

Zibby Garnett Travelling Fellowship

Report by Scott MacAskill



Traditional masonry works at Nidaros Cathedral,
Trondheim, Norway

21 August – 2 September 2016

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Introduction

My name is Scott MacAskill, I am 29 years old, a British National and I live and work in Scotland. I am a time served Stone Mason and the Principle Trainer with the Scottish Lime Centre Trust (SLCT), a building conservation trust dedicated to encouraging the appropriate repair of traditional buildings. This involves the delivery of a programme of training workshops to the main stakeholders of the built environment, namely, building contractors, building professionals and owners of historic buildings. I teach both the theory and practical side of conserving masonry buildings, for the most part solid walled buildings of natural stone and brick bedded and finished in lime mortars, renders, plasters and limewash.

I am very conscious that as I am not working directly in the building contracting industry that I must keep up my working knowledge of building and conserving techniques and am keen to take up any opportunities to further my knowledge and skills. In 2014 I was able to travel to Iceland and learn all about traditional turf building techniques, and more recently I have been able to gain skills and understanding for repairing historic earth buildings in Scotland. Also, as part of my job, I am asked to work on building conservation sites as a trainer and this can entail working on all manner of buildings and structures from castles to cottages and bridges to lighthouses.

I served my time as an apprentice Stone Mason with the SLCT's masonry squad and with a commercial masonry contractor in Edinburgh. I achieved my Advanced Craft qualification in 2009 and went on to successfully gain a National Progression Award in Masonry Conservation in 2010. Soon after that, I was asked to rejoin the SLCT as the Principle Trainer and I now deliver a wide ranging number of courses and workshops for the appropriate repair of traditional buildings. These include building and repairing formal ashlar masonry, rubble walling, lime harling and rendering, traditional lime plaster work, cutting and dressing natural stone and limewashing. Our learners come from a wide range of backgrounds from complete novices to time served trades persons. In addition, we hold engaging workshops for school children groups, special interest groups and historical societies and introduce them to

the world of traditional buildings, their materials and the way they are put together. I like to think that I inspire school children in particular to take up a traditional craft trade.

Study trip

My study trip was to Nidaros Cathedral, Trondheim in Norway to take part in a project to restore the King's Entrance constructed of soap stone and marble details. Trondheim is the third largest city located in central Norway and is a port on the Trondheimsfjord which leads to the Norwegian Sea. It has a population of around 143,000 and is an important commercial, industrial and shipping centre.



Figure 1: Map of Norway showing location of Trondheim

This was to be the third restoration in the history of the cathedral which dates back to 1031. Two previous schemes of restoration were conducted in 1870 and 1959 and executed in cement mortars to the detriment of the fabric of the cathedral and beset with problems of water ingress and accelerated decay of stone. The present scheme was to use more appropriate lime based mortars, which are 'breathable' and do not cause retention of moisture in the fabric of the building and are also softer than the building stones, reducing the propensity for accelerated decay of the soapstone and marble details.

Before I left Scotland to travel to Norway, I made sure I did some background reading and research about Nidaros Cathedral, and I was in touch with one of the Cathedral Masons working on the restoration of the King's Entrance regarding the scope of work I would encounter.

I travelled from Aberdeen by plane to Amsterdam and then onto Trondheim, leaving on 21 August 2016 and returning on 2 September 2016. I started my work placement on 22 August with the *Nidaros Domkirkes Restaureringsarbeider* (the restoration workshops of Nidaros Cathedral) established in 1869.

Aims of the study trip

- The main aims for the trip were:
- Gaining experience in cutting and dressing soapstone (a material I was unfamiliar with);
- Building in new dressed and carved replacement stones to very tight tolerances;
- To understand the restoration process and how decisions were made;
- To understand how a multi-disciplinary team work on a large restoration project.

Costs

The total cost of the trip was £ 1,241 of which £ 950 was generously awarded by the Zibby Garnett Travel Fellowship. The additional costs were met by my employer, the Scottish Lime Centre Trust.

Nidaros Cathedral

Nidaros Cathedral is the northern most medieval cathedral in the world, located in the city of Trondheim, Norway on the banks of the Nidelva River. Dating back to around 1070, the original structure was built entirely of Norwegian soapstone. During the late Middle Ages, it was ravaged by a series of fires, particularly the great fire of 1531, and the cathedral fell partially into a ruin. The nave stood without a roof for nearly 340 years, and only the chancel (choir) and the transepts were kept in use.

Having been unified with Denmark since 1380, Norway entered a loose union with Sweden in 1814, but as a separate and independent kingdom sharing only the monarch. After centuries of Danish rule, there was new sense of nationalistic pride in Norway, and it was decided that Nidaros Cathedral was, to a large extent, to be rebuilt and restored to its former glory and status. A dedicated restoration workshop was set up in 1869 encompassing all the required trades and crafts including stone masons (carvers and restoration masons), plasterers, glaziers, joiners and blacksmiths.

Nidaros Cathedral



Figure 2: Nidros Cathedral

The King's Entrance

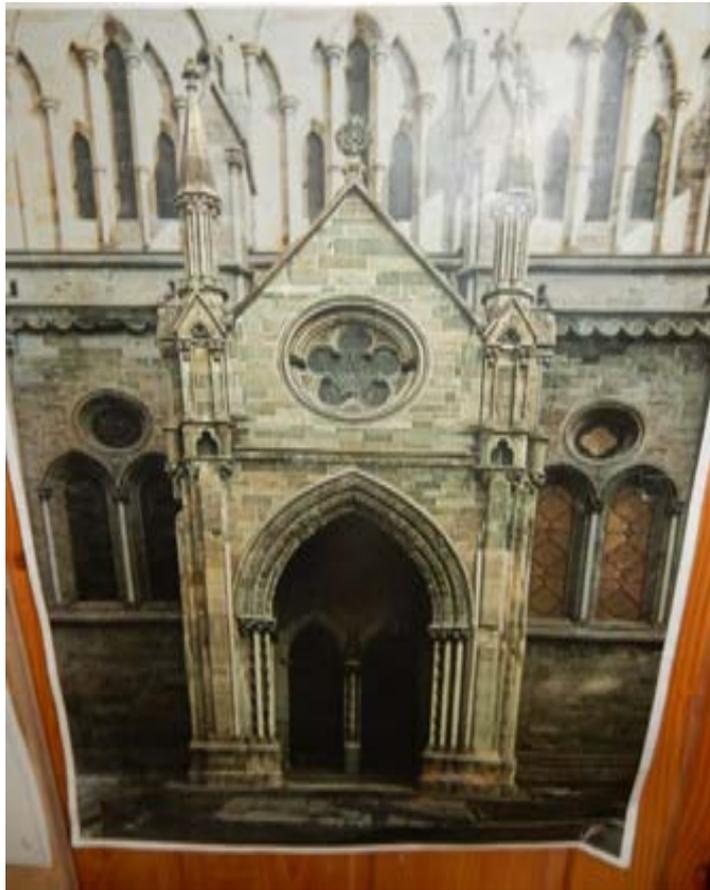


Figure 3: Photo of the King's Entrance before restoration

The King's Entrance is a portal with a porch on the south façade of Nidaros Cathedral's chancel. According to current history, it was built around 1230 and is today regarded as amongst the most decorative parts of the cathedral. Drawings from the early 1800s show the southern side of the chancel and the King's Entrance before the restoration of the cathedral that began in 1869.

This restoration was completed officially some 130 years later, in 2001. During this period, a number of different types of cement based mortars were used. These cement mortars were developed over time, which brought about changes in masonry construction and techniques. Prior to the advent of cement, structures built with lime mortar were reliant on the bonding (the way the stones were placed) of the stones for their strength. It is the compressive forces provided by the size and weight of each stone that make these structures strong and stable, not the strength of the mortar. At Nidaros Cathedral, the reliance during the previous restoration programmes on hard

cement mortar to 'glue' stones together has resulted in less façade stone and more infill, and the use of smaller stones and more infill has created a structure with poor bonding. Consequently, with its inflexible cement mortar and 'glued', the King's Entrance is rigid and subject to tensile forces (blowing stones apart).

The extensive use of impervious hard cement based mortars during the restoration from 1869 to 2001 has caused many of the cathedral's problems to date. I was now involved in a project to restore the restorations.

The first few days

On the first day I was introduced to the cathedral with a guided tour to gain an understanding of the evolution of the building. My [mentors](#) throughout my placement were Chris Pennock and Rune Langas.

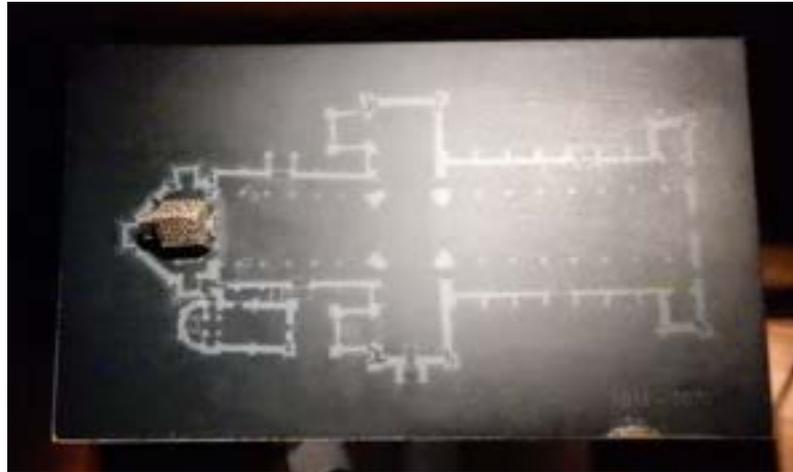


Figure 4: The shrine erected in 1035 over King Olaf's tomb

The cathedral developed from a small shrine erected in 1035 over King Olaf's final resting tomb, who was killed in battle and was highly regarded for his martyrdom for his people and ultimately awarded a sainthood.

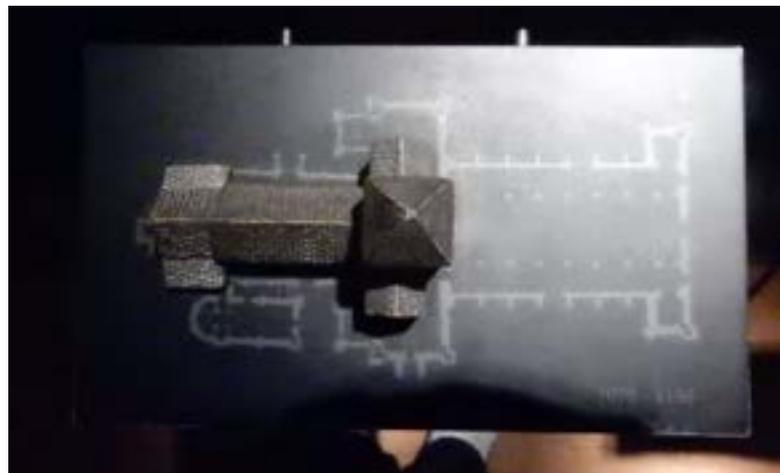


Figure 5: The church started in 1070

In 1070 Olaf 3rd commences work on a church building over St Olaf's resting place. In 1153, Nidaros becomes an archbishopdom, and works starts on a major expansion of St Olaf's church including the building of a transept and chapter house.

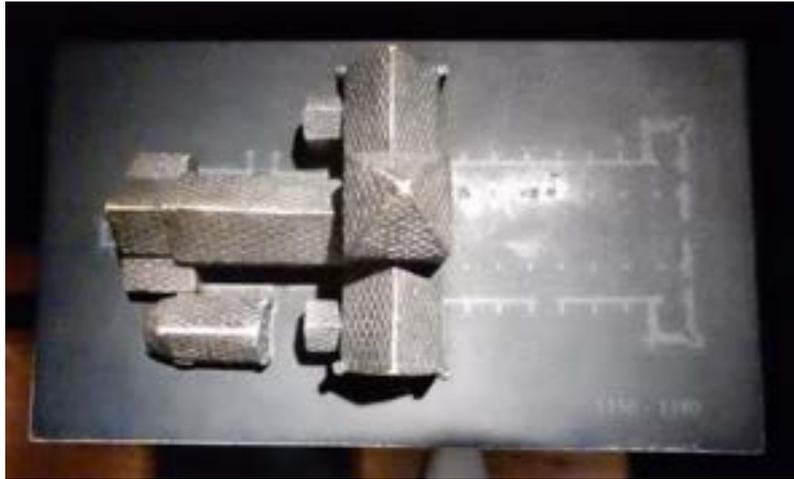


Figure 6: Further developments between 1150 and 1180



Figure 7: The church with the distinctive octagon and new choir

In 1180, work starts on the distinctive octagon and a new choir is built.

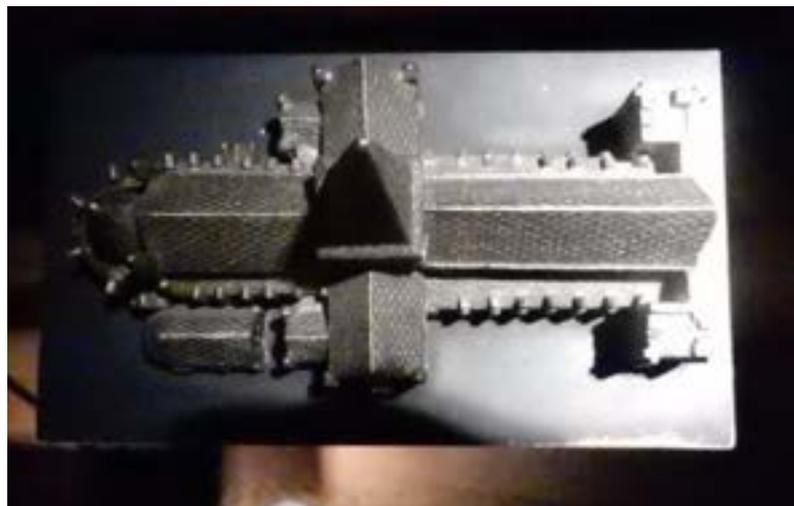


Figure 8: The completed nave, inspired by English cathedrals

By 1280 a nave is completed in a gothic style, clearly inspired by English cathedrals, in particular Lincoln Cathedral and Westminster Abbey.

In 1328 to 1432, Nidaros Cathedral suffers from several fires until the great fire 1531 leaving the cathedral a ruin. The nave is left as a ruin until the late 1800s. The rest of the cathedral is restored throughout the 16th and 17th centuries.

In 1537 a reformation takes place and Norway's last Archbishop flees the country. St Olaf's shrine is destroyed and his remains buried in Nidaros Cathedral, which becomes a parish church.



Figure 9: The cathedral between 1531-1719

In 1708 and 1719, again the cathedral suffers major fires.

In 1814 Norway gets its own constitution and Nidaros cathedral becomes its own coronation church. Karl 11 Johan, the Union King and is crowned in Nidaros Cathedral in 1818.

In 1869, the restoration workshops were formed to restore Nidaros Cathedral to its former glory. Between 1901 and 2001 saw the complete restoration of the cathedral.



Figure 10: Nidros Cathedral after restoration

By the end of the first few days, I gained an appreciation of the development of the cathedral, its enormous history and the materials employed in its construction. The illustration below shows the deterioration of the soapstone in situ.



Figure 11: Deterioration of the soapstone in situ

The Drawing Room

My next task was to learn about how the King's Entrance masonry was dismantled, set aside and assessed if replacement stones required to be cut, carved and dressed for the restoration works.



Figure 12: Marked elevation drawings

I poured over the marked up elevation drawings to gain a sense of the extent of the restoration process in terms of replacement stone and areas of masonry to be repaired.

The Tracing Floor

The Tracing Floor houses the full scale drawings for each course of stonework.



Figure 13: The tracing floor with full scale drawings

Each stone is given a unique reference number denoting its position in the wall. The full scale tracings are then passed onto the Stone carving Workshops to produce templates which allow the masons to replicate the exact dimensions of the replacement stones.

Stone Carving Workshop



Figure 14: The stone carving workshop

The masons cut their own stone, first using wet saws with tungsten rope to generate the dimensions of stone to be carved.



Figure 15: Roughing out of the stone

The mason here is 'roughing out' individual stones to fit to the templates.



Figure 16: Trimming off waste with axe

The mason uses an axe to trim off waste ready for finishing chisels.



Figure 17: Selection of [mason's tools](#)

Above, a selection of the different axes used by the mason's. This is unlike tools used in Scotland for cutting and dressing sandstone (in the main).



Figure 18: Workshop of the project

Another British mason working on the same project.



Figure 19: Last stone worked on during the course

The last stone being carved for the course of masonry I was working on.



Figure 20: Capital carved with special guiding 'rig'

A new capital being carved with the aid of a special 'rig,' guiding and linking the dimensions of the old capital (in the foreground) to the new capital. A Medieval 3D printer!

Stone Repair



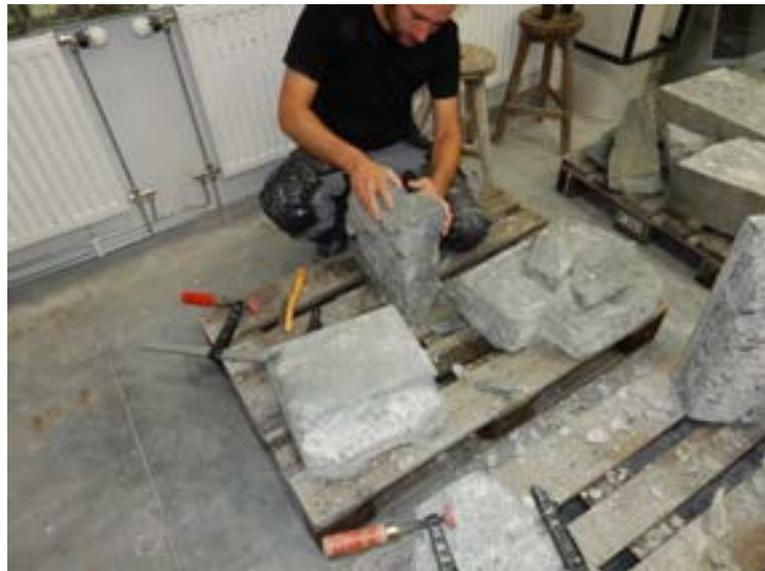
Figure 21: Repaired stone with dovetail joints

This stone has been repaired using dovetail joints to secure the new piece of stone (in the centre).



Figure 22: Pallet containing individual stones

Each numbered pallet of stone contains individual stones (with a unique reference number) to be assessed for full re-carving, partial indent (as above) or resin repair.



The mason is cleaning up the weathered stone, and 'dry' piecing it back together.



Figure 24-23: Mason piecing together stone

Once the 'jigsaw' has been put back together dry, then a resin glue is used to secure the repair (see below). This type of repair is only ever carried out on stones that will be in compression in the wall (ie with stones built on top of them rather than free standing elements).



Figure 25: Stone showing the glue used to secure repair

Off to the Scaffold



Figure 26: Drawing to identify stones

Guided by the drawings, we are able to identify all the stones required for rebuilding the course of masonry in hand. As all the stones have individual numbers, it is relatively easy to locate them, unless individual errors have been made. Then it is like finding a needle in a hay stack!



Figure 27: A numbered stone



Figure 28: Preparations for the Lewis Pins

Preparing the stones to be lifted individually using the traditional way by Lewis Pins. These are like back to front 'scissors', the pins being anchored into drilled holes in the stones.



Figure 29-29: Lifting of stones with Lewis Pins and 'dry' laying stones to check position and dimension

'Dry' laying the stones in place to check for position and dimension checking.

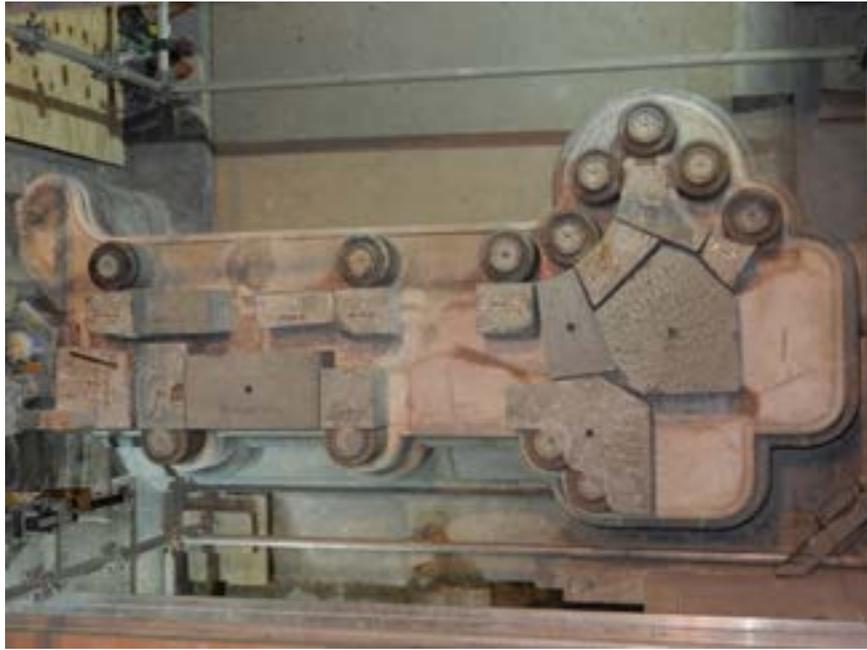


Figure 31: Finished 'dry' laying showing the position of the different stones

Making 'hot mixed' mortar



Figure 32: Kiln used to burn the quicklime

In a determined attempt to be authentic, both technically and aesthetically, the decision was made to burn local limestone to make the mortars. Quicklime (the product made in a limekiln (above) is then mixed with a local sand and water under controlled conditions). There is an exothermic reaction when quicklime is exposed to water and this can produce high temperatures within a very few seconds. Essentially a caustic soup has been made that can have serious consequences if in contact with exposed skin or eyes. Health and safety at the cathedral is taken very seriously, and echoes practices we adopt at the SLCT.



Figure 33: Forced action mixer

A forced action mixer is used to produce the mortar.



Figure 34: The mortar bed for the stone

A bed of mortar is laid down to receive the replacement stone. It is important to make sure the perpendicular joints (vertical) are fully coated with mortar.



Figure 35: Lowering the stone onto the mortar bed

Laser check to ensure everything is plumb and level.



Figure 36: Lines and laser check to ensure it is plumb and level

Stained Glass Workshop



Figure 37: Design for the glass work

As an extra bonus, I was introduced to two new trades, the first being stained glass. I was given guidance on how to design and cut out pieces of glass to form a Saltire Cross.

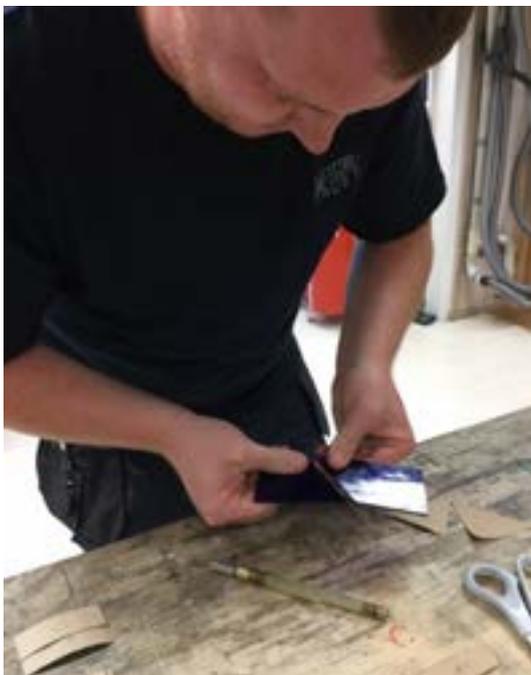


Figure 39-38: Cutting the glass and laying out the design

This was an introduction to a very interesting craft.



Figure 40: Soldering the glass together

Soldering the lead comes.



Figure 41: The finished panel

The finished article.

Blacksmithing workshop



Figure 42: Blacksmithing projects

Then, I was introduced to the blacksmithing workshops.



Figure 43: Furnace while fire is being lit

Lighting the fire to get the furnace going.



Figure 44: Lit furnace and blacksmithing workshop

With the furnace going, work could start on creating a metal scribe (for marking stonework).



Figure 45: Hammering metal

Hammering hot metal to stretch it into the desired shape.



Figure 46: Metal leaves

Practice pieces to create a leaf shape.



Figure 47: Almost finished scribe

Almost finished scribe ready to be bend into shape.



Figure 48: Finished scribe to mark stones for masonry process

Conclusion

The two week placement was an invaluable experience to see how a major restoration project is organised and executed. I felt the combination of practical work and theory was just right and the ability to learn about other crafts was an added bonus.

I feel I have successfully achieved the aims I set for myself. The cutting and dressing of a very unfamiliar stone was particularly interesting. For me the most interesting insight I received was from watching a multi-disciplinary team work together for common aims. The meticulous detail that was put in down to the numbering of individual stones and the computer systems that were used to check and ensure the right stone was laid in the right place was outstanding.

I was also particularly grateful for the chance to learn about two other crafts, not just stonemasonry. A well rounded tradesman should have an appreciation of other trades and crafts because in a traditionally constructed building such as a cathedral, the way the trades and crafts work together is critical to the success of the restoration project.

Since returning to the UK, I feel my confidence has been boosted and I am able to pass on the knowledge and skills gained to our learners at the SLCT.

My hosts at the restoration workshop were very generous in their input to make my two week placement very worthwhile.