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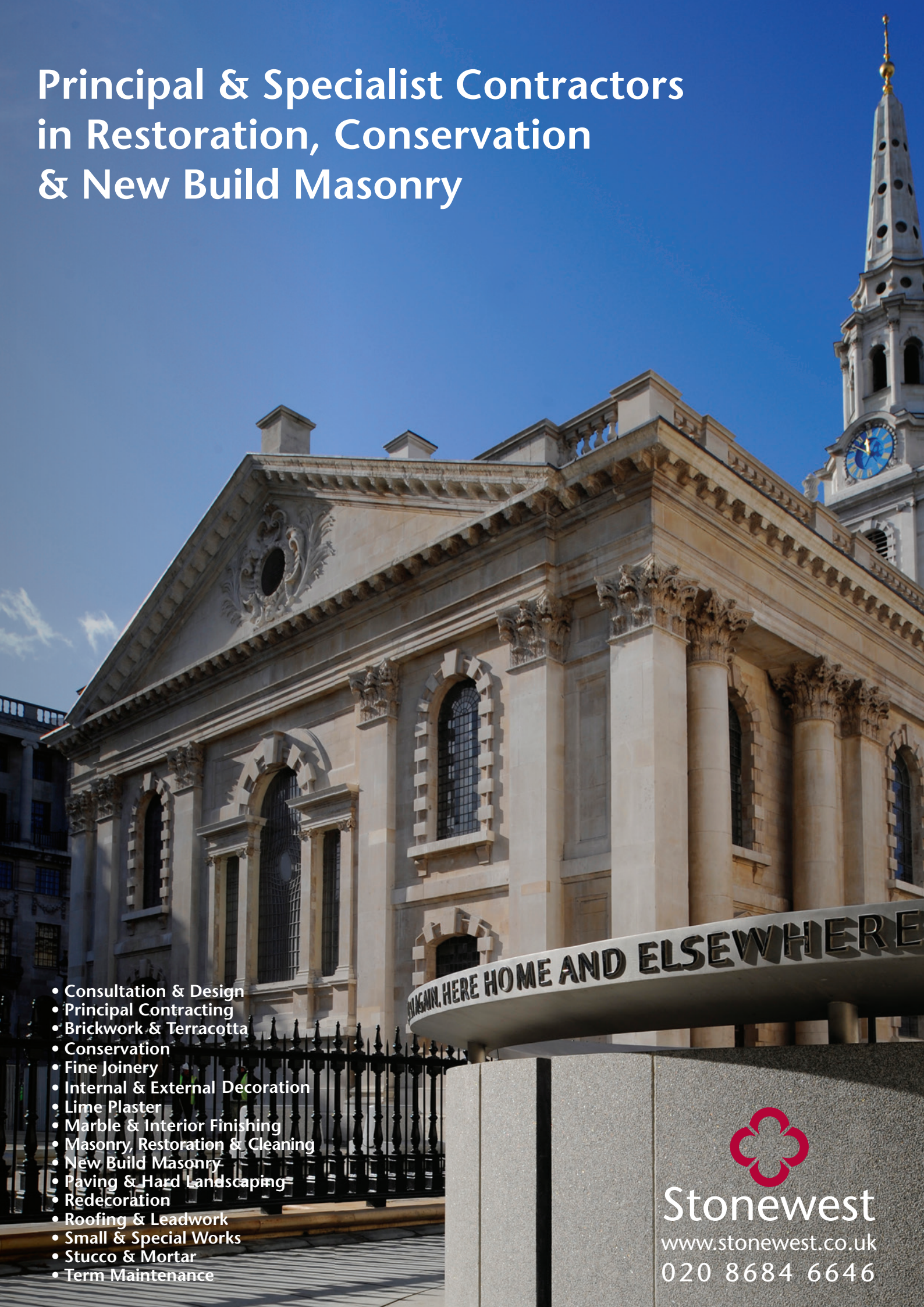

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COVER ILLUSTRATION
Detail of timber screen by Grinling Gibbons at Trinity College Chapel (see page 41) (Photo: Bruce Hammersley)

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CATHEDRAL COMMUNICATIONS

CONTENTS

FROM THE EDITORS

The stately procession of articles in this 24th edition is led out by the Rt Revd Dr John Inge, Bishop of Worcester. Arguing that churches can best secure their future by acting as 'vibrant centres of service to the community', he draws on another author's observation that churches 'are more like people than stone or brick'. As you read on you may be struck by how well those words apply to other elements of church heritage, objects which seem equally invested with spirit and personality.

Take the story of the brass eagle lectern: a tale of creativity, destruction and renaissance. During the Reformation fine examples were carefully hidden from zealous parliamentarians, almost like fugitive family members. They took centuries to resurface, giving impetus when they did to a grand Victorian revival of church ornament. The carvings of Grinling Gibbons, meanwhile, are filled with character not only by the startling realisation of figures from solid wood, but also by our sense of engagement. Brought to life by the skill of the craftsman, they defy the passage of time, uniting worshippers past, present and future.

Ecclesiastical works of art often seem to have lives of their own and they give fresh force to the Bishop of Worcester's characterisation of historic churches as 'living places'. This is their great strength: that which lives can change, adapt and survive.

SACRED SPACE and COMMUNITY

John Inge, Bishop of Worcester

A concert at St John the Baptist, Tredington, Gloucestershire (Photo: James Kerr/Archbishops' Council)

THE CHURCH of England is responsible for 15,700 parish churches, 78 per cent of which are listed. Among them are 45 per cent of all Grade I listed buildings in England. Together with our cathedrals, parish churches are surely the jewel in the crown of England's built heritage. Over 57 per cent of Church of England churches are in rural areas and their physical presence enriches our landscape immeasurably.

The collective importance of these buildings as part of our heritage is immense but their significance is much broader than their architecture. Most of them still serve their communities in all sorts of ways. Rural churches are often the only 'public' buildings left in villages. The number of people attending them on any given Sunday might not be large – nationally, a quarter of the 15,700 churches have weekly attendances below 16 and further analysis indicates that around 2,000 have a weekly attendance below ten. However, a glance at the registers of many such churches will show that they did not have very much larger congregations in past generations. This does not mean that they have not, and are not, valued by their communities. They are, rather, much loved and used in all sorts of ways. As the Church Heritage Forum's *Building Faith in our Future* report (2004) put it, churches are:

> *a major contributor to social capital, providing a physical base where people can meet and be supported, practically, emotionally and spiritually – expressing the church's unending concern to recognise all humanity as neighbours. Day in, day out, church buildings host groups of all types and all age ranges,*

Community centre and café at All Saints, Hereford (Photo: Alastair Lever/Archbishops' Council)

> *from toddlers upwards, reaching many who lack confidence to find self-worth elsewhere.*

The practical contribution they make to their communities is huge but we would be wrong to ignore their deeper symbolic significance. As Sarah Coakley (see Further Information) observes:

> *'The Church is not a building.' That is most certainly true. But buildings in which 'prayer has been valid' are more like people than stone or brick, because of their vibrant association with the folk we and others have loved. They are not so much haunted as 'thin' to another world in which past, present and future converge. And when, as in the parish system in England, each such building holds the memories of a particular geographical community, it is well to be aware of its remaining symbolic power – even if it now seems neglected, under-used or actively vandalised.*

They are the repositories of the stories of communities, their parishes. The notion of 'parish', derives from the integration of the Christian church into the civic life of the Roman Empire. The English parish system is very ancient and its churches are valued by their parishioners but by many others besides. Writing in *The Shell Guide to England's Parish Churches*, Robert Harbison in 1992 described what he called a 'vast avalanche' of books on England's parish churches. These are guides for church-spotters, of which John Betjeman's *English Parish Churches* (1958) is still the paradigm. They often comment on the broader place of the parish church in the English natural and social landscape though the latter is only now being investigated more thoroughly (see Further Information, Davison and Millbank, Rumsey).

There is much to celebrate in terms of the health of these wonderful buildings. A glance at 18th-century prints makes clear the parlous state into which the majority had fallen at that time. Following all the restoration and building work of the 19th century, war consumed much energy during the first half of the 20th century. Fortunately, huge amounts of money have been spent on them in the last generation. Our churches are arguably in a better state as far as their fabric is concerned than has ever been the case.

What of the future? The Church of England is the custodian of these buildings which are everyone's heritage and maintaining them is an increasing burden. In financial terms we are the least established church in Western Europe: before the recent *Roof Repair Fund* and *First World War Centenary Cathedrals Repair Fund* there had been no direct government funding for the repair of parish churches. In most other countries there is either a church tax or the state is responsible for the maintenance of historic churches.

Our approach has its advantages: most of our churches feel 'loved' in a way that, for example, French churches do not. There is, however, a challenge and, with that in mind, I was asked by the Archbishops' Council of the Church of England to chair a group charged with undertaking a review of the Church of England's stewardship of its church buildings.

In September 2015 the group produced its report, which was well received by the Archbishops' Council and Church Commissioners. It disappointed some who feel that church buildings are a millstone around the neck of the Church of England. As Giles Fraser put it in *The Guardian*, they are 'sapping the energy of our wider social and religious mission, and transforming the church into a buildings department of the heritage industry'. We disagree. We feel that to take a Beeching type axe to the churches of this land would be to do a disservice both to the church and to the nation. We feel this to be the case precisely because they are more than historic monuments and because they are still, wonderfully, being used for the purpose for which they

were built. They offer something unique and hard to define in addition to their architectural glory.

Perhaps that additional something is better captured by novelists and poets than by architects, theologians and historians. What the novelist Susan Hill writes of cathedrals (see Further Information), could be said of parish churches: 'Where else in the heart of a city is such a place, where the sense of all past, all present, is distilled into the eternal moment at the still point of the turning world?' She asks another rhetorical question which amplifies the point:

> *But surely there are other places that will serve the purpose? To which people may come freely, to be alone among others? To pray, to reflect, to plead, gather strength, rest, summon up courage, to listen to solemn words. What are these other places? To which the pilgrim or the traveller, the seeker, the refugee, the petitioner or the thanksgiver may quietly come, anonymously, perhaps, without fear of comment or remark, question or disturbance... To think of the world without these cathedrals, without all cathedrals, is like a bereavement. It is painful. The loss of the buildings themselves, the grandeur, the beauty, is unimaginable – the mind veers away from it. But think of the world without the great palaces. Surely that is the same? We know, deeply, instinctively, that it is not. Destroy all the churches then. Is not that the same? We know that it is more. And that it is not merely a question of thunderbolts.*

There is indeed more, much more. That is surely because these buildings are 'living'. This makes them particularly precious and, at the same time, something of a headache as far as their conservation is concerned. There are those who feel similarly to William Morris, whose words are quoted in the SPAB manifesto, who felt it proper

> *to resist all tampering with either the fabric or ornament of the building as it stands; if it has become inconvenient for its present use, to raise another building rather than alter or enlarge the old one; in fine to treat our ancient buildings as monuments of a bygone art, created by bygone manners, that modern art cannot meddle with without destroying.*

Morris, of course, was protesting against Victorian restoration of buildings. We may feel that restoration to have been heavy-handed but the fact is that, had it not taken place, many would have fallen down and they would not be usable today. Buildings had, in fact, been significantly adapted many times over the centuries. One of their glories is the hotchpotch of architectural styles they display. These changes have enabled them to 'live', and to subject them to Morris's imperative would be to sign their death warrant. They would become lifeless museums which, if listed, could probably not be put to any alternative use anyway.

How can their health be assured? The approach of the Church of England in this regard is different from that of other denominations. Many of the free churches are happy to dispose of old buildings and build anew because they don't have a great emphasis on or regard for heritage or sacred space. Meanwhile, the Roman Catholic Church is bound by a ruling dating back to the Council of Trent that their church buildings can only be used for worship and, as such, are less of a problem for the conservationist. Since Henry VIII gave us 'Brexit' from Rome and its rules, the Church of England has been free to re-discover and reintroduce the mixed economy of medieval Christendom.

To advocate such a mixed economy is not to deny the holiness of our churches. In our report we observe that 'in Church of England polity some places, notably churches and graveyards, are deemed to be "holy" by virtue of their consecration'. It should be noted that the word 'holy' simply means set apart. What are churches 'set apart' for? They are set apart to symbolise the Christian faith. We observe that if they are to be effective symbols of the Christian faith we must avoid them becoming redundant or museums by allowing them to live and breathe. This will often mean re-ordering and adapting in a manner which is sensitive to their heritage but that will enable the life of contemporary worshipping Christians and service of the community (see Further Information, Walter and Mottram, Poulios).

We argue that one of the reasons a number of churches have become more like museums is possibly a lack of awareness that both parts of Jesus's summary of the Commandments have repercussions for churches, as they do for disciples. The first purpose of churches, as with human beings, is to worship God and churches generally do reasonably well on the first Great Commandment.

The record is not always so good with the second, to love our neighbour. As it applies to churches, it implies that they should be vibrant centres of service to the community. Traditionally, churches were at the heart of the communities in which they stand, in both a human and a geographical sense. It is well known that in the medieval period much 'secular' activity would have taken place within them. Over the years, however, a pietism crept in which tended to exclude everything but public worship from them, all other activity being transferred to places such as halls and community centres. Far too many churches remain locked and stand like mausoleums

St Stephen's, Rochester Row, London: Zumba class in the nave (Photo: Joseph Friedrich/Archbishops' Council)

Wymondham Abbey, Norfolk: the building's visible history of change and adaptation is part of its beauty (Photo: Barry Cawston/Archbishops' Council)

St Mary the Virgin, Ashford, Kent: reordering for community centre with removal of pews (Photo: Lee Evans Partnership)

except when open for worship and are increasingly marginal to the life of the communities they exist to serve. They remain oases of calm, but unavailable.

The picture is far from hopeless. We commend a rising wave of imaginative adaptation of church buildings for community use which has breathed new life into them. An increasing number, like St Giles's, Langford, near Chelmsford, now house a village shop or post office. Many, like St Stephen's in Redditch, are home to a food bank. Some, like St Mary's in Ashford, Kent, have been reordered to become community arts venues as well as places of worship. New and ever more imaginative schemes are constantly springing up: All Saints in Murston, Sittingbourne, is the first to host a community bank.

The examples are myriad and should serve as an inspiration. If church buildings are to succeed, their adaptation and alteration must be welcomed. It should be sensitive to their heritage and to their primary purpose as places of worship of Almighty God, but it should emphatically not make preserving the status quo a primary aim. Proper conservation is about managing change not preventing it. A case in point is pews, very often a quite recent addition to churches. Removing them enables a flexibility in the use of the building which would have been possible in the past but which pews prevent.

Only if such flexibility is not merely allowed but welcomed and encouraged will churches remain healthy and vibrant and continue to be used for their original purpose. The alternative will be for them to close and that, as I have argued above, would be a great loss. While our report acknowledges that some churches will need to be closed, it also advocates a change in the mood music: with a positive mind-set we can see their true potential, rather than simply characterising them as a 'burden'. In *A Little History of the English Country Church* (2007), Sir Roy Strong advocates 'giving the church building back to the local community, albeit with safeguards for worship. Change has been the lifeblood of the country church through the ages. Adaptation will be more important than preservation'. Amen to that, I say.

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JOHN INGE PhD is the 113th Bishop of Worcester and lead bishop on Cathedrals and Church Buildings for the Church of England. His book, *A Christian Theology of Place*, was shortlisted for the Michael Ramsey Prize for Theological Writing.

INTERVENTION and EVOLUTION

at Emmanuel Church, West Hampstead, London

Neil McLaughlin

LIKE MOST historic buildings, churches develop over time to accommodate the changing needs of the people who use them. For churches today, this means adapting as congregations and surrounding communities fluctuate, and in order to remain at the centre of local activity, many historic churches find they need to diversify. By providing multi-functional meeting rooms and modern kitchen and toilet facilities, churches can cater for a wide range of local groups. Together with improved heating, lighting and level access, these interventions vastly improve the flexibility of service which churches can offer their communities. However, these changes can be difficult to achieve in a historic building, especially one that's listed.

Located in West Hampstead and close to inner-city areas of great depravation, the church of Emmanuel illustrates well how even listed places of worship can respond to the challenge of diversification. Today, this Edwardian parish church hosts activities organised through the West Hampstead Community Association and it has longstanding partnerships with Alcoholics Anonymous and Narcotics Anonymous. Emmanuel Church also participates in a winter night shelter scheme for the homeless, which is operated by 14 Camden churches from a variety of denominations. The churches take it in turns to accommodate up to 16 homeless adults a night, providing hot meals, showers and beds.

For the architects commissioned to adapt Emmanuel Church, Francis Maude and Neil McLaughlin from Donald Insall Associates (DIA), the first step was to assess its significance.

The nave and narthex of Emmanuel Church, West Hampstead, with completed community rooms to either aisle and simple railings (Photo: Thomas Erskine)

Using this knowledge as the basis of proposed new interventions, DIA was able to balance careful conservation against sensitive new insertions in locations of lower historic impact.

Listed Grade II, this Edwardian Gothic Revival church was designed by the architect JA Thomas of Whitfield & Thomas in 1896 to replace a smaller church situated a few streets away. Built in red brick externally, with fair-faced white brick with red details and stone dressings internally, the chancel and four bays were consecrated in 1898. A pause in construction due to a lack of funds meant that the nave, narthex and porches were not completed until 1903, with only the ground and first floor of the tower eventually being built.

In 1968, a meeting room with a flat roof was installed in the south aisle and around the same time half of the pews were removed and a WC and a small kitchen area were installed in the south west entrance porch. By the end of the century, demand for community

The former single storey meeting room to south aisle, built in 1968 (above) and the new brick-walled community rooms which replaced it (left)

space had increased dramatically, and having the right spaces and facilities had become increasingly important to fulfilling Emmanuel's vision of its role in the community.

In 2007, the Reverend Professor Peter Galloway, who was then the priest in charge, instructed the church's architects to provide options for repairing the uneven main floor to make all areas of the church floor safe and accessible. Responding to the increase in demand from local groups for spaces to hire, it was also suggested that extra community rooms within the nave and aisles might be added as the existing facilities could not keep up with demand. In line with the increase in meeting room space, the kitchen and toilet facilities required updating to include a new accessible toilet and level access from the entrance porches.

Proposals halted when Peter Galloway sadly passed away in 2008, but discussions started again with great fervour in late 2009, under instruction from the Reverend Jonathan Kester, the new priest in charge.

STRUCTURAL ISSUES

One of the main items noted by DIA in earlier quinquennial inspection reports was the structural movement of the floor in the main body of the church. By the time the project restarted, parts of the parquet floor had become so buckled that level changes of around 100mm were evident in various parts of the church, causing trip hazards and limiting their use.

Although Emmanuel Church has been kept in reasonable condition since it was constructed, it has a history of structural movement. Underpinning and structural restraint ties were required at the east end of the church following dry summers in the 1920s and bombing during the second world war had caused cracks to the north aisle which were repaired in 1953. The church had also experienced movement in the north nave arcade in the west end of the church following a dry summer in the mid-1990s.

Given the history of structural movement caused by the soft clay on which the church is built, Stuart Tappin of Stand Consulting Engineers arranged soil investigations in early 2010 and provided structural advice for proposals to rectify the uneven floor. The conclusion was that the best solution was to remove the existing floor slab completely throughout the nave, aisles and narthex, and to replace it with a new slab supported on 30 piles over a void, as this would allow for future clay movement. In addition, a screed incorporating underfloor heating was proposed which would allow the removal of the wall-mounted perimeter heaters and provide a more even level of heating.

DESIGN CHALLENGES

The removal of the existing floor slab meant the existing community room, which was of a low historic significance, would need to be dismantled. It was decided to use the footprint of this room as a basis for the new proposals. Installing a further community room of the same footprint in the opposite north aisle would not only double the existing footprint for spaces to hire, it would also restore balance to the nave. The remainder of the aisles were to be left available for parking prams and buggies, a requirement during services and for many of the community room user-groups.

From an enhanced brief on the requirements of church users, it was clear that the list of existing patrons was already extensive. Many other potential users were also interested in hiring space but required improved facilities – further evidence that the maximum number of new community rooms was necessary.

It was decided to install the new kitchen and accessible toilet within the ground floor of the south aisle, leaving a smaller community room adjacent to it. The larger kitchen was, among other aspects of the proposed interventions, crucial for the future of the church, not only for providing coffee and tea following services, but as somewhere groups hiring the community rooms could prepare their own refreshments, as a facility for larger events such as concerts, and to prepare hot meals as part of the homeless shelter scheme. Likewise, the accessible toilet was not only essential for those in the parish with

special mobility requirements, this room was to provide a baby changing station for parents and a shower for use by homeless people.

The architects also prepared a proposal for new railings with central gates to the narthex arched openings, in keeping with the aesthetic of the church, but of sufficient height to prevent climbing. These were needed to provide secure separate access to the main body of the church when the community rooms are in use.

Access improvements also included proposals for a new internal ramp to the north-east porch, paved with tiles to match the originals. This would replace a steep and rather ugly concrete ramp which had been built inside the porch, rather than building it externally where it would detract from the quality of the architecture and its setting – a conservation area.

In 2010, the architects prepared proposals that were sent to the Diocese of London for their initial feedback. Because the funds available for the project were then unknown, the proposals included two options, one with community rooms on the ground floor only and a second option including upper community rooms with associated metal staircases to access them. The architects met with representatives from the London Diocesan Fund on site to review the proposed designs and some amendments were made to the design of the new railings to the narthex to reflect other modern railings at the other end of the nave.

In late 2010 certification was received from the diocesan advisory committee (DAC) recommending the proposals, and a quantity surveyor was then engaged to prepare preliminary cost estimates for the different options.

As a place of worship owned by one of the exempt denominations, alterations which would usually require listed building consent are dealt with under the ecclesiastical exemption, so there was no requirement for listed building consent. However, the DAC's recommendation included the requirement to consult with the local planning authority and the Victorian Society because of the extent of the proposals and the impact they would have on the Grade II listed building.

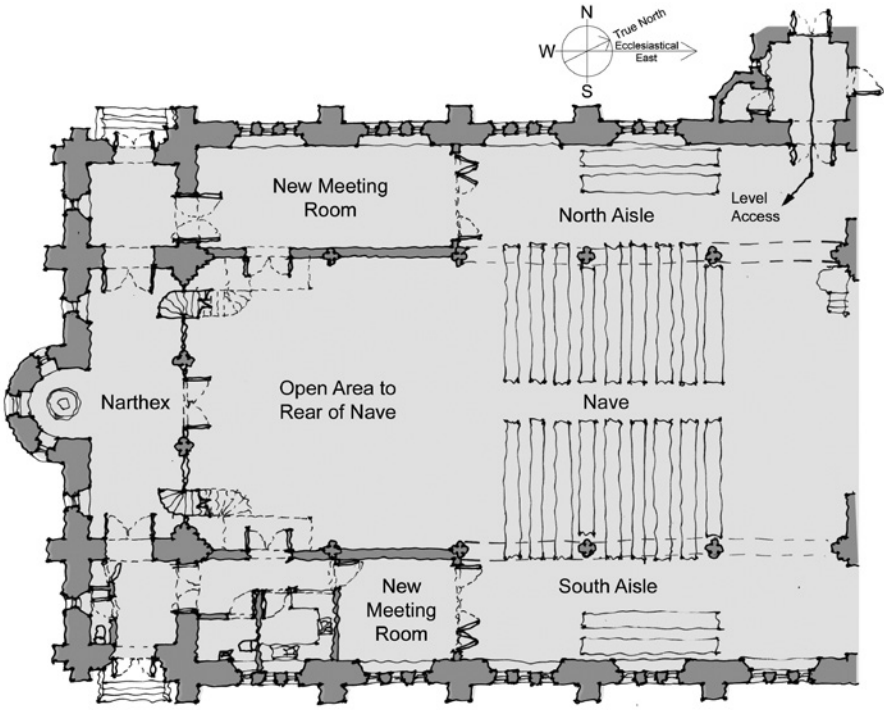
Consultations with Camden Council conservation officers and the Victorian Society progressed through 2011 and in December the designs were presented to the DAC's plans group of consultant architects and surveyors for comments. In addition to requiring further information from the structural engineer, the group suggested increasing the kitchen and toilet facilities, but as this could not be achieved without losing one of the two ground floor community rooms, the proposals remain unchanged.

Following changes in local authority planning policy, charges were introduced by Camden Council for all consultations, and the DAC agreed that further advice from council officers was no longer required. However, the Victorian Society continued to advise and was supportive of the plans. No objections were raised to the structural proposals for the floor or to the new narthex railings, but the society was concerned that the full-height infills within the aisle arches to form the new community rooms could cause visual harm. Further discussions addressed the position of the walls in relation to the arch columns and the form of construction the new insertions should take.

Following the preliminary cost estimates prepared by the quantity surveyor, it was decided to tender the project in November 2013 as the church needed to be absolutely sure that adequate funding was in place before appointing a main contractor. From the tenders received it was apparent that extra fundraising would be required. Furthermore, costs increased when, in another part of the church, the roofs above the north and south aisles together with their cast iron gutters and downpipes also began to need attention. The favoured main contractor undertook these repair works in 2014 following receipt of a separate faculty from the London DAC, in advance of the major internal project. Unfortunately, this main contractor went into administration in early summer 2015, so a new tender issue was planned.

In line with the established conservation principles, it was decided

One of the new community room doors with traditional leadwork and bespoke ironmongery (Photo: Thomas Erskine)



Plan showing the new meeting rooms and their separated access route via the narthex

The nave and chancel of Emmanuel Church, West Hampstead with its new oak floor (Photo: Thomas Erskine)

that the new community rooms should be constructed in brickwork to match the surrounding walls, rather than in painted plasterboard like the 1968 meeting room walls. Although a lightweight timber frame and plasterboard may seem the more reversible of the two options, steel beams would have been needed to support the upper community room floor structure. By progressing the design further with structural input from Stand Consulting Engineers, it was agreed that the proposed brick masonry infills would be a more 'honest' intervention, and would form a more permanent part of the building's story as a place which evolves to meet the needs of the parish.

After presenting this approach to the Victorian Society, outlining how the masonry designs would effectively be as reversible as a timber frame design, the society confirmed in mid-summer 2015 that it would not object to the granting of a faculty. The senior conservation adviser (churches) at the Victorian Society expressed the view that:

> *By being designed with permanence in mind, the proposed subdivisions will benefit from a quality of design and materials that will actually make them less harmful than similar subdivisions in studwork which might be just as 'permanent' in practice.*

The proposals were duly granted a faculty by the Diocese of London in July 2015 and a tender for the works was issued to main contractors the following month. By January 2016 the project had started on site, with the nearby Emmanuel Church of England School used for services as the works progressed.

COMPLETION

The project achieved practical completion in November 2016 and was dedicated and officially opened the same month. The completed works were so seamless with the existing building that during the opening ceremony many guests unfamiliar with the previous internal layout had to ask what the works had entailed.

From its earliest beginnings Emmanuel Church has been a place developing to reflect the ever-changing needs of its parish. From the construction of a larger church for an increasing congregation in 1898, to the removal of pews and creation of the 1968 meeting room, to the new community spaces completed in 2016, the church has continuously responded to changing needs and circumstances.

Financing at Emmanuel Church, as with many large historic structures, has been a factor throughout the history of the building's development, with elements being completed as and when resources were available. Although this project took close to a decade from inception to completion, the resulting new community spaces and ancillary areas will suit a wide range of uses, where all the previous users of the church can be accommodated and many more can be welcomed. The project will provide income for future maintenance work and has allowed the church to remain a cultural centre for the West Hampstead community.

NEIL McLAUGHLIN is an associate at Donald Insall Associates (see page 11). Founded in 1958 by Sir Donald Insall, DIA is an architectural practice with close to 60 years' experience in the conservation of listed buildings and the sensitive interventions often required to ensure their future usability.

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CHURCH MONUMENTS and THEIR ENVIRONMENT

Sally Strachey

OUR NATION'S churches, cathedrals and abbeys contain the largest collection of fine art in the country. These priceless heritage assets, often by the greatest designers and craftsmen of their day, are still displayed in the setting for which they were designed. It would therefore be a mistake to think of them as being in any way less important or less authentic works of art than those on show in museums and art galleries. However, church monuments should not be seen as beautiful objects alone: they provide a living record of religious, political and social history and are an invaluable and engaging learning resource. They allow us to touch the lives of those they commemorate and to understand something of how those characters and their families fit into the complex tapestry of history, and they deserve our attention.

Because church monuments are not in museum conditions but inside historic buildings in varying states of repair, careful attention should always be paid to understanding the building envelope and the internal environment. Recently, Sally Strachey Historic Conservation has been lucky enough to work on a number of fascinating monuments across the country. In every case the deterioration of structural integrity and surface condition was largely due to the monument's environment. Improving and monitoring their surroundings forms a critical part of their conservation.

The monument to Sir Edward and Lady Francis Rodney on the west wall of the Rodney Chapel, St Leonard's Church, Rodney Stoke, Somerset: investigation windows were opened up above the monument (top left and right) to ensure there was no evidence of early plaster and decorative schemes, and the hard plaster was removed at lower levels.

DAMP AND ITS EFFECTS

Church monuments are occasionally freestanding but it is more usual to find them built into the church fabric and their condition is inevitably a reflection of the surrounding environment. Few churches are used all the time, so almost all are subject to intermittent heating and ventilation, which can have a significant impact on the microclimate around the monument. Furthermore, most churches have been subject to reordering, particularly during the 19th century, and this has resulted in monuments of all shapes and sizes being dismantled, relocated and rebuilt, often in ever-decreasing space.

The construction methods used can be complex. Materials include alabaster and marble and a variety of limestones, sandstones and other regional building stones, held together with an internal structure of iron fixings. Larger monuments may also contain a filler material (rubble for example) for structural support. The surfaces and inscription panels may also retain areas

The monument to the Hon Robert Dormer (d1726), Church of the Holy Cross, Quainton, Buckinghamshire, showing the location of the iron fixings and the significant movement through the joints caused by the corroding iron fixings

The canopy to the monument to Sir Edward and Lady Francis Rodney during dismantling showing corroded iron fixings

Salt crystallisation damage at a high level caused by warm, moist air condensing on cold fabric

of historic decoration, including pigment and sometimes gilding. All these materials are subject to decay mechanisms associated with moisture, either as a liquid or a vapour, which can compromise the structural integrity of the monument and cause surfaces to deteriorate, leading to a loss of detail and decoration.

Typically, the cause of structural movement is the deterioration of the system of iron fixings used to construct the monument. Iron is susceptible to corrosion in the presence of moisture and air. This causes the fixings to expand, exerting pressure on the sections of stone and often resulting in dramatic movement through the joints, cracking and buckling. Rust 'jacking' has the power to lift substantial free-standing elements, destabilising them. An example of this can be seen on the monument to Robert Dormer (illustrated above left), which is attributed to the great Flemish-born sculptor John Michael Rysbrack. Here, two large sculptures have been lifted out of position through pressure exerted by the corroded iron fixings. Once the pointing mortar falls out, this type of deterioration accelerates due to the greater exposure of the iron to both moisture and air.

The critical factor which draws the attention of the PCC and architect to a church monument is usually evidence of movement through the joints, sections of the monument shifting out of alignment and associated iron-staining on the surface. At this stage a monument may pose a significant threat to public safety and demands investigation.

Surface deterioration often indicates high levels of moisture in the building envelope and the internal environment. Historic fabric will always retain moisture and soluble salts and the management of salt activity is one of the biggest challenges in the treatment and care of church monuments. Cyclical changes in temperature and relative humidity in the microclimate can trigger an acceleration in the movement of soluble salts through porous material towards the surface, where they move out of solution and crystallise either on the surface (efflorescence) or just behind the surface (cryptoflorescence).

Some salts are hygroscopic and draw moisture in from the surrounding microclimate, causing them to dissolve and recrystallise in the pores of the material in increasing concentrations. The force of crystal growth, like rust expansion, can be substantial, breaking down the integrity of the pore structure and leading to blistering, spalling and loss to areas of pigment. This relentless decay mechanism is particularly damaging to the fine limestones widely used for architectural detail and monuments as they are vulnerable to damage by sulphates, chloride and nitrate salts.

Deterioration of historic paint layers, biological growth and surface-staining of church monuments can be associated with the microclimate and repetitive cyclical changes in temperature and humidity. Condensation can form on surfaces which are colder than the general environment, contributing to ongoing salt activity, staining and deterioration of paint layers. The problem of spring condensation in churches – when warm, humid air enters the building and condenses on interior fabric – is well-documented.

MANAGING THE ENVIRONMENT

Because critical decay mechanisms such as the corrosion of iron fixings and salt activity are associated with different forms of moisture, it is essential to reduce the levels of moisture within the fabric. A detailed inspection of roof coverings, rainwater goods and drainage is necessary to identify any defects. This may not be as straightforward as it sounds. Historic churches often have complicated roof structures and drainage systems which have been subject to numerous adjustments. The ground level around churches can gradually become elevated as drainage channels are dug out and other debris builds up. Moisture readings should always be taken on the internal fabric surrounding the monument as well as on the monument itself to assist in understanding how the building distributes moisture.

The external walling must also be inspected. Decay and fracturing to the stonework with hairline cracking and failure to the pointing will dramatically increase the levels of moisture immediately behind and around the monument. The presence and extent of cement mortars should be recorded because they reduce the surface area through which moisture can evaporate significantly. Cement mortars also cause ongoing damage to the surrounding historic stonework.

The condition of the external fabric needs to be addressed before a monument conservation programme can begin and this can present a significant and sometimes unexpected cost to the local community. Improvements to the drainage system can be complicated by raised ground levels, the presence of underground water systems and more

recent interventions. In this case it is recommended that inspection holes are opened up and, if necessary, a ground-penetrating radar survey undertaken.

The nature of the internal fabric is an important factor in the movement of moisture and salts through and around the monument. If the monument is surrounded by modern impervious plasters, these will encourage moisture and soluble salts into its more porous materials. The monument becomes a wick to a continuous reservoir of moisture, resulting in increased levels of moisture and associated salt activity.

The management of the microclimate around a monument can be more difficult as it is inevitably related to the use of the building and the associated issues of heating and ventilation. Intermittent use of the church results in a rise in internal temperature due to comfort heating as well as a rise in moisture levels from human activity, particularly if clothes are damp. Ventilation can also be problematic as it can introduce increased levels of moist air into the building, thereby increasing the volume of water in the microclimate. When the heating is switched on, the warm air can hold more moisture, but when it cools, condensation occurs on cool surfaces.

All the above effects on the internal and external fabric must be considered before and alongside treating a church monument, and in many cases a compromise will have to be reached if the internal environment is to attain the stability it needs. In order to work towards this it is important to consider using the 'buffering' provided by the volumetric mass of the historic fabric to control and stabilise temperature, moisture and relative humidity. The improvement and ongoing maintenance of the building envelope is therefore the priority treatment in improving the environment surrounding the monument. To fully understand the microclimate, ongoing monitoring over an extended period is essential to implement a long-term strategy for the church to manage its heritage assets.

THE RODNEY MONUMENTS

The recent conservation of the Rodney monuments at St Leonard's Church in Rodney Stoke, Somerset illustrates how decay mechanisms and ongoing deterioration are closely associated with their environment. This group of monuments to different generations of the same family is located in the Rodney family chapel on the north side of the church, and includes five substantial and stylistically distinct examples. Dating from the 16th and 17th century, four are constructed from limestone and one from alabaster. The limestone monuments all retain areas of original pigment which give a valuable insight into the original aesthetic of the monuments.

Concerns were raised at the damp conditions in the Rodney Chapel and the rate at which the once vivid colours were fading. Overall, the monuments were in structurally sound condition so it was only necessary to partially dismantle the canopies of the monuments to Sir Edward and Lady Francis on the west wall and Sir Thomas Rodney on the south wall where the iron cramps were suffering from corrosion and causing sections of the monument to become unstable. A detailed programme of cleaning, repair and consolidation of pigment was carried out but the main objective was to slow down the decay mechanisms causing the surface deterioration. As a result, investigating the chapel environment and making the necessary interventions to the fabric were, and are, at the heart of this project.

The roof and rainwater goods had undergone a recent programme of repair which had reduced the level of moisture at high level but had not resolved the issues of damp in the

Detail of flanking figure to Sir Edward and Lady Francis Rodney monument showing pigment loss (Photo: Roger Vlitos)

Detail of the lower section of the monument to Sir Edward and Lady Francis at St Leonard's showing salt efflorescence with associated blistering and loss of surface due to raised levels of moisture and salt activity

The south east corner of the Rodney Chapel after conservation showing the monuments to (right) Anne Lake (d1630) and Sir George Rodney (d1651)

chapel. Beginning in June 2016 moisture readings were taken twice a week from 30 locations in the chapel alongside a record of the weather conditions and rainfall. After the first few weeks it became apparent that excessive levels of moisture were being retained in the fabric of the Rodney Chapel including the internal walls and at high level. In some areas there was a delayed response in relation to the rainfall.

In discussion with Mark Taylor of architects Beech Tyldesley, the conservators looked more closely at the drainage, foundations and soil levels surrounding the Rodney Chapel. Inspection holes were made to all elevations with investigations at the east end revealing a 1970s drainage system with a brick soakaway. This was found to be too close to the chapel and at a higher level than the floor.

It was felt that the soakaway could be contributing to the high levels of moisture throughout the fabric of the chapel and a temporary diversion to the rainwater goods was set up on the east elevation to take the water from the downpipe to the drain at the far south corner. The intention was to allow the soakaway to dry out while continuing to monitor the levels of moisture in the chapel for a minimum of 12 months.

Recent readings after an extended dry spell showed an overall reduction in moisture levels but with high levels still present across the interior wall between the chancel and chapel where the monument to Sir Thomas Rodney is located. The next stage is to take readings after a period of heavy rainfall. The surrounding environment at St Leonard's is further complicated by the presence of underground water courses running off the Mendip Hills.

Tests pits were also dug to assess the possibility of installing a French drain. However, the test pit which was dug against the west wall of the chapel revealed that there were no foundations between the original church buttress and the later buttress to the chapel, and there was only soil under the Lias limestone slabs to the plinth. Unlike the chancel, where the floor level was raised during the 19th-century restorations, the chapel is built off the ground with minimal foundations. In this case the porous fabric of the envelope and the monuments will continually draw moisture up from ground level. This underlined the importance of ensuring that the external and internal structure had to manage and distribute moisture as efficiently as possible.

Further investigations were carried out between the north porch and the west end of the chapel to find the location and direction of two drains and to determine whether there were any breakages. Both drains were found to be in good order with no cracks or leaks.

Detail of the Anne Lake monument

The monument to Sir Edward and Lady Francis after conservation and with the new lime plaster in place

However, there was an issue where the two drains meet: the drain from the west end of the chapel and the drain from the nave converge in a Y section. In the event of leaves or debris going down the drain there is a strong possibility that they will cause a blockage because this is a non-standard join. The PCC was advised of the importance of regularly checking the mesh installed just below the downpipe to catch leaves and debris.

The area of grass between the west wall of the Rodney Chapel and the porch was piled up with debris and soil which was considered to be a possible trap for rainwater to track back into the chapel. The turf was lifted and the debris removed to slope the ground away from the chapel. The turf was then reinstated.

The improvements to the internal environment had to take into account how the chapel was used. One of the chapel's important functions for the community was to act as a changing room for the choir. An electric socket had been installed immediately below the monument to Sir Edward and Lady Francis on the west wall to plug in a heater while the choir changed. This is an area where salt efflorescence with associated blistering and spalling of the stonework was present. The sharp rise in temperature in the microclimate caused by the heater would have accelerated salt activity through this section of the wall and monument. In addition, a heavy velvet curtain had been hung on the north side of St Thomas for privacy and to prevent drafts, which reduced the airflow around the monument.

The socket and electrics were relocated from the west wall to the north wall near the door with advice to raise the temperature only to the minimum required. The velvet curtain and fixings were removed and the surface of the monument repaired. The parish was advised to invest in a folding screen which could be installed before and for the duration of services.

The internal wall around the monument to Sir Edward and Lady Frances Rodney had an extremely hard ash plaster. After discussion with the architect, this was removed and replaced with a lime plaster made from lime putty which had been aged for 20 years, and it was then given three coats of limewash toned to match the surrounding walls. The use of aged lime putty produces the most plastic mix, so the plaster adheres extremely well and is less likely to crack. Its purpose was to reduce the movement of moisture and soluble salts through the porous stonework of the monument and to slow down the decay mechanism associated with loss of surface and historic pigment. The new lime plaster also creates a large surface area through which vapour, moisture and salts can move freely to the external elevation.

The Rodney Chapel's environment is complex and although critical improvements have been made towards stabilising and better understanding the internal environment, it will be necessary to continue to monitor the moisture levels. The parish was advised to install an environmental monitoring system in the chapel to monitor it over the long term. The information can be collated to gather a more comprehensive overview of the performance of the building envelope in order to develop a robust strategy to manage the environment of this delightful church.

The north and west elevations of the Rodney Chapel showing the lime mortar pointing on the west elevation and the lowered ground level, now re-turfed and sloping away from the base of the stonework

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A NANOLIME CASE STUDY

The City of London Cemetery entrance screen

Ben Newman

ONE OF the core principles of conservation is to save and repair as much surviving material as possible. However, repairs often effect a degree of change, posing ethical issues as well as technical challenges for the conservator, and few aspects of conservation are quite as challenging as consolidation. For example, where a fine medieval timber boss has largely been destroyed by woodworm, consolidating its remains in resin raises questions about originality and significance in much the same way that its replacement with a new timber carving would.

From a technical perspective, the aim is to find a consolidant which binds the original material together effectively, but without harming it or the rest of the structure. Where the fabric to be consolidated is on the exterior of a building, this can be particularly challenging, and there is much ongoing research into the ability of a new lime-based material, nanolime, to consolidate decayed limestone and plaster. In particular, the EC-funded Stonecore project carried out extensive research into the use of the material from 2008-11 and its findings were disseminated across Europe through a series of public meetings. More recently, research carried out at the University of Bath for Historic England has led to the publication of guidance by Historic England (see Further Information).

This article will explore nanolime's benefits and limitations through a case study of the work that London Stone Conservation undertook on the entrance screen to The City of London Cemetery in spring 2016.

WHAT IS NANOLIME?

Nanolime consists of artificially made, nano-sized particles of calcium hydroxide suspended in alcohol. There are two commercially available brands: Calosil was introduced to the market in 2006 followed by Nanorestore in 2008. The alcohol can be ethanol, isopropanol or n-propanol.

The City of London Cemetery screen before the project: the use of impermeable cement repairs had increased the rate of decay to the point that the stonework had become unsafe. The central shield in particular was perilously close to becoming detached.

A nanometre (nm) is a unit of measure equivalent to one millionth of a millimetre and visible only under the most powerful microscopes. Nanolime particles are typically 150nm and since the average size of stone pore structure is around 1,000nm there is a very good potential to fill some of this space, thereby consolidating decayed stone and reducing further loss.

For the conservation of limestones and other lime-based materials, nanolime seems particularly appropriate because it is based on a well-established traditional material, lime, as opposed to the organic consolidants widely used in the last century, such as alkoxysilanes. These organic consolidants have been controversial because they change the stone, both chemically and visually (see Further Information, Hull). Using lime is preferable because after carbonation the calcium hydroxide is converted into calcium carbonate which is the main constituent of limestone – in essence a 'like-for-like' replacement. One downside is the inconsistency in depth of penetration, which is dependent on varying environmental and stone characteristics.

The consolidation of stone with nanolime follows the same principles as 'lime watering', which is part of the 'lime technique' pioneered by Professor Baker on Wells Cathedral in the 1970s, but has the advantage that the lime is carried by the fluid in a suspension, rather than in a solution like lime water. Consequently, a significantly larger amount of lime can be introduced into the stone with each application; lime water typically contains 1.7g of lime per litre compared to 50g/l available in nanolime. The alcohol of the nanolime will evaporate leaving behind the lime to carbonate and bond with the stone, whereas lime water requires more than 40 applications to be effective. The large amount of water that is absorbed by the stone may mobilise salts in the masonry, accelerating the decay process which the treatment is attempting to slow down. This is a particular problem where salt crystallisation is already contributing to the decay, as is often the case.

The bottom of the crest before work: note the cementitious repair (left) and adjacent erosion.

The bottom of the crest completed: note the retained original fine carved medallion and the new shield above it. The friable areas of stone were first consolidated with nanolime, then mortar repaired and limewashed.

THE ENTRANCE SCREEN

The main entrance screen of The City of London Cemetery was designed by William Haywood (1821–94), architect and chief engineer to the City Commissioners of Sewers and best remembered for his work on the Holborn Viaduct (1863).

The cemetery was built in 1853 at a time when London's churchyards were in crisis due to a population explosion coupled with an increase in cholera-related deaths. The City of London Corporation moved to build a new 'super-cemetery' that would fulfil the needs of all the City churchyards and it was Haywood's job to instigate this. The cemetery remains the largest municipal facility of its type in the UK.

The screen is a traditional construction of Kentish Ragstone walling with Caen stone quoins, copings and decorative carved elements. Caen stone is a soft French limestone which was ideally suited for fine carving and it was widely imported by the Victorians: the down side is that it performs poorly in a polluted environment.

The rain during the 19th century and up to *The Clean Air Act* of 1956 was much more acidic than it is today, accelerating the decay of limestones. Carbonates in the stone are turned into sulphates which are more soluble, allowing acid rain to penetrate further into the stone. Sulphate-crystallisation occurs in the drying cycles, and as these crystals grow they expand within the pore structure, causing the stone's structure to break down, forming voids.

Because the entrance screen faces south west it is subject to frequent rain and direct sun. This results in the stonework receiving extremes of weather, including freeze-thaw and wet-dry cycles.

At the start of the conservation and repair programme, the conservators (London Stone Conservation) were faced with the damage caused to the structure by numerous interventions. Premature decay of the stone elements just 43 years after building completion was evident in the many Victorian cementitious mortar repairs, including those to a pair of decorative panels inscribed 'Erected 1855' and 'Restored 1898'.

These repairs present a major threat to the future of the screen. Portland cement is both hard and impervious, so it does not allow the stone to breathe. Moisture trapped by the cement is forced to evaporate from the softer more porous stone around the edges of the repairs. Here, the same natural decay mechanisms described above are accelerated due to the greater accumulation of soluble salts. Eventually the cement repair de-bonds from the surrounding stone. The resulting friable surfaces are most prominent in the ornate central panel due to the number of cement repairs, and because the increased surface area of all the sculptural carving amplifies their wetting and drying cycles.

FINDING A SOLUTION

Repairing the screen posed a number of challenges. A mix of stone replacement and lime mortar repair was proposed, lime mortar being much softer and far more permeable than Portland cement. As the stone copings had been entirely encased in cement, they all had to be replaced with new stone. Instead of the original Caen of Normandy a similarly fine-grained limestone was specified from Lavoux near Poitier. This is the stone currently used as a Caen replacement at Canterbury Cathedral due to its superior weathering characteristics and frost resistance.

On dismantling, the structure was found to be saturated in areas below the cement copings, especially under the canopies of the central panel. The new stone replacement copings would allow the structure to dry out and slow the decay process because, unlike the cement, the stone will allow moisture to evaporate.

After close examination of the central panel it was realised that the condition was far worse than originally thought and it was necessary to carry out extra work to improve the structural stability and integrity of the stone elements. It was decided to treat the whole central panel with nanolime to improve the friable surfaces of the stone.

A series of nanolime trials was undertaken to ascertain the best type of Calosil to use. The main aim was to ensure maximum penetration so the consolidating effect of the lime will have an effect through the body of the stone instead of just at the surface.

A four-pronged approach was adopted to the repair of the central panel:

1 Cement repairs were selectively removed to slow down decay of the carved stone.
2 The entire surface was treated with a combination of Calosil E5 (which contains 5g nanolime per litre) and E25 (25g per litre), the rationale being that the E5 will give greater penetration to start with, followed by the E25 to deliver maximum amounts of lime to the structure. The Calosil was applied with a pressurised garden spray; five applications of E5 followed by three of E25 over a two-day period. The area was covered with cling-film between applications to prevent premature evaporation of the ethanol and so promote maximum penetration. It is important that water is sprayed onto the treated area for a period afterwards because the lime requires both air and water to carbonate.
3 Selected areas of previous mortar repairs were reinstated in a hybrid mortar to slow down further stone

The central crest after consolidation and repair: note the new stone shield, Muscovy hat, copings and foliate corbels with nanolime consolidation and limewash.

The depth of penetration of the nanolime was gauged with the use of phenolphthalein, which turns pink in the presence of un-carbonated lime. The sample of stone treated with the nanolime was cut in half and sprayed with the indicator: the depth of penetration is clearly seen.

Nanolime was applied with a pressurised garden spray and the area was covered in cling-film between applications to delay evaporation of the ethanol and promote maximum penetration.

decay. This contained lime putty, Prompt natural cement, Westerham sand and Bath stone dust in the proportions 2:1:3:3 (lime: natural cement: sand: stone dust).

4 Stone elements which were at risk of falling because of their overhanging position were replaced like-for-like in Caen stone. Two such stones were the shield bearing the city crest and the Muscovy hat, both of which had multiple fractures and were at considerable risk of detachment.

Once the repairs were completed, the whole area was given five coats of specially colour-blended, casein-bound limewash to unite the central panel. This also helped to cover any white bloom from the nanolime and will further protect the fragile nature of the carved work.

Remodelling selected areas of cement repairs in lime mortar helped to slow down the decay of the stone and the nanolime definitely improved the many flaky, friable surfaces on the panel, providing a much firmer surface for the application of limewash. Nanolime consolidation seems a viable method for surface protection but for deep penetration it proved difficult to achieve reliably. Tests indicated that the best penetration achieved was 7mm using Calosil E5 (illustrated above left), which was generally considered sufficient to bind the friable surfaces to sound substrate. Better results have been obtained in laboratory conditions. The environmental factors of temperature and particularly relative humidity (RH) have a major effect on the time required for evaporation of the ethanol and consequent depth that nanolime is carried into the stone. Colder, overcast days with high RH offer the best conditions for obtaining good penetration results on site.

Used in conjunction with mortar repairs and limewashing, the consolidating effect to the surface provided an excellent ground to receive further treatments of lime protection, given that the friable stone surfaces are not sound enough to bond properly with mortar and limewash.

It is tempting to view nanolime as a new wonder treatment. In practice, however, its success depends on many variables, including the pore structure of the stone and the type of damage that has occurred, as outlined in Historic England's new research publication. In some stones, for example, the pore structure may have limited continuity, reducing the depth of penetration, and larger gaps and fissures cannot be bridged by nanolime alone, such as where delamination has occurred. The research also highlights problems where limestones are covered by a gypsum crust, as this layer can be almost completely impermeable, and any consolidation may actually be counter-productive. Nevertheless, what nanolime does offer is another weapon in an arsenal of conservation materials, and in many situations it can be used very effectively in combination with other lime products.

In this case, the entrance screen certainly benefitted from this new material in slowing down the complex combination of decay mechanisms which were eroding the central panel. Nanolime is not suited to every situation but it does offer an option to stave off the need to replace original fabric and extend the life of our historic structures without always having to resort to stone replacement or less sympathetic consolidants.

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BRASS EAGLE LECTERNS IN ENGLAND

Marcus van der Meulen

IN THE Anglican church interior the brass bookstand with a reading desk in the shape of an eagle is part of the standard fittings. The freestanding bookrest is used for supporting the Bible, for readings from the scriptures or as a minor pulpit. Most are creations of the Victorian age, output from a serial production of ecclesiastical furnishings on an industrial scale.

Inspiration for these Victorian bookstands came from the eagle lecterns of the late 15th and early 16th century, many of which had vanished during the Reformation's great purge of ecclesiastical ornament. The revival was prompted by a series of discoveries. At Oundle, Northamptonshire, the eagle lectern reappeared from the river Nene when it was dredged in the early 19th century. Around the same time a lectern was found in the marshes outside Isleham, Cambridgeshire, and another was dug up in the churchyard of Snettisham, Norfolk. In the 1830s a lectern unlike any other in the country was found buried in the bishop's garden in Norwich. This pelican lectern was restored, receiving some 19th-century additions at the same time, including three statuettes representing the priesthood. Finally, in 1841 it was returned to its pre-Reformation home, Norwich Cathedral.

In the same year the Church of St Chad, Birmingham, designed by AWN Pugin, was inaugurated. Later raised to cathedral status (the first Catholic cathedral in England since the Reformation), the ecclesiastical space designed by Pugin was fashioned to the principles set out in his influential books *Contrasts* (1836) and *The True Principles of Pointed or Christian Architecture* (1841). Pugin's books laid the theoretical foundations for the Gothic Revival and envisioned a return to the pre-Reformation church interior.

The ecclesiastical space of St Chad's was adorned with fittings predating

The Birmingham lectern acquired by the Earl of Shrewsbury for the church of St Chad by Augustus Pugin, today in The Met Cloisters, part of the Metropolitan Museum of Art in New York (Photo: Metropolitan Museum of Art, The Cloisters Collection, 1968)

A late 19th-century advertisement by an ecclesiastical fittings supplier

the English Reformation in an attempt to recreate an interior from the period before England turned its back on Rome. An impressive piece acquired for the church was the early 16th-century lectern (page 23) which was bought at auction by the 16th Earl of Shrewsbury, Pugin's close friend and patron. Its influence was immediate, as can be seen at Norwich Cathedral where the three statuettes added during the restoration of the pelican lectern are clearly derived from the Birmingham example.

The revival of the liturgy in the Anglican church in the 19th century, of course, is the result of the Oxford Movement. Of great importance were *Tracts for the Times*, published between 1833 and 1841. Once a Catholic fixture, the brass eagle lectern was again seen to be an appropriate Anglican church fitting, at least in the high church. Many cathedrals were refurbished according to the principles of the Gothic Revival. At Hereford as at Durham not only was a screen replaced but a new lectern was made and placed in front of it. The newly created cathedral at Truro was embellished with an impressive bookstand that again draws inspiration from the Birmingham lectern.

Suppliers of ecclesiastical fixtures were soon producing their own versions of the brass eagle lectern. From the 1840s firms like John Hardman of Birmingham; Hart, Son, Peard & Co of London; and Benson & Froud of London began mass-producing lecterns. Advertised in newspapers and transported by rail, the Victorian designs often closely followed those of the gothic examples that had been discovered, and they found their way into Anglican church interiors across Britain.

PRE-REFORMATION DESIGN

The freestanding bookrest with its eagle-shaped reading desk has three components: the pedestal, the stand and the desk. In the late 15th to early 16th century the pedestal becomes circular and is supported by three or four small lions, seated or *couchant*. The stand is treated as a column or baluster, decorated with geometrical shapes at both ends of the stem and repeated in the middle. The stand is topped by a sphere on which the eagle rests, its wings outstretched to form the reading desk.

A fine example of an early brass eagle lectern can be seen at St Bride's Church, Fleet Street in the City of London (page 25), which is typical of the style popular in England in the decades prior to the Reformation (roughly 1470–1530).

These Tudor lecterns, which later inspired the Victorians, share a similar design and are the products of a similar metalworking tradition. Brass or 'latten', the difference is purely linguistic, is an alloy of copper and zinc. The latter was unknown as a material for a large part of our history and instead the powder of a stone containing high concentrations of zinc ore was used. This stone was called calamine and was found in abundance in the region between Aix-la-Chapelle and Liège in modern Belgium.

The Meuse Valley became a centre for brass-workers, filling domestic and ecclesiastical interiors with candlesticks and kettles from the 10th century onwards. In the early 12th century Theophilus Presbyter described the process of brass-making in his book *Schedula diversarum atrium*, and archaeological finds from the 13th to the 15th century support his account. Copper was heated in a crucible, then charcoal and the powdered calamine were added. A vapour containing the zinc ore reacted with the copper to produce brass. This process is called cementation and was used for brass-making until the Industrial Revolution. It remained a skilled craft and trade secrets were not readily shared.

At the top end of the market were ecclesiastical fittings like large candleholders and eagle lecterns. These objects were too big to cast in one piece so they were assembled from many individually cast segments using a lost-wax technique. Moulds were taken from wooden or plaster models. The pedestal and its lion-shaped feet were separate parts and even the bird's talons were individual pieces, as the following examples illustrate.

At Christ's College Chapel, Cambridge, the lions are substituted by greyhounds (thought to be a reference to Lady Margaret Beaufort who re-founded the college in 1505). The colour difference suggests these were not made in the same workshop as the lectern. Two of the three lions of the lectern in Croft, Lincolnshire, were stolen in 2008 and later replaced.

Several eagles are now missing their original individually cast talons and their loss is often blamed on Oliver Cromwell. At Wolborough, Devon, the lost talons were later replaced in silver. More recently, the talons of the eagle at Oxborough, Norfolk were replaced, taking inspiration from those of the contemporary and similar lectern at Southwell Minster. The conservation of the lectern, including the replacement of the talons, was done by Rupert Harris Conservation Ltd of London.

It was not unusual to have two lecterns in a church, as the Gospels were read from the *cornu Evangelii* on one side of the altar, while the Epistles were read from the *cornu Epistolae* on the other, as is recalled in the *Rites of Durham*. This is confirmed by the 13th-century writings on liturgy by William Durand, the Bishop of Mende. The locations may be situated to the north and south of the altar. In the chancel behind a screen or *pulpitum*, the area reserved for the clergy, the Gospel and the Epistle were sung in Latin.

According to the 16th century author of the *Rites of Durham*:

> *At the North end of the high altar, there was a goodly fine letteron* [lectern] *of brasse where they sung the epistle and the gospel, with a gilt pelican on the height of it finely gilded pulling hir bloud out hir breast to hir young ones, and winges spread abroade wheron did lye the book that they did singe the epistle and the gospel.*

This evocative description formed the basis of Sir George Gilbert Scott's design for the present pelican lectern at Durham Cathedral, which was made by Francis Skidmore of Coventry. Late 19th-century photographs (page 26) provide a view of the intended effect and its location at the end of the aisle in front of the screen. Placing lecterns in this central position became widespread during the Reformation. Previously hidden behind the screen and supporting a Gospel or Epistle handwritten in Latin, the lectern now addressed the congregation and held a printed Bible in English.

In 1539 the Great Bible was presented and a copy had to be displayed for all to consult. Freestanding bookstands like the brass eagle lectern already present in some houses of worship could fulfil the task perfectly. In the Church of St Petrock, Exeter, the lectern was placed in 'the body of the church, to set the Bible on.' The inventory of 1554 describes 'an egle of latten whiche ys to leye the Bible on' in the church of Havering, Greater London. Of all the brass eagle lecterns in England dating from before the Gothic Revival of the 19th century and the industrial output that followed, a surprisingly large number can be dated to between 1470 and 1530. Only one is earlier and can truly be called medieval, that of Holy Rood Abbey, Southampton, today at St Michael's Church. From the 18th century two survive, one at Brasenose College, Oxford, the other at St Paul's Cathedral. Less than a dozen were made in the 17th century, and none during the Commonwealth. Yet a staggering 40 or so survive from the relatively short period between the end of the Wars of the Roses and the beginning of the English Reformation.

THE DECLINE

The consequences for the church interior could not have been anticipated when Henry VIII broke away from Rome in 1534. In the process the liturgy was reformed, heralding a rising influence of protestant attitudes towards idolatry, with radical implications for the church interior.

At Westminster Abbey the sale of two brass lecterns was ordered by the chapter in 1549 as they were 'monuments to idolatry and superstition.' The supposed profanity can be explained by the iconographical connotations of the eagle. It is a symbol of St John the Evangelist, whose Gospel starts with the words *In principio erat Verbum* ('In the beginning was the Word'), so there was a symbolic connection between the eagle and the Bible which rested on its wings – the word of God. The eagle is one of the four animals of Ezekiel, a tetramorph which is completed by the bull for Luke, the lion for Mark and an angel for Matthew. Depictions based on texts in the Bible were accepted by many early protestants. One of the earliest Lutheran church interiors, the chapel at Wilhelmsburg Castle in Schmalkanden, features a curious altar-cum-font supported by all four creatures from Ezekiel's vision.

Yet another connotation of the eagle could be regarded as outright blasphemy. The *Physiologus*, a medieval encyclopedia describing the earth as an allegory of heaven, regards the eagle as the King of Heaven. In the 13th century Thomas Aquinas wrote 'as an Eagle He [Christ] ascended aloft into heaven.' As an allegory for Christ, the brass eagle lectern was the epitome of the idolatry which Puritans wished to excise.

Brass eagle lectern c1500 at Wren's Church of St Bride, Fleet Street, London (Photo: Marcus van der Meulen)

The *Physiologus* also provides an explanation for the pelican's significance, claiming that the bird would pierce its own breast to feed or revive its brood. In one of his Eucharistic hymns for the Feast of Corpus Christi (1264) Thomas Aquinas made the connection with Christ even clearer: *Pie Pellicane, Iesu Domine. Me immundum mundo tua sanguine* ('Pious pelican, Lord Jesus, cleanse me, impure one, in your blood'). The pelican thus provided the church with a vibrant allegory for Christ, his sacrifice

Interior of Durham Cathedral looking towards the choir in the late 19th century, with Scott and Skidmore's pelican lectern in the location for which it was conceived (Source: AD White Architectural Photographs Collection, 15/5/3090.01048, Cornell University Library)

on the cross washing away the sin of mankind. It is unsurprising that Puritan protestants of the 16th and 17th century regarded such objects as idols. The pelican lectern at Norwich was buried, probably to prevent its destruction. By the late 16th century, few church wardens regarded the opulence of the lectern as a fitting support for the Bible.

Of the 100 or so brass lecterns mentioned in inventories in 1536, less than half survive today, and many probably ended up in the melting pot. Many of these pre-Reformation lecterns had only recently arrived in the churches. At Peterborough the inscriptions on the lectern presented by the Abbot William Ramsey and Prior John Malden are illegible today, but they were recorded in the past and date the lectern to between 1471 and 1496. At Wiggenhall St Mary Magdalen, Norfolk the engravings can be deciphered as reading *orate pro anima fratris Robti Bernard gardiani Walsingham anno Domini 1518*. The one now at Southwell Minster, recovered from the lake at Newstead Abbey, is dated 1503 and the lectern at Lowestoft is dated 1504. Among the later pre-Reformation lecterns is the one in Woolpit which dates from 1520.

No attempt was made by the Tudors to strip church interiors of these objects of idolatry on a national scale. However, many church wardens chose to replace the lavish lectern with a bookstand made of a humbler material like wood. At Long Melford, Suffolk, the medieval Rood Cross was used to fabricate a support for the English Bible.

The lecterns which survived the big sell-off during the 16th century became objects of a witch hunt in the years of the Civil War and the Commonwealth. A Puritan rage tried to cleanse the nation of its blasphemous bookrests, an unsurpassed iconoclasm smashing to pieces centuries of religious heritage. In 1642 troops under the command of Colonel Sandys destroyed the early 16th-century lectern inside Canterbury Cathedral. Not far from the bridge at Cropredy, site of a Civil War battle of 1644, a brass eagle lectern was retrieved from the river and now sits in the local church. Whether it was hidden from Parliamentary troops before the battle or thrown in by Puritans is unknown. Similar stories are told across the country, from Bovey Tracy in Devon to Oundle in Northamptonshire. Many lecterns were not recovered until the early 19th century, an unexpected resurrection after being buried for centuries.

At Canterbury Cathedral a new beginning was marked when a brass eagle lectern was placed in the choir during the Restoration, made by William Borroughes of London in 1662. Once again the brass eagle lectern adorned an English ecclesiastical space, translated to the new function and location for an Anglican liturgy, supporting the Bible in the English language and placed in the body of the church.

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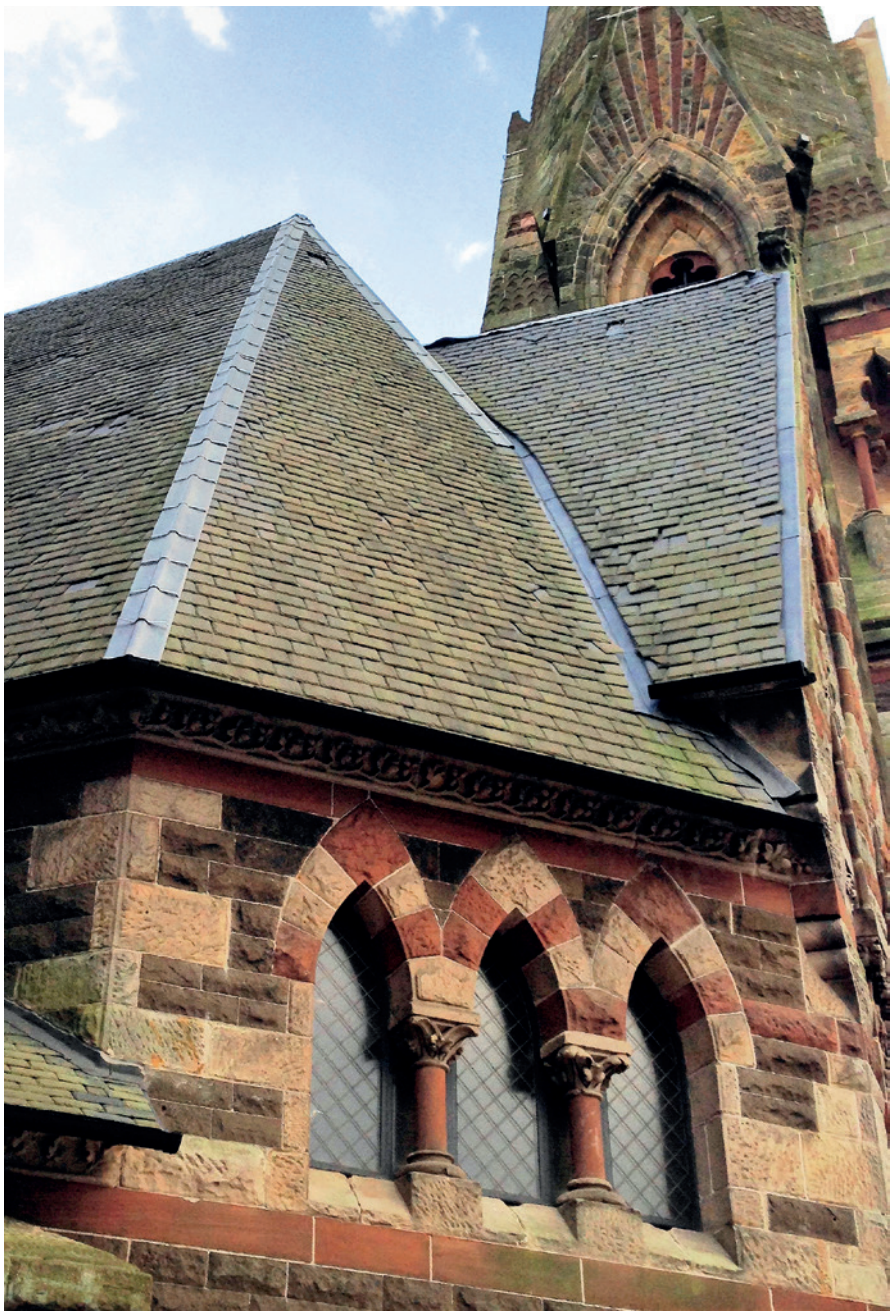
BATTLING THE ELEMENTS

Church roof repairs in the west of Scotland

Rebecca Cadie

WITH THE help of grants from the Listed Places of Worship Roof Repair Fund, the Heritage Lottery Fund and the VAT recovery scheme, the last few years have been extremely busy with roof repairs to a good number of churches in rural and coastal locations for us in the west of Scotland. Weather conditions for the Inverclyde and Ayrshire coasts of the River Clyde, Argyll and the Western Isles have a reputation for being a challenge, with high rainfall combined with prevailing south-westerly winds often resulting in prolonged periods of driving rain. It has been well reported that there has been as much as a 50 per cent increase in annual precipitation in the last 50 years and an increased frequency of gales and storms as a result of climate change. Many of the churches are now 150 to 200 years old and are reaching a stage of decay where roofing materials can no longer cope with the persistent wet climate. For these churches, regular maintenance and patching up repairs are no longer enough; comprehensive conservation work and re-roofing is often the only option.

Much of ARPL Architects' work is involved with Scottish Episcopal churches, which often have simple Victorian Gothic style steeply pitched slate roofs on timber sarking boards and trussed or tied rafter roofs that are exposed to the interior. Other typical features include raised gables with skews (gable parapets) and a bell-cote or tower intersecting with the main roof. Many of these churches are located on the seafront or a raised hillside and have been experiencing some extreme winter storms, which are becoming noticeably more frequent. These storms lift and disturb slates, pull up lead flashings, and in a few situations have broken and blown off stone finials.



Storm damage to the roof of Trinity Church in Irvine, North Ayrshire due to poor slate fixings and the use of lightweight zinc ridges (All photos: Rebecca Cadie)

Erosion of skew masonry beneath defective flashings, with flush cope stones above

Rotten sarking caused by a failing skew abutment

In some recent cases, bell-cotes or pinnacles struck by lightning have even fallen to the ground or through a roof. In addition to the sudden and catastrophic damage caused by storms, a constant and challenging condition is dealing with the consequences of increased rainfall, with water penetration through stonework and the strain on capacity of rainwater disposal systems.

While the conditions in the west of Scotland may be among the most severe in Britain, the solutions and techniques developed here will be of interest to churches throughout the UK now experiencing more frequent extreme weather events.

As with all conservation work, the starting point for church roof repairs is a thorough survey, noting historic and traditional details, and developing an understanding of any weak points in the envelope and its system of rainwater disposal. When assessing the extent of repairs required, regular issues are often found that need not just repair, but more robust details and solutions to withstand the changing weather conditions. These have to be carefully detailed using traditional materials to be sympathetic with historic fabric and to ensure long life expectancy. Here the practical advice and design details provided by the Lead Sheet Association are invaluable, as is the advice given on a rolling programme by Historic Environment Scotland. The latter's recent publication *Short Guide 11 Climate Change Adaptation for Traditional Buildings* sets out the correct approach to take when looking for a more robust defence against severe weather.

A new 'watergate' with a lead skew flashing and a storm roll to prevent storm water spreading into the sarking

LIGHTNING PROTECTION

It is surprising to find that many of the churches do not have lightning conductors, and a specialist assessment for a protection system is now a routine 'improvement' to be considered. Lightning has become more frequent in the west of Scotland due to the warmer and wetter conditions. The location and route of the conductor cables can be discreetly positioned, tucked into buttress internal corners, run along the blind side of a ridge or inside skews and then down to ground terminals located appropriately away from any graves in the church grounds.

FLASHINGS AND MORTAR FILLETS

Major problems often occur on the gable walls where the up-stand skews are highly exposed to wind and driven rain. The copes that perform best have a projecting drip, but many are eroded or were designed without the drip. Wind-driven rain can also penetrate the mortar bedding joints and this may be improved by re-bedding the cope stones on to a lead damp-proof course and securely fixing them through the lead to the wall-head. Skew abutment flashings in particular have been failing under the weather conditions with water penetration causing damage to church interiors. Aged leadwork which has had to be dressed back repeatedly following storms becomes malleable and brittle with cracks developing, making it more vulnerable to wind-lift.

On removing slates and skew flashings it is common to find that the sarking boards abutting the skew are rotten, with a strip of decay up to one metre wide. When water penetration has been prolonged, the first rafter may also be rotten if it is touching or close to the skew stonework. Replacement sarking should be formed with treated softwood timber boards of the same thickness as the original and preferably butt-jointed. Ply sheet is not a suitable substitute because it does not allow the same level of air flow across the roof and it is difficult to nail slates to it securely.

If stonework remains saturated following prolonged periods of rain, damp is likely to spread, penetrating the core of the walls and damaging interior plaster. A traditional detail found where skew copes have shallow up-stands is a mortar 'parging' fillet, which can be badly affected by cycles of saturation and wind-drying that produce cracking. If it is not possible to replace the fillet with a lead flashing, a more robust alternative is to form a new fillet over a stainless steel mesh that is wedged into the skew bed.

Erosion of stone underneath lead flashings can occur when the stone has been under saturation conditions and indents are often required to ensure a sound base for new leadwork. The risk of saturation may be reduced by increasing the roof-cover width of the leadwork to form a 'watergate' (a lead-lined channel) with the upstand on one side and a lead roll to the slate edge on the other. This detail can greatly improve the safe disposal of water and reduce seepage and leaks into the sarking. An increase to the up-stand of the lead flashing and deeper cover flashing depth may be considered if there has been stone repair, but it may be more appropriate to dress back into the original chase to avoid weakening or damaging the skew stonework. Traditionally, the leadwork would be pointed in with a lime mortar. However, with increased

A reslated roof with lead caps to the skews

A roofer cheek nailing slates on an exposed roof

rain and wind action and more thermal movement of the lead, it can be more effective for long term performance to use a lead plumber's mastic sealant to the top of the cover flashing.

Where water penetration through skews has become extensive, further protection can be provided by cloaking the copes with a lead capping, either by tucking the lead into a groove or 'raggle' cut into the top surface of the cope, or entirely capping the cope. This not only changes the appearance quite dramatically (in some cases requiring formal planning and listed building consents), but it also changes the way a cope behaves, with an increase in fast water run-off from its smoother surface. As this may affect the wall below, careful consideration should be given to whether a full covering is really necessary.

The replacement of lead flashings and dressings that have aged or are storm-damaged provides an opportunity for more robust detailing. Increasing the code of the lead flashings improves their resistance to wind-lift and enables the girth and cover of flashings to be extended. At valleys and parapet gutters the lap may be extended under the slates and the depths of the stepped joints may be increased, while catch pits or 'sumps' can be added at outlets to increase the capacity of the gutter. Combining these improvements with larger chutes and outlets to hoppers enables the disposal system to handle a greater volume of rainwater.

ROOFING SLATES

Slates disturbed by high winds often rattle on their fixings, which wears away the fixing holes and then loosens them, making them more prone to slippage. The choice of nails and fixing methods can make a significant difference to whether a roof can withstand extreme weather.

The importance of the diminishing courses typical of traditional roofs has often been under-appreciated, but the smaller slates at the higher parts of the roof are less likely to be flipped up by the wind due to their greater weight relative to size, while the lower, larger slates are better for coping with a larger shedding of water. New slates that are uniformly sized and larger than the typical small traditional ones, will not perform well when on an exposed roof, even if they are of good quality.

The typical specification for Scottish slating is to ensure a good deep lap of slate coursing, and commonly the outer two metre edge of a roof is fixed more securely by double nailing or cheek nailing (a nail at the head and another at the side of each slate). We have seen an extraordinary collection of refixing methods, using 'tingles' (clips) and adhesives as an attempt to keep the slates on, but have found the same roof will remain sound in storm conditions if properly re-slated with traditional detailing and in accordance with best practice.

The selection of replacement slate is important. It is often possible to salvage up to 50 per cent of the slate from an existing roof for reuse on the most appropriate roof planes. Ideally, these would be supplemented with new material to match, so it is a disappointment that there are no longer slate quarries open in Scotland on a commercial basis, and the stock of salvaged slate is constantly diminishing. Nevertheless, it is usually possible to find slates which match those originally used in the area and which perform well in the climate, being of similar weight and density and resistance to frost. For best weathering and aesthetic results, either second-hand scotch slate

A wind-damaged slate roof with tingles and a variety of other poor repairs

New Welsh slate work on the vestry spire of Trinity, Irvine with code 6 lead roll hip ridges

A relined channel gutter with a new watergate detail above

Rainwater goods replaced with larger cast iron sections and a wide watergate to cope with increased rainwater

can be specified for a historically sensitive roof repair, or Welsh or Cumbrian slates of assorted sizes for re-roofing.

For the higher roofs found on churches it is important that ridges are also robust enough to withstand the increased severity of weather. These can often be stone ridge pieces or clay ridge tiles and checking integrity and bedding is important to ensure they continue to perform well. The zinc ridge flashings and clips often used on lower roofs and houses are prone to storm damage when used in a highly exposed location, and the use of traditional lead roll ridges reduces the problems. If constructed using lead of code 8 or 9, these should be heavy enough to withstand intense storms and can incorporate a discreet ventilation detail which helps keep the roof timbers healthy.

GUTTERS AND DOWNPIPES

A particular detail of older churches with a classical Georgian design is a lead-lined channel on a parapet. This detail is routinely found to be a problem as the capacity of the channel is incapable of handling the quantity of water now experienced and the stonework is often badly eroded. Capacity may be increased by indenting the channel or by fixing a timber section to the outer edge to increase depth, which can then be dressed in lead. Forming steps in the lead lining of these channel gutters is usually not possible and the use of neoprene gasket jointing strips (such as T-Pren) may be necessary.

Where eaves gutters are used the majority are cast iron. The material is unrivalled for durability and strength, and if well maintained can last in excess of 80 years. Many traditional patterns that match original fittings are still manufactured, and these would always be a first choice when replacing badly corroded pieces. In some situations, cast aluminium sections with traditional profiles may be used for cost savings and for easier handling of longer sections.

The whole rainwater disposal system needs to be regularly checked for blockages and vegetation build-up as overflowing gutters and downpipes can cause considerable damage to the walls and the interior. The run of gutter levels should be checked and joints re-sealed before decorating. When full replacement of a cast iron system is required, it is practical to increase the capacity with larger half round gutters or deeper ogee sections, and with larger or more frequent downpipes. Eaves cornice gutters that sit on a stone eaves corbel can incorporate a lead 'safe' flashing which is visually discreet and is tucked up under lower slates to prevent flash-flood overflow into the building.

Some changes to the way roofs are detailed may be necessary to ensure the survival of the fabric below, but they should only be undertaken once the original details have been properly recorded and understood. Often these evolved out of the need to provide the most effective use of locally available materials, and ignoring their significance leads to the erosion of character and regional distinctiveness. In some cases, the result is also a roof that does not work.

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Wireless movement detectors mounted on a clerestory wall: for church roofs, movement detectors often require bespoke lenses and sensors.

Mounted at the west end of the north aisle, this sensor provides an early warning of unauthorised access to the church roof.

A sensor behind a parapet wall, supervising an area of roof on the north aisle of a church. Great care is taken with regard to sensor placement and installation.

BELL FRAMES and BELL TOWERS

A practical approach to assessment

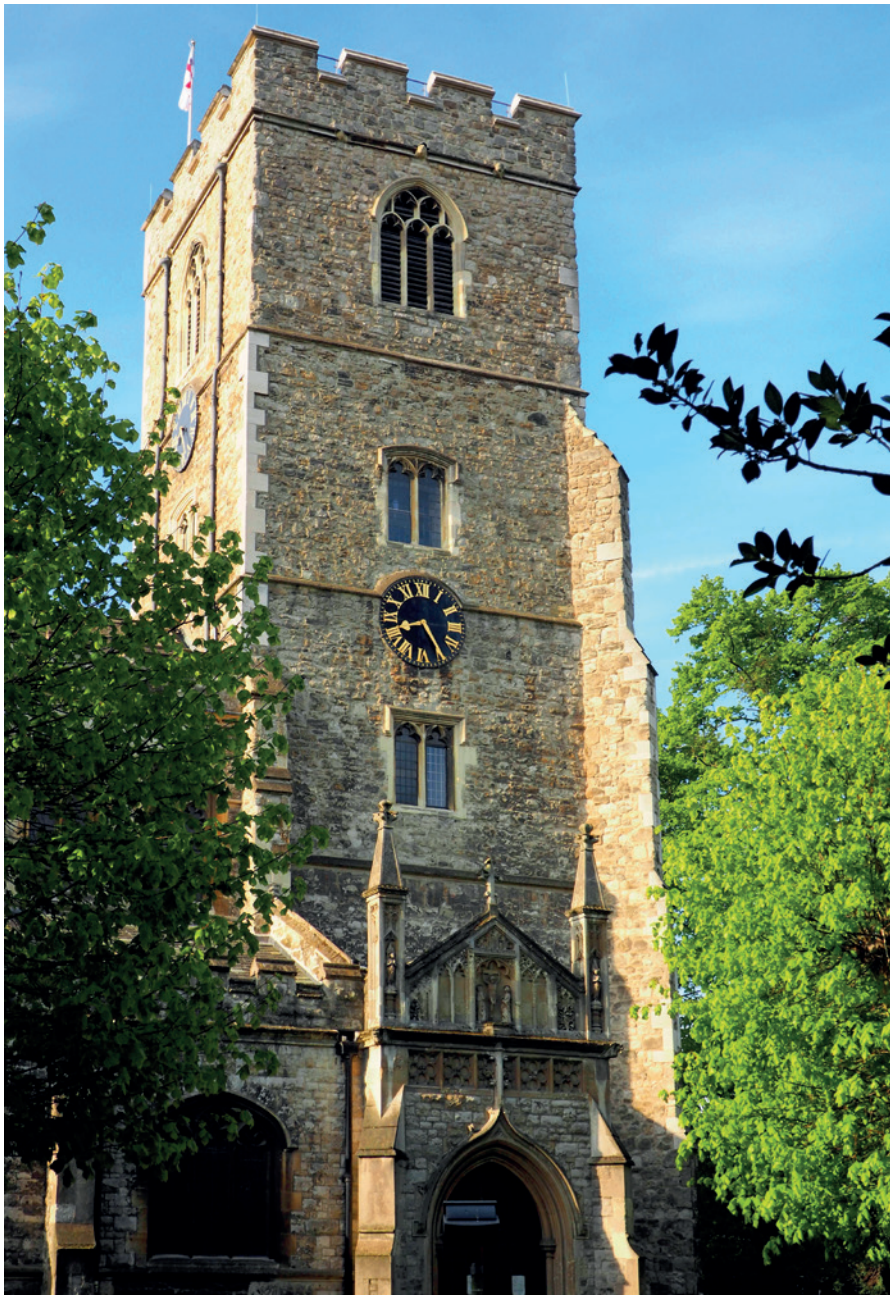
Andrew Dutton

IN ENGLISH bell ringing, or 'full-circle ringing', each bell is attached to a wheel on a frame enabling it to be rotated through 360 degrees. Bell ringers regularly need to balance their bell with the mouth upwards, yet the larger, 'tenor' bells typically weigh around 500kg. Needless to say, bell ringing is always hard work but any movement in the frame or the tower affects the arc of the swing, making some rings particularly difficult, and bell ringers frequently ask what can be done to make ringing easier.

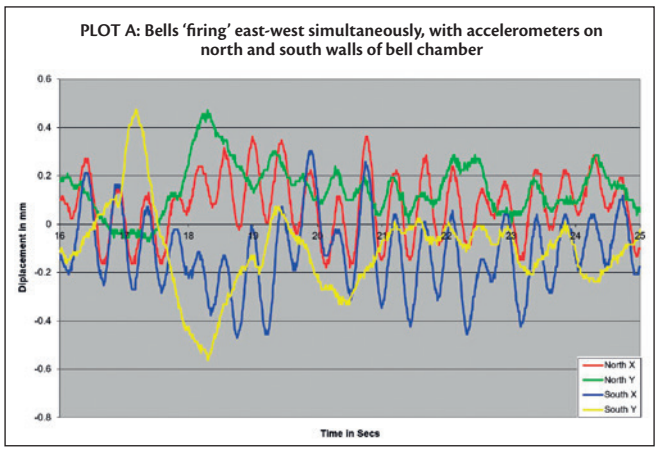
There are several factors which can affect the quality of the ring. Except for the problem of poor bearings, which can be dealt with by the bell founder, the issues of structural concern are slackness in the bell frames, lack of stiffness in the foundation beams to the bell frames, and movement in the tower itself. These potential movements are caused by the swings of each bell, some of which are oriented north-south and some east-west, so the forces and the subsequent movements are irregular in both time and direction.

The vertical force caused by a swinging bell is close to 4¼ times the deadweight of the bell and the horizontal force can be 2½ times the deadweight of the bell (see Further Information, Heywood). The movements of the bell frame mean that the pivots to the bells are continuously jerking about and that makes it difficult to hold the bell in the upright position, just past top dead centre, on the stay.

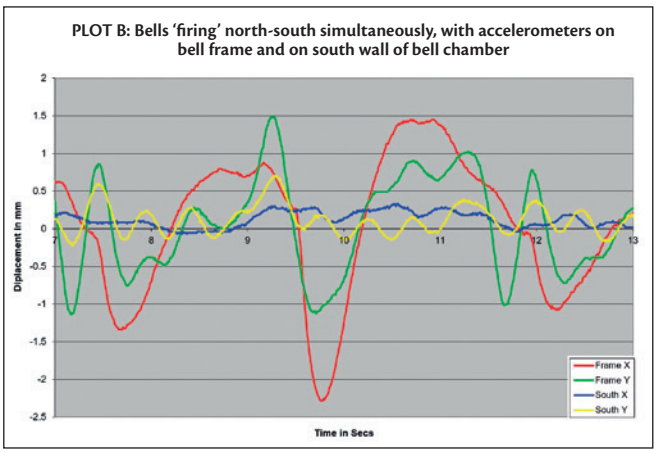
Old bell frames were made of timber, braced with diagonal struts and tensioned with iron ties. The timbers flex and the joints 'work' during ringing, loosening with time. Regular tightening of the tie bolts can help to minimise the slackness, but the frames are not as stiff as the later cast iron frames and, more recently, fabricated steel frames.



All Saints Church, Fulham, London where the medieval oak bell frame had gradually dried out and warped. The resulting movement had made bell ringing increasingly difficult and was beginning to damage the tower masonry.



This plot shows the movement in the north and south walls of the bell chamber when all bells oriented east-west (the Y axis) are rung simultaneously, producing a large pulse. The effect on the tower is captured by accelerometers attached to the masonry of the north and south walls of the bell chamber. The pulse leads to a jerk on the east-west axis (yellow and green lines) which is much longer than the natural frequency of the tower which is just over 2Hz.



A comparison between the movement of the frame on the north-south (X) axis in red, and the much smaller movement of the south wall (blue) on the same axis. This shows the considerable benefit which can be achieved by stiffening up the frame.

Timber bell frames were usually mounted on timber foundation girders, spanning across the tower but they may have been replaced with steel beams at some stage. The timber bell frame foundation girders are usually of substantial proportion but they will still flex a little and they can also slip in and out of the sockets in the walls. Steel foundation beams are more flexible and need to be substantially braced to limit their flexing. In one church, where a timber frame was mounted in three parallel but unbraced steel beams, the beams were found to be flexing by over 6mm laterally during some ringing sequences. The anchorages of the steel beams in the walls can also be problematic with hammering occurring.

The tower itself can be considered as an elastic structure which will move under the forces induced by bell ringing. Ideally it will act as a single box which is very stiff. However, there are normally weaknesses in the walls of the tower in the form of window and sound louvre openings and it is not uncommon to find vertical cracks running down the centres of each wall from opening to opening. These cracks effectively reduce the stiffness from that of a box with a side of 'x' to four angles with a side of half 'x,' which are therefore much less stiff. In a sense, the action of the bell ringing is trying to reduce the stiffness of the tower to this lower state by increasing the size of the cracks. The natural frequency of the tower will change as the cracks develop.

Cracks can also develop in the window reveals, indicating that the wall thickness is spreading as the rubble fill in the walls is shaken down. This is a particular problem in flint towers.

While the bells are rung to a rhythmic sequence, their different orientation and the ringing changes mean that the imposed forces do not rise and fall smoothly in a simple sine wave, but result in a series of jerks as each bell swings. On occasions this can produce a sequence of pulses which briefly match the natural frequency of the tower.

MONITORING

With careful monitoring, it should be possible to differentiate between the movements of the bell frame, the movements of the foundation beams and the movement of the tower at different levels. This requires measuring movement in each of these three elements simultaneously. From the three sets of data it will be possible to discover what portion of the total movement of the top of the bell frame (and hence the difficulty to ring) is due to slackness in the bell frame, sway in the foundation beams below, and sway in the tower as a whole. The bell ringers can then assess the benefits to be gained from various levels of improvement.

It could easily be the case that a 50 per cent reduction in the movement at the bell pivots can be achieved by improvements to a timber bell frame, whereas the more expensive option of installing new foundation beams might only give a 10 per cent improvement. Similarly, the even more expensive option of lowering the bell frame in the tower to reduce sway itself may give only a very small improvement and, for reasons which will be discussed later, could even result in greater movement.

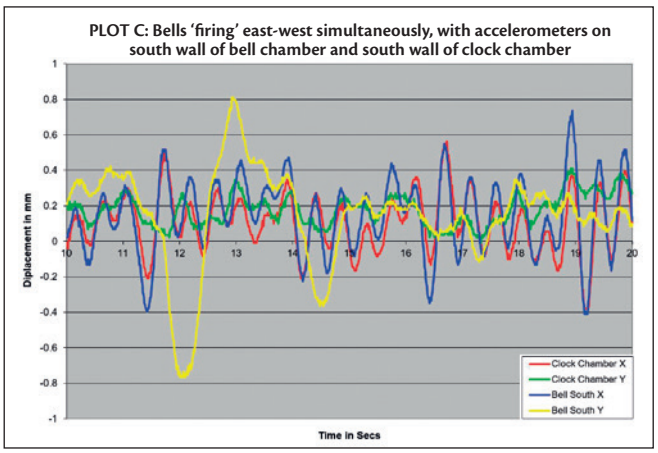
Monitoring can take many forms depending on what is being sought. A finger placed across a crack running up the centre of the wall during ringing will be sensitive enough to feel whether the crack is 'working' (opening and closing).

To determine the benefit of tightening up a timber frame or replacing it with a metal frame, it is possible to install temporary wedging and blocking between the frames and the walls so they cannot move differentially to the tower. This is only a temporary expedient, however, because potential hammering as the wedges loosen can damage the masonry.

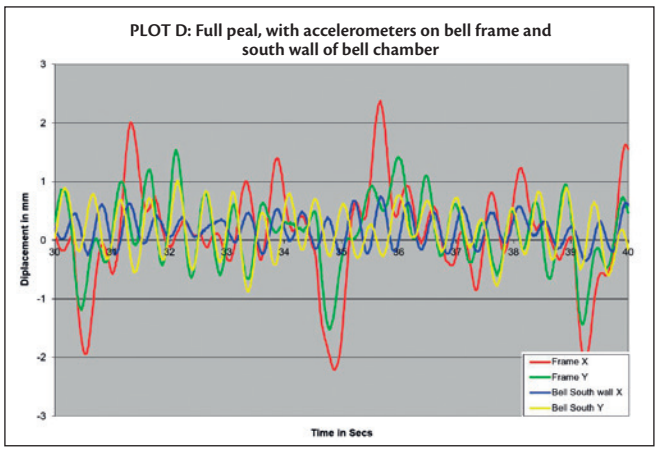
Ideally, accurate electronic measurement of all elements simultaneously will yield the most information. Electronic measurement of bell frame movement was developed by the late Harry Windsor of the Central Council of Church Bell Ringers when it became apparent that a lowered bell frame had resulted in increased movement in one church tower. Windsor produced a publication on his method of monitoring and his assessment of why the movement might have increased, based on the harmonics of the bell ringing matching the natural frequency of the tower. He was about to publish a revision to his booklet when he died in 2007 (see Further Information, Windsor).

Windsor's method of monitoring employed accelerometers mounted on the bell frames and tower with a data logger. The accelerometer information then had to be transferred to spreadsheets for the actual displacement to be calculated by the mathematical process of double integration, a slow and tedious process.

At this time I was developing my own electronic system which automatically calculated displacements from the accelerations and simultaneously carried out the data integration as a continuous process, allowing instant plots of the movement. Three accelerometers, each able to measure the acceleration in the x and y directions simultaneously, could



This plot shows the movement of the south wall at bell chamber level and the clock chamber 4m below. It can be noted that the impulse momentarily distorts the wall of the bell chamber in the east-west axis (yellow) while the wall below (green) moves much more closely with the natural frequency of the tower.



With a peal (with bells swung in both axes), the frames move much more than the wall in both X (red) and Y (green) axes. The yellow and blue plots give a clear indication of the natural frequency of the tower in each direction.

be mounted at key locations. Typical locations are on the bell frame at pivot level, on the foundation beams and on the tower walls in the bell chamber. Another combination may be to locate the accelerometers at different positions up the tower to measure the tower shape as it moves. This, in conjunction with measuring the natural frequency of the tower, will help to predict the benefits of changing the level of the bell frame. Plots A–C (above) show the movement for various combinations of excitation at different locations within the same tower.

When monitoring the movement, there are a number of methods of excitation. To measure the natural frequency of the tower, a single pulse input while measuring the decay frequency would be optimum. It is not possible to achieve that with a full circle swing of a bell due to the complex combination of forces which are applied as the bell swings. A better method is to have a heavy sandbag swinging on a rope and impacting on a wall. However, in reality, even when ringing a peal, it is possible to pick out the natural frequency from the plots (Plot D).

Determining the maximum potential movement of the tower can be difficult due to the wide range of peal sequences. I have used a combination of the bob minor peal (when bells are rung in sequence) and 'firing' (when all the bells are rung simultaneously) in one of the orthogonal directions. Firing will produce a large jerk (see Plots A–C).

Where there are cracks of specific concern, it is possible to measure the movement in each side of the crack simultaneously, with the difference between the two plotlines representing the movement at the crack.

There is a limit to the accuracy of the movement recorded. The electronic integration method introduces background 'noise' in the signal. As a result, movements of less than about 0.2mm will be lost in the background noise.

One clear lesson of the monitoring is that human perception is very sensitive and actual movement is usually much less than people expect.

BELL FRAME ALTERATIONS

Stiffening up the bell frame or foundation beams to reduce movement of the tower can have unpredictable effects. The slackness in the system means that the energy transfer from the bells to the tower is delayed, with energy temporarily stored in the frames and beams as they flex, and then released at slightly different times. This can change the frequency of the forces imposed on the tower and it can also increase them.

Imagine placing a football against a wall and kicking it onto the wall. The impact on the foot, and hence the wall will be tolerable. Now replace the ball with a hollow metal ball of the same mass and kick. Broken toes could be the result, indicating a much higher impact force. The energy absorption of the frames and foundation beams is similar. It is possible that stiffening of the frames and foundation beams could increase the movement of the tower, either due to the sharper impact pulse or because the modified input frequency is nearer to the natural frequency of the tower. Unfortunately, monitoring of the tower will not help with this dilemma.

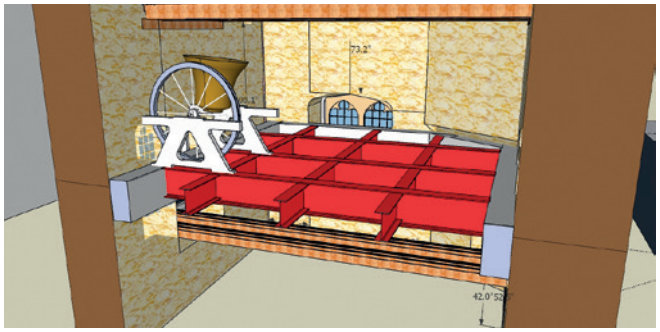
Changing the level of the bell frame can also have unpredictable effects if it means that the force is applied at a position nearer to the point of maximum movement of the tower. Some towers will sway as a simple cantilever from the ground. Others, possibly with stone spires with a higher centre of mass, may develop a 'standing node' approximately two thirds of the height, about which the structure oscillates. If the force is applied near the point one third of the height, excitation can occur. Hence the need to monitor the shape of the displacement up the tower. Harry Windsor and others have attempted to analyse what happens but it seems to me that too many changes take place when a bell frame is altered to allow isolation of specific parameters.

Changing the configuration of the bells in the frame can also change the forces on the tower. One of the reasons bell ringers want to have their bell frames modified is to improve the arrangement of the hanging bell ropes. Ideally, they should form a circle so that each ringer can see all the other ringers. This often means changing the direction of swing of some of the heavier bells. The tenor might have been swinging east-west for 200 years and will now swing north-south and be close to the west wall of the tower. The north-south forces in the west wall could increase significantly.

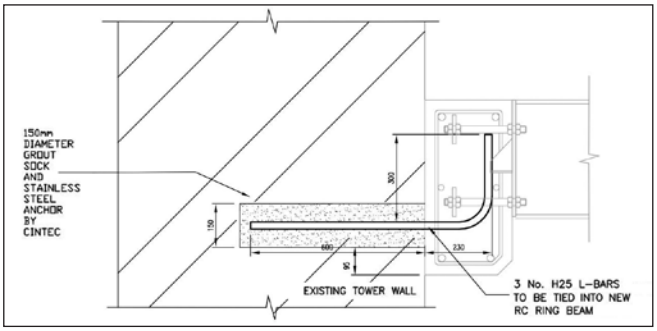
TOWER WEAKNESSES, CRACKS AND REMEDIAL MEASURES

Generally, where vertical cracks have developed in the centre of each wall of a tower, these do not get significantly worse after formation. However, if they do 'work' during ringing, tiny particles of debris will work their way down the cracks, slowly enlarging them. Cracks can also be worsened if changes made to a bell frame alter the forces induced in the tower walls. For this reason, when it is proposed to alter a bell frame in a way that will change the forces induced in the tower, it is recommended that the cracks are tied.

Historically, cracks were tied with



This typical new bell frame foundation with a concrete ring beam inside the tower walls was installed at All Saints, Fulham (see page 33).



A typical anchor tie into the wall

large diameter iron bars with large pattress plates on the outside to anchor them. The current practice is to use bespoke stainless steel ties such as Cintec. These are drilled through the full breadth of each face of the tower from corner to corner and grouted in place. The core from the facing stone is then re-fixed, leaving an almost invisible repair. The positioning of these ties depends on the configuration of the tower, but generally they are positioned above the openings in the walls at each level.

Some towers develop cracks in the window reveals. These are more serious, indicating that the wall thickness is spreading due to the rubble fill in the centre of the wall consolidating and pushing the two masonry faces apart. These cracks are quite common in flint towers where the rounded flints in the centre of the wall can move more easily and wedge down into gaps between the flints below, pushing the faces apart. Spreading is likely to worsen with continued bell ringing.

Through-thickness tying can be used where there are stone or brick facings and the cores can be grouted with a fluid lime mortar grouting. Flint walls can be more problematic due to the difficulty of coring – drilling out the tie holes with a hollow cylindrical bit – and the smaller size of each flint. The Society for the Protection of Ancient Buildings recommends cutting pockets through the wall and building in stainless steel mesh ties (see Further Information), but this may be difficult to achieve in practice.

NEW FOUNDATIONS FOR BELL FRAMES

Occasionally, there is a requirement to install a bell frame in a tower which has not previously had full-swing bells. More commonly, there is a requirement to change the level of a bell frame. In both cases it is first necessary to establish how to install the bell frame while following sound conservation principles.

In the mid-20th century, square concrete rings were often cut into and embedded in the internal faces of the tower with either a concrete floor or integral transverse beams supporting the bell frames. This approach leads to significant loss of original fabric and would be difficult to reverse without causing extensive damage to the original masonry, particularly when breaking out the embedded concrete.

Nevertheless, the concrete ring serves the fundamental function of holding the four sides of the tower together and spreading the forces from the bell ringing more uniformly into the walls. To retain these benefits while minimising loss of fabric, one option is to construct the reinforced concrete ring beam adjacent to the inside face of the tower and tie it to the walls by a series of stainless steel anchor bars grouted into 150mm diameter pockets cored into the walls at regular intervals. If removal were required, the ring beam could be cut using vibrationless methods such as diamond sawing and the anchors in the wall could be cored out.

MONITORING FOLLOWING CHANGES TO THE BELL FRAME

From the viewpoint of the bell ringers, there is nothing to be gained by monitoring after the changes have taken place. However, by improving our understanding of the behaviour of these structures there is much to be learned.

The interaction between full swing bells and bell towers is complex. The forces are significant and all bell towers move. The bell frames on which the bells are mounted distort as the bells swing and they are jerked when an adjacent bell swings. Not only can these forces make ringing difficult, but they can also be highly destructive.

Monitoring can be used to identify where movement is occurring and may demonstrate that there is no need for major changes if the frames can be tightened up. Monitoring can also show the movement shape of the tower and the distortions of the walls. However, monitoring will not be able to determine how the movement of the tower will change for any given alterations to the frames.

With time, if sufficient pre- and post-alteration monitoring is carried out, a better understanding may develop. Harry Windsor was undertaking this work when he died. His work was voluntary, my own is commercial. As a practising structural engineer, I have found bell ringers reluctant to fund work which gives them no direct benefit and I have not been called back to carry out post-alteration monitoring. Until we have the opportunity to carry out the ongoing monitoring required, advising on the impact of changing bell frames will remain more an art than a science.

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COBBLE REPAIRS

Robin Russell

A WIDE VARIETY of paving using locally-available small stones can be found in churchyards across the UK. Lying forgotten within their hallowed grounds, they are often the last surviving examples of the traditional surfaces used on neighbouring streets and paths, so give a valuable insight into the appearance of the local townscape before it became covered in tarmac. Generally, these 'small-unit' materials fall into two categories; cobbles or setts.

Small stones which are cut and shaped, often quite roughly, are now known as setts, although many people still refer to them as cobbles, In areas of the country where the local stone was easily split, thin setts are sometimes end-bedded or 'pitched' into the ground. (The term pitched has nothing to do with the use of bituminous pitch.) Granite setts are the most hard-wearing and can be found furthest from their source as they often replaced softer local stones following the development of canals and then the railways to transport them.

The term 'cobbles' describes the smoother, more rounded stones that were fashioned by natural erosion or running water, and were used uncut, as found. Cobbles were used extensively to create paths, roads and hardstanding areas, such as courtyards. Cobble-laying is a simple but very useful technique, but unfortunately, as with other trades, the knowledge of how to do it well has largely been lost as cheaper and often less-effective methods have been adopted.

Where cobbled paths have survived, it is important to carry out repairs using appropriate materials for both cobbles and bedding, and to preserve as much of the original scheme as possible. At the outset of a project it is therefore important to identify which areas of the cobble are to be repaired. Photographs and sketches should be used to clearly communicate the nature and scope of the work to any contractors and controlling authorities. The key principles are:

Documentation – record the cobble before intervention and document the intervention itself so that future conservation work is well informed

Minimal intervention – retain the maximum amount of historic cobble and repair rather than replace wherever possible

Reversibility – ensure that alterations and additions to cobbled areas can be undone without harm

Like-for-like – wherever possible, match materials and techniques to the existing work

Tightly packed flat-topped cobbles bound by small kerb stones provide a relatively even surface at St Peter's, Tiverton, Devon

St Swithuns, Sandford, Devon: some areas have sunk and collect water, but otherwise this section is in good repair

Ugly concrete infill and cement repairs

Another inappropriate repair using mismatched stones

Plants removed from cobble revealing a worn original earth mortar infill

Cobbles partially backfilled with sub-soil, showing the flat-topped form of reclaimed river-worn cobbles

Appearance – make the solution honest but aesthetically neat or invisible: there is no justifiable reason why modern repairs, once aged, should not add character and appeal in the same way as historic ones.

Traditionally, cobbles were laid in non-porous subsoil, especially clays, and it is generally best to copy what went before. Often some coarser binder was added, such as a local sand or grit. More recently lime (or sometimes cement) mortars have been used but they are not recommended unless vehicles will be using the area. The original materials were probably sourced locally so it is best to try to find matching cobbles and subsoil locally too if possible. Patterns or even lettering were often formed in cobbles by laying stones of the same or similar types in different directions, or by using different colours or types of stone. These may not be immediately obvious, so when relaying cobbles it is important that each one is placed back in the ground in the same orientation as before.

Sourcing appropriate cobbles is the most difficult and time-consuming aspect of cobble repairs, and is best done before any work commences. Many traditional cobbled areas are made from flat-topped cobbles, which were usually found in local streams and river beds. The stones were flattened and smoothed uniquely over the centuries by the passing of water, silt and other material. They were placed with the flattened side on show. Rounded cobbles, which are commonly found on beaches where they are shaped by being washed up and down and tumbled by the waves, should not be used as a substitute. Bear in mind that those dug from the ground may also have been formed on beaches, many millennia ago. They are not the same as river-worn cobbles. Consequently it is important to try to source the cobbles from a similar place to the originals.

River cobbles can no longer be extracted in this country, and the cobbles which are available from quarries are usually rounded beach-type cobbles. The best solution is to find cobbles salvaged from earlier schemes. Local authorities used to store the cobbles which were extracted from culverts or when relaying roads, but few still do so, and specifiers may find themselves passed from pillar to post in the hope of finding mythological depots. Private estates are more likely to retain cobbles from similar sources, although finding the shapes and sizes required may involve a great deal of sorting.

Cobbles were traditionally set into rammed subsoil which was laid for the purpose in the area to be cobbled. The stones were set into the subsoil by hammering them home so that they were touching adjacent stones. Additional bedding material was packed between the touching stones to help to stabilise them, and longer stones were hammered deeper to further improve the key and prevent movement. Usually, these 'peg-stones' are distributed fairly evenly across the scheme, but in some places all the stones are found to be peg-shaped and hammered in deeply.

The process is rather like building a stone wall on its side and the bedding material is like the mortar. The tools are simple and include hammers of various sizes, shapes and materials to knock the stones into place evenly. A large mallet and a timber board are particularly useful. Spades and a crow-bar also come in handy, initially to prise stones from position and later, to back-fill the substrate between the stones. A string-line is used to help

Calcite lettering on a path at St Peter's, Tiverton

position the top edge to present an even surface, which is then stabilised by infilling between the stones with a loose subsoil, brushed and packed in place using a stiff hand-brush similar to a churn-brush. It is usually best to water the repair area, for example with a watering-can, then infill again if any of the material washes in too deeply.

Where the cobbled area is not bordered by walls or heavy stone kerbs, the edge must be particularly well constructed if rapid deterioration is to be avoided. In this case, the edging stones can be fixed with a mass of lime mortar sloping into the ground ('haunching'), which can be covered over, for example with grass, to disguise it.

Most importantly, the cobbled area must shed water. It should always have a camber to the edges and should generally be made of a non-porous material so that rainwater is shed to the outer edges. It is important that the rainwater is then carried away or drains quickly.

Areas which have sunken and so collect water are defective and should be repaired by bringing them up to the level of surrounding cobbles. Often sunken areas result from vehicles such as cherry-pickers or vans passing over cobbles which were not designed to carry such traffic.

Repairs in the past have often been carried out in unsuitable materials. It is vital to repair surrounding areas using similar methods to the original work.

Cobbles are easy to maintain and, as always, a stitch in time saves nine. Cobbled areas should be inspected regularly, taking particular care to identify areas where the cobbles are becoming loose. If appropriate action is taken quickly, cobbles can usually be repaired. The most likely deterioration is where the infill between stones is lost, or the edging of the cobbled area is defective, causing individual stones to become loose. Also, areas of cobble sometimes sink, usually as a result of being driven over but occasionally because the substrate is subsiding. A sunken area of cobble will not shed water effectively.

Cobble repairs are more challenging when they form part of a much bigger project with a fixed timescale. In this context it is important to recognise the cobbling for what it is: a significant risk area which the project manager should prioritise as early as possible to ensure that the right materials are sourced and that a suitably skilled contractor is engaged.

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GRINLING GIBBONS

at Trinity College Chapel, Oxford

Martin Hall

TRINITY COLLEGE was founded in 1555 by Sir Thomas Pope using the buildings of the former Durham College. The medieval chapel, consecrated in 1410, was retained, but by the late 17th century it was in a poor state of repair, its condition exacerbated by lack of maintenance during the Civil War. When Ralph Bathurst became president of the college in 1664 he devoted himself to the restoration of Trinity's fortunes. He cherished the dream of a new chapel for three decades. With great generosity, he paid for the building shell himself, while college records show that he wrote many letters to solicit funds to enable him to pay for the completion of the magnificent interior. The result was the current chapel. Completed in 1694, it was built largely on the footprint of the original chapel.

Letters reveal that Bathurst had assistance from Sir Christopher Wren who was consulted on the design at a late stage, but in time to influence the chapel's external appearance and to give the parapets their distinctive flaming urns.

On entering the chapel today, the most striking feature is Grinling Gibbons' magnificent screen which divides the antechapel from the nave. It features fluted Corinthian columns and an arched pediment, topped with carvings of the Evangelists, and has two fretwork panels either side, with putti (infant angels) at their centres.

Passing through the screen reveals the impressive reredos behind the altar, which was also designed by Grinling Gibbons and is considered to be one of the best examples of his work. Above, the sumptuous ceiling is decorated with exquisitely carved and moulded plasterwork, thought to be heavily influenced by Gibbons and hand modelled, possibly by Bradbury and Pettifer or Edward Goudge, 'the beste master in England in his profession.' At its centre is a painting, 'Christ in Glory', by Pierre Berchet, about eight metres long and set between two smaller painted panels. The result was

Conservators at work on Grinling Gibbons' screen which divides the antechapel from the nave (All photos: Bruce Hammersley)

The conserved reredos against the dried out east wall of the chapel

described by diarist Celia Fiennes, a pioneering and enthusiastic 17th-century traveller, as 'a fine neate chapple new made finely painted… a Beautiful Magnificent Structure'.

Apart from several changes to the decoration over the centuries, the most significant alteration to the chapel was the replacement of the original clear glass windows with stained glass in the late 19th century, and the installation of successive organs, most recently in 1965 with a case by Stephen Dykes Bower in the Gothic Revival style. Major repairs to the roof and ceiling were carried out in the 1930s, and its eight stained glass windows were removed during the war for their protection. All but one of these were reinstated after the war. Research during the conservation work found this window to be from a German school of stained glass.

Plans for an extensive conservation project were conceived in 2010 following a quinquennial survey. Owing to the importance of the Grade I listed chapel, many experts were asked to give their opinions on the main internal features, including the carvings and woodwork, plasterwork, ceiling painting and stained glass windows. All confirmed the need for urgent repairs and conservation. This article focusses on the timber conservation elements of the programme that followed, and on the conservation of the Grinling Gibbons wood carvings in particular.

THE REREDOS AND THE EAST WALL

A condition report on the timber carvings, panelling and decorative works revealed that much of the oak panelling was in good order, but that the Grinling Gibbons carvings which form the pièce de résistance around the starburst panel above the altar were in need of careful conservation. There was also concern that the reredos panelling was set against a damp wall. Much of the stonework of the outer walls had been replaced in the 1960s to make good the decay caused by coal-fire pollution, but the east wall had not been re-faced.

An environmental monitoring survey was carried out by Brian Ridout of Ridout Associates to evaluate the level of damp and relative humidity. The evidence showed that moisture levels in the east wall were excessive, especially at its base. Fortunately for the important woodwork, conditions elsewhere in the chapel were found to be relatively benign.

It was decided to repair and conserve the existing stonework. A lime mortar was used to fill in any voids and a lime mortar shelter-coat was applied over the surface. At the same time, the ground level was lowered at the foot of the wall and a drainage trench (or 'French drain') filled with free-draining gravel was created to enable it to dry out.

Limewood cherubs and chalice from the head of the reredos during cleaning

Removing one of the small panels in the lower part of the reredos yielded an interesting discovery: the main parquetry panels are set on a pine backing panel, made up of vertical tongue-and-groove boards, with a layer of pitch coating the rear surface (which abuts the outer wall). This early precaution was made by the original carpenters and joiners to protect the screen and has been successful in keeping the woodwork in generally good condition.

THE REREDOS

Early on, the decision was taken to carry out detailed research to try to establish the original appearance of the different woodwork features of the reredos. One of the most exciting outcomes has been confirmation that the carvings, in limewood, oak and exotic hardwood, are all the work of Grinling Gibbons.

One of the most famous craftsmen of his era, Gibbons (1648–1721) was a carver of great skill in both wood and stone. He was born in Rotterdam and came to England in his youth, gathering experience and a growing reputation while in the employ of the architect Hugh May. Gibbons went on to work with Wren at St Paul's Cathedral, where his most famous work can be seen in the carved ornament of the choir stalls and Bishop's throne (1696–8). John Summerson describes Gibbons as having:

> *…an astonishing facility for naturalistic carving in soft woods which accounts for the universal and continued popularity of his creations. His aim, quite evidently, was to emulate the Dutch flower painters in his own medium, and he succeeded to a miracle.* (*Architecture in Britain 1530–1830,* p238–9)

A lithograph of the interior c1840

The richly-coloured central panel of the reredos is surrounded by contrasting, pale limewood carvings. These were found to be fixed crudely with clout-cut, handmade nails struck directly into the backing boards. After some effort and with extreme care, the carvings were removed by wood carvings conservator Alan Lamb and his team for condition assessment at their workshop.

Many areas had been so badly eaten away by common furniture beetle that they were composed more of voids than substance. These elements were consolidated using poly vinyl butyral in ethanol (2–3% in solution), which had been used successfully on other Gibbons limewood carvings.

The partially cleaned faces of putti from the antechapel screen: the thick varnish had been applied in the 1860s, obscuring fine detail in the Bermudan cedar carvings

Conservator David Mendieta carving a repair to replace a missing leaf tip

Using mid-19th and early 20th-century photographs, Alan Lamb was able to determine which elements had been lost over time and a number of these were replaced. The decision on what to replace was generally guided by the 'six-foot rule': if it can't easily be seen from six feet away, don't replace it.

After careful test cleaning and analysis of the layers of the varnish and paint it was discovered that for at least the first 50 years the carved limewood had been left undecorated. Having become very dirty and dusty, it had been given a 'reviving' coat of oil-based lead paint directly over the original surface finish (without even attempting to clean it, a layer of dirt was clearly visible under the first application of paint). This was an attempt to replicate the original

Woodworm damage in carvings of the reredos

appearance and colour of the limewood and since then it has been repainted several times.

Alan Lamb's team cleaned off as much of the paint and varnish as possible without damaging the underlying wood, and recreated the most significant missing elements, leaving carvings that are now close to their original appearance.

THE SCREEN

The figures of the Evangelists, which rest on the pediment of the antechapel screen along with their symbols – a winged bull, an eagle, a winged lion and an angel – as well as the two Victories on the pediment of the reredos, are carved in oak and rare Bermudan cedar (*Juniperus bermudiana*). This type of cedar is no longer available because the trees are endangered, but fortunately one of the college's generous donors found a small supply of old timber which enabled repairs to be carved from matching wood.

When the Evangelists were being reinstalled, Alan Lamb's team encountered difficulty in fitting the eagle to the figure at the north east. On checking a 1914 photograph it was realised that the Evangelists at the north east and south west had been swapped sometime after this date. The beardless Evangelist (St John) has now been correctly replaced with his eagle, facing into the chapel.

The two magnificent pierced panels in the antechapel screen are also carved in Bermudan cedar. Thorough cleaning to reveal the original finish has shown them to be carved to an exceptionally high standard and, like the limewood, to be some of Grinling Gibbons' best work. Late Victorian photographs showed that these screens had previously faced the other way, which is how they have been reinstated: the putti now face outwards into the antechapel, as originally intended.

The pierced cedar panels and the figures on the pediment had been finished in a thick, dark varnish, obscuring the quality of the original carving. A key piece of research indicated that this dark scheme was a Victorian intervention. In 1867, following a visit to Trinity, Mr WG Rogers presented a paper to the Royal Institute of British Architects in which he noted:

> *When I was there, I complained to the verger that I could not make out the faces of the angels on the altar pediment, but when I put my hand on the open worked panels, I found they had been painted over with a thick oil darkened with Vandyke brown as sticky and moist as if it had been done over less than a week ago.*

Since even unboiled linseed oil would have dried within a couple of months, Rogers' account helped to establish the date of the dark varnish quite accurately and corroborated the analysis of the varnish report.

Many of the chapel's important wood carvings had retained this dark finish for 150 years, so 'winding the clock back' to before the Victorian intervention was a drastic proposal. However, the combination of the varnish analysis and historical research convinced the college and the diocesan advisory committee to allow the carvings to be returned to the appearance that Grinling Gibbons and Bathurst intended. As much of the dark varnish as could safely be removed was carefully lifted to reveal the carvings beneath in their original glory.

In the process of cleaning the woodwork, the restorers were able to discern the marks of the different carvers, adding greatly to the understanding of how Grinling Gibbons' workshop carried out the work.

Repairs to the raised floor below the pews, with a mixture of new European oak boards and sections of salvaged originals

The new lighting scheme: LED light pads beneath the candle holders provide additional lighting during services.

OTHER WORKS

The north and south walls are lined with oak panelling as a backdrop to the fixed stalls and pews facing towards the aisle. These too had been over-waxed, stained and polished. They were cleaned back to remove the layers of wax and repaired at the same time.

The supports to the raised floors beneath the pews had deteriorated over time and many were supported on pieces of brick and timber. The main oak bearers had disintegrated, mainly from dampness and death watch beetle. The floor structure was removed entirely then carefully reconstructed, reusing original material where possible.

The ceilings were carefully cleaned and missing elements of plasterwork were restored by Cliveden Conservation. Because repairs to the ceiling paintings had been so crudely executed in the past, it was not realistically possible to revert to the original paintwork. It was therefore decided to clean the old varnish off and re-varnish. A matt finish was chosen because movement in the past had resulted in an uneven surface, and the reflections from the old glossier varnish had been distracting. This has enabled a better view of the paintings.

A new lighting scheme was essential because the main light sources were 500w halogen lamps which sat crudely above the timber cornices and constituted a fire hazard. Designed by church-lighting specialist Mark Sutton Vane Associates, the new scheme includes modern LED lighting, much of which highlights particular features and has transformed the internal appearance of the chapel.

The stained glass windows were carefully cleaned by the York Glaziers Trust using small cotton wool swabs, and the German window, which had been left in an attic since the second world war, was reinstated. Although the glass was in good condition, the painted surfaces of the coloured glass were felt to be too fragile to expose to the elements. The existing (plain) outer window, installed after the window was removed in the 1940s, has therefore been retained to act as a protective shield, with the restored stained glass located inside it, with its own sub-frame. This method of iso-thermal glazing was developed by the York Glaziers Trust and has been used by them to similar effect in York Minster.

RE-OPENED AND RESPLENDENT

Following one of the most comprehensive conservation and cleaning programmes it has ever undergone, the Grade I listed chapel re-opened in April 2016. After a year's closure and a great deal of painstaking work, it is once again resplendent.

Over 50 craftspeople were involved in this major project, which is probably the most significant and wide-ranging work to be undertaken on the chapel since its construction. The project has captured the imagination of all of those who have worked on it and their contributions have widened our understanding of Trinity's best-known and most fascinating building. The project has been honoured by the local Oxford Preservation Trust and commended by the Georgian Society.

Detail of the ceiling paintings and plasterwork after cleaning and revarnishing

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THE YORKSHIRE MAINTENANCE PROJECT

Eddie Tulasiewicz

CLEARING GUTTERS and fixing leaking downpipes is the kind of basic, routine work we carry out on our own homes to keep them in good condition and to avoid being saddled with big repair bills when the roof starts to leak. But sometimes dealing with regular maintenance is the one job that churches and chapels, all too often with no paid building staff, find it difficult to get around to.

That's why the National Churches Trust (NCT), with the support of the Heritage Lottery Fund, has launched the Yorkshire Maintenance Project, a new scheme to help keep churches and chapels in Yorkshire in good condition and avoid expensive repairs.

The project will help to sustain the rich religious built heritage of Yorkshire, where there are 1,095 listed places of worship including 346 Grade I churches, buildings of the highest heritage significance. As maintenance of these important historic buildings is often neglected, their future could be at risk.

The key aims of the Yorkshire Maintenance Project are:

- to increase the number of Yorkshire churches that regularly undertake gutter maintenance
- to promote awareness of the benefits of preventive maintenance through training
- to improve knowledge of the conditions of churches at high/roof level
- to improve the condition of historic buildings through regular maintenance care and inspections.

THE NATIONAL SURVEY REPORT

Back in 2011 the NCT conducted a survey to better understand the issues affecting the sustainability of the UK's church buildings. The survey gathered responses from more than 7,000 church representatives.

The trust's national survey report stated that 'for those buildings in need of them, the average cost of urgent repairs is just over £80,000, including VAT'. Assuming relative uniformity given the sample size, there could be a total urgent repair bill for the UK's Christian places of worship of around £1 billion, including VAT.

Typical signs of damp caused by an overflowing parapet gutter

Six years later, there is still a significant backlog of outstanding repairs. Efforts must be made to avoid further damage and degradation of church fabric through more effective preventive maintenance practice so that funding for repairs can reduce the backlog rather than just trying to keep up with ever-increasing need.

The trust's 2011 survey confirmed a positive relationship between formal maintenance and general building condition. When looking at all UK church buildings, it is estimated that more than 80 per cent of those which are in good condition carry out regular maintenance, 13 per cent of them in accordance with a formal maintenance plan agreed with a qualified professional. Conversely, for those in poor or very poor condition, barely more than half carry out regular maintenance.

THE YORKSHIRE MAINTENANCE PROJECT

The Yorkshire Maintenance Project has three key parts – drone surveys, church maintenance training and the MaintenanceBooker web-based maintenance service – which are described in more detail below.

Drone surveys

Every five years, churches are inspected internally and externally by a qualified architect or surveyor as part of its quinquennial inspection. The upper parts of the building are studied from the tower, if the church has one and it is accessible, or from the ground using a pair of binoculars. It is not possible, however, to see certain parts of the building from these two vantage points or to see them

in enough detail to assess the nature and scale of any necessary remedial action.

In contrast, one of the great advantages of drone surveys, according to Dr Rauxloh of the Museum of London Archaeology (MOLA), is that they allow 'directed shots of known areas of building weakness', especially when they are conducted in association with those who know the building best. Drone surveys can provide information and evidence for management and maintenance plans, quinquennial inspections and immediate repair needs.

Dr Rauxloh and his team looked at nine churches in the Sheffield diocese over the course of three weeks. The purpose of the work was to determine how drone technology can help the early detection of defects and ongoing monitoring of these precious buildings by providing detailed information which is unattainable from the ground. This information can be used to create dimensionally accurate 3-D models and other digital products.

The core output was a report in which the products derived from the drone flight can be studied to see how they can benefit the inspection and monitoring process. This assessment was carried out in association with architects, the NCT, diocesan representatives and incumbents. The project disks containing images captured by the drones were also given to each church to share with their architects.

Church maintenance training

Maintenance training is delivered by the Society for the Protection of Ancient Buildings (SPAB) to church wardens and other volunteers responsible for looking after church buildings.

Janet Edmond, project manager of the Yorkshire Maintenance Project, has been leading the training, which has brought new awareness of the importance of maintenance to the volunteers who look after historic church buildings. She and her team ran a series of maintenance training sessions in partnership with SPAB in Doncaster, Sheffield, York and Dewsbury during November 2016 with follow-up training sessions in March 2017. Videos of the training can be seen on Vimeo (https://vimeo.com/album/4588505).

The main aims of the training sessions were to raise awareness of the Yorkshire Maintenance Project and the new MaintenanceBooker website service and associated grant funding, to highlight the importance of building maintenance and to give basic training to church wardens and church volunteers on how to manage maintenance issues in their places of worship.

Reverend Eleanor Robertshaw helps to direct a drone survey at St Laurence Priory, Snaith, East Yorkshire

Over the two training sessions delegates learned how to conduct a baseline condition survey and create a maintenance plan for their places of worship as well as how to recognise maintenance problems at an early stage. They were also invited to consider the benefits of forming a maintenance co-operative, a group of church wardens and church maintenance volunteers who regularly meet or communicate with and support each other to look after their buildings.

MaintenanceBooker

The third part of the Yorkshire Maintenance Project is MaintenanceBooker, a web-based service that allows the people tasked with looking after churches to quickly identify and secure an appointment for maintenance services through a qualified craftsperson or contractor. The service is available to all churches across Yorkshire, listed and unlisted.

The website, which has been launched as a partnership with 2buy2 (a national buying group for UK businesses, charities, schools and churches), provides an online 'one-stop shop' where churches and chapels can book accredited contractors for services including gutter clearance, tree maintenance and inspection of lightning protection systems.

All contractors registered with MaintenanceBooker will provide a fully professional and value-for-money service. The selection criteria for contractors include experience working with churches and historic buildings, appropriate qualifications, references from completed works and having an adequate level of insurance.

As well as churches and chapels, organisations tasked with looking after non-ecclesiastical historic buildings can also make use of MaintenanceBooker.

Cost can be a major barrier for churches seeking to tackle maintenance tasks but more help is available through the Preventative Maintenance Micro-Grant programme. The micro-grants, made available by The Pilgrim Trust, cover 50 per cent of a church's gutter clearance service if booked through MaintenanceBooker. If a church is listed it may also be eligible for an award from the National Churches Trust's Maintenance Grant Programme.

Although currently operating only in Yorkshire and Humber, there are already plans to make MaintenanceBooker services available in other parts of England and Wales.

The hope is that the website will help many overburdened church wardens, volunteers and clergy throughout the country to identify and engage professional help to maintain their buildings.

REGULAR MAINTENANCE SAVES MONEY

According to Michael Murray, director of church support at the NCT, the Yorkshire Maintenance Project will help to ensure that Yorkshire's churches and chapels are well maintained, minimising the risk of serious damage to them. He hopes that the project will result in 274 churches in the dioceses of Sheffield, York and West Yorkshire joining the scheme.

'Regular maintenance is essential for churches' he said. 'An overflowing gutter soon soaks the wall beneath, rots the roof timbers behind it and makes the whole building vulnerable'. He also pointed out that, as well as keeping a church building in good repair, preventive maintenance saves money. It has been estimated that every £1 spent on keeping a church in good condition saves £30 in repair costs within five years.

In the past so much additional cost and work has been caused by poor repairs or volunteers not knowing who to contact for help. Getting the basics right, knowing which materials and methods to use, when to seek advice and having a regular maintenance plan in place will be hugely beneficial.

Further Information

www.nationalchurchestrust.org/building-advice/yorkshire-maintenance-project
www.maintenancebooker.org.uk

EDDIE TULASIEWICZ is head of communications at the National Churches Trust.

HLF GRANTS UPDATE

THE LARGEST source of funding for the UK's historic places of worship is closing. The Heritage Lottery Fund (HLF) currently distributes £30 million to listed places of worship in the UK each year through its Grants for Places of Worship (GPOW) scheme. Those grant offers already made under the scheme will not be affected, and there will be a final round of applications for places of worship in England, Wales and Northern Ireland in August 2017. The scheme is likely to be continued in Scotland where it is administered jointly with Historic Environment Scotland.

The GPOW scheme offers grants of £10,000–£250,000 for urgent structural repairs and for improvements such as the provision of toilets and access ramps. While it is the only HLF scheme dedicated to the needs of places of worship, two other HLF grant schemes are available for general heritage projects: Our Heritage (for grants of £10,000–£100,000) and Heritage Grants (up to £5 million). Both can be used for the conservation and repair of a wide range of heritage assets, including places of worship whether or not they are listed. The HLF believes that congregations will find these schemes useful for a wider range of purposes, allowing them to carry out projects which make places of worship more sustainable.

A proportion of the money available under the two general heritage schemes will be ring-fenced this year for projects which would have been funded under the GPOW. However, there is no guarantee that funding will be ring-fenced beyond this, and it is likely that places of worship will have to compete for grant aid with all other aspects of our heritage in the future. Competition for HLF grants is already intense, and recently there has been a decline in lottery ticket sales, reducing the funding available next year by about a third.

The windows, nave and transept of St Andrew's, Roker, Sunderland (1907) were restored with the aid of a grant of £140,000 under the GPOW scheme. Grade I listed, it is often referred to as the Cathedral of the Arts and Crafts Movement, attracting visitors from across the country. The support of a dedicated grant source is essential for small parishes to keep treasures like this open and in good repair.

The closure of the GPOW has drawn criticism from across the sector, and highlights the need for an alternative mechanism for supporting the conservation of historic places of worship in the long term. Almost half of all Grade I listed buildings in England are places of worship, and many of them are managed by small congregations. It makes sense to ring-fence funds for such an important sector and to target grants in a manner which best suits the unique requirements and limited resources of the recipients. The dominant concern for congregations is funding for occasional major repairs, and the GPOW is generally considered to satisfy this need more effectively than the two general heritage schemes will. In particular, the GPOW provides a two-stage process with expert assistance, which means that congregations are supported in the upfront costs of developing their project. In contrast, the Our Heritage scheme is relatively simple but it does not currently provide such assistance, while the requirements of the Heritage Grant scheme have a reputation for being particularly onerous and needing specialist expertise, which can be expensive.

The Church of England's ChurchCare website points out that the poorer and less well-resourced churches will be disproportionately affected by the loss of the GPOW as they are already struggling to access the funding required to develop proposals. Parishes in rural areas and inner cities may be worst affected as they often have both the smallest congregations and the most complex requirements. Given the competition for heritage funding and without public funds ring-fenced to support congregations in carrying out major repairs, the concern is that many necessary but expensive repairs will simply not be carried out.

Further Information

The Heritage Lottery Fund website – in particular, see 'A new approach to supporting places of worship', www.hlf.org.uk/about-us/news-features/new-approach-supporting-places-worship

The Historic Religious Buildings Alliance website – for the latest information and links to other sources of information, see www.hrballiance.org.uk/consultations-2/hlf-closure-of-gpow

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www.rias.org.uk/services/conservation

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Royal Institution of Chartered Surveyors
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www.rics.org

RICS Building Conservation Accreditation Scheme
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www.rics.org/uk/join/member-accreditations-list/building-conservation-accreditation/

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Scottish Catholic Historical Association
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www.scottishcatholicarchives.org.uk

The Scottish Government, Culture & Historic Environment Division
Tel 0131 244 7888
www.gov.scot/Topics/ArtsCultureSport/arts/Historic-environment

The Scottish Redundant Churches Trust
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The Scottish Stained Glass Trust & Symposium
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Society of Architectural Historians of Great Britain
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Society for Church Archaeology
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The Society for the Protection of Ancient Buildings
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www.spab.org.uk

Stained Glass Museum
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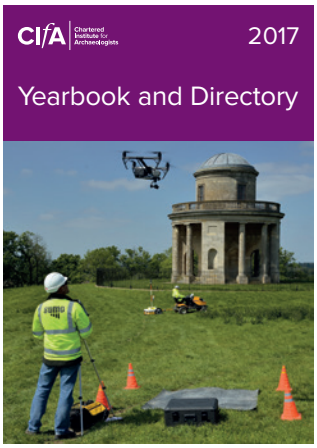

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Email info@williams-restoration.co.uk
www.williams-restoration.co.uk
See advertisement on page 31.

BRICK SUPPLIERS

THE YORK HANDMADE BRICK COMPANY LIMITED

See advertisement on page 32.

BUILDING CONTRACTORS

BARLEY MANOR HERITAGE BUILDERS

Barley House, Isleworth Road,
Exeter EX4 1AN
Tel 01392 422419
Email enquiries@
barleymanor.co.uk
www.barleymanor.co.uk
Barley Manor Heritage expertly carries out all sizes of contracts for conservation, restoration, alterations and additions to churches of all ages in the South West. Works include masonry, lime rendering and plastering, roofing, leadwork, cleaning, carpentry, glazing (including stained glass), electrical, plumbing, drainage and groundworks, cast iron rainwater systems, painting and decorating.

BETWEEN TIME LTD

Ambler View,
Marsh Lane,
Stanstead Abbotts,
Hertfordshire SG12 8HH
Tel 01920 877822
Fax 01920 877933
Email info@
betweentime.uk.com
www.betweentime.uk.com

Undertaking conservation contracts to historic buildings. 32 years of care and repair to listed buildings, churches and heritage sites in Hertfordshire, Essex and London. Teams of skilled craftsmen work with lime renders and mortars, handmade bricks, stone and flint, architectural joinery, lead and metal sheet roofing, cast iron and period decoration.

BUILDING CONSERVATION (UK) LTD
See advertisement on page 11.

C R L RESTORATION
See advertisement on page 1.

OWLSWORTH
See advertisement on page 32.

PAYE CONSERVATION
Stationmaster's House, Mottingham Station Approach,
London SE9 4EL
Tel 020 8857 9111
Fax 020 8857 9222
Email spencerhall@paye.net
www.payeconservation.net
See advertisement on page 39.

ROSEWOOD LTD
See advertisement on page 12.

STONEWEST LIMITED
See advertisement on the inside front cover.

SZERELMEY CONSERVATION
The Stone Works, Terminus Road, Chichester,
West Sussex PO19 8TX
Tel 01243 682031
Email info@szcl.uk
www.szerelmey.com
See advertisement on page 40.

WILLIAMS RESTORATION
See advertisement on page 31.

DOOR & WINDOW FITTINGS

MBL
3c St Francis Way, Shefford Industrial Park, Shefford,
Bedfordshire SG17 5DZ
Tel 01462 811212 Fax 01462 811901
Email info@mblai.co.uk
www.mblai.co.uk
Founded in 1990, MBL provides a quality service for restoration, repair and replication of historic and period ironmongery, locks and keys.

FINE ART CONSERVATORS

FRANCIS DOWNING ACR SPECIALIST PAINTINGS CONSERVATOR AIFCA
See advertisement on page 40.

HIRST CONSERVATION LTD
Head office – Laughton, Sleaford, Lincolnshire NG34 0HE
Tel 01529 497449
• London office – 75 Cowcross Street, London EC1M 6EL
Tel 0800 917 8664
Email pa@hirst-conservation.com
www.hirst-conservation.com
See advertisement on page 21.

HEATING

J & J W LONGBOTTOM LTD
Bridge Foundry, Holmfirth, Huddersfield HD9 7AW
Tel 01484 682141 Fax 01484 681513
www.longbottomfoundry.co.uk
Ornamental gratings for heating duct systems are produced by this long-established traditional foundry. In addition to a wide range of standard patterns, castings to match other existing designs can be produced. Catalogue available on request.
See entry in Roof Drainage, page 57.

HERITAGE CONSULTANTS

HIRST CONSERVATION LTD
Head office – Laughton, Sleaford, Lincolnshire NG34 0HE
Tel 01529 497449
• London office – 75 Cowcross Street, London EC1M 6EL
Tel 0800 917 8664
Email pa@hirst-conservation.com
www.hirst-conservation.com
See advertisement on page 21.

SZERELMEY CONSERVATION
The Stone Works, Terminus Road, Chichester,
West Sussex PO19 8TX
Tel 01243 682031
Email info@szcl.uk
www.szerelmey.com
See advertisement on page 40.

INTERIOR CONSULTANTS & CONSERVATORS

CLOUGH HARRIS LIMITED
See advertisement on page 40.

HESP JONES & CO LTD
The Cedars, Beningbrough, York YO30 1BY
Tel 01904 470256 Fax 01904 470937
Email enquiries@hespandjones.co.uk
www.hespandjones.co.uk
Hesp Jones & Co Ltd is a small firm with a large reputation in the field of specialist decoration and restoration. Trading since 1976, it has amassed a priceless amount of experience decorating and restoring some of the finest buildings in Britain and Europe, including the tambour of the dome in St Paul's Cathedral, and various churches throughout the county, reinstating traditional designs by Bodley and Pugin. Skilled in all aspects restoration including gilding, graining, stencilling, signwriting and cleaning and commissioning of art works, all to the highest standards using the correct traditional and modern techniques.

HIRST CONSERVATION LTD
Head office – Laughton, Sleaford, Lincolnshire NG34 0HE
Tel 01529 497449
• London office – 75 Cowcross Street, London EC1M 6EL
Tel 0800 917 8664
Email pa@hirst-conservation.com
www.hirst-conservation.com
See advertisement on page 21.

HOWELL & HOWELL LTD


66a High Street,
Saffron Walden,
Essex CB10 1EE
Tel 01799 522402
Email howellandhowell@btconnect.com
Specialist church decorators and restorers. Many years experience and knowledge have resulted in a prestigious client list. New schemes are undertaken as well as the conservation and restoration of existing decoration. Projects large or small, interior or exterior. Specialist advice and information is available.

PAYE CONSERVATION
Stationmaster's House, Mottingham Station Approach,
London SE9 4EL
Tel 020 8857 9111 Fax 020 8857 9222
Email spencerhall@paye.net
www.payeconservation.net
See advertisement on page 39.

LEAD PROTECTION

E-BOUND AVX LTD
See advertisement on page 31.

MASONRY CLEANING

CLIVEDEN CONSERVATION WORKSHOP LTD
South East, Head office – The Tennis Courts, Cliveden Estate,
Taplow, Maidenhead, Berkshire SL6 0JA
Tel 01628 604721 Fax 01628 660379
• West, Bath office – Home Farm, Ammerdown Estate, Kilmersdon,
Bath, Somerset BA3 5SN
Tel 01761 420300 Fax 01761 420400
Email info@clivedenconservation.com
• East and North, Houghton office – The Old Coach House,
Houghton, Norfolk PE31 6TY
Tel 01485 528970 Fax 01485 529336
Email enq.houghton@clivedenconservation.com
www.clivedenconservation.com
Stone and plasterwork, monuments, sculpture, mosaic and wall paintings conservation. *See advertisement on page 39 and profile entry in Stone, page 58.*

WILLIAMS RESTORATION
85 Elmwood Drive, Epsom, Surrey KT17 2NL
Tel 020 3544 8861 Mobile 07833 452703
Email info@williams-restoration.co.uk
www.williams-restoration.co.uk
See advertisement on page 31.

MATERIALS ANALYSTS

CLIVEDEN CONSERVATION WORKSHOP LTD
South East, Head office – The Tennis Courts, Cliveden Estate,
Taplow, Maidenhead, Berkshire SL6 0JA
Tel 01628 604721 Fax 01628 660379
• West, Bath office – Home Farm, Ammerdown Estate, Kilmersdon,
Bath, Somerset BA3 5SN
Tel 01761 420300 Fax 01761 420400
Email info@clivedenconservation.com
• East and North, Houghton office – The Old Coach House,
Houghton, Norfolk PE31 6TY
Tel 01485 528970 Fax 01485 529336
Email enq.houghton@clivedenconservation.com
www.clivedenconservation.com
Stone and plasterwork, monuments, sculpture, mosaic and wall paintings conservation. *See advertisement on page 39 and profile entry in Stone, page 58.*

HIRST CONSERVATION LTD
Head office – Laughton, Sleaford, Lincolnshire NG34 0HE
Tel 01529 497449
• London office – 75 Cowcross Street, London EC1M 6EL
Tel 0800 917 8664
Email pa@hirst-conservation.com
www.hirst-conservation.com
See advertisement on page 21.

MORTARS & RENDERS

HIRST CONSERVATION LTD
Head office – Laughton, Sleaford, Lincolnshire NG34 0HE
Tel 01529 497449
• London office – 75 Cowcross Street, London EC1M 6EL
Tel 0800 917 8664
Email pa@hirst-conservation.com
www.hirst-conservation.com
See advertisement on page 21.

■ ORGANISATIONS

NATIONAL CHURCHES TRUST

7 Tufton Street,
London SW1P 3QP
Tel 020 7222 0605
Fax 020 7796 2442
Email info@
nationalchurchestrust.org
www.nationalchurchestrust.org
The National Churches Trust is dedicated to the repair and support of the UK's churches, chapels and meeting houses. As the successor to the Historic Churches Preservation Trust it has helped over 10,000 church buildings of all the major denominations in England, Scotland, Wales and Northern Ireland. The Trust receives no income from either government or church authorities and relies exclusively on voluntary contributions to continue its work. By becoming a National Churches Trust Friend you can help restore and revitalise more of our nation's churches and ensure they are there for future generations to enjoy.

■ PAINT REMOVAL

HIRST CONSERVATION LTD

Head office – Laughton, Sleaford, Lincolnshire NG34 0HE
Tel 01529 497449
• London office – 75 Cowcross Street, London EC1M 6EL
Tel 0800 917 8664
Email pa@hirst-conservation.com
www.hirst-conservation.com
See advertisement on page 21.

■ PAINTERS & DECORATORS

HIRST CONSERVATION LTD

Head office – Laughton, Sleaford, Lincolnshire NG34 0HE
Tel 01529 497449
• London office – 75 Cowcross Street, London EC1M 6EL
Tel 0800 917 8664
Email pa@hirst-conservation.com
www.hirst-conservation.com
See advertisement on page 21.

■ PAINTS & FINISHES

HIRST CONSERVATION LTD

Head office – Laughton, Sleaford, Lincolnshire NG34 0HE
Tel 01529 497449
• London office – 75 Cowcross Street, London EC1M 6EL
Tel 0800 917 8664
Email pa@hirst-conservation.com
www.hirst-conservation.com
See advertisement on page 21.

■ PLASTERWORK

CLIVEDEN CONSERVATION WORKSHOP LTD

South East, Head office – The Tennis Courts, Cliveden Estate, Taplow, Maidenhead, Berkshire SL6 0JA
Tel 01628 604721 Fax 01628 660379
• West, Bath office – Home Farm, Ammerdown Estate, Kilmersdon, Bath, Somerset BA3 5SN
Tel 01761 420300 Fax 01761 420400
Email info@clivedenconservation.com
• East and North, Houghton office – The Old Coach House, Houghton, Norfolk PE31 6TY
Tel 01485 528970 Fax 01485 529336
Email enq.houghton@clivedenconservation.com
www.clivedenconservation.com
Stone and plasterwork, monuments, sculpture, mosaic and wall paintings conservation. *See advertisement on page 39 and profile entry in Stone, page 58.*

PAYE CONSERVATION

Stationmaster's House, Mottingham Station Approach, London SE9 4EL
Tel 020 8857 9111 Fax 020 8857 9222
Email spencerhall@paye.net
www.payeconservation.net
See advertisement on page 39.

■ PUBLICATIONS

WWW.BUILDINGCONSERVATION.COM

See advertisement on page 51.

■ QUANTITY SURVEYORS

SYNERGY CONSTRUCTION & PROPERTY CONSULTANTS LLP

(formerly Synergy Bare Leaning & Bare)
2 Bath Street,
Bath,
Somerset BA1 1SA
Tel 01225 461704
Email bath@synergyllp.com
www.synergyllp.co.uk
The partnership has extensive experience in the repair, alteration and extension of churches and church-owned properties throughout the UK. A full range of QS and project management services are offered, together with costing of quinquennial reports, grant aid applications, health and safety and VAT liability advice. Clients include many cathedrals and Anglican, Roman Catholic and non-conformist churches.

ROOF DRAINAGE

J & J W LONGBOTTOM LTD

Bridge Foundry, Holmfirth, Huddersfield HD9 7AW
Tel 01484 682141 Fax 01484 681513
www.longbottomfoundry.co.uk
Long-established foundry producing cast iron rainwater goods, gutters, pipes and fittings, air bricks and ornamental heads. Ex-stock service on all standard items. Special requirements, including curved gutters, made promptly. Catalogue available on request. *See entry in Heating, page 54.*

JOHN WILLIAMS & CO LTD

See advertisement on page 31.

SAINT-GOBAIN PAM UK

Lows Lane,
Stanton-by-Dale,
Ilkeston,
Derbyshire DE7 4QU
Tel 0115 930 5000
Fax 0115 932 9513
www.saint-gobain-pam.co.uk
Cast iron rainwater systems. The Classical range includes a choice of gutter profiles in standard half round, beaded and deep half round, and the more decorative ogee, moulded no 46 and Notts ogee. Downpipe systems are available in circular, square and rectangular profiles available black primer coated or in the Classical Plus pre-painted finish. Free take-off service. Free site visits.

ROOFING CONTRACTORS

MARTIN-BROOKS (ROOFING SPECIALISTS) LTD

Ross Street,
Darnall,
Sheffield S9 4PU
Tel 0114 244 7720
Fax 0114 243 6060
Email mb@allroofing.co.uk
www.martin-brooks.co.uk
This family business, formed in 1984, specialises in working on heritage and ecclesiastical buildings using directly-employed highly skilled roofers, joiners and leadworkers. Regular clients include English Heritage and the National Trust and recent projects include Lincoln Castle, and Wakefield and Sheffield cathedrals. The company is also a long-term member of the National Federation of Roofing Contractors and is listed on its heritage register.

SAFES

BRAMAH

19 Danes Road,
Romford, Essex RM7 0HL
Tel 020 7637 8500 option 3
Fax 01708 768825
Email lock.sales@bramah.co.uk
www.bramah.co.uk
Bramah, a member of the Master Locksmiths Association, supplies and fits a range of wall, alms, votive offering, donation, church collection, free standing and underfloor safes for protecting church valuables. These units are locked with a high security Bramah key and come with an opening for coinage and notes, with an anti-pilfering baffle attached.

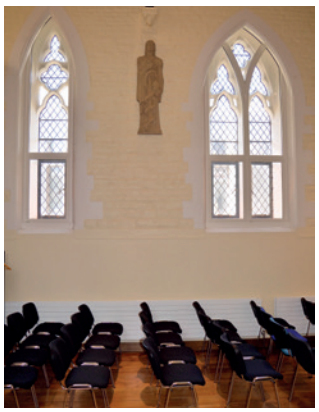
SCULPTURE

CLIVEDEN CONSERVATION WORKSHOP LTD

South East, Head office – The Tennis Courts, Cliveden Estate, Taplow, Maidenhead, Berkshire SL6 0JA
Tel 01628 604721 Fax 01628 660379
• West, Bath office – Home Farm, Ammerdown Estate, Kilmersdon, Bath, Somerset BA3 5SN
Tel 01761 420300 Fax 01761 420400
Email info@clivedenconservation.com
• East and North, Houghton office – The Old Coach House, Houghton, Norfolk PE31 6TY
Tel 01485 528970 Fax 01485 529336
Email enq.houghton@clivedenconservation.com
www.clivedenconservation.com
Stone and plasterwork, monuments, sculpture, mosaic and wall paintings conservation. *See advertisement on page 39 and profile entry in Stone, page 58.*

SECONDARY GLAZING

SELECTAGLAZE LTD



Alban Park, Hatfield Road,
St Albans, Hertfordshire AL4 0JJ
Tel 01727 837271
Fax 01727 844053
Email enquiries@
selectaglaze.co.uk
www.selectaglaze.co.uk
Churches tend to have large inefficient single glazed leaded windows, with intricate stained glass and curved designs. Their thermal performance is generally poor and they do little to stop noise ingress and egress. Secondary glazing is a reversible adaptation which is recommended by heritage bodies and offers significantly improved energy efficiency, noise insulation, draught proofing and with strengthened glass and locks, a comforting level of security. Selectaglaze provides assistance with designs and finishes that are sympathetic to the architectural character of the building and existing décor. Established in 1966 and Royal Warrant Holder since 2004, Selectaglaze is one of the UK's leading specialist designers of secondary glazing systems.

STAINED GLASS

THE CATHEDRAL STUDIOS
See advertisement on page 22.

THE YORK GLAZIERS TRUST
See advertisement on page 22.

STONE

A F JONES STONEMASONS LTD

33 Bedford Road, Reading,
Berkshire RG1 7EX
Tel 0118 957 3537
Fax 0118 957 4334
Email angus@afjones.co.uk
www.afjones.co.uk
Established in 1865 by Arthur F Jones and continued today by A G Jones, this firm has the accumulated experience and expertise of five generations of stonemasons. Currently employing 20 skilled craftsmen restoring, carving, cleaning and conserving stone facades. A complete service from consultancy and specification to production and site fixing. Contractor for Churches Conservation Trust, English Heritage, National Trust and Historic Royal Palaces.

CLIVEDEN CONSERVATION WORKSHOP LTD

South East, Head office –
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Tel 01628 604721
Fax 01628 660379
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Home Farm,
Ammerdown Estate,
Kilmersdon, Bath,
Somerset BA3 5SN
Tel 01761 420300
Fax 01761 420400
Email info@
clivedenconservation.com
• East and North,
Houghton office –
The Old Coach House, Houghton, Norfolk PE31 6TY
Tel 01485 528970 Fax 01485 529336
Email enq.houghton@clivedenconservation.com
www.clivedenconservation.com
Established in 1982 as the National Trust Statuary Workshop, independent since 1991. Retained as the National Trust centre for the conservation of statuary, stone and plasterwork. Also serving English Heritage and the Royal Palaces. Projects extensively in country houses and churches. Consultancy service, specifications, security work and materials analysis.
See advertisement on page 39.

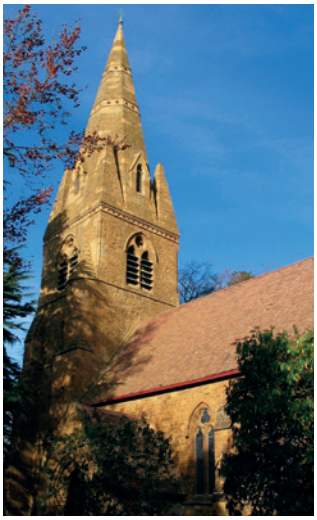
LONDON STONE CONSERVATION LTD
See advertisement on page 21.

PAYE CONSERVATION
See advertisement on page 39.

PIERRA LTD
See advertisement on outside back cover.

SZERELMEY CONSERVATION
See advertisement on page 40.

WELDON STONE ENTERPRISES LTD



106 Kettering Road,
Weldon, Corby,
Northamptonshire NN17 3JG
Tel 01536 261545
Email peter@weldonstone.co.uk
www.weldonstone.co.uk
Weldon Stone is a well-established company with experience in the restoration and conservation of churches, stately homes, and other listed buildings. Weldon takes pride in producing accurately sawn and worked masonry, fixed by teams of masons who understand the importance of careful handling and traditional techniques.

WELLS MASONRY SERVICES LTD

Cotswold Hill Quarry,
Ford, nr Cheltenham,
Gloucestershire GL54 5RU
Tel 01386 585700
Fax 01386 584073
Email info@wells-group.co.uk
www.wells-group.co.uk
A highly regarded company specialising in stone restoration to churches and listed buildings. Its fully equipped banker shop produces moulded and carved stone of the highest quality. The company also carries out stone and brick cleaning and offers stone selection advice and a full design service.

WILLIAMS RESTORATION
85 Elmwood Drive, Epsom, Surrey KT17 2NL
Tel 020 3544 8861 Mobile 07833 452703
Email info@williams-restoration.co.uk
www.williams-restoration.co.uk
See advertisement on page 31.

STRUCTURAL ENGINEERS

BLACKETT-ORD CONSERVATION LIMITED

**33 Chapel Street,
Appleby-in-Westmorland,
Cumbria CA16 6QR**
**• Studio 522,
Horton House,
Exchange Flags,
Liverpool L2 3PF**
Tel 01768 352572
Email engineering@blackett-ordconservation.co.uk
www.blackett-ordconservation.co.uk
This practice includes CARE and AABC accredited architect and structural engineers and specialises in the repair of historic buildings in the North and North West of England, southern Scotland and Wales. Recent projects include: Manchester Cathedral height-adjustable dais, bell frames and towers, spires, masonry movement and decay, timber and concrete roof repairs and assessment of long-term structural movement. Contact Charles Blackett-Ord, Engineer Accredited in Conservation (CARE).

CHRIS PIKE ASSOCIATES

13 Claremont Hill, Shrewsbury, Shropshire SY1 1RD
Tel 01952 581751 Mobile 07506 407874
Email enquiry@cpaconservation.co.uk
www.cpaconservation.co.uk
Chris Pike Associates, historic environment engineers, provides specialist consultancy advice and engineering design services in the field of historic environment conservation. The practice is managed by Christopher Ian Pike, who is a Conservation Accredited Engineer and Chartered Structural Engineer with over 30 years consultancy practice experience, including project work on many traditional parish churches and vernacular Welsh chapels.

THE MORTON PARTNERSHIP LTD

**Old Timber Yard House,
55 The Timber Yard,
Drysdale Street,
London N1 6ND
Tel 020 7324 7270
Fax 020 7729 1196
Email london@
themortonpartnership.co.uk**
**• Leonardo House,
11 Market Place, Halesworth,
Suffolk IP19 8BA
Tel 01986 875651
Fax 01986 875085
Email halesworth@themortonpartnership.co.uk**
www.themortonpartnership.co.uk
Established in 1966 The Morton Partnership's portfolio includes over 500 churches and 25 cathedrals. Structural engineering consultants for all forms of conservation construction. Projects include Canterbury Cathedral, Sheffield Cathedral, St Bride's Church spire, Fleet Street and Angel Award winner Church of St James the Greater, Ab Kettleby.

SURVEYORS

WHITWORTH

**18 Hatter Street, Bury St Edmunds, Suffolk IP33 1NE
Tel 01284 760421 Fax 01284 704734
• 22a North Street, Bishops Stortford, Hertfordshire CM23 2LW
Tel 01279 507775
Email sboniface@whitworth.co.uk
www.whitworth.co.uk
Contact Stephen Boniface**
See entry in Architects, page 53.

WALL PAINTING CONSERVATORS

CLIVEDEN CONSERVATION WORKSHOP LTD

**South East, Head office – The Tennis Courts, Cliveden Estate,
Taplow, Maidenhead, Berkshire SL6 0JA
Tel 01628 604721 Fax 01628 660379
• West, Bath office – Home Farm, Ammerdown Estate, Kilmersdon,
Bath, Somerset BA3 5SN
Tel 01761 420300 Fax 01761 420400
Email info@clivedenconservation.com
• East and North, Houghton office – The Old Coach House,
Houghton, Norfolk PE31 6TY
Tel 01485 528970 Fax 01485 529336
Email enq.houghton@clivedenconservation.com
www.clivedenconservation.com**
Stone and plasterwork, monuments, sculpture, mosaic and wall paintings conservation. *See advertisement on page 39 and profile entry in Stone, page 58.*

EVERYTHING ELSE

THE BUILDING CONSERVATION DIRECTORY

**Cathedral Communications
Limited, High Street,
Tisbury,
Wiltshire SP3 6HA
Tel 01747 871717
Email bcd@cathcomm.co.uk
www.buildingconservation.com**
For all your specialist products and service requirements and loads of useful information, order the latest edition of *The Building Conservation Directory*.

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Access Platforms

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- Expert practitioners, experienced, certificated operators or self drive.
- Sophisticated, modern equipment. Compact, lightweight. Ability to pass through personnel doorway (0.8 x 1.9m). Heights to over 50m.
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- Interior and exterior applications. Wheeled and tracked equipment.
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- UK National Coverage.
- Day/night/weekend, all hours and fast response.

Silent battery power to 42 metres height with max 230 Kgs SWL

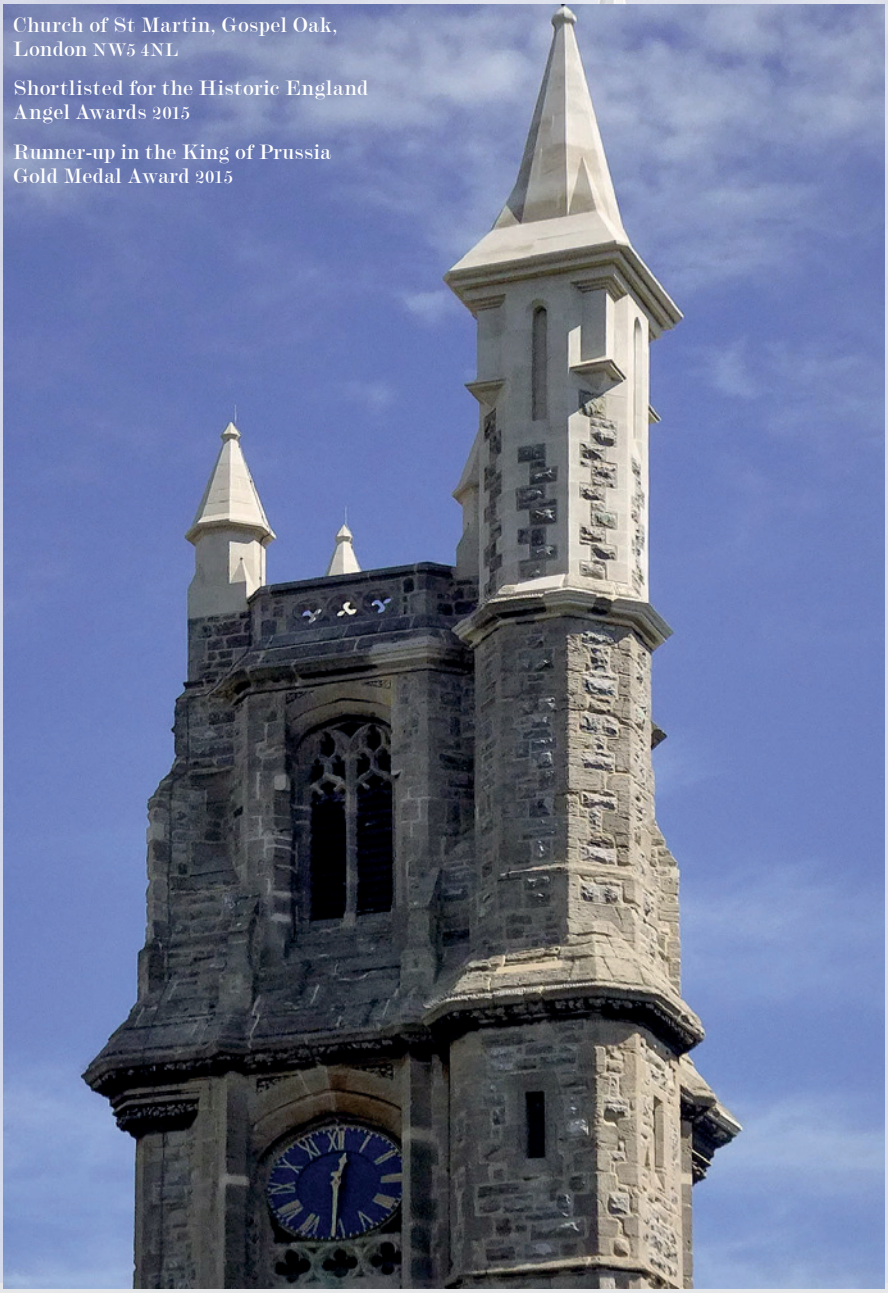
Paramount Platforms Ltd, The Rough Hill Complex, The Tye, East Hanningfield, Chelmsford, Essex CM3 8BY
01245 401110 Out of hours (24/7) 07754 162878

www.paramountplatforms.com

PIERRA

Building Restoration, Conservation & Stone Masonry

www.pierra.co.uk



Church of St Martin, Gospel Oak,
London NW5 4NL

Shortlisted for the Historic England
Angel Awards 2015

Runner-up in the King of Prussia
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QMS ISO 14001 REGISTERED
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CHAS Accredited Contractor www.chas.gov.uk
Considerate Constructors Registered Company 00827
Constructionline A UK GOVERNMENT CERTIFICATION SERVICE
exor APPROVED
Federation Stone Great Britain

Unit C4, Water House, Texcel Business Park,
Thames Road, Crayford DA1 4TQ
Tel: 01322 556691 Fax: 01322 556692
Email: enquiries@pierra.co.uk

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