural fibre sacks and up to polypropylene fabric sacks. Because the bags can be filled with anything, ranging from sand
and gravel to hard clay, this is a remarkably versatile and inexpensive technique. For additional earthquake resistance, continuous wire of barbed wire is placed as a “mortar” between each row of bags. This not only prevents slipping of the sacks, but also provides reinforcement that gives the entire foundation resistance to stretching, helping the elements of the construction to remain united as a single element.

The disadvantages of this system are mostly related to sustainability. Natural fibre bags break down if exposed to moisture. Polypropylene bags, although immune to rot, quickly disintegrate in ultraviolet light. Protecting sacks with a “mud-screen” immediately after construction and then coating them with earth prevent degradation due to sunlight exposure.

2.2 “EarthShip” Houses

Building EarthShip (Fig. 4) homes using worn tires and bottles/landfills filled with earth is a cheap alternative to conventional solutions (brick, concrete, concrete, etc.), and the degree of thermal insulation is superior.

Fig. 2. Design and construction of ecological houses in relation to environmental protection and current technological knowledge [2]

Fig. 3. Examples of EarthBag houses [2,9]
This solution allows maintaining a constant temperature (both summer and winter) using at least heating or cooling resources to have permanent thermal compliance. Efficiency increases if the construction is partially buried in the earth, and in this way the temperature of 21-23°C is ensured permanently throughout the year. Alternatively, it is possible to choose an alternative that combines the two solutions, thus creating a hybrid system in tires, bottles, pet or other materials capable of encapsulating the earth.

2.3 "Straw bales" Houses

The straw bales (Fig. 5) are now increasingly sought after, which is due in particular to the many factors that make their built house a healthy, safe and efficient home: the cost of the building materials is significantly reduced, the straw is itself a very good insulator, does not require additional thermal insulation, fire resistance, earthquake resistance [2]. A house built from straw bales can be as modern, appealing and energy efficient as any other home, but much cheaper. Natural building materials with exceptional capillary capacity (moisture retention) provide us with a very pleasant indoor climate.

2.4 Chirpice Houses

Chirpicius involves a mixture of clay and straw, and drying is done by exposure to the sun. The crunch does not dry in furnaces or other fast drying equipment. For masonry, a paste made by mixing the yellow earth with water and, in some cases, a lime addition is used as a binder. Chirpic structures (Fig. 6) are well behaved as a result of seismic action because the material is flexible and allows for displacements that do not structurally affect the building, but also due to the fact that in general the structures of the chirpics are arranged on a single level, rarely encountering two levels.
Chirpice houses are very cool in summer and warm in winter, they are "breathing" houses very well, especially those with straw roof and natural clay floor. If proper maintenance is ensured, the lifespan of a chirpic construction can reach 170 years. The biggest disadvantage of this material is that it is sensitive to moisture and, when soaked with water, it loses its carrying capacity.

Typically, a stone or brick foundation is used widely enough to support walls of 45-60 cm wide. The foundation must be tall to keep the wall dry, away from the dampness that rises from the ground or from the rainwater that sprinkles when it hits the ground. Paint and plaster must allow the wall to breathe. Cement based plasters are not recommended. It is recommended to use a sandy cousin plaster, inside a two-layer clay coat.

Before plastering it is advisable to leave the wall dry for a year. The wood in the corkscrew does not degrade due to moisture. Wheat or oatmeal straw is used. Adding straws is usually done with the forks at the ground level, near the wall where they are to be placed.

2.5 "Cob" Houses

Cob is a traditional English term that denotes the style of building clay, sand and plenty of long straw (Fig. 7). This is useful in damp areas, where the crunching is more difficult. Some of the best examples of cob structures are found in England and Wales, being used there for almost five centuries. Cob enjoys growing popularity in circles of alternative techniques. In simple terms, the cobb combines clay, sand, straw and water into heaps of bread loaves, which are thrown into the wall and “crocheted” to each other to form a continuous meal.

The earth-bags, can be arranged for curved lines due to malleability. But unlike sacks of earth, the grain requires considerable amounts of straw. Straw plays the role of steel in concrete, giving the walls better tensile strength, especially when the heaps of the cobs are interlaced with the “cob's finger” or even with bare hands and fingers. When lifting the walls, it is necessary to let it pass for a while until they sit, before proceeding with the elevation.
As it rises, the cob above can deform the rows below if they have not dried. We will call the quantity of cob that can be placed once "load". Each layer should be left to dry prior to laying the next layer to avoid deformation by bombardment. Their tensile strength is sufficient to prevent deformations, regardless of the moisture content of the soil mixture in the bags. Here are the main advantages of earth sacs on the cob: lack of straw, lack of settling times, a wider range of possible humidity and less specific soil mix.

2.6 "CordWood" Houses

One of the oldest houses built of cut logs has been standing since 1895. Those who chose to build such houses are generally people who live very close to the forest, thus having the raw material at hand. Advantages of cordwood homes (Fig. 8): Use natural materials, fit very well and do not pollute the environment, unique aesthetics, cheap and economical both in construction and in the long term, can be built with minimal knowledge in the field of construction.

2.7 "Rammed Earth" Houses

The beauty of this building technique lies in the simplicity and naturalness of the oldest building material - the earth. A home made of beaten earth (Fig. 9) is made using wooden formworks that are gradually filled, beaten, raised.

The construction of a whole wall starts with a temporary frame, usually made of wood or plywood (40-50 cm), to act as a mold for the desired shape and the dimensions of each wall section. The shape must be robust and well fixed, and the two opposite surfaces of the barrel are snugly clamped together to prevent deformation, bulging from large compression forces. The material is compressed iteratively, in batches, to the top of the frame. Hand tools or similar pneumatic tools are used to reduce construction time. Advantages: it does not require a wooden structure if the location allows it, it does not even require a foundation, nor a concrete foundation, it costs very little, it allows the floor heating, or through the walls.

Fig. 8. Examples of cordwood houses [2,3]

Fig. 9. Examples of rammed earth houses [2,3]
3. CONCEPTS AND TRENDS ON HOUSE DESIGN

3.1 Houses on Wheels (portable)

It should be known that these types of housing do not require construction permits, do not require architectural plans and no taxes are paid after they are built on wheels. With a rustic look, these mobile homes (Fig. 10) can be ideal for a family of 3-4 people, as holiday homes, camping, parks, recreation areas [2].

The walls, the floor and the roof are made up of six layers; in the middle, there is always a 10cm insulation of hemp mattresses. Wood surfaces are treated with flake-based linseed, making them more durable but also healthier. The customer can choose different sizes (2x3 m, 2.4x5 m, 2.4x7 m, 2.4x8 m, 2.4x10 m, 3x7 m), and any of the mobile homes can be equipped with heating, water, sewage, electricity depending on customer requirements.

Prices start from 600 euro/m$^2$, and a special tax is granted for houses on wheels that exceed the width of 2.4 m because they are transported in pieces and will be mounted at the final placement. Compartments are made according to customer requirements. The weight of mobile homes varies between 1-4 tons. They can be ordered with wheels (rubber, steel) or four-leg supports [3].

3.2 Rotating/Mobile-elements Houses

Sharifi-ha or rotating house (Fig. 11) is an ingenious residence that can adapt to the temperature changes that occur from one season to another. The building is made up of several rotating rooms, creating open or closed spaces. The idea is inspired by the architecture of traditional Iranian houses, which usually have two living rooms, one for summer and one for winter.

According to architects, the building has 7 levels: two basements dedicated to fitness and wellness facilities; the ground floor, which houses garages and rooms for housekeeping; first and second floors for joint activities and third and fourth for the private lives.
Rotating rooms can adapt to the needs of their users. For example, the second-floor guest room can be reconfigured in an office, while the first and third levels of office and dining rooms can change their formal appearance into a more casual one.

3.3 Solutions for Small Living Spaces

YO! Home is the new housing concept that is said to revolutionise contemporary homes because it proposes an ingenious solution: the multifunctionality of the living space [2]. Through some built-in wall, floor and ceiling functions, some parts of the room slide and move various pieces of furniture, which can be easily masked or uncovered as needed.

In the traditional view, when people were thinking about their homes, they had an almost mathematical conception: the sofa + TV = the living room, respectively the bed + the closet = the bedroom. However, in a global context of continuous urbanisation, where people have a smaller habitat (it is forecast that most people will live in very narrow urban areas), the perception of living spaces is becoming more fluid. Take the couch, for example, in the past the central part of the living room and so of the house. Now, it's not just space for socialising. People eat on the couch, in small apartments, and use it for sleeping. Neither is it a mandatory gesture in a world obsessed with wireless and gadgets. The trend extends to other areas of the house, small spaces forcing objects to become many functional pieces where work, eating, socialising and playing can be done.

The furniture will, therefore, become more versatile, forced to cling to the new ways of living. Neither storage will remain the same. People begin to understand that the urban environment is not suitable for massive cabinets and generous storage. In addition, many of the things physically stored in the past (music, movies, books) are now digitized. The dwellings will become more airy and the few things stored will probably be carefully exposed.

Another direction of furniture products is tactileness [3] - the extension of touch screen gadgets that we have included in our lives. Materials will keep pace with technological developments and will not be limited to visuals. The tactile component will become more and more important in choosing home objects.

3.4 Office Design Trends

In recent years, Romanian companies have aligned with the international trend and have begun to pay due attention to the design of office space. Well-appointed, bright and atmospheric offices motivate employees and increase their productivity. Moreover, the knowledge of the trends in the office area also offers the latest technical solutions, indispensable for the convenience and intelligent use of the available resources.

Regardless of the organisational culture promoted by the field of activity, companies have become aware of the fact that space influences the work of the collective. Efforts are made to conquer employees with creative and versatile workspaces. In general, open space offices - are the new office trends. They stimulate efficient collaboration among colleagues and reduce the differences in organisational hierarchy.

4. FUNCTIONALITY AND TRENDS IN HOUSE PLANNING

The 3D trend has expanded into the world of interior design, and the result is fascinating. Epoxy resin floors have revolutionised interiors through the versatility and uniqueness of the created models. Recently, a company in Dubai has implemented 3D printing technology for epoxy resins, radically changing the floor concept. The result is spectacular: a smooth surface, but perceived as a three-dimensional image with various textures and shades. The layer on which it is traversed, usually ignored, thus achieves a maximum impact [2].

For decorating bathrooms, the most common designs are marine: algae, dolphins, fish, water, waves, sand. Viewed from the right angle they seem alive. Furniture can be adjusted to drawings on the floor to look like an extension. In addition to the aesthetically pleasing appearance, this type of decorative finish has the advantage of an uninterrupted surface of expansion or assembly joints, high wear resistance, shocks and chemicals.

The kitchens gradually become the most important chambers in the house. Here we cook and eat, socialize with family at the end of the day, spend the morning with a cup of aromatic coffee and often here we get our friends too. No wonder interior decorators are increasingly
concentrating on setting up the kitchen on a warm, welcoming, functional and organized space at the same time, but perhaps most importantly, as a space with style.

The kitchen of the future (Fig. 12), more precisely that of 2025, also called “thinking kitchen”, will be as a technological friend of man, making it a more organized and healthy life [3]; the kitchen of the future will not only think for us, it will think with us, anticipating the physical, mental and emotional needs. This futuristic concept involves the existence in the kitchen of intelligent recycling systems that automatically separate garbage, deal with energy monitoring, plant cultivation, storage and long-term storage of food.

Besides these principles - the return to nature, smart devices, physical and mental health at the highest level - the project also presents ways in which futuristic cuisine merges with the emotional side of man. What will attract attention will be a kitchen table, "a table for living". It identifies foods, designs cooking instructions, suggests recipes based on ingredients on the table, weighs and even includes an induction cooktop. The smart table will not only be used to cook and serve but will also be a playground for children.

Living and dining are rooms where you retire after a tiring day to relax, whatever that means - a snack on the couch in front of the TV, a game on the console or a good book. Such spaces will take on the pleasant form of relaxation, will help you feel wonderful at home and enjoy a decoration to your liking, in which case you will notice: Geometric patterns, functional furniture, declarative pieces and the diversity of textures.

A comfortable bedroom is one of the key points of the house. The harmony of the arrangement depends on the whole atmosphere. Everything has to be in balance - from the correct distribution of light sources to the chosen decorative objects, every detail will build that much dreamed space for your daily relaxation.

A comfortable bedroom (Fig. 13) should allow you to breathe, without choking you with things that do not have a place, if you follow the ideas pursued in the concept of the whole ensemble, and you can let your imagination make changes to perfect the room. Setting up your baby room can be a serious challenge.

To reconcile your design preferences with the necessary functionality in such a room and at the same time not to forget the impact that the environment created on his childhood will be a demanding project. From kindergarten to high school, the office is a key element in a child's room. In order to learn, read or draw, the office should not be neglected when it comes to arranging rooms for the little ones (Fig. 14).

The hall is the business card of the whole house. This space you first see when you enter a house must be an integral part of the whole home, it must be well organised, clean and welcoming. Here, you or your guests, your clothes, umbrellas and shoes, as well as many other things, that's why this room should not be neglected either in terms of functionality or design. The lobby is one of the rooms we choose to ignore most of the time, although it is the first access to our homes. And if we think about arranging it, a hanger seems to us enough. The space for the hallway can provide us with more design opportunities that can enrich the décor of the dwelling as a whole.
Outdoor time definitely influences our state of well-being. In the urban environment, balconies and terraces are the main links of living space with the outside. But the two are different concepts with different potential. There is also the concept of loggias, similar to a balcony, but which, structurally, appears embedded in the building.

The significant difference between the two is the size. Generally, balconies are significantly smaller than terraces, although this is not necessarily a rule. Given the reduced size, a balcony is not such a versatile space as a terrace, its role being that of connecting the interior space to the exterior. However, even a small balcony can contribute to the space of a room, primarily through the degree of natural light entering the room and the additional space provided. Balconies are often used as living room extensions. The wall that separates the two areas can be removed, thus creating an additional room or just a closed space as an extension of the living room.

On the other hand, with a more generous stretch than a balcony, the terrace can be used for various entertainment purposes. It can be arranged as a garden rich in plants and shrubs, a true green oasis in the middle of the city. You can even install a swimming pool for the hot days. Because summer is often a term synonymous with outdoor time, balconies and terraces are gaining in this season, and not only, an increased importance within the home.

They become the place of relaxation at the end of the day or the breakfast place on the weekend. Most of the time, these rooms do not offer many square meters to run. Taking into account the scale and how we use this area of the house, we will emphasise those features that will support us in our approach. The design ideas
for these exterior spaces of our houses are extremely varied. Prioritise according to your needs and decorate them for pleasure and relaxing moments.

5. CONCLUSION

Interest in ecological homes is growing! but why?

5.1 A Good Deal!

Some choose to build ecological homes just because they understand that interest is growing. So they chose to build houses on the wooden structure and OSB cladding. There are builders who understand what an ecological house means, respect ecological principles, and earn their bread by re-profiling their work.

5.2 A Trend, a New Fashion

Some choose to resort to ecological constructions just to keep up with fashion or what they see on television. These people are not necessarily convinced of the benefits of building with natural materials, often making major compromises using both ecological and synthetic materials, so we call these houses “environmentally friendly”.

5.3 A necessity, Cheaper Houses

More and more people are being documented about ecological constructions. I understand what they are, they like the idea, they want such a house, but the most important reason why they choose such a house is that it is cheaper. On the other hand, some consider a house only a necessary "object", like a television, as a car. So I find it beneficial to have (yet) a house, but this time an ecological one. The house costs will depend on the team that will build the house.

5.4 It is a Shelter for the Family

At all three points above, costs were discussed. No matter why you choose to build an ecological home, the cost of building and maintaining an ecological home should be reduced. There are many people who do not see a business by building their own home. I see such a house as part of their family life.

The house thus built will be an "object" that your family needs to shelter, but also an object to be given to it ... when you build it, when you live it, when you care for it. Such a house is gained by the maximum involvement, the closeness and observation of nature, the proximity to the people around you, and not the different items you buy or obtain. Such a house can mean another lifestyle.

ACKNOWLEDGEMENT

Authors are deeply grateful to all the students and active contributors who have shown interest for the “Green house between dream and reality” symposium.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/26849