Roof renovation - listed building experiences

The Mansion House at Greys Court, near Henley on Thames, is a Grade I listed building owned by the National Trust. The roof of the principal wing of the building has been dated as from the 16th century. Here Richard Oxley reports on how the roofing works were undertaken in an environmentally sensitive way in 2006, to improve the thermal performance of the roof, and to bring an under used attic space back into use as a staff/custodian flat.

The principal east elevation of the Grade ! listed Mansion House. Note the fan kit in the door as the building was being air pressure tested during the time of the photo. All photos courtesy of the the author.

In this case study of the renovation of the Mansion House, I want to concentrate on the work carried out to the roof but first I want to highlight the fact that improvements can be made to important historic buildings using innovative and ecological sound products in combination with traditional know-how. However, considerable care is necessary to:

- maintain the appearance and character of the building
- design and apply systems to be compatible with the building's original style and design characteristics
- design systems that overcome inherent building detailing
- identify and target the areas that are most in need of improvement
- ensure that issues associated with the introduction of modern building materials to an old building can be overcome.

The work, once completed, not only made improvements in the thermal performance of the roof but also incorporated measures to reduce the risk of water penetration as a result of increasingly frequent deluges of heavy rainfall.

Understanding the building as a whole

The first step, before making any changes or improvements to any building, is to gain an understanding of its construction and condition. The National Trust, like the Church of England, has a system of periodic inspection and reporting on the condition of the buildings in their care once every five years; the quinquennial inspection survey report.

The five yearly inspection report identified the poor and deteriorating condition of the roof coverings and the ongoing and long-standing problems of water penetration and associated timber decay below the parapet gutters. The problems of water penetration were becoming more frequent, as a result of heavy deluges of rainfall overloading the concealed parapet gutters and their

Photo 1: detail of the outlet to one of the parapet gutters, the narrow pipe is prone to overloading and associated water penetration.

Photo 2: here the blower changes the air pressure in the building so that air leaks can be identified.

Photo 3: the complex oak roof frame was exposed on the removal of the roof coverings.

Photo 4: example of typical decay found below the parapet gutters. The end of the beam and the wallplate have suffered from extensive decay where they have been in contact with the damp masonry.

outlets, which were narrow pipes that could not cope with heavy and prolonged rainfall (photo 1). This situation was exacerbated by the poor detailing and condition of the leadwork in the parapet gutters.

In keeping with the strong conservation ethos at the National Trust an environmental assessment, including an air pressure test (photo 2), was carried out. The air pressure test allowed the areas where excessive air infiltration, and therefore heat loss, was taking place to be identified.

It was calculated that approximately 30% of the heat from the building was being lost through the roof. This was physically illustrated by the amount of air movement experienced during the air test, with the greatest amount of movement experienced at the top of the second floor/attic level stairs.

Design and implementation

Both the inspection and the environmental assessment reports identified the need to address the roof to remove problems of water penetration and to improve the thermal efficiency of the building.

The need to overhaul the tiled roof coverings and replace the lead and provide improved detailing to the parapet gutters provided an opportunity to incorporate improvements to the thermal performance of the roof and comfort levels within the attic space.

Both the local authority conservation officer and English Heritage were consulted on the proposed works and a listed building consent application was made and consent granted. The roof above the attic flat is mainly concealed behind gables and parapet walls. This enabled improvements to be made without visually detracting from the appearance or character of the building, which was important in gaining the necessary listed building consent approvals.

The roof is complex (photo 3), with the two principal ranges containing the attic flat comprising pitched roofs, with both horizontal and sloping ceilings and vertical partition walls to eaves voids.

The method that was considered to be the most effective means of improving the performance of the roof was to create a ‘warm roof’ with 50mm thick wood fibreboard (photo 7), over the rafters and the parapet gutters, and, in this case, cotton hemp insulation above the sloping and horizontal ceilings. To maximise the air tightness of the warm roof system a vapour permeable roofing felt was specified to be placed directly over the wood fibreboard. This was largely to overcome the difficulties that would be encountered in fitting the insulation to what are highly irregular roof slopes.

The wood fibreboard was chosen to provide thermal mass and decrement delay to the roof, which would assist in reducing both heat loss and heat gain, which is important for an attic space. The wood fibreboard and the cotton hemp insulation were carefully selected as they had similar performance characteristics to those of the building; being both permeable and hygroscopic, thus achieving some consistency in the performance of the roof with the remainder of the building, maintaining the ‘breathing’ performance of the roof was a primary selection criterion for the products used.

As with many older buildings once works commenced, and the roof coverings were stripped, the true constructional detailing and condition of a complex roof structure was revealed (photo 3). The oak roof timbers located below parapet gutters and in contact with gable and parapet walls were in a poor condition, having suffered from serious decay (photo 4). The remaining timbers were found to be in a very good condition, with little repair being necessary to these timbers, albeit that they are around 500 years old.

One of the most difficult areas to renovate was the vertical stud partitions to the eaves of the attic rooms (photo 6). The working area was severely restricted and the construction of the stud walls highly individual, with timbers of varied sizes at irregular spacing.

The solution was developed with the input of the contractor; to ensure that the method devised would be effective and practicable. The method devised to insulate the stud partition walls was applying cotton hemp insulation, held in place with a vapour permeable roofing membrane, which also improved air tightness, and battens fixed to the vertical studs.

In this case it was found that if the cotton hemp insulation was not held tightly in place with the roofing felt there would be a risk of slumping of the insulation over time. To reduce this risk the contractor was asked to achieve a full and tight insulation behind the felt, very much like a punch bag (photo 6). If the membrane was tight like a drum with no insulation in contact, or was soft like a pillow the risk of slumping was deemed too great. This set a simple understandable method by which the standard of work could be measured on site.

Insulation was placed above the sloping and horizontal ceilings. The depth of insulation which could be achieved varied considerably from 50mm to up to 200mm depending on the original construction. The aim was to

Photo 5: the same beam after repair Repair techniques were devised to maximise the retention of historic fabric and surface finishes so that archaeological evidence, such as carpenters marks could be retained.

Photo 6: the insulation to the vertical stud partition walls of the attic room.

Photo 7: vertical and tongue and grooved wood fibreboard was intalled over the existing rafters.

install as much insulation as practically possible.

To enable future inspection and maintenance of the concealed voids in the roofspace below the parapet gutters, maintenance access hatches were installed. These were designed to minimise air leakage.

Once the sloping ceilings of the attic were insulated using hemp insulation, the external pitched slopes could be boarded using tongue and grooved wood fibreboard (photo 7). This was a difficult process; the roof was not straight or level and had several valleys. This meant that the boards, for each section of slope had to be close fitted then lifted off, re-scribed and cut and then refitted and secured to achieve an airtight fit.

It was a primary aim to ensure that the undulation of the roof was maintained. Sample areas were laid which showed that the wood fibreboard would follow the undulations in the roof and would maintain the character of the building. Great care was needed to ensure that the tongue and groove joints were maintained, or, where this was not possible, the joints were taped and sealed. The provision of the vapour permeable roofing membrane, directly over the wood fibreboard, helped mitigate any areas where the joints could not be made fully air tight.

An important part of the installation of the wood fibreboard was working closely with the supplier to ensure that suitable fixings were used that achieved a good grip and pulled the boards down without ripping through the boards (photo 9).

Significant care and attention to detail was necessary to maximise the airtightness of the building. The wood fibreboard was physically separated from potentially damp masonry, such as chimney stacks and gable walls, to reduce the risk of future problems caused by the boards being in prolonged contact with damp walls, as this could result in the decomposition and/or expansion of the wood fibreboard. It was also important, at this stage, for all gaps to be filled whilst access was available (photo 10).

An important stage in the improvement of the building is to ensure that the works carried out will be effective before the completion of the building work. The success and effectiveness of the workmanship was enhanced by the fact that the contractor was given the use of the fan pressure kit which they could use to assess where air infiltration was occouring. This provided the opportunity, whilst the labour and materials were still on site, for gaps and holes in the fabric to be filled. This method, although not quantifiable at this stage, enhanced the level of success as the areas that need attention were identified and addressed. A similar process will be adopted when the internal works are carried out, to fill gaps and cracks in plaster where air leakage is present, thus considerably improving the effectiveness of the improvements made.

Issues arising from modern materials

The use of modern materials, and the application of modern building standards on an existing building, raised a number of issues that were difficult to resolve. Attempting to provide ventilation below a lead lined parapet gutter, as recommended by the Lead Sheet Association, created issues of detailing where the use of a conventional tilt fillet/batten created a water trap where ventilation was provided below the parapet gutter (photo 11). The tilt fillet/battens to the roof had to be adjusted to remove the water trap and roofing membrane over ventilation routes had to be addressed.

The use of wood fibreboard insulation over the rafters resulted in the raising of the roof line by the depth of the boards and counter battens (75mm). In general this did not cause too many problems, as the roofs were concealed by the gable and parapet walls. Also, the provision of wood fibreboard to the slopes and in the parapet gutters meant that the location of the parapet gutters and their outlets changed; they moved higher up the parapet wall.

Once the level of the parapet gutters was determined the hopperheads had to be refitted. The historic lead hopper was repaired and retained (photo 12) and provided with a new detail that improves the capacity and reduces the risk of overloading and associated problems of water penetration from incapacity in rain storms. The size of the outlets was also increased (compare photo 12 with photo 1). This addressed a principal cause of a problem to the building and provided an improved level of future proofing. Insulating dormers was also a challenge. Luckily the Mansion House does not have highly visible dormers, so making improvements to these features does affect their appearance; the depth of the cheeks and roof have to be increased – and where they sit on flat roofs that are to be insulated the sill has to be adjusted to reflect this change

The amount of insulation in the building before renovation took place was minimal. One wing had been provided with foil-backed foam insulation. These were not well laid, with numerous gaps and open joints. Under current assessment methods this would provide a favourable rating, irrespective that the effectiveness of

Photo 8: the uneven and irregular nature of an historic roof frame.

Photo 9: the wood fibreboards were plyable enough to follow the undulations of the roof.

Photo 10: airtightness detailing was ensured, even through the breather membrane over the woodfibre boards.

the insulation would be minimal (photo13).

The opportunity was taken to provide well detailed insulation that would significantly improve the thermal performance of this part of the building. The foil-backed foam boards/batts were re-used, being well detailed and double-lapped, behind foil backed plasterboard to the partition walls to this part of the building, where vapour permeability was not important, thus maximising the re-use of materials and reducing waste.

Conclusion

Careful design and workmanship have allowed improvements to be made to a building of national architectural and historic importance that do not detract from the appearance and character of the building. The improvements made will enhance the management of rainwater as well as the thermal performance and comfort levels.

This case study illustrates that the most effective improvements are only practicable, and financially viable when the building is under going extensive repair or other improvement work; which will be typical when making improvements to many existing buildings.

The effectiveness of the improvements can be significantly enhanced where the contractor has a clear understanding of the aim of the work and is actively involved in adapting the design to the idiosyncrasies of the building.

The work at the Mansion House at Greys Court is another example of the National Trust putting their environmental strategy into practice and leading by example.

Richard Oxley

Client:	The National Trust
Historic buildings' consultant:	Richard Oxley (Oxley Conservation)
Environmental consultant:	Peter Warm
Air fan pressure test:	Paul Jennings
Chartered quantity surveyors:	Bare, Leaning & Bare
Contractor:	St Blaise, Dorchester, Dorset

This highly complex job was made slightly easier by complete enclosure within a scaffolding building.

The completed project.

Photo 11: the thickness of the roof was raised by the use of the woodfibre boards. This is the eaves detail in tha parapet gutter area.

Photo 12: therainwater outlets were restored and or changed to hoppers.

Photo 13: the original insulation prior to renovation was badly fitted with gaps and shortfalls.