The Convertible House

DETAILS AND MATHEMATICAL DECSRIPTION

Module .... Film
Theme .... A planet organized by humans
Languages .... Japanese, English

Description

The Convertible House film was produced for nearly three months – from May to July 2012. However, the ideas, presented in it, have been accumulated during a much broader period – from mid-2005 to early 2012.

This film blends concepts and ideas from different dimensions of human activities – from theoretical science and engineering to ecology, education and art. It spans over a wide spectrum of subjects like mathematics, physics, architecture, computer science, meteorology, urban design, computer graphics, history and literature.

Scientific and engineering dimension

The film addresses several scientific and engineering challenges and suggests a solution for them. They are described briefly in the next subsections.

The architectural perspective

The film represents an architectural design of a convertible house. The house is split into four partitions. Some of the walls in the house are solid and thick; others are transparent and thin (see Figure 1). Three of the partitions can move and thus reshape the interior and the exterior of the house.
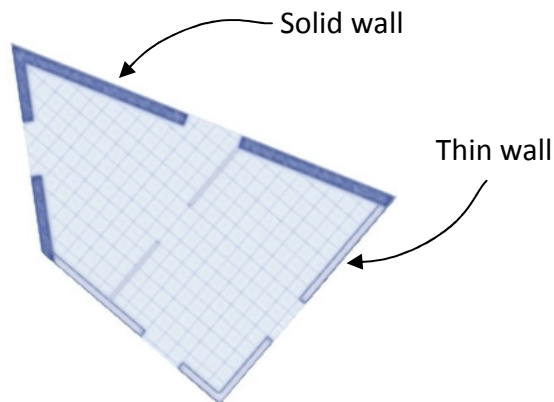

Figure 1. A partition of the house containing two rooms – the two darker walls are thick and solid, while the other two are thin and transparent

The central (and also largest) partition of the convertible house is static and it hosts a small garden. The garden in the film resembles Japanese gardens – short trees, decorative bushes, small pond and a few bridges (see Figure 2).
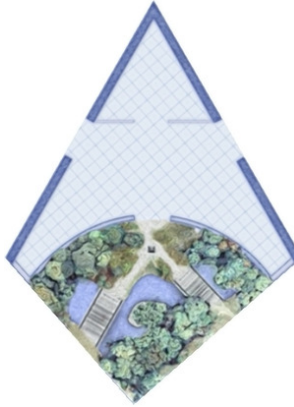

Figure 2. The central partition of the house and its Japanese-style garden

The environmental perspective

The different house configurations provide comfortable living environment that accustoms to various weather conditions. In sunny days the house can turn its transparent walls in a way that all the rooms are sun-light-friendly, while during storms the house can curl up with its solid walls on the outside, thus protecting itself (see Figure 3).
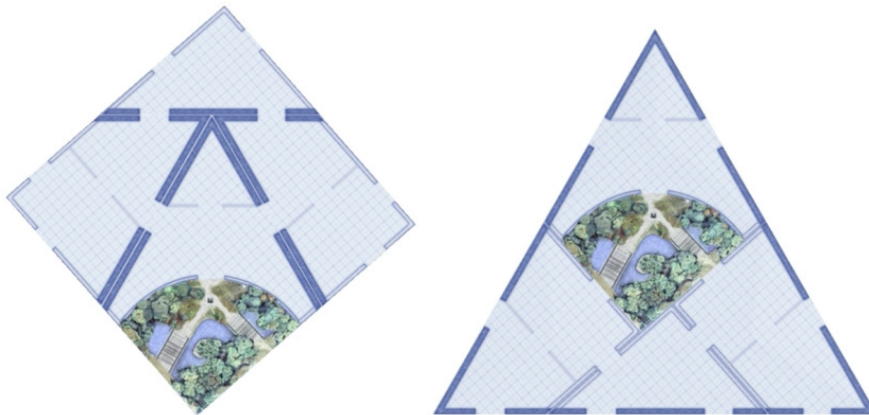

Figure 3. The house in its open and closed configurations

In its most open configuration the house provides unprecedented 360° panoramic view. In its most protective configuration the house becomes a "fortress".

The ecological perspective

The ecological perspective of the film is to demonstrate how a house could be energy efficient and Nature-aware. By rearranging the rooms, the house can expose itself to or shield itself from virtually any direction. The garden in the central partition can be easily transformed from open-air summer garden into an in-door winter garden.

Such flexibility contributes to preservation of natural resources by reducing the energy footprint of house lighting, heating and air-conditioning. Figure 4 shows three configurations of the house that demonstrate three different exposures.
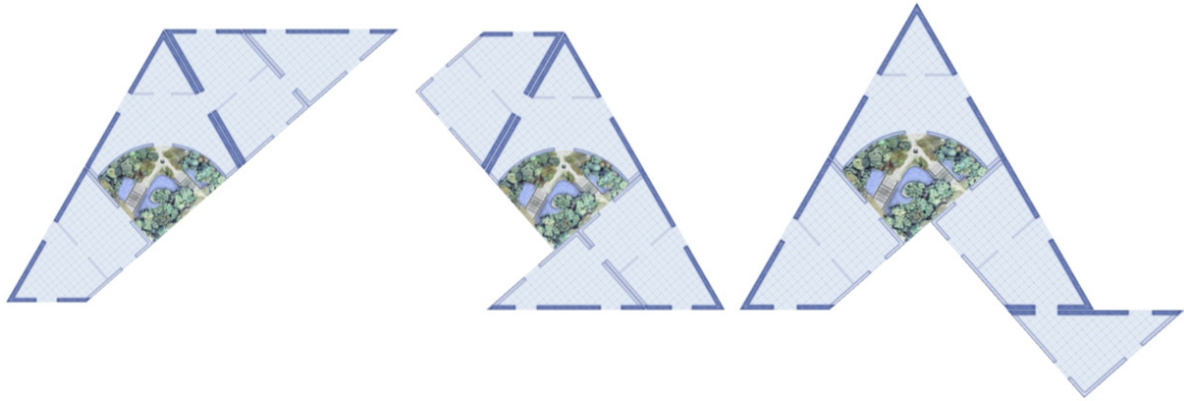

Figure 4. The left house is facing south-east, the middle one is facing west, and the right one lets a stream of freshness to reach the garden (suitable for early spring mornings)

An interesting case is to split the house in several areas separated by thick walls – some areas accumulate warmth from the sun; while others are naturally kept cool. Such layout would be used in spring and autumn days, when it is too cold in the mornings but too hot in afternoons.

Educational dimension

The film (and the making of the film) has potential educational use. It demonstrates and provides topics for discussion of important concepts in mathematics, computer science, art and Far East literature.

The mathematical perspective

More than a century ago Henry Dudeney [11] set out the nowadays famous Haberdasher's problem [10]. The task is to dissect an equilateral triangle into a square by making only three straight-line cuts. The partitioning of the house follows closely the mathematical solution of the Haberdasher's problem. As a result, the shape of the house can transform from equilateral triangle into a square … and then back into a triangle as shown in Figure 5.
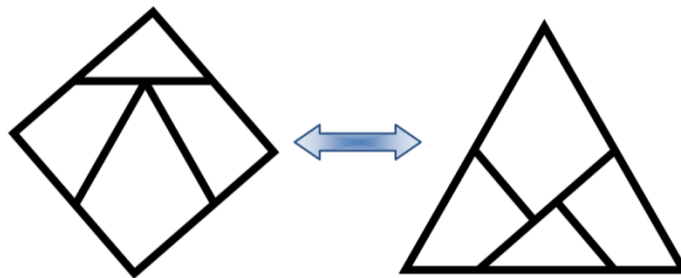

Figure 5. A solution of the Haberdasher's problem

The partitions are connected by hinges that correspond to and support the mathematical concepts of symmetry and rotation. The locations of each room's doors are calculated in a way that for any possible configuration if two rooms share a common wall, and then their doors map exactly one against another. This renders the house completely passable at any stationary moment (i.e. the house is not half-way between one configuration and another).
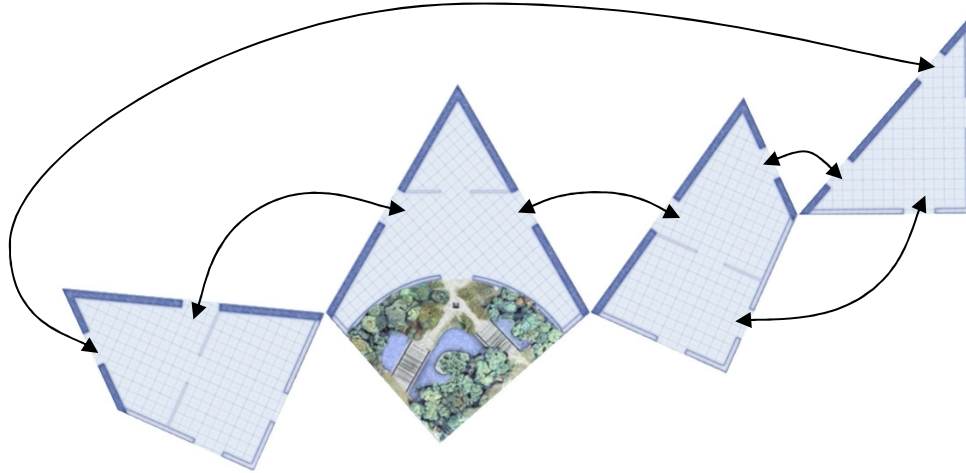

Figure 6. Doors map perfectly when their walls are adjacent

The computer science perspective

This film is implemented as a software program that controls programmatically animations and other visual effects. This approach of film production, being opposite to the interactive drag-and-drop approach, provides educational opportunities to present and discuss how computer science (especially programming) can be used to design virtual models of various structures.

The artistic perspectives

The Convertible House is a digital film. It has been digital since its beginning. The making of the film required significant efforts for fine-tuning its artistic aspects: generating and digitally manipulating textures, aligning sound effects, synchronizing video time-line with the sound track. The making of this film is included as a topic in the newly redesigned university course *Fundamentals of Computer Graphics* in the Faculty of Mathematics and Informatics at Sofia University [3]. The artistic impact of the film on education is yet to be witnessed in 2013.

The cultural perspective

The scenes in the film are accompanied by carefully selected haiku poems. Haiku is a Japanese poetry characterized by its very short form and significant emotional impact on the reader [9]. Key components of a haiku poem are the direct or indirect relation to seasons and Nature; and the juxtaposition of images. The poems selected for the film are semantically aligned to the depicted house configurations providing correlation between the seasonal image of the poem and the arrangement of rooms. In order to support the cultural perspective, the haiku poems are selected from eight different Japanese classical poets like Basho [2], Buson [7], Issa [8] and Shiki [5], to name half of them.
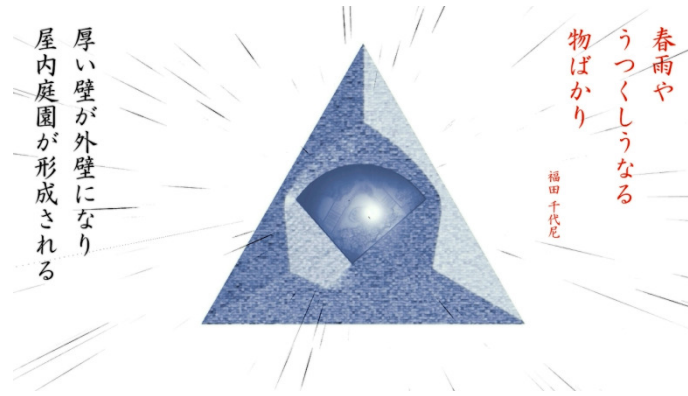
Figure 7. The house as seen from outside during a rainy day – the middle glossy section is the roof of the winter garden; the text in black describes a feature of the house; the text in red is a haiku poem

The harmony of Japanese culture and the beauty of the classical haiku poems were the two most significant factors that predetermined the film to be originally created in Japanese (see Figure 7).

The technological and social dimensions

The main social purpose of the convertible house is to provide the two extreme social states – privacy and globalisation. The people in the house are of full control over these states; they can freely switch to any of them and to any intermediate level of privacy.

The sociotechnological perspective

In accordance to the juxtaposition in the haiku poems, the concept of a convertible house blends two completely different worlds. The house is Nature-aware, but it is also well equipped with technology that provides a sufficient sociosphere [4] for the people living in the house. The so called "glass walls" are not plain glass windows, but large wall-sized transparent multimedia screens. They can be used to show interactive dynamic content (like TV programs, movies, weather forecasts, computer games) in an immersive [6] and augmented [1] way. When the screen-walls are not active, they are either completely transparent to make the house light-friendly; or they can actually show virtual blinds to provide various degree of dimming. Dimming could even be spot-focused and dynamic, thus shedding direct light in real time.

Possible future development

The most unexpected result of the design of the convertible house is the understanding that this model provides possibilities for future development. It is not feasible to include all such ideas in a 2-minutes long film, so they are intentionally left out of it. Here are some of these ideas:

Connectivity

The house could be connected with neighbouring houses to share information about evolving weather conditions. Having an adequate and precise meteomap of the district may be crucial during disasters (think about wildfires, tsunamis, tornadoes…)

Splitting

The house transformation could be stopped half-way. This will result in partitions that are completely separated – i.e. a person cannot go from one partition to another through a common joint door. Such configurations might be useful to modify the house into a collection of individual lodges and bungalows (see Figure 6); or even to form a private guest house as in Figure 8.
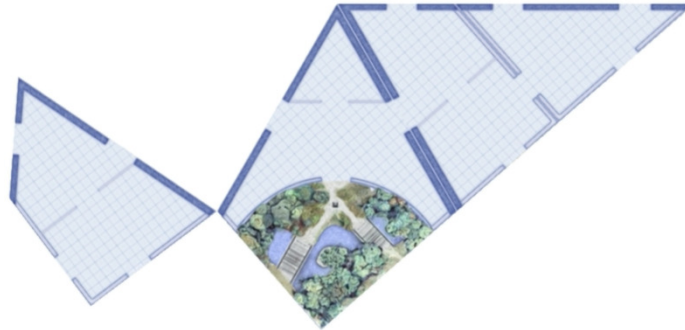

Figure 8. The left partition of the house split as a private separate guest house

Underground utilisation

It is possible to build underground structures like pools. A suitable place for a pool would be such that during the summer it is completely open air and during the winter it is under the floor of a folded house partition. Thus the area under the house span could be utilized completely, depending on the season and on the weather conditions.

Virtual joining

Friends living in different houses may establish audio-visual contact. When walls of different houses are connected virtually, a live image of each room is shown on the wall of the other. In such case, people in a room will perceive it as if it is extended with the room from the other house. In this manner the two groups of friends will virtually join their rooms and share a joined meeting, party or another event (see Figure 9). Three or more groups of people could form a virtual hall – a chain of connected rooms.
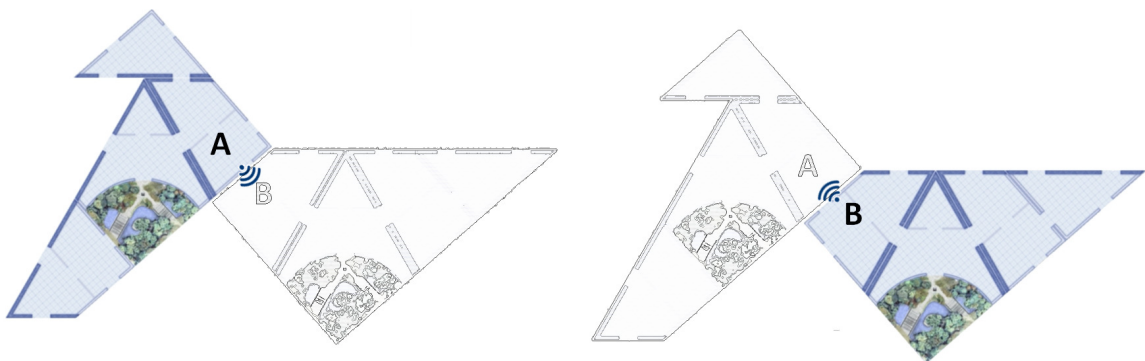

Figure 9. Being physically far from each other, two houses are virtually joined so that people in room A would think that their room extends into B and vice versa

Additional information

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