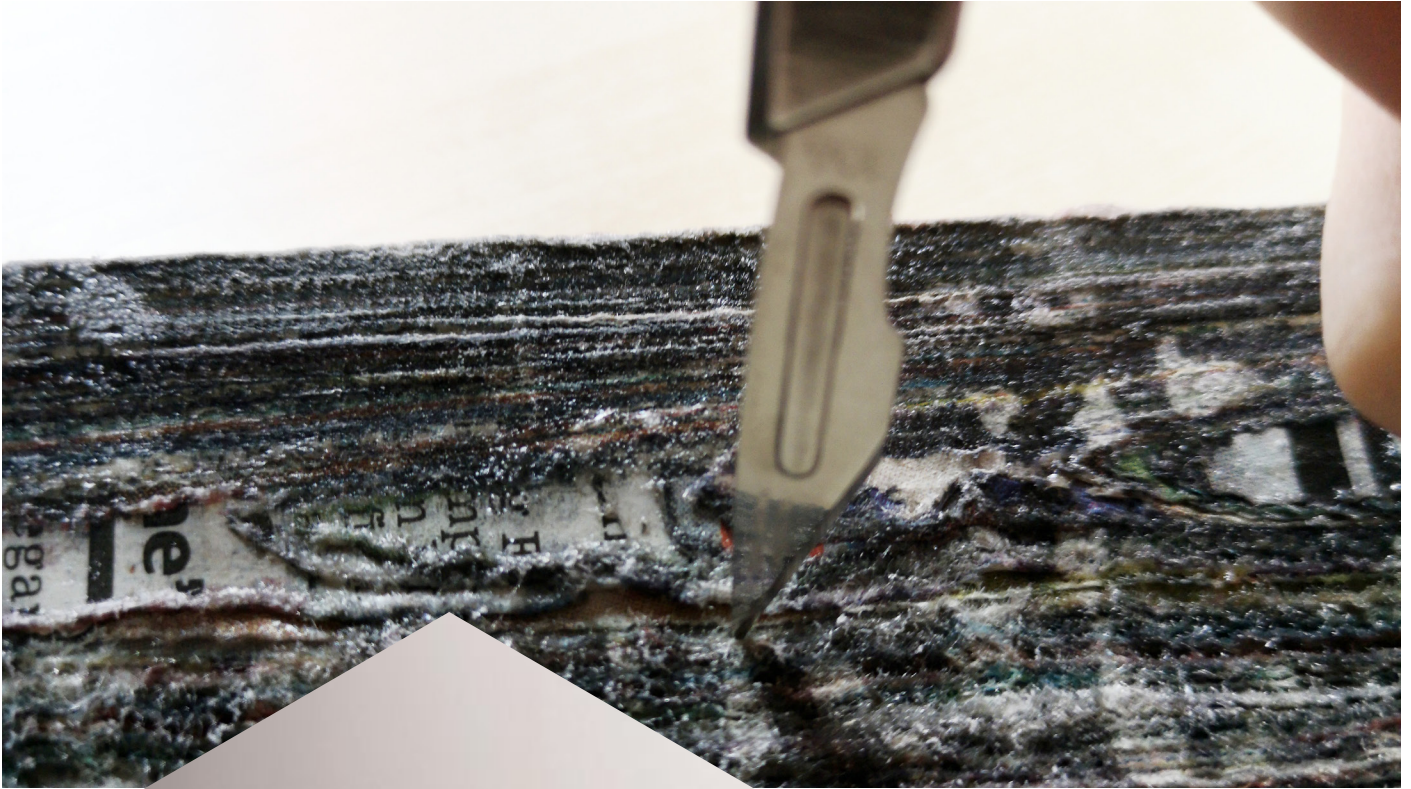


Research Portfolio:  
“Can organic waste be used in  
commercial building construction?”



Emily Burton

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# Introduction

The topic route I chose for this dissertation is sustainable materials, especially in the commercial building industry. By looking at how different products are made from organic waste this can feed into new methods of producing sustainable materials for commercial buildings. One fact that I found while researching, which has stuck with me since starting this task, was that “Research is a process, not just a product” (England, 1994, p.82). As stated, research is an ongoing process that does not end once you get the information. By having creative people doing both a study paper and studio practice, this demonstrates that practice as research not only produces knowledge but promotes a better understanding. As a result, this shows how creatives reveal their understanding, acquire the knowledge and express art within creative work. By doing this research it gives creative people additional knowledge on their discipline, which can later inform their practice.

When thinking about architecture the first thing that came to mind is the aesthetic of a building. Little do we know that “architecture” always has a cultural dimension to it” (Ballantyne, 2002, p.2). These cultural dimensions include the materials of the building. These show you what decade the building was built. Steel frame work within buildings tells us that they were made in the modern age.

People define architecture, with boundaries, by defining the space and movement of the space using walls, enclosures and openings. By having a boundary this creates a limit within a space, and to define the difference between zones either exterior or interior. Today, modern architectural spaces want to be more open plan. Architects are beginning to use natural and sustainable materials more and more into their practices. As a result, the buildings will be more environmentally friendly and have a longer lifetime.

# Inspiration

Most of the projects that I have done at University have always been centred around nature and using natural materials within the spaces. A recent project I created, was designed based on making the site greener. A key element in this design was to involve the interior with the exterior of the building by continuing themes from the outdoor space.

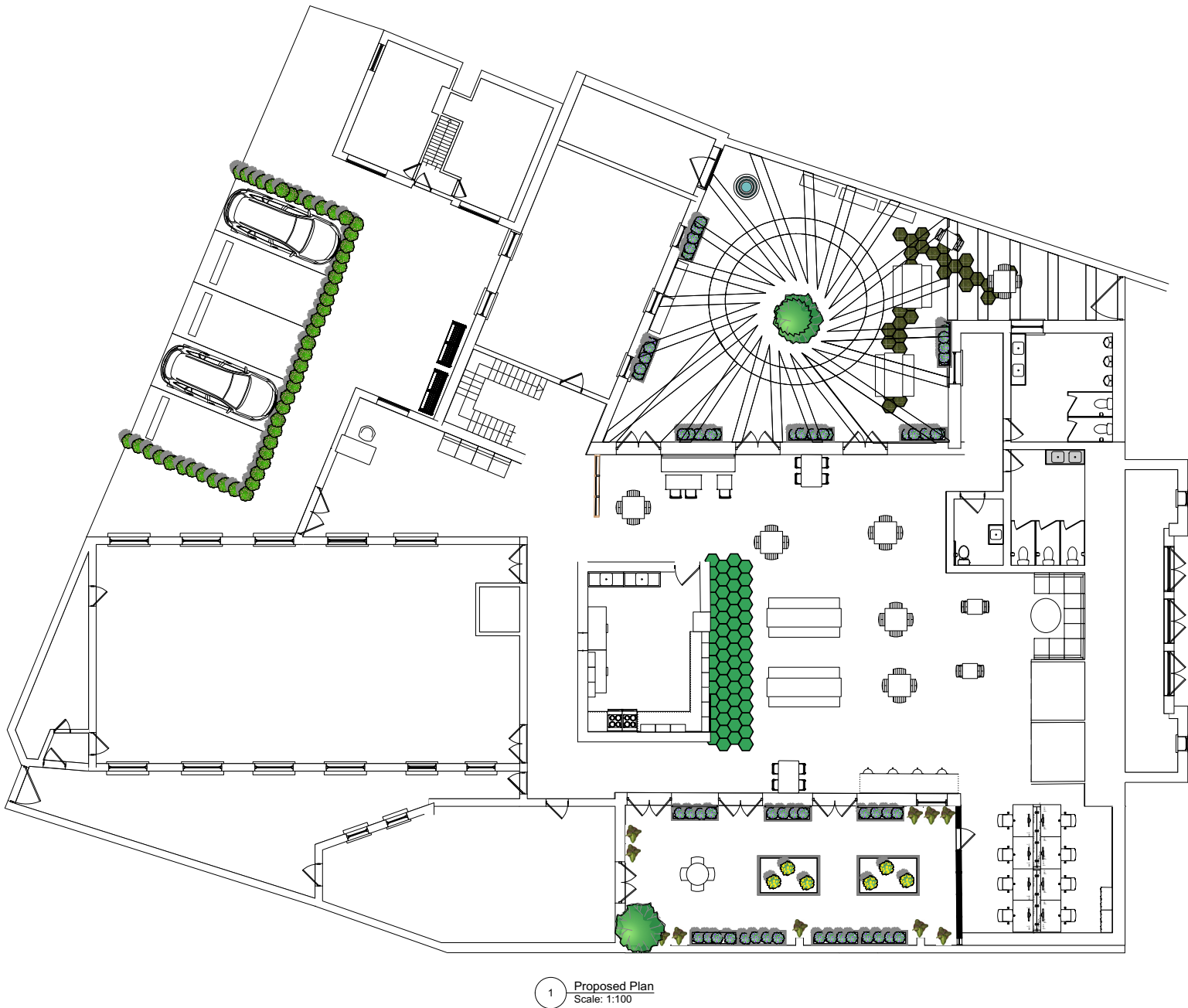


Fig 1: Authors work showing the floor plans of a project that brings the outside design indoors, (Burton, 2018)





Fig 2: Authors photo of Nottingham Contemporary cafe, (Burton, 2018)



Fig 3: Authors photo of the Nottingham Contemporary entrance, (Burton, 2018)



Fig 4: Authors photo of a closer view of Nottingham Contemporary entrance, (Burton, 2018)

A personal interest of mine is being in the outdoors. Nature puts my mind at ease, seeing sunrises and sunsets change the sky is fascinating, and being there just to experience is breath taking. When exploring new cities, I enjoy going on a journey finding green spaces within the busy centres. I admire the new materials used on the buildings. For example, I went to Nottingham and found the material used on the exterior of the Nottingham Contemporary building captivating. A lace design on the concrete panelling of the exterior was used that was digitally scanned in a warehouse to reveal the history of the lace industry in the city.

# Research Topic



Fig 5: Pile of Newspaper, (Arcadia Power, 2019)

**A topic I am interested in is sustainability, and how we can reuse recycled materials to create new building materials without impacting the environment too much. I have investigated how other designers have used environmentally friendly materials to create products with unusual materials such as algae.**

Reading articles and seeing what is already existing in the design world has made me think about the use of organic waste and how we can use it in a safer way to preserve our beautiful world. I am leaning towards the idea of seeing how organic waste can be used in commercial construction. Natural materials are being used in architecture more in the creative industry now. I got leaflets from 'The Grand Design Live Show', in Birmingham, that included a few simple ways which you could reduce the amount of plastic waste people use at home.



Fig 6: Plastic waste, (Cuthbertson, A. 2018)



# Small scale organic products



Fig 7: Building construction site (SINTEF, 2018)

In this dissertation, the question I would like to answer is, can organic waste be used in commercial building construction? I will be investigating the types of materials which already exist, to see which are made from organic waste. I will see how the materials can then be produced on a bigger scale, for commercial construction. My findings will show what sort of materials can be sustainable for a building, and if they would last longer than standard building materials. After researching into organic waste building materials, I found out that a couple of architects and designers have

produced prototypes. Prototypes are small-scale products that can be used within the construction process such as partition walls and insulation. The materials used are peanut shells, rice, bananas, potatoes, newspapers, nappies and animal bloods. These types of common products could be turned into sustainable construction resources on a building site. Organic materials could be the solution for using renewable materials because they are more environmentally friendly after more research and testing.

# Organic Waste Materials



Fig 8: Kokoboard Peanut Shell is a biocomposite board made of waste peanut shells, (Material District, 2014)



Fig 9: Rice husk ash used in cement, (Mujtaba, M. 2015)

**According to the ‘Organic waste could provide the building materials of the future’ (Fitzgerald. 2018) article, waste such as food products can be turned into construction materials.**

Many of these products can be treated to be flame resistant, and made waterproof. Current available products include partition boards which can be made from peanut shells (Figure 8) and raw rice which are both flame resistant and leak-proof. To reduce the need for fillers in cement, a combination of rice husk ash mixed with cement can produce an eco-friendlier material (Figure 9). The benefits of using bananas is they contain high fibre strength which is good for acoustic absorption, and durability in materials.

Potato peel is a very useful material as shown in (Figure 10) once cleaned, pressed and dried as it is low weight, insulating and absorbs acoustic vibrations. A common trend found in this article is that re-using food products after use, and producing new products out of them would be more sustainable for the building industry than the current materials.



Fig 10: The material is made from a potato peel binding agent mixed with fibres from potatoes, bamboo, wood or hops (Dezeen, 2018)



# Waste Materials

**Another article ‘Nine building materials made entirely from waste products’ (City Metric. 2015) states that they have used existing products which have been repurposed into useful construction materials for future production. These products include newspaper and nappies that can be used to produce renewable materials.**

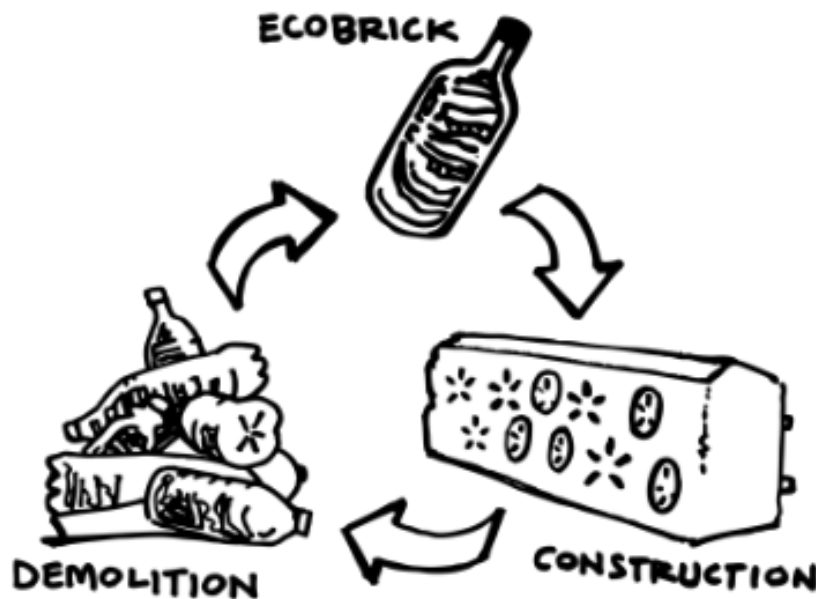


Fig 11: Cycle of using waste to make construction materials (Web Design, 2019)

The idea to use newspaper came from Norway, as it is continually recycled each year. The material is easily made and treated to be fire resistant and waterproof. Newspaper wood can be used instead of wood during building construction. There is a way to create roofing tiles from sanitary products and nappies, by using special recycling plants. These plants separate organic waste from polymers. The polymers would be used to create fibre-based construction materials. Plastic bag bottles, animal bloods and glass bottles can be recycled to make bricks. The plastic bag bottles cannot withhold much weight so they would be better used for dividing rooms or external use. An issue with the bricks, made from animal blood, is that it is not classed as an organic waste product. Even though, there are

issues with the brick, being wasted in cultures other than food production, it is still a useful resource. The blood contains high levels of protein as it is one of the strongest bio-adhesives around. An idea projected by an architecture student called Jack Munro is to use freeze dried blood powder, mixed with sand to form a paste to cast as bricks. This project would be ideal for rural communities with limited construction materials. Glass bottle shapes are now made in cuboid shapes, which are ideal to stack to create a wall structure. From my research so far into smaller scale waste, it looks possible that they could use this in a larger scale construction. I need to research more into design projects that have used these sorts of materials.

# Mushroom-Based Insulation



Fig 12: Mushroom Insulation, (Bramen, 2009)

**I found a UK entrepreneur, named Ehab Syed, who developed a mushroom-based insulation, and other biological materials for the building construction industry.**

**The insulation material is made from mycelium, which is the vegetative part of the mushroom. The material has exceptional insulation qualities such as being naturally self- extinguishing and feeds off waste while it grows and purifies the air once in place in the wall.**

His company looked at organic materials that are completely natural, biodegradable and vegan to improve the current materials used in industry. To create the insulation blocks they let the fungus feed on a substance such as sawdust, which allows it to grow into a shaped mould as the filaments fuse together quickly. Once happy with the amount of insulation in the wall, the fungus can be easily stopped by drying the substance.

From producing an insulation material, this led on to develop an interlocking construction system called 'Triagomy'. This interlocking system is based on a molecular structure of carbon that enables moveable walls in construction. The system is useful for adding new rooms to existing buildings as it uses minimum fuss in the building process. This new development is a step forward in the right direction for the construction industry by improving the type of materials we use.

# Plastic Waste



Fig 13: Eco-brick building, (The Sunday Post, 2018)

**A popular topic about waste that always comes up in my research is plastic waste. The article ‘How to turn mixed plastic waste and bottles into Ecobricks’ (WasteAid. 2019) shows a way to use this type of waste in a constructive way.**

A plastic bottle stuffed full of plastic waste is a very solid product which can be used instead of regular bricks in construction. To reduce plastic waste in our oceans and beaches, this method can put many types of plastic waste into a more productive use. Plastic waste needs to be washed before being packed in to the bottles. By packing the bottles tightly, they do not release harmful fumes. This could risk the bottles safety in the structure and make the building unsafe. Organic waste such as soil, can also be used to fill plastic bottles.

These bricks are just as stable. Plastic bricks provide a free construction material that is highly insulating, lightweight and robust which people in less developed countries could use. Thousands of homes and schools all around the world have been built using Ecobricks. To construct a wall using this method there are two possible ways to do this, either horizontally or vertically. By stacking the bricks vertically, they fill in for the timber frames normally used in a building construction.

If assembled horizontally, the bricks will need to be mortared together with clay or cement like standard bricklaying techniques. Glass bottles are an alternative material to use instead of plastic as they are stronger and do not need to be filled.



# Transparent Solar Panels

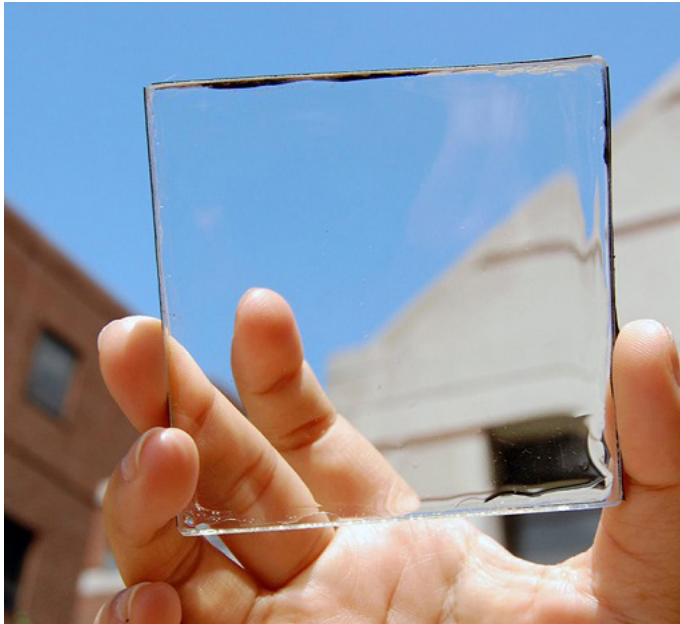


Fig 14: Researcher Yimu Zhao holding up a transparent luminescent solar concentrator module (MMK, 2019)

A new product has just been developed by researchers from Michigan State University which is a completely transparent solar panel. The transparent luminescent solar concentrator can be placed over a clear surface such as a glass window. The solar panels work by the technology of using organic molecules which absorb light wavelengths such as infrared and ultraviolet light through the window. The wavelengths are guided to the edge which has solar cells that collect the energy.

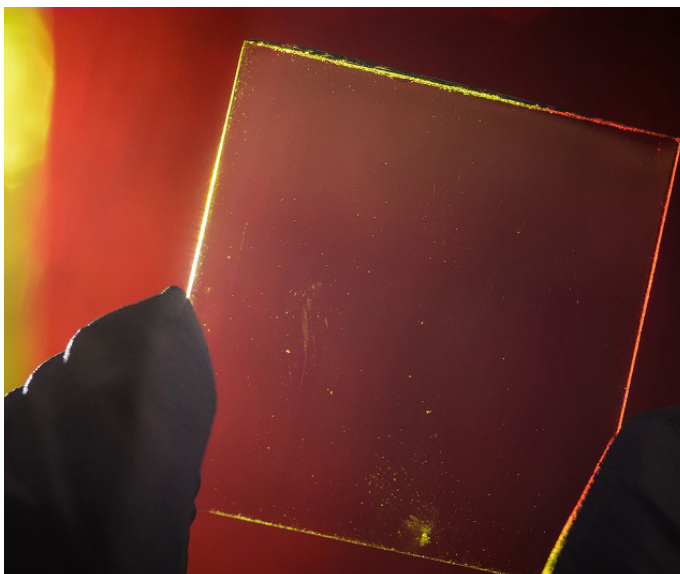


Fig 15: A transparent luminescent solar concentrator waveguide is shown with colorful traditional luminescent solar concentrators in the background. The new LSC can create solar energy but is not visible on windows or other clear surfaces.(MMK 2019)

This panel does not affect the transfer of light through the window. The panel size is bigger than roof tiles which is ideal to use on building facades such as glass towers. These can be integrated into old existing buildings too. This product would not be noticeable on structures, and it reduces electricity bills which is a sustainable material to have for the commercial building industry.



# Large-Scale Organic Material

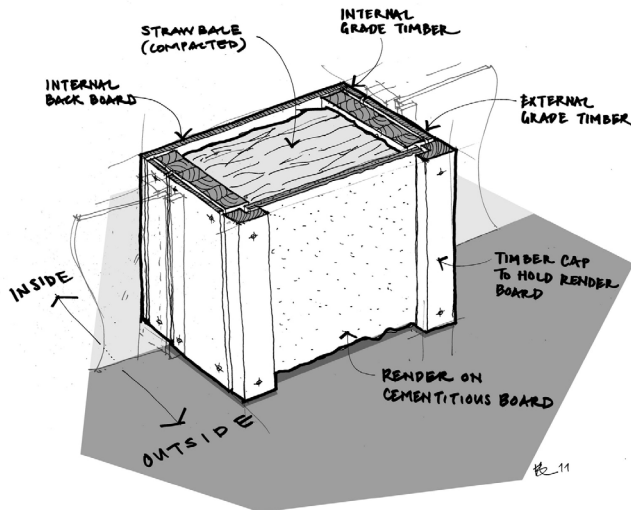


Fig 16: Straw provides a low-tech, cost effective insulating material for high-performance cladding systems. (Make Architects, 2011)



Fig 17: It takes straw bale construction one step further using straw within an external curtain wall system. (Make Architects, 2011)

Research has led me to find buildings that have been constructed on a larger scale, rather than just small-scale parts. Organic waste construction materials were used in a commercial building with a material such as straw. As 'The Gateway Building' (Anon. 2011) article proves, buildings can be made from other materials rather than standard construction methods.

The University of Nottingham's Sutton Bonington Campus held a competition for architects to design an extension to the University to reflect the status of the campus. The architects that won the competition were called Make Architects who created an external curtain wall system using straw. This straw wall system was fitted into the timber frames which is a similar method to how plastic bottles would be placed in a wall structure. The materials were prefabricated in a local flying factory and sourced from the Universities' own farmland on campus.

This saved on transportation emissions. In the main atrium there are windows that expose the raw straw structure. When walking past the structure the public can see the straw process in between the walls. The building incorporates labs, teaching spaces, offices and study areas which has boosted the multi purpose interior space in the university. This Gateway Building is one of the largest single straw-bale buildings in the UK. Researching this topic was really eye opening, and interesting to find out what sort of waste could be turned into a new product. So much organic waste can be repurposed into construction materials and can easily replace the materials we use now to build commercial buildings. All the architects and designers agree that a new method in construction is needed with more environmentally friendly materials.



Fig 18: The Gateway Building. (Make Architects, 2011)





## Research Aim

My aim for my research project, is to create an organic construction material, in order to investigate my dissertation question: “Can organic waste be used in commercial building construction?”

## Research Method

I am going to investigate this question by physically making my own organic waste material with a sustainable material. I chose this method as it relates back to my research. By creating this material, I will test out how easily it can be made and produced on a larger scale. The tests on the material will also prove how reliable the material would be in the construction industry. By pursuing this research project, I will answer my dissertation question.

## Proposed Material

For this task I am producing a piece of newspaper wood, where I will be testing and recording the results of how durable the material would be on a commercial construction site. I did some research into finding out the best instructions to follow to create this wood. By looking at the article ‘How to Re-Engineer paper back into wood.’ (Instructables.com. (2017). This article had the clearest information and was straight to the point.

Once I have completed this task, I will carry out several procedures to see how well the material stands under pressure. This would see if it can withstand pressure in building construction. After reading the instructions from the article I collected the materials and worked out how long the technique would take to carry out.

## Proposed Analysis Technique

After creating the newspaper wood, I will record the process and then test out the finished product to see how durable it is. During this process I will find out pros and cons of the material. I want to create an organic material that will last a long time within a building. The tests will be carried out indoors, so the outdoor elements do not affect the results. I will compare, my attempt of an organic waste material with an existing structure to see the similarities in the materials.

## Proposed Timetable

This task should not take long to make. It should be completed within a week or two at the most. Making the newspaper wood will take two to three days. There is a lot of layering the paper involved which is time consuming. Once the layering is finished, it should take a couple of hours to sand and polish the wood. The newspaper wood should resemble the texture and look of standard wood. The final stage of the process is testing out the wood. This last stage is testing out the wood. It will take half a day or more to complete the various tasks to see if the wood is durable.







# Newspaper Wood

I completed my research task and below is the equipment and instructions I used to create my newspaper wood.

## Equipment

- Newspaper/ paper
- Wooden dowel
- Water based adhesive
- Paint tray
- Roller brush
- Bandsaw



Fig 21: Equipment needed to make the Newspaper wood, (Burton, 2019)

## Instructions

First, I prepared my workspace by having all my equipment in front of me to start with. This included my newspaper, wooden dowel, ruler, scissors, scalpel and UHU glue as shown in my picture.





Fig 22: Piece of newspaper next to a ruler ready to be measured, (Burton, 2019)

The paper size needs to be the same, and the suggested size to use is 11" x 8.5". This is roughly 27cm length and 21cm wide which is the size I decided to go for. The newspaper sheets need to be cut and marked out with a ruler to get an accurate size every time.



Fig 23: Newspaper ready to be rolled on the wooden dowel, (Burton, 2019)

I used a wooden dowel with a large radius as it is hard to wrap around a tight circle. Start by attaching the 11" length edge of your first sheet of newspaper to the dowel as shown in the photo above. Make sure it is perfectly straight when applying glue to the dowel then press down to make it secure.





Fig 24: Rolling Newspaper, (Burton, 2019)

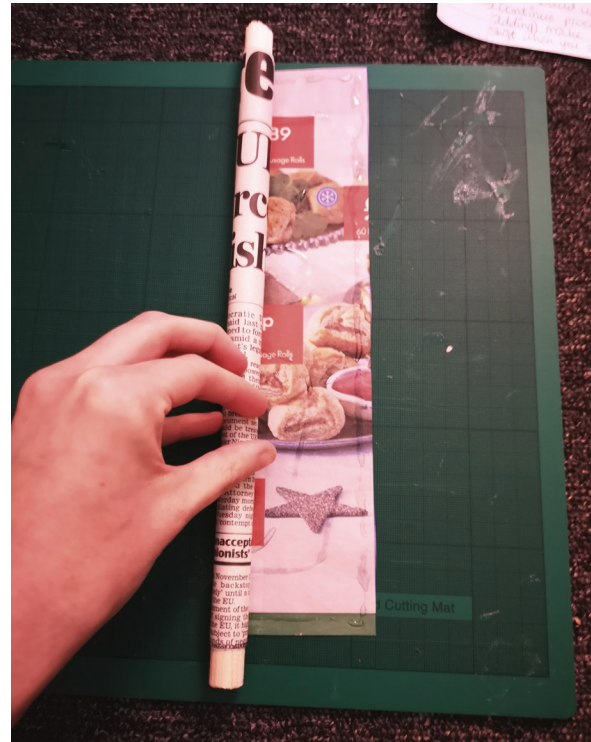


Fig 25: Rolling Newspaper (Burton, 2019)

Before rolling the newspaper, make sure the side of newspaper that will be in contact with the dowel has a coat of glue on it so that it is secure. Slowly, roll the newspaper tightly around the dowel making sure you roll straight. Use your fingers to press out the air bubbles and the glue build up within the layer.



Fig 26: Newspaper rolling in progress, (Burton, 2019)



Fig 27: Newspaper completely rolled , (Burton, 2019)

Continue this process in ten to twenty-page intervals. Make sure it is dry between layers, so the layers do not shift when pressure is applied. Stop, once the roll feels thick enough with plenty of layers of newspaper. Make sure, that the final layer has been glued securely so it does not peel off.







## Final Step



Fig 29: After being cut on the Bandsaw (Burton, 2019)

Now that I have finished rolling the newspaper, I need to cut the material to make the wood pieces. I used a bandsaw in the workshops to cut my newspaper on either side of the dowel. I cut straight along one side of the dowel. The piece cut off now resembles a panel of wood. This panel of wood can be cut into sections and squared off at the edges. The newspaper can now be treated like natural wood by sanding and finishing it off to the standard of normal wood.



# Testing Materials

I carried out numerous tests on the newspaper wood to see how well it can withstand pressures it would have to handle in construction. I did three experiments that include using water to see its absorbency, tests for strength of the material and the durability.

## Water Resistance



Fig 30: Testing newspaper wood with water (Burton, 2019)



Fig 31: Testing newspaper wood with water (Burton, 2019)

I tested how well the newspaper wood would absorb water by running water from the tap over the material. My results were different to what I expected. I thought the material would change when wet as it is known for being weak when wet. The wood retained its shape, however, the edges which had no treatment on them got damp and flimsy. The treatment on the newspaper wood gave it protection and helped repel water.





Fig 32: Testing newspaper wood with scalpel (Burton, 2019)



# Strength of Material



Fig 33: Testing newspaper wood with standing on it (Burton, 2019)

I did a range of tests to see the strength of the wood such as a dent test, scratch test and weight test. To test out if the material would dent when objects have been dropped on the wood, I used a variety of different weights from different heights to see the impact on the wood. The results of this showed that the newspaper wood had not been damaged during this experiment.

The material needs to withstand scuffs and scratches when people walk on it, as well as chairs scraping on the floor. I used a coin for the scratch test and scraped it as hard as possible on the

newspaper wood. There was no impact on the wood. Finally, I pierced the wood with a scalpel to see how the material would retain its shape when cut into. It had no effect on the wood. I stood on my newspaper wood to see how much weight it could withstand. As it is a material for flooring it would need to be able to handle the weight of a person. The newspaper made an initial noise when I stood on it, but it stayed strong and did not buckle under my weight.



Fig 34: Testing newspaper wood with chair (Burton, 2019)

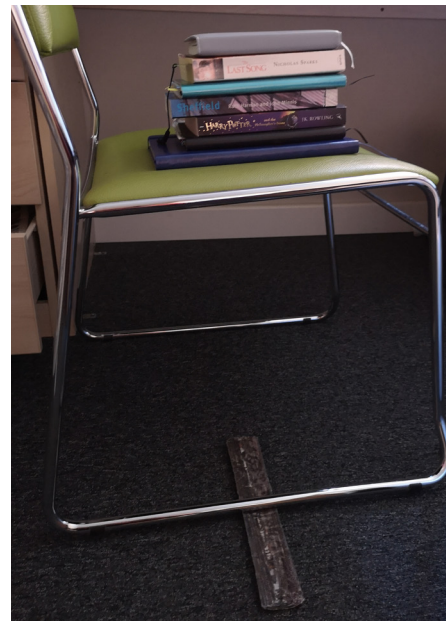


Fig 35: Testing newspaper wood with chair with weight (Burton, 2019)

As this material would be used for flooring, I tested out furniture that would normally leave marks on the flooring. I put my piece of newspaper wood under my chair with and without books to see if it could withstand the weight of both. The results surprised me by finding out that the material was still intact with no damage.



# Flexibility

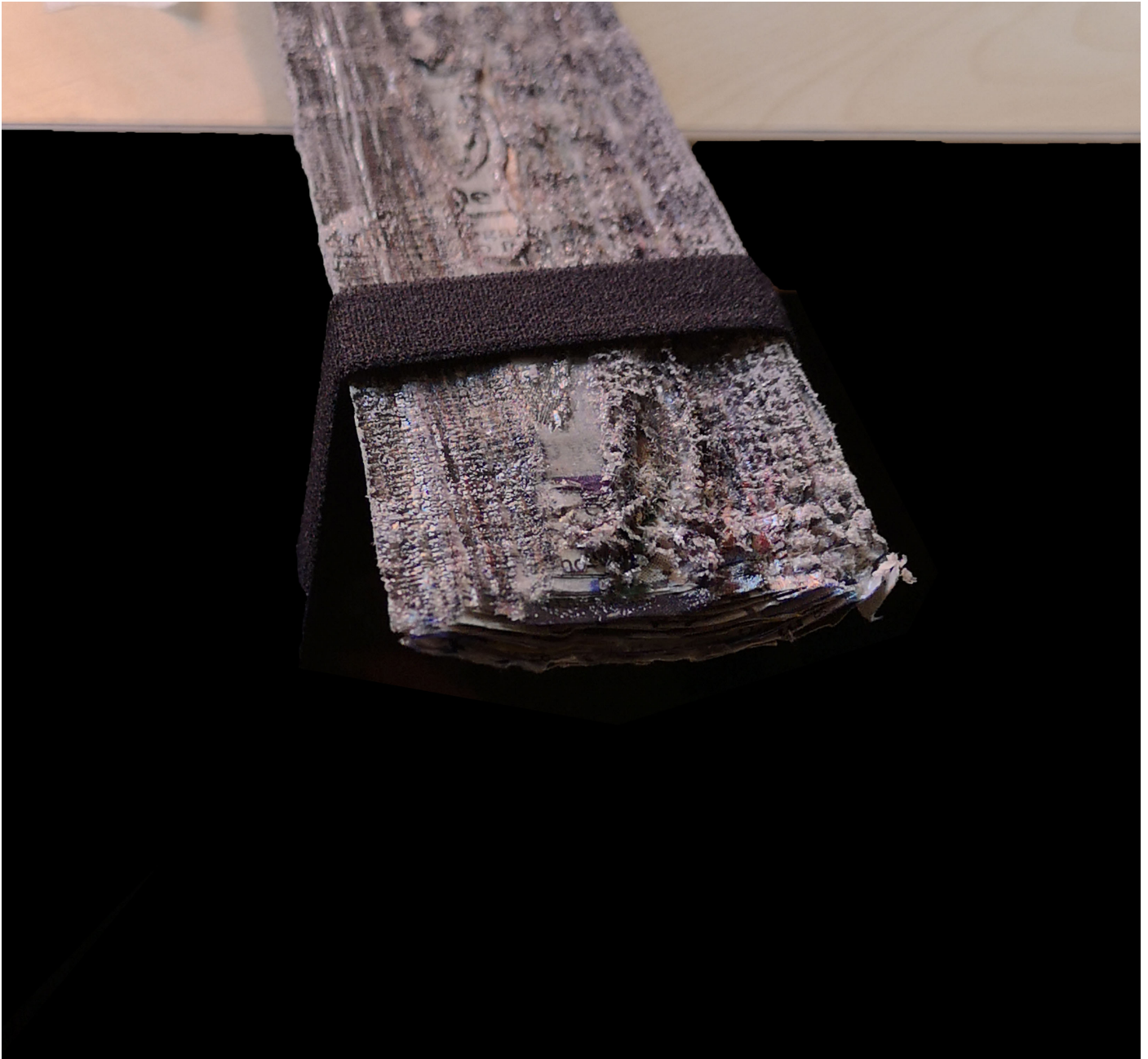


Fig 36: Testing newspaper wood with heavy weights on the end (Burton, 2019)

The first experiment I did for bending my newspaper wood was gripping both ends of the material and applying pressure on each end. This resulted in the middle structure retaining however the edges warped under the pressure and started to bend. I added weights to the end of the wood to see how much it would bend. I taped down the wood to my table and then hung different weights on the end. The outcome of this test was that the more weight added to the end the more it struggled and started to bend.

# Analysis of The Process

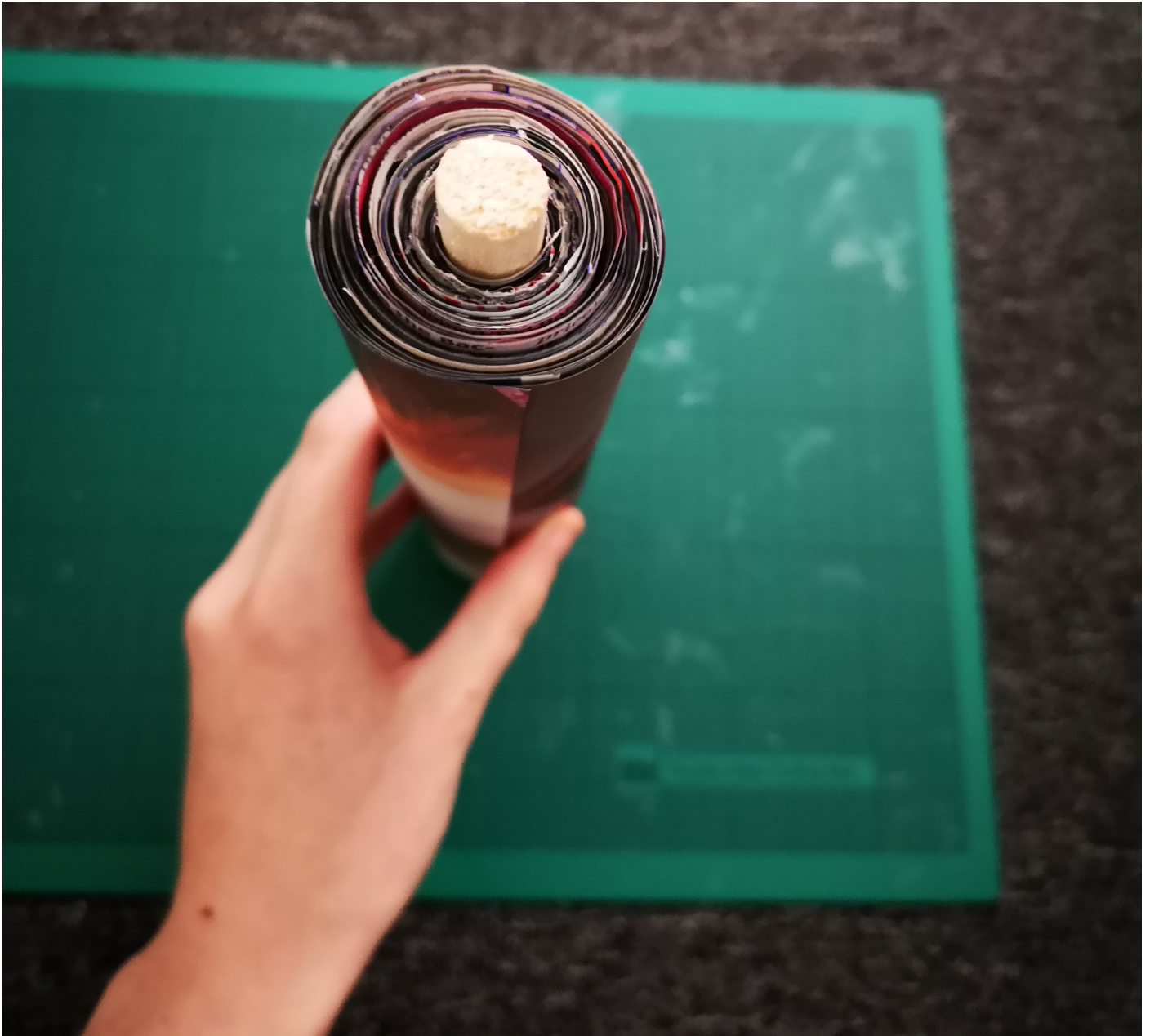


Fig 37: Newspaper Wood, (Burton, 2019)

During this making process I found out that my material was very time consuming to produce, however, machines can make this process a lot quicker in the commercial industry. The main problem I faced were timings for each part of the method. I had under estimated how long they would take. My first setback happened when I was reading the instructions. It made me realise that I had to dedicate a lot of time to cutting each individual piece of newspaper to the right size. Cutting the paper became very time consuming, because I used up to sixty-one sheets of newspaper. Another challenge I faced was the time it took to wrap all the newspaper. I needed a thick enough roll of newspaper to cut with the bandsaw. In the end I decided to cut only one side of the wooden dowel as the other side was not very stable. I had not applied enough glue during the layering stages, so it was not safe to use the bandsaw.

By completing my research task, I have found out that producing an organic waste material is a very simple method. The material is much stronger than I imagined it would be especially being newspaper. My method took a long time, however, if this was done in the commercial industry it would take less time as they would use machines to create this product quicker. The advantage of this material is that newspaper is sustainable. You can recycle and reuse this material continuously, compared to other materials in the industry. A disadvantage of this material is that the newspaper wood is not as high quality as existing materials that are used for flooring.



# Case Study: The Gateway Building



Fig 38: Each straw bale panel consists of a cross-laminated timber frame filled with compressed straw and finished with render for a natural look to the external face, (Make Architects, 2011)

In my research I briefly looked at The Gateway Building and how the architects have used sustainable materials for their structure. This relates to my research, as the newspaper wood is something I want to produce in commercial construction of buildings. The University of Nottingham were the clients for this project as they set it as a competition for architects to design an extension. The building is about half an hour from Nottingham City Centre. The goal for this building was for the university to have an extension on their campus to reflect on the status and expand the campus. The extension needed to reflect the students using that building which was home to plant and animal science courses. The architects who won the competition are called Make Architects who satisfied the clients brief by using resources that relate to the courses within that building. The architects designed the external curtain wall system using straw for the extension of the campus. With straw being a natural agricultural by-product, it makes it an environmentally friendly alternative to conventional materials which is the aim of this dissertation. The audience for the building are the members of public who travel to the university and the students who study there.

The process of making the straw curtain wall was a simple method that is similar to my newspaper wood. Both projects took a couple of steps to create the new materials. It was easy to make my wood material by rolling newspaper, and from looking at the website about this building in Nottingham, this process was easy to produce with simply filling in the gaps in the timber frames. Both projects had the materials treated at the end to keep the structure strong in production. This meant that the organic material could be shown off to its full potential within the structure. Even though my material is designed for the floor and the Gateway Building material is designed for a external wall, they both have to deal with the elements.



Fig 39: Straw is a natural agricultural by- product and an environmentally-friendly alternative to conventional building materials (Make Architects, 2011)

# Conclusion

I would like to close by saying that I learned a lot about organic waste materials that are used within construction. I found out that so many materials can easily be turned into construction materials. These objects include items we use every day like banana peel to unusual organic waste such as animal blood powder. This draws on current issues we face in the industry with construction materials been thrown away after use. Only recently we have started to think more about the materials we use. This is a throw away generation. After using a product once, we decide to get rid of it, and it ends up in landfills, affecting our environment. We are now starting to think more about sustainable materials and ways we can reuse objects so they can have more than one life. Recent food waste campaigns try to remind us about the organic waste we throw away daily. We can use the waste we would of thrown away to produce strong, reliable construction materials. The next step is to start getting these organic waste materials into more commercial construction buildings, as we know it can be done.

This can be related to my own practice by considering the materials I use. My current project is about libraries and this ties in perfectly with using organic sustainable furniture inside the building. I could use paper or newspaper material-based furniture for seating or other components in the library. After producing the newspaper wood, I've decided to incorporate that material into cladding my reading pods on the exterior of my building.



# Figures

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- Figure 15: MMK (2019) A transparent luminescent solar concentrator waveguide is shown with colorful traditional luminescent solar concentrators in the background. The new LSC can create solar energy but is not visible on windows or other clear surfaces [Image]. Retrieved from <https://www.architectureanddesign.net/transparent-solar-panels/?fbclid=IwAR2AhkF6YSQMm2RBhmWmeV3SDRGkW7pQ0JZYK5EwfGJk5Asn8B1tECUEsoE>
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- Figure 17: Make Architects (2011) )It takes straw bale construction one step further using straw within an external curtain wall system. [Image]. Retrieved from <https://www.makearchitects.com/projects/the-gateway-building/>
- Figure 18: Make Architects (2011) )The Gateway Building. [Image]. Retrieved from <https://www.makearchitects.com/projects/the-gateway-building/>
- Figure 19: Make Architects, (2011) In the main entrance atrium a series of ‘truth windows’ tell the story of the building’s construction allowing visitors to see the straw bales, which would otherwise be concealed from view. [Image]. Retrieved from <https://www.makearchitects.com/projects/the-gateway-building/>
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- Figure 37:Burton, E (2019) Newspaper Wood [Photo] Sheffield, UK
- Figure 38: Make Architects. (2011) Each straw bale panel consists of a cross-laminated timber frame filled with compressed straw and finished with render for a natural look to the external face [Image]. Retrieved from <https://www.makearchitects.com/projects/the-gateway-building/>
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