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Handheld Laser Profilometry of Certain Medieval Inscribed Stones

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A Thesis Submitted to the National University of Ireland, Cork in Fulfilment of the Degree of PhD

Department of English NUI, Cork

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Introduction

The aim of this thesis is to critically evaluate the Polhemus FastSCAN handheld laser scanner as a method of rereading certain medieval inscribed stone monuments. The effectiveness of the methodology will be measured by focussing on certain monuments in Munster.

The outcomes of the research involve conservation, preservation, education and possibly understanding of texts and images lost for centuries.

Initially the equipment and method are discussed and the process described. Chapters one, two, three and four each highlight a single site and inscription. Chapter five analyses and discusses the results and evaluates the method's usefulness in rereading early medieval Irish inscriptions and decorated monuments.

Stone monuments in Ireland are subject to decay; whether indoors or out, urban or rural, advertised or ignored, dressed stone is wearing away. *The Stone Monuments Decay Study 2000* states that there are many different decay forms: 'the age of the monument; the influence of stone type; structural damage; the loss of carved and dressed stonework; biological colonisation; influence of later interventions; the influence of the environment'(5.2.4; Pavia and Bolton). Pollution, vandalism and geography all influence the decay levels of a monument.

This recent research on carved stonework for the Heritage Council of Ireland has stated that there is 'a possibility that the topography of carvings and dressing

may predispose them to increased weathering rates'. It was also noted that 'a number of masonry blocks exhibit abnormal amounts of material loss along dressed surfaces … all sandstone examined exhibits loss of carved detail'(Pavia and Bolton 5.2.4). One of the specific examples cited is the inscribed Hiberno-Romanesque arch at Killeshin, Co. Laois.

The primary function of any preservation or conservation measure is to record immediately the monument or site under threat. Historically this has been achieved by using technologies that were limited to two-dimensional representation including photographic records, drawings, and rubbings. However, small-scale models and replica casts have also been utilised to record heritage data.

The outcomes generated by using laser-scanning technology, a three-dimensional tool, offer the possibility of replica creation, and a manoeuvrable digital image that may be used in a variety of ways. This three dimensional dataset is malleable enough to support conservation, preservation and education efforts.

Laser scanning has sub millimetre accuracy and can create a permanent three-dimensional record of objects now recognized to be impermanent. It is achieved through the use of the laser and triangulating data points.

The Polhemus FastSCAN handheld laser scanner is a non-contact digitiser that allows for the fast scanning of three-dimensional objects. This non-contact element is a vital aspect of the process as it ensures that the object scanned is

unharmed by the methodology whereas rubbings or making casts have the potential to damage a fragile artefact. The scanning process is much like spray-painting the object: a laser beam emitted by a wand is smoothly swept over the object. A main component of the system is a processing unit, about the size of a desktop computer, which takes care of the registration process in real time in order to combine together the overlapping sweeps. The wand itself is a non-contact range finder, based on the simultaneous projection and detection of laser light (using plane of light technology) coupled with a magnetic system to keep track of the position and orientation of the wand. When activated, this wand emits a laser beam (a Class II laser, 1mW at a wavelength of 670nm) that is read by one of two cameras mounted on each end, while the 3D location of the profile is computed by triangulation using the magnetic tracking system.

The processing unit plugs into the computer's printer port, and the wand connects into this unit. During the acquisition of the data, the processing unit is connected to a Compaq Evo (1.2GHz - 256Mb Ram) laptop. Later a Dell Dimension 4550 (2.6 GHz - 512Mb Ram) desktop is used for post-processing the raw scans. During the acquisition process, the FastSCAN software allows a view of the model as point clouds, as a wire frame, or as a smooth shaded image; only polygonal and point cloud data can be generated as output (Daubos).

RapidForm2004 Origin from INUS Technology Inc. is powerful reverse engineering software that enables the construction of a complete 3D digital model from a point cloud. This software is the leading application used in a wide variety of technical fields, such as industrial reverse engineering, mass

customisation, graphics animation, rapid inspection, and 3D photography to create 3D digital models.

In this project, RapidForm Origin is used to process the raw point cloud data obtained from the FastSCAN scanner into polygon meshes. The main problem with the raw data is the slight mis-registration that exists between successive overlapping sweeps. This problem induces noise in the triangulated model in the form of 'spikes'. Another important problem is the presence of holes in the point cloud data. These holes correspond to areas, usually narrow cavities, that cannot be reached under any direction by the laser beam. During the one-month period when Thierry Daubos evaluated RapidForm, the software proved itself fairly efficient at solving the problems mentioned above.

An attempt to directly triangulate the point cloud would lead to a 3D model with too many holes to be filled. On the other hand, cleaning up the data prior to triangulation, in order to later reduce the number of holes, would lead to an overly smooth 3D model and a significant loss of detail and or resolution. Instead of having to trade accuracy for continuity, RapidForm allows for a more satisfactory approach: first a nearly hole-free, continuous shell is created from a smoothed subset of the point cloud data. This shell is then fitted to a copy of the point cloud data that has undergone much less smoothing.

The use of two-dimensional digital imaging to enhance manuscript quality and legibility has been an acknowledged technique for years, using drawing, measurement and photography. It was a logical progression to look at ways of

representing monuments in three dimensions, and also to explore methods of enhancing decayed inscriptions.

Yet the use of such emerging technologies within humanities research is a contentious issue. The title of a recent article of Huggett's in *Archaeologica e Calcolatori* (Huggett, a) encapsulates the debate, 'Archaeology and the New Technological Fetishism'. Is it scholarship or is it the zeitgeist? The features of good research are constant, irrespective of discipline or method: 'innovation, economy of argument, an empirical basis and thoroughness' (Clarke, Hardman and Kilbride)(1). This article essentially advocates that although research methods may have changed, research values have not. It points to the success of the peer review and strict editorial control. *Internet Archaeology* at http://intarch.ac.uk is a good example of 'digital' scholarship. These scholars stress the need for reason behind the production of 'pretty pictures' and a cohesive approach within the humanities that embraces emerging technologies.

Recently Ugan, Bright and Rogers have gone to the extreme of designing a mathematical function for the technology debate, in their article, 'When is technology worth the trouble?' where investment in technology is treated only as one of many decision variables within the decision making process.(Ugan, Bright and Rogers)

It is hoped that the use in this project of independently verifiable scientific data, combined with epigraphic and palaeographic techniques, will enable new readings of these monuments which will contribute to both our understanding of

the history of early medieval Ireland and perhaps also to the history of the sites examined.

Chapter 1 Toureen Peacaun, Co. Tipperary

The first monument selected for scanning was the inscribed East Cross at Toureen Peacaun. It is situated at the site of St. Beccan's hermitage, in the Glen of Aherlow, Co. Tipperary.

St. Beccan was founder of the hermitage and according to the *Annals of Inisfallen* lived there until his death in 689. In the *Martyrology of Oengus* he is said to have loved vigils. In both Rawl 505, f 214 and specifically in Laud 610 f 65 it is reported on May 26 that: 'bécan carais figli icluain aird aadhba', 'Beccan who loved vigils in Cluain Ard had his abode'; this is elaborated upon further in the *Vitae Sanctorum Hiberniae*: 'Qui etiam fecit sibi crucem lapideam foris seorsum, et cotidie diluculo in prima parte diei, quamuis esset vel serenem, vel turbida aut frigida vel calida, crucifigens se ad illam crucem, totum canebat psalterium; 'He had a stone cross erected outside apart and there daily at dawn in the first part of the day however the weather was either fair or disordered, or cold or hot he did the cross-vigil at that cross while singing the psalter' (my translation). It is possible that the cross referred to here might be the East Cross or a similar monument. The inscription on this monument is the subject of laser scanning described in this chapter. It is not unusual to find a cross in this type of small ecclesiastic enclosure; what is unusual is the existence of a long inscription on the shaft of the monument.

Crosses were and still are an integral part of monastic life. There is a very high number of high crosses, cross slabs and other artefacts depicting this symbol throughout the Irish landscape dating from the sixth century. The apotropaic and practical function of these crosses has been noted by many scholars: ' One

difference between secular and ecclesiastical enclosures was that the latter might be marked by the erection of crosses in wood or stone on the boundary or *termon* of an area of sanctuary or at the gateway to the enclosure. These were the Christian symbols of sanctuary and protection…' (Edwards)(106). In the case of St. Beccan the cross was a focus for devotion, prayer and penitence.

Crosses functioned at many levels. Visually they were a potent symbol of Christianity, but in addition to marking boundaries, they also acted as burial markers, commemorated people and events, and were the focus for liturgical celebration of the divine office and mass. Ann Hamlin has written on the many functions of the cross in early Ireland gleaning a huge variety of material from written sources (Hamlin)(138-140). Richard Bailey has also written on the subject of early cross types, on the possible transition from wooden to stone crosses, and also on the introduction of elaboration in the form of ornament to the earliest forms of high crosses (Bailey)(42-52).

Site

The site is inaccessible by car and access to the site was gained through two gates and across railway lines. The equipment was carried through a farmyard beyond these gates, beside a meandering stream, for about forty metres to reach the monastic site, which also contains the ruins of a Romanesque church, a holy well, a west cross, many cross slabs, and numerous small inscribed slabs.

Scanning

This initial scan in the field required a minimum of two people to complete. The petrol generator used to power the equipment proved heavy and unwieldy, and was subsequently replaced by battery power. The scanning unit itself comprises five separate elements, the laptop, the scanner, the processing unit, and two separate parts of the magnetic tracking system. One of these is held in the hand of the person doing the scanning, while the other must be positioned on a fixed point on or near the monument to enable tracking of the successive sweeps of the wand.

The scanning process took over two hours to complete. Weather conditions were damp and overcast. A mixture of moss and lichen covers the stone (Image 1). There is also a significant break at the top of the shaft where the cross arms and top of the shaft had once been fitted, and have since fallen. Over the years water has eroded a section of the inscription, running in the crack down the face of the shaft caused by the cross head falling off, using the incised lines of the carving, and the crevice created by the break as a 'canal' to traverse the face of the stone. This has led to significant erosion of some of the central sections of the inscription. These areas are indicated in black in the IDL image of the monument. A detailed account of the scanning methodology and explanation of the basic terms used is given in the Appendix.

Inscription

The inscription on the west face of the shaft is almost illegible. Petrie, in *Christian Inscriptions in the Irish Language* (Petrie) did not recognise the inscription on the monument. Crawford in 1909 made no mention of the text.

There have been many attempts at deciphering this intriguing and difficult inscription. Macalister in *Corpus Inscriptionem Insularum Celticarum* writes about: 'a sadly

defaced inscription in six lines of lettering. When I first saw it I felt an assurance that it was in Runic letters and I even essayed to read a word or two. But I could get no further, either then or in subsequent visits that I made to the site, and I am now inclined to adopt a suggestion made to me by Mr. Leask, that the letters are in the decorative form of Roman capitals, which we may see on the cup commonly called the Ardagh Chalice, or the opening pages of the *Lindisfarne Gospels*. I fear, however, that it is too much injured to allow decipherment,' (Macalister, 101)

Duignan took a photograph of the inscription in 1944 (Image 2). It is clear that there has been substantial damage to the monument since this photograph was taken. The inscription is now only barely perceptible to the naked eye, whereas in the photograph the last two lines of the inscription are clearly visible.

Reconstruction of the composite monument by M.V. Duignan during his excavation in 1944 yielded the following measurements: 4.06 m in total length, 3.01m in length from the foot of the cross to the top of the tenon. It was 73.5 cm wide at the foot and tapered to 48 cm, the thickness being about 23 cm (Waddell and Holland, 169). As it stands at present, the measurements of the shaft are: c. 200 cm high, 52 cm wide and 23 cm thick (Okasha and Forsyth, 291).

Duignan, as reported in Waddell and Holland, noted: 'The cross-shaft was wrought from a grey-green micaceous sandstone which is very rich in mica, and therefore both hard to dress and very susceptible to flaking. Nothing more suitable for his purpose being available, the cross-maker had to do his best with it. Being unable to fashion a monolithic cross, he set about making a joiner's cross, a cross of planks as it were, the 13 ½ foot tapering shaft of micaceous sandstone, the transoms of course yellow sandstone, the transoms mortised into the shaft, the whole crowned with some sort of finial which was secured by a tenon and mortise joint. In the coarse [sic] of time this top-heavy, composite, cross tilted backwards. … And so the complete cross was in a very real way a joiner's job'(Waddell and Holland, 179).

Duignan in 1944 thought it possible that the inscription began with the conventional OR [OIT] and that the last line included DERNAD … 'some letters, O, N, I, L and possibly D were identifiable, [but] he was unable to decipher sufficient to make it intelligible' (Waddell and Holland, 179).

Moloney in his reading submits that the final words may be tentatively read as:

…….LAIS

DERNAD IN LIE

and that a proper name form 'roughly resembling BIORNANAIN might do duty for the name of the person commissioning the work' (Moloney, 101).

The reading of Okasha and Forsyth is:

O [..-]<u>OR</u>[.]

A[.-]

[.]O[.-R]O[..]

C/T[.]R[-]

[.]/TTO[-NURNINI]

DERN[A]D[..G]IB

(Okasha and Forsyth, 293)

Gifford Charles-Edwards has recently put forward an argument for a Latin reading of the inscription in *Archaeology Ireland* (Charles-Edwards) and also in the JRSAI (Charles-Edwards, 2002). Hers is an interesting reading of the lettering in Latin and Irish, using four separate casts made by Duignan now in the NMI:

OB MERITA EIUS –

? line undeciphered

[DOM]V[S] [?possible place name]

[DONA [VIT PER S] ABAN [?]

BECANI ANIMA LASN/

DERNAD [reduction in size possible late addition] OSGYD

(Charles-Edwards 2003, 14).

Based on the scanned image it is possible to argue for OB and MERITA; however lines two, three, and four seem less probable. Lines five and six provide an interesting platform for discussion as Latin ANIMA and Irish ANMAIN and Irish AINOIM are arguably all possible interpretations of the lettering. The other ideas expressed in the article concerning the influence of

woodworking techniques on the angular shapes of the lettering, and also the widespread use of such an angular script at the time enliven the debate.

So far, these attempts agree on the opening letters of the first and sixth lines and very little else. According to Higgitt, this inscription is 'exceptional' (Higgitt, 128) as inscriptions on Irish crosses are usually written in half uncial lettering. Higgitt, like Leask, observes that these capitals are of the kind that occur on the Ardagh Chalice, and perhaps also in the *Lindisfarne Gospels*. Okasha and Forsyth also cite the lozenge shaped 'O' with head and foot lines as a point for comparison (Okasha and Forsyth, 295). The cross is also unusual, though not unique, in not having the inscription at the base of monument, but higher up in the middle of the shaft (Higgitt, 197). In addition to the badly deteriorated surface of the stone, the use of the decorative display script makes any attempt at reading the inscription extremely difficult. However, the decorative script does allow an argument for dating the text to between the beginning of the eighth century and the early ninth century when this decorative script was popular in the insular world. The high position of the inscription on the cross shaft rather than at the bottom of the shaft also suggests an early date: the early eighth century Kilnasaggart cross's inscription is set equally high up (Okasha and Forsyth, 296).

Duignan made concrete casts of the inscription that remain in the National Museum of Ireland. In April 2003 the project team undertook laser scanning of the cast and mould of the Toureen Peacaun inscription in the NMI. Over a period of one and half hours Thierry Daubos scanned the positive and negative casts and also the mould. The appendix contains details about the processes that

produced the scans in the form in which they are represented here. Images 3 to 6 represent the results of these scans in the NMI of the Toureen Peacaun casts and mould. Image 3 is a scan of the positive cast made by Duignan now held in the NMI. Image 4 is the same image as 3 above, but a texture displaying the minimum curvature measurements on the surface of the stone has been applied, so that all the lowest points appear in a darker shade of blue. Image 5 is an example of a three dimensional model that, when viewed on a computer screen can be tilted and turned, right and left. It can be viewed under different lighting conditions. All of these functions allow for the monument's inscription to be better understood. Image 6 is the final rendered image.

The scans generated a good point cloud dataset. The point cloud data was then processed using the Rapidform software to produce two good triangulated 3D models of the cast and mould, which were used with scans of the monument itself to create a digital version of the monument from which data was then manipulated. The resulting model is malleable through three dimensions. The legibility of the inscription has increased. This acquisition of three-dimensional datasets of the artefact records data with accuracy, enabling a thorough, scientific, factual base for rereading the inscription. This dataset also allows visualisation of the monument in a variety of colours and textures using light and contrast to enhance the inscription in the image.

My initial reading of the inscription in the field with the naked eye was extremely limited. The lichen and algae growing on the stone, together with damp conditions, obscured the lettering. It was possible to see the ruled lines

that constitute the boundary markers of the inscription and also some vertical lines, the word ‘dernad’ in line six, and the incised cross underneath the inscription. It was not possible to read anything other than that one recognisable word.

My suggested reading of the monument follows detailed study of the images produced in IDL of the inscription. While it is tempting to ‘fill in the blanks’ I have resisted the temptation of the imagination. Image 6 is the final image, the image produced after scanning and texturing was complete.

The new reading post scanning is:

Line 1 OB (P) III … A ...O I

Line 2 A V … XIII ZI N(A) I L(B) III

Line 3 … O … OO I

Line 4 D(B) I …

Line 5 BIOIRII AINOIM LAI(S)

Line 6 DERNAD OS G(L)YD(B)

… Denotes an indecipherable letter form

( ) letters within brackets offer an alternative interpretation of the preceding letter.

Line 1: The first letter of this inscription is clear. It is not a lozenge shaped O as occurs further on in the inscription, and as the ascenders turn inwards to meet the ruled lines the letter is clear. The next letter may be either a P or a B underneath the curve of the P (or the upper part of a letter B) there is an incision which may or may not be part of a letter B; judging by the image in IDL it might also be the lower part of a separate ascender, which has been water damaged. Next there are three ascenders which may be 'gated', marked by two separate sloping lines which intersect with the ascenders diagonally. These are followed by an indecipherable group of clearly marked vertical lines and two bow shapes on either side of a horizontal band that seem to mirror each other in an exaggerated H shape. The last two letters appear to be a curved O that verges on a lozenge shape; this time it has clearly marked ruling bands at its head and foot. The final letter in this line is an I.

Line 2: This line is enhanced by the processing of the image, but not to a point where any word may be clearly read. The beginning is an A followed by a V; the next section is water damaged and the next letter that appears legible is also damaged. I suggest an X slightly to the left of the midpoint of the line, followed by an ascender I, and two other ascenders. Next is a Z with a clear diagonal line between the ruling bars. This is followed by another clearly marked ascender above and to the right of which seems to be either a smaller N or perhaps an A with a squared off apex. The next letter is another ascender which may be either an I or part of the curved shape that follows it, a L in a lambda shape or part of a B perhaps. Lastly there appear to be three ascenders at the end of this line.

Line 3: Much of the centre of this line has been either obliterated or badly damaged by water. Most interesting is the pair of interlocking lozenge shaped Os that occur towards the end of the line; these are followed by a vertical which may meet a short diagonal at the top, but this is bordering a damaged section and so it is difficult to be sure.

Line 4: The opening letter of line 4 may be interpreted as either a B or a D followed by a vertical bar. The rest of the line is illegible.

Line 5: BIOIRII AINOIM LAI (S). The last letter just needs a short curved bar to meet it at the top in order for the word to read as 'Las' which would be appropriate for some suggested translations.

Line 6: DERNAD OSG(L) YD(B). Both the G form, which may also be interpreted as a sigma / lambda shape in the middle of this word, and the D at the end which may also be interpreted as a B, prevent the word being clearly read as the Anglo-Saxon recorded female name Osgyd.

Reading any inscription is problematic. However, this inscription presents particular difficulties, not just due to the stone quality and water damage, but also because of the probability that the script used by the inscriber of the monument is a de luxe uncial most commonly seen in the display capitals of luxury gospel books, and also on the Ardagh Chalice. This is most clear in lines two and five. Examples of the script such as those used on the highly decorated gospel incipits

in both the *Lindisfarne Gospels* and the *Book of Kells* suggest that the inscription would still be difficult to decipher even if it was completely legible.

The layout on the stone also makes interpretation difficult. The carver set out parallel lines as a boundary, or marker, for the lettering and at times it is difficult to decipher when a letter begins and where the ruled line ends. Consequently this reading is tentative. Features that are common to all recent readings are the identification of the lozenge shaped ◊ 'o' s throughout the inscription, and the Irish uncial script in the final line of the inscription.

Bischoff cites a number of peculiarities of Irish style, especially a peculiar stylisation of decorated capitals (Bischoff, 87), that are relevant to interpreting this inscription. This enlarged script together with decorated initials, belongs to the repertoire of decoration, and consists of letters drawn from capitals, uncial and half uncial that are, for the most part written in an angular way – or have had their form altered still more. He cites G, L, V, and ◊ the lozenge shaped 'O' between two brackets (meaning with a framing horizontal stroke at top and end of the letter), and the 'gated' M which is constructed like a gate from 3 ascenders and one or two cross strokes (Bischoff, 87). The lozenge shaped O and the gated M both occur on this cross shaft.

Another difficulty is caused by the two types of uncial used, one the angular, linear shapes of the first five lines and the other more familiar rounded type seen also in the other inscriptions at Toureen Peacaun, and in line 6. Another stone at the site, with the names CUMMENE and LADCEN inscribed on it also displays

both the rounded capital forms, and the angular form, the gated M with three ascenders. There is a clear photograph in Okasha and Forsyth (Okasha and Forsyth, 253-5) and a discussion of the two scripts (Okasha and Forsyth, 254).

Further difficulty arises with the question of language. All recent readings of the stone have noted that the word at the beginning of line 6 is in Irish, 'DERNAD'. However, there is no such certainty about the other five lines of the inscription and it has been argued that these lines are in Latin. Based on my reading of the stone it is difficult to see how this can be said with certainty.

Why the inscriber of this cross chose to organise the inscription as (s)he did is interesting and suggests a range of considerations. The familiar argument about which came first, whether decoration on metal, wood, stone or in manuscripts, is perplexing. The clear boundary lines on this monument reflect the metalwork of the Ardagh chalice. There the ruling is part of the decoration forming a horizontal band that contained the names of the apostles just under the rim of the vessel. The spaces between the letters on the chalice were pock marked so that the smooth letterforms stand out in the band. In the *Trier Gospels*, Trier Cathedral Treasury MS 61, the Matthew texts f 20r and f 21r each begin with ruled bands containing a de luxe uncial display script and f 19v has examples of a cross barred A and a lozenge shaped O. Similarly f 18v of the *Echternach Gospels*, Paris, Bibliothèque Nationale lat. 9389, has a lozenge shaped O and an A with two diagonal strokes intersecting and a 'hat' formed by a horizontal stroke at its apex. Folios 75v and 115v of the *Echternach Gospels* also have examples of two gated M letters and in the case of the 'Imago Vituli' page, a

lozenge shaped O. Many other examples on stone exist: they range from the epitaph of King Catamanus of Gwynedd (d.625) which shows a mix of half uncial with forms of A and M that reappear in Irish Northumbrian decorative capitals (Bischoff, 89) to the slabs at Hartlepool in Co Durham (Okasha "The Non-Runic Scripts of Anglo-Saxon Inscriptions", 324-5), and those at Lindisfarne (Okasha "The Non-Runic Scripts of Anglo-Saxon Inscriptions", 326-7). This monument is clearly an ambitious project with parallels within an insular monastic milieu.

Charles – Edward's argument is particularly interesting when considering the chronology of high cross production and decoration. She maintains that this cross with its mortise and tenon joint marks the crossover between woodworking and metalworking to construction in stone, and that the angular features of the inscription and the 'ruling' of the borders suggests that this cross was one of the first of its kind (Charles-Edwards, 14). The use of the angular script suggests an early date: also recent scholarship suggests alternative loci for such production beyond Lindisfarne alone (Netzer).

Henry classified the group of crosses at Ahenny, Co. Tipperary as Group 1 early Irish High Crosses, and significantly notes that similar crosses stood at Lorrha, Co. Tipperary near the north shore of Lough Derg sixty miles away (Henry, 22). She wonders why and how such similarity could have been the case: was it due to the wanderings of a sculptor? Were these representative of a type that was widespread at one time? She also recognises, 'something crisp, nearly brittle in their appearance which suggests metallic inspiration' (Henry, 22), and concludes

that ‘they may well have been imitations on a larger scale of gilt bronze objects worked in the typical ‘chip carving’ technique so common on eighth century Irish metalwork’ (Henry, 22). She concludes that analogies with metalwork and manuscripts can also help with the dating of objects, and that at times patterns are so similar as to have been probably produced by craftsmen working side by side.

The situation of these early high crosses at Ahenny in Co. Tipperary may suggest a culture of cross production in the area. When the Irish first began to replace their ecclesiastical wooden buildings with stone, they may have replaced wooden crosses with stone crosses. Writing about the possible origin of the Ahenny crosses Seaborne says, ‘It is often suggested that the prototypes … may have been wooden crosses of a similar form. Certainly it is interesting that at the base of the north cross (at Ahenny, my parenthesis) there is a carving of a figure holding a ring headed processional cross, presumably of wood’ (Seaborne, 45). Kelly also argued that early stone crosses imitated wooden crosses (Kelly, 131). Bailey lists what he describes as a series of suggestive coincidences in tracing the emergence of the cult of the cross in Anglo-Saxon stone sculpture and mentions that: ‘St. Willibrord had a miracle-working fragment of the wooden cross during his period in Ireland’ (Bailey, 50). In tracing the development of the free standing decorated cross as a part of the second phase of English sculpture, he queries whether any undecorated crosses could be assigned to an earlier period and mentions two in particular, one at Whitby and the other on St. Cuthbert’s coffin and comments that these are rare items in England: ‘in contrast to the situation in Ireland where such forms are relatively common’ (Bailey, 51).

Is it possible that this early attempt at a high cross at Toureen Peacaun was the precursor to Henry's 'Group 1' in her classification of the beginning of early Irish high cross production in Munster, perhaps at Ahenny?

As was first noted by Leask, there is another example of this de luxe script outside of a manuscript context, inscribed in metalwork, on the portable Ardagh Chalice, found eighty kilometres from the Glen of Aherlow. The similarities are immediately obvious. On the chalice the names of the apostles are inscribed in a decorative band around the cup. They are both an integral part of the visual effect of the monument, and an intriguing addition to a liturgical vessel. The angular forms and circular forms of 'O' are used; gated 'M's, ligatures, diminution of certain letters, the 'x' shaped cross bar of the capital 'A' are all also visible.

Clearly the monastic houses in the midlands required artefacts for the celebration of the office and mass, and it is possible that they were patrons commissioning work from centres of skilled production. Alternatively, perhaps there were wandering craftsmen who fulfilled this role, or there may have been workshops where manuscripts, liturgical vessels and stone sculpture were made side by side, each style influencing the other in an exuberant and often ambitious celebration (See also Mytum, 240). Styles and cultures mixed in an era of trade, conversion and community before the Viking raids. The use of so-called 'Lindisfarne' capitals on a stone cross shaft in the Glen of Aherlow is understandable in such a

context. The monastic milieu that brought vigils and dressed stone could also disseminate writing styles.

Conclusion

The laser scanning of the monument, while not offering a definitive answer to the 'riddle' of the inscription, does offer the potential for scholarly debate. The inscription is now clearly visible, and legible, if not decipherable. The first word 'DERNAD' in the final line is clearly visible in rounded uncial script. The contrast between types of lettering is interesting and echoed on the Ardagh Chalice. The opening letter on this inscription is 'O', but it is not lozenge shaped, while those 'O's on lines three and five clearly have lozenge shapes. The ruling is well measured and the layout well executed. The damage done by water from the broken crosshead can be clearly seen down through the left side of the inscription. From the scan it is now absolutely clear that the shaft is inscribed using angular shaped letters reminiscent of both the Lindisfarne Gospels and the Ardagh Chalice.

Tentatively I have concluded that the inscription is in the Irish language, with the possibility that the proper name at the end is an Anglo-Saxon name. The opening word problematises this interpretation however, as I read it as either 'OB' or 'OP'; a third Irish interpretation which would not be out of place in this context would be 'OR' an abbreviated form of OROIT meaning 'a prayer for …' or 'pray for…'. The inclusion of the proper name in line 5 roughly read as 'BIOIRII' and the word 'AINOIM' would also support this. Certainly the clearest word is the word 'DERNAD' taken with the possible 'LAS' in the

previous line it means ‘for whom it was made’. As the name OSGYD has previously been inscribed on a memorial slab it is tempting to see it again here on this slab, and certainly it would fuel the debate about the movement and development of the geometric capital letterform on these islands.

The Toureen Peacaun image remains evocative and challenging.

Chapter 2 Lismore, Co. Waterford

The second set of monuments selected for scanning by the project team was the inscribed stones set in to the west wall of St. Carthage's Cathedral in Lismore, Co. Waterford.

St. Carthage, also known as Carthagus, Carthach, and Mochuda, founded a monastery in Lismore in 636. He was born in Co. Kerry and spent over forty years of his life in the monastery he founded c. 590 at Rahan, Co. Offaly. He was expelled from Rahan, apparently as a result of his conflict with neighbouring monasteries due to his 'Romanitas', as he observed the Roman system for the calculation of Easter (Power *The Place-Names of the Decies*, 18) and (Sanderlin 27). Together with his company of monks and nuns they travelled to Lismore. Power also remarks on an implied reference in the Vita S. Carthagi that Carthage was returning to an earlier settlement at Lismore which he himself had founded on his way to Rahan years earlier (Power *Waterford and Lismore: A Compendious History of the United Dioceses*, 217).

St. Carthage died shortly after arriving in Lismore, not later than 638. The monastery he founded became a great centre for learning, with scholars and clerics coming from Ireland and abroad to study there. It was a centre of book production (Sanderlin 28) and had links with the strict, ascetic Céle Dé movement. The Betha Mochuda, Brussels Bibliothèque Royale MS 2324, 4v reveals that: 'Ar do-ridh nacht Día dó gach fert no bhennaighfedh coná téisedh ifearnach inn…' ' God had granted that no one would be damned from any grave that Mochuda had blessed (Power *Waterford and Lismore: A Compendious History of the United Dioceses*, 182)'. This is of course a standard statement

used by hagiographers as a method of encouraging burial in their monasteries, as this was a source of income. It is interesting nonetheless that five of the six stones found during the excavations for the building of a new tower at St. Carthage's Cathedral in 1827 are memorial slabs. The sixth stone to be discussed is of particular interest as a scanned model. It is a figure holding an open book on which a sadly deteriorated text is inscribed. Okasha and Forsyth have documented formerly ignored material detailing the ill-defined journey of these stones from their find spots to their present setting in the nave (Okasha and Forsyth, 333-34)

Later in its history it is evident that Lismore became a place of pilgrimage for 'religious from other parts of Ireland' (Thornton, 10) by the end of the eleventh century. Lismore remained a significant ecclesiastical centre into the twelfth century despite having suffered Viking raids. It was granted diocesan status after the Synod of Ráith Bressail in 1111.

Site

The west wall of the cathedral is now cordoned off from the public. When we visited the site the public were not allowed within three metres of the spire either inside or outside the cathedral. Remedial work was being undertaken in the cathedral grounds to ameliorate structural problems. The wall in which the stones are set is extremely damp. Two of the slabs are wet and green with algae even though they are indoors. The wall is also white with inch deep fungus due to the damp conditions (image 7).

Scanning

The scanning took only one hour to complete. The indoor conditions, good indirect light, and the predominantly flat surfaces of the stones embedded in the nave wall meant that the scanning process was much easier than scanning a three-dimensional object outdoors. As the stones are now set into the wall it is impossible to scan the back of the stones: complete models unfortunately cannot be constructed. The lettering on the memorial slabs was immediately legible and the crosses inscribed on the slabs were clearly visible. The ring on the small crosshead was also apparent. The only inscription not visible to the naked eye is the inscription on the pages of the opened book held by the Romanesque architectural figure; this interesting sculpture provides the main focus for analysis in this chapter.

Inscriptions

Image 8 relates to one aspect of the small crosshead. Unlike the previous images from Toureen Peacaun, this image is shown with a green, shiny surface. We noted that this choice of both colour and texture enhance the legibility of the surfaces. The reflective quality of the 'shininess' parameter chosen as a surface within the software allows a light to be shone at given angles on the model thus improving one's ability to read the script.

The crosshead is fixed to the wall of the cathedral by a metal bracket thus enabling both sides of the cross head to be viewed in turn. Initially we feared that this metal fixing would interfere with the scan, but this was not the case and

a perfect model resulted. I concur with previous readings from Okasha and Forsyth:

[Ō]R· DO CŌR

MAC · P

Pray for Cormac, *presbyter*

Or

A prayer for Cormac, *presbyter*

I think that the ligatured P appears particularly well in the model and I would agree with the possibility that it is an abbreviation for *presbyter*, which is a title that means 'priest'. Given the layout on the crosshead itself I think it doubtful that it represents the beginning of another word or that there could be another line of text on this monument. Okasha and Forsyth discuss Lindsay's suggestion of the *p* being an abbreviation for *pro* and Macalister's suggestion that it is an abbreviated form of *p(res)b(yte)r* (Okasha and Forsyth, 345-6).

Image 9 is another untextured image of an inscribed slab with a linear Latin cross with expanded terminals. Pixels from a photograph of the original slab in the wall have not been fixed to this model; it too is rendered in a green colour. It clearly reads:

BENDACHT

FOR AN

MARTAN

A blessing on the soul of Martan

This agrees with other readings of the slab.

The shaft of the cross provides a visual break between the two words FOR and the abbreviated ANMAIN. The linear Latin cross around which the text is inscribed seems either to be on a stand, or alternatively is double barred. This representation of the cross is similar to that on the Kilnasaggart inscribed pillar. If it is a double barred cross it suggests a representation of the 'true cross', relics of which are recorded in Ireland from the ninth century (Ó Floinn 37). Earlier representations do exist, most famous of which is the double barred cross carpet page from the *Book of Durrow* f 1v.

Image 10 models the slab depicting an outline Latin cross on a base. The half uncial inscription here reads:

ŌR DO DONN

CHAD

Pray for Donnchad

Or

A prayer for Donnchad

This slab has a similar formula to the other slabs one that exhorts the onlooker to pray for the person named. There is also a later inscription which has one letter D and C on either side of the upper cross shaft. A lot of pitting and deterioration is clearly visible on this model. The later D and C suggest that the stone was reused and exposed to the elements. This could perhaps explain the difference between this and the smoother surfaces of some of the other models.

Image 11 is a deliberately included image of an inaccurate scan. If a direct comparison is made between the scanned image and the photograph below, it is

clear that the scan has missed a large section of the central portion of the inscription. The ringed cross with expanded terminals is clearly visible, but many letters of the half uncial inscription are obliterated by a wavy series of lines across the model. This corresponds to an area where an inexperienced hand operated the scanner and took the sweep of this part of the slab too quickly. Such an error is not always immediately apparent during the scanning process, as one may think that there are sufficient sweeps from other angles to make up for this lack. Clearly in this case this is not so, and the model is incomplete.



The text SUIBNE · M · CONCUIDIR is visible from the photograph. This is a personal name with an abbreviation which is separated by two punctuation marks. The ‘m’ corresponds to the word ‘mac’ which means son. In

this case the inscription reads Suibne son of Concuidir. Again this reading confirms earlier readings.

The next image 12 depicts an inscribed slab with an outline ringed cross with expanded terminals. The terminals are not expanded uniformly. The uppermost terminal is clearly divided into two separate serifs or leaves, the left and right terminals mirror each other with their divided spatulated ends. The lowest expansion could possibly be, as described in Okasha and Forsyth, 'an internally divided wedge shape' (Okasha and Forsyth, 34). An argument that this shape represents the top of a stand, or that there is further decoration beneath is possible when one examines the model.

The upper part of this slab has suffered deterioration. This is clearly visible on the model where the undulations in the stone show clearly on the green surface. The half uncial text remains legible:

BENDA

CHT FOR

ANMAIN

COLGEN

A blessing on the soul of Colgen.

On this slab there is no AN abbreviation for anmain and the word is written out in full. Again the reading produced by scanning corresponds with and confirms previous readings of the slab.

These five stones are beautiful examples of half uncial epigraphy and also display a fine range of cross types. It is sad to see them and the cathedral in which they are set in such a hazardous position.

The early Romanesque architectural figure holding an opened book posed most interesting difficulties for scanning and processing purposes. Unlike the other slabs set in the west wall at Lismore which had flatter surfaces, this figure proffers a realistic opened book. It is not a flat surface. The book that the figure is holding in its hand is inscribed with a badly deteriorated text, and furthermore, as this sculpture is in relief, the book is not flat but angled slightly at the spine in an authentic representation of an opened bifolium. Consequently, this interesting sculpture provides the main focus for analysis in this chapter.

Westropp, noting the figure in 1897, thought that it was St. John by deciphering the inscription on the open pages of the book as:

Erat verbum

'Was the Word'

from the incipit to the gospel of St. John (357-8).

Henry in 1937 commented that: ' …on the photograph, there seems to be an inscription on the open pages of the book I could see no trace of it on the carving itself' (Henry, 307).

Macalister in 1938 however was able to discern a full phrase, which he read as:

in me(n)sam domini ierusalem det arma et coronas aur(i)

This he translated as: “Upon the table of the Lord let Jerusalem lay (her) arms and crowns of gold” (300).

Okasha and Forsyth identified the text thus:

- || -

[.NN..] || [.RUSAU]

[…….] || [.UM -]

[P.NN..] || [.URN.]

and they remark that: ‘It is not clear whether the text read across the two pages or down each page in turn, nor is it even certain what language the text was in. In these circumstances the text is not now recoverable’ (Okasha and Forsyth, 348)

Image 13 is an untextured model of an ecclesiastic/ Christ figure holding an opened, inscribed book. This image has also been rendered in the choice of green and shiny colours and texture. It is an arresting image and it is difficult to see how Henry could have missed the text. This is an advantage of the scanning process. The Rapidform software allows the user to pick from a number of colours and textures. It also allows the user to fix a parameter that relates to the ‘shine’ on the model. Light from different angles is used to enhance the legibility of the texts. The angle of the light may be fixed at any interval, so that one can artificially create the effect of raking light, direct sunlight, and varying degrees of shade on a model. The efficacy of these effects is most clearly shown in the animated video sequence of the model where the text is deteriorated. This is available on the CD as image Lismore13_1.

Image 14 is a 3D still captured from the Rapidform software that shows stages in the decision making process. Many sweeps of this model were taken. Some were better than others, so some were kept for use in the final model. In this image each sweep has a corresponding colour. This allows the operator to decide between sweeps and also to see clearly how the sweeps build and interconnect to form the model. Once a sweep has been decided upon as being the best possible for an area of the model it is then fixed into place and the operator moves on to choose the next best sweep for the next section of the model. The fixed sweeps are clearly marked here by the overlapping grey boxes that intersect and overlap throughout the model.

Image 15 allows a clearer vision of the emerging model without the graph lines. Image 16 shows the image having been textured using a photograph of the original figure as a source for colour and shade gradation. It can be seen that this texture is not the best possible one for deciphering the inscription. It is realistic, and an accurate model of what is now in the west wall. However, it was necessary to break down the process further in order to attempt to decipher the inscription.

We decided to 'cut' the inscription away from the rest of the figure. Appendix image 17 shows a close up of the inscription in IDL that clearly illustrates the height fluctuation. When the wavelet filtering has been applied at images 18 – 21 it is possible to begin to see more of the inscription than is now visible to the

naked eye. However the difficulties already mentioned by Okasha and Forsyth relating to language and organisation of text on the page still prevail.

My reading of the inscription:

IUNC IxI l – C

NIINC SU – U

IV O - - NNA - - I S

I I I N I I I I-I a Y

I make two assumptions in an attempt to recover this inscription. The first that the language is Latin, at least in places, and that the text is to be read across the two pages of the opened book.

Line 1: The first letter or part of a letter is an ascender, a clear vertical line. The second letter is an uncial 'U', with a curving bow. The third letter seems to be ligatured to the fourth. I suggest that the first element of the letterform is an ascender which is linked to the curved bow of the final letter on this section of the page, 'C'. The 'N' has an x-shaped cross bar tying it to the 'C'. This is echoed in the first letter of the next page; two ascenders are joined by another x-shaped cross bar. This may form an 'A' or 'N'. The next ascender has a curved end, then there is a small break, and then a final 'C'.

Line 2: There are six ascenders in a row in the first word of this line. I think that the first two ascenders, and the last two of the six, are joined by

diagonal lines to form two ‘N’ letters. The intervening two ascenders do not seem to be joined. I read the final letter as a smaller ‘C’ than that on the first line. Continuing onto the second page the next letter extends beyond the perceived line of the text down into the line below it in a sweeping curved shape. This could be either an ‘S’ or a ‘G’ it is followed by a curved ‘U’; then there is a break and the line finishes with another ‘U’.

Line 3: The first letter is very unclear. It seems to be a diagonal ‘D’, made with straight diagonal lines rather than having a curving bow, the diagonal of which extends. There is a break. The second visible letter is a rounded ‘O’ shape, and the third is another ‘N’ this time curved rather than angular. On the next page there are four ascenders joined to form two ‘N’s. The next letter is an angular ‘A’. It is followed by two curved shapes that are not readily identifiable as any particular letter, followed by a single ascender. The final letter is an ‘S’ formed on a sigma / lambda diagonal.

Line 4: The letters begin with three vertical strokes. The next letter is ‘N’ followed by another single vertical line. The next page begins with another three vertical strokes, the third of which may be joined to a fourth ascender by a horizontal line. The next letter is an ‘A’ followed by a final ‘Y’.

A close comparison between my analysis and that of Okasha and Forsyth reveals many similarities, particularly on a reading of the ascenders, the number of which is almost identical in both readings. The ‘S’ in the second line reflects readings by others and suggests a reason behind Macalister’s ‘ierusalem’. I

agree that the inscription in its present form is not readily recoverable, but the possibility remains that the images could prompt a reader to remember or suggest a phrase.

Testing the possibility that the first word at the top left of the inscription reads TUNC, NUNC or HUNC I conducted a detailed search of the hypertext of the Vulgate both Old and New Testaments("Vulgate Bible Search"). This search yielded nothing that could offer an adequate reconstruction of the inscription.

I think that it is clear that here the software has allowed a better reading of the text than previously existed. Also we have developed a method for the interrogation of such difficult inscriptions that allows for further scholarship and debate.

Other recent scholarship considering the development of early Irish examples of Romanesque sculpture and architecture has examined Lismore's sculpture fragments and the Romanesque arch now at Lismore castle which once was part of the ecclesiastical site. Tadhg O Keeffe has proposed that the examples of the Romanesque at Lismore provide vital chronological clues to the overall development of the style in Ireland(O'Keeffe, 119). The bishop of Waterford-Lismore, Malchus, later became bishop at Cashel. O Keeffe, in looking at the examples at Lismore, points to a possible parallel for the architectural figure from the continent. Regensburg (Ratisbon) was in close contact with Cashel during this period (O'Keeffe, 139-40), and O Keeffe has suggested that the Lismore figure is a seated Christ figure as is seen at St. Emmeram's in

Regensburg (O'Keeffe, 121). Images of this figure are at (Hearn) pages 56 and 57.

The Regensburg relief is one metre high, while the Lismore figure is 55 cm in height and provides interesting parallels for our figure. The folds and draping over the knees to suggest a seated figure are particularly interesting, as these are also suggested on the Lismore figure.

The hand holding the book open together with the depiction of the facial hair are also both interesting parallels for the Lismore figure. Certainly the image of Christ in Majesty, the Maiestas, is well attested in manuscript sources, but what is interesting here is the similarity of these architectural styles. Hearn notes that during the Carolingian renovatio Christ is depicted in architectural spaces in France (Hearn 27-29) , but there are no examples known in Ireland.

From an Irish perspective it is also interesting to note the measures which the authorities at Regensburg have undertaken in order to protect their Romanesque architectural heritage. They make use of curtain-walling to simultaneously preserve and display the monument while maintaining access. See: http://europeforvisitors.com/europe/galleries/germany/photos/regensburg_jakobskirche_portal_through_glass_p1020857.jpg .

The arch is entirely enclosed behind glass curtain-walling. It is still clearly visible and accessible to visitors, but it is protected from the weather and other environmental pollution. Given the state of Hiberno-Romanesque arches such as

that at Freshford, Co. Kilkenny, and particularly the sadly deteriorated one at St. Cronan's in Roscrea, it seems a matter of urgency that if such conservation measures are not to be enacted here, then a detailed record of the arches be compiled so that accurate models can be created for education and heritage purposes.

Conclusion

The laser technology has contributed accurate digital models as records of the stone slabs at Lismore. In particular the technology has improved the legibility of the inscription on the opened pages of the book held by the figure. In this particular case the synthetic video sequence, a product of the separate processes offered by the software, offers a better possibility of deciphering the inscription than any previously available. Ultimately one hopes that the availability of such an image will stimulate debate, educate, and provide a model for preservation and conservation purposes.

Chapter 3 Monaincha, Co. Tipperary

The third site which was chosen for scanning was Monaincha, Co. Tipperary. The ruined remains of the church at Monaincha, Co. Tipperary, have been recorded as a place of retreat since the seventh century. It has been associated with saints Canice of Aghaboe and also Crónán of Roscrea. There is a reference too in the *Annals of Ulster* for the year 806 that reads: 'Elarius, ancorita 7 scriba Locha Cre, dormiuit';' In this year Elarius, anchorite and scribe of Loch Cré fell asleep.' More recently, in November 2000, vespers were sung at Monaincha led by the local bishop to mark the millennium (Cunningham, 16). Monaincha was once one of two islands in a bog, which is now drained as Ledwich's early drawing confirms. Of the two islands only one remains.

Site

Today Monaincha is an arresting site. The enclosure as it now stands is elevated and striking. It is marked on its south-western edge by two huge beech trees, which lean away from the remaining structure. The site is well kept and far from traffic. The enclosure is at the east of the original settlement and comprises a low stone wall which marks out the twelfth-century church and its later addition of a sacristy. There is a twelfth-century high cross at the western end of the site. This is situated just beyond the doorway in the west gable which is framed by the focus of this chapter, the inscribed Hiberno-Romanesque arch.

Inscription

Ledwich was the first to record the site at Monaincha (image 30) in his *Antiquities of Ireland* published in 1790 but, although he drew the arch and gave a detailed history of the foundation (Ledwich, 63-74), he did not give a transliteration of the inscription (image 31): '…I have been favoured with some antient inscriptions, which I shall not transcribe, as they do not at present appear, nor am I certain of their authenticity…' (Ledwich, 73)

It was not until Petrie that the first transliteration was recorded. He read the inscription as:

OR DO C … CS

Pray for C … CS

Or

A prayer for C…CS

Petrie notes: ' for two feet eight inches the stone is weathered and broken away, then the letters CS are legible, after which the stone for one foot three inches is so worn away as to leave no certain trace of the letters' (Petrie, 35).

Leask (Leask, 131) records the text as:

or do t …

Just as Petrie did, Leask reads the opening as ' Or do …' 'pray for…', or ' a prayer for…' but he differs from Petrie in reading the first letter of the name of the person to be prayed for as T rather than C.

Stout in 1984 records: ‘On the south side of the doorway there is an inscription OR DO T … and OF’ (Stout, 92).

Stout, like Petrie thought that there was a further inscription closer to the base of the three-sided pilaster (see: image 34). She reads this as ‘OF’; previously Petrie had read it as CS.

Okasha and Forsyth (Okasha and Forsyth, 207) reiterate Leask’s reading and the first element of Stout’s reading: ‘ The text on the top stone reads *o r do* [t] … The fifth letter is probably T or, less likely, C. Ledwich’s drawing suggests that the text could have begun *or do c-* or *or do t-* ’. (Ledwich, pl. V)

My reading of the digital model echoes that of Leask.

OR DO T…

A prayer for T …

Or

Pray for T …

where T indicates the first letter of a proper name. In the greyscale model of the inscribed fifth letter, I think the debate about whether this letter represents a C or a T is put to rest. A horizontal stroke is clearly visible over the curve (image 34). Unfortunately, due to further damage since Stout’s survey in 1984, we were unable to retrieve any other parts of the inscription from further down the pilaster. It is clear that since 1984, when Stout was able to read more letters of the inscription further down the pilaster, that further damage has taken place. The remote location of this site has not been sufficient protection in this case. I

agree with Okasha and Forsyth's interpretation that the legible part of the inscription now ends at the T.

All commentators agree on the opening letters of this inscription, and we have already seen what they mean at Lismore. 'Or do … ' is an abbreviation for 'Oroit do …' which means 'a prayer for …' or 'pray for …' with a person's name to be inserted thereafter. In the other nearby inscribed Romanesque arches which have survived, the inscription usually requests a prayer for the benefactor and / or the craftsman. This arch is one of a group of inscribed arches that stretch across the midlands: Killeshin, in Co. Laois (images 22 - 24), Freshford, Co. Kilkenny (images 25 - 26), and Monaincha, Co. Tipperary (images 30 – 33). Fionnbarr Moore also made a recent discovery at Ardfert, Co. Kerry where an inscribed voussoir has been discovered in Templenahoe (images 27 – 29) (Okasha and Forsyth, 133).

Petrie read the inscription at Killeshin (images 23 and 24) as:

[OR DO] ART […RIG] LAGEN … ACUS DO … ON… AERCINN[E]CH … CH..

OR DO … LENA …UAMEL …DUAGH ..

+ OR DO CELLAC AMI

or

Pray for Art (king) of Leinster and for … steward

Pray for …lena descendant of Mel … Duach

+ Pray for Cellac ami… (Petrie, 85-86).

This is a very long inscription asking for prayers for the king (the patron?) and also, later in the inscription for other perhaps less exalted persons who may have been local secular or religious leaders, or perhaps the inscriber or builder of the monument. *The Stone Decay Study* (Pavia and Bolton) mentions this particular arch at Killeshin as being under threat, even though it is situated away from an urban area in a rural location on a hill above the main road on a by-road leading uphill and away from the village. For close-up photographs of the inscription on the arch see images 23 and 24. It provides us with a useful parallel for Monaincha as the inscription as it is designed is integral to the arch, as the one at Monaincha presumably was also.

The inscription at St. Lachtain's in Freshford (image 25 and close-up 26) is recorded by Petrie as:

OR DO GILLEMOCHOLMÓC [U] CE[NN]CUCAIN DORIGNI
OR DO NEIM I[N]GIN CUIRC ACUS DO MATHGAMAIN
[…U] CHIARMEIC LAS IN DERNAD IN TEMPULSA

Pray for Gilla Mocholmóc (descendant of) Cenncucan, who made [this]
Pray for Niam, daughter of Corc, and for Mathgamain, descendant of Ciamac by whom this temple was built (Petrie 89).

The Heritage Council report on St. Lachtain's in 2004 recommended urgent action to record the arch. It is situated almost directly on the main road and at a busy junction (Quinlan and Foley, 36).

The recently discovered reused inscribed voussoir at Templenahoe in Ardfert (image 27) also has a name inscribed on it. This building has been dated to 'before 1190' as it was built during the time of Bishop O' Conarchy (CISP, Ardfert) who died in 1193. The inscription is found reused on the inside of the building (image 30 and close-up image 31).

Okasha and Forsyth read the Ardfert inscription as:

[--U]A F(H)OGAR[TACH] [--

Again this is a personal name, UA denotes 'descendant of' in Irish and Fhógar[tach] is an Irish name.

Having considered these other arches it is possible then to suggest that the name beginning with 'T' that followed the 'oroit do' exhortation was either the local patron of the building, or the person who built it.

Scanning

The decision to scan the inscribed Hiberno-Romanesque arch at Monaincha in Co. Tipperary was the most ambitious test of the hand-held scanner undertaken by the project. The scale of the monument, the situation of the monument, and the three dimensional nature of the sculpture in relief within the arch, all combined to make this the most challenging of the inscribed stones for all aspects of the technology.

If we had simply scanned the inscription on the pilaster of the southern jamb of the arch the model would have been complete within twenty-four hours. However, the decision was taken to scan the decorated orders of the arch in their

entirety with their outer pilasters and this meant that the scanning took over four days and four separate visits to complete.

The second arch ring proved most intricate and complex. It is difficult to reach as it is between the first and third rings, and the decoration of chevron and roll moulding outlined with pellets was extremely difficult to scan from all angles in order to perfect the model. Unlike the scanning of a two-dimensional image, the laser light had to reach the back of the mouldings, which was a difficult task given the structure of the arch itself. Image 36 shows the amount of registered sweeps generated in order to attempt a model. This image reflects only the registered sweeps; many more sweeps were attempted before these were finally decided upon.

Subsequently, the file sizes that were generated by the initial field scans were the largest of any of the inscribed stones scanned so far. This meant that work was extremely slow, as we had to wait for the laptop to process elements of the images as they were scanned. We needed to wait in order to ensure that we were getting all aspects of the decoration within the orders of the arch. This proved very difficult due to a number of factors.

Unlike an inscription, the decorative elements within the orders of the arch are almost identical and repetitive. Chevrons visualised through the malleable three dimensions of the software look very alike. Due to the slowness of the laptop because of the processing of the large file sizes, Dr. Daubos elected to do smaller scans of the surface area, but more of them, to create a patchwork of scans but

using smaller sweeps (image 36). The repeating pattern made this very time consuming. On one occasion missing a section of the arch necessitated a return trip to scan again. This difficulty was exacerbated further by the tendency of the laptop to crash repeatedly when dealing with the large file sizes. Later, off site and during the processing of the collected data, there were also repeated crashes. Dr. Daubos has subsequently concluded that this was due to the software itself rather than the use of the laptop in the field with its smaller capacity, and he has increased the capacity of the processor and the memory of the computer to alleviate this problem.

Other factors also meant that this monument posed challenges for data capture. As at Toureen Peacaun this monument is in situ in the open air. The twelfth century church is now situated on an elevated exposed site in the middle of a large field. On one occasion we scanned through a hailstorm. The scanner proved itself weather proof at Monaincha. It scanned in wet, cold, damp and frosty conditions.

Conclusion

The resulting image of the arch (image 35) with its inscription on the southern pilaster is an example of what may be achieved throughout Ireland with this laser scanner. The data capture was achieved in all weather conditions, far from mains power sources. It is a complete digital replica of the arch in situ, from which a model of any size may be generated with sub millimetre accuracy.

The evident damage since 1984 and the resultant loss is yet another example of the potential for this technology as a method of recording and preserving in an accessible way monuments such as these. The recent heritage council study of St. Lachtain's church in Freshford, Co. Kilkenny noted that the arch was '…exposed to continuous risk from, vibration, air borne pollutants and accidental impact, all arising from its proximity to the road' (Quinlan and Foley, 36). The authors produced a policy document as part of their report in order to 'halt the deterioration of fabric and prevent further deterioration by putting in place a range of conservation measures to retain material integrity'(Quinlan and Foley, 42).

Amongst other suggestions they recommend:

> The construction of a full-scale model of the porch as a replica before further deterioration takes place. The replica should be installed in the annexe where it should form part of the interpretative material provided (Quinlan and Foley, 42)

Amongst other places, the deterioration due to pollution of the arch at St. Crónán's in Roscrea is a startling reminder of the fragility of these monuments.

The arch at Monaincha is much more complex a monument than either of those at Freshford and Killeshin. The high relief found at Monaincha is not present in the arch at Freshford. This method could clearly be used as an accurate, non-invasive method of recording and preserving such structures. The scanning methodology enables a range of outcomes from large-scale replicas, to three-dimensional CD production, or simply a link on a web page.

Chapter 4 Tullylease, Co. Cork

The fourth site to be scanned was Tullylease in Co. Cork. The ruined old church marks the ecclesiastic enclosure in the village of Tullylease in North Cork. There are also two holy wells dedicated to St. Berichter within the enclosure and a structure known as St. Berichter's house. The recent report of the Archaeological Survey of North Cork yielded sixteen worked stone pieces of Early Christian date that were either still at the site or were at one time recorded at the site. Some pieces remain at the site, some are at the National Museum of Ireland, and some are now lost.

The obvious reason for choosing Tullylease was to take the opportunity to scan and create an accurate digital record of 'St. Berichter's Stone', which is now set into the south wall of the church, exposed to the elements, and to pilgrims' rubbings. It is a custom that pilgrims to such sites rub or touch the stone as part of their devotion; pilgrims also use stones at the site to make or scrape drawings of a cross.

Site

St. Berichter's Stone has a little wooden canopy overhead to offer some protection from the rain. Beneath this stone there is a recess in the south wall of the church into which have been set three stone slabs and a bullaun stone that was previously used as a holy water font in the old church. Fixed to the east wall of the church is the stone first recorded by Henderson and Okasha in 1992, when

it had been reused as a grave marker in the churchyard. In their 1997 addendum to the 1992 work, both writers re-examined this slab as it had been disinterred and now presented an incised figure as well as the seven-petalled marigold (images 46-47). From the photograph, image 46, the marigold and the figure are both clearly visible. On the day the project scanned the monument a naked eye examination of the marigold stone, now newly set into the east wall of the church, revealed almost no trace of this figure, except for the fingers of the left hand.

Scanning

The scanning took place on a dull day, and did not take long to complete. The predominantly flat surface of St. Berichter's stone meant the data capture was straightforward. The recessed wall press presented surprisingly few difficulties as the light from the laser was able to penetrate to the back of the recess. This ease of scanning was also facilitated by the lack of deep relief on the stone slabs. The fragments / slabs within the recess in the south wall all measure roughly 51 cm in height by 24 cm in width: it is now almost impossible to determine their edges as they are set into the wall. All the slabs depict crosses or parts of crosses (images 39-42). The dimensions of this wall press meant that we were scanning in a limited space, and this presented another challenge for the technology. The metal clamps holding the 'marigold' slab to the east wall were a cause for concern, as the metal could have presented a difficulty for the magnetic triangulation of the point cloud dataset. In this case there was no difficulty caused by the metal, as there was not sufficient metal present to interfere with the magnetic field.

St. Berichter's Stone Inscription

Of the stones at this site one in particular has become called 'St. Berichter's Stone' and has long been associated with f. 26 v of the *Book of Lindisfarne* (image 38). This stone, since Reeves' report of 1858, has received a tremendous amount of scholarly attention (comprehensive bibliography at(Okasha and Forsyth, 122)). Notwithstanding the merits of the inscribed stone, this has perhaps been to the detriment of the site as a whole: many stones once recorded are now missing. However recent finds suggest new material is still to be uncovered within the ecclesiastical enclosure.

There are two texts on this stone; the first is inscribed in half-uncial script high up on the right hand corner of the slab.

It reads:

xps

with a length mark above the p – this is the received Greek abbreviation for Christus. Unfortunately the top left hand corner of the slab has broken off. There is much speculation as to the possibility of a corresponding *ihs* on the top left hand corner of the slab, and it must remain just that.

The second text written in insular majuscule is:

qui cum quæ hunc titulu

legerit orat pro

berechtuine

which means:

whoever will have read this inscription let / may he or she pray for Berechtuine

The inscription is legible and there is agreement amongst scholars as to its letter-forms and meaning. This happy state notwithstanding, the enigma posed by the occurrence of an Anglo-Saxon name Beorhtwine on a highly decorated slab in north Cork has encouraged much speculation. Bede's reference in his *Historia Ecclesiastica* III 27 to the quantity of the English race who had come to study in Ireland is just one indication of what Dáibhí Ó Cróinín has called 'early Anglo-Irish relations' (Ó Cróinín, 16). This enigma has been further compounded by the difficulty in the annals of definitively identifying any one name that could be the Beorhtwine of the inscription, and also the possibility that various annalistic references to 'Tulach Leis' and 'na Saxan' might also be Tysaxon or Tullylish and refer to either settlements in Co. Mayo or Co. Down respectively. It seems that the Berichtir of Tulach-Leis who in the *Annals of the Four Masters* died on Dec. 6th 839AD ' 7 Berichtir Tulca leis décc 6 December' (460-461) has been long associated with the community at Tullylease and that the name on the stone over time may mistakenly have become associated with him (Henderson and Okasha "The Early Christian Inscribed and Carved Stones of Tullylease, Co. Cork. Addendum", 22). Further work remains to be done on both the personal names and the place name.

A recent example of such eliding of names at Tullylease is given by Grove – White writing about St. Berichter's name in 1920. He remarked: ' for among the peasantry who annually throng from all parts of Limerick and Cork to attend his 'pattern' at Tullylease, he became (and continues) known as St. Benjamin'(267).

Grove –White also notes that many children in the area at that time were named Benjamin.

The formula used is not usual on either Irish or Anglo-Saxon stones, but a similar formula is found in two gospel colophons, one in the Macregol Gospels f 169v and the other in the Paris Psalter (Henderson and Okasha "The Early Christian Inscribed and Carved Stones of Tullylease, Co. Cork. Addendum", 9).

Macregol. Dipincxit hoc euangelium. Quicumque. Legerit et intellegerit istam narrationem orat pro macreguil scriptori.

Macregol. Illuminated this gospel. Whoever reads and understands this narrative pray for Macregol scribe.

And the Paris psalter (f 186r):

Quicumque legerit scriptum. Anime sue expetiat uotum.

Whoever reads this literary work his soul (would) expect a prayer.

Two Welsh stones have also been identified with a similar formula, 'Eliseg's Pillar, a fragment of the inscription reads:

[+ Q]uic[umque re]citat manescrip[tu]m [det bene]dictionem super [animam Eliseg +]

Whoever reads this writing give a blessing on the soul of Eliseg +.

(CISP, http://www.ucl.ac.uk/archaeology/cisp/database/stone/ltysl_1.html).(Forsyth)

The formula is also seen on a stone from Llanwnnws (Henderson and Okasha "The Early Christian Inscribed and Carved Stones of Tullylease, Co. Cork"):

[IHS] CHRISTUS Q[U]ICUNQ[UE] EXPLICAU[ER]IT H[OC] NO[MEN] DET BENEDIXIONEM PRO ANIMA HIROIDIL FILIUS CAROTINN

(The cross of) [Jesus] Christ whoever understands / reads this name give a blessing for the soul of Carotinn son of Hiroidil. (Expansion and translation taken from CISP at http://www.ucl.ac.uk/archaeology/cisp/database/site/lwnnw.html).

Most interesting is the distinctly Irish use of word spacing between all of the words which would be less usual in an Anglo-Saxon context at this date.

Decoration

In their 1992 article Henderson and Okasha sought to free this stone from its long association with Lindisfarne f 26v. The main points of comparison remain that the Greek cross has u-shaped expansions, fits a rectangular frame and has rivets at three central points along its vertical axis. The decoration on the stone however also has four circular disks in each quadrant of the cross. The stone has the two inscriptions one at the top of the slab in Greek and the other in Latin in the lower half of the slab with the exhortation to pray. Whether or not the makers of the monument knew that 'xps' was Christ in Greek is a topic for debate. There are many other stones with this formula: the aforementioned stone at Llanwnnws and another at St. David's Cathedral, the Gurmarc stone amongst others. It is possible that the mason used the letters as symbols, just as alpha and omega were used. Certainly an educated monastic audience would appreciate their meaning, but perhaps not everyone in the congregation would have understood the concept of the 'holy name' in Greek.

The stone also has spiral terminals coming from the ends of the u-shaped expansions; these are not present on the manuscript page. Slabs at Lindisfarne, Hartlepool, and Clonmacnoise also display similar attributes(Okasha "Name-Stones" 548-51); they have u-shaped terminals, inscriptions, and expand to fill a framed rectangular space.

Yet, both the stone and f26v are designed on the diagonal, and Bruce-Mitford has shown how the stepped patterns were constructed using a diagonal grid across the surface of the stone or page. Although the manuscript does not have spirals extending from either side of the terminals, it instead has interlace expanding into the frame at the midpoints of each side of the frame, and the interlace background of the carpet page also suggests spiral forms. Rather than making a direct comparison with Lindisfarne, Henderson and Okasha suggest instead another connection with a shared model, perhaps either Echternach or Augsburg, where the fret patterns, arrows and t-shapes of those manuscripts reflect the design on this cross more closely (Henderson and Okasha "The Early Christian Inscribed and Carved Stones of Tullylease, Co. Cork", 24)

Another possibility is posited by the work of Edwards (Edwards) who has also written convincingly on the emergence of step patterns from metalwork sources. When discussing the step pattern on the Bealin cross she suggests an origin in metalwork:

> where the lines of the step pattern have first been cut out of the wood and then silver hammered into them so that it protrudes giving a contrast

> between the shining silver and the dark wood…step patterns have also been found on the Ossory crosses (Edwards 1983b,19-20) but are most characteristic of those at Kilree and Killamery (Edwards 1990, 47-9).

Perhaps a portable object such as processional wooden cross, or a metal cross, served as an intermediary for the combination and assimilation of these design ideas.

The stone is interesting in the context of early Anglo-Irish relations. An Anglo-Saxon name is inscribed on a stone slab in Ireland; it has Irish word spacing and relationships with work in other media, including manuscript and stone. Richard Bailey has argued for the possibility of a Merovingian background for material similar to this stone. He acknowledges that this type of sculpture:

> (slabs) which are carefully shaped and carry incised and relief crosses (of varying complexity) and inscriptions … has often been assumed to be of Irish derivation … but there is no convincing evidence to show that Ireland was familiar with the form before it appeared in Anglo-Saxon England…it is intriguing to note that the form is limited to sites, three of whose foundation dates are known to be pre 674 (1996, 40).

Leask called this slab a precocious slab, a slab that, aside from its association with f26v of the Book of Lindisfarne, offers many possibilities for interpretation to the historian, art historian and archaeologist.

Scanning

Stone slabs in recess of south wall

In the general view of the south wall (image 37) and the close up of the wall press (image 39) the challenge of the location for scanning purposes is clear. The manoeuvrability of the hand-held wand proved extremely effective in reaching the spaces at the back of the recess, and in the ability to scan them from more than one angle – which is necessary for an accurate model. There is a tremendous difference in clarity between the photographs taken with the ordinary digital camera, images 39, 40, 41 and 42, in comparison with the digital models, images 48, 49, 50 and 51. In the models, the decoration is clearly visible and lines are sharp and well defined.

Decoration

East wall slab

This slab is a fragment of a larger slab showing what appears to be a cross arm filled with four-strand plaitwork. Crosses filled with interlace are not uncommon in visual art. The project also scanned two upright cross slabs bearing interlace, one at Fahan and another at Carndonagh. On the seven-petalled marigold slab in Carndonagh the interlace formed part of the shafts of two crosses, linking both. The Tullylease slab appears to have been cut down from a larger slab. It does not have a frame.

South wall slab

This slab is a simple cross with a lozenge at the intersection of the cross arms and with the terminals expanded into triangular shapes to meet the rectangular frame.

West wall slab

This slab also has a rectangular frame. It seems as though the base of this cross at the back of the recess may have been curved, although the slab is now too damaged to be sure of this. The cross has rectangular shaped expansions, a square at its centre and a well-worked frame. The skill of the craftsman is still visible in the (now) upper part of the stone at the intersection of the cross arms where there is a delicate framing detail at the junction of the cross arms.

'Marigold' stone

Decoration

When this stone was first discovered in 1992, only the marigold cross was visible as the rest of the slab was still in the ground. It was described then as a seven-petalled marigold and it had clearly defined 'lips' on the petals, that is, there was a double-edged outline to each petal. When the slab was disinterred in 1997 and subsequently fixed to the east wall of the church it was found to have a figure, possibly a Christ figure, in either an orans or cruciform posture; image 46 is a photograph taken at the time, and image 47 is a line drawing from the same photograph. The figure was then described as having either a rayed nimbus or wiry hair ((Henderson and Okasha "The Early Christian Inscribed and Carved Stones of Tullylease, Co. Cork"). Crosses of arcs, Maltese crosses and 'marigold' crosses are to be found throughout Ireland. The marigold slab at Carndonagh is just one other example and it also has seven petals. It was thought at first that perhaps the Tullylease slab was a motif piece; the discovery of the figure suggests otherwise. If the orientation of the slab was tilted to place the figure in a central position it is possible that this stone was used as an altar

frontispiece with another (now lost) marigold at the left hand side of the recut slab.

Scanning

On our visit, only the marigold was visible on the slab to the naked eye (image 43 and image 44). It was clear that flaking of the sandstone had occurred (image 45). Subsequently it became apparent that the line where the flaking had taken place corresponded to the shoulder span of the incised figure. We scanned the entire slab; image 52 shows the fixed sweeps in colour. Already from those sweeps we could see the outline of the figure emerging. When the sweeps were fixed, that data was once again rendered in the green reflective coating. When put through the obliquely lit synthetic video sequence the image of the figure, complete with loincloth, legs and feet is clearly visible. Image 53 is a still from this synthetic video sequence clearly showing the figure. Image 54 is the image rendered using the texture captured from the digital photograph. Comparing these two images one can see that the use of the high reflectance properties of the green render clearly shows the figure, while the matt render from the photograph does not.

It is important to reiterate that no trace of the figure's body is visible to the naked eye on the stone. Visits to the site at different hours of the day, and using raking light yielded no results. The fingers of the left hand are all that is roughly visible. The sub-millimetre accuracy of the scanner was able to pick up the incised lines in the layer of stone beneath that which had flaked off. Even the

subsequent rendering of the slab using a digital photograph for colour is not as clear an image as that produced by the software.

Conclusion

The scanning has delivered a good rendered digital model of the famous stone at Tullylease known as ‘St. Berichter’s Stone’. It also made good, clear, digital images of the three stone slabs in the recess in the south wall of the church. Most significantly the scanning process was able to detect an image now invisible to the naked eye when scanning the ‘marigold stone’ at Tullylease, and produce a clear digital image of that figure.

Chapter 5 Discussion

There are many issues concerning this technological approach to medieval monuments. Methodologies must necessarily be analysed and measured in and of themselves in order that their individual merits and failings be recognised. As with any aspect of scholarship this methodology must be evaluated in terms of the adequacy and rigour of the results produced. There are social, cultural and theoretical aspects to this debate. Laser scanning of stone monuments offers the academic community and the wider community the opportunity to engage with issues surrounding education, heritage and participation. Topics to be considered in this chapter include: access and participation, promoting a fundamental e-literacy, theorising meaningful participation with interdisciplinary technologies, and ultimately using this technology in a meaningful way.

In Ireland, with the dissolution of the Heritage service and the devolving of powers to the Department of the Environment, there is a renewed onus on stakeholders other than the state to protect, promote, conserve and educate the wider community about heritage issues. In Scotland, Historic Scotland have produced an archaeology paper: "Carved Stones: Historic Scotland's Approach" (Foster). It lists legal protection, the raising of awareness of the vulnerability of carved stones, conservation strategies and practice including intervention, research and information, and the setting of an example of best practice. In Wales Cadw have a National Committee for the Recording and Protection of Early Medieval Inscribed Stones and Stone Sculpture which was established in line with the Board's Recommendations in its 2000-01 Annual Report. England, following the publication of the Monuments at Risk Survey of England, has also put strategies in place to record and protect heritage sites (Darvill and Fulton). In

Ireland, *The Stone Decay Study* of 2000 has yet to be followed up in any coordinated, strategic way; since the dissolution of Dúchas formal national routes for this seem to have fallen to local interest groups and the academic community.

Access and Participation

One of the most obvious functions for this technology is to record sculpture in the context of conservation and preservation. Previous reference has been made to the Conservation Report for St. Lachtain's in Freshford, Co. Kilkenny. This is an excellent example of a site where laser technology might be used in an immediate, practical, non-invasive way. Mike Spearman has called the creation of such a digital model a reusable learning object (Spearman). Once a life size model of the arch is made for display within the local community, another smaller one could be produced for local schools. A digital model could be made available on the web, one which unlike conventional two-dimensional images could be manoeuvred through all dimensions, zoomed in on and explored by students at all levels.

This 'reusable learning object' is accessible on multiple levels and to multiple end users of multiple abilities. It is visible in a simple way as a two dimensional image on paper, on a poster, in a book. It is visible in three-dimensional way either on a CD for those without the internet, or on the internet itself. Even within the digital sphere the malleability of the technology means that the end user might be a primary school student looking for a picture for their local history project, or a postgraduate student looking at Leask's Romanesque as an essay topic, or a tourist looking for places of interest in Co. Kilkenny. It could

also be used within a museum context, and certainly would be interactive and visually stimulating as part of a projected display.

In a recent radio interview the Minister for Communications in Ireland, Mr. Noel Dempsey proposed making the G.P.O. on O'Connell Street in Dublin into a museum of the 1916 Rising. In the interview he stresses that unlike other museums he wanted this to be a place 'that the public would go into', that unlike other museums in the capital the exhibits would not be static, they would be interactive and visually stimulating – 'like the presidential museums in America'. These buzzwords of 'interactivity' and 'visual stimulation' are met by laser technology. However, before access can be gained to interact with the public and visually stimulate them into active participation, other issues remain to be addressed.

Promoting a fundamental e-literacy and participation with interdisciplinary technologies

Within the academic community digital divides have often existed in the past, with practitioners in one subject area seeing their speciality as completely separate from the other, and occasionally viewing the other with suspicion. In order for scholarship in both areas to move forward, an interdisciplinary approach is fundamental. The only way for meaningful, usable, practical technologies to be created is in conjunction with the teachers, academics, archaeologists and others who will be using them.

Technology that nobody will use is purposeless. Communication between disciplines is vital, as humanities' specialists also need to understand the capabilities and limits of a technology. Playstations, Pixar, and George Lucas' 'Industrial Light and Magic' have perhaps created a misleading view of what may be achieved by an experimental physics department using virtual reality modelling. It is only by working together that adequate solutions may be found to informatics and praxis issues.

Also it may be argued that within the humanities academics need to engage with new ways of presenting their work in a digital way and to suit multiple environments. Computing and word-processing are skills now essential for a student to achieve an MA degree; similarly the web, email and new mobile 3G and 4G technologies are now impacting on student experience and at an increasingly younger age. A fundamental e-literacy is critical for an understanding of the needs of end users and in order to be able to engage with those producing the technology in a meaningful way.

Aims and outcomes of the thesis

This project endeavours to offer just such an interdisciplinary approach. In 'Hype or Hyper-reality' Goodrich and Earl examine how to overcome the scepticism that any technology that produces images 'is a system for producing pretty pictures' (Goodrich and Earl). Laser scanning is not just for 'techies'. I acknowledge that there is an inherent subjectivity in making any reduced choice from the range of sculpture available within Ireland; this choice was made with defined parameters in mind. The aim of this thesis has been to test what the

technology is capable of within certain realistic constraints of the technology, manpower, and budget. We scanned outdoors and in, on a large and on a small scale. We scanned in the dark and we scanned in the rain. We scanned different types of monument with varying cost implications due to their size and location. The applications for this methodology proved many and various. While remaining cogniscent of the implications for cultural theory and visualisation studies, my focus is practical. The aim of the thesis was a practical evaluation, in full knowledge of the multi-faceted discursive space that surrounds the method.

The aim was to produce accurate digital models of the stone sculpture selected and to evaluate the practicality of the technology and of its outputs. The laser is limited by certain factors. Excessive sunlight means that the cameras cannot read the laser light, so the scanner works better in shadow, and works most efficiently in the dark. Magnets and metal in significant amounts can interfere with the operation of the triangulation process whereby the successive sweeps of the wand are mapped and matched. If there is an excessively dark corner in a piece of sculpture caused by dampness or dirt, the darkness absorbs the light and it will not bounce back in order to register as a scan. The proximity of a given sculpture to other structures also limits the ability of the scanner to produce a fully three-dimensional model. If the back of a stone is too close to another structure, for example the gable wall of a church, the wand cannot beam light onto the surface, and so the image cannot be generated. Notwithstanding these potential difficulties successful models were created at all the chosen sites.

At Toureen Peacaun a good model was generated from a mixture of data from the casts in the National Museum and from the shaft of the high cross in the field. The model produced represents a significant improvement on what is visible on the sadly defaced monument today and will hopefully contribute to the debate about the development of High Cross production in Ireland, and the way in which a letterform analysis of geometric capitals may inform the debate about the influences of the Saxons in Ireland, and the influence of the Irish abroad.

The geometric capitals on the cross shaft at Toureen Peacaun were more clearly visualised if not ultimately deciphered using the method. Unlike virtual reality there is no intervention in the model produced, there is no interpolation or attempted reconstruction. The image is authentic. The surface is mapped; the data generates the model. Just as with any other image it would be possible to 'fill in the blanks' but that is not the aim. The method thus retains its interpretative validity and offers an audience an accessible, malleable inscription to explore.

The stone slabs set into the damp wall in Lismore were also accurately recorded and models made. In the context of the rapidly deteriorating fabric of the building this is a significant measure, as precise digital copies now exist should damage occur to the originals. The architectural figure holding the book benefited from a digital video imaging sequence and will hopefully contribute further to O'Keeffe's analysis of the emergence of the Romanesque in Munster.

The scale of the arch at Monaincha was the biggest challenge for the technology. The inscription on south side of the arch is short and we were not able to add to the previously existing scholarship, except to state that letter-forms previously legible further down the pilaster are now gone, and to note that even in such a remote location damage was being caused to monuments. The scale of the arch and the nature of the relief tested the hand-held scanner to the limit of its capabilities. We succeeded in generating a digital model of the arch which allows a viewer / scholar in a digital environment to move from a frontal view to zoom in up under the arches to get a close-up of the decoration. This represents a significant improvement on traditional two-dimensional representation. The software can also generate line drawings, and black and white or gray scale images of all images. This further increases the accessibility and functionality of the model once generated.

The scanner has also generated a good model of the high cross at Carndonagh, Co. Donegal. Nonetheless it would be impossible for this size of a scanner to scan large buildings in their entirety; rather its portability and functionality are specifically directed at smaller monuments.

At Tullylease digital models of all the early Christian sculpture at the site were made. In particular the ability of the scanner to generate good images from the scans of the slabs in the small recess was a significant success. Other scanners that are mounted on a fixed frame, like a scaffold, would not have the flexibility to achieve such good results. The capability of the scanner to read the incised figure that had flaked away from the surface of the ‘marigold’ stone

demonstrated the range and potential of the technology. The ‘re’visualisation of the figure in Rapidform was a success, displaying the conservatory aspect of the technology. This recovery proved the submillimetre accuracy of the technology and the ability of the scanner to read that which is no longer apparent to the human eye.

The potential for the method is good. The laser is compact, portable and easy to use. The expertise required for data capture is a skill easily acquired. Analysing the captured data is the area which requires specialist knowledge. However, with training in the proprietary software package Rapidform, this too is a skill that can be learnt once parameters have been set.

The outputs of the data, in this case the models, are such that they may be presented in many forms: two-dimensional, three-dimensional, hard copy, electronic and virtual. Thus they can be accessed by many levels of viewer / interrogator; they may be enjoyed simply as pretty pictures, or in the spirit of this thesis promote a meaningful way for all levels of interested stakeholders to access and participate in this interdisciplinary approach.

Images

Image 1: Team scanning at Toureen Peacaun: the red laser light is just visible on the cross shaft



Image 2: M.V. Duignan's 1944 photograph

with thanks to Prof Dáibhí Ó Cróinín, Dept of History, NUIG



Image 3: Scan of the positive cast made by Duignan, now held at the National Museum of Ireland



Image 4: This is the same image as 3 above, but a texture displaying the minimum curvature measurements on the surface of the stone has been applied, (ie) all the points appear in a darker shade of blue.



Image 5: This is a still image from a synthetic video sequence. It can be lit from various directions, its texture changed and its relief exaggerated.

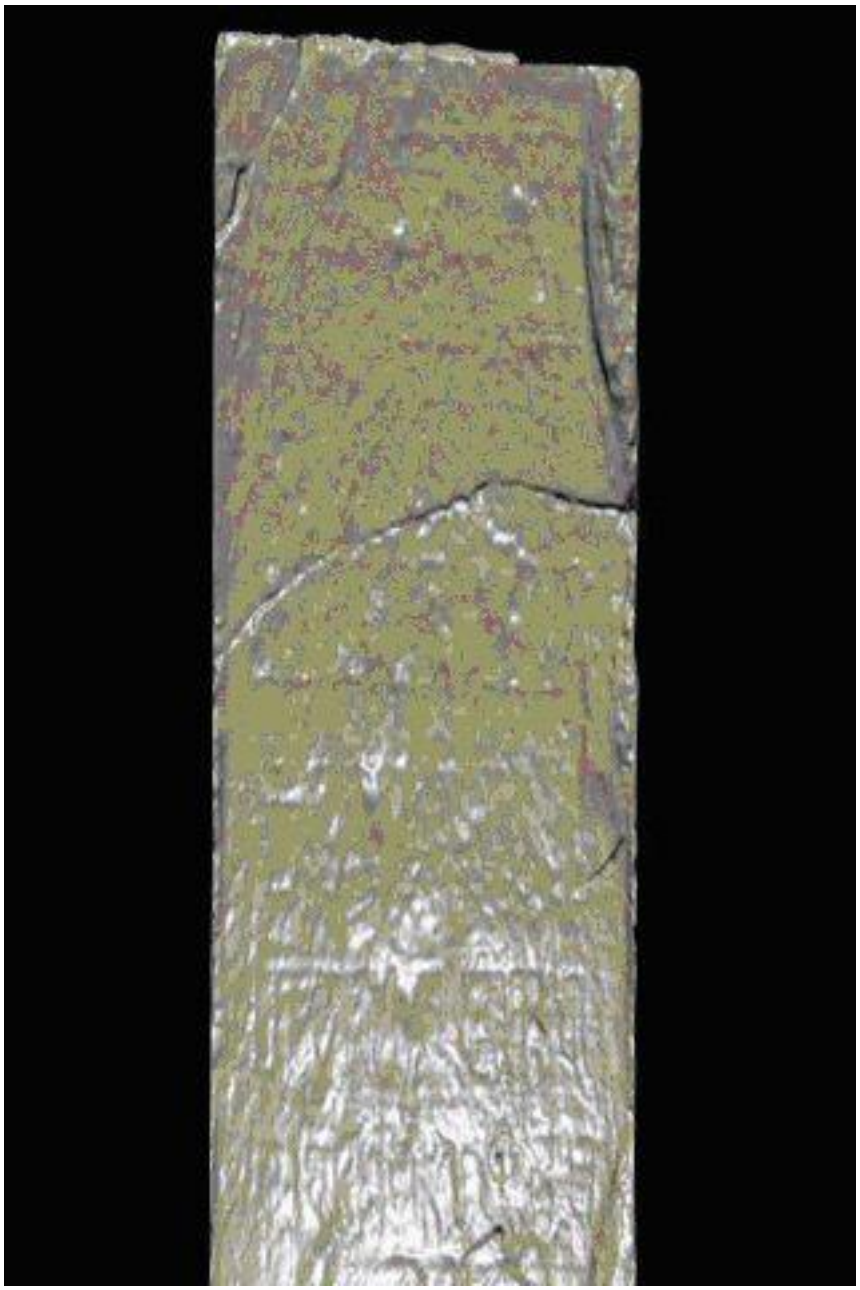


Image 6: Final image post rendering



Image 7: Lismore slabs positioned at bottom left of photograph and are set into the wall.



Image 8: Untextured model of small inscribed cross head at Lismore



Image 9: Untextured image of inscribed slab with linear Latin cross with expanded terminals



Image 10: Untextured image of inscribed slab with incised outline Latin cross set on base.



Image 11: Untextured image of inscribed slab with incised ringed cross with expanded terminals

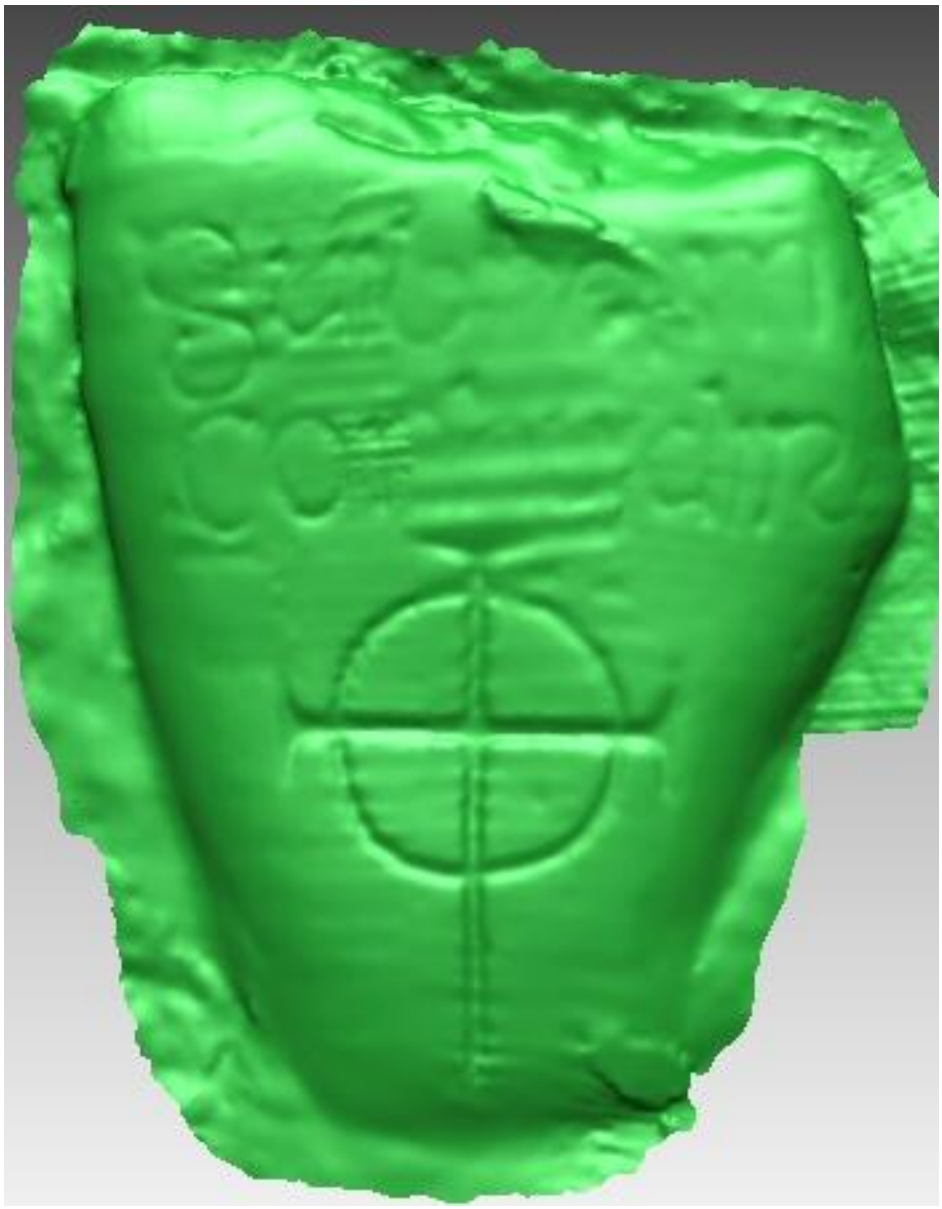


Image 12: Untextured image of inscribed slab with outline ringed cross with expanded terminals



Image 13: Untextured image of seated ecclesiastic/ Christ figure holding opened, inscribed book.



Image 14: 3D still from Rapidform showing each sweep of wand as a separate colour, and showing each fixed chosen sweep ‘boxed’

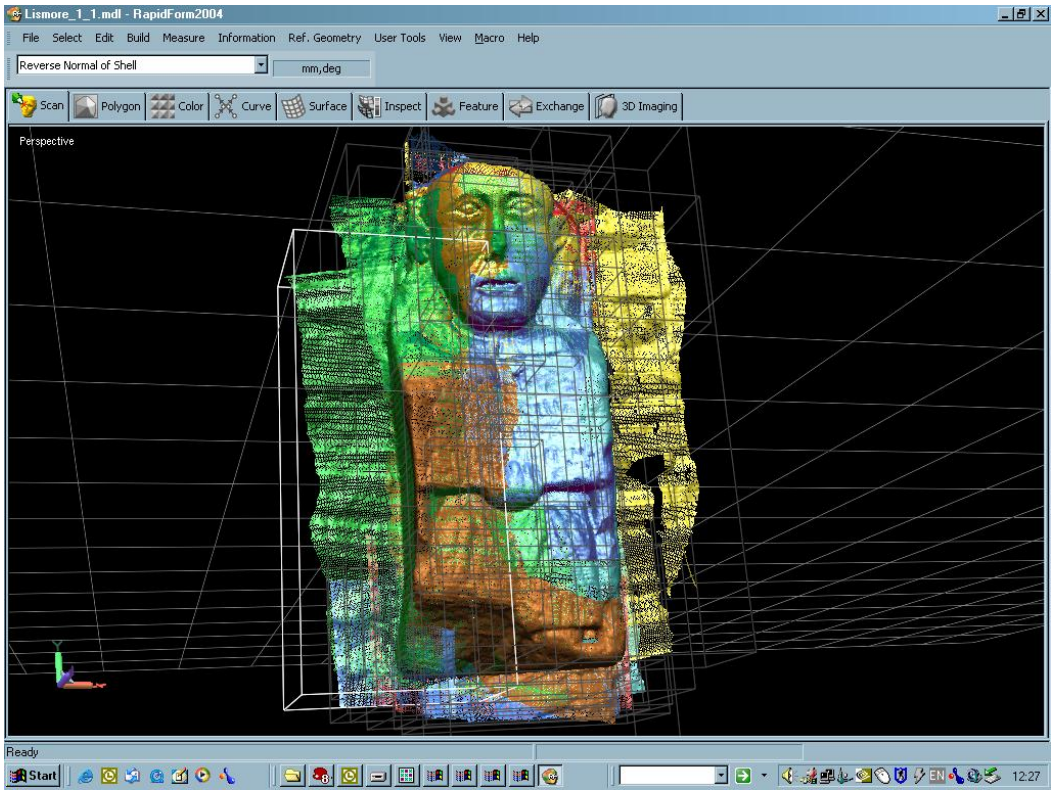


Image 15: 3D still of image with sweeps fixed

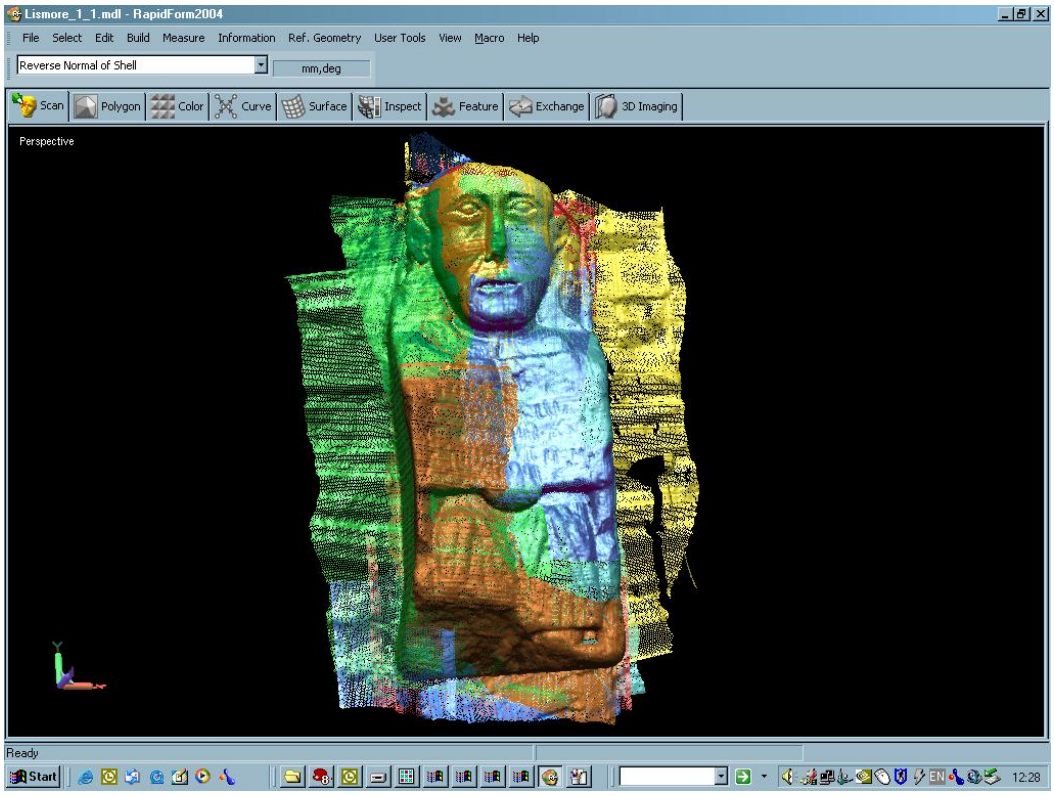


Image 16: Textured 3D model of figure with book from Lismore cathedral captured with Rapidform

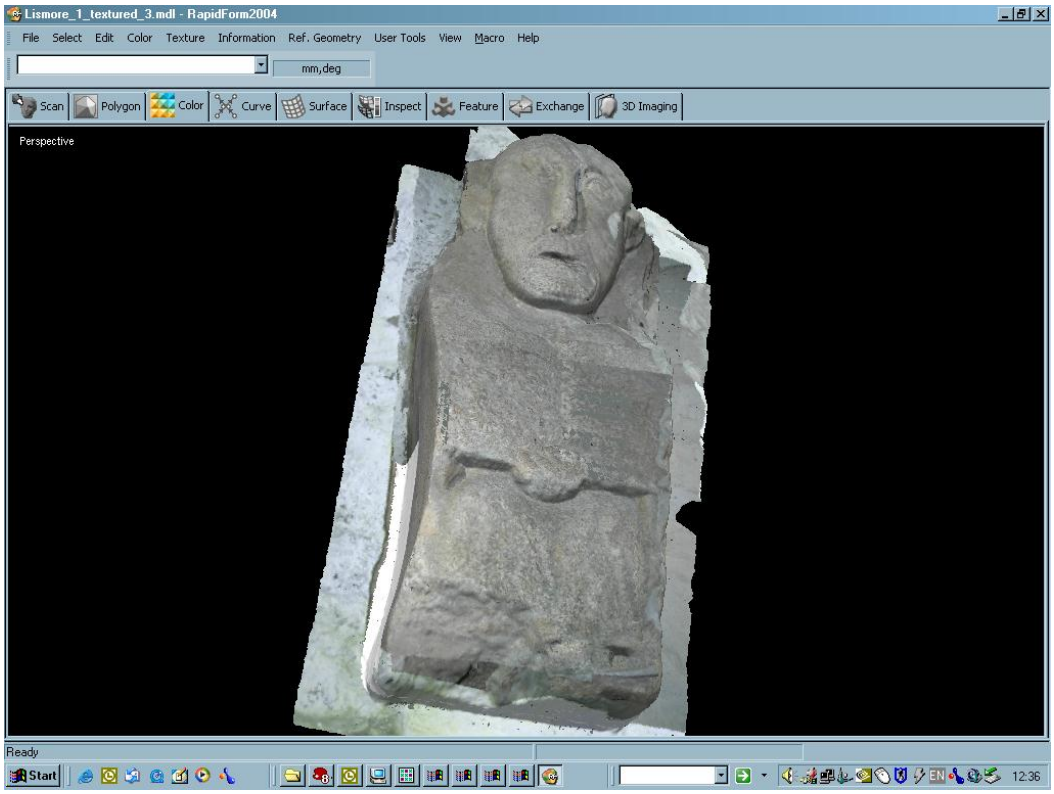
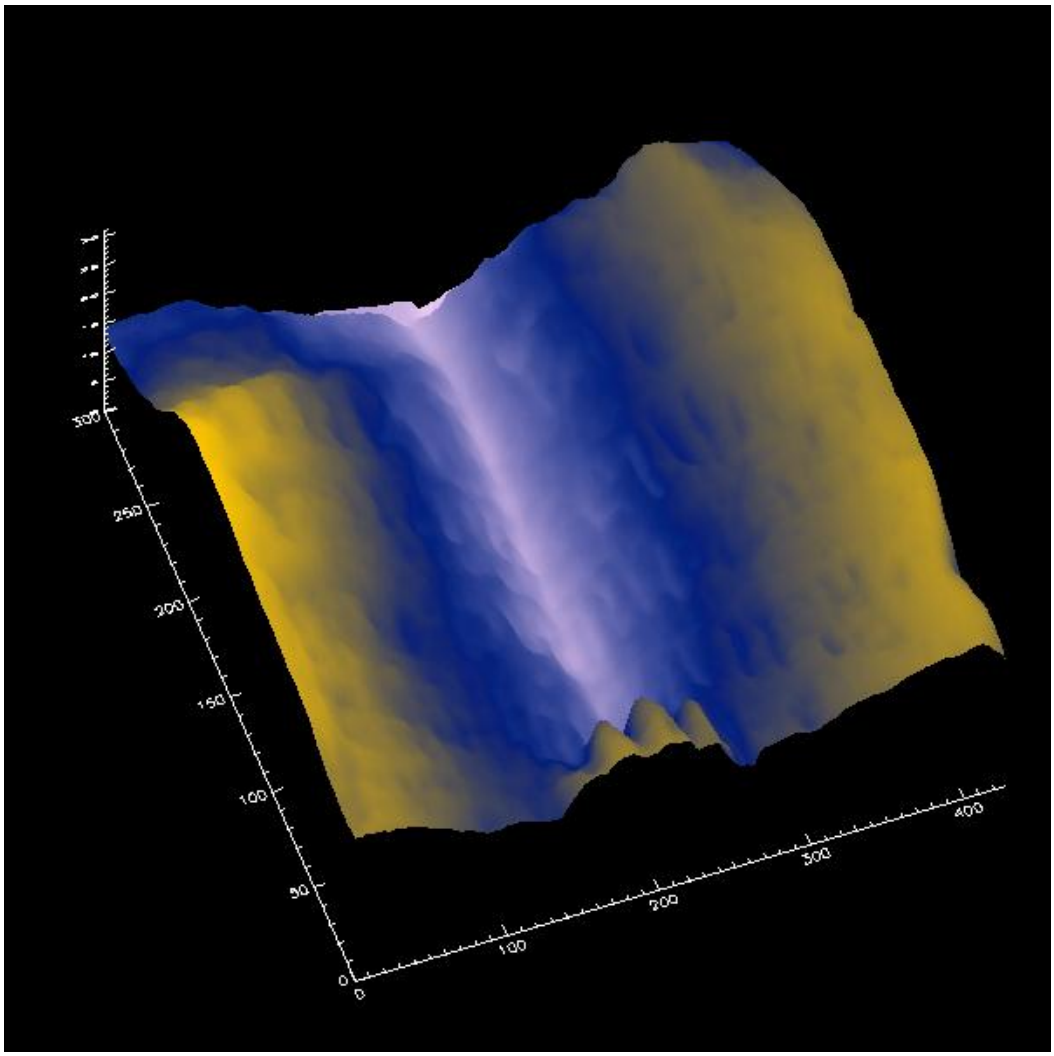


Image 17: Close up of inscription on opened book from Lismore Cathedral illustrating the difficulty with the surface



Images 18 – 21: close ups of inscription using various filters and shades of colour in Paintshop Pro

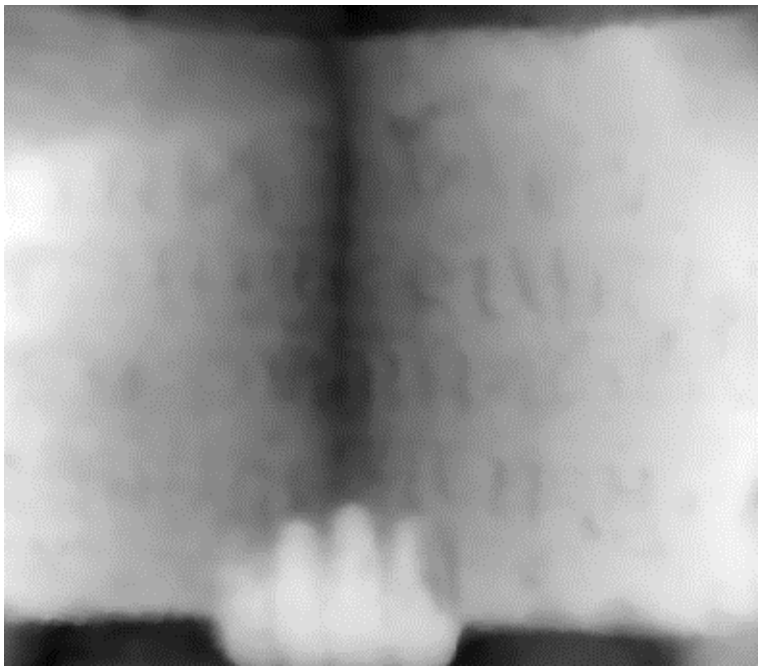


Image 19

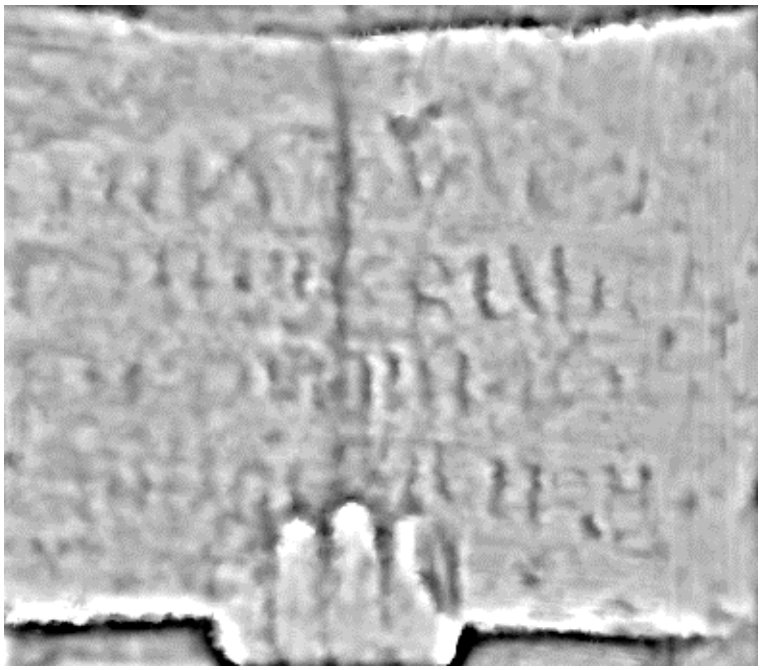


Image 20:

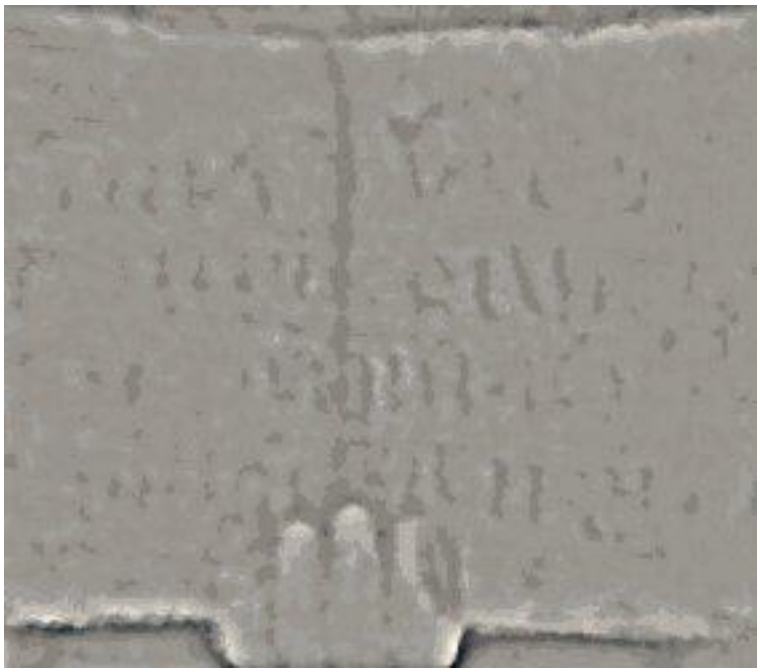


Image 21:

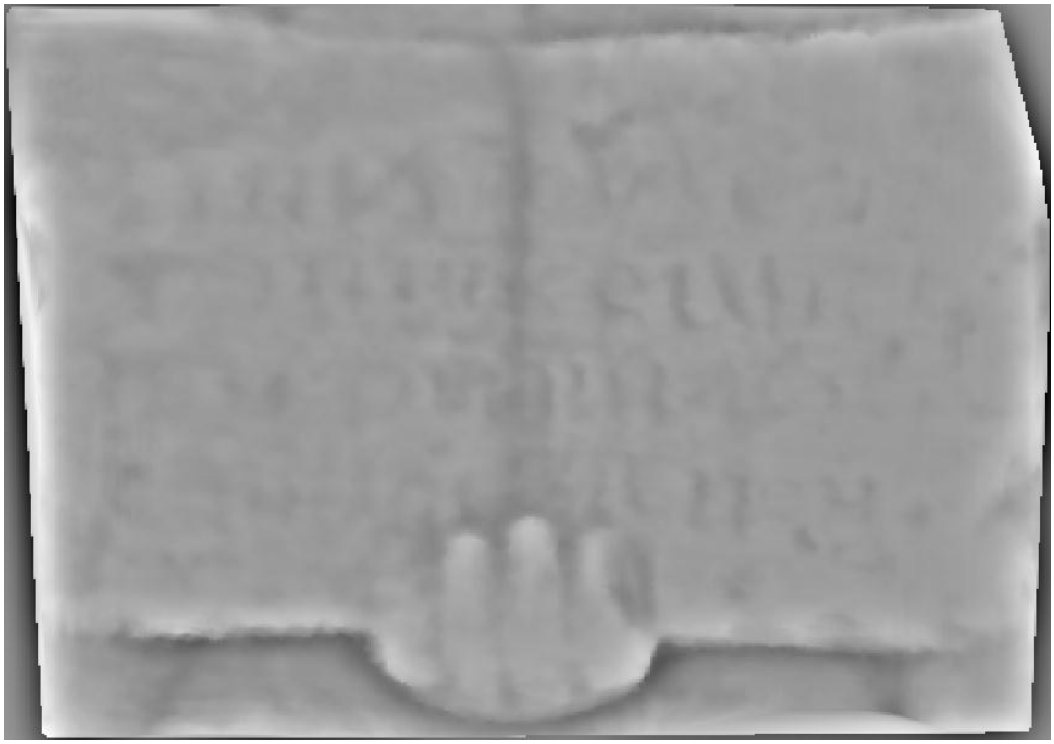


Image 22: Romanesque arch at Killeshin, Co. Laois. General View.



Image 23: Killeshin, Co. Laois. Close up of inscription left side.

(Inscription is positioned along the top of pilasters, above the carved heads)



Image 24: Killeshin, Co. Laois. Close up of right side



Image 25: Freshford, Co. Kilkenny



Image 26: Freshford Co. Kilkenny. Close up of inscribed arch.



Image 27: Ardfert, Co. Kerry. Templenahoe. External view of arch.

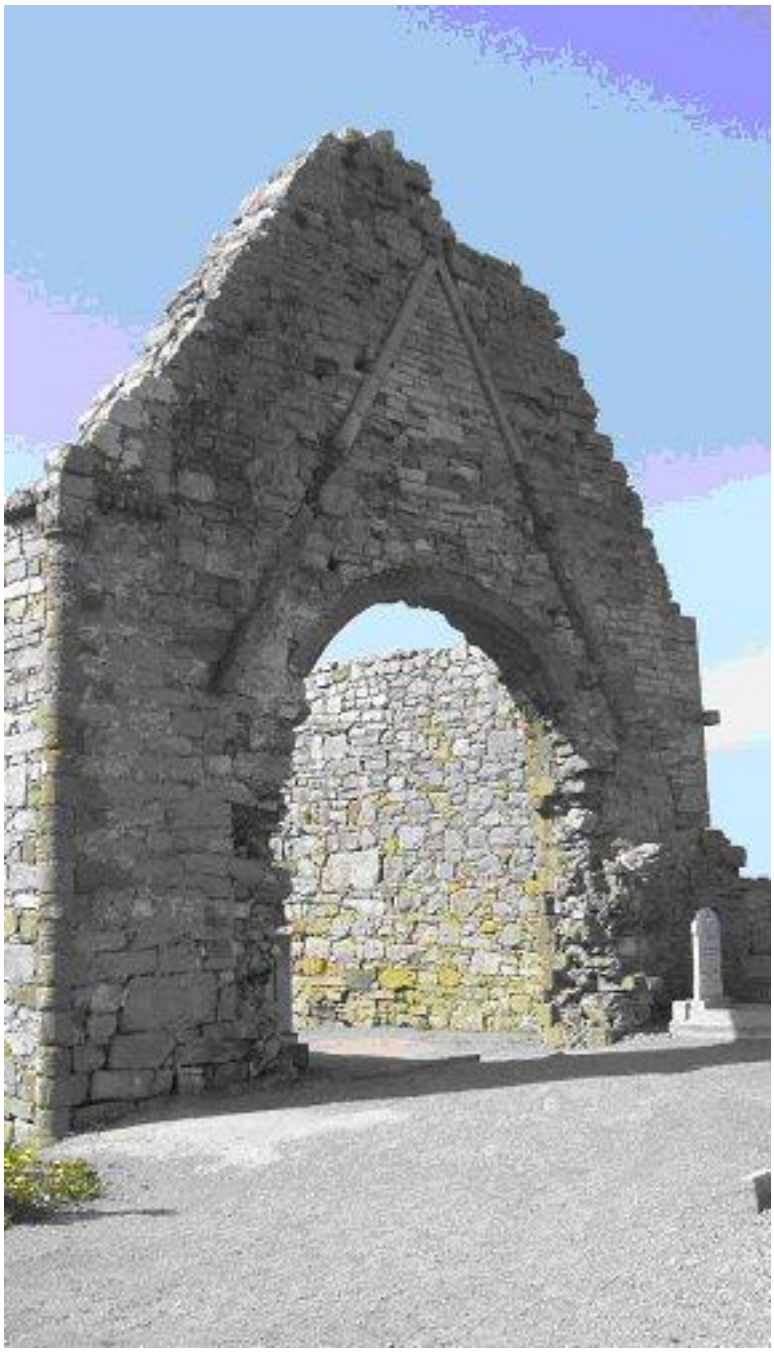


Image 28: Ardfert, Co. Kerry. Templenahoe. Internal view.

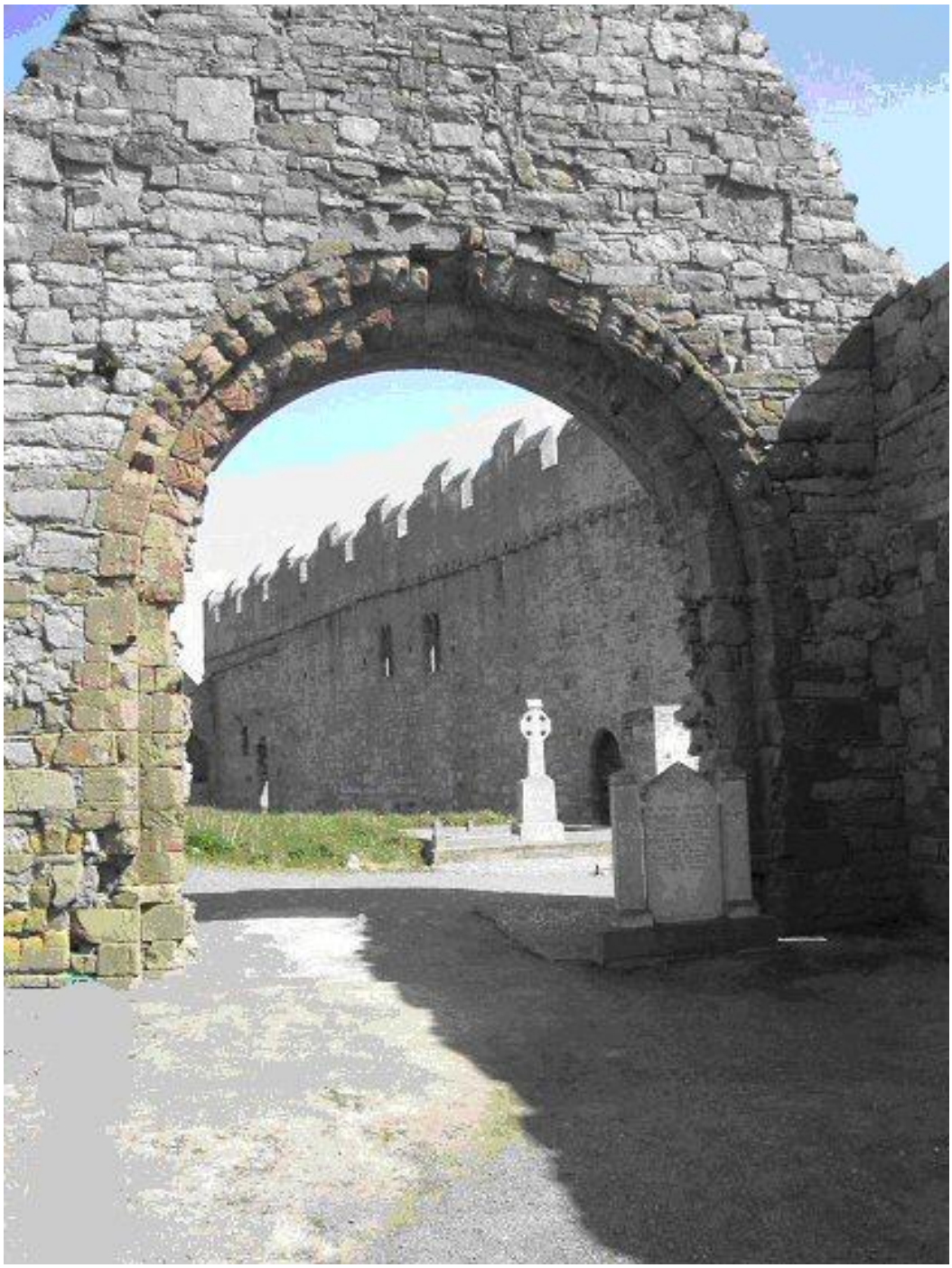


Image 29: Ardfert, Co. Kerry. Close up of section with inscribed stone, internal arch.



Image 30: Monaincha, Co. Tipperary. General view

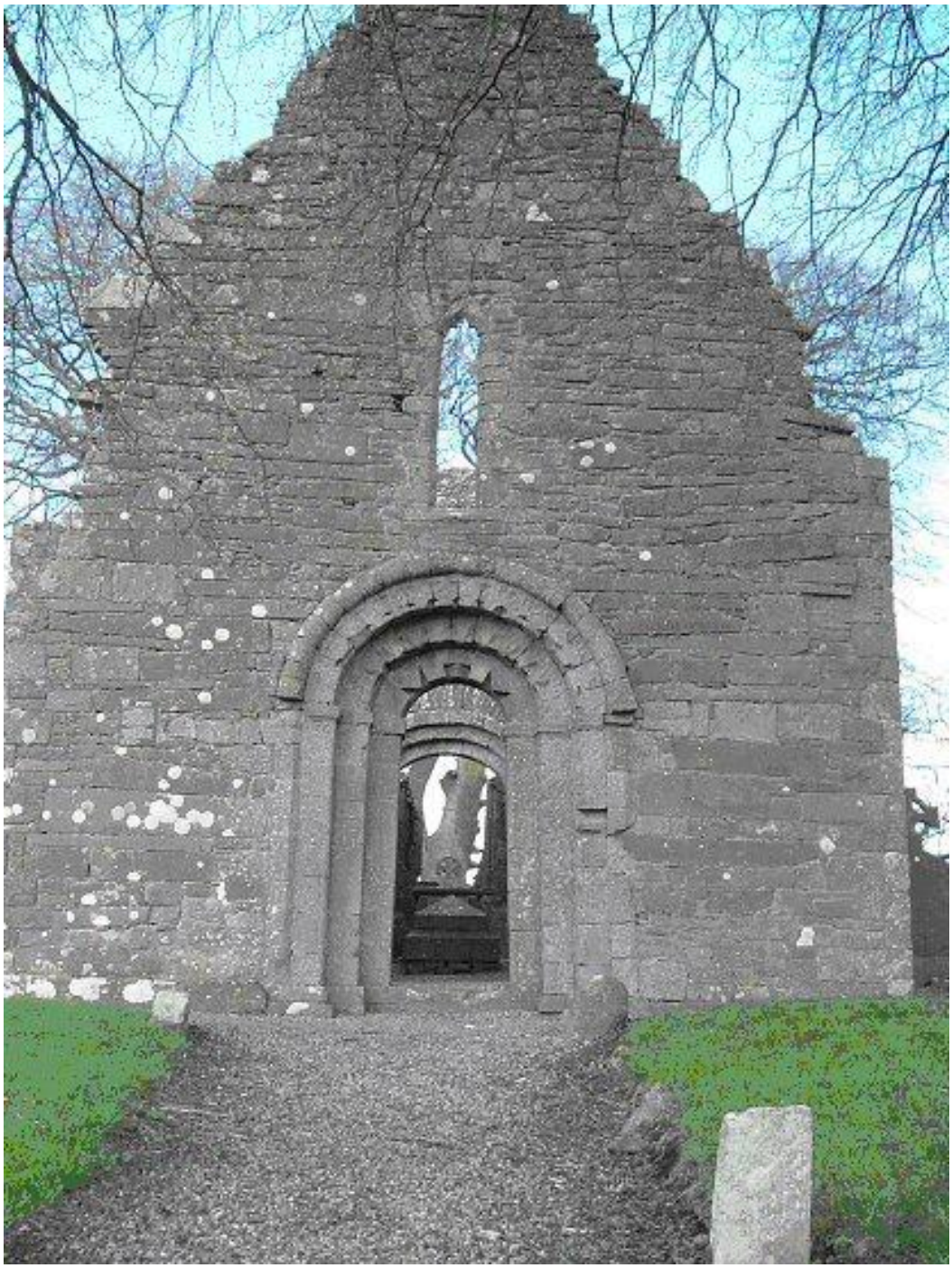


Image 31: Monaincha, Co. Tipperary. Close up of inscribed stone in south pilaster.



Image 32: Monaincha, Co. Tipperary. Close up of southern section of the doorway, showing damage to outer pilaster.

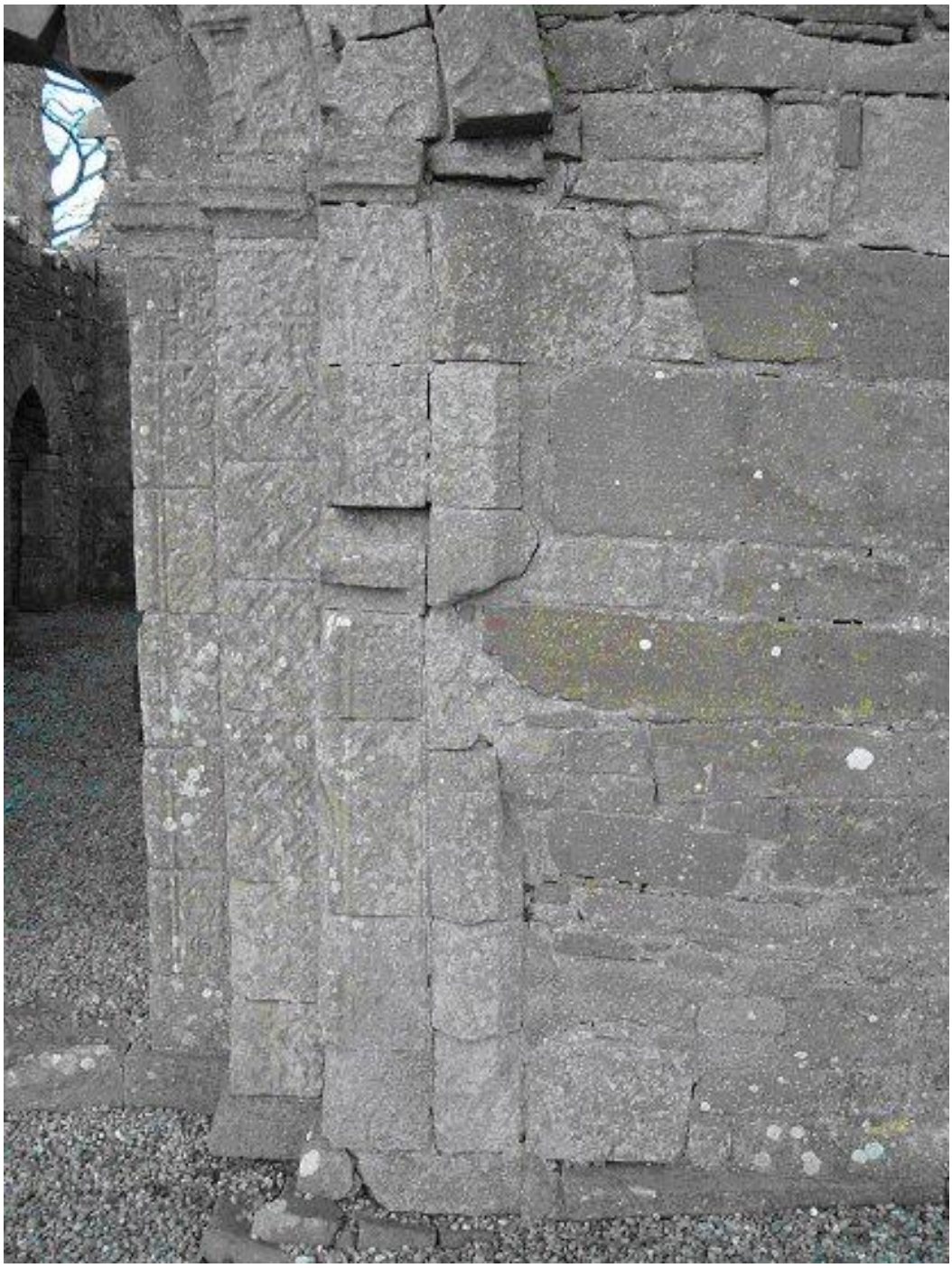


Image 33: Monaincha, Co. Tipperary. Model of inscription.

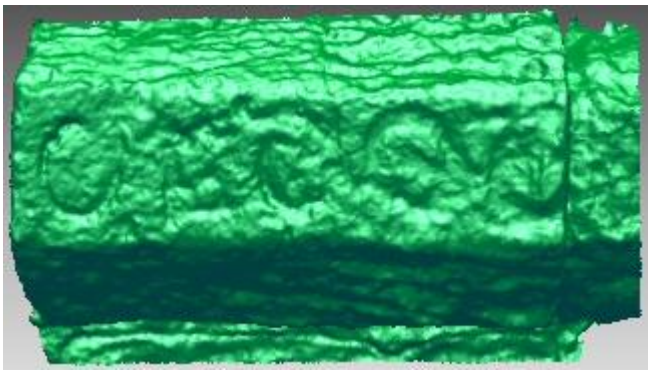


Image 34: Monaincha, Co. Tipperary. Digital model in black and white.



Image 35: Partially modelled arch, again the reflective quality of the chosen render highlights the decoration of a two dimensional image.



Image 36: Still from Rapidform software displaying the amount of sweeps necessary to capture one segment of the arch.

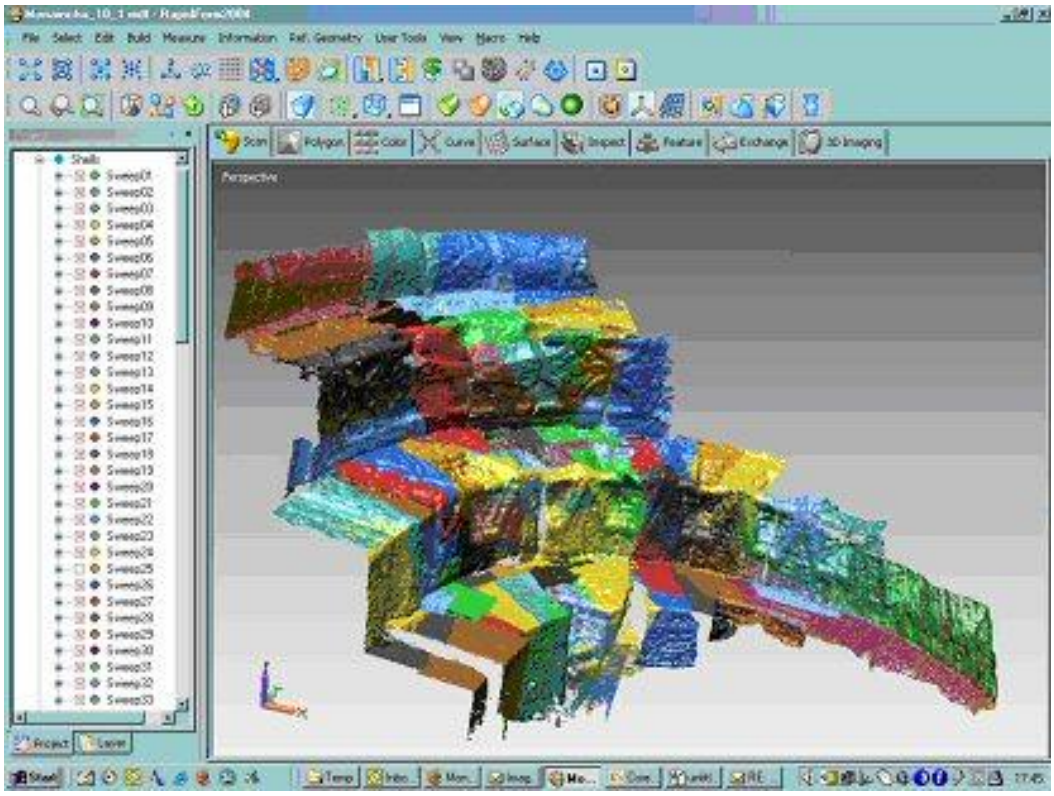


Image 37: Tullylease, general view of St. Berichter's Stone with recessed wall press underneath.



Image 38: Tullylease, close up of St. Berichter's Stone



Image 39: Tullylease, close up of wall press



Image 40: Tullylease, east side of wall press slab



Image 41: Tullylease, south side of wall press slab.



Image 42: Tullylease, west side of wall press slab



Image 43: Tullylease, general view of ‘marigold’ cross slab, fixed to east wall of the church



Image 44: Tullylease, close up of marigold on slab



Image 45: Tullylease, image showing flaking of sandstone



Image 46: Photograph from Henderson and Okasha 1997 of marigold stone with figure

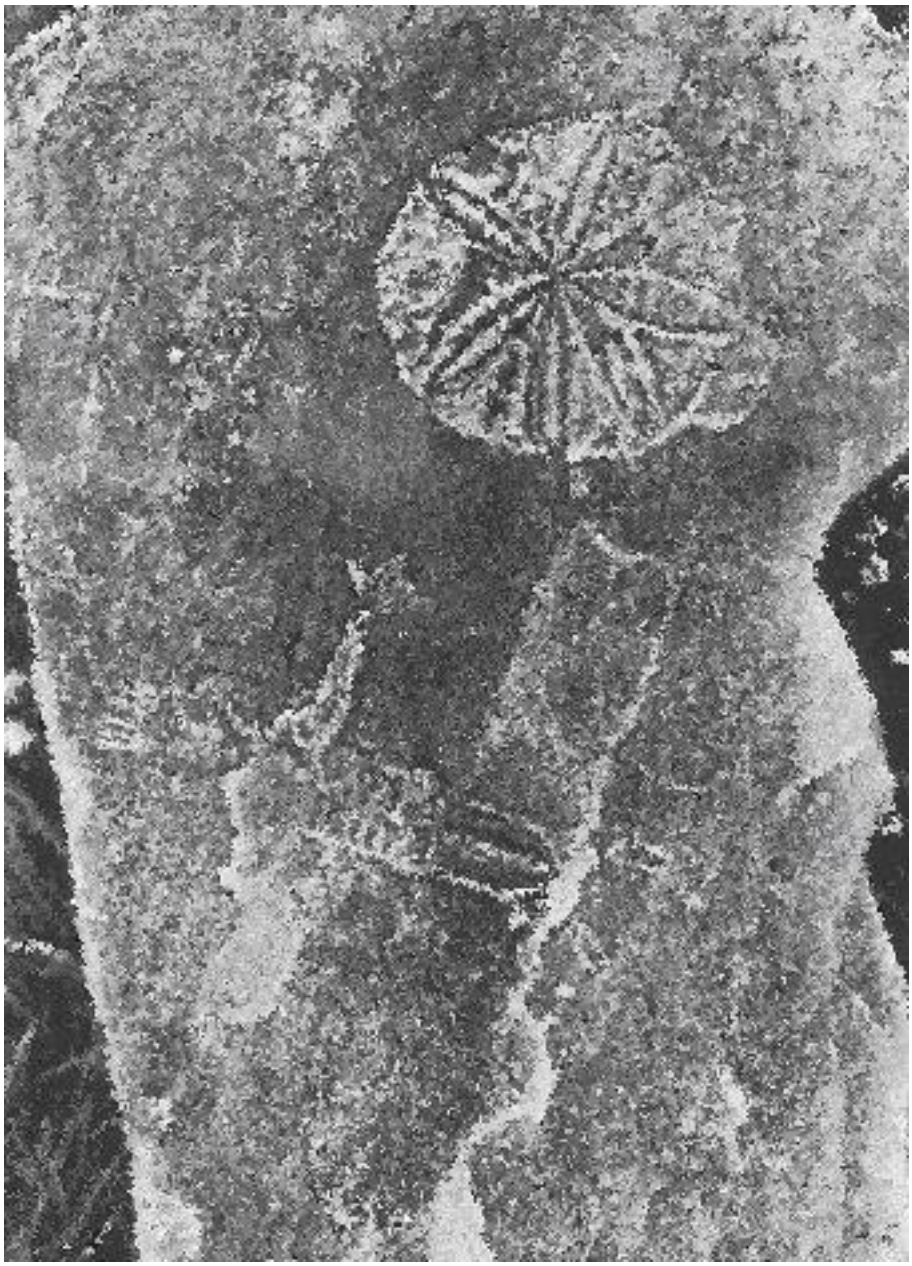


Image 47: Line drawing of marigold stone with figure by George Henderson, from Henderson and Okasha 1997

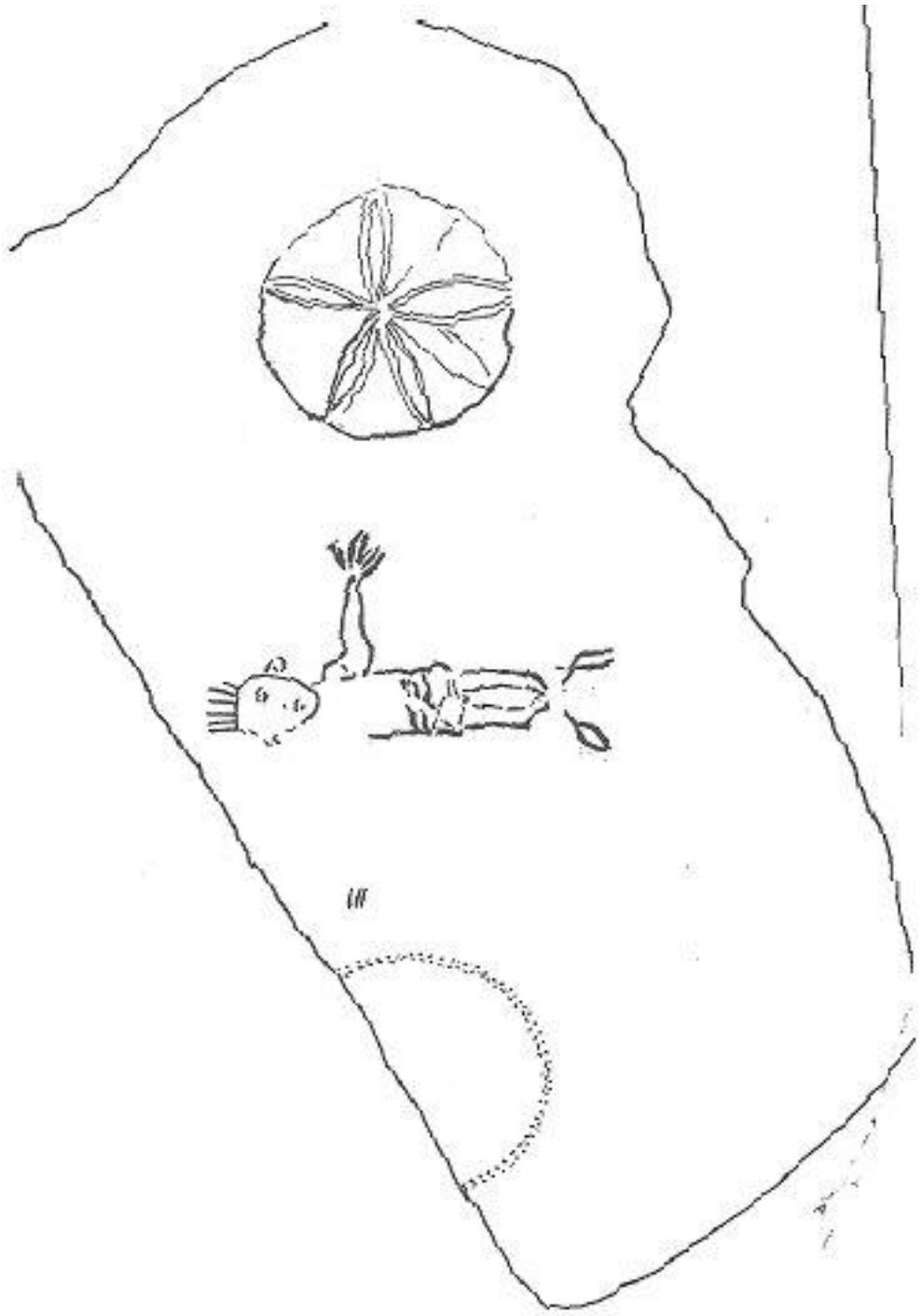


Image 48: Rendered version of ‘St. Berichter’s Stone’



Image 49: Tullylease, rendered version of east wall press slab



Image 50: Tullylease, rendered version of south wall press slab



Image 51: Tullylease, rendered version of west wall press slab



Image 52: Tullylease, marigold slab – sweeps in Rapidform

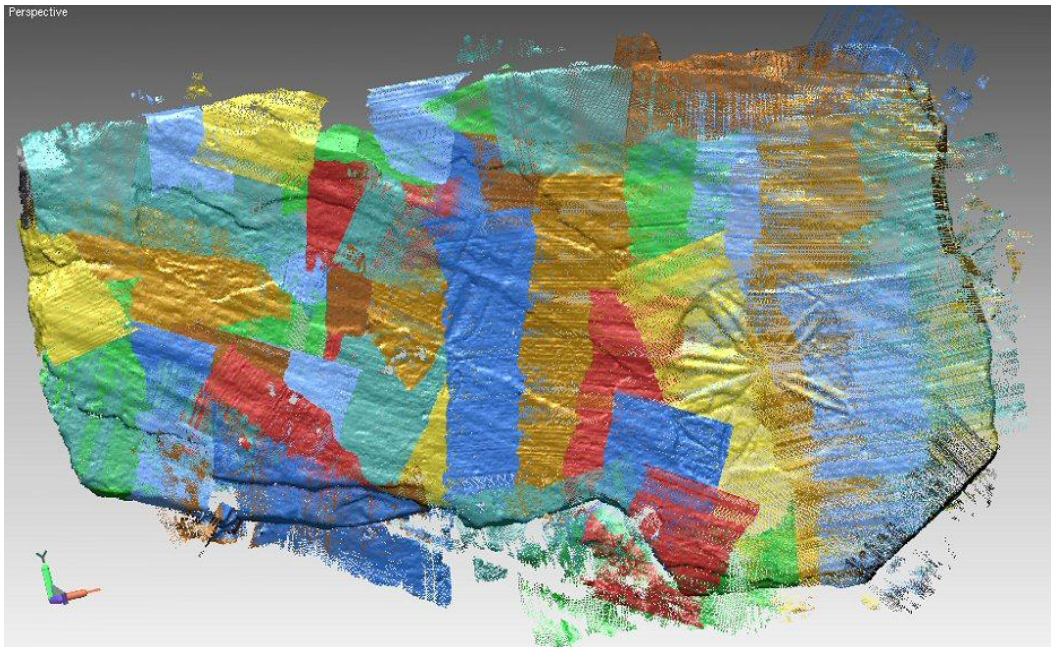


Image 53: Tullylease, still from animated digital video sequence showing figure at centre

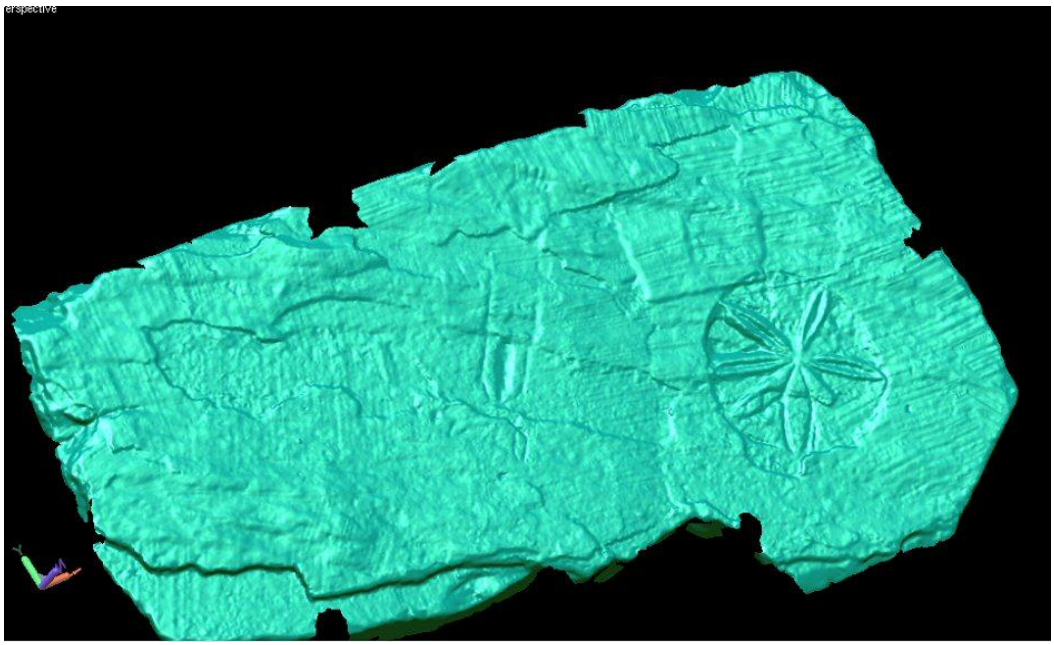


Image 54: Tullylease, marigold slab post rendering



Works Cited

"Vulgate Bible Search". *ARTFL Project*. University of Chicago. 18 October 2005. <http://www.lib.uchicago.edu/efts/ARTFL/public/bibles/vulgate.search.html>.

Bailey, Richard. *England's Earliest Sculptors*. Toronto: Pontifical Institute of Mediaeval Studies, 1996. Print.

Bischoff, Bernhard. *Latin Palaeography : Antiquity and the Middle Ages* Trans. Ó Cróinín, Dáibhí and David Ganz. Cambridge: Cambridge University Press, 1990. Print.

Charles-Edwards, Gifford. "The East Cross Inscription from Toureen Peacaun: Letterform Analysis and a Suggested Reading." *Archaeology Ireland* 17 (2003): 13-15. Print.

---. "The East Cross Inscription from Toureen Peacaun: Letterform Analysis and a Suggested Reading." *Journal of the Royal Society of Antiquaries of Ireland* 132 (2002): 114-26. Print.

Clarke, J.P. , C.S. Hardman, and W. G. Kilbride. "Comprehensiveness for All: The Oasis Project and Research Values in the Digital Age." *CSA Newsletter* XV.3 (2003). 1 Sept. 2003 <http://csanet.org/newsletter/winter03/nlw0305.html>.

Cunningham, George. "Monaincha – Móin Na Hinse – the Holy Island of Loch Cré – the 31st Wonder of the World." *Scéal na Móna* 13.37 (2001): 16-18. Print.

Darvill, Timothy, and Andrew Fulton. *The Monuments at Risk Survey of England 1995*. London: English Heritage, 1998. Print.

Daubos, Thierry. "Virtual Archive of Inscribed Stones in the Irish Landscape". 2003. 1 September 2003 <http://www.daubos.com>

Edwards, Nancy. "A Group of Shafts and Related Sculpture from Clonmacnoise and Its Environs." *Clonmacnoise Studies* 1 (2004): 101-18. Print.

Forsyth, Katharine. "Corpus of Inscribed Stones Project." (2004). 22 June 2004 <http://www.ucl.ac.uk/archaeology/cisp/database/stone/>.

Foster, Sally M. *Carved Stones: Historic Scotland's Approach*. Edinburgh: Historic Scotland, 2003. Print.

Goodrich, Glyn, and Graeme Earl. "A Manufactured Past: Virtual Reality in Archaeology." *Internet Archaeology*.15 (2004). 14 February 2006 <http://intarch.ac.uk/journal/issue15/earl_toc.html>.

Hamlin, Ann. "Crosses in Early Ireland: The Evidence from Written Sources." *Ireland and Insular Art: Ad 500 – 1200*. Ed. Ryan, Michael. Dublin: Royal Irish Academy, 1987. Print.

Hearn, M.F. . *Romanesque Sculpture: The Revival of Monumental Stone Sculpture in the Eleventh and Twelfth Centuries*. Oxford: Phaidon, 1981. Print.

Henderson, Isabel, and Elisabeth Okasha. "The Early Christian Inscribed and Carved Stones of Tullylease, Co. Cork." *Cambridge Medieval Celtic Studies* 24 (1992): 1-36. Print.

---. "The Early Christian Inscribed and Carved Stones of Tullylease, Co. Cork. Addendum." *Cambrian Medieval Celtic Studies* 33 (1997): 9-17. Print.

Henry, François. *Irish High Crosses*. Dublin: Three Candles, 1964. Print.

Higgitt, John. "Words and Crosses: The Inscribed Stone Cross in Early Medieval Britain and Ireland." *Early Medieval Sculpture in Britain and Ireland*. Oxford1986 of *BAR British Series 152*. Print.
Huggett, Jeremy. "Archaeology and the New Technological Fetishism." *Archaeologica e Calcolatori* 15 (2004): 81-92 pp. 15 May 2006 <http://soi.cnr.it/archcalc/indice/PDF15/05_Huggett.pdf>.
Kelly, D. "The Heart of the Matter: Models for Irish High Crosses." *Journal of the Royal Society of Antiquaries of Ireland* 121 (1991): 105-45. Print.
Leask, H. G. *Irish Churches and Monastic Buildings 1. The First Phases and the Romanesque*. Dundalk: Dundalgan, 1955. Print.
Ledwich, E. *Antiquities of Ireland*. Dublin: Grueber, 1970. Print.
Macalister, R.A.S. *Corpus Inscriptionum Insularum Celticarum 2*. Dublin: Stationery Office, 1949. Print.
Moloney, M. "Beccan's Hermitage in Aherlow: The Riddle of the Slabs." *North Munster Antiquarian Journal* 9 (1964): 99-107. Print.
Mytum, Harold. *The Origins of Early Christian Ireland*. London: Routledge, 1992. Print.
Netzer, Nancy. *Cultural Interplay in the Eighth Century: The Trier Gospel and the Making of a Scriptorium at Echternach*. Cambridge: Cambridge University Press, 1994. Print.
Ó Cróinín, Dáibhí. *The First Century of Anglo-Irish Relations : Ad 600-700 : The 31st O'donnell Lecture* O'donnell Lectures. Dublin: National University of Ireland, 2003. Print.
O'Keeffe, Tadhg. "Lismore and Cashel: Reflections on the Beginnings of Romanesque Architecture in Munster." *Journal of the Royal Society of Antiquaries of Ireland* 124 (1994): 118-52. Print.
Okasha, Elisabeth. "Name-Stones." *Reallexikon der Germanischen Altertumskunde* 20 (2002): 544-51. Print.
---. "The Non-Runic Scripts of Anglo-Saxon Inscriptions." *Cambridge Bibliographical Society* 4.5 (1968): 321-38. Print.
Okasha, Elisabeth, and Katherine Forsyth. *Early Christian Inscriptions of Munster: A Corpus of the Inscribed Stones*. Cork: Cork University Press, 2001. Print.
Pavia, Sara, and Jason Bolton. *Stone Monument Decay Study 2000: An Assessment of the Degree of Erosion and Degradation of a Sample of Stone Monuments in the Republic of Ireland 2000*. Dublin: Heritage Council Ireland, 2001. Print.
Petrie, George. *Christian Inscriptions in the Irish Language*. Dublin: Royal Historical and Archaeological Association of Ireland, 1872-8. Print.
Power, Patrick. *The Place-Names of the Decies*. London: Nutt, 1907. Print.
---. *Waterford and Lismore: A Compendious History of the United Dioceses*. Cork: Cork University Press, 1937. Print.
Quinlan, Margaret, and Timothy Foley. *Saint Lachtain's Church Freshford County Kilkenny Conservation Plan*. Dublin: Heritage Council, 2004. Print.
Seaborne, Malcolm "Celtic Crosses of Britain and Ireland." *Shire Archaeology* 57 (1989): 45-46. Print.
Spearman, Mike. "Intelligent 3d Imaging." *Digitising Our Heritage Conference*. NMI, 2003. Print.

Stout, G. T. . *Archaeological Survey of the Barony of Ikerrin*. Roscrea: Roscrea Heritage Society, 1984. Print.
Thornton, Donna J. "The Lives of St Carthage of Lismore." PhD Thesis. University College Cork, 2002. Print.
Ugan, Andrew, Jason Bright, and Alan Rogers. "When Is Technology Worth the Trouble?" *Journal of Archaeological Science* 30.10 (2003): 1315-29 pp. <http://www.sciencedirect.com/science/article/pii/S0305440303000220>.
Waddell, J., and P. Holland. "The Peakaun Site: Duignan's 1944 Investigations." *Tipperary Historical Journal* (1990): 165-86. Print.

Appendix

The Polhemus FastSCAN handheld laser scanner is a non-contact digitiser that allows for the fast scanning of three-dimensional objects. The scanning process is like spray-painting the object: a laser beam emitted by a wand is smoothly swept over the object. A main component of the system is a processing unit, about the size of a desktop computer, which takes care in real-time of the registration process to combine the overlapping sweeps together. The wand itself is a non-contact range finder based on the simultaneous projection and detection of laser light (using plane of light technology) coupled with a magnetic system to keep track of the position and orientation of the wand. When activated, this wand emits a laser beam (a Class II laser, 1mW at a wavelength of 670nm) that is read by one of two cameras mounted on each end, while the 3D location of the profile is computed by triangulation using the magnetic tracking system.

The processing unit plugs into the computer's printer port, and the wand connects into this unit. During the acquisition of the data, the processing unit is connected to a Compaq Evo (1.2GHz - 256Mb Ram) laptop. Later a Dell Dimension 4550 (2.6 GHz - 512Mb Ram) desktop is used for post-processing the raw scans. During the acquisition process, the FastSCAN software allows a view of the model as point clouds, as a wire frame, or as a smooth shaded image; only polygonal and point cloud data can be generated as output.

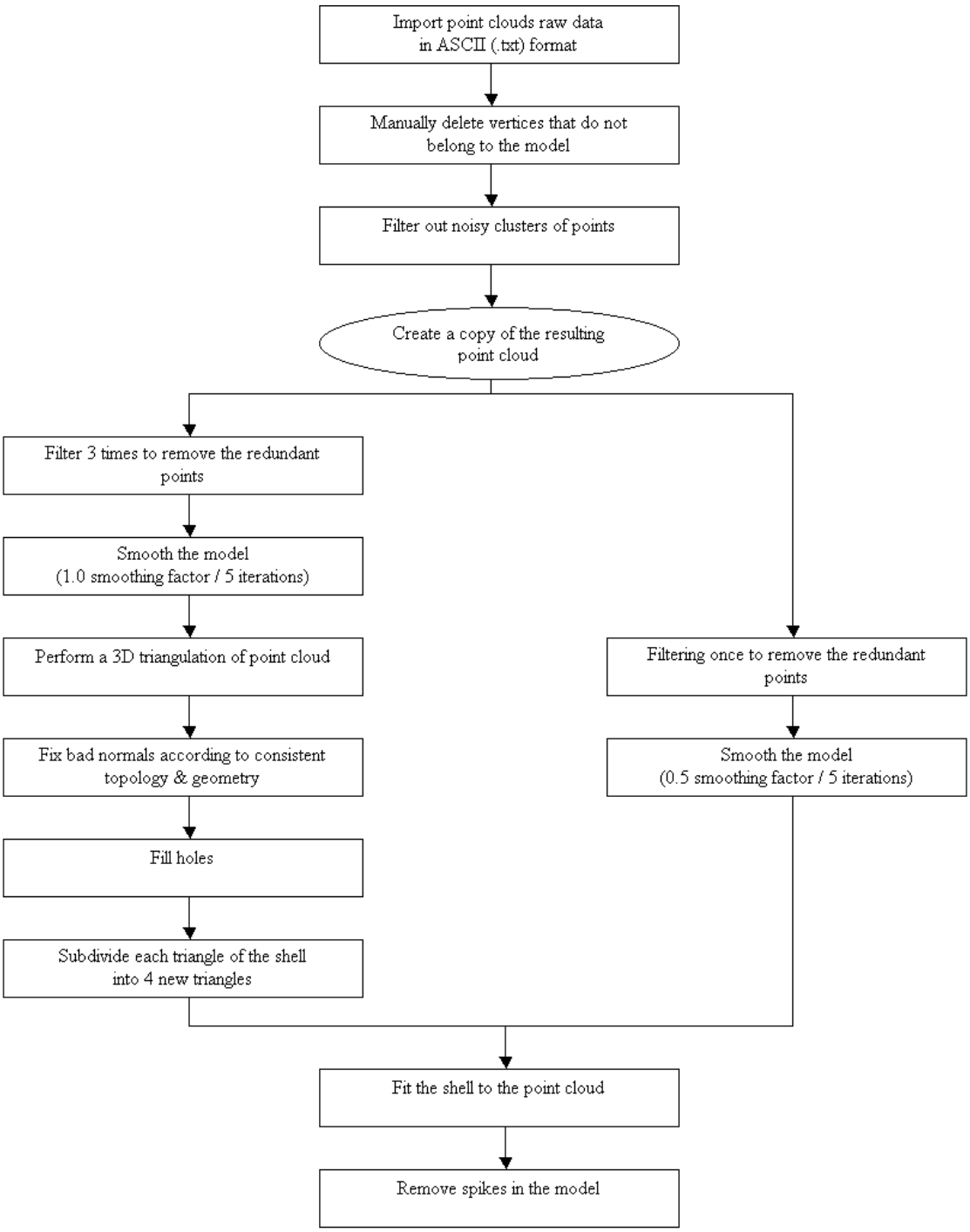
This point cloud is a set of points at known x, y, z locations in space. The resulting digital file is comprised of voxels, 3D pixels, in the computer. This point cloud dataset can then be processed by the Rapidform Software.

RapidForm2004 Origin from INUS Technology Inc. is powerful reverse engineering software that enables the construction of a complete 3D digital model from a point cloud. This software is the leading application used in a wide variety of technical fields; such as industrial reverse engineering, mass customisation, graphics animation, rapid inspection, and 3D photography to create 3D digital models.

In this project, RapidForm Origin is used to process the raw point cloud data obtained from the FastSCAN scanner into polygon meshes. The main problem with the raw data is the slight mis-registration that exists between successive overlapping sweeps. This problem induces noise in the triangulated model in the form of 'spikes'. The second most important problem is the presence of holes in the point cloud data. These holes correspond to areas, usually narrow cavities, that cannot be reached under any direction by the laser beam. During the one-month period when Thierry Daubos evaluated RapidForm, the software proved itself fairly efficient at solving the problems mentioned above.

An attempt to directly triangulate the point cloud would lead to a 3D model with too many holes to be filled. On the other hand, cleaning up the data prior to triangulation, in order to later reduce the number of holes, would lead to an overly smooth 3D model and a significant loss of details/resolution. Instead of having to trade accuracy for continuity, RapidForm allows for a more satisfactory approach: first a nearly hole-free, continuous shell is created from a smoothed subset of the point cloud data. Then, this shell is fitted to a copy of the point cloud data that has undertaken much less smoothing.

The following data flow diagram displays each element of the process from point cloud to digital model.



Flow Diagram of the Rapidform Process generated by Thierry Daubos <http://www.daubos.com>

The team begins with a real object and generates a 3D model. What seems to be a continuous surface on the model is a set of linked points in space, like pixels in a digital image. In the initial image of the positive cast of the Toureen Peacaun inscription model in our sample, while the inscribed area is 37.4 cm x 73.4 cm in height it consists of 411,000 vertices and 821,000 triangles in the model.

When the image is thus captured it is possible to adjust the ambient, diffuse and specular colours of the material, as well as a shininess parameter, in order to enhance the legibility of the characters of the inscription. The resulting 3D file can be lit from various directions, its surface texture can be changed and its relief can be exaggerated.

One of the possibilities of the software process is called minimum curvature texturing. In this case the computer searches for the flattest curve that will pass through a given point on the surface. If the point is at the bottom of a depression – like an inscribed letter – then it has a negative value. The computer collates numbers for each point. Then, in order to make the numbers visible, the negative values are assigned a particular, perhaps darker, colour. This then is not at all like a normal photograph: it is a mapping of numerical values that record curvature. See: Appendix Image 1: Minimum Curvature Texturing of the Model of the Positive Cast.

Another aspect of the process involves flattening the stone's surface. The natural fluctuations in the stone's surface may be removed using IDL, Image Data Language. The idea is to remove the background height fluctuations whose frequencies are below the frequencies of the inscription in order to make it appear as if it had been written on a flat surface. Images are then displayed as a

‘height field’ in IDL – like a topographic map. A haze colour table in IDL marks the highest parts in gold and the lowest in purple in our example. See: Appendix Image 2: Removal of height fluctuation in IDL.

If there is a low frequency in height across the model (for example a shallow dip, top to bottom, like a valley) this impedes a clear reading of the inscription. In order to remove it the image is processed again using wavelet filtering. See: Appendix Image 3: Application of wavelet filtering.

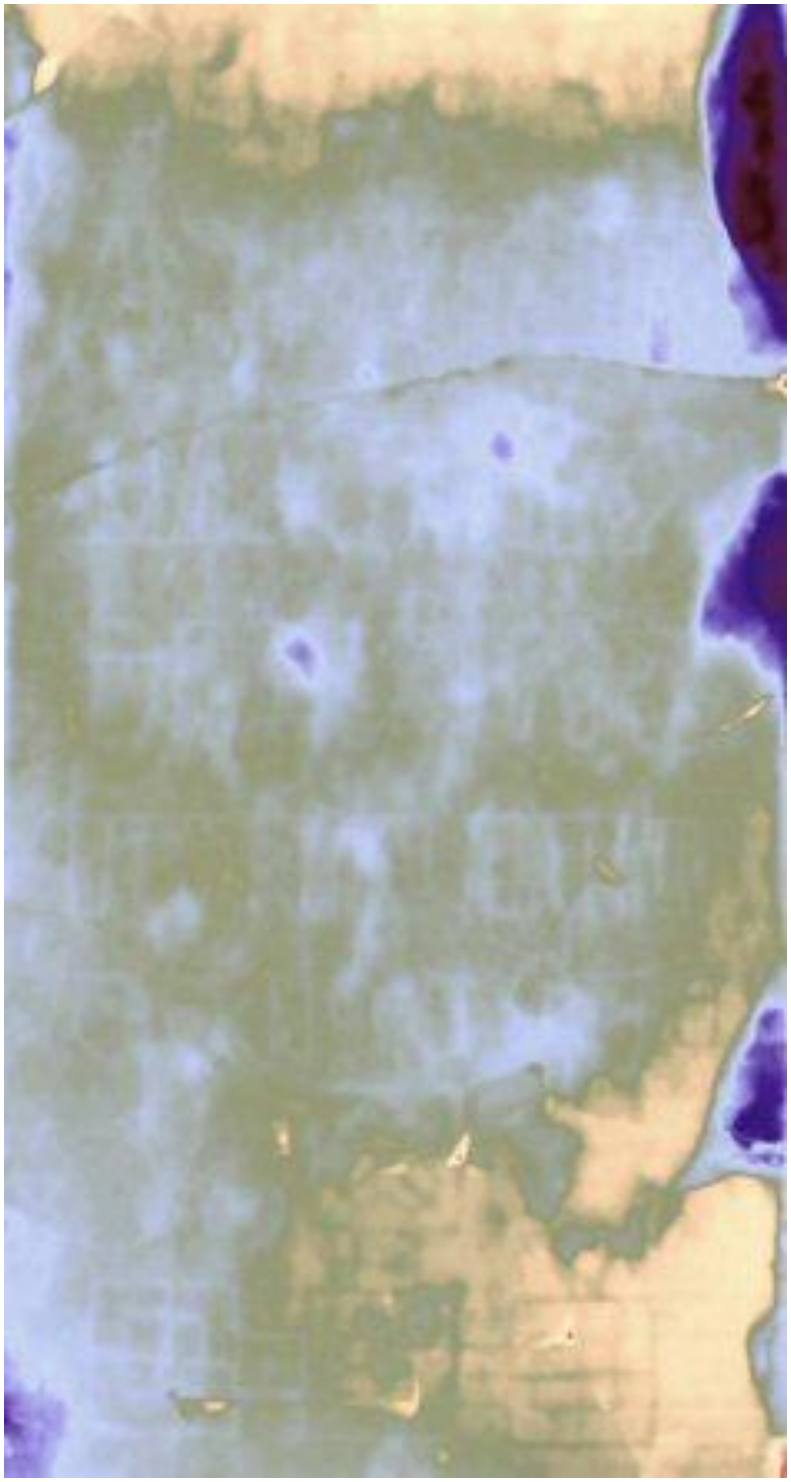
It is also possible to make movies from the 3D model. Appendix Image 4 is a still from a synthetic video sequence generated by importing the 3D model into 3D studio max software. An artificial texture with high reflectance properties is applied to the model and different light conditions are stimulated by moving the artificial projected light source around the model.

Hardcopy images on following page…

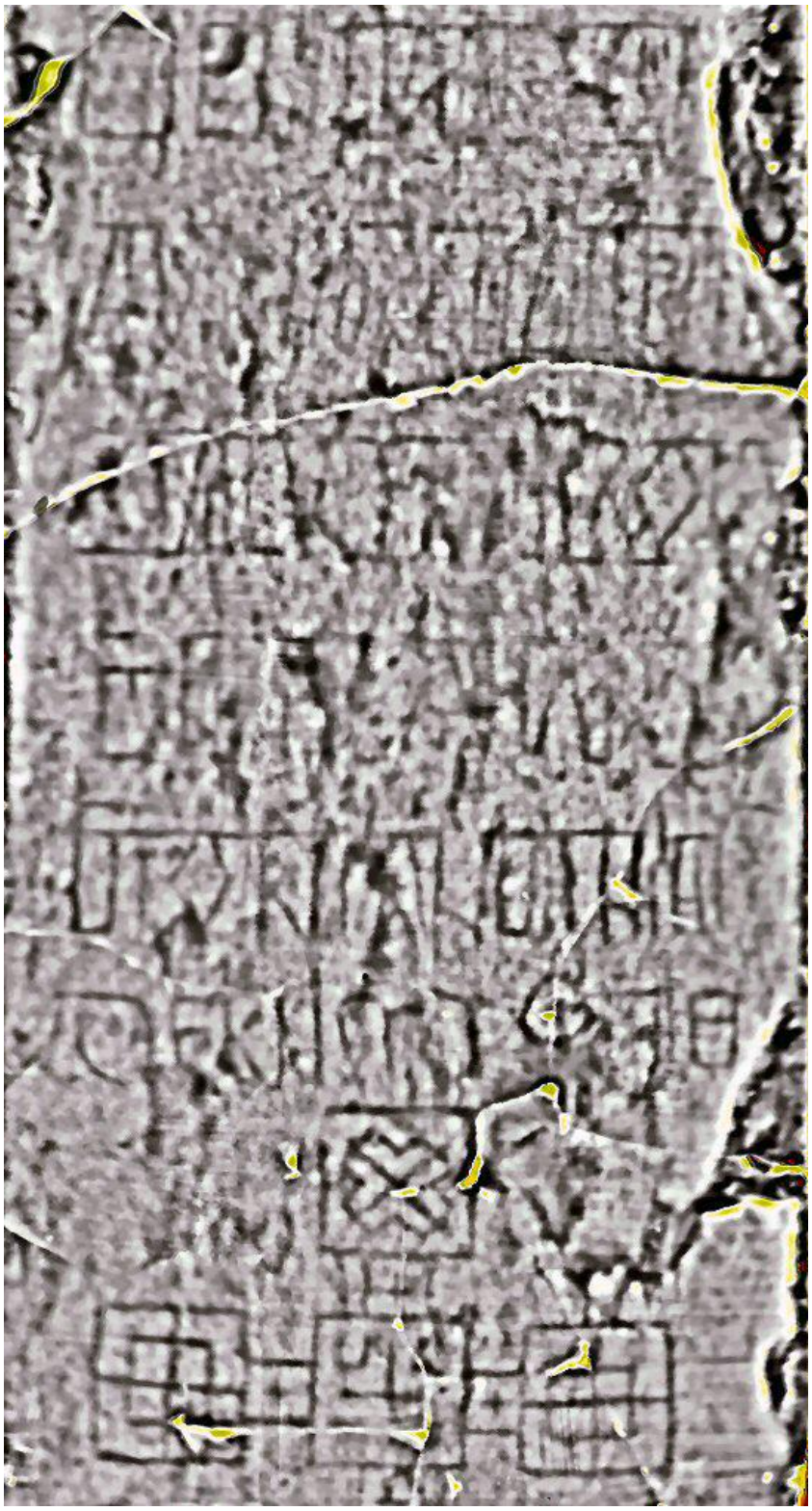
Appendix Image 1: Minimum Curvature Texturing of the Model of the Positive Cast



Appendix Image 2: Removal of height fluctuation in IDL



Appendix Image 3: Application of wavelet filtering



Appendix image 4: Still Image from Synthetic Video Sequence

