Beyond the Bunker, Using Virtual Environments to Better Understand User Preferences and Tornado Resistant Housing

Holly Brinker, P.I. McNair Scholar, Dr. Walsh, Mentor

Abstract

According to scientists at the National Oceanic and Atmospheric Administration (NOAA), tornadoes continue to pose an increasingly serious threat to communities throughout the American Mid-West, tornado alley, the most tornado-prone region on earth (see Fig. 1). One question being researchers concerned with architecture is how to design and construct safer more resistant buildings. Engineers continue to develop a variety of novel building forms and construction details, more resistant to the tremendous forces of tornado born projectiles. One problem that remains is that these new solutions do not appear to be getting adopted on a significant enough scale to make an impact or realign the housing market. If we have a better understanding of what is desired, we may better understand why this is happening. Likewise, if people will not buy a stronger yet odd looking house, better research is needed to understand just what people would want instead of a radical new design. This study explores these issues using a mixed methods strategy employing two different experiments and a participatory approach to begin to gain a better understanding of how current housing trends and preferences can be impacted. The first is a card sorting exercise in which the participants review cards and evaluates ten different scenarios. The second is a computerized scenario task which participants can experience each in various preference. The first is a card sorting exercise in which the participants review cards and evaluates ten different scenarios. The second is a computerized scenario task which participants can experience each in various preference.

Materials & Methods

For this study there were a total of 25 participants divided into two groups: group A given prior knowledge to tornado resistance being a part of the study) and group B who were not told about tornado until the post-presentation. This study begins with a card sorting exercise where both groups were asked to pick their top and bottom 3 houses and a house with no impact on the weather. Following this exercise, participants watched three video scenarios of models produced on First (architecture industry standard of computer modeling) and Enscape (game engine). Those in group B were also given the videos in different orders allowing for different scenarios of how the tornado was a post questionnaires. The questionnaire asked questions ranging from the cards, different scenarios, how much participants would be willing to pay for turning on a storm and how resistant for a home. This study was done completely virtually where the user could do the study at their leisure. This specific research is defining which details that make a home resistant were used to draw in include in their home or vice versa. For example, would consumers be willing to spend more improving their exterior and interior walls to become thicker to improve the structural soundness of the overall house. These results will provide possibilities for homeowners and buyers to investigate further research is exploring the question of which design and which ones are being chosen. Also, are tornado a big enough factor for the home buyer or owner in the Midwest that these are design details they would even begin to consider.

Data & Results

Part 1

Fig. 1: Tornado Watches 2019 (NOAA)

Lit Review


Fig. 2: Card Sorting Exercise

Above are the cumulative results from the consumer preferences in part 1 (Fig. 2).

Part 2

Part 2 Scenarios A, B, and C

Scenarios:

A. A tornado resistant home.
B. A home which can withstand a tornado.
C. A home which can neither protects against a tornado.

To the right are the three scenarios used for the video walkthrough. Each scenario has different characteristics. Scenario A has walls that are 24" thick making the interior smaller. Scenario B has a home with no windows and doors with shutters. Scenario C has a glass dome that shelters the whole unit in the case there is a tornado. Overall, scenario C was the number one pick for group B and the majority of group A picked scenario B.

Fig. 3: Card Sorting Exercise

Conclusion

Outcomes: Anticipated and Actual

At the beginning of this study I was expecting participants to pick houses in the card exercise based on their preference. Even though I believe this still occurred, but it also appears there was some experimental bias with some users in group B (anterior to tornado resistant). These participants chose houses such as house A as their favorite, in order to "help" the results. In contrast, users in group A, scenarios of the tornado aspect chose house A as their least favorite. This result raises interesting new questions such as whether residents should be a mandate to inform all potential owners of the reality of tornado in the region, if this seems to factor into decision making if I were to conduct a similar study, I would have questions prior to the card sorting exercise about design preferences.

For Part 2: Another aspect I anticipated with the scenarios was that scenario C would be outvoted in its security with a glass dome shielding the entire unit. Representing this strategy was challenging because its apparent impact was harder to reveal. It is important to include because engineers are currently exploring dome structures to shield homes from strong winds. For these two experiments, participants selected this as their preferred scenario, yet this now appears to have resulted primarily from the obvious abundance of natural lighting. People seemed heavily influenced by how big spaces felt and the amount of lighting. This seems to suggest that designing strategies that afford additional space might be crucial to making a tornado resistant house feel less like a bunker, the challenge the current emergency warnings are not as effective in most normal housing applications. Perhaps this light might be attained by other means such as through the inclusion of reinforced glass materials.

Further Research

We can expect houses to continue to be built in tornado alley, and the tornado here are predicted to be increasing in frequency and intensity. And should we continue to be overbuilt and be ready to rapidly build a replacement? Or should there be a requirement to build tornado proof your home to some extent? Can the use virtual environments and early consumer participation enable architects and homeowners do better at designing homes ability to weather these storms while remaining architecturally pleasing? Strictly speaking, the results from this study are inconclusive, yet these results are still promising; at this point there are still more aspects left to explore and additional technologies should soon be available. Making this even more reliable and possible as a method of inquiry. Architectural design is moving forward with technology such as Virtual reality that is integrated with architectural design is beginning to help us explore the psychological side of design more deeply. Tamari (2015) discusses how architectural can be an artistic practice that entails sensuousness and embodied thought in order to establish the sense of being in the world. There research will test the feasibility of using virtual reality to gain accurate qualitative and design human responses. Qiangan (2018) used a kind of computer adaptation design and methods to maintain the stability between the layout of the adjacent three-dimensional space to enhance the integrity of the interior design method. Using these technologies has the potential to improve methods for incorporating user experience and evaluation of design ideas. Tornadoes are likely to be a continuing threat to the Midwest long into the future, and this research demonstrates a potential for emerging visualization and virtual reality methods to finding comfortable new solutions to this significant challenge.