DIN L-ART ĦELWA

PRIZE FOR ARCHITECTURAL HERITAGE 2018

RESTORATION AND CONSERVATION CATEGORY

INSTALLATION OF AN ENVIRONMENTAL CONTROL SYSTEM FOR THE CONSERVATION OF THE GRAND MASTERS' CRYPT AT ST. JOHN'S CO-CATHEDRAL, VALLETTA

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TBA periti

1. Preface

The primary objective of this ambitious and sensitive endeavour was to address the control of the internal micro climatic environment within the Grand Masters' Crypt at St. John's Co-Cathedral, so as to preserve this unique world-class artefact. The prevalent ambient conditions in this space resulted from the confinement and absence of controlled ventilation. As one can comprehend, the challenge was not only a technological one, but, above all, it required a design solution, which had to be seamlessly integrated with the sensitive fabric of the Crypt, and the Main Altar in St. John's Co-Cathedral overlying the Crypt. Furthermore, the implementation phase required unprecedented care and attention to detail, to ensure that what was proposed on paper could in effect be implemented without in any way compromising such a historic and important building.

TBA Periti were responsible for the overall design and project execution bringing together varied expertise to identify the best possible, and least intrusive solution, whilst ensuring that the potential design ambient conditions, made possible by today's technological advances in micro-climatic control, were both achievable and sustainable.

This project was undertaken over the past 5 years, and was carried out in collaboration with Galea Curmi Engineering, Bill Weedman, Bajada New Energy, Agius Stoneworks and the very dedicated staff at St. John's Co-Cathedral under the guidance of the Curator, Ms Cynthia de Giorgio, on behalf of the St. John Co-Cathedral Foundation.

2. Brief History of the Site (Site Context):

The Grand Masters' Crypt is a subterranean chamber underlying the High Altar at St John's Co-Cathedral. The Crypt was constructed at the same time as the church, in the 16th century, and houses the remains of the first twelve Grand Masters who headed the Order of the Knights Hospitaller of St. John of Jerusalem, Rhodes and Malta between 1522 and 1623. The Grand Masters buried there are L'Isle Adam, del Ponte, d'Omedes, de la Sengle, de Valette, del Monte, La Cassière, Verdale, Garzes, Alof de Wignacourt, Vasconcellos, and Ximenes.

Four of the Grand Masters are buried in elaborate sarcophagi placed within four of the arched alcoves of the Crypt. Those of L'Isle Adam, Jean de Valette and Loubens de Verdale depict the figures of the Grand Masters carved in marble and bronze and are amongst the most important sculptural monuments of the 16th century in Malta.

The vault of the Crypt was frescoed in the late 1720s by Nicolò Nasoni, a Florentine artist who was also responsible for the illusionistic decorative ceiling of the corridors in the Grand Masters' Palace in Valletta. The ceiling decorations of the Crypt allude to Old Testament biblical episodes surrounded by numerous festoons, scrolls and fruits. Playful putti rest above the monuments holding objects, symbolic of the Order of St John.

The first stage of this project pre-dates this intervention. This comprised the actual restoration of the frescoes, which was carried out between 2008 and 2012. This delicate work was carried out by the Courtauld Institute, who are experts in fresco preservation. Since 2012, minor conservation works were always ongoing to ensure that the works carried out remain effective. Prior to any works in 2009, the Crypt was sealed and monitored for one year in order to understand the micro-climatic conditions of this subterranean chamber. Without any mechanical control, the Crypt ambient conditions had stabilised to a Relative Humidity level between 85% - 90% and an Ambient Temperature between 20°C - 23°C. A detailed study carried out by the Courtauld Institute concluded that, for the deterioration of the frescoes to slow down (that is, by limiting the growth of micro-organisms and fungi), the ambient conditions of the Crypt had to be controlled to achieve a Relative Humidity level between 70% - 75% and an Ambient Temperature between 18°C - 19°C. These conditions could only be

achieved by means of using an environmental control system, since they are not the natural conditions of the Crypt, and since these values are difficult to achieve by natural means.

Prior to this project, the ambient temperature and relative humidity within the Crypt were controlled with three standalone A/C units, a humidifier and a de-humidifier, all of which were controlled manually, and all of which could not be properly positioned within the Crypt because of the site restrictions within the Crypt itself. The temporary equipment did not respond efficiently to sudden weather fluctuations, and therefore, some damage/deterioration was unavoidable. This setup was closely monitored by the in- house conservator, who constantly manually-adjusted the equipment, so as to try to improve the ambient conditions of the Crypt.

Considering the delicate nature and national importance of the subterranean chamber, the Foundation of St. John's Co-Cathedral together with TBA Periti and Galea Curmi Engineering proposed the installation of a more sophisticated automated environmental control system, which responded efficiently and effectively to the fluctuating weather conditions, thereby avoiding the need for constant manual adjustment of the inefficient temporary equipment. Following numerous attempts and assessments of various technologies and equipment, a technical possible solution was identified

2.1 The Grand Masters' Crypt Location:

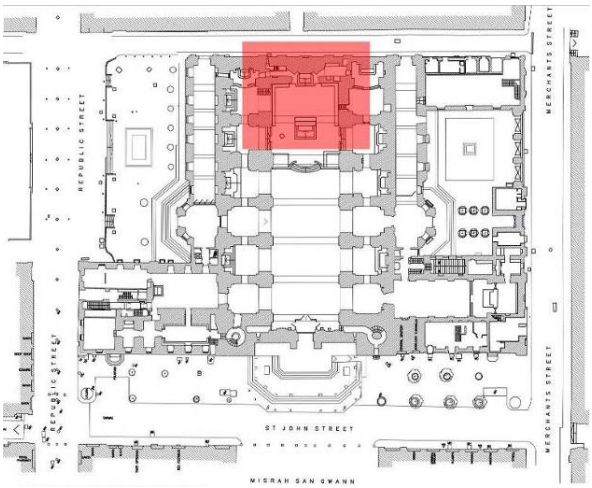


Figure 1: Key plan/site plan of St. John's Co-Cathedral indicating the location of the Crypt

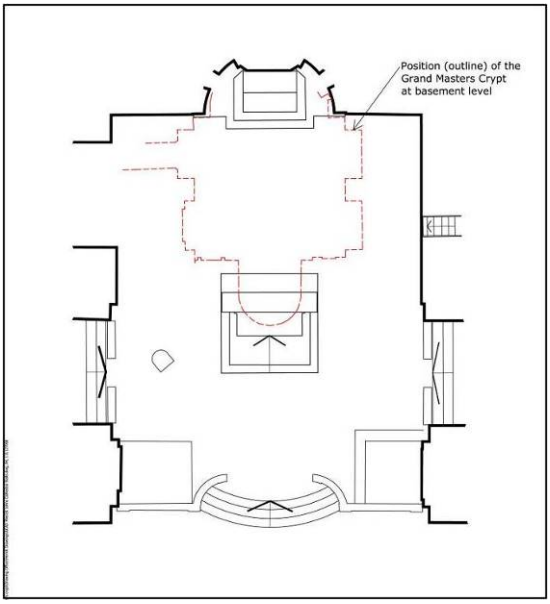


Figure 2: The exact location of the Crypt located beneath the high altar is indicated in the diagram above in red

2.2 The Proposed Environmental Control System:

The Crypt is accessed from the Co-Cathedral via a straight staircase from the Chapel of the Anglo-Bavarian Langue. This is the only physical link between this underground chamber and the Co-Cathedral which permits access on foot. The other links consist of four oculi or vents located in the Crypt's vaulted roof (indicated in the diagram below in red). These oculi originally emerged at Main Altar level. However, during the re-design of the Main Altar, these were blocked off. A plan and section through these oculi has also been reproduced below.

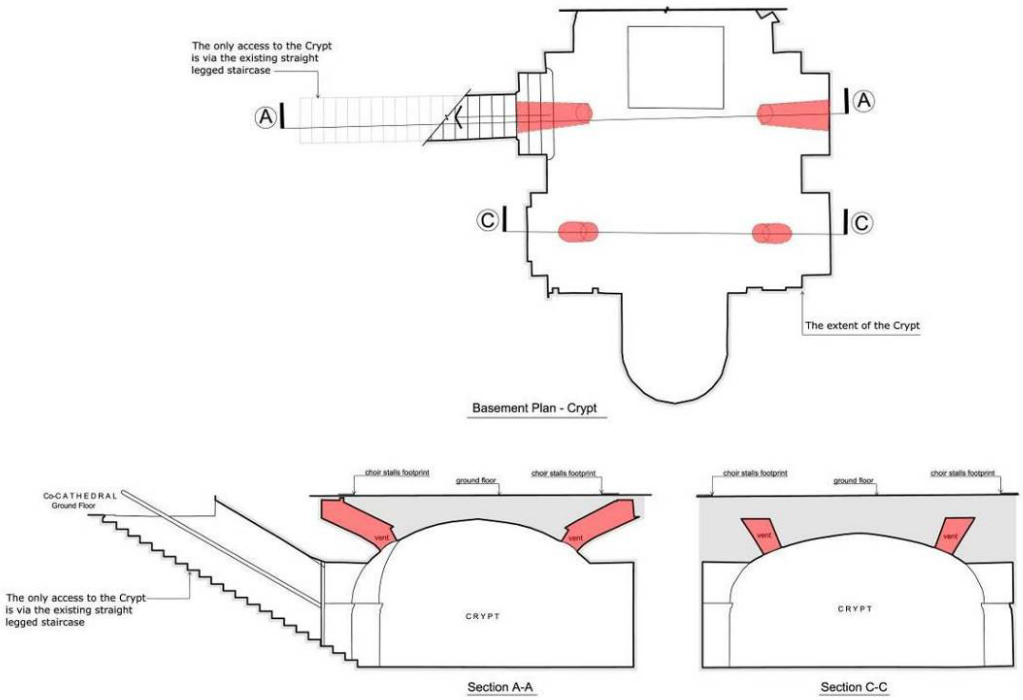


Figure 3: Plan and sections of the Crypt

Numerous equipment options were explored, with the original intent being that of housing the equipment within the Crypt itself (as was done in the Ħal Saflieni Hypogeum). However, the smallest equipment available on the market was still too large to be accommodated within the Crypt, and there still remained the challenges of how to power and drain the system.

The only viable solution was dependent on the re-utilisation of the strategically-located oculi, which were buried beneath the existing marble finish around the overlying Main Altar, which meant that these oculi had to be re-exposed (unearthed) and utilised as the inlets and outlets of the controlled and filtered air.

Figure 4: General image of the Crypt depicting the temporary/portable equipment located adjacent to the (only) entrance.

3. The Challenges:

Where is the equipment to be housed? How will the ducts reach the Mina Altar? How will the oculi be accessed?

These were the major technical problems, which had to be solved, and which TBA Periti, together with the staff of St. John's Co-Cathedral meticulously studied. This exercise, which included historic research, trial investigative works, and numerous meetings with the Superintendence of Cultural Heritage (SCH) in order to discuss the possible options, eventually proved fruitful. After circa 2 years of discussions and research, a route for the ducts and location for the equipment was finally defined and there was enough information and confidence that two of the four existing oculi could be accessed. Thus, a Planning Authority application for these works was submitted, which included detailed drawings showing the proposed routes and interventions. The application was eventually approved by Planning Authority.

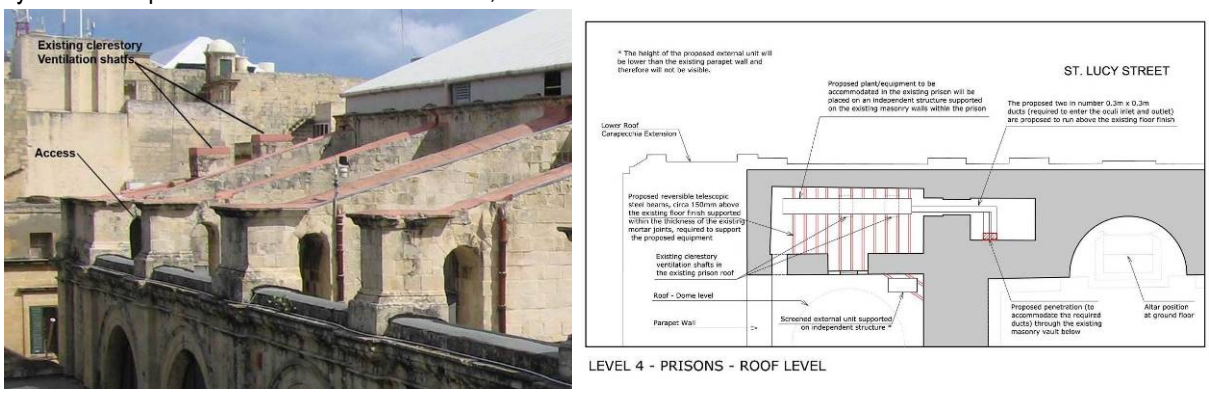
From the research carried out, which included surveys, 3D scans and investigative archaeological work, it was discovered/confirmed that two spaces, to the right and left of the Main Altar were constructed (from altar level to roof level) at a later stage (this conclusion was later confirmed by findings during the course of the works). These (secondary) spaces, apart from being additions to the original extent of the Co-Cathedral, also had a number of additions (accretions), which were added during the continued decoration/development of the Co-Cathedral, in particular during the installation of the organs.

3.1 The Equipment

The environmental control system consists of a custom-made unit which includes: heating and cooling, and dehumidification and humidification equipment. The equipment is 7.00m in length, with a width and height of approximately 1.00m. The equipment was brought in sections and assembled on site. The equipment controls the ambient conditions within the Crypt via two square section 0.30m x 0.30m ducts (supply and returns), which eventually branch into the existing four oculi situated beneath the existing marble tiling which form the Main Altar.

3.2 The Route:

The equipment described above is located within the North Prisons at roof level (see image below). This space was chosen, since as opposed to the South Prisons, this space has two existing clerestory ventilation shafts within its roof, which provide sufficient air changes (natural ventilation) for the proposed environmental control system. The prison is accessed from the roof, and is not linked to the internal volume of the Co-Cathedral.



Figures 5a and 5b: Photograph and plan of the North Prisons at roof level

The equipment is supported on an independent and completely reversible steel structure composed of galvanised telescopic beams, which are supported on the existing load bearing masonry walls of the North Prison. The ends of the telescopic beams are supported within the thickness of the existing mortar joints, thus avoiding any irreversible interventions to the masonry fabric. In addition, between the telescopic beams and the equipment, there are a series of isolators acting as 'shock absorbers', which eliminate any vibration

transmittance from the equipment into the masonry fabric. In this way, the existing limestone slab flooring (*'ċangatura'*) and existing roof are not affected in any way.

Figures 6a and 6b: The 'North Prison' fully equipped with the plant and equipment which is completely independent of the existing masonry fabric

The North Prison links up to a small room, which is located above the secondary spaces described above. These small rooms/spaces, on three overlying levels, go down to altar level. The ventilation ducts, therefore, branch off into this small space, and through two minor interventions within the masonry fabric, and by utilising the existing openings (created to accommodate the organ equipment), and previous interventions and recesses within the wall thickness, they arrive within a cabinet (recessed within the wall thickness) at Main Altar level. Where the masonry was intervened upon, all the masonry units/elements were duly numbered and retained for possible future re-instatement. During the course of the works, a number of very interesting 'lost/covered' features were re-discovered, thus shedding light on the timeline of the Co-Cathedral. These features will be very briefly described in Section 4 of this presentation.

At Main altar level, the ducts emerged within an existing cabinet adjacent to the Main Altar (separated by a wall). Thus following numerous site meetings with the Superintendence of Cultural Heritage, the location for a small breach in the masonry fabric was identified. Through this breach (roughly 600mm by 300mm) the ducts emerged directly beneath the existing choir stalls, which are raised by about 500mm above the Main Altar finished level. The space beneath the choir stalls which was easily accessible was just about large enough to accommodate the required ducts. The choir stalls floor is composed of a number of timber boards, these were temporarily removed and eventually reinstated. The supporting structure beneath the choir stalls, which included considerable interventions, was composed of vertical timber elements (which were retained) and large masonry units, placed to provide additional support to the deteriorated horizontal timber elements. These large masonry units were carefully replaced with neat (slimmer) galvanised steel supports, which freed up the space required to accommodate the ducts.

Figure 7: New structural steelwork elements beneath the choir stalls to free up the space required for the ducting


Figures 8a and 8b: Ventilation ducts tucked away neatly within the existing restricted spaces



Figures 9a, 9b and 9c: Ducting very neatly accommodated beneath the choir stalls, and the custom-made ducts produced to travel beneath the Main Altar.

Once the ducts were installed beneath the choir stalls, the largest challenge remained, that of running the ducting beneath the existing marble flooring around the Main Altar and just above the vault, which roofs over the Crypt itself, until the oculi were duly reached.

3.3 Altar Level:

The build-up beneath the Main Altar includes the visible marble tiles, which were laid directly above older cangatura, which in turn are supported on fill material placed directly above the vaulted Crypt.

3.4 Surveys, Assessment and Works:

A detailed 3D scan of the Crypt was carried out, so that the position of the oculi could be accurately identified and marked at Main Altar level.

Numerous sections were drawn up at various locations, so that the depth of the build-up and underlying structure could be accurately identified. From these sections running through the oculi and highest vault position (within the Crypt), it became clear that the volume of fill and the building fabric varied between approximately 650mm and circa 1100mm. The space required for the ducts and overlying marble floor did not exceed 500mm.

Figure 10: Detailed sections through the Crypt produced using a 3D scan, showing the oculi and the Main Altar

As a result of this further investigation, the proposed route to cross the Main Altar (above the highest point of the Crypt), was altered from the approved route in PA 1955/15, in accordance with the Superintendence of Cultural Heritage. The route was amended so as to ensure an available depth of at least 1000mm. During the course of the works, crossing the Main Altar with the ducting became easier, since an older finish was discovered at a lower level, which was low enough for us to accommodate the required ducts and reinstate the cangatura and overlying marble tiles.

A detailed survey of the existing marble flooring was prepared. This allowed the exact route to be plotted, and the exact number of tiles, which had to be carefully-removed, to be clearly identified. The works were originally split into 8 phases, thus limiting the number of tiles, which had to be removed at any one time. The number of marble tiles identified for each phase were defined by the extent of the underlying *ċangatura*. The full extents of the underlying *ċangatura* units were uncovered so as to allow the easy removal of the underlying *ċangatura*. Due to the different laying orientation of the marble tiles and *ċangatura*, each stage included the removal of circa 7 to 8 *ċangatura* tiles, and between 30 to 50 marble tiles. Due to the research findings made during the course of the works, the number of phases executed had to be amended slightly.

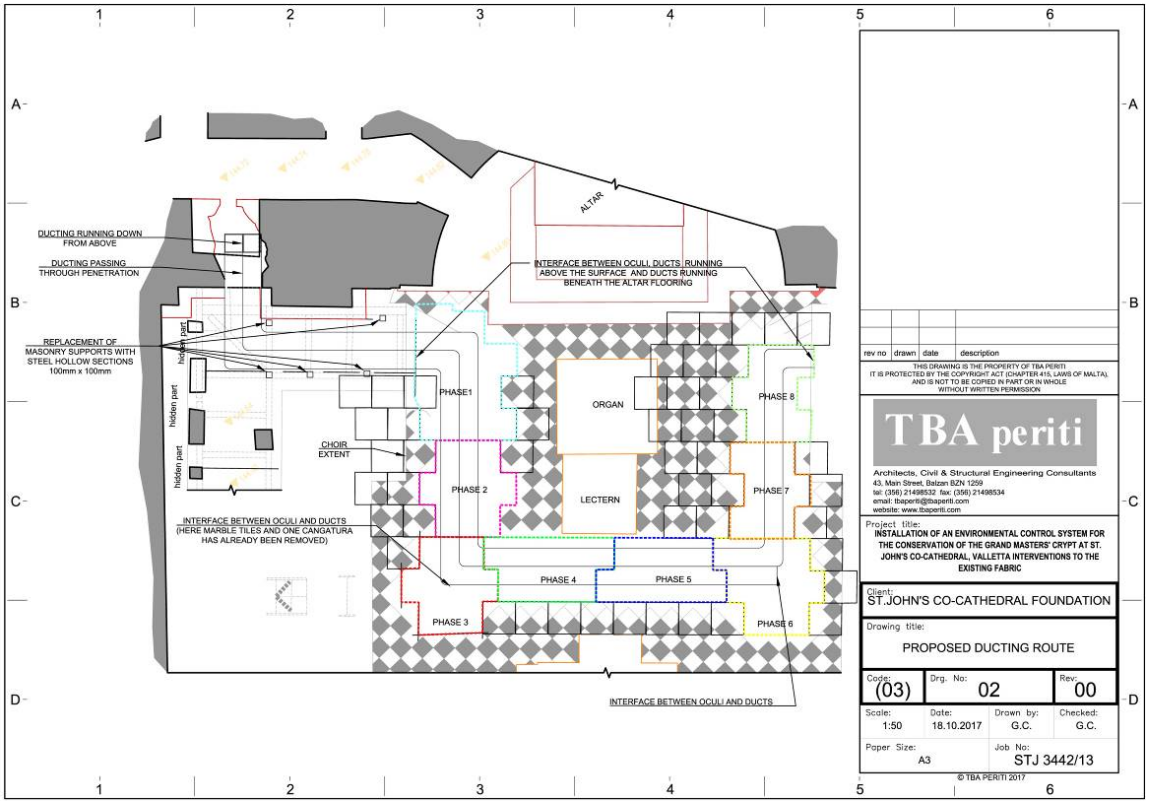


Figure 11: Proposed phasing plan, identifying the tiles and cangatura which needed to be removed

All the marble tiles were duly marked (numbered) and mapped (on drawings and photographs) thereby ensuring that they are correctly reinstated with their correct orientation. The 3D scan, which contained images of each element also helped in this regard. Each tile was carefully stored on site temporarily, within plastic boxes, at altar level, until these were reinstated in accordance with the phasing plan. The tiles were marked using completely reversible tapes. Once the phases were marked on site, the marble tiles and cangatura were very carefully and diligently removed by the 'marmisti' (marble specialists) who work with the St. John Co-Cathedral Foundation.

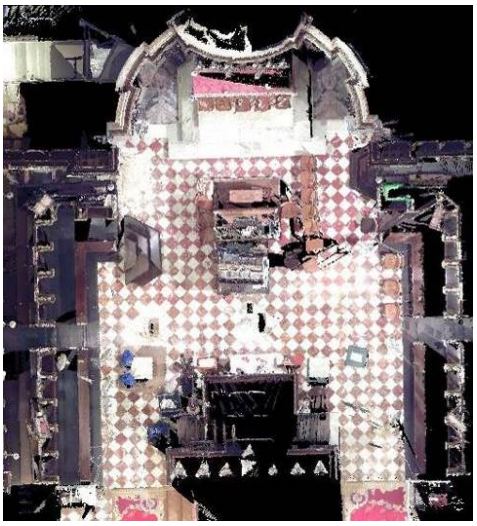


Figure 12: 3D scan of the Main Altar which was utilised to clearly mark the tiles being removed, for their eventual reinstatement.

Figures 13a, 13b and 13c: Marble tiles duly marked and very carefully removed

Once the cangatura were removed, the underling material was uncovered. The material consisted of a mix of soil and random rubble. This was carefully removed using hand held chipping hammers and small hand tools. All the material was stored in sacks, for eventual reinstatement.

Figures 14a and 14b: Images showing the delicate removal of material to prepare the route for the required duct work. The route linked up all the four oculi.

Once a portion of the route was defined, the ducts were installed. The ducting used beneath the Main Altar were custom-made, and structurally-capable of withstanding the superimposed dead and live floor loading. The ducts were manufactured on site, to fit within the restricted spaces, using polypropylene material so as to avoid corrosion of the ducting. Each length and section was made to measure.

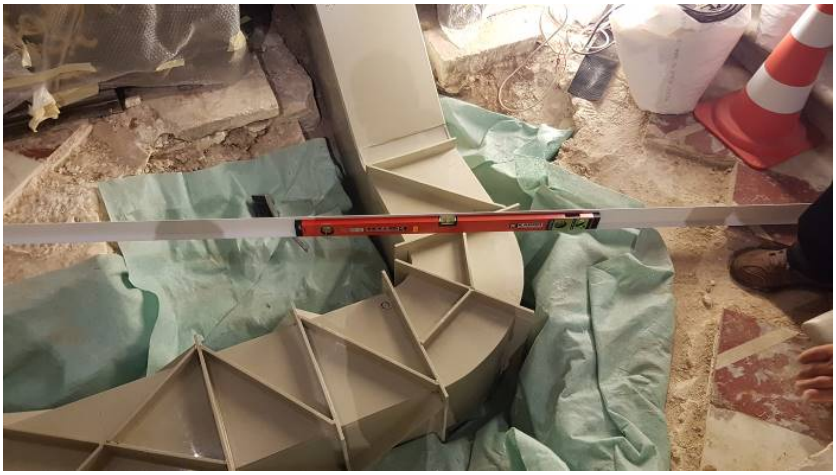


Figure 15: Detail of the custom made ducting within the routes created

Figures 16a & 16b: Custom made ducts being manufactured on site to fit within the restricted & awkward spaces.

Once the duct runs were complete, the space between the duct and the unearthed material was carefully backfilled using the same material removed. This material, when re-instated, was mixed with hydraulic lime and very small quantities of water to ensure that the spaces are properly backfilled and compact. The 'new' re-instated material was isolated from the 'original' undisturbed material with the introduction of a geotextile, thus clearly identifying the areas intervened upon. The masonry *ċangatura* removed, which could not be completely re-instated (due to the limited depths available), were numbered and stored on site.

Figure 17: Reinforced and strengthened duct inserted within the space available with underlying geotextile.

Figures 18a and 18b: The oculi exposed at Main Altar level, together with the 'original' *ċangatura* and finished floor level. The carefully removed volume to accommodate the duct was then carefully backfilled

Figure 19: All the tiles were reinstated once the duct work was all installed and tested beneath the Main Altar

Figure 20: View of Main Altar following completion of the works

All of these works were carried out under the strict supervision of TBA Periti (as requested by Superintendence of Cultural Heritage), and that of the Conservator and Curator of the St. John Co-Cathedral Foundation.

It is important to point out, that the Superintendence of Cultural Heritage was constantly updated during every step of the works described above, since all the works required its approval.

4. Brief Description of Major Findings

Above the cabinet where the ducts were accommodated an 'original' window was uncovered. This was blocked off to accommodate the entrance for the organ. *Could the 'original' extent of the Co-Cathedral been different*?

Figures 21a and 21b: Elements forming the 'original security bars, and windows jambs uncovered.

When the marble tiles were being carefully removed, *ċangatura* was uncovered. The face of the *ċangatura* was not smooth, just like the *ċangatura* beneath the choir stalls (which are no longer visible to a visitor/user). Instead, the face is hacked, as though the face was trimmed back to accommodate the marble finish, while retaining the same floor finished level.

Once the second oculus was uncovered, an older finished floor level (FFL), consisting of a *ċangatura* finish, was also uncovered.

Upon further investigation, more of the *ċangatura* finish was uncovered and eventually, towards the centre of the Main Altar, two steps were also uncovered, each having a rise of between, 160mm - 170mm, which suggests that four steps were required to reach the existing FFL set at +660mm for the uncovered older finished floor level;

Figures 22a and 22b: Beautiful details (old steps and a lower 'original' floor finish) uncovered, thereby shedding light on the changes/ development of the Main Altar.

5. Next Stages:

Now that the environmental control system is running and the temporary/portable equipment has been switched off and will shortly be removed, (currently retained as back up), the ambient conditions within the Crypt have settled and are now stable and within the required ranges stipulated by the Courtauld Institute. The system is being closely monitored by the Conservator and Curator of the St. John Co-Cathedral Foundation.

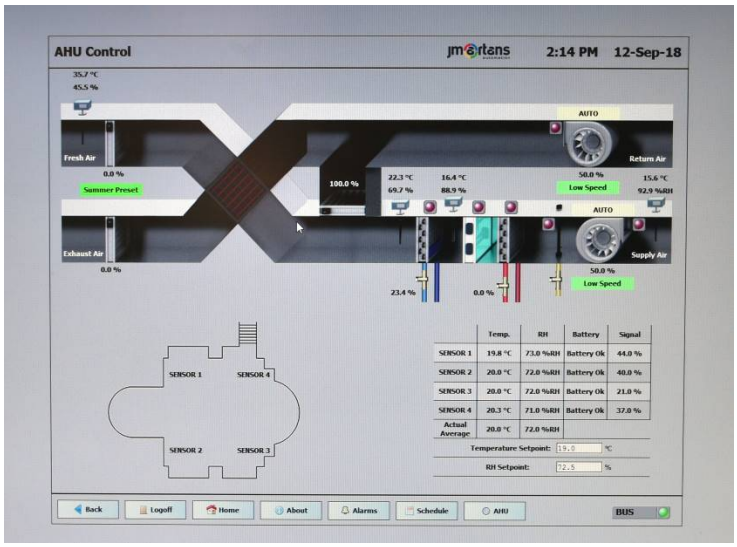


Figure 23: Image of the sophisticated building management system which controls the micro-climate in the Crypt.

Considering the above, the uncovered steps at Main Altar level, as per images above, are to remain visible for further research and studies. For this reason, this area was not backfilled and is going to be roofed over with glazed floor covering, which is currently being installed.

The Crypt is to have a viewing gallery/platform installed at its entrance to allow visitors the possibility to view this magnificent space, which has been closed off to the public for the past 25 years. The viewing gallery will be glazed and openable to allow access into the crypt for maintenance and restoration works.

Figure 24: Image of a full scale model of the viewing gallery/platform, being fitted on site, to assess the contact points, thus ensuring that no damage is caused to the existing masonry fabric. The actual gallery/platform, which will include curved glass will be installed towards the beginning of 2019.

Concurrently an appropriate lighting system within the Crypt, which shall also be fully reversible, is being studied. It is anticipated that the Grand Masters Crypt will eventually be open to the public for viewing by mid-2019.