

How can Wool be used in Architecture?

Abstract

Due to the practicality and inexpensive nature of synthetics, large quantities of wool are going to waste. One practical application to avoid such waste could be in architecture, as wool has been established as a durable material that offers protection against the elements. However, most uses of wool in Dutch architecture are especially limited to interior decoration or small use of hidden insulation. This research will analyze how wool could be used as an architectural material by looking at the aesthetic value of wool as a product in the different shearing layers of change in a building as proposed by Brand. By using the experiment-by-design method, it will attempt to measure aesthetic value through surveys. The resulting prototypes will be used to create an architectural (re)design that includes wool in as many of Brand's shearing layers as possible.

Introduction

As a fibre artist and architecture student, the question arises as to why wool is not a well-known product in architecture. Using wool in the built environment can help reduce the overload of wasted wool as it is a natural product which is many cases a left-over product instead of a material production (Beijer, 2021). As wool has served for many centuries as a skin for humans, it is plausible for it to be functional as a second skin for a building. It has already proven to be an insulator as seen in many traditional cultures and modern times. For making wool useful in architecture, it must also have durability and aesthetic value next to functional adequacy according to Vitruvius' triad (fig 1).

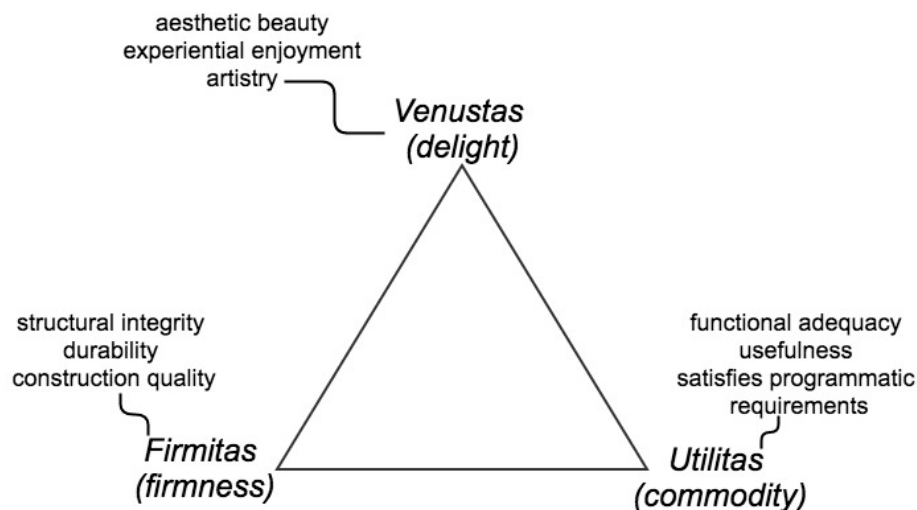


Fig 1. *The Vitruvian Triangle.* (Mcmansionhell, 2017)

Dénes et al. (2019) have proven that the durability of wool has similarities and differences to products made from non-renewable sources, such as plastics from oil. The technical differences are not a disadvantage in the case of wool (Dénes et al, 2019, p.240), therefore why wool still isn't used in architecture might come from the lack of knowledge about what

the aesthetic value might be for architecture. This leads to the question; “In which way can wool be used in architecture to achieve its optimum aesthetic value?”. Aesthetic values are based on human experiences that are mostly connected with intangible feelings and emotions. Finding the answer to this question is therefore only measurable with physical models. To find out which physical models to make and to measure the aesthetic value, the following sub-questions are formulated;

- Which techniques of wool processing can be used in architecture?
- How can wool be used in different layers of the building?
- Where do the aesthetical properties of wool sit in the spectrum of aesthetic experience?

The physical models are part of the experiment-by-design method which will be based on case projects. Finding the optimum aesthetic value for wool in architecture will consist of interviews and comparisons made during the exposition of wool in physical models. Optimizing the aesthetic value will help to find out what physical models need to be developed further to make a useful impact in the world of architecture.

Framework

Wool has been used for centuries to protect our bodies by serving as a second skin. Sheep are bred in many ways to provide us with meat, milk and different fibres. The sheep that are bred for meat and milk is their wool most of the time unsuitable for clothing (Rasali, 2011). In the last century, wool for clothing has been used a lot less due to acrylics proving to be a cheaper and more comfortable solution in the textile industry (Jenkins, 2004, p.27). Modifications could be made to avoid the itchiness and allergies that wool can cause. On top of this, the process of spinning wool into yarn requires several steps of cleaning which tends to be too expensive. This has resulted in nearly 1,5 kilos of wool going to waste in the Netherlands alone (Beijer, 2021). Even though sheep are used less often for their wool they have found way in other sectors in the Netherlands like maintaining natural habitats, such as dikes and Natura 2000 areas. Sheep are an effective method of preserving natural habitats as they eat away the most harmful and threatening nitrogenous plants (Golluscio et al., 2009). It therefore is apparent that sheep will stay an important part of the modern landscape, which means a solution must be found to prevent further waste of wool. This will include the need for more than just the clothing sectors for use of the large amounts of wool.

The relationship between wool and the built environment is not unknown. Wool has been used as an insulation material for centuries, in the form of carpets, tapestries and curtains. It was also a way to preserve the right moisture in rooms, as it has a natural absorption and repulsion (Shorter, 1924). Nowadays insulation is used between the walls instead of being placed on the inside of them. This has resulted in wool becoming less interesting than other materials which are made for example from basalt or plastics due to their higher thermal conductivity coefficient (λ) (Zach et al., 2012). When comparing wool to these insulations, it appeared to keep its insulation value longer when it's partially wet than basalt or plastics, which completely lose their insulative abilities when wet. This shows that wool has advantages over materials currently used for building. In this case, wool is used as a building material with no aesthetic meaning for architecture, even though historically it was a different story as it had been seen in interior applications.

Vitruvius stated that an architectural design must contain the tenants' functionality, durability and aesthetic beauty (2021, p.17), also known as the Vitruvius' triad. For using wool in architecture, the only one not researched from these three tenants is aesthetic beauty. The next step is thus to find the comparable level of value that wool has in functionality and durability in aesthetic beauty. Coburn et al (2017) made the connection from aesthetic beauty to aesthetic experience. As aesthetic experiences such as feelings and emotions are intangible, they make clear what relationship wool might have with architecture. The goal of this research is to find options for the use of wool in a building which will have an optimum aesthetical value to architecture compared to functionality and durability. The following chapter will describe the methodology of this research.

Methodology

To find the answer to: "In which way can wool be used in architecture to achieve its optimum aesthetic value?", the experiment-by-design method will be used. This means making different physical models as prototypes and testing their aesthetical values that are associated with the different shearing layers within a building. The choice of prototypes will be based on literature and case projects related to textiles and fibre arts and answer the sub-questions. This will be done as follows:

The first sub-question will analyse the techniques of wool processing used for architecture, where certain aspects of wool and their applications are further explained. By specifying the techniques, such as weaving, knitting and felting, criteria will be made to which the case projects should be related to.

The second sub-question will start with collecting several case projects which relate to different building layers based on the theory of shearing layers from Brand (1994) shown in Figure 2. Every layer will have a minimum of three and a maximum of five case projects in which at least 2 out of 3 techniques will be used. As most exterior projects might not be made from wool, it's optional to find case projects that contain polystyrene or carbon fibre. The reason why more than one case project is necessary is to compare the cases and decide which aspects of the cases I want to test in my prototypes.

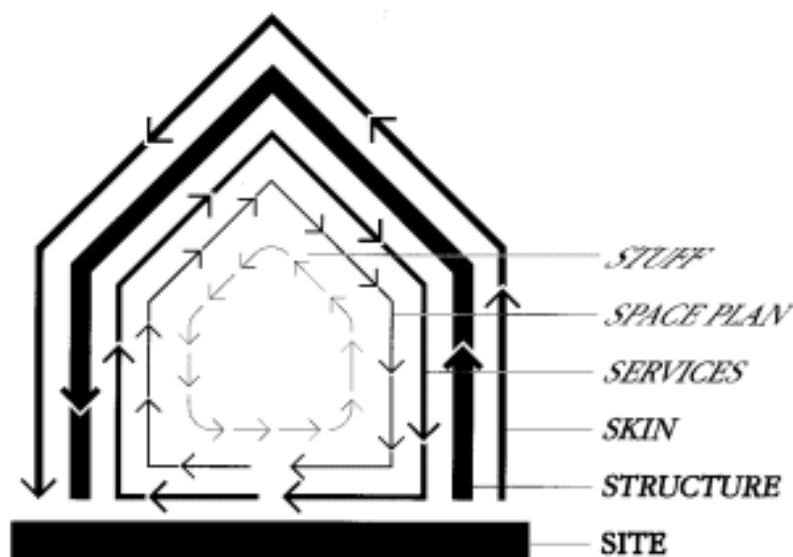


Fig 2. *Shearing building layers of change* (Brand, S. 1994)

The next step is making the prototypes, which are based on the case projects. With prototypes, it's not only possible to answer the question of how wool can be used in different building layers, but also where the aesthetic properties of wool sit in the aesthetic experience. As aesthetic experience is not only based on sight but also on feelings and emotions, having prototypes is essential to value their aesthetic properties. This is why there are at least one and max three prototypes per building layer necessary to value the aspects gathered from the case projects. Every prototype is made in three techniques, chosen from the first chapter. In the end there will be a minimum of 18 prototypes and a maximum of 54 prototypes.

After making the prototypes, the aesthetic experience will be tested with the help of the aesthetic triad (Fig 3). According to Coburn et al (2017) the aesthetic triad can also be applied to the neuroscience of architecture. Based on the topics of their research, I made a small questionnaire (appendix 1) to find these aesthetical properties. The questionnaire is in Dutch, as the relation to the framework is in the Netherlands. These questionnaires will be shared during an exposition and later on, compared to each other. The result will be a collection of prototypes useful for architects to design with the optimized aesthetic value of wool to architecture.

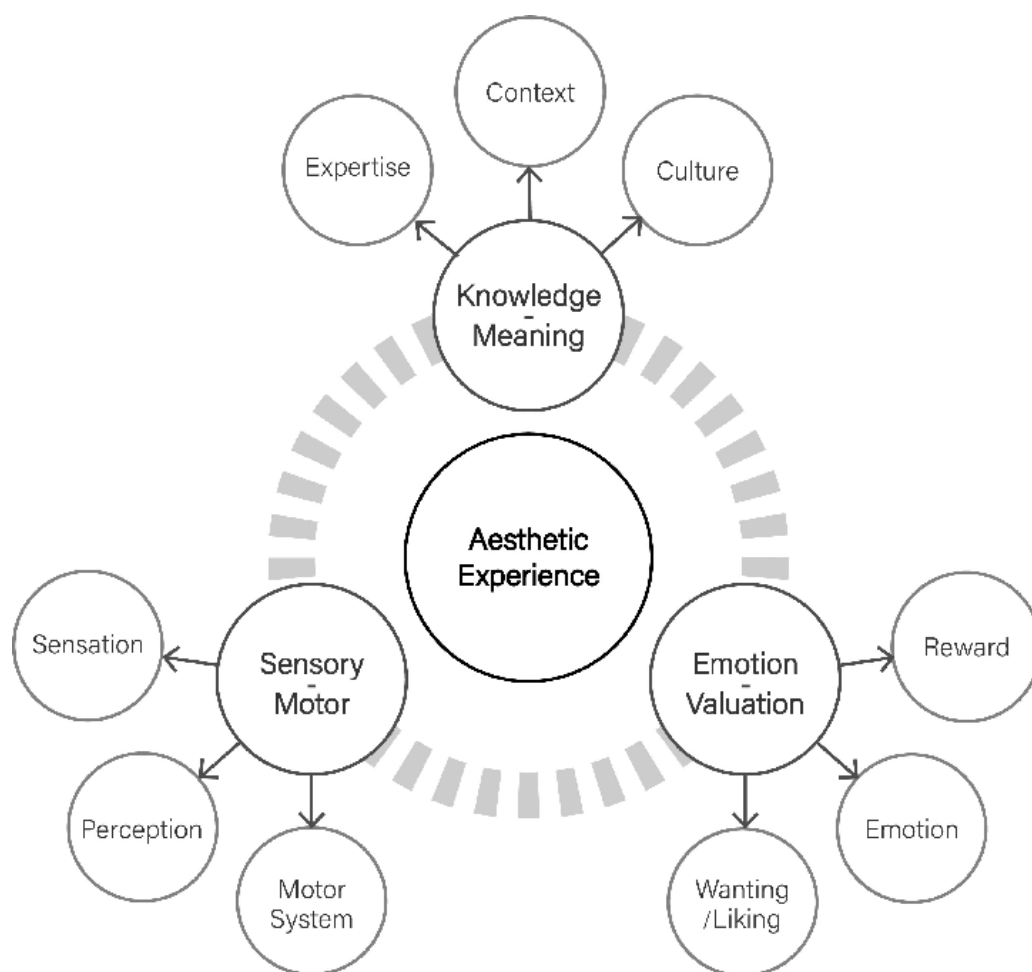


Fig 3. *The aesthetic triad system in neuroaesthetics (Spivak, 2013)*

Expected results

The use of the method of experiment-by-design will help to further understand the possibilities of using wool in architecture and its aesthetic value. In some cases, this might already be known, like in the layer of 'Stuff', where wool is already used in furniture, carpets and décor. For the layers 'Space-plan' & 'Services', wool has already been used but not to its full extent. For the layers 'Structure' & 'Skin' it might be harder to figure out if wool can be useful for architecture. The main challenge of this research consists of finding ways in which wool can be used in the structure and exterior of the building and how it can relate to the aesthetics of a building. One important note about the prototypes is that wool can only be combined with other materials as a composite when alternatives are not possible with the case project. The last layer, 'Site', can be interpreted in many ways, which needs to be defined in the research. It will most likely contain the relationship between sheep, humans and buildings, making this layer the connection in which they come together. How this will be materialized depends on the case projects.

By focusing on the value of aesthetics, the relationship of wool with architecture will be defined. This will create a helpful tool to define which prototypes to use and which are not valuable for a design project. Basing the choice on the most suitable prototype does not only mean it needs to be the most aesthetic one, but it also needs to be durable and functional as Vitruvius stated. This will help in the next step of designing with wool as a material.

Relationship with designing

Working with wool is a passion of mine which has led me to the connection of design with the fibre-arts. This led me to search for a suitable location in the Netherlands that has a social and cultural connection to wool. I found the village Geldrop, which was next to Tilburg one of the most important villages that have produced woollen products since the 17th century. Later this disappeared, but remarkably there is still the Weverijmuseum in Geldrop, which represents a connection with the industrialization of textiles. Unfortunately, it doesn't show the relationship the village had with wool. The goal is therefore to bring back the relationship of wool to this location using the prototypes resulting from this research as a design tool.

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Appendix 1

Questionnaire in Dutch

Achtergrond vragen

- 1 Heeft u ervaring met wol verwerken? Zo ja, in welke vorm(en)?
- | | | |
|------------------------------|---------------------------------|---|
| ☐ Ja, | ☐ Breien | ☐ Spinnen |
| | ☐ Haken | ☐ Viltten |
| | ☐ Weven | ☐ Anders, namelijk ... |
- ☐ Nee
- 2 Heeft u een herinnering of ervaring met de wol industrie? Zo ja, geeft een korte beschrijving.
- ☐ Nee
- ☐ Ja,
- 3 Heeft u een connectie met wol vanuit uw cultuur of achtergrond? Zo ja, geef een korte toelichting.
- ☐ Nee
- ☐ Ja,

Prototype vragen

- 1 Welke bouwlaag beoordeeld u?
- | | |
|-------------------------------------|------------------------------------|
| ☐ Stuff | ☐ Skin |
| ☐ Space Plan | ☐ Structure |
| ☐ Service | ☐ Site |
- 2 Ven de 3 technieken, welke spreekt u het meeste aan? Licht kort toe waarom
- | | | |
|----------------------------------|---------------------------------|--------------------------------|
| ☐ Viltten | ☐ Breien | ☐ Weven |
|----------------------------------|---------------------------------|--------------------------------|
- Omdat, ...
- 3 Onder welke ruimtelijke condities maakte u een keuze? Vink hieronder aan welke van toepassing zijn.
- | | | | | | | |
|------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|------|
| koud | ☐ | ☐ | ☐ | ☐ | ☐ | warm |
|------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|------|

donker	☐	☐	☐	☐	☐	licht
grote ruimte	☐	☐	☐	☐	☐	kleine ruimte

4 Hoe snel maakte u een keuze op vraag 2? Een schatting van aantal minuten volstaat.

5 Welke emoties roept het gekozen prototype bij u op? Vink hieronder aan welke van toepassing zijn.

			Neutraal			
Blij	☐	☐	☐	☐	☐	Boos
Tevreden	☐	☐	☐	☐	☐	Depressief
Opgewonden	☐	☐	☐	☐	☐	Ontspannen
Nerveus	☐	☐	☐	☐	☐	Gelaten

6 Op een schaal van 1 tot 5, hoeveel zou u het prototype waarderen in de bouwlaag?

1	☐	☐	☐	☐	☐	5
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7 Op een schaal van 1 tot 5, hoe graag zou u het prototype willen aanraden aan architecten?

1	☐	☐	☐	☐	☐	5
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