Grain Architecture

natural sustainable design

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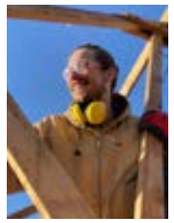
About Grain Architecture

Grain Architecture is a small architectural design practice with a focus on sustainable building using natural materials. Started in 2015 in the Hampshire-Surrey area, the Grain design team has now grown to four, all working remotely from our homes near Hereford, Leamington Spa, Bristol, and Brighton. With our projects located across the UK, including: Devon, Wales, Bristol, Surrey, London, Kent, Suffolk and Norfolk. We enjoy working remotely and flexibly, which we find beneficial to a healthy work-life balance, while using technology to communicate regularly with clients and contractors, and still making site visits when and where needed.






At Grain, we aim to produce inspiring, high-quality spaces that are healthy, beautiful, functional, long-lasting, low-carbon and low-energy. We are a very environmentally conscious practice and all of our projects have a strong ethical drive to not only reduce negative impact, but ideally create a positive impact. We do this through using positive materials, minimising carbon emissions, optimising building performance, and making beneficial impacts on people, biodiversity and planet at every stage.

Principles

Sustainable development requires a project to cause no damage, but Grain Architecture strives to go one step further by taking on regenerative projects that repair and nurture a lasting positive impact.

All Grain projects are committed to being environmentally responsible and truly sustainable above and beyond the standards, adhering to the following principles wherever possible:

Efficiency
Optimising use of materials, energy and space through creative design solutions.

Embodied Energy
Using low levels of energy in all aspects of production of a material or service, including minimisation of the extraction of raw materials, processing, packaging and transportation.

Sharing Knowledge
Working with students, giving talks to other architects and re-training contractors to use low-carbon materials.

Natural Materials
Using materials in their raw state or those with very little processing, avoiding additives such as chemical treatments.

Beauty
Designing high quality buildings and spaces that look beautiful and feel generous, carefully crafted to meet the client's needs and suit their surroundings.

Low Emissions
Reducing pollution, VOCs, CO_2 emissions and other greenhouse gases released during material manufacture, construction and building use.

Breathability
Creating buildings which use vapour permeable materials to naturally manage moisture for healthier living environments.

Social Equality
Encouraging and supporting diversity in the workplace, being non-hierarchical, and giving equal opportunities.

Circular Economy
Using products that are reclaimed, recycled, renewable, reusable, recyclable and/or compostable, to keep the material cycle going.






Natural Materials

Never assume that new building work has to be conventional brick and block. We believe natural materials, with low embodied carbon, should make up the vast majority of a building, and we avoid conventional materials with high embodied carbon such as cement, metals and plastics.

Natural materials are often the best option for overall building performance, whether in finishes, structure or insulations, due to their natural humidity regulation, durability, lack of toxins, flexibility, and cradle-to-cradle potential.

When used properly, these materials create buildings that are strong, long-lasting, efficient, well insulated and healthy, with a low impact on the surrounding and wider environment.

The natural building materials appropriate for a project will vary depending on the climate, local resources and building requirements. There is no one single solution to fit all situations.

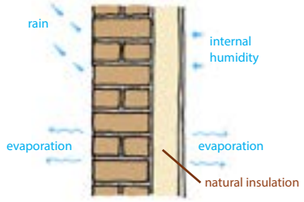
Plant-based materials such as straw, hemp and timber absorb CO_2 whilst growing, so using them locks it up within the building, called sequestration, enabling buildings to be 'zero-carbon' or 'carbon-negative' during the life of the building. They can also be composted, reused or recycled at the end of their life.

Understanding Building Physics

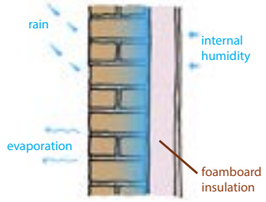
Vapour-permeability, hygroscopicity & moisture

'Vapour-permeable' (sometimes called 'vapour-open' or 'breathable') means that moisture vapour or humidity can 'breathe' through the material and self-regulate without getting trapped. If a conventional vapour-closed material (such as cement or plastic) is added in the wrong place to an otherwise vapour-open wall, then problems such as damp, rot and mould can occur.

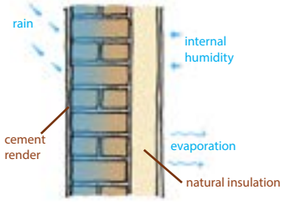
Hygroscopicity means that a material can help regulate humidity further through an ability to absorb, hold onto and then release moisture vapour.



Fully vapour-open wall: brick with lime mortar and internal natural insulation



Moisture trapped in the brick wall by internal vapour-closed insulation such as foamboard



Moisture trapped in the brick wall by external vapour-closed cement render

Insulation vs thermal mass

'High thermal mass' refers to a heavy material like earth or stone, which absorbs heat slowly and then radiates it out again slowly on all sides. Insulation slows heat transfer, so it keeps the heat on one side of it.

Spaces made of light materials, such as timber, have low thermal mass, so they will heat up and cool down more quickly compared to stone. A space you use constantly is more suited to high thermal mass, but careful design is required to avoid increasing the risk of overheating.

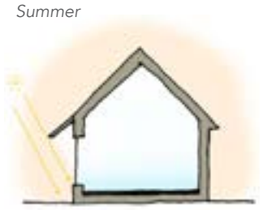
Insulation & thermal bridging

A perfect thermal envelope with no interruptions

Insulation interrupted causing thermal bridges, appearing as cold or damp spots inside

Solar gain & thermal mass

Summer



Shading prevents over-heating in summer, and thermal mass will store 'coolth' from the night time, helping keep internal temperatures low during the day.

Winter

The building benefits from solar gain in winter, and thermal mass will store heat from the sun, helping keep internal temperatures up during the night.

Ventilation, air quality & air tightness

Passive stack ventilation with openings high and low creating a natural flow as warm air rises.

Ventilation is essential in any building to provide fresh air and maintain good air quality, although with non-toxic and vapour-permeable buildings the air quality is naturally better. There are two types of ventilation: Background Ventilation (can be achieved by draughts, trickle-vents, or mechanical ventilation) and Purge Ventilation (opening a window, or mechanical ventilation).

Passive stack ventilation is based on the principle that warm air rises, so a flow can be generated by well positioned openings. In winter, when you want fresh air but don't want to open the window and lose heat, mechanical ventilation systems can recover heat and exchange it to the fresh air coming in, called an MVHR system.

Air tightness is just as necessary and achievable with natural buildings as with conventional ones. Avoiding draughts through careful design details is key to good thermal performance. Draught-proofing and properly ventilating your house may be the best thing you can do.

Sustainable Design Principles

Choose materials early on

This is vital to a successful project as the design needs to be appropriate for the materials.

'A good pair of boots and a good hat'

Make sure your building is well protected from ground water and driving rain. It can be a good idea to raise it above ground level and over-hang the roof.

Building orientation

Design your building specifically for your site, noting where the sun will hit it and the direction of prevailing wind. Glazing on the south can benefit from solar gain even in winter, but may need solar shading to avoid overheating in summer, while excessive glazing on the north will loose heat year round.

Efficient building shape

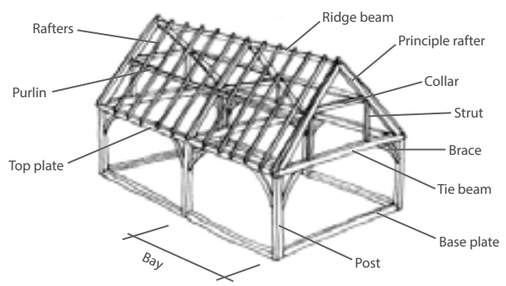
An efficiently designed building maximises the amount of internal space relative to external surfaces (walls, roofs & floors), this minimises heat loss and saves money.

Good layouts will help keep plumbing generally together, keep ventilation ducts short for any MVHR, and keep any plant space or hot water tank (which may be warm) away from a cold space (e.g. larder) with easy access for maintenance.

Know the limitations

Key to the success of any building is understanding the limitations. There is never one solution to all problems. The materials and design need to be appropriate.

Designing for timber framing

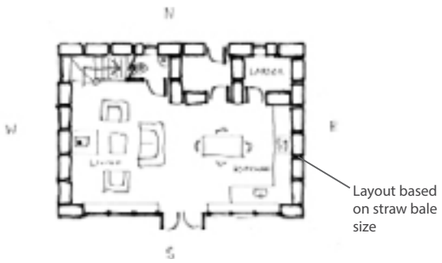


When designing for a traditional timber frame it's important to think about the length required for timber and where main support posts might be needed. Traditionally, bays are usually kept to 3-4m, while the building width (the tie beam) is often about 5-6m. Spanning larger distances with timber is certainly possible but may require some engineering.

Prefabricated timber structures can help achieve high quality standards with quick installation on site, and can still be insulated using natural materials.

Designing for straw bale building

Straw bales come in certain sizes, usually about 1m x 0.5m x 0.35m, although this can vary slightly so check with your supplier. It makes sense to design your building layout using these sizes, like giant Lego blocks, to reduce time spent cutting and re-sizing bales on site. Alternatively, you can use straw in a panel system, such as EcoCocon or ModCell, where panels are made off-site and then built on site within just a few days.



Layout based on straw bale size

Choosing an appropriate roofing material

The most suitable roofing material will depend on the roof pitch. For a successful roof, know the limitations.

Thatch requires a steep pitch of 45° or more.

Timber shingles last longer at steep pitches of about 45°, but can be used on lower pitches.

Clay roof tiles usually have a minimum pitch of about 35°, but some tile types can go lower.

Natural slates can have a pitch as low as 22°. Man-made alternatives can go lower, but with higher carbon-footprint.

Pitches lower than 16° require a membrane, which we try and avoid, but a green roof is a good option when required.

Services

Retrofit / Design / Consultancy

Improving the performance of an existing building

Architectural design of a new build or an existing building

Advice, talks or workshops to clients or others in the industry

- We can coordinate sustainable retrofit projects, usually involving upgrading the thermal envelope of a building, removing draughts, improving air quality and incorporating renewable energy systems.
- We provide consultancy advice to architects/designers or clients, to share our knowledge and expertise on detailing for the use of natural building materials, where to source them and who can use them.
- We offer full or partial architectural design services for new or existing buildings, with a step-by-step process from start to finish, following the RIBA stages of work:

The Design Process:

Our design fees are usually charged on a time basis at £75/hr (revised annually). Project fees always vary depending on the project scale and complexity, but below are our typical fees per stage for three different scales of project based on their build costs:

Project build cost = <£250k

Project build cost = £250k - £500k

Project build cost = £500k - £1M

0: Strategic Definition (Initial Meeting) - We offer a free 1.5hr initial meeting, in-person or virtual (Travel time will be charged at our standard hourly rate), where we would usually talk about what you want and need from your project, any initial ideas, site restrictions and build costs.

Free	Free	Free

1: Preparation & Brief - A full brief will take into account the client's vision and aims, the space requirements, a schedule of accommodation, any restrictions or constraints, budget and environmental principles. The brief is written by the client, but Grain Architecture can help with the brief and advise on required survey information. We can also be employed to carry out a measured building survey or help arrange a measured survey to be done by others and we will advise on other useful surveys and consultants.

£0 - £1,750	£0 - £2,500	£0 - £3,000

2: Concept Design - We will produce concept sketches and review them with you in a video meeting. We will develop the design with sketch drawings, plans, elevations, sections and perspectives as appropriate which help visualise ideas and establish the design direction you would like your project to take. Through meetings and revisions we will resolve the design to 1:100 scale. We can provide you with a basic design document suitable for pre-planning application advice (pre-app) if appropriate.

£1,500 - £4,500	£3,000 - £8,000	£5,000 - £10,000

3: Spatial Coordination (Planning) - At this stage we refine the design, consult with relevant specialists, and put together drawings & documentation appropriate for a planning application. This may include arranging and coordinating additional surveys and reports.

£750 - £2,500	£1,500 - £3,500	£3,000 - £7,500

4: Technical Design - We will liaise with all necessary engineers and consultants on your behalf and work with them to resolve the detailed design. We can prepare a Full Plans Building Regulations application as required, and will produce a set of detailed construction drawings. We can assist with finding a suitable contractor though a tender process or help negotiate a price with a chosen contractor. Once a contractor has been selected we find that working alongside them to resolve construction details is a real benefit to the build.

£2,500 - £8,000	£4,500 - £11,500	£8,000 - £16,500

5: Manufacturing & Construction - During construction we offer Contract Administration to help work proceed smoothly, we will make regular site inspections to review progress and ensure the works are in accordance with the building contract and the environmental principles. At completion we will inspect the building and issue a practical completion certificate.

£1,500 - £5,500	£2,500 - £7,500	£5,000 - £10,000

6: Handover - On completion of the construction we will provide a defects (snagging) list, following this there will be an agreed period of 6/12 months by the end of which the contractor will need to fix any outstanding or new defects. When we have inspected the building to ensure this has been done, we will help agree the final account and issue the final certificate.

£600 - £1,250	£1,000 - £2,000	£1,500 - £3,000

7: Use - We believe it's very important to stay in touch with clients, have meetings from time-to-time and keep track of how they feel about their building. This helps ensure that we continue to create spaces that work successfully and buildings that perform as efficiently as they should.

Free	Free	Free

Retrofit

What is retrofit?

Retrofit is the process of improving the performance of a building after it has been built, typically through installing insulation, reducing draughts, and improving the ventilation and heating systems. In order to meet the climate crises head-on it's vital that we improve the carbon impact of heating our homes by reducing heat loss and making the heating systems more energy/carbon efficient. It is also a major health issue as poorly ventilated, draughty, cold, and damp buildings create an unhealthy internal environment with condensation and mould growth.

Understanding existing buildings

An understanding of how an existing building works in terms of moisture and ventilation is crucial to avoid increasing the risk of condensation inside homes.

Historic buildings were almost always built using vapour permeable materials and ventilated by draughts and open chimneys. Over time many homes have had impermeable materials added and draughts blocked up.

During a retrofit inappropriate past work may need to be remedied, new work should be carried out using vapour permeable materials that do not further harm the building, and ensuring that the house is well ventilated is crucial, especially when airtightness is improved or insulation is added.

Existing building showing some of the common sources of moisture and weak points for airtightness in buildings.

Well ventilated, airtight, fully insulated, warm, and dry home with a low-carbon heating system after retrofit.

Retrofit Process

At Grain we work with clients and builders to develop a retrofit strategy to make the biggest energy savings and create a healthy home, our retrofit projects take a "fabric first" approach by prioritising:

i. Fixing defects like leaking gutters and damaged roofs

ii. Improving airtightness to minimise draughts and heat loss. Aiming for a continuous, unbroken airtight layer generally on the inside of the building.

iii. Ventilating properly for the health of occupants, the building, and the environment. Ideally with a whole house MVHR system, but at minimum continuously running extract fans in all wet rooms (bathrooms, WCs, kitchens & Utilities) with fresh air provided by trickle vents in living spaces.

iv. Providing a continuous layer of vapour permeable insulation around the entire building using natural materials to keep heat in without trapping moisture. And minimising cold bridges (breaks in insulation) at junctions, floor joists, window reveals, etc. as these create cold spots where mould is most likely to form.

v. Upgrading the heating system with a low-carbon solution. Often this will mean a heat pump which are most efficient when a building is properly insulated and airtight. This can be combined with low carbon energy generation such as Photovoltaic Panels (PVs) but this is normally only worth investing in after all other improvements to the building have been carried out.

Passivhaus

Passivhaus Standard

Passivhaus is a low energy building standard developed in Germany. It uses a scientific approach to building design where all the building data is entered in the Passivhaus software (PHPP) to model how it will perform based on it's detailed design, climate, and surrounding context. To achieve the Passivhaus standard a building must be designed and built to require a very low level of heating (and cooling in hotter climates), and provide a high level of thermal comfort and internal air quality.

In the UK climate, this requires a highly efficient mechanical ventilation system with heat recovery (MVHR), a very high level of airtightness, high levels of insulation with almost no thermal bridges (interruptions to the insulation), high performance triple glazed windows and doors, and a very high level of quality control during design and construction to ensure the building is built as designed. Passivhaus strongly encourages an efficient building shape and optimised glazing design as these make it much easier to achieve the standard. If the site or brief require a less optimal shape or glazing then the standard can still be achieved, but it will require improvements to be made, such as further increasing the level of insulation.

Enerphit & Passivhaus Approach

Although the Passivhaus standard has been achieved on retrofit projects, it is much harder to reach when dealing with an existing building so the Passivhaus Institute has created a lower standard for existing buildings called Enerphit. Enerphit projects require all the same information as Passivhaus, and although not as low energy as Passivhaus, an Enerphit project is still significantly better than a house that only meets the Building Regulations requirements for a new house in the UK.

The approach to building design used in Passivhaus can also be applied to non-Passivhaus projects. At Grain we have an in-house certified Passivhaus Designer, and we can use the PHPP software to model our projects to optimise their design even when we are not trying to achieve certification. Though certification does give the advantage of a highly experienced certifier reviewing all the project information, and guarantees the very low energy requirements for the building.

Passivhaus Myths

"You can't open windows in a Passivhaus"

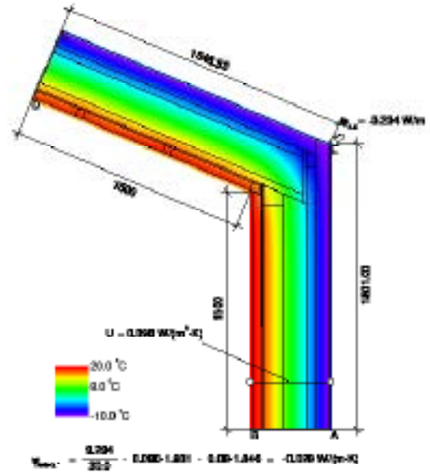
It's actually a requirement to have opening windows in a Passivhaus to ensure occupants have control over the ventilation, this is especially important in summer to help keep the building cool. However you will not need to open windows in winter to have guaranteed fresh air and good indoor air quality because of the whole house ventilation system.

"You can't build a Passivhaus with natural materials"

Passivhaus does not define the materials that a building can be built from. Airtight doesn't have mean vapour tight, so buildings can be built using vapour open natural materials. There are even Passivhaus certified construction systems based around straw, timber frame, and woodfibre. At Grain we aim to design highly energy efficient buildings using natural materials wherever possible in order to create healthy buildings that minimise the embodied carbon as well as the in-use carbon from heating, hot water, and appliances etc.

"Passivhaus buildings overheat"

This can technically be true as the Passivhaus standard allows buildings to be designed to go over 25°C up to 10% of the year. However the latest version of the Passivhaus software has a built-in tool to model the risk of overheating in summer, and certifiers in the UK will generally reject designs that are predicted to overheat more than 2% of the year. At Grain we aim to get this down to 0% of the year by making good use of external shading and cross ventilation from opening windows. It is a requirement of the standard to provide occupants with a guide on how best to keep the building cool in summer.



We can model thermal bridges to see how much heat is lost through junctions and penetrations through insulation.

At Grain Architecture, we work on a variety of projects including: garden structures, house extensions, deep retrofits, new-build houses, workshops, school buildings, community facilities, sustainability centres, eco-housing developments and masterplanning regenerative sites.

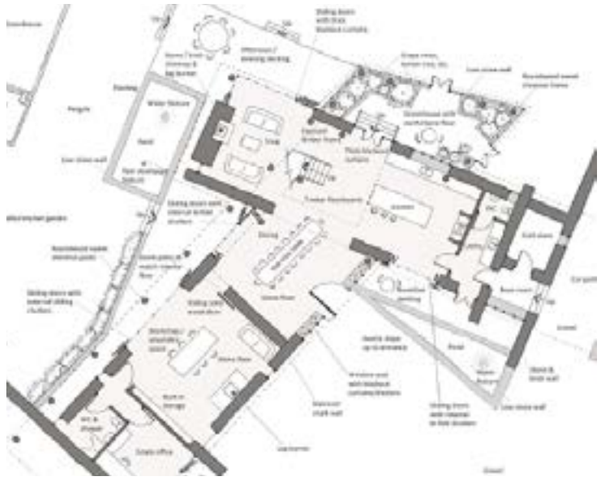
community

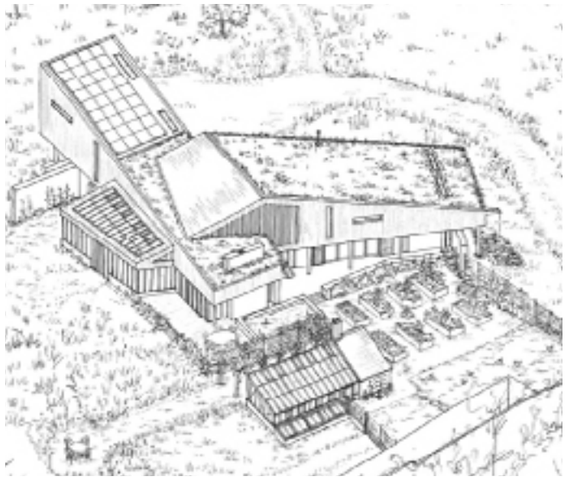
residential

education

Extensions & Retrofits

New buildings





Bespoke straw-panel country house

The Sawmill House is an exciting proposed new-build house in the countryside. The proposed 3 bedroom house is for a family who manage an estate and yurt business in the South Downs National Park. The design is based on the two forms of the existing disused sawmill and intersects them to create a dynamic form with sloping roofs covered in wildflowers and solar panels. The first floor is to be vertically clad in natural timber sourced from the estate to reflect the surrounding woodland, and 'floats' on a light ground floor of white lime rendered straw panel walls and glass doors that open up to allow the internal spaces to flow outside. Two local-stone clad walls extend out further connecting the house to the garden, forming the kitchen garden wall.

A central internal rammed chalk wall features in a double-height space in the heart of the house, linking the two 'wings' together and providing a natural thermal store. The overhang of the first floor provides solar shading in summer to the glazed rooms below, and shutters are integrated all round to ensure minimal light pollution at night. The old Victorian coldframes are restored to include a greenhouse and the old boiler house restored as a potting shed. The property will be heated from a biomass boiler using timber from the estate, and solar thermal panels for hot water.

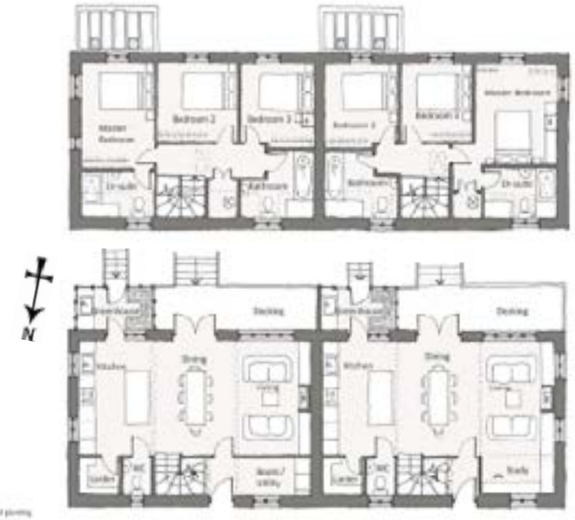
Many rural communities in the UK are dissipating and local economies weakening because of an affordable housing problem.

This proposed development includes 10 new dwellings built to very high environmental standards yet kept at a low cost to provide housing for people within the community.

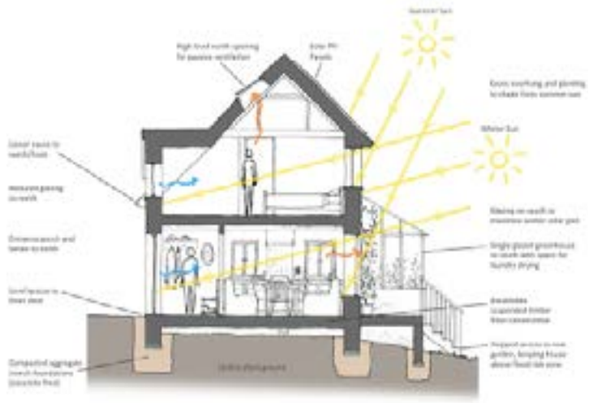
Sustainable rural community housing development

The development was to be set up and managed by local people as a CLT (Community Land Trust), with 50-60% of the 10 proposed dwellings as affordable housing. It also included a community orchard, a small playground, a protected wildlife area and a community energy scheme.

The proposed new dwellings include four 2-bed cottages, four 3-bed cottages, and two 4-bed cottages. The internal floor area sizes range from approximately 70m^2 to 100m^2.



Floor plans of 3-bedroom cottages, 2017



Typical house section elevation

The housing development is at a suitable scale and density for this rural village, avoiding the feel of urbanisation. The style and character reflect that of the original village, while also including contemporary lifestyle and design elements.

The design and materials have been sensitively chosen to increase energy efficiency using the solar orientation and excellent levels of insulation, and further reduce environmental impact using natural building principles & techniques.

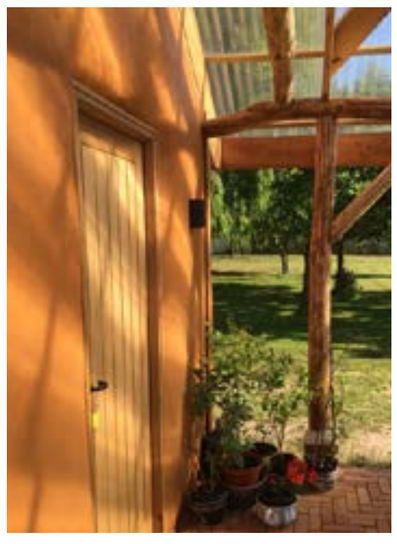
Street front elevation 2017

Pottery & Jewellery Workshops

In 2019 we saw the fantastic build process, with Hartwyn sustainable builders and their apprentices, of our pottery and jewellery workshops project. The building includes two super-insulated craft workshops linked by an outdoor dining space, and also a wood store, garden store and kiln room.

The foundations are rubble trenches with limecrete strip footings under brick plinth walls, and the floors are made up of foamglas (expanded recycled glass) insulation below a rammed earth floor, with underfloor heating pipes connected to the biomass boiler.

The walls are timber framed throughout, with straw bales and wood fibre board for the super insulated workshop spaces. They're finished with clay plaster internally, lime render and natural larch cladding externally. The roof is a corrugated tin to reflect the old cow-shed that the building replaced in this rural Suffolk setting.

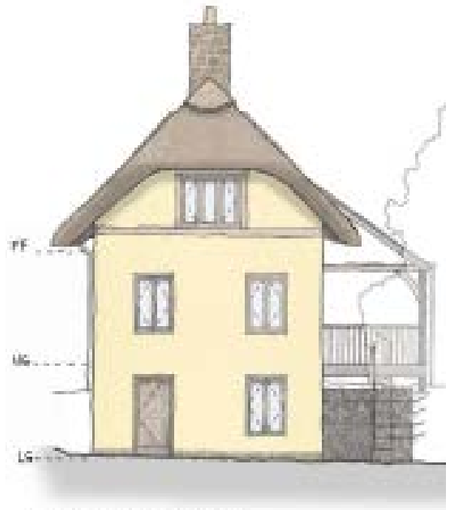


Modest thatched cottage renovation and extension

This renovation and extension to an old thatched cottage is in a rural part of the South Downs National Park, near Petersfield. The proposal involved the demolition of part of an old 1950's extension, and a new extension using natural and locally sourced reclaimed materials throughout.

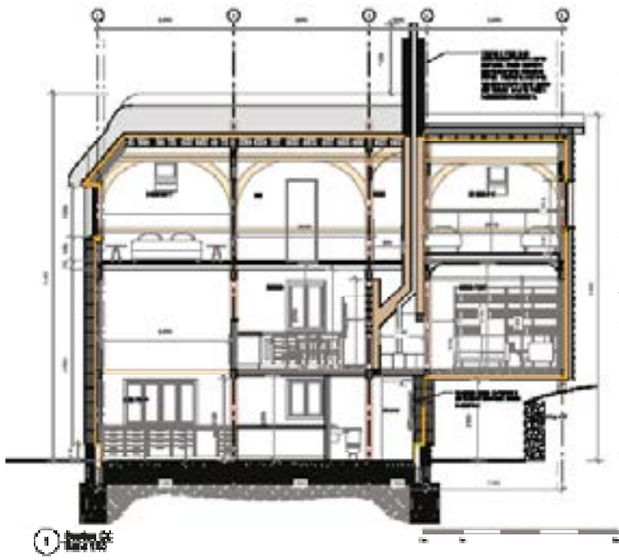
The new extension is visually modest and sympathetic in scale to the original thatched cottage, inspired by outbuildings and studio-workshops.

Photos by Sebastian Lomas Photography



North-West Elevation

South-West (Front) Elevation



rtist's Orchard Studio-House

We successfully got planning permission in 2020 for this new artist's live-work zero-carbon building in the countryside, next to their existing studio. The new building is nestled into the hill among the trees, and will provide the artist with somewhere to stay with his family while he works on his art, inspired by the wildlife and orchard trees of the site, most of which he planted himself.

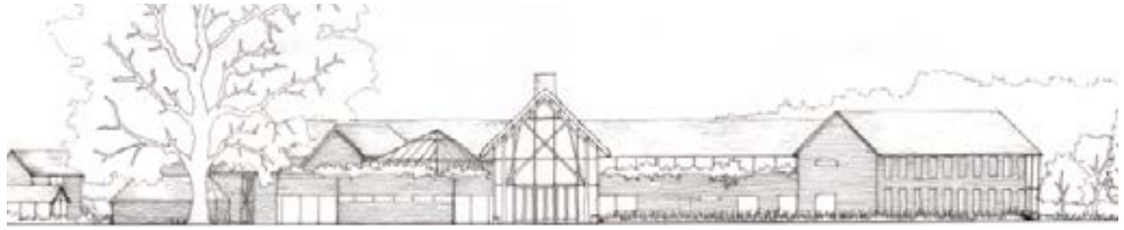
The unusual plan is split over three floors, with a print room and archive in ground floor. The upper-grour houses a farmhouse style kit and sitting room opening out onto the hill. A feature fireplace of rammed earth sits at the heart of the house, and the stairs wrap around it to the loft bedrooms.

Straw bale reciprocal frame roundhouse with sedum roof

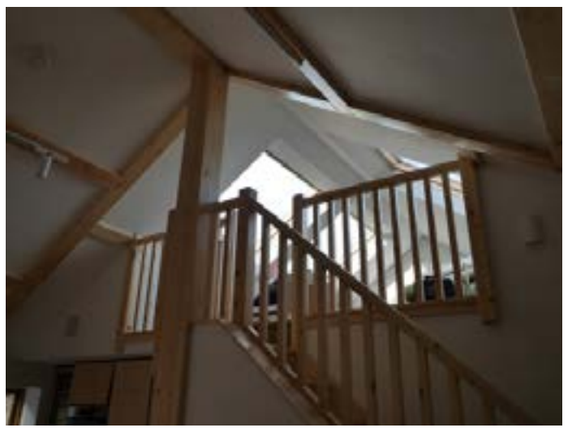
This roundhouse in Norfolk is accommodation for guests at a luxury eco-friendly campsite. It comprises straw bale walls, and a roundwood larch frame with reciprocal roof covered by a sedum mat. The building was self-built by the owners over about 2 years, and volunteers of all ages and levels of experience have been helping and learning along the way.

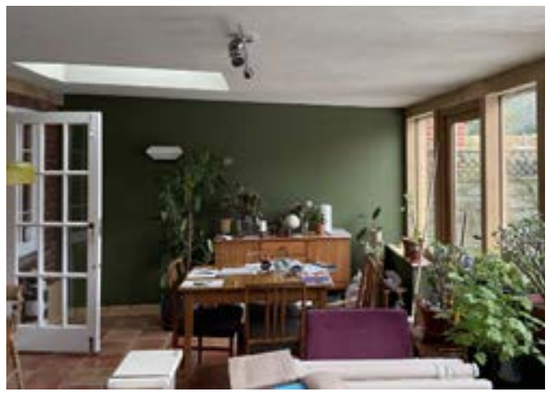
The roundhouse was completed in Summer 2020, and could be the first roundhouse of it's kind to pass full plans Building Regulations in the UK.

Selection of design projects



Selection of active & recently completed projects





Contact us about your project

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