

A Digital Map for the Interior Restoration of St. Ninian's Cathedral

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ABSTRACT:

When it was built, St. Ninian's Cathedral, in Antigonish, Nova Scotia, Canada had nearly every interior surface covered with trompe l'oeil frescoes framing saints and scenes depicting the mysteries of the Catholic faith. However, over the years, reigning bishops have opted to paint over much of the decoration for reasons of economy until today those elaborate frescos have been reduced to four medallions on the ceiling and a dozen saints floating, without context, above the arches. The parish now recognizes the value of the covered decorations and would like to have the process reversed. Our challenge was to devise something that would provide guidance to the conservators trying to find and restore covered the artwork.

Archival photographs and drawings showing elements of the decoration, digital photography of the current situation and a geometric survey of the building and surviving artwork became the basis of our solution. All files were catalogued and the digital photographs rectified and inserted into AutoCAD to create a 2½D CAD model. The scans of the archival material were then added to the model resulting in a blend of the contemporary with the archival, creating a photo mosaic which was to become the basis for the conservation work to come.

Typically this would be the end of the recording work but, as a final product, everything – the drawings, the photographs (contemporary and historical, rectified and source), the historical documents, our reports and even the survey data – was assembled into a set of web pages. Normally this would be a big job but, because each file had been carefully cataloged as it was created, this could be easily automated. So, even if the conservation work does not go forward, a resource has been assembled that will be valuable whenever any work is contemplated on the cathedral and, in the event of disaster, there are almost 2000 3D points which can be used for monitoring changes.



Introduction

The abstract explains the motivation of the clients in commissioning this work but this paper will be written from the perspective of the Heritage Recorder. Of course the two sets of criteria coincide in many respects but the recorder has other issues to consider, technique and efficiency of course but also ethics. What are our responsibilities to the project? To the site? To the data we have collected?

Often we are working in a bit of a vacuum with little knowledge of the history or the importance of the resource, little input as to what should be recorded and even less about the uses to which our work is to be put. Far too often, we hand in our report and hear nothing further. How often is our work misinterpreted or even filed away to be lost and forgotten?

The project at St. Ninian's Cathedral was fairly clear in scope. It was to map the surviving artwork and to try to correlate the existing with what was known about the original. But the process, of necessity, goes well beyond this relatively simple request. To describe the condition of the frescos one must understand the condition of the building and the Heritage Recorders, in the course of their investigation may learn things that might be invaluable for the long term health of the resource.

This paper will discuss the procedures and the relatively simple tools we used to record and model St. Ninian's and its frescoes, current and historical, but it will also look at the by-products of the investigation and conclude with some thoughts on what should be done with the resulting data set.

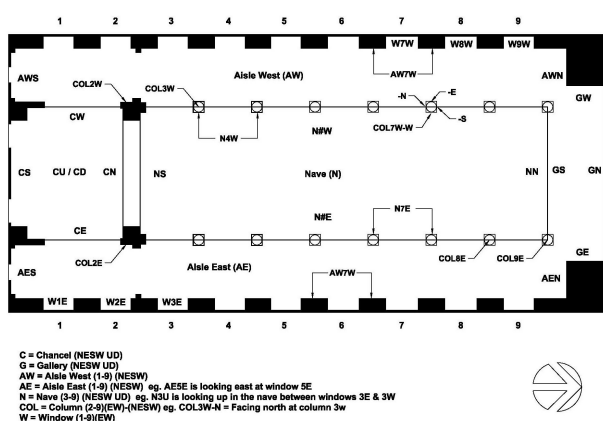
The Frescos of St. Ninian's

St. Ninian's Cathedral, in Antigonish, Nova Scotia, Canada was constructed starting in 1867 and was decorated around the turn of the century by Ozias Leduc, a preeminent church painter of the time. By 1906 nearly every interior surface was covered with trompe l'oeil frescoes framing saints and scenes depicting the mysteries of the Catholic faith. However over the years the church was redecorated several times and, bit by bit most of the decoration was painted over "as an economy measure". By 1970 the elaborate frescos had been reduced to four medallions on the ceiling and a dozen saints floating, without context, above the arches.

In 2005 the parish wanted to reverse this process and restore the church to it's original condition. However, contrary to the promises of the over-painters, the layers of enamel covering the artwork were *not* easy to remove. As a result we were asked to devise a method whereby some guidance could be given to the conservators as to where they might find the lost details.

The pieces we prepared for this puzzle included:

- Scans of any photographs, drawings or sketches showing elements of the decoration collected by the Art Historians during an extensive search of the archives of both the parish and the artist.
- Digital photographs of the entire building with an emphasis on the current state of the artwork.
- A total station survey of the cathedral
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Cataloguing

Our definition of "cataloguing" refers to the organization of the electronic files created by and for the project. Typically the files of a work in progress are kept all over the computer, often in directories determined by "Windows®" (My Documents, My Pictures, etc.) though the names of the individual files usually make more sense as some thought is required when a file is first saved. In general, however, the organization of this material is left until report writing time. By then memories have faded and at best it becomes a time consuming task pulling everything together while at worst data can be lost or forgotten and, if someone else has to take over mid-project, it can become a disaster. The new search capabilities of our computers can help a lot but you still can't search on image content so a tightly organized file naming convention can save immense amounts of time and frustration.

The most difficult part of the cataloguing exercise is the

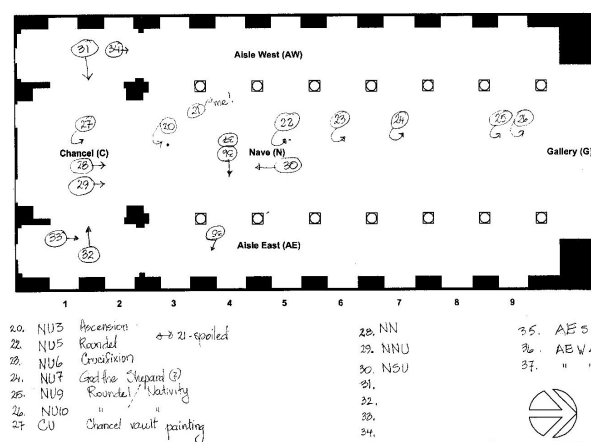
definition of a naming schema but this is the key to keeping the project moving smoothly and, if well done, will pay back handsomely during field work and report writing. Our cataloguing efforts started before the first files arrived from the archives. Studying the plans and elevations of the building and with a pretty good idea of what we needed to record we devised a file naming recipe based primarily on the physical elements of the building.

We settled on file names that incorporated:

- the area of the church (Nave, Chancel, Aisles, etc.)
- the bay (between columns numbered north to south)
- the direction of view (North, South, Up, Down, Etc)
- and the year represented (1900 - 2005)

Plans and elevations annotated with the standardized terms were printed and distributed to the participants as memory aides to help them keep their field notes consistent and to keep the names they assigned to their notes, sketches and photographs as coordinated as possible. These drawings were also printed in a stripped down format to provide backgrounds for the field notes themselves.

The floor plan below is an example. The hand written notes are part of the field component of a photo key plan. For instance frame 20 was from the 3rd bay of the Nave looking Up and was to be catalogued as "NU3" (Nave-Up-bay_3) to which the date and a number to keep things unique would be added during cataloguing. With the notes these sheets became primary resources in themselves so they too were scanned and catalogued into the archive as "Naming Criteria" providing the link between other written field notes and the survey as well as the CAD modelling that was to follow.



The Digital Photography

The cameras used for the digital photography were nothing special and, though they were capable of more, most of the pictures intended for the photo mosaic were taken at resolutions of about 2 mega pixels. At this resolution the detail is as accurate as the survey and, not suffering from the current epidemic of "megapixelitis", the CAD model, in which some 70 images are embedded, is much easier to handle than if the images were taken at a higher resolution. We also calibrated the camera lenses at both minimum and maximum zooms using the calibration routine included with our rectifying software.

As soon as they were downloaded the photographs were catalogued and immediately we began reaping rewards from the structured file names. With the directory set to "Thumbnails" a simple sort-by-name lays out everything in order making it easy



to determine whether we had suitable coverage with which to build the photo mosaics.

Having identified the images we intend to rectify we printed them so that they could be used for note taking during the survey. We found that black and white worked better than colour and that a full sheet of letter size paper was necessary to identify the details chosen for measurement and to allow the necessary space for annotations during the survey.

The Survey

Armed with printouts of the plans, elevations and artwork the survey was performed using a Leica T1000 with a Disto visible EDM mounted above. More modern equipment would be nice but our competition is not Photogrammetry and Laser Scanners but rather tape measures and plumb bobs. We have to be cheap and we have to be fast and these old tools, held together by velcro and some home grown software get the job done.

Another economy is the fact that we don't usually do a formal transit, opting instead for a sort of "daisy chain" based on a large number of "found" benchmarks (corners of pedestals, punctuation on inscriptions, tops of fire hydrants, etc.). Anything we don't think will move and do think will be there for future reference. We collect these points as we find them, then from each new survey station, re-capture as many as we can see.

To establish the geometry of the building we take longitudinal and transverse sections from most, if not all, of our stations while for plans we set the instrument to the horizontal and shoot what we can see from as many stations as it takes to get a complete footprint. The different stations are put together in AutoCAD based on a "best fit" of the benchmarks and the margin of error is established by the discrepancies between them. At St. Ninians the maximum variation was less than 1.5 cm over 39 metres but because there is considerable redundancy we can ignore the worst from each station.

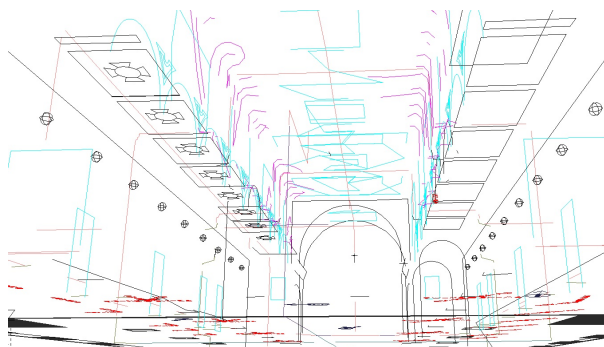
Because the primary objective was to place any surviving artwork correctly in 3D space we recorded the nose and toes of all the figures as well as points

on any surviving borders and architectural details that were visible in the old photographs we had (or that we thought might be visible in future discoveries).



Building the Model

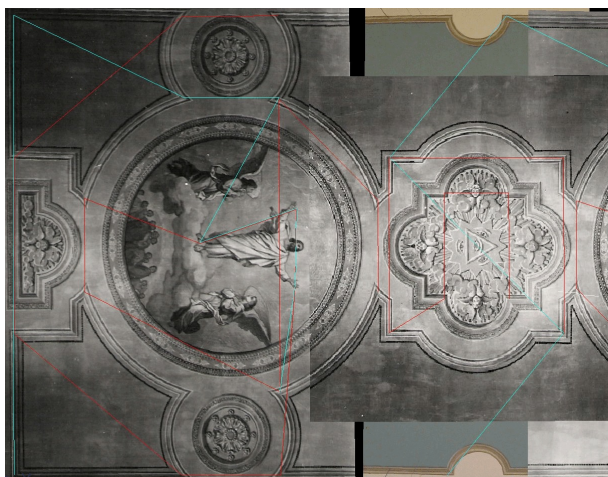
The database of some 2000 surveyed points was populated with information from the field notes, including the "names" of the objects on which the points lay and from these points a 3D wire frame model was created in AutoCAD. By creating the CAD objects on layers based on the names of the physical objects it makes it easy to find them, including the points needed for rectification, simply turn off all layers except the one having the same name as the object. EEDs (Extended Entity Data) and Hyperlinks were also added linking the CAD objects to images of the objects or to their web pages if they exist. Not only does this, more intelligent, drawing make navigation through the model much more convenient but the drawing itself becomes a quite sophisticated visual interface to the other data.



The rectification of the contemporary photography was next, using the survey points identifiable in the images. Unless your rectifier accepts 3D points you will have to select 3 of the surveyed points to create a coordinate system on which to place the image and then transform them and the other points to be used for rectification to that plane. Do the rectification using those points then insert it into AutoCAD and scale it to a best fit of the points used. We find that by drawing a polyline connecting the points to be used and making it visible over the image a sense of the accuracy of the operation can be achieved. The final step is to crop the image so that only the plane you want remains visible.

The next step was to adjust the scans of the archival photographs, drawings and sketches to fit the surveyed points. Whenever possible we used the actual points surveyed but, because most of the good photos of the contemporary artwork were of relatively

small details (such as a single saint) other points had to be derived from the rectifications of the digital photography already inserted into the model. To do this we had to adopt the coordinate system of that image (a 2D plane) and select details that did not appear to have been touched up during earlier restorations and which were identifiable in both the digital photograph and in the archival material. Again the easiest way to do this is to draw a polyline to connect these points then insert the archival photograph and scale to a best fit.



The lines overlaying this mosaic connect the survey points from two different stations. The discrepancies between them and the features on the images represent the margin of error.

The contemporary photographs were corrected for lens distortion before rectification but, of course, this was not possible with the archival material. We assume this to be the source of much of our final error (the discrepancy between the old images and the new), which sometimes approached 7 cm, while the discrepancy between different contemporary photographs showing the same detail was generally less than 1 cm (except at the extreme edges of the rectified images where it occasionally exceeded 10 cm).

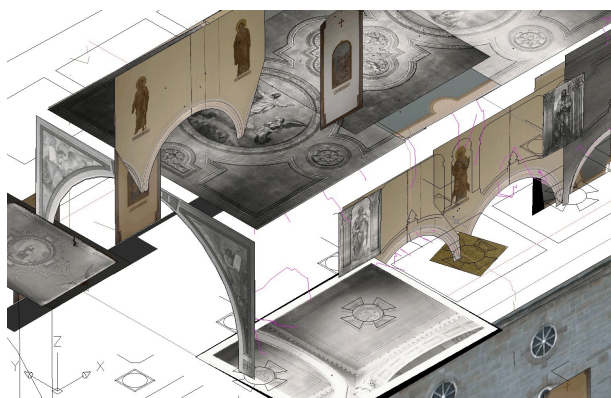


Image display order requires manipulation for each view to be printed

Getting the rectified images into AutoCAD can be time consuming if you have to do it manually, but the really hard work comes when preparing the model for presentation. Not only must each image be trimmed of everything not on the rectified plane but the display order must be tweaked for each view as AutoCAD does not yet (ver. 2005) consider images for hidden line removal.

Our final result was a CAD model blending the survey with the contemporary and archival photographs and scans. Plan, section, elevation and reflected ceiling views of this drawing were prepared using paper-space and view-ports and by adopting the

coordinate systems of the images these views could be used as a background over which we sketched details visible in the images which could not be used directly due to their having too few identifiable points or because of their extreme obliqueness. Often we had only a single example of a feature that was apparently reused for each bay, such as the decorations between the saints or the medallions along the aisles and these we would trace and clone as line-work into the other areas we knew would have had a similar treatment.



A part of the finished 2½D photomosaic as a DWF showing Layer control and a Hyperlink to the source image.

Beyond the scope of the contract

Unlike laser scanners, Heritage Recorders are people. They are in the business because of an interest in the objects they are recording and many bring with them special areas of expertise. Of all those involved in developing a restoration project they may well be in the building the most, especially before the restoration work begins and things start to change. They are peering closely at details as they take their measurements and carrying a digital camera into areas that others may not need to access. These characteristics create possibilities that should not be overlooked.

Our mandate was to document the art work but in the course of our 5 days on site we went into every space and took pictures of areas and details that had nothing to do with the frescoes. Yet these documents represent a moment in time of the building and, in the event of a catastrophe, may be important to help recall the spirit of the place. A case in point is the photograph below.



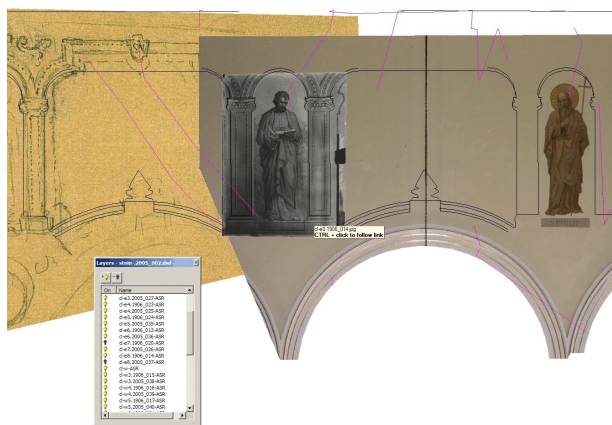
While crawling along the footing trench we noticed this object. It is a deck prism, used to illuminate the dark areas below decks in sailing ships. They were arrayed along both rows of footings and would have provided light for maintenance in the crawlspace except for the fact that they had been covered over during a change of flooring some time in the past. Antigonish was and is a maritime community and, no doubt, shipbuilders were involved in the construction of this cathedral.

Publication

The fact that all our files have structured file names, means that by the end of the project we were pretty much ready to hand in the material. A CD with a READ-ME explaining the file naming schema and a written report is about all that should be necessary. However I have learned that it is unlikely that anything but the report will ever be looked at so I usually spend a lot of time writing and choosing suitable illustrations and images. However, if the report becomes comprehensive enough even that won't be read because it will become intimidating by its sheer size. And still it will contain only a fraction of what has been recorded!.

Instead we opted for more data and less work and turned the whole data set into a series of web pages which we copied onto a CD and handed in as our final report.

The catalogued data structure itself should go a long way towards satisfying an interested scholar but really the full data set needs to be published so that it can be found by a wider audience. The internet offers this opportunity but more convenient ways to utilize its potential are needed. Our 5 days at St. Ninian's produced almost 1000 files, just under 600 megabytes, so clearly no manual approach will be appropriate. The answer is software created specifically with Heritage Documentation in mind. Something that will automate this task.



Screen shot from the DWF showing mosaic of current & archival photographs as well as Leduc's preliminary sketches, our tracings and the surveyed cracks

Software:

The tools we used at St. Ninian's automated almost everything though, unfortunately, most of the software is still at the prototype stage.

Cataloguing: ASCix⁽¹⁾ is a prototype database program that deals with the cataloguing and renaming of electronic files. Its primary responsibility is to ensure that all files have names that fit the schema but it also offers a limited amount of data management such as: keywords, captions, comments, etc. The directory it creates is intended to be archival with all the information being either coded into the file name or contained in a series of ASCII files that can be read by any computer or software.

Rectification: We used ASRix⁽²⁾ which has grown out of a long collaboration among CIPA members dating back to 1992. It can be used like any other rectifier but features have been added specifically for the Heritage Recorder.

- It has archival characteristics. The rectification parameters

are kept in an ASCII file which identifies the source image, the camera used and its distortion characteristics (ASRix will also calibrate the lenses of digital cameras) and, most importantly, the points and the coordinate system on which the transformation was based (where the photo fits into the building).

- It works with 3D coordinates. Very few of the objects we record are 2 dimensional. Even if they are close it is good to know how close and not having to transform the 3D points for each "flat" surface onto a new coordinate system saves a lot of time and potential errors.
- It takes World Coordinates directly from the survey instrument. Another time saver and error reduction feature, ASRix will look up coordinates directly from the flat file downloaded from the survey instrument.
- It works with AutoCAD. We generally do all the rectification tasks from inside AutoCAD. Click on an object with an EED or on a layer resembling an image name and that image will be loaded into the rectifier. Select a point on the image and give it a point number and the 3D coordinates for that number will be imported. When you are happy with the rectification save the results and the image will be inserted into AutoCAD in the correct location and at the correct scale (unfortunately it still has to be trimmed manually).

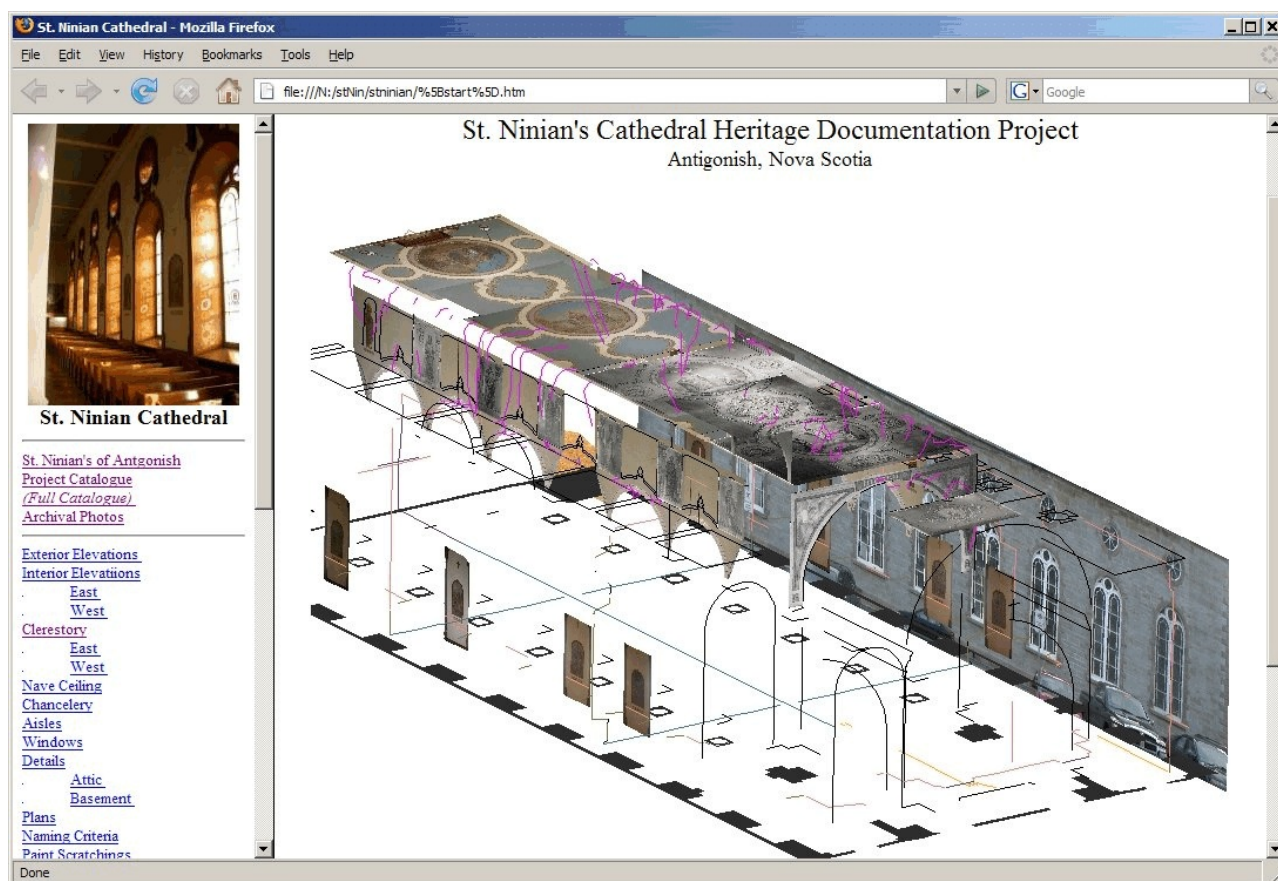
CAD Drafting: the CART⁽³⁾ AutoCAD[®] drawing generator reads an annotated point list (the same as ASRix uses to fill in World Coordinates) and draws the results. It can use anything in the database to create names and it will apply them to layers, blocks or EEDs. Also, it creates Hyperlinks to anything it draws (again like ASRix). If the drawing is catalogued into the same directory as the images and other support data the DWF exported from the drawing will be fully linked when posted on the web making it a user friendly visual index to other files with similar names.

Publishing: CARTHTML⁽⁴⁾ is an automatic web publishing tool. Today there are lots of these and this one is quite out of date. It uses a simple concept: take a directory, sort by file name, test the file names against a series of user defined rules and turn the files it understands into a web supported format (warning the user about those it cannot handle). It then builds an index to everything it processes and issues a non-compliance report which flags files not named according to the rules. Our directory, created by ASCix, is perfect for such automatic processing because the files have structured names and the support files it creates are in simple formats. The result is a set of web pages, simple but with everything laid out so it can be explored by anyone with a web browser.

Conclusions

The intent was that our record would become the basis for the conservation work to come. Perhaps it did but I doubt it or I would have had some questions about how to handle the drawing. In any event I haven't heard. Used as intended the conservators would have a map telling them where things should be within a few centimetres and, as they scratch away, more points would appear that could be measured allowing the accuracy of the model to be improved. New resources, such as the parish wide quest for more photographs of the interior, could easily be added to further refine the digital model or simply catalogued to become addendums to the automatically generated web pages.

But even if the conservation work does not go forward a resource has been assembled that should be valuable whenever any work



is contemplated on the cathedral. In the event of disaster. The survey has identified almost 2000 3D points several hundred of which, because they are linked to identifiable points or to the rectified photographs, can be used for monitoring changes to the structure or the artwork itself. Even the miscellaneous photographs might prove useful, interesting or educational.

The problem is that almost no one has access to this data! The specific reasons for this material being withheld are immaterial, they are always different but always the same, either it is to "protect" the artifact or because somebody thinks they "own" it. In some situations the protection argument is valid, new archaeological sites sometimes qualify, but in a situation like this protection is not an issue and what could they possibly own? The building was built and maintained with donations from the community and it has been publicly subsidized through tax exemptions. Even for privately owned properties the claim is somehow suspect because of subsidies and because at least part of the value of a heritage property is in its "heritage" and that is a quality conferred on it in the minds of the community. The question I want to raise is this: What should my responsibilities be as a Heritage Recorder?

If St. Ninian's Cathedral were to burn tomorrow I still have my record and could make it accessible but, with each passing year, this possibility becomes less likely. Even if the parish keeps a copy of the CD I gave them off site, if nobody knows about it or maintains it, it too will be lost. The only true posterity is through the widely held knowledge that something exists. Our work should rightly be in the public domain and we can make our work stand on its own, as raw data organized for easy access. The internet and simple ideas and tools such as were discussed here can help us towards the technical realization of that goal. How shall we approach its moral realization?

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