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Integrative Design Team – A Path for Innovation in the Case Study of Caltun Refuge

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Abstract

The project for Caltun Refuge gathered a complex team of specialists that managed to reach a high level of collaboration and performance in designing a unique sustainable object that answers the extreme conditions of the Fagaras Alpine Natural Park. The concept for the shelter is a prefabricated module that represents a pilot project and a starting point of analysis for future development in three possible configurations. The project team will be able to continue to analyse and develop in the future the shelter typology for different sites and program variations. The following article analyses and presents, from a project management point of view, the integrative Design-Build-Operate process. Consequently, the analysis of the project's characteristics and impact on a larger scale will underline its sustainable features that were encompassed from the conceptual design stage.

Keywords:	Remote architecture; Project management; Integrative design; Modular system
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1. Introduction

Situated in the Romanian Southern Carpathian Mountains (Figure 1) at an altitude of 2160 meters is the newest remote shelter in case of danger designed by a complex team of specialists and volunteers coordinated by architect Marius Miclăuș. Owned by the Emergency Service of Salvamont Sibiu the Caltun Refuge is about 350 meters below the Caltun peak in an area considered one with the highest risk of accidents in the Fagaras Alpine Natural Park.

The present article firstly analyses the project considerations related to the remote location in the Southern Carpathian Mountains and the extreme challenges resulted

It is important to introduce the refuge notion, defined as a simple construction, low-comfort, that can be found in isolated areas with long and difficult trails [2] as it is the case of the Fagaras ridge trail.

These conditions represent complex challenges for any project so the article starts with key points that describe the process to overpass these obstacles and lead to a successful sustainable module using an integrative planning process.

The starting point for the new Caltun Refuge represented the observation from the Emergency Service of Salvamont Sibiu about the advanced overall state of degradation that the previous shelter was in (Figure 2). The first project proposal was a conventional structure with reinforced concrete foundations that weighted around 18 tons. An alternative was sought out with a call for bids made by the owner Sibiu County Council together with the Emergency Service of Salvamont Sibiu. The agreed upon solution was to purchase a prefabricated module that works as a shelter for tourists and a permanent centre for emergency personnel.

Figure 1. Southern Carpathian Mountains Fagaras Alpine goal Natural Park [1]

Figure 2. Călțun Refuge between 70’s and 2016 [3]

Figure 3. Călțun Refuge [3]

2. Extreme challenges

The extreme location of the project's site and its characteristic features was the task hardest part for the bidding team. The project was first analysed from a multi point criteria taking into consideration the environment, project destination, time and budget, transportation, means of manufacturing and building process.

One of the defining factors in the development of the project was the calculation of load bearing of snow and wind specific to the stress analysis at the location. The standardized loads for wind calculation measure more than 160 km/h and for snow that can reach 4 meters high the corresponding load is 2.5 tons/m^2.(Figure 3) These parameters influenced the complex process of cad design in the planning of a rigid shell that evenly distributes the resulting efforts and loads.

The high altitude of 2160 meters was accepted as a challenge by the entire team and the resulting structure is a premier - the highest positioned Cross Laminated Timber – CLT structure in Central and East Europe. Additionally the environment protection was one of the most challenging issues that was taken into consideration. Due to natural park regulations the project's footprint must be reversible so no foundations were allowed, only a limited number of rock anchors for stability. Also the new Călțun-Refuge was placed in a different location than the previous one, a few meters higher, so in order to avoid pollution of the lake area. The old platform located near the lake has become a helicopter landing position in case of emergency rescue.

Sensitive architecture was one of the important focus point of the project so the team developed a model that was sensitive to the environment. Therefore, shape and materials were heavily assessed before being outlined into the project. General considerations were taken into account for materials with eco-friendly properties that in time would not endanger the environment, that would integrate and blend into the surroundings (Figure.4).

Besides the strict choice of materials a lifecycle overview with a focus on planning for disposal phase was taken into consideration. Therefore the structure can be disassembled anytime, within 4–5 hours, and transported to another location without affecting the environment it was located in. So the environmental impact is relatively small because of the innovative solution given by the proposed modular structure. Călțun Refuge, as modular construction, allows the possibility of flexible partitioning and fast manufacturing and relocation, features that among others are framed in the category of sustainable buildings. Such characteristics have improved the project design brief that requested the development of a bipolar structure consisting of an Emergency Service permanent point and a space for tourists, representing an area of 36 m^2

Figure 4. Călțun Refuge 2016 [3]

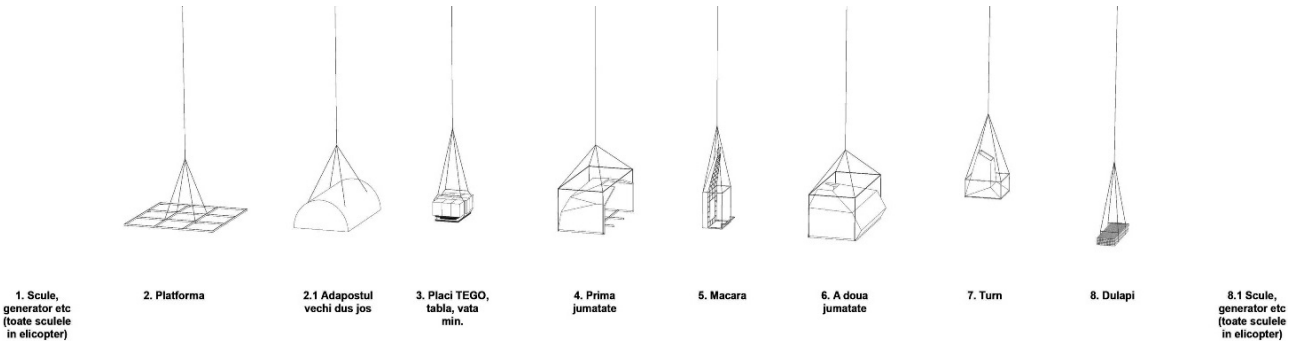

Figure 5. Planned transportation [3]

Figure 6. Călțun Refuge 2016 [3]

divided into two rooms. The resulted design offered the possibility of transportation with a helicopter at the location and assembly on site using a minimum number of trips (Figure 5). Reducing the carbon footprint was a hard task due to fuel consumption by the helicopter and was studied during a multidisciplinary design process including CAD laborious testing for aerodynamic loads. Also transportation had a great impact on project manufacturing methods and materials together with the building and assembling process.

Remote design led to the solution of off-grid solar panels for electricity and a responsible mountaineering usage. The budget and strict time schedule made the task more complicated because the starting budget was a low cost one (less than 30.000 EUR), not including transportation, and only 3% (855 EUR) were used for design.

Early stage conceptual thinking of the architect Marius Miclaus's idea of „a lighthouse in in the mountains" (Figure 6) was the real extreme challenge to be accomplished by the multidisciplinary team. Through all of the project stages the module versions preserved the shelter tower as a conceptual shape.

3. Integrative design team

The initial analysis made by the bidding team pushed them in the direction of a master builder type of thinking, therefore taking into consideration the entire project management and even further. A master builder is a concept, updated by the architect and consultant Bill Reed [4], that describes the integrative design process as the modern equivalent of the master builder in pre-industrial society that sums the knowledge of building science and technology, knowledge about the available resources of the area and the elements needes for building and construction operations. A perfect example for the case is the Caltun shelter project that was developed by a team of 42 people including architects, engineers, architects, students, rescuers, pilots, volunteers and more (Figure 10).

Head of project and management design, Marius Miclăuş, assembled the multidisciplinary team with young professionals capable of developing the project from beginning to end. The project team included Marius Şoflete - an engineer specialized in wood construction, engineer Cornel Farcas - responsible for the metallic structure concept and coordination, and young architects and architecture students volunteers: Ovidiu Balan, Paula Avram, Maria Andrecencu, Raluca Nicoleta Ciobanu, Raul Andronache. The flight team that included Chirita Neculai (flight team commander), Carstoiu Traian (second pilot), Canache Neculai (tasks operator) and Pavel Octavian (technical foreman board) was part of the solution development from the start, having the task of coordination and supervision of the design details. Everything was conducted under the watchful eye of the mountain rescue service coordinator

Adrian David. All the photos and videos during the construction were made by volunteer architects Andi Buftea and Micsa Ovidiu togheter with photographer Olimpiu Vuia. Each member had a well-established role and, in an interactive way, they managed to carry out this great challenge named Călțun refuge.

Overgaard graphically outlined the iterative design process following the project lifecycle stages (Figure 7).

Conventionally, the iterative design process is individually performed by each design discipline: the architect designs the plans, sections and elevations of the building, the structural engineer produces the spatial structure that allows the building to be built, the plumbing engineer will generate a solution that will make the space comfortable and so on. Designers would occasionally meet during their work to ensure that their solutions are not in conflict. So the project is defined separately and not as a result of a joint process of thinking. Such an interaction in the planning process was the interaction between CLT manufacturer, the design team and the pilot chef Nicolae Chirita.

As a result of this collaborative team effort the final structural and manufacturing solutions consisted of 29 mm diameter bars, that were threaded into existing rocks on the site, covered with CLT (Cross Laminated Timber), that is a natural material derived from wood with very high mechanical strength and moisture, and protected from the elements with a special aluminium sheet brought from Norway. The entire construction shell is held together with 3000 screws that were calculated exactly for each panel.

Engineers from the company that delivered the panels recommended a thickness of at least 14 cm to withstand the wind load over 160 km/h (Figure 8) and snow of 4 meters high and 2.5 tones/m^2 heavy. Such thickness implied a bigger load for transportation and the entire budget would be compromised. Due to extensive design and strong concept oultine the entire building functions as a rigid shell that distributes uniform the resulting efforts, so the iteration of the CAD modelling resulted in 6 cm of CLT for walls and 8 cm CLT for roof structure.

The last 23% of the budget was given to transport and the pilot's team is maybe one of the best in Romanian aviation. An amount of 4.5 h of communication between the pilot crew chef and the design team were needed to integrate the transportation knowledge into the model. At the end, 8 tons of kerosene were burned for delivering the model on site.

Nevertheless, when design is approached from an integrative perspective, the project team understands, develops and generates collective solutions, therefore the design process becomes an organic one. Due to high performance expectations imposed by the environment, transportation method, low budget and function the

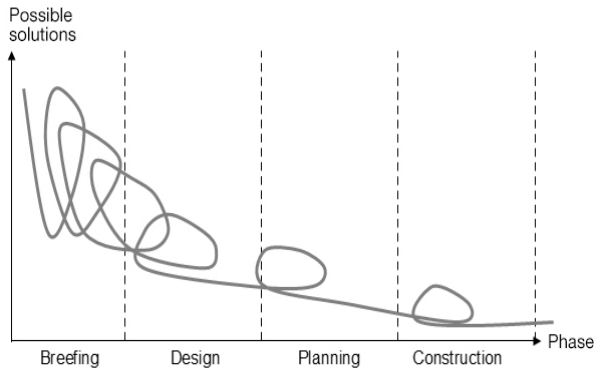

Figure 7. Iteration in different phases of construction projects [5]

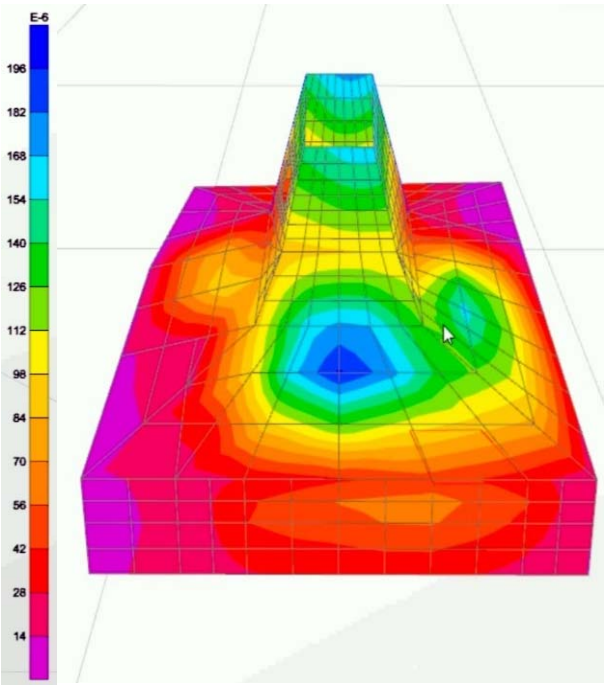

Figure 8. CAD planning

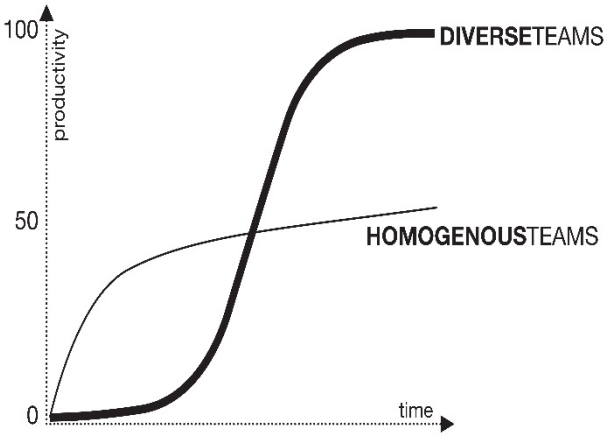

Figure 9. Diverse teams V.S. Homogenous teams [6]

project has encompassed a time frame equivalent to the design process of three apartment buildings, as engineer Marius Soflete told in an interview for Zeppelin (2016). But innovative ideas arise when participants go beyond their limits of expertise, support, innovation and performance in complementary disciplines. This is what effective examples of integrative design processes are teaching us.
This result is partially due to the limited degree of familiarity and associativity that allows multidisciplinary teams to develop performant solutions. (Author Frans Johansson's The Medici Effect "speech in 2004) (Figure 9).

Finally, a natural bound was build inside the project team due to a spirit of camaraderie and their deep love for the mountain that each participant was sharing (Figure 10).

4. Innovation and results

In conclusion is essential to underline the unique outcome that defines the flexible modular system developed by an integrative design team.

The modular structure of the shelter is capable of adapting and responding to different conditions. It was designed to be used and delivered in three versions because of the three functional modules with a capacity of 8, 16 or 22 places inside (Figure 11). A version without the Emergency Rescue room (16 people), another version without the front access space with kitchen and a third option, another basic module, without the parts mentioned above (8 people).

All versions of the module preserve the shelter tower concept idea of „a lighthouse in in the mountains" Marius Miclaus . In its complete form it can provide optimum protection for 22 tourists and four mountain rescuers.

The resulted work can be defined as an unique sustainable object sensitive with the users and the surrounding environment.

The ongoing first year user assessment of the project has been giving an overall good appreciation for project characteristics. The following factors were assesed: functionality, accessibility, interior space, materials, interior temperature comfort, air quality, light, general interior confort, aesthetic value. The questionnaire that focused on user satisfaction, concluded until now, that the Caltun shelter project is well apreciated with 9.4 points out of 10 average user satisfaction score. The assessment brought to light a ventilation deficiency that is already on the design teams table for research and development.

5. Conclusions

Due to overall performance, the pilot project can be considered a model for best practice regarding integrative design.

Figure 10. Project implementation team

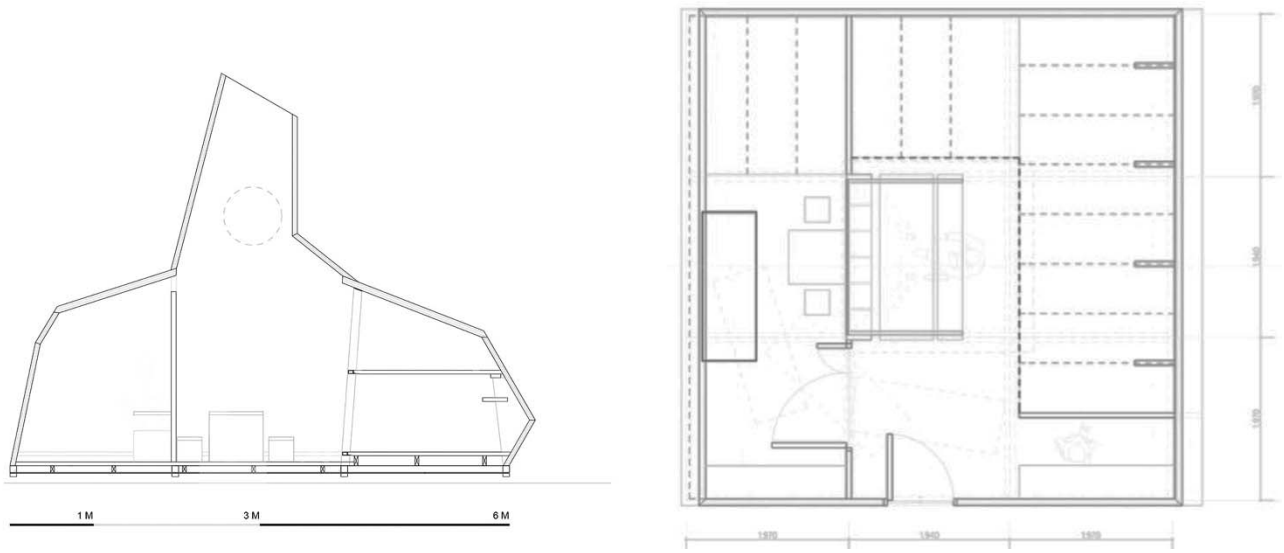

Figure 11. Project plan and cross section

According to the authors' opinion, supported by the user response, Caltun shelter represents a very successful project experience where the principles of sustainable planning have been applied on a common benefit initiative.

The innovative part of the process for this type of structures is the modular system construction that offers the possibility for further development and improvement regarding comfort and can be used as a design solution response to extreme conditions in other extreme locations in the Carpathian Mountains or elsewhere.

6. Founding source

Utopia N.G.O. – Non-governmental organization concerned with matters related to sustainable design, architecture and urban development. Utopia N.G.O. has sponsored the research process of the present article.

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