ARCHITECTURAL SURVEY AT CHURCH OF ST MARY WHITBY

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Commission 11, Working Group 1: Real-time mapping technologies: Land based

KEY WORDS: Reflectorless EDM (REDM), Real-time CAD survey, Disto, Field CAD, Architectural Survey, Measured Drawing.

ABSTRACT

The survey was carried out at the request of English Heritage as a part of the Whitby Headland Project to record the interior architecture of the church for both national record and as a base for analysis.
The Church is unusual in that it retains a system of box pews arranged on galleries and the selected view of the interior was chosen to reveal this structure as well as the Romanesque origins of the building.
Architectural Survey usually employs two complementary techniques: photogrammetry (or at least photo-based measurement) and measured drawing by either field notes or direct drawing to scale on site. The English Heritage Survey Team seek to improve the integration of these two activities by use of field-based CAD and REDM to enhance the metric value of measured drawing work as a part of a controlled approach to the problem of mapping architectural detail with good positional precision.
The application of REDM survey to internal surveys of a complex historic structure provided the 3D positional control needed for the presentation of correct elevational views (particularly the view of the transept seen from the nave).

1.PRINCIPAL SURVEY TECHNIQUES USED IN THE SURVEY

1.1 Measured drawing

The selective use of measured drawing was applied to the furniture and details (see figures 1&2) . The value of the technique for this project lay in the nature of the subject: a number of distinct architectural styles have been employed in the church and each required the correct thematic input in terms of edge selection and form recognition. It should be noted that the mouldings shown on the survey are all drawn from prototypes fitted to measurement rather than from the use of profiling tools.

1.2 Use of Photogrammetry

Photogrammetry was used for a full stereo record of the church exterior and the interior of the chancel where the obstruction to the elevations was less than elsewhere in the church. The photogrammetric record was prepared for 1:20 scale presentation from monochrome photography.

1.3 Use of Rectified photography

Rectified photography was used to provide cover of all of the internal surfaces of the church; this proved to be immensely useful in the verification of EDM and CAD work. The photography was printed to 1:10 scale in colour. The large number of wall monuments in the church required a photographic record as the hand draughting of the lettering and decoration on these would be a poor use of a draughtsman`s time compared to the furniture details.

2. NEW DEVELOPMENTS DEPLOYED IN THE SURVEY

The survey provided the Survey Team with the opportunity to develop some new techniques. The evaluation of CAD draughting and measured drawing as appropriately applied needs to be done to differentiate the tasks that REDM is best suited to. Producing a frame work which can be used to `hang` detail to in 3D space; fine architectural detais are best recorded by careful measured drawing and then digitised at large scale or full size.

2.1 Surveying in CAD : Real-time monitoring of the 3D wire frame

The 3D data produced by REDM in CAD was a great benefit as a check on error is maintained; and the selection of targets can be verified for clarity of overlap with photography or measured drawing.

The project used both the DIOR and DISTO reflectorless EDMs and demonstrated the superior precision and signal discretion of the DISTO at ranges up to 30m. The DIOR had a speed advantage and is subject to less target reflectance failure.

The equipment used was:

Wild T1000 3" electronic theodolite
Wild DIOR 3002s
Leica DISTO
Wild TC1000

The major problem was ensuring a consistency of point density between observers and the different distance characteristics between the DISTO and the DIOR.

The software used on the survey was of two distinct types: to monitor the results in real-time PenMap was used running on a Compaq Concerto pen computer. AutoCadLt was used to review the data in 3D on a daily basis and for direct plotting of some detail.

2.2 Digital image manipulation

The rectified photography of the internal elevations of the church was prepared by the Survey Team photographer using carefully controlled camera positions and lighting. The high quality of the images was a vital component to the success of the project: the images included a simple scale on the main plane of the subject .T he REDM wire frame provided 3D control of planes beyond the main plane.

The camera used was a Pentax 6" x 7" format with 55mm (wide angle) lens, a Norman hand held flash was used to support the available lighting. Kodak PS120 film was chosen for its colour properties and latitude.

The images were scanned using an Epson GT850 A4 flatbed scanner to a resolution of 1600 DPI (software interpolated) from 400DPI so that selected detail could be plotted at 1:20 without loss of definition. The selected areas of image to be used were isolated and cut in EPSON TWAIN to reduce the amount of image transferred to CAD. AutoCad r14 was used to separate the required detail from the image and fit it into the vector drawing.

The images were fixed in position and scale in Auto Cad r14 to infill the decorative detail of the wall monuments in the CAD data.

2.3 Large scale detail integration of the various data sources

3 methods were used:

1) digitising of original art work prepared at scale by an experienced architectural surveyor.
2) plotting in CAD measured positions from field notes.
3) direct plotting in CAD on site (sec 2.4).

The extract from the section shown in figure 1 displays three data types integrated in CAD: The sectional view of the chancel arch was prepared by fitting a hand measured profile to the 3D position of the joints supplied from the photogrammetric work.
The large central pew (the Cholmley Pew) is shown as cut by the section line. The position and profile of the barley sugar twist column is from photogrammetric plotting of the profile, the capital is from measured drawing. The panel behind the Cholmley Pew is traced from a rectified photograph by digitising in CAD.
Most of the work was carried out at a tolerance commensurate to a scale of 1:20 and fitted to the wire frame some of the furniture details were full size, some at 1:10 scale

2.4 Field CAD draughting

The use of CAD in the field is limited by two factors:

1) Speed of data collection/draughting
2) Availability of good field computers.

CAD is slow compared to draughting direct on site: the utility of CAD is restricted to "red lining" or the plotting of simple repeated detail (such as nail heads in figure 2). The benefits of seeing the wire frame from EDM in CAD are great as the selected target points and lines appear in real-time.

3.0 EVALUATION OF TECHNIQUES USED IN THE SURVEY

The survey generated a number of valuable lessons:

3.1 The on site verified 3dwire frame is a valuable control for Architectural Survey

The use of a 3D wire frame from EDM for fixing detail to a common control with photogrammetry gave a consistent positional accuracy to the fixing of detail. The infill of the photogrammetric survey by field CAD allowed a high order of verification by working "over scale" on site. The extent of the wireframe need only be as much as is required for the specific view of the subject; it is easy to generate too much data with REDM: it is important for the instrument work to match the work of those working on detail.

3.2 Digital imagery fitted to CAD can enable combined raster/vector products to be prepared

The use of digital imagery as infill to vector survey drawing in CAD offers users the benefit of both photo-realistic definition of the subject and the colour rendition of decorative details. By using CAD for the fitting of the imagery it is possible to maintain 3D positional accuracy. It is a useful attribute of AutoCad r14 to be able to read raster data. The record of the wall monuments can now be seen together with the line drawing of the church fixtures (see Figure 2).

3.3 The use of field CAD needs to be selective

The difficulty of handling large CAD files on low powered field computers needs careful use of "Xref" or similar file division system.
The nail heads and splits in the foot board at the bottom of Figure 2 were plotted direct in AutoCadLt on site; this was done when the job was nearly complete by using a copied block and a hand tape to fix the location from other previously plotted detail. Attempts to plot larger features failed as the speed of CAD work reduces its utility on site to the plotting of repeated detail.

3.2 Using CAD hands free helps CAD users on site

The ergonomics of field computing need to be addressed by manufactures of portable computers: CAD editing in the field needs the use of a 'hands free' (e.g Leica part no: 10663090/91) set up. Pen computers make using a mouse and key board redundant but the optimum of a large light-weight clear screen with good daylight visibility and really fast pen to screen speed is still some way off; it will be some time before computers are really at home in the field. Users are going to bump them about in all manner of varying light, in rain or shine, and will expect battery working life to at least exceed the working day.

The difficulty of moving around a building, taking measurements by hand and plotting the results puts some interesting demands on both computer and user.

The use of pan and zoom commands slows the work and can cause problems in plotting detail to scale by interpolation from previously plotted detail.

Pen computers are undoubtedly the best platform for computer fieldwork as the pen offers a reasonably fast and accurate screen pointer so that selection of commands can be made swiftly even with gloved hands!

The idea that a user can sketch on a pen computer in the same way as a pencil on paper is a long way from reality, pencil sketched site notes are far superior to the results from the same time spent in CAD. Power consumption of CAD packages is a consideration few have to make (apart from the obvious efficiencies of DOS programmes over Windows) Programmes which write to disk continually such as PenMap caused power problems compared to AutoCad Lt which only calls on the hard disk drive when invoked by the user.

4.0 CONCLUSIONS

It is important to remember there is no single solution to the problem of architectural survey; a variety of complementary techniques appropriately applied need to be deployed for the successful handling of detail in a good metric framework. By taking the CAD platform to the subject of the survey much time can be saved on verification of the survey; precise fits can be made using image-based products in the field; EDM can be used to perform fitting of detail (vector or raster) in real time, REDM is a valuable aid to the fixing of in accessible detail.

4.1 Surveying in CAD

A new way of working is emerging; this can be described as surveying in CAD. The two software solutions employed in the survey caused problems with incompatible command structures and the awkwardness of DXF file Transfers for the 3D verification was not ideal. It would be beneficial for surveyors to work in a CAD environment that is consistent in speed and command structure from one task to another. The process of collecting the 3D wireframe data can be seen as a digitising task comparable to 2D digitising as used for tracing detail into CAD. It seems clumsy to use different software for the 3D work with REDM when most CAD skills are based on the use of software like AutoCad.

The integration of the data in CAD could be improved by use of a single "surveying in CAD" solution. Using CAD for field data collection is a viable route for the completion and verification of Architectural Survey by photo based techniques; the use of EDM (particularly Reflectorless) as a tool for data acquisition in CAD is rapid and precise allowing the concentration of high cost/high skill techniques on detail.

4.2 Real-time verification of REDM work is essential

The variation of target reflectance characteristics, edge profiles and obliqueness all need to be checked as the REDM is used, the best method is to use CAD to check the results as they are fed from the instrument. Auto CAD Lt is a good cheap CAD platform with sufficient layering and 3D viewing capacity to meet all requirements for checking wire frame integrity.

4.3 Draughting skills are needed for detail survey

The high quality achieved in the survey has been the result of a team effort: Field surveyors have learnt how to get the best out of REDM, the rectified photography was taken with great care and consideration for shadow and lighting, the photogrammetric work was diligent and the draughting of both notes and plots of the detail shows how the application of architectural knowledge has culminated in an appropriate architectural record of the building. Cad operations such as digitising detail plots requires patience and skill.The Survey Team at English Heritage can take credit for the highly developed skills it has brought together to show how the combination of survey techniques can produce sucessful Architectural Survey.

Figure 1: Church of St Mary Whitby: Section looking South, the chancel arch has been mapped by photogrammetry, the transept arch by REDM. All details are from measured drawing digitised into CAD .

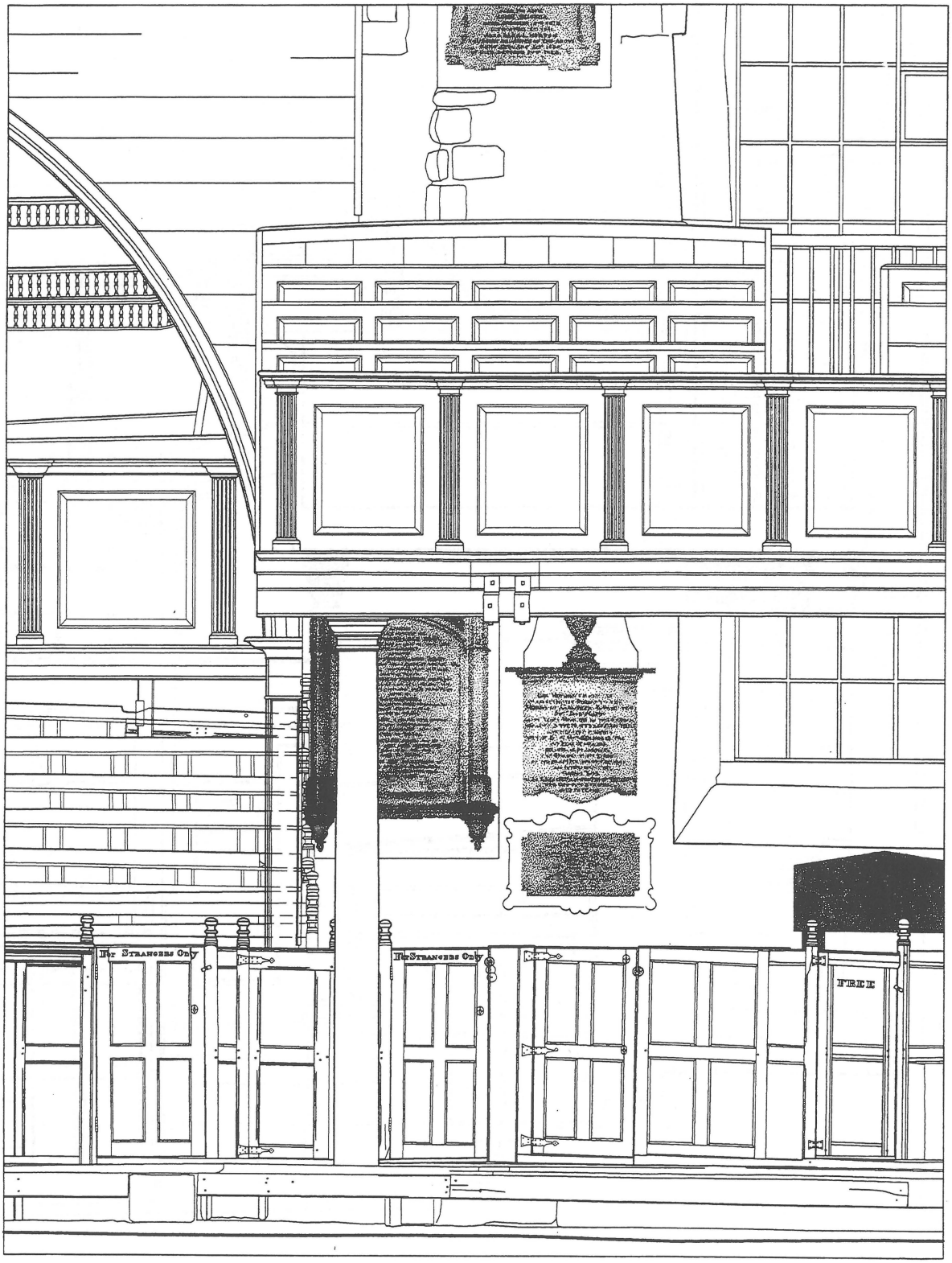

Figure 2: Church of St Mary, Whitby: Sectional elevation of Nave, looking South: The 3D position of the pew fronts was fixed by REDM, the furniture details were drawn up at 1:10 and digitised into CAD.