

Clothing and Housing: Using Materials with Adaptable Features Can Improve Comfort and Safety in Emergency Situations

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ABSTRACT

In this paper, we intend to present adaptable solutions to improve the safety and comfort of users during or after natural catastrophes (earthquakes, eruptions, floods, hurricanes, droughts) or man-made disasters (conflicts and war). We will explore several suggestions, which I will list below: new applications of signage and innovative materials, which allow a more efficient communication in an emergency situation; garments that become shelters, to minimize the negative impact caused by the destruction and loss of the victims' houses; thermochromic materials, reflectors and color used as warning signs, model partitions, lightweight structures, etc. Those are some examples of the features that enable temporary installations to be created in order to relieve human suffering.

Conclusions: In this study, we present some versatile, adaptable, and ecological structures, which reflect the environmental and social changes in our western society. We have put together a series of solutions to create temporary shelter. Projects which are a response to the needs of today's world: contemporary nomadism and struggles in renting or buying a house, due to the rising cost of essential goods and the cost of living. The recent past has been marked by a series of unpredictable events: a pandemic, man-made disasters (Russian-Ukrainian War) and natural catastrophes (a heat wave that hit Europe and increased the risk of fire, heavy and persistent rain that caused floods, falling trees and the recent earthquake in Turkey and Syria). Different occurrences that have left several people homeless. When working in extreme conditions and with limited resources, the provision of a shelter can reduce vulnerability in social and economic terms, physical integrity and well-being. It has been found that the development of this type of product has advantages in terms of comfort, mobility, and safety, as it allows for a rapid adaptation and recovery.

Keywords: Disaster zones, Design, Innovative materials, Signage, Mobile shelter, Color

INTRODUCTION

In this paper we will try to explore the possibility of incorporating signage in coverings and pavements. Strategies are sought to guide and walk safely in new spaces and environments. With various advantages, it is possible to achieve greater time saving and user independence, improve detection

and identification of areas or buildings, increase safety levels in public spaces, workplaces or fire situations, avoid risks or prevent accidents, facilitate understanding.

In a second moment we will study colour as a way of improving communication, protection and safety. Thinking about the main colours that allow us to identify dangers and information on accident prevention. Then we will point out some responsive and adaptable materials, which react to a certain stimulus by changing colour. There are a number of products that require temperature control and monitoring — food and drink — during manufacture, storage, distribution, administration. Temperature fluctuations compromise the quality, safety and efficacy of the product, especially in the pharmaceutical and medical area — e.g. vaccines, eye drops, insulins. Consumers demand more and more information about the products they buy. Today, there are increasingly flexible, competitive and viable solutions, thanks to the use of thermo-sensitive pigments, adhesive labels/indicators, self-adhesive thermometers, etc.

Finally, we will identify some experimental projects of portable architecture, flexible structures or garments that are understood and shrunk, that are in motion but can also be parked. Reactive, unexpected and mobile pieces that allow to improve the safety and comfort of the user.

DEVELOPMENT

1 — Security and Signage

Informative signage is commonplace and even compulsory in certain situations, although it uses methods and materials that are not very appealing from an aesthetic or sensorial point of view. We are talking about pictograms and traditional photoluminescent panels. The challenge is to understand if it is possible, beyond their informative function, to improve their presentation from an aesthetic point of view. Making possible a continuity of the ceramic surface for the sign, without changing the material, conferring unity and harmony. To think of systems capable of incorporating information although in a non-disruptive way, on the contrary, as harmoniously and aesthetically as possible without ever leaving aside the main function of communication, to inform the user clearly and intuitively.

So let's think about a space covered with ceramic material in which all the information will be communicated to the users, written or drawn, through letters or symbols incorporated in the ceramic tile itself. Without recourse to panels and information boards applied over the cladding, a solution that inhibits the use of extra pieces and facilitates cleaning.

“Today, any built space must be thought of as a function of the users, encompassing not only their Locomotion needs, but also their communication needs. The diversity of people who make use of environments reflects, proportionally, the challenges of a communication project in increasingly complex built spaces” (D’Agostini, 2017, p. 138).

In addition to improving the technical properties of materials, we seek to encourage bolder applications, the creation of experiences, memories and

greater enjoyment of spaces. The graphic design serves to clarify the purpose of the building and make a message remarkable, share cultural aspects, communicate the subtlety of time (Poulin, 2013). Already at the dawn of civilisation, man communicated through symbols, drawings marked on cave walls, on rocks. Signposting is an integral part of our daily lives and allows for better experiences in each space. In some cases it is mandatory and there is a need to respect the laws that govern each place. We seek to achieve an alignment of these rules, which regulate each building, effectiveness of the passage of information and the aesthetic part.

There is a high resistance from architects or decorators to the application of mandatory signage, as it is seen as noise. The most common thing is that architecture and signage do not communicate in unison. What we find in our buildings is a rigid material (photoluminescent) prefabricated applied later, with different shapes and colours, depending on the message they must convey — danger, obligation, prohibition, information, evacuation routes and emergency equipment and fire alarm and firefighting equipment — which leads to standard signage being avoided whenever possible or often hidden or camouflaged by decorative elements.

Company D'tile, is a very fortunate example, which has developed a tiling system, a finishing tile. In addition to attributing characteristics to the space, emphasising its identity, it allows the accumulation of rubbish to be reduced, improves in terms of safety since the rounded edges cancel out sharp corners and avoids the use of other accessories of different materials such as shelves, hangers, ventilation tiles. Architects and designers were keen to explore the possibility of ceramic tiles and flooring being extended to tables, counters, chairs, washbasins, fireplaces, flower boxes, toilet paper holders, book holders, etc.

It might be interesting to extend this synthesis, this harmony, with the environment to the information media and even speculate on the application of intelligent materials on ceramic surfaces, which become visible only when justified. Enhancing strategies that influence the experiences of using spaces. Striking a balance between information and form. Trying to convey the message effectively without forgetting formal coherence, looking at signposts as part of a communication system.

For example, in case of fire, develop wayfinding systems that become visible depending on temperature, smoke or gases, thus facilitating users' orientation, reinforcing the fastest route to the exits.

2 — Safety and Colour

Colour is inextricably linked to all of this. Let's imagine changing the colour of a coating or a surface to convey information. Let's imagine a wall that reacts through its components to a certain stimulus such as gas, thus allowing the colour of the surface to change? Immediately the user would be informed of the presence of something harmful to his health.

We find it easier to understand what we see, which is why shocking images were placed on cigarette packets. In the same way that there are textiles that

change colour when they are in very polluted environments, it could be interesting if the walls, especially in smokers' spaces, alerted to the fact that the environment is harmful to health, to the importance of opening a window, to get out of that environment or to change a habit. Darkened walls, a parallel with the inflamed lungs of a smoker.

Hospitals, hotels, airports, schools, commercial spaces, industries, stadiums, spas, etc... have different functions and communication needs. Regardless of the space, it is necessary that the environments communicate, that they are easily identified, that one understands which are the possible routes and which are the risks that space offers.

Every year in the European Union about 5 million people are victims of accidents at work, according to EU-OSHA, the European Agency for Safety and Health at Work. "Accidents at work occur in all industries and include slips and trips, falls, falls from objects, from sharp and hot objects, and accidents involving vehicles and machinery" (EU-OSHA, 2001).

Our thinking is pragmatic and action-oriented. Next, we present some products where colour is the bearer of a message. The goal is to try to understand if it is possible to transpose these pigments, technology, or knowledge to Architecture, adding value and making buildings safer and more intuitive.

For example, glasses with photochromic lenses, which on sunny days react and become darker, offering protection against the sun's radiation. In our buildings we can find glass that varies between translucent and transparent, depending on the temperature it lets radiation pass into the interior of the buildings or reflects infrared rays preventing heat from settling inside, making the interior of the building thermally more comfortable (Ritter, 2007). On the roads we can find safety signs, which only become visible when there is a risk of falling ice. The snowflake symbol becomes noticeable, changing colour when the temperature is below -1°C (Ferrara and Bengisu, 2013). The tomme tippee brand's baby bottles or thermal cutlery show when the temperature of the food or drink is at the right temperature. Drink Savvy's range of plastic cups and utensils, such as straws, change colour when the presence of drugs in drinks is detected. Fever-bugz® flat thermometers are used to measure body temperature. They allow you to continuously monitor how hot your body is by applying an adhesive patch to your forehead. This changes colour depending on the temperature. The use of thermo-sensitive pigments is also applied to labels of brands such as Matua, Mikkeller, Coor light or Khortytza. With the purpose of indicating the temperature at which a drink is, it is thus visually possible to perceive the optimal temperature for consumption. The "Eco Freshness Tag" project by the designer Zeyuan Zhang, which detects the pH helps to understand if the egg is within the expiration date to be consumed or not, thus avoiding waste, as the aim is to use first those that are near the end of their shelf life. The Coral pan by William Spiga & Juliana Martins changes colour when hot, avoiding burns and accidents in the kitchen and allowing the user to interact with the product in a more intuitive way. The Russell Hobbs brand launched ThermoColor Kettles, a kettle that changes colour when the water is hot.

Smart materials can add benefits in terms of thermal comfort, sustainability, and interactivity (Couceiro and Carvalho, 2022b).

We also mentioned at the beginning of this document that colour is also used to improve communication. With regard to safety colour codes for marking hazards, in addition to the warning symbol, the background colour also indicates the type of hazard. The OSHA standard regulates safety signs and labels for accident prevention. And it aims to make the signage easy to use and understand. For example, red for immediate danger, yellow for warning, green for safety instructions.

If we look at the symbolism of colours in our daily lives, yellow is a colour that draws attention to danger. It is an eye-catching, garish colour, used internationally as a warning colour on traffic signs or on signalling and marking tapes to identify danger zones, construction sites or to delimit safety perimeters. Its visibility from a distance enables radioactive, poisonous or explosive materials to be quickly recognised, or dangerous edges on machinery or low areas (Heller, 2013). Equally interesting is the case of a yellow flag flying on a ship. This situation symbolizes the occurrence of a pandemic on board, preventing passengers from boarding and leaving the ship. In the flags signalling, the colour yellow symbolizes quarantine. In analogy with the nautical environment, in the middle ages, the existence of a yellow flag flying in a village symbolised the black plague (Heller, 2013).

Another important colour when it comes to dangerous situations is red. Most traffic signs or emergency buttons, which prohibit or alert, to dangerous situations are red. This colour was chosen because it offers the greatest contrast to the sky or landscape (Heller, 2013).

Orange, considered the colour of danger. Due to its high visibility, it is also widely used when the topic is safety: the flashing light on cars, the items used for shipwrecks such as life jackets, buoys and lifeboats or safety clothing for workers. Poisonous products are usually identified with a skull symbol on an orange background (Heller, 2013).

Green is a colour that also plays an important role, as normally emergency exits and paths of distress, appear marked in white on a green background. In the medical field, green uniforms are used not only because it is a calming colour, but also because it has the advantage that when blood is spilled on it, it turns brown, lessening the stress or frightening impact it can have on your natural red colour (Heller, 2013).

Several studies show that there is a bodily reaction to colour. Max Lüscher who states that there is an elevation of blood pressure when an individual, is forced to look for a certain time at the colour red. Or a decrease in heart rate and respiration when it comes to the colour blue, as it is considered psychologically calming (Farina, Perez and Bastos, 2006).

Colour affects everything that surrounds us: our food, health, mood and way of being, our biorhythms, character, the way we dress, the space we inhabit, etc. (Moreira da Silva, 2009) Chromotherapists warn that the use of yellow and coffee colours should be avoided inside an aeroplane, as they cause nausea, whereas a dining room painted in cheerful colours stimulates the appetite, for a bedroom preference should be given to soft tones, as they make the space more peaceful (Farina, Perez and Bastos, 2006).

Besides the safety theme, comfort is also an important vector in this paper. Brown is a colour which is associated with the feeling of comfort, with rustic

materials, with wooden coverings used simultaneously on the walls and on the floor. This makes the spaces more cosy and gives the impression that they are smaller (Heller, 2013).

For some centuries now, attempts have been made to use colour therapy, to take advantage of the healing properties of colours. For example, the use of colours similar to the colour of the disease was one method used. Scientifically it is not possible to prove any curative effect by applying colours. However psychological action, the power of belief, faith can have some positive impact. The contemplation of coloured precious stones, anointing with coloured oils, chromotherapy, art therapy, therapeutic painting are some alternative therapies, experiences with satisfactory results, although they cannot defeat the illness, they can reduce the anguish of the patients (Heller, 2013).

3 – Security, Housing and Clothing

Previously we developed the importance of safety from the perspective of the user as occupant of the spaces. It is interesting to make the bridge to scenarios where the space can no longer offer safety and comfort conditions to the user and it is necessary to provide people with mechanisms to keep them safe temporarily.

In a previous investigation we looked at existing shelters whose features can have a very positive impact when you are working in extreme conditions and with limited resources. For example, low price, material resistance, easy assembly or transport.

The use of textiles in architecture is associated with significant energy savings (Carvalho *et al.*, 2021). We have studied existing shelters whose features can have a very positive impact in cases of extreme conditions and with limited resources. For example, they may have a reduced price, a material resistance, an accessibility in assembling or transporting. It can reduce post-disaster trauma and ensure some privacy, thermal comfort, and ventilation. Solutions that allow quick rehousing and improve the interaction between teams of volunteers and the affected communities, during a transitory period (Couceiro and Carvalho, 2022a).

Whether by choice or by necessity, it is certain that everyone needs a safe place, a home, a haven. On the one hand, there are the nomadic peoples who, out of culture and their own will, have chosen to take their own home with them, sometimes living in the unknown. It is clear that both urgently need a safe haven solution.

There are pieces, used by those who decided to live a nomadic life. From a cardboard box to a typical suitcase, which accompanies the traveller, which reveals their journeys with stickers of the destinations they've been to, to a shopping cart appropriated by a homeless person, which works as a container of their objects, which allows them to navigate in different environments. Departing from the supermarket trolley to something that may come closer to portable architecture is the "Homeless Vehicle", a project by David Lurie and Krzysztof Wodiczko, is a shelter vehicle designed from a shopping trolley. A piece that can be used both for personal shelter, as it has been adjusted

to the size of the traveller's body, but also allows for the transport and storage of their items (Kronenburg, 1998). A personal and private space, which simultaneously offers the feeling of privacy and protection are the Airstream trailers. They ensure mobility and comfort at the same time. Like a car, the "Dymaxion house" (1927), designed by Buckminster Fuller, was intended to be marketed as a whole. It is a habitable machine that combines mobility and speed (Echavarria M., 2008). Mobility is something that continues to be desirable, not only out of necessity, but also for pleasure. BMW's partnership with tent company Autohome has resulted in a Roof Tent for Mini Countryman, which looks like a normal roof storage box, but can be opened to create a shelter. Giving you the possibility to rest or spend a night anywhere. The fabric is weatherproof, lightweight, tear-proof and moisture wicking (Autohome, 2017).

We will list some projects that due to their mobility characteristics are a quick response to the needs of users and guarantee protection, security, comfort, and intimacy. They aim to improve the quality of life in a transitory phase until they have a definitive dwelling.

The case of Noah's Ark, is possibly one of the "most primitive examples of the provision of shelter against a catastrophe" (Davis, 1980). Also in fables, such as the Story of the Three Little Pigs, destroyed houses are depicted, leaving the main characters homeless. In real life we can list several catastrophes that caused many people to need temporary shelter.

We do not intend to make an exhaustive survey, just to list some of the most important events: Great Fire Of London (1666), Lisbon Earthquake (1755), San Francisco Earthquake (1906), Tokyo Earthquake And Fire (1923), World War II (1939-1945), Tsunami in Indonesia (2004), Hurricane Katrina (2005), Kashmir earthquake in Pakistan (2005), Rio de Janeiro landslide (2011), Hurricane Harvey (2017), Hurricane Irma (2017), Invasion of Ukraine by Russia (2022-current), Earthquake in Turkey and Syria (2023).

"Times of war and emergency architecture have always driven the development of new techniques, reducing the focus on aesthetic design, but generating ingenious designs, new materials, ever lighter and easier to assemble structures" (Echavarria M., 2008, p.19). For example, the architect Alvar Aalto during World War II designed a shelter, which could accommodate up to four families. There are many examples on the market of buildings that are designed for people who are in a vulnerable situation. They range from prefabricated modular systems (rigid structures or the combination of rigid structures and canvas), to tensioned systems (rigid structure combined with a membrane, polyester, or canvas), inflatable or pneumatic systems. There are also shelters that prioritise mobility and can serve as inspiration for projects whose main objective is to rehome populations that are victims of political and social conflicts or natural disasters or even religious phenomena.

Other examples of mobility in architecture are some of the projects developed by Frei Otto, Renzo Piano, Herron Associates, or Future Systems in which it is visible the will to develop ephemeral solutions and easy assembly and disassembly (Kronenburg, 1998).

Groups of architects such as Coop Himmelblau, Superstudio and Archigram, and individual architects such as Renzo Piano, Arthur Quarmby, Hans

Hollein, Ionel Schein, George Nelson, Yona Friedman, Richard Hordon, present alternatives to traditional housing, proposing living environments reduced to a plastic bubble, minimal capsule, prefabricated, modular and mobile houses, small structures or hybrid garments (Kronenburg, 1998).

Some of the projects of the Archigram group of architects have become icons of fluid architecture, such as Walking cities (Ron Herron, 1964), Plug-in Cities (Peter Cook, 1964), Capsule Homes (Warren Chalk, 1964), Gasket Homes (Ron Herron/ Warren Chalk, 1965), Living Pod (David Greene, 1967), Cushicle (Micheal Webb, 1966-7), Suitaloon (Micheal Webb, 1968) or Hornsey Capsules (Peter Cook, 1965-6). (Kronenburg, 1998). Archigram argues that clothing adapts more quickly to the needs of a changing society, as opposed to architecture which responds more slowly. (Quinn, 2003). They have pioneered a wearable structures system, explore through their designs the concept of nomadic clothing/shelter.

Not only architects but also designers and artists have created hybrid pieces in which clothing, shelter and public spaces interconnect. Committed to developing materials that make textiles highly resistant, they create a synergy between the wearer, clothing and the environment.

“The snail carries the house on its back” is a common saying. Its shell allows it to protect its soft body from possible predators or adverse conditions. We are going to list some projects that manage to offer a portable solution that allows its user a sense of shelter, refuge, and security.

Final Home (Kosuke Tsumura, 1994) argues that “as urban nomads, we should be fully equipped with clothing that can become a protective shell equipped with extra warmth and enough provisions to allow us to spend a night away from home” (Quinn, 2003, p.103). Hussein Chalayan, with his projects dilutes the boundaries between fashion, furniture, architecture, and technology, creating pieces that are a kind of environmental protection armour. Cp company is dedicated to creating garments that can be transformed into tents or pieces of furniture. Yeohlee argues that “our clothes, which are modular, are also our shelters, which is the main function of buildings. Depending on what extreme you want to be, you could say that clothing is your ultimate home.” (Quinn, 2003, p.111). Artist Lucy Orta pioneered wearable dwellings and developed sections or individual units that can be interconnected to make multiple individual dwellings or combined as a single building (Quinn, 2003). Artists Adrienne Pao and Robin Lasser have been exploring this concept of wearable architecture since 2004 and have created several installations for the Dress Tents project. Martín Azúa’s Basic House II (1999) developed an experimental prototype made from metallised polyester. It is a space that fills with air with body heat or the heat of the sun. A house that fits in the pocket and that protects from cold and heat and questions the exaggerated consumption of products. Other enigmatic projects created by artists are Anna-Sophie Berger’s “The Wearer of Clothes” (2019), Jacqueline Bradley’s “boat dress” (2010-12) which is part of three series of costumes and objects created to mediate the interactions between the artist and the natural environment. The “wearable habitats” as Craig Green himself describes them, designed for the Italian brand Moncler Genius (2018).

We end with the bicycle helmet, for urban cyclists described by the Hovding brand itself as the “world’s safest helmet is not a helmet”. It is a collar that is placed around the neck. Its intelligent features allow the airbag to inflate on impact in less than 0.1 seconds protecting the head and neck. This artificial intelligence technology puts it at an advantage over traditional helmets in terms of aesthetics, but even more importantly in terms of safety. It can anticipate accidents and protect the user. (Hövding Sverige AB, 2023)

CONCLUSION

In spite of technological advances, it is still difficult to predict these sudden events and alert the population in order to avoid a higher number of victims. The solutions presented work as a starting point for a rapid recovery from disaster, to give shelter to refugees and displaced or homeless people. Items which simultaneously guarantee the right to clothing, housing, and security.

In this paper we present adaptable solutions that allow better safety and comfort for the user. We started from the built heritage to wearable structures. Presenting new materials, technologies, or new applications of pigments already on the market. The signage and colour were studied, with the aim of improving communication between the building and the user, in emergency situations. These are moments in which it is intended that the interaction between the space, is intuitive and efficient. We started from the building itself to the actual absence of it. Finally, we analysed products with flexible and versatile characteristics, which can offer security, privacy and freedom in unstable situations. Portable and accessible structures, solutions that allow us to create a refuge to face adversities with greater security and comfort (whether they are climate changes or living in cities with a high cost of living). We believe we are on the right track to find something achievable and capable of increasing quality of life.

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REFERENCES

- Autohome (2017) *AUTOHOME roof tent for MINI Countryman*. Available at: <https://shop.autohome-official.com/en/tested-and-approved-by-mini/50-autohome-roof-tent-for-mini-countryman.html> (Accessed: 9 February 2023).
- Carvalho, C. *et al.* (2021) ‘Textiles in Architecture: Floors and Wall Coverings’, in, pp. 632–637. doi: 10.1007/978-3-030-80829-7_78.
- Couceiro, M. and Carvalho, C. (2022a) ‘Flexible coverings: (Re) dressing bodies and facades. Analogies between the epidermis of our body and the epidermis of our buildings facades’, in. doi: 10.54941/ahfe1001550.
- Couceiro, M. and Carvalho, C. (2022b) ‘Thermal comfort of buildings and their occupants - Dialogue between Nature, Textiles and Architecture’, in. doi: 10.54941/ahfe1001556.
- D’Agostini, D. (2017) *Design de Sinalização*. Blucher.

- Davis, I. (1980) *Aquitectura de Emergencia*. Gustavo Gili.
- Echavarría M., P. (2008) *Arquitectura Portátil*. Links International.
- EU-OSHA (2001) *Uma Gestão Bem Sucedida para Prevenir Acidentes, Agência Europeia para a Segurança e a Saúde no Trabalho - Facts*.
- Farina, M., Perez, C. and Bastos, D. (2006) *Psicodinâmica das Cores em Comunicação - 5ª Edição Revista e Ampliada*. 5ª. Editora Edgard Blucher LTDA.
- Ferrara, M. and Bengisu, M. (2013) *Materials that Change Color: Smart Materials, Intelligent Design (SpringerBriefs in Applied Sciences and Technology)*. Available at: <http://www.amazon.com/exec/obidos/redirect?tag=citeulike07-20&path=ASIN/3319002899>.
- Hövdning Sverige AB (2023) *The world's safest bicycle helmet isn't a helmet*. Available at: <https://hovding.com/> (Accessed: 10 February 2023).
- Heller, E. (2013) *A psicologia das cores. Como as cores afetam a emoção e a razão*. Editora G. Gili Ltda.
- Kronenburg, R. (1998) *Transportable Environments: Theory, Context, Design and Technology, Transportable Environments*. Taylor & Francis; 1st edition (November 6, 2017).
- Moreira da Silva, F. (2009) 'A importância da Cor na Vida', in: Lisboa. Poulin, R. (2013) *Graphic design + architecture, a 20th century history: a guide to type, image, symbol, and visual storytelling in the modern world, Choice Reviews Online*.
- Quinn, B. (2003) *The Fashion of Architecture*. Bloomsbury Academic; First Edition (November 1, 2003).
- Ritter, A. (2007) *Smart Materials in Architecture, Interior Architecture and Design*. Berlin: Birkhäuser Architecture.
- Rockport Publishers. doi: 10.5860/choice.50-4240.