GRAPHIC ARCHAEOLOGY NEWS

SPRING 2013

THE NEWSLETTER OF THE GRAPHIC ARCHAEOLOGY GROUP

Visualising Stonehenge: Revealing the Prehistoric Carvings

COMMITTEE NEWS

Dear Members,

Well, a few things have happened since the last newsletter. Firstly, can I thank all of you who voted in the IfA Council Elections in the Autumn – I have now been elected to Council and your support is really appreciated.

Over the last few months we have been working to integrate the assessments procedures practiced by the AAI&S for full membership into the IfA Validation procedures. During the merger, one of the key concerns raised was whether the face-to-face element of the application process – the portfolio assessment – would be retained. This had been agreed, and over the past months we have put a lot of work into establishing how we can put this into practice. The assessment criteria used on assessing candidates for full membership of the AAI&S have been correlated with IfA membership criteria resulting in a competence matrix that can be used to assess candidates with a background in the Graphics field. In the next few months this will be trialled and at the Conference in April we will be running an introductory workshop session to explain the process and we hope to assess any individual candidates who wish either to join IfA or upgrade their existing membership. For further information, please get in touch.

Also on at the IfA Conference will be a discussion session on the use of images to promote and propagate archaeological projects and we will be working with the Buildings Archaeology Group on a session about the impact of new technology on the profession. The exhibition will once again be present and fresh material is requested – please contact Sarah Lucas if you have anything you wish to submit.

And of course we will have our Group AGM. Currently there are two vacancies for election to GAG committee. If you wish to stand for committee you have to get a proposal form which you must complete and return to GAG secretary before the AGM. The conference timetable is in draft form at the time of writing and will be available via the IfA Website shortly.

Elsewhere in this issue you will find a report back on the successful Lithics workshop held in Worcester in September. Discussions with the AOI are ongoing. Tom is currently implementing an update and rebranding of the former AAI&S Website which will become the GAG website in advance of a major redesign and integration of the IfA website. In the next year we also intend to conduct a review of on-line training resources, to find out what is available, what the costs are, how they can be accessed by our members – and indeed whether there are any gaps that we could fill.

We also need contributions for this newsletter. If there is anything you have been working on that you feel would benefit the rest of the profession this newsletter can be your first port of call.

Best wishes,
Steve Allen.

COMMITTEE MEMBERS

The Graphic Archaeology Group Committee as of Spring 2013

ELECTED MEMBERS

STEVE ALLEN: CHAIR

Steve is Archaeological Wood Technologist at York Archaeological Trust. As well as Chairing the Graphic Archaeology Group he is also a member of the IfA Validation Committee.

LESLEY COLLETT: SECRETARY

Lesley is Graphics and Publications Officer at York Archaeological Trust. In between organising meetings and taking minutes she supports the work of other committee members.

LAURA TEMPLETON: TREASURER

Laura is head of the Graphics office at Worcestershire ACS Archaeology Unit. As Treasurer she is responsible for tracking the Group's budget and expenditure.

TOM SMALL:

Tom is looking at setting up a skills group for those working in multimedia; contact him on any issues in this field. He is also looking at updating the former AAI&S Web Gallery for use by GAG.

LEEANNE WHITELAW:

Graphics Manager at CFA Archaeology, her areas of interest are historic building recording, surveying & laser scanning. Leeanne hopes to organise training to bridge the gap in skills from traditional methods to cutting edge technology.

JENNIE ANDERSON:

Jennie is a freelance illustrator based in Swindon and also works for English Heritage. She has taken over the Editorship of the GAG Newsletter.

ELIZABETH GARDNER:

Liz is a freelance illustrator based in Cambridgeshire, and is currently reviewing and revising our guidance notes for new starters in graphics work.

CO-OPTED MEMBERS

ROB READ:

Rob is co-opted to IfA Council and is working with the Association of Illustrators (AOI) on behalf of the GAG; copyright issues and the rights of the freelance illustrator are his particular fields.

SARAH LUCAS:

Sarah is responsible for archaeological graphics at the University of Reading. She organises the exhibition of members' work at the IfA Conference and elsewhere.

IfA Conference 2013, Weds 17th - Fri 19th April

As you will all know by now this year's conference will be in Birmingham, based at Aston University, just off the city centre. GAG has several contributions over the three days – we look forward to seeing many of you during at least one of these events!

First off we have a discussion session. 'Impact requires Imagery' is the title of our discussion session. We aim to look at how graphics can be used to best effect in the production, interpretation and promotion of archaeological projects. The session sets out to explore how images are used; why particular images are important and how effective they can be when properly used. At the time of writing we have four good papers lined up from Richard Bryant, Judith Dobie, Liz Gardner and Aisling Nash – abstracts will appear in the conference programme due shortly.

We are also contributing to the Buildings Archaeology group session on recent technology in professional practice. This is an issue of concern to both our groups (and indeed to the wider profession) and we aim to explore the impact of technology on how we practice on a day to day basis.

Something very specific to our members will be the portfolio assessment session we plan. The aim is to spend the first part of the session discussing application procedures both for new members and for members who wish to upgrade their existing membership grade. Many people from a graphics background may feel that it is difficult to successfully apply for IfA membership. We aim to show that this is not the case and offer guidance to potential applicants.

We will discuss the GAG competence matrix and how this relates to the existing Validation process. We will have some members of the Validation committee present for advice. In the second part of the session, provided of course there are people interested, we would like to run portfolio assessments for potential candidates. Places will be limited owing to time constraints but if you are interested, please let us know as soon as possible!

Finally of course we will have our AGM. This will be a short business meeting but as ever we will be needing contributions from the floor. There are currently two vacancies for elections to the formal GAG committee – again, get in touch with Lesley if you would like to participate – nomination paperwork is a requirement these days!

Steve Allen.

The GAG Exhibition!

Once again, Sarah Lucas will be preparing our exhibition for the Conference. This is a reminder for members to send in examples of your work for inclusion. GAG has a number of reusable frames for artwork which will be used to mount the work for the exhibition. This helps to give a unifying feel to the presentation. However we need to tailor the exhibition to the theme of the event and so Sarah needs a good portfolio of material from which we can select work.

Although it will not be possible to show absolutely everything submitted at each and every venue there needs to be enough variety of good graphics work to allow the exhibition to be themed to a particular event and enough work to allow for the refreshment of the exhibition, so that it does not remain static and unchanging over time. So if you want work included in the exhibition, please get in touch with Sarah for further information and acceptable formats well in advance.

Please don't bring material along on the day and expect it to be pinned or propped up because that not only spoils the look of the overall exhibition but makes it very difficult to keep to the overall theme of the work already chosen and negates the hard work done beforehand by the exhibition designer!

Steve Allen.

Lithics Workshop at The Hive, Worcester

In September 2012 the IfA supported a Lithics workshop for illustrators. Hugo Anderson Whymark, a lithics specialist based in Oxford,led the workshop and demonstrated the technology of creating stone tools and the features which illustrators need to recognise when depicting a lithic collection.

Hugo's experience ranges from the late Upper Palaeolithic to Post medieval industries of the British Isles and he was able to demonstrate and discuss with us aspects of manufacture,use damage, wear and other features relevant to an illustrator depicting a collection for a technical report. Together we examined results of the first strike on a flint nodule using different types of hammer, through the processes of tool making up to the finished articles and the cores left behind.

Our location in The Hive meant that we were able to refer to the large collection of archaeological volumes kept in the University and Public library and consider methods of publication over the last 100 years. It was interesting to see how the invention of photography altered how artefacts were represented in journals in the first part of the 20th century and to compare that with the abilities we now have of using photography as a method of illustration in reports.

There were 7 attendees – a deliberately small number so that we could give each person plenty of opportunity to contribute and ask questions. The Hive allowed us to use one of the meeting rooms at no charge, and the IfA subsidy meant that the day was priced £30 per person or £20 GAG members.

Thanks therefore go to the IfA and the Hive for the funding and the location, and many thanks to Hugo for an extremely useful workshop.

If any GAG member is interested in another Lithics for Illustrators workshop, please let the GAG committee know and we will arrange another. And perhaps also for other specialist illustration subjects - Prehistoric Pottery anyone?

Laura Templeton.

Hugo Anderson-Whymark

The Hive, Worcester

Training & Continuous Personal Development (CPD)

Although this article is written from the point of view of archaeological illustrators undoubtedly some points raised may be applicable in other specialist areas and to anyone engaged in producing visuals from archaeological data.

Training opportunities for archaeological illustrators have always been a hit and miss affair and over my career of nearly forty years, twenty of them as a full time employee, I can count the number of day's formal training I have received on the fingers of one hand. In common with other skill areas within the profession the majority of training opportunities have been informal, on the job and provided in answer to specific needs dictated by the work programme and technical developments. Access to formal training outside of the workplace is variable with those working for employers with a training culture e.g. local government based units etc. appearing to have greater opportunities than those working within other areas of the profession although the present economic pressures have seen training budgets, where they exist, cut drastically.

The Government supports workplace based training and the development by employers of training and qualifications they need, an approach the IfA supports. There are pitfalls with this method of training which is focussed on the requirements of employers and not on an individual's needs for enhancing existing skills and career development. It also fails to address the requirements of the self-employed, freelance members of the profession or indeed those at entry level who wish to pursue a career in this area and are looking for both guidance and training to attain this goal.

Almost without exception new students inevitably ask two questions; "what skills do I need to acquire to potentially fulfil the role of an archaeological illustrator" and secondly "what level of skill and knowledge do I require to have a possibility of employment as a specialist archaeological illustrator". Both questions are difficult to answer; if you refer to recent job advertisements the answer to both is basically everything you can think of from traditional drawing skills to a large range of software applications. In reality the numbers of people who have this range of skills are small and are likely to be employed in organisations similar to those advertising the position and consequently in the long term a diminishing resource. As a specialism we need to look at and consider the broader training requirements to include those operating outside the employed model whose access to future bursaries, apprenticeships and accredited workplace qualifications is limited or non-existent and whose main focus will be CPD.

There are two main areas which, as a specialism, we need to address, the first to investigate the relevant training opportunities which already exist, its quality and relevance. In this digital age there are numerous training paths which are on offer, either free or subscription based, presented in formal and informal training formats including forums and social media. The question, in this plethora of training opportunities, is which are relevant and useful, easy to use and what level of existing background knowledge do they require. The second question concerns the level of expertise required at different stages of an illustrator's career. Do employers actually expect illustrators to appear fully formed with skills ranging from traditional to high level digital or do we need to define skill levels on a developing career basis from entry level to practitioner to advanced level to encourage a more realistic expectation within the profession.

In the long term CPD will play an increasingly important role in association with work placed training and the answers to the questions raised above should influence both approaches and help contribute to a fully informed framework of training provision. In the short term the Graphics Archaeology Group is considering a project to address the questions raised. In terms of existing training provision it is suggested that peer review of digital based training and traditional publications would be useful based initially on the recommendations of GAG members and the results made available as a CPD resource to enable a personal training programmes to be devised by individuals. Allied to this is the question of developing skill levels throughout a career and this may be approached via a consultation process with its members, external organisations and interested non-members.
Archaeological illustration or the visualisation of archaeological data in its many guises is an integral part of the archaeological process and although text is still regarded as 'King' it has an important role. If we recognise the necessity of providing a developing, high quality enhanced product to our clients we should also recognise that illustration has a major contribution to make which needs a clearly defined training resource and specialists who not only have the craft skills but also creativity and design knowledge.

Training

Having been recently 'elevated' to the position of Programme Leader on the only full time course in archaeological illustration I have been reviewing the available teaching resources. The course has been running for well over twenty years originally at HND level and then developing via the BA to its present MA status. In the old days of traditional drawing techniques it was fairly easy to find examples of exemplary work and methodologies remained fairly constant.

The advent of digital graphics has changed this and innovation has gathered momentum both in technique and approaches to visualisation. The MA focusses on new and innovative approaches but the difficulty is obtaining examples of work which may not be readily available due to its purpose (grey literature), it's dissemination format, or merely because the publication is not easily available.

What I would like to ask GAG members is whether they could contribute examples of work with a little background detail on the project and the production process which we could maintain as a purely educational resource. In order to ensure that this is the case, although not absolutely necessary for educational use, copyright licences will be issued so that the copyright and intellectual rights are preserved by the illustrator or copyright owner. Any material donated, preferably as a PDF, would be studied by students on the course and projected for lectures with no other use allowed unless consented to as specified by the licence.

If there is anyone who feels that they may be able to help please get in contact.

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Programme Leader – MA Archaeological Illustration
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Visualising Stonehenge; Revealing the prehistoric carvings

Marcus Abbott MIfA, Head of Geomatics and Visualisation, ArcHeritage. Sheffield UK

1. Introduction

In 2011 English Heritage commissioned the most detailed digital survey of Stonehenge ever undertaken. Utilising the latest in laser scanning technology, Greenhatch Group recorded the surface of every stone at a 0.5mm point density. In March 2012 ArcHeritage were commissioned by English Heritage to examine and visualise this digital data in a manner that both confirms existing discoveries and reveals new information about the faces of stones. Any new discoveries would be integrated with the wider context of the monument and its landscape [FiP10]. Key to the completion of this objective was the involvement of Hugo Anderson-Whymark, a freelance lithics specialist and expert on Stonehenge, Hugo provided the interpretation and context to all of the discoveries and was instrumental to the success of this project.

The full results of this ground breaking research will be made available in an English Heritage research report due to be published later this year [AAW12], English Heritage intend to use this work to inform the interpretation design for the new visitor centre, the construction of which is due for completion in 2014. The success of this project therefore has the potential to influence the way Stonehenge is presented to the public for the next decade and beyond.

A secondary goal of this project sought to develop the technologies that underlie the visualisation of cultural heritage. While pursuing our assigned brief, we expanded our proposal to research and identify working methodologies that can be applied to the analysis of digital survey data, not only on Stonehenge, but also at a variety of chronologically and geographically diverse future heritage projects. We supplemented the supplied laser scan data with a photogrammetric dataset that provided a distinctly different but complementary opportunity to visualise the monument. The use of both laser scan and photogrammetric data collection created different data formats that could be analysed in different ways, providing opportunities for comparison between the data sets and numerous options for visualising the surface of the stones. This variance in the technologies and methodologies utilised to investigate a single target is a defining characteristic of this project.

Altogether, the Stonehenge laser scan analysis project has revealed a variety of new information on the history of the stones and the construction of the monument. This paper concentrates on one aspect of the wider analysis and focuses on our investigations to create a technique to visualise prehistoric carvings on the stones at Stonehenge.

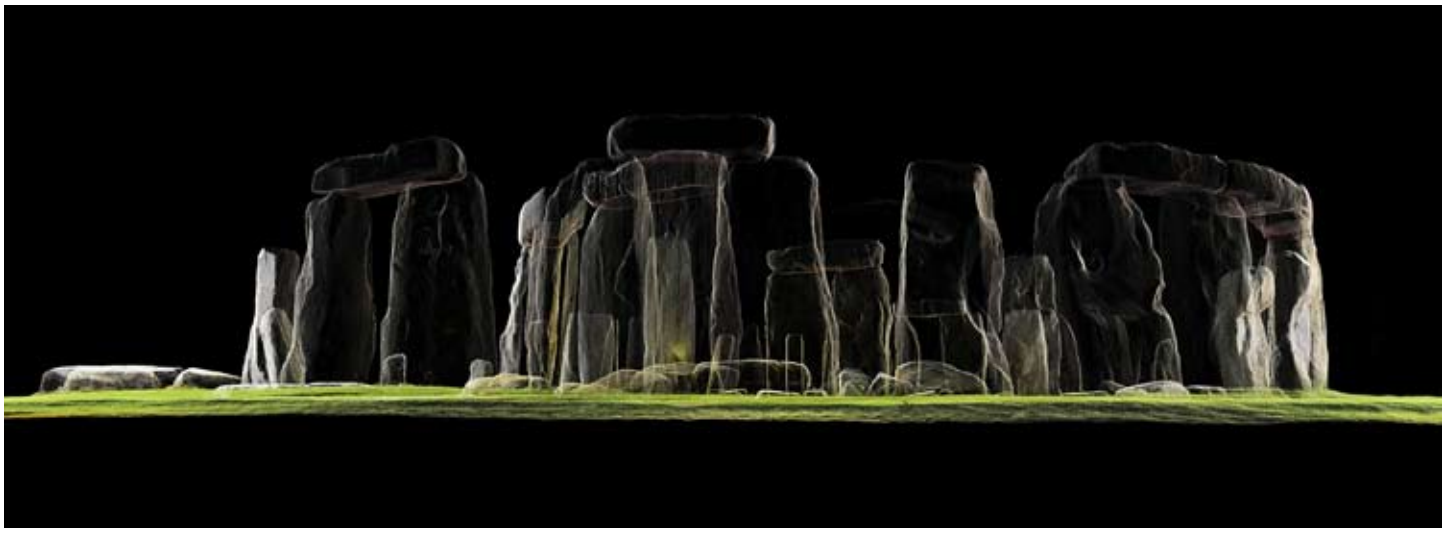

Figure 1: *point cloud render generated in Leica Cyclone 7 showing the laser scan data supplied by English Heritage*

2. Background

The first documented discovery of prehistoric carvings at Stonehenge was made on the 10th July 1953, by Richard Atkinson [Atk79]. A shadow on stone 53 revealed the form of a hilted dagger and an axe-head carved into the surface of the stone, and several other carvings were noted in the years following. The carvings are said to represent Bronze Age axes, unhafted, with their crescent blades facing upward. Previous to our research there were 44 axe carvings and two dagger carvings known at Stonehenge, most of which had been discovered in the 1950's and 1970's. Two additional axe carvings were discovered after T Goskar experimented with laser scanning on three partial stone faces in 2002 [GCC03]. This discovery gave us a tantalising glimpse of what might be possible with the implementation of high resolution survey technology and the subsequent analysis of the data. A decade later with the increase in development of laser scanning and photogrammetric technology, the question was asked: could more carvings be discovered?

3. Digital Data

English Heritage supplied ArcHeritage with geo-referenced point cloud data at a spacing of 0.5mm for every stone face (Figure 1). They also supplied mesh model data in the form of .OBJ files. These meshes were at 1mm resolution for the entire site, with areas of known carvings meshed at full 0.5mm resolution. The meshes were created in Geomagic by the original survey company, Greenhatch Group. ArcHeritage also created a photogrammetric data set of selected areas during our on-site visits. With the addition of this second, photogrammetric dataset, we were able to supplement the original laser scan information with a comparative sample. Thus we were able to work with and visualise two sets of data (laser scan and photogrammetric) and, within each of these sets, two types of data (point cloud and mesh data). The ability to work with complimentary lines of investigation provided a number of options in how to approach the visualisation and analysis of the different data sets, but most importantly, it gave us the ability to compare and confirm our results.

4. The Photogrammetric data

Photogrammetric data of selected stone surfaces was collected with the intention of creating high-resolution surface meshes. These meshes would be used to establish the resolution at which individual features become visible. This dataset was initially intended to act as a reference, but the results were so successful that we decided to include the photogrammetric data as a primary source for the analysis of the stone surfaces. Photoscan the software used to generate the photogrammetry data, was created by AgiSoft.

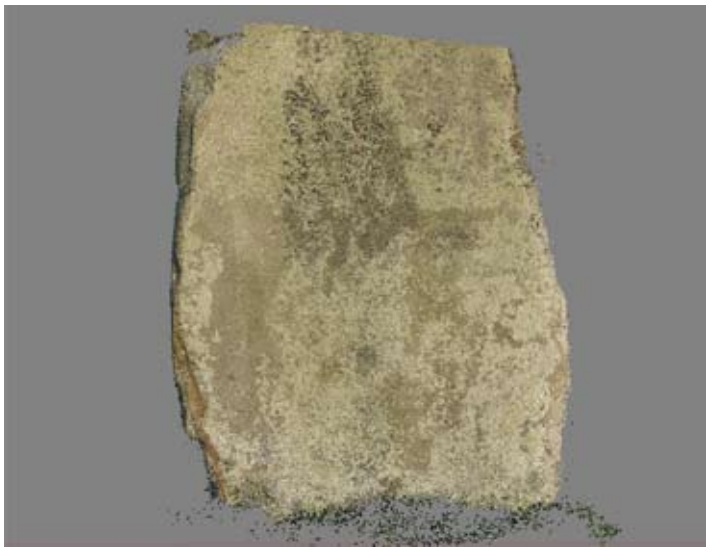

Figure 2: point cloud of the East face of stone number 4 generated in Agisoft photoscan from 128 photographs

This software allows for the use of a consumer grade digital camera; our results were captured with a Leica V-LUX 2, 14 megapixel digital camera. On average we took thirty photographs per square metre of rock surface. Although the photogrammetry software provides a convergent solution so it is not necessary to create stereo pairs, our photographic strategy was to create a series of overlapping parallel images and a set of images oblique to the stone surface.

For each stone panel, the photographs of the area were aligned in PhotoScan at the high accuracy setting, creating a point cloud derived from 100+ photos (Figure 2). Mesh generation was then conducted using the 'high' setting, generating a final mesh model of approximately 25 million polygons. Ordinarily 3-D control would have been incorporated into the project through the use of known control points on the stone surfaces, but we were able to use the laser scan data as a control for the scaling and geo-referencing of our mesh data. If collecting data without the benefit of a laser scan survey, control points would need to be added and surveyed in order to scale and geo-reference the project.

5. Visualising mesh data

Both the laser scan data and the photogrammetry data produced comparable mesh models. Examination of the high-resolution mesh data initially focused on controlling the interplay of light and shadow, a well documented method for highlighting surface variations that has been used successfully on numerous heritage projects [Duf12]. We also referred to recent advancements in the use of reflectance imaging, and Hewlett-Packard's development of Polynomial Texture Mapping (PTM) provided proven methodologies for data analysis and enhancement.

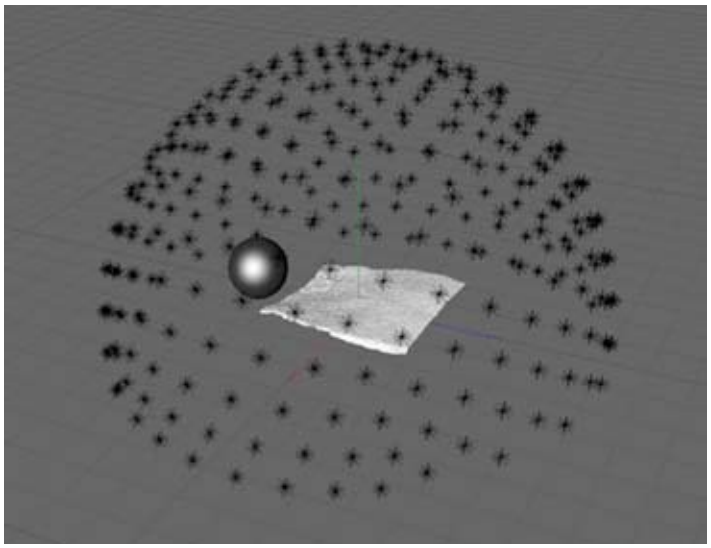

Figure 3: Lights in a hemispheric pattern positioned above the mesh data for stone number 4. The sphere provides location information for the software.

The initial analysis of the meshes was conducted in a virtual environment created in Cinema 4D R13 and consisted of 280 lights positioned in a hemispheric pattern about a single point of origin (Figure 3). The selected mesh was centred on this point. A single parallel camera positioned directly above the mesh rendered out a high definition image lit by one of the 280 lights. The light is then extinguished and a new light source engaged. The image is repeatedly rendered from the same camera position with each new light source. The pitch and azimuth of the new light are different from the previous and therefore cast different shadows across the 3-D surface. Using an animation, the process is repeated with all 280 light sources to produce a series of images. The suite of images are mathematically synthesised into a PTM file that allows the user to choose the direction of the light source and interactively re-light the surface of the stones. This is done with software from Cultural Heritage Imaging (CHI). The changing interplay of light and shadow reveals fine

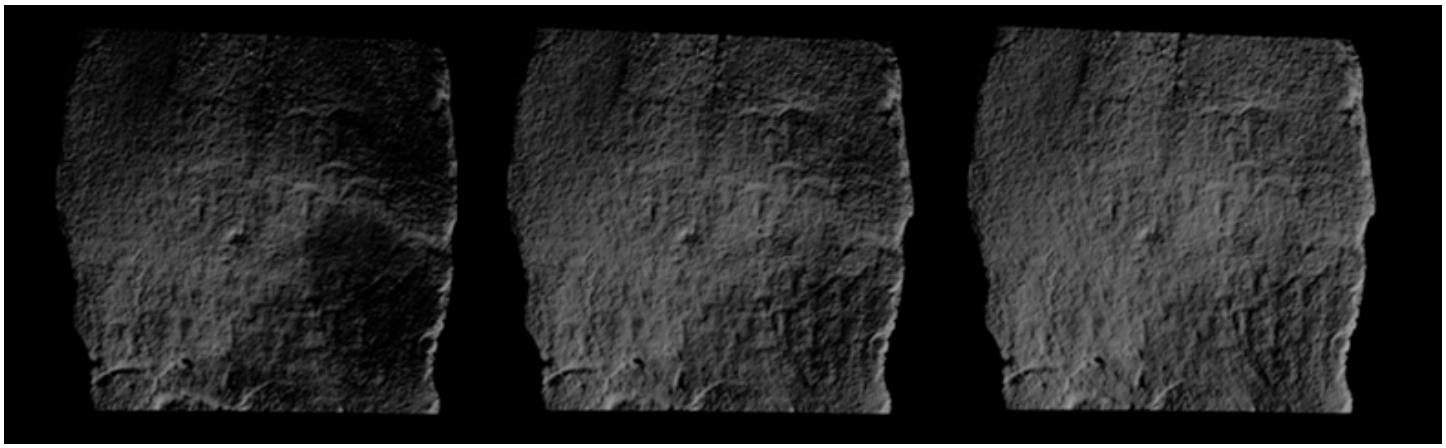

Figure 4: *image of the mesh data for stone number 4 the interplay of light and shadow revealing surface carvings*

details in the surface of the 3-D mesh, which appear and disappear as the light passes over.

Using this technique, individual and unique carvings could be seen and identified (Figure 4). It became clear that as well as the documented carvings, previously unknown carvings were also present on the surface of the stones. The data also showed that there might be further discoveries to be made; a noticeable data signature seemed to indicate additional areas of shallow carving. This signature appeared as an area of patterning which was reminiscent of a hammered sheet of metal, a pattern that stood out against the neighbouring stone surface. Together, the combination of the identified carvings and the data signature seemed to form panels of artwork that provided us with target areas on which we could concentrate and focus our visualisation techniques. To further define these areas and hopefully detect more carvings we turned our focus to the point cloud data.

6. Visualising point cloud data

Visualisation of the point cloud data allowed us to investigate whether the data signature was a real surface feature or a product of the meshing process. Visualising this dataset also provided an opportunity to clarify the outlines of newly discovered rock art and to enhance the shapes seen in the data signature.

The point cloud data was visualised in Pointools using the plane shading function. This function works by defining a grey scale shading band in relation to a fixed camera position and camera plane (a hypothetical plane perpendicular to the direction of the camera) (Figure 5). Experiments determined that in order to identify stone surface features the optimum depth for the grey scale band was 75mm. The bands were moved through the point data at

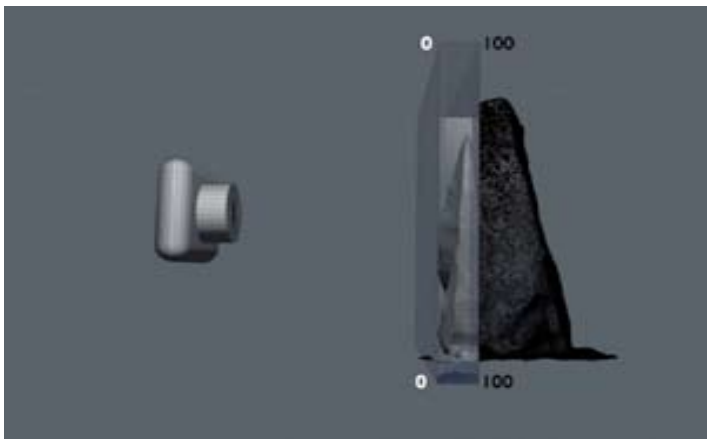

Figure 5: *schematic illustration showing how a grey scale shading band moves through the mesh colouring points on the mesh surface from white (0) to black (100)*

Figure 6: *plane shaded pointcloud data for the NW face of stone number 53 prehistoric carvings are clearly visible*

1mm intervals; each point completes a full colour change from white to black in 75mm. Each 1mm movement was recorded using a virtual parallel camera to create a high definition orthorectified image of the shaded grey scale pattern (Figure 6). This band was repeated to fill the space required to visualise different contours of the stone. Individual points in the cloud would be assigned a grey scale value based on their position within each band and its distance from the camera plane. These differences in grey scale values between neighbouring points reveal subtle changes in surface topography.

These 75 images were rendered to form a complete animation of the sequence. The resulting animation shows prehistoric carvings fading in and out of view as the grey scale band moved through the rock surface. From this we could identify previously recorded carvings and better define the newly discovered carvings present in the mesh data.

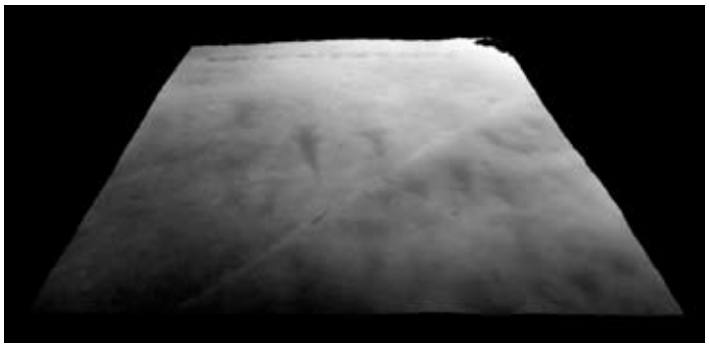

Figure 7: *plane shaded texture locked to the point cloud to aid visual perception of the prehistoric carvings*

As a result this technique was deemed successful and was the most effective way of visualising the point cloud data (Figure 7), but there were still limitations, we were still unable to visualise the areas of the data signature with any clarity. The contours of the rock surface created large areas of dark banding which obscured fine details. This process, whilst successful, was not particularly efficent as a global solution; however it did provide us with confirmation that the data signature was a phenomenon on the rock surface and not an artefact of the meshing process.

Figure 8: *Trilithon number 2. All stones were examined in a virtual environment created in Cinema 4D R13*

7. A new technique: 'Luminance Lensing'

Evaluating our experience using plane shading as a tool to investigate carvings, we concluded that, plane shading was a useful approach, but its application in this context is limited. One of the fundamental problems we had noticed with PTM and plane shading was that both these techniques relied on a fixed camera position. Prior to our investigations of carvings, we first completed documentation of the many tool marks that cover the surface of the stones. Our investigations into the tool marks had been completed in real time in the 3-D environment. We had been able to handle the stones as if they were portable lithics rather that megaliths; we could examine the mesh model surfaces much like a lithic specialist would examine a hand axe (Figure 8).

From this research we noticed that features in the mesh data were often only discernible from oblique viewing angles, and that a surface may have several features, each only visable from a unique angle. These techniques for examining the tooling of the stones did not translate to the identification of prehistoric carvings, partially because the real-time visualisation relied on the observation of the interplay of light and shadow across the stone surface. This process whilst successful in identifying ancient working practices was only partially successful in defining prehistoric carvings. Still, there remained the possibility that

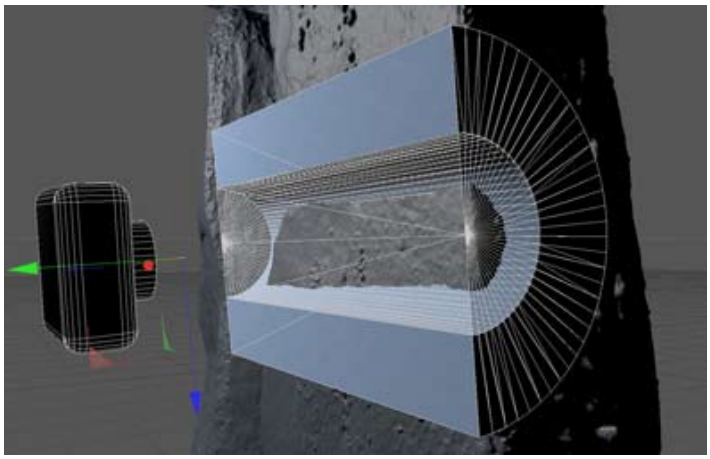

Figure 9: *Schematic illustration of the concept of 'Luminance Lensing'. The 3D shape interacts with the mesh causing the polygons to emit more or less light based on their position to the centre of the 3D shape. This light is then captured as an image by a virtual camera.*

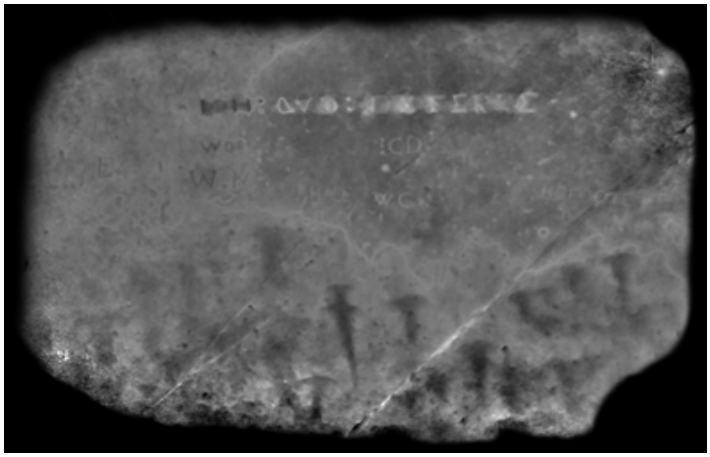

Figure 10: *Part of the photogrammetric derived mesh for stone number 53 illuminated using the luminance lens technique. Prehistoric carvings are clearly visible.*

a real-time visualisation solution that combined the successful features of both techniques would allow us to define and discover more carvings. It therefore became necessary to develop a technique that would allow us to visualise the stone surfaces and manipulate the mesh models in real time.

'Luminance Lensing' was a creative idea developed independently in-house that combines real-time visualisation with surface topographical enhancement. Executed in Cinema 4D R13, Luminance Lensing uses a custom shader to adjust the luminance channel of a material which has been applied to a 3-D mesh. The luminance value for each polygon is determined based on its relationship to a hypothetical intersecting 3-D shape (Figure 9). The position of this 3-D shape is fixed in relation to the viewing camera angle; the camera essentially looks through the shape at the mesh surface.

The luminance value of each polygon can be 'focused' by moving the camera back and forth in relation to the mesh surface. Polygons emit more or less light based on their proximity to the 3-D shape. As the camera pans across and in/out of the surface rock art features are revealed as areas of increasing or diminishing brightness. Settings allow for both a positive and negative (much like the negative of a photograph) view of the 3-D rock surface.

The Luminance Lensing technique allows rock art to be visualised in real time on the 3-D mesh. High definition renders can be made of the 'focused' area and enhanced in a composite image output (Figure 10). The results of this technique produce clear and concise images of the prehistoric carvings. These images are particularly useful, as they represent an objective visualisation of the data set and, when presented alongside the interpretative drawings, illustrate the process and foundation on which interpretations are based (Figure 11).

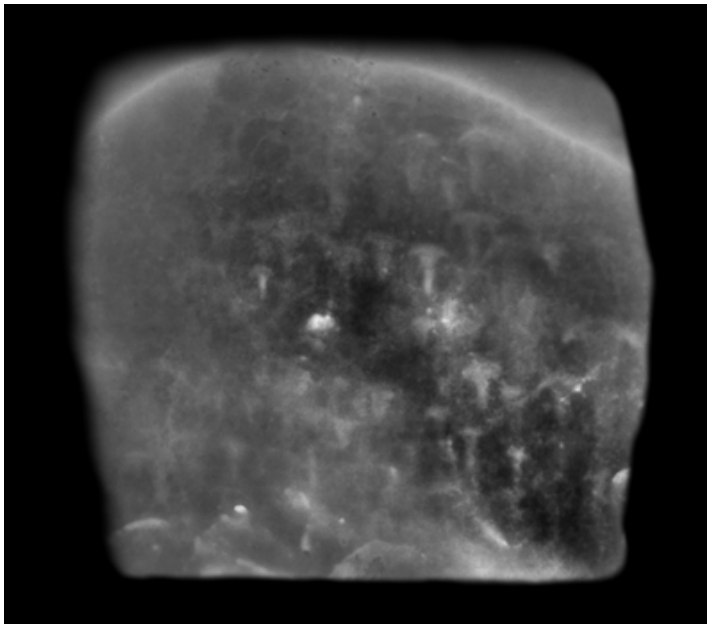

Figure 11: *Part of the photogrammetric derived mesh for stone number 4. The luminance lens technique creates concise outlines for the prehistoric carvings.*

8. Work-flow

We created a simple and yet effective work-flow that allows us to examine the meshes in real-time and accurately plot any new discoveries. First the Luminance Lens technique is applied to a mesh, once an area of carving has been identified and illuminated on the mesh surface, we bake the colour channel to the mesh UV texture map, creating a mapped texture of the results for that area of the stone surface. The texture map file is opened in Photoshop and a new layer is created, and in this layer we can trace the outline of the carvings. The Photoshop layer is then duplicated to a master file which contains the UV texture map of the stone's original photographic texture. This process is repeated as we scan the mesh surface looking for prehistoric carvings, eventually building up a layered Photoshop file that contains the exact UV coordinates for each carving. We can then texture our mesh with the composite UV map file and directly relate our findings with the photographic texture of the stone surface. Orthographic scale images can be created from the textured 3-D model to provide an accurate illustration of the carvings.

Luminance Lensing provides a solution which is not only effective in its execution but also elegantly simple to use. Above all it opened new possibilities. PTM and Plane Shading, whilst producing successful results, required both intensive data processing and further analysis of the resulting output, a time consuming process that prohibited a comprehensive examination of all stone surfaces. Luminance lensing is instant: the results are interactively displayed on the mesh as a texture, and the lens could be moved in real time displaying the results in real time. This working procedure gave us the ability to examine every stone in unparalleled detail and lead to some exciting new discoveries.

9. Results

Forty-four prehistoric axe carvings were known at Stonehenge before this research. Using the techniques outlined in this paper we were able to identify and map a further seventy-one axe carvings located on four stones from the thirty-four stones we examined. This is a significant increase of prehistoric carvings at Stonehenge and a remarkable national increase of double the previous number of these rare Bronze Age artworks. Working with Hugo Anderson-Wymark we were able to confirm these new discoveries and place them not only in the wider context of the monument and its landscape but also in the context of other Bronze Age axe carvings in Britain. It is clear that these axe carvings are rare, and although they are distributed across Britain the concentration of numbers identified at Stonehenge (155 axe carvings) is unique to this monument.

It is now possible to start to categorise the shape and position of these carvings. Our study has noted several distinct characteristics which can be used to separate the carvings into distinct types. Analysis of the different shapes of the carvings can also help clarify areas on the stone surfaces which are believed to be partially surviving carvings. We can overlay carvings from one stone on another to compare forms. For example a partial/eroded carving on stone 53 might now be interpreted as the remains of a carving similar in style to a newly discovered type on stone 4 (Figure 12). This digital technology has created the possibility for new research projects. There are many intriguing questions that can be asked about the carvings: Are they really representations of Bronze Age axes? And can a direct link be made between the forms of the

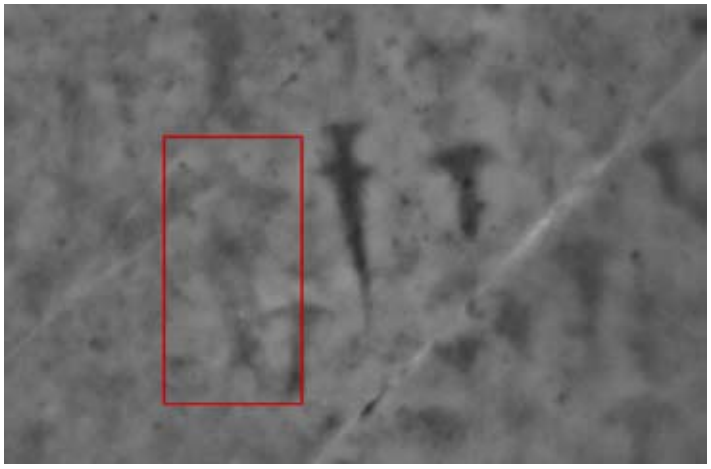

Figure 12: *With an understanding of the typology of the carvings it might be possible to define unidentified shapes as carvings like this example to the left of the dagger on stone 53*

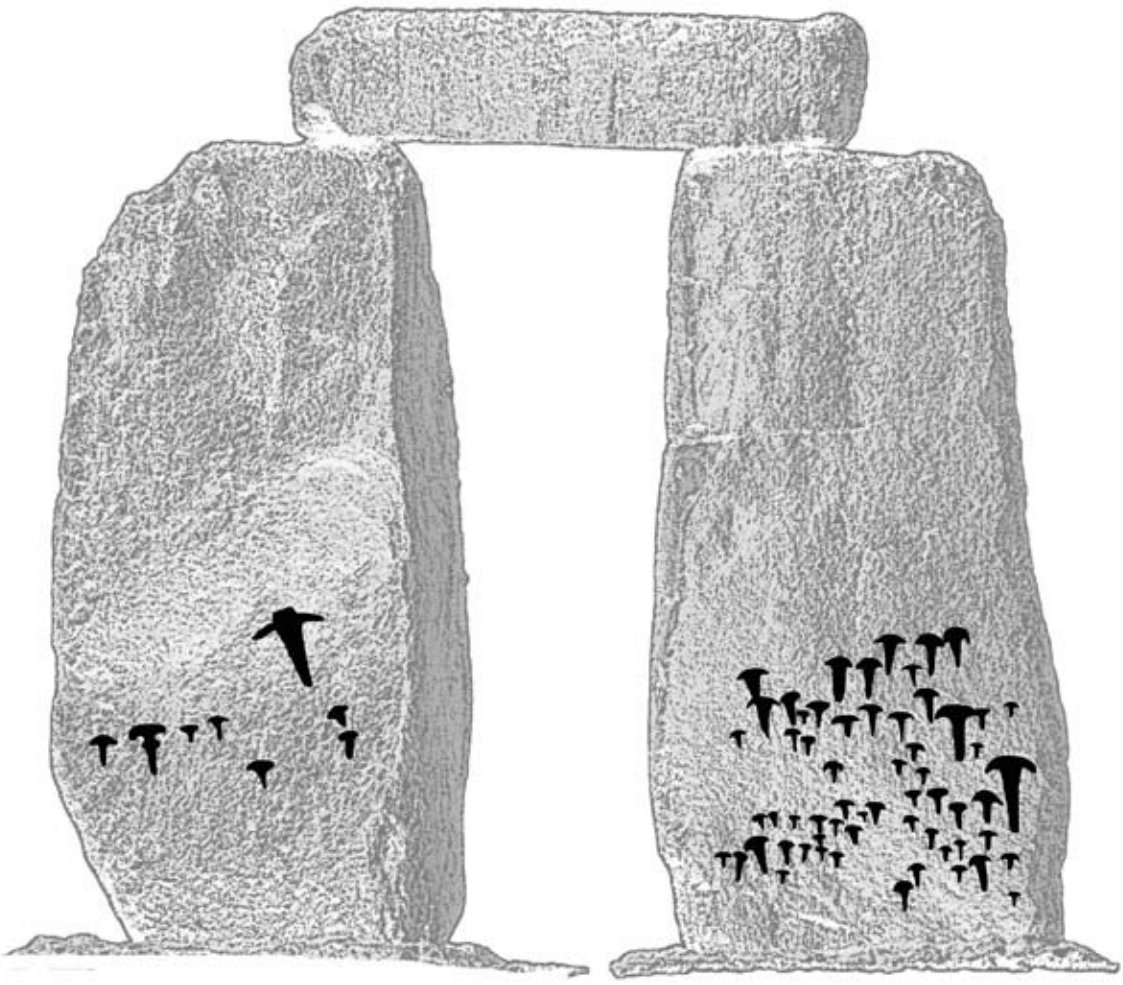

Figure 13: *The plotted results for stones 4 and 5 generate intriguing questions on the placement of these carvings. Stones 4 and 5 are decorated on the eastern side, perhaps suggesting that the important axis of Stonehenge has changed from the NE-SW solstitial axis in the Neolithic to the E-W axis in the Bronze Age.*

carvings and the forms of the actual artefacts they may represent? The use of digital technology has created a unique catalogue of the carvings that now makes it feasible to generate enough information to attempt to answer these questions.

10. Conclusion

The results of this experience in photogrammetry are particularly promising. We have been able to produce 3-D meshes of the stone surfaces that equal, if not excel, in density those generated from the laser scanning data. They also appear comparable in accuracy to the meshes generated from the laser scan data. The high resolution of the photogrammetric data has major potential to impact on the survey techniques used in the heritage sector. The affordability and accessibility of this technique makes it a viable alternative to laser scanning in many circumstances. However, it is still the view of the author that the two technologies when employed together, in a structured way, complement each other and provide a rich and meaningful data set that benefits from the diversity of the two methods. A single rock face may be better recorded using photogrammetry, but the wider context in which that rock exists is potentially better captured through laser scanning.

Acknowledgements

This project was funded by English Heritage. Hugo Anderson-Whymark is co-author of the research report and worked with ArcHeritage throughout this project. The project is also grateful for input from Mike Parker Pearson, Colin Richards and Rob Ixer. The project would also like to thank Agisoft (Photoscan) and Bently Systems (Pointools) for their support.

Marcus Abbott.

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Seeing, Thinking, Doing: Visualisation as Archaeological Research

Organizers: Catriona Cooper (catriona.cooper@soton.ac.uk) & Sara Perry (sara.perry@york.ac.uk)

Dr. Sara Perry and Catriona Cooper are organising a session at the TAG USA Conference in Chicago (9th-11th May 2013). Please see the information, below. The session will be streamed through four sites; TAG Chicago, University of Victoria (Canada), University of Southampton (UK) and the University of York (UK). Deadline for submission of abstracts to Sara and Catriona is the 1st of March 2013.

Research tends to begin with a series of observations on a site, object, monument or related space as it stands in the present, and leads to the construction of narratives which aim to craft a dialogue between that experience of the real today and the experience of the real in the recent and distant past. Visualisation is a critical methodology in such narrative creation—extending far beyond mere presentation of results into the actual constitution of data and the working and reworking of archaeological ideas. It is a key player, then, in the process of mediating the real. The visual tools we use (both new and old), their interactions with our ways of seeing, and the relationships between these interactions and our experiences on-the-ground — with collaborators, spaces, and other sensory engagements — affect how we do archaeology and conceive of the past. In other words, visual practices are intimately connected to different ways of thinking, and such connections can be (and have long been) exploited to productive effect.

This session seeks to explore such ideas via a session linked across two continents, broadcast online in the form of a series of ten minute papers followed by roundtable discussion. The discussion will be accessible to participants in Chicago, Victoria (Canada), and in the UK at both the University of York and University of Southampton. We welcome short papers introducing different methods of visualisation (including illustration, photography, survey, creative media or computer graphics) or different modes of collaborating visually. Our intention is to nurture a discussion around how vision and imaging impact upon archaeological knowledge creation, shaping our research and the future of our practice.

For more details see: http://tag2013.uchicago.edu/program.html#U

Many thanks for your interest and attention!
Sara

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UPCOMING EVENTS

17–19 April 2013
IfA Annual Conference and CPD workshops:
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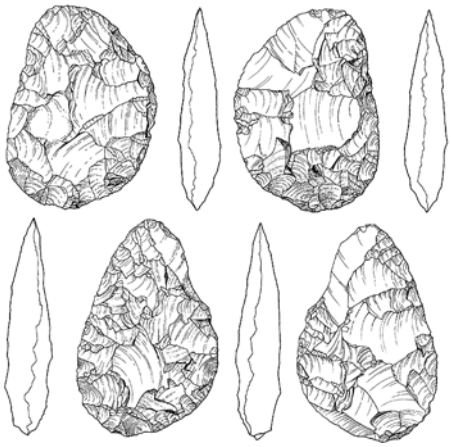
REMEMBER!

More material is always welcomed for the GAG exhibition. We want to represent **all** aspects of archaeological graphics – survey, artefact illustrations, plans and photographs as well as reconstruction art. Contact Sarah Lucas at **s.m.lucas@reading.ac.uk**

Abingdon Abbey
Sami Abd-Rabbo

Late Roman gateway, Burgh Castle
Drew Smith

Socketed bronze axe head
Hugh Kavanagh



Palaeolithic flint axes
Margaret Mathews

Newsletter contributions

We welcome contributions of all kinds, whether articles, news or comments; the next GAG newsletter is due out in June. Please contact us at issig@archaeologists.net

Copy deadline for next issue: 31 May 2013