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## Transformable Shelter: Evaluation and New Architectural Design Proposals

Dr. Maziar Asefi<sup>a</sup>, Faegheh Ahangar Sirus<sup>b</sup>

<sup>a</sup>Tabriz Islamic Art University, Tabriz, Iran

<sup>b</sup>Tabriz Islamic Art University, Tabriz, Iran

<sup>a</sup>[mazi1017@yahoo.com](mailto:mazi1017@yahoo.com), <sup>b</sup>[hasti\\_arch64@yahoo.com](mailto:hasti_arch64@yahoo.com)

### Abstract

The current shelters mostly are difficult and time-consuming to be erected and are usually made of heavy materials. Many of them are not foldable in a configurable geometrical order which make their transportation more difficult and their storage for future use is mostly problematic. This paper by evaluating major existing shelters, proposes a lightweight, foldable and modular shelter that can be replaced, repaired and stored in a very short period of time. The proposed structure has the capability to be expanded by adding more space to its ends and sides. Considering that triangle is a stable form, this shelter is consisted of triangular parts which are moveable both on upper rails and the rails on which modules can be moved and opened in a sliding mechanism on the field. This system can meet different topographical and environmental conditions and also different functions. The structure, in addition to its main function as a temporary shelter, can be used for temporary exhibitions and also for many temporary applications.

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*Keywords: Shelter, Temporary, Foldable, Sliding, Application, Modular components*

### 1. Introduction

A tent as a temporary shelter plays an important role in responding to different architectural requirements. There is now a huge demand for temporary spaces for exhibition, care and camping units that are required to be used in different locations in different period of times. The current shelters mostly are difficult and time-consuming to be erected and also they are usually made of heavy materials. Many of them are not foldable in a configurable geometrical order which make their transportation more difficult and their storage for future use is mostly problematic. All of these mean that there is a necessity for the development of lightweight and transportable units that are able to meet different expectations and requirements and have the ability to be store for future use and be deployed in a short period of time (Ergunay, 1999).

The paper aims to propose and design a temporary shelter with a modular system in order to overcome the expected building shortage after a possible disaster and to create an easy foldable unit that folds in a short period of time (Asefi 2010). This paper by considering the main existing temporary shelters that use foldable and assembly mechanisms will propose a new solution that is easy to be folded and transported and at the same time has a capability to be expanded as required.

**2. Design and Evaluation Criteria for Temporary Shelters**



In order to make the process of selection easier, architects need to set design evaluation criteria at an early stage of the design process. These criteria derive from the function and size of the structure, design context, type of use - temporary or permanent - expected lifecycle and criteria that are related to the particular project. The skill of a good designer of such buildings, is to establish a balance between requirements and constraints such as available resources, financial issues, structural and operational concerns and maintenance issues (Asefi, 2010).

Main design and evaluation criteria are under sum of constructional, humane and sociological necessities required for a temporary shelter and living unit. This table was organised based on a holistic understanding of major primary and required aspects of the design of temporary, multi-functional spaces.

**3.Examination of the existing shelters**

In general ,there are two main types of shelers in terms of material ,use and construction technology. 1-shelter with transformable elements (use both rigid and flexible materials), 2-shelter with non-transformable elements (use rigid materials). following table shows some examples of both types and their main characteristics.

Table 1.comperion of shelter types

Rigid forms	Flexible forms
	
<p>Main characteristics</p> <ul style="list-style-type: none"> <li>- Large Volume</li> <li>- Security</li> <li>- Can Use recyclable materials</li> <li>- Energy efficiency in production and use</li> <li>- Ease of assembly but takes time</li> <li>- Less environmental pollution</li> <li>- Ease of manufacturing</li> <li>- Expandability</li> <li>- Less flexibility</li> <li>- Heavy</li> </ul>	<p>Main characteristics</p> <ul style="list-style-type: none"> <li>- Flexibility in form</li> <li>- Foldability</li> <li>- Ease of Transportation</li> <li>- User s aesthetic preferences</li> <li>- Using recyclable materials</li> <li>- Visual communication</li> <li>- Easy of assembly</li> <li>- Difficult to be expanded</li> <li>- Light weight</li> </ul>

*3.1.Shelter with transformable elements (use both rigid and flexible materials)*

As this research is to propose a new type of transformable shelter, only the second group of shelters are evaluated.

*3.1.1.Folding bamboo house*

A simple elegant design, the Folding Bamboo House, designed by Ming Tang, is constructed from bamboo and recycled paper and can be cheaply manufactured (Fig.1). Tang designed the geometric folding structure after a 7.9 earthquake hit central China. The structures can be folded into many different shapes, allowing a range of structures to be created. This shelter due to its elegant design and re-configurability of is structure is suitable for temporary application especially exhibition spaces (wildday, 2011).

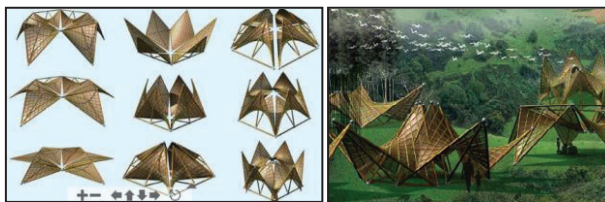


Figure 1.Folding bamboo house



Figure 2.Recover accordion shelter

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