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AARGnews is the newsletter of the Aerial Archaeology Research Group

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Edited by Rog Palmer
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Editorial

AARG 2013, Amersfoort
This year we had almost 100 participants at AARG – helped, as in recent years, by linking of ArcLand’s meeting with AARG. Conference contributions included a session on fluvial landscapes (Yorkshire, Cambodia, Bénin), management of cultural heritage (Wales, England, Ireland, Romania), innovative trends in remote sensing (vegetation marks, airborne imaging spectroscopy, ALS and relief models, access to data). We were told about landscapes (Austria, Chile, N Frisian islands, upper Egypt – presented as a superbly choreographed double act – and Czech Republic) and how close-range and 3D photogrammetry can be applied to old, new and near-future images. The final session was a debate on cognition and image interpretation that began with an oration on texture using crafted artwork from ALS data and concluded with some results on some eye-tracking experiments that had been conducted at Poznań (see Mlekuž and Michalik in this issue). Presentations were spaced to allow for discussion which was plentiful, interesting and helpful and the venue was comfortable and spacious thanks to DECARS, RCE and the local team of organisers.

AARG’s 30th birthday was celebrated via a series of (supposedly) short talks (sorry!) by selected ‘oldies’ who opened the conference with looks to the past and future. We resurrected the humorous evening sessions of the past with a cleverly-constructed presentation by Cathy Stoertz in which she assembled the crop mark that is AARG from its roots in the 19th century to the uppermost clusters of seeds in the present. Pete Horne then showed a chronological collection of hilarious pictures of AARG events of which the earliest were of the international Keleinmachnow meeting that germinated AARG’s involvement in Europe and AARG’s meeting at St Ives meeting (both in 1994). Photos included images of unbelievably-young people and conveyed the relaxed (or do I mean silly?) atmosphere that has characterised AARG meetings from the beginning and is easily fuelled by the application of beer plus the fact that we are a small group who have known one another, in some cases, for at least 30 years and form an AARG family into which new children of any age are welcomed.

We hope that selected highlights from the 30th celebrations will be on AARG’s website – perhaps they already are – and ask any of you with other photos, etc that document AARG’s history and the people involved to consider depositing a copy in our archives. These are currently held at the editorial office, so please contact me with any offers.

The final day, after a week of beautifully sunny autumn weather, was to the WHS site Schokland – now an island in reclaimed land but formerly surrounded by the sea – and then to the Nieuwland Erfgoedcentrum (a museum focusing on land reclamation and things wet, including an educational water-management area for kids). Lunch there confirmed that the bread roll is Holland’s national dish.

Ethics?
On a disquieting note, the meeting was punctuated by a barrage of clicking cameras and waving mobile devices stealing pictures of speakers’ images and presentations. These were so many and so frequent that I began to think about the ethics of image theft, although

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inhabitants of today’s I want it now society may think it is a perfectly reasonable thing to do. I’ve been told that this is now frequent practice at conferences even though most people think it is bloody rude – especially as the copiers usually don’t bother to ask first but assume it to be their right to take what they like. At many conferences, including AARG, much of the work presented is ‘in progress’ and therefore liable to change and copied images are likely to include data that is original and essential to the speakers’ research – and that is probably their attraction to the copiers. Of more concern than just image theft is the use of i-pads, etc to record a complete presentation as that surely is stealing someone’s intellectual property. Waving phones, i-pads and clicking cameras are also distractions to those of us who want to sit, listen and think. For these reasons, I suggest that use of mobile devices to capture all or parts of presentations is banned from future AARG conferences except, perhaps, to record web addresses by those incapable of writing quickly.

I’m all for Open Access, but it needs to be controlled rather than just helping yourself to whatever you fancy at the time. Some people presenting work in progress might want a delay of a year or two before their illustrations are used (probably unacknowledged) by image thieves. In the case of AARG, we are a sufficiently small group that most of us are known to others or can easily be approached and asked politely for a pdf copy of their presentations.

And before you ask, grabbing images using mobile devices is not the modern equivalent of taking notes. Notes, by definition, tend to be shortened versions of a presentation, perhaps a few keywords and place names, but do not usually attempt to transcribe a complete presentation. So if you are all going to sit there pointing mobile phones and tablets at speakers we could ask why we bother to have ‘live’ meetings at all? Perhaps future papers can be presented from the comfort of our own computers to an unseen audience who then have immediate access to whatever we present. Companionable virtual meals and drinks can be programmed to follow later.

Annual subscriptions
Every year our poor Secretary (or the several of them we’ve had) complains that a number of AARG members don’t identify themselves adequately when renewing subscriptions. If you’re reading this in March you probably did do it properly while others are lost behind self-inflicted anonymity. I quote from the present Secretary:

I am sorting subs out at the moment. Why do people like Dave use the online form everytime (which is absolutely correct) but others just use PayPal using strange mail addresses without mentioning their name or even better pay via bank transfer and call themselves: PMMS. Who the hell are they? And then, after a while, they write me a not so polite mail asking why I never got back to them as they wanted to become a member.

A role for workshops
In October 2013 I was teaching at a workshop organised by Darja Grosman at Zadar, Croatia: Aerial Archaeology in the Karst Region. This was the second aerial archaeology school organised by University of Ljubljana, Slovenia in collaboration with Arheološki muzej Zadar within the framework of ArcLand project. Students had previous knowledge of karst landscapes and, because we were not working with the usual mishmash of assorted backgrounds, could focus on local problems. Our approach was to be project based so, after

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[2] A report on the first workshop, held at Kostolac, Serbia, was in AARGnews 43.
some basic introductory (and interactive) talks, the students were divided into two groups and told to devise local research projects that may be helped by aerial photography and its applications. After an introductory flight they were able to plan their own tracks and targets after which they sat, looked, thought, interpreted, chased internet references and prepared summary presentations of their results. Bad weather delayed the airborne part of the projects by at least a day but the students plugged away and had to be thrown out of the room when it needed to be changed from a classroom to the dining room of the Zadar youth hostel. Despite the short time they had for their projects their results and presentations were hugely impressive, so much so that I asked each ‘general’ [Darja’s collective name for the group leaders, Neda Ocelić and Filomena Sirovica] if they could write up results of their projects for AARGnews. Reading their texts, which are not much different to the workshop presentations, made these projects seem even more productive and make me proud to have been involved. We publish them as an indication of what can be achieved by determined students at aerial workshops (see Ocelić and Sirovica, this issue).

Also in this issue
Other than the workshop project reports, contributions in this issue can be grouped under two headings: reports on other workshops and the debate session at AARG 2013. The small flood of workshop reports show how much activity there is at present – partly due to the flexibility and funding that the ArcLand umbrella gives to individuals to organise things. Stefano Campana has been organising workshops and summer schools almost as long as I’ve known him and Nina Heiska reports on a UAV workshop held at Pontignano last September. The second workshop was one of a series organised by Włodek Rączkowski at Poznań which covered topics that he wanted to know more about (pers com). What better reason is there for running a workshop? The AARG debate session, titled Cognition and technique: the operation of image interpretation, aroused considerable interest and discussion had to be cut short. I am pleased to be able to include versions of those papers – by Dmitrij Mlekuž and Tomasz Michalik – in this issue and hope that they may arouse further interest in issues of seeing and understanding.

Martin Gojda has written a short ‘farewell’ to Ivan Kuzma who, among other things, was responsible for aerial work in Slovakia. We first met at Kleinmachnow 1994 and kept in contact, exchanging papers, etc, until a year or so before his death. I enjoyed the company of this bear-like man who should be remembered as one who helped establish aerial survey in his country.

Holidays
For years, holidays for me have been either doing the same thing somewhere else, helping to run workshops or (in ancient times) living in my tent and digging. It’s been a good way to live and I felt slightly embarrassed to be taking a holiday earlier this year for no purpose. A friend’s daughter was working in Cape Town and, over a pint and a curry, it seemed a good excuse to visit. British Airways gave us a superb welcoming view on the approach by flying north along Cape Peninsular and – to make the holiday seem a bit more like real life – I’d spent some time trying to book a photographic flight for myself. After a lot of ‘we aren’t licenced for aerial photography’ or ‘we can’t open the window’, I finally booked a flight with Agulas 360 (http://www.agulhas360.co.za/) in their Cessna 206. The weather was warm enough to keep the window open between take-off and landing and so I was able to get a cover photo for this issue. Do you think I could pass the cost on to AARG?
Chairman’s Piece: The contribution of aerial techniques to archaeology

Oscar Aldred

In recent months I have often wondered about the impact that the techniques of aerial archaeology have had on our understanding of the past. Within our small AARG group this contribution is well known, and largely agreed on – although its history may differ – but the way in which it is discussed is mostly focused on the establishment of the aerial perspective’s past contribution. The reflective character of our past understanding is not predominant in present discourse. For instance, a claim was made by the recently aired BBC TV show The Flying Archaeologist:

This small sub-discipline has done more to reveal the rich history of the English landscape than any other investigative technique that we have developed over the last 100 years. And yet this contribution to understanding our past is not nearly as well-known as it should be.


Of course, this statement does not only apply to the ‘English’ landscape: we can quite literally see the impact that aerial archaeology has had on practice and knowledge across Europe and beyond. What I want to discuss briefly is what, if anything, can AARG do to help promote what it does today to others in archaeology and beyond the discipline? And not only assess what its past contribution has been, but how it can help shape future practices and acquire new knowledge about the past sites and landscapes? And to expand the reflective approach to our existing set of predicaments, such as the use of new technologies and the increasingly rich and detailed data sets that are being produced.

The historical part of this question is somewhat addressed by looking at the way in which AARG continues to promote itself and its related activities. Clearly in 1915 in An Introduction to Field Archaeology as illustrated by Hampshire, its author, Williams-Freeman, saw much potential in the view from the above:

In a few years we shall doubtless fly from hill to hill, ... aviation will undoubtedly do much for the study of earthworks

(quoted by Dave Cowley at last year’s AARG conference).

AARG does well to encourage all involved in aerial archaeology and its sister remote sensing to publish and disseminate their findings today. This is not only the results, but also the manner in which research has been carried out; a so-called Clifford Geertz ‘thick’ description of practice. However, this is also a part of the problem. We tend to preach what we know and do to the already converted! The workshops that AARG runs, as well as those associated with ArcLand, are full of people with some basic knowledge about the benefits of aerial archaeology and remote sensing. These people may want to know more about the operation of aerial archaeology from a practitioner point of view. Yet if we are to entice those who are not in the know about the ‘dark’ arts of aerial archaeology, we need to approach how we promote what we do differently. I have no real solutions to offer, but I think some movements in the

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right directions are beginning to happen. For example, we are beginning to write about what we do in a more reflexive way (e.g. Brophey & Cowley 2005 *From the Air: Understanding Aerial Archaeology*). Heritage managers across Europe are also beginning to become more and more aware of the reconnaissance value and the non-intrusive benefits resulting from techniques like aerial archaeology, and the role these have for the continuous monitoring of sites and landscapes in a positive and active way. And we are making some headway in encouraging younger researchers – principally those with an interest in landscape archaeology – to AARG. I think though that we need to present more of what we do in different ways, for instance how our collections of aerial images intersect with different fields of research.

It is clear that lidar and airborne remote sensing techniques are beginning to become more and more commonplace methods of aerial survey. Most landscape archaeology projects will conduct some form of aerial survey. Perhaps this is to assess the ground, or to provide a record of sites and landscapes, or as a means of presentation. The real interest here is the way in which small-scale aerial survey techniques are having an impact on the understanding of local sites. For instance, colleagues in Iceland have been using kites and long poles in recent year to gain an aerial view of sites as they were being surveyed or excavated. The aerial view not only presented the site visually, but it also added to the knowledge about the context and the preservation of the sites under the camera.

However, aerial images are at their most useful to archaeology when they have been interpreted and converted to map form as this extracts the archaeological information in a way in which it can be most effectively understood. At the heart of aerial archaeology is *mapping*, yet we rarely discuss this directly anymore at our meetings – by this I mean conventions and the level of detail involved – mapping has become a small topic of discussion as of late. Paraphrasing James Deetz, even small things can be forgotten, and I wonder what has happened to this aspect of our practice when lidar algorithms and computer modelling seem to be replacing more basic and arguably more important facets of aerial archaeology?

I would hope that at our next conference – in Dublin – some of these questions about contributions past and future can be addressed in order to share knowledge and to increase the profile of what we do and our contribution to archaeology. Though we are a modest and quiet bunch and, like many, tend not to blow our own trumpets to others, I think we should sometimes stand and shout more loudly.
*FIRST CALL FOR PAPERS*

International Aerial Archaeology Conference

AARG 2014

Dublin, Ireland

24th – 26th September 2014

Suggested conference themes:

Landscapes or aerial data-to-knowledge, Public and crowdsourcing aerial archaeology, New technologies, Local session (Ireland), Aerial survey detail: top-down/bottom-up, Conflict archaeology: from the air.

Organised by:

Aerial Archaeology Research Group,
University College Dublin & Discovery Programme

Papers and posters are invited for 24th – 25th September

26th September: Field Trip

(Tara, Slane, Brú na Bóine, New Grange – Knowth via Dublin Airport)

All conference paper and poster offers to:

Oscar Aldred, School of History, Classics and Archaeology, Newcastle University

Email: aargchair@gmail.com

Closing date for all proposals (with title and abstract) is 31st May 2014

AARG website: http://www.univie.ac.at/aarg/php/cms/Next-AARG-Events/

Facebook: https://www.facebook.com/aerialarchaeologyresearchgroup

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STUDENT/YOUNG RESEARCHERS BURSARIES FOR AARG 2014

These are to support bona fide students and young researchers who are interested in aerial archaeology and wish to attend the conference. There is no formal application form but please provide the following information (headed with Student/Young Research Bursaries): Your interests in archaeology and aerial archaeology; place of study; the name and contact details of a supervisor or employer (email) who can provide a reference; why you would benefit from attending the conference; and an estimate of travel costs to attend. Furthermore, you should also be willing to provide a poster, or for exceptional work provide an abstract for a paper (20 mins) in one of the session. Failure to provide a title and abstract for a poster or paper will mean no bursary. Applications addressed to Oscar Aldred by email (aargchair@gmail.com). In addition, there will be a competition for the best Student/Young researcher poster or paper, judged by the Chairman and Vice-Chairman. The prize will be a free 2015 conference package (registration fee, dinner and field trip). All entries for the competition must apply for the Student/Young Researchers Bursaries to be eligible.

Closing date for applications (with title and abstract) is 31st May 2014
AARG Vacancies: Chairman, Vice-Chairman & Honorary Secretary

At the next Annual General Meeting during the conference in Dublin the three vacancies of Chairman, Vice-Chairman and Honorary Secretary will be voted on and filled. The AARG constitution states (Sept 2013 edition):

5.1 The officers of the Group shall be elected by ballot at an Annual General Meeting. Nominations shall be sent to the Honorary Secretary, with the permission of the Nominee and the support of a Proposer and Seconder (who shall be individual or institutional members of the Group), not less than 30 days before the meeting. Forms bearing the names of the candidates and the names and signatures of single proposers and seconders (who shall be individual or institutional members of the Group) shall be returned to the Honorary Secretary not less than 30 days before the meeting, along with the written agreement of the candidate to stand for office.

Nominations are thereafter sought from AARG members in the way stated by the constitution:

1. Name of nominated person
2. Single proposers and seconders names
3. The nomination returned to the Honorary Secretary before 14th August, 2014:
   aarg.secretary@googlemail.com

The Derrick Riley Bursary

The Derrick Riley Bursary still exists. It is £500 a year, usually a single award, but sometimes is split and given to two people.

There should be an application form on the Sheffield Archaeology Department website and a Riley Bursary page on the Sheffield website where potential applicants will be able to find information and download the application form.

Finding the relevant page represents the first challenge, but if you can’t please contact Bob Johnston (r.johnston@sheffield.ac.uk) who administers the bursary.

Information for AARGnews contributors

AARGnews is published at six-monthly intervals. Copy for AARGnews 49 needs to be with me by August 24, 2014. Editorial policy (for want of a better word) tends to be that if I am sent interesting contributions they go in unless there’s a danger of an issue overflowing. Vague instructions for contributors are on the AARG website and please do not use any ‘clever’ formatting.

Address for contributions: rog.palmer@ntlworld.com
A Farewell to Ivan Kuzma

Martin Gojda

Ten years after the death of M. Bálek, the Moravian pioneer of aerial archaeology in former Czechoslovakia, a dreadful announcement arrived in my e-mail box in early December 2013, informing me that a strong heart attack caused the immediate death of the founder and leading figure of aerial archaeology in the Slovak Republic, Dr. Ivan Kuzma (1955 – 2013). He died too early being just 58 years old, unbelievably the same age at which M. Bálek lost his life.

Ivan’s professional career was almost completely connected with the Institute of Archaeology, Slovak Academy of Sciences. He was accepted at the Institute as a prehistorian whose focus of interest was the Neolithic, and indeed this passion remained with him all his life. From 1987 he oriented his interest to aerial survey and this is the date in which aerial archaeology in Slovakia started its 25-year history, although aerial photography occasionally had been used to record known sites since the 1960s. Before the fall of communist regime Ivan worked mostly with archival vertical photos trying to identify large enclosures. Immediately after the November 1989 “Velvet Revolution” he started to organize a programme of aerial reconnaissance inside the Institute and soon became its head. Ivan established a small team of colleagues (E. Blažová, I.Rajtár, M. Bartík) who effectively carried out the principal aims of the programme. Success arrived very quickly. At the beginning of the 1990s during the first flights over south-western Slovakia (the territory north of the Danube that has been the main focus of Slovak air reconnaissance during the past 25 years)
years) a group of Roman marching (temporary) camps was identified via cropmarks. Ground investigation using surface artefact collection, geophysical survey and test digs brought important data on the age of these military installations (the so-called Marcomannian wars dated to 166 – 180 A.D.). This evidence is of primary importance for the study of Roman military activities north of the *limes* in the central Danube valley, as it has helped to establish the range and characteristics of the Germanic – Roman military relations in one of the crucial periods of the Empire in the second half of the 2nd century A.D.

Apart from the military evidence on Rome’s northernmost Danubian frontier, the attention of Ivan and his collaborators focused on large prehistoric enclosures, notably the so-called *rondels* of the Early Neolithic, of which a number of previously unknown examples had been detected during 1990s and 2000s. They became a target for further investigation by means of geophysical measurements, carried out by advanced machines (cesium magnetometer) and processed by software written by J. Tirpák (an associate member of Ivan’s team) that produced 3D digital models. Surface artefact collection and test excavations provided an integrated approach to the study of these enclosures that produced remarkable results appreciated by Neolithic specialists all over, and beyond, Central Europe.

Obviously, Ivan Kuzma’s aerial prospection and personal research has recorded other types of prehistoric, ancient and historical sites and features that provide a valuable set of information to help the process of cognition of the Slovak past. I am sure that his professional contribution to central European archaeological remote sensing will never be forgotten. It is just to be hoped that followers (or at least one) of Ivan will soon appear and that the continuation of the Slovak aerial programme will be soon assured.
5th International Conference on Remote Sensing in Archaeology: 
THE AGE OF SENSING


The 1990s will be remembered in the history of archaeology as the age of GIS. Now, we are ready to embrace new methods of recording, interpreting, conceptualizing and communicating archaeological data and relationships across the passage of time. In the next few years, we will have the opportunity to blend the physical world with a sensory-rich ‘virtual’ world where archaeologists can naturally and intuitively manipulate, navigate and remotely share interpretations and case studies. Our understanding of archaeology will be taken to a new level, enhancing our capacity to develop interpretations and to present them to fellow specialists and to the general public as simulated scenarios in 4D.

This conference seeks to explore the age of sensing, broadly defined. Papers and workshops will address the following topics:

- Large Scale Remote Sensing
- Close Range Sensing
- 3D Modelling
- Body sensing
- Immersive Sensing
- Aerial Photography
- GIS and Sensing
- Spatial Technologies and Landscape
- Virtual Landscapes
- Integrated Technologies
- Intra and inter-site Applications
- Lidar Applications
- Geophysics
- Sensing and Urban Context
- Cultural Resource Management
- Drones, UAV etc
- Virtual Reality and Cyber-Archaeology
- Defining High Standards
- Commercial Archaeological Remote Sensing

We are seeking abstracts and workshop proposals by March 31, 2014 that address the conference theme—the Age of Sensing.


For workshops: Proposals, including a title, expected number of participants, technical requirements, and a description of the workshop. To: space2place@duke.edu

Registration

Full Participant (includes lunches, coffee breaks, social dinner) $350
Student (includes lunches, coffee breaks, and social dinner) $150
Student (without meals) FREE

Register online at: http://space2place.classicalstudies.duke.edu/registration

Main Contact: space2place@duke.edu

Organizers

Conference Chair - Maurizio Forte (maurizio.forte@duke.edu)
Conference Co-chair - Stefano Campana (campana@unisi.it)
General Secretariat - Melissa Huber (melissa.huber@duke.edu)
Touching images: thinking through textures

Dimitrij Mlekuz
University of Ljubljana and Institute for the protection of cultural heritage of Slovenia

Introduction
As aerial archaeologists, most of our work consists of looking at images. We look for meaningful features, but distinctive features are only a small part of what is encoded on the image. Aerial photographs and high resolution topographic data is rich with textures. What can we do with textures? How can they be harnessed for deciphering the biography of surfaces and the way people interacted with the land in close physical contact? Can they open a different way to look at imagery?

Textures are the most immediate contact the landscape. Ploughing, grazing, clearance – create distinctive textures of a surface, some of them deliberately created for the properties of the texture itself. Textures incorporate time; they are a result of a slow but constant change of the very texture of surface. Mundane practices which might have a minimum impact on the surface can, in a long term, combine to form a distinctive texture. People relate to landscapes through tactile and visual experience of surfaces around them, beneath their feet and in their hands.

Sight and touch
In the modern, Western, world the visual sense has primacy over the other senses. Since the sixteenth century, vision has become increasingly important in how we engage with and understand our world, with the other senses marginalised. The visual became considered the most reliable form of representation. Archaeology, and especially aerial archaeology, has come to rely almost solely on vision for both the collection of data and the dissemination of information.

Of course, there are very good reasons for the dominance of vision. Visual sense turns us into spectators, detached and distanced from the object of study. In this way, landscape becomes a particular way of seeing and representing the world from an elevated, detached and even "objective" vantage point: as an artistic genre and a culturally conditioned habit of visual perception, unique to European, Western, societies (see Cosgrove 2002; Wylie 2007, 55-93). Visual technologies (photography, lidar, GIS) and modes of representation (cartography) establish landscape as an external, separate reality to be rationally perceived and accurately represented. But, as Daniel Cosgrove (2002, 257) states: "The evolving relationship between vision, technology and landscape is not a morally or politically neutral affair. Privileging vision as the principal means of knowing the world devalues alternative modes of experience and cognition".

Tim Ingold, in his essays on environmental perception (2000) demonstrates that recent critique of vision has been based on a limited conception of sight as perception which distances and objectifies. Ingold points out that sight can also be intimate and engaging. It is not the emphasis on vision that is problematic, but rather a particular "way of seeing". Of capitalism, consumerism, surveillance, and ethnography: an "instrumental vision" that uses

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the thing seen as an object for knowledge and control (Marks 2000, 131). Maybe it is worth exploring other ways of seeing.

Sight is, of course, not isolated: when we look, we look from and with our bodies. Our bodies give us orientation, sense of direction, enable movement, and operate as a coherent system helping to give a sense of wholeness. Sight, as well as other senses, is embodied.

The idea that an individual body is crucial in structuring perception resonates with ideas raised by French phenomenologist Merleau-Ponty, who calls our attention to the fact that certain ideas can only be grasped through our bodies and the sensory experience of matter. Perception is always embodied, subjective. Perception draws from this deep well of sensory experience, sedimented in our bodies: "My body is a thing amongst things, it is caught in the fabric of the world" (Merleau-Ponty 1969, 256).

Sight is a sense that can be distinguished from others, but is not isolated from them. As we perceive image, our other senses inform our vision, drawing upon past experiences. Since perception is embodied, visual perception of images is always already a synesthesia and synoptic as perception extends outward and inward, fusing outer and inner realities (Sobchak 1992, 85).

There is no object-subject relationship between observer and landscape, but permanent intertwining of landscape, image, world and embodied viewer. Due to the material nature of bodies and landscape, our perception is "woven" into the landscape. In this way, landscape is not only a way of seeing but becomes an arena for engagement and involvement. Landscape is not a scene to be viewed, but a "lifeworld", a world to live in, something woven through interaction with the world.

This allows other ways of looking at the landscape, by involving other senses, by using the eye as an organ of touch. And this is the idea of **haptic visuality**.

**Haptic visuality**
Due to an embodied and multisensory nature of perception, our bodies and senses are involved when we look at images on the desk or in front of a computer. Thus imagery cannot be described only in optical terms, but should be an enquiry into how image calls up multisensory experience (Marks 2000, 131)

Thus vision can be tactile too, it works when we touch the image with the eye, when we use eye as an organ of touch. When our eyes move across a richly textured surface, occasionally pausing but not really focusing, making us wonder what we are actually seeing, then eyes are functioning like organs of touch, like fingers.

Optical visuality, the usual way of looking, is the deep space vision we engage with while viewing a scene. This optical visuality provides us with mostly distinguishable objects for vision. This perceptual decision can be based on many cues, including size, shape, or variation of colour and texture. This is the way we interpret remote sensing imagery, and is of course not a straightforward procedure, but a skill that "needs to be learned, practiced, tested and honed" (Palmer 2012, 88).
On the other hand, haptic visuality is the touch response in the body triggered when presented with the image that comes very close, and cannot be separated into ground and figure. Closer we are to the object, more difficult it is to separate objects, the greater the touch response.

This lack of certainty of the object by the eye leads to other senses having increased involvement, uniting in a shared response, leading to a more integrated sensory experience. The experience of looking recalls memories encoded in touch, sound and smell, based on our sedimented experiences and cultural associations.

Haptic images invite us to respond in an intimate, embodied, way and facilitate the experience of other sensory impressions that inform sensiorium, the bodily organisation of sense experience (Marks 2000, 2).

Thus haptic visuality is different way of looking, a quality of visual perception comparable with that of touch, it is an experience of texture and the material solidity, without three dimensional visual depth. Haptic visuality and optical visuality are both modes of vision that, like the senses, exist together but can be individually distinguished.

Haptic visuality sees the world as if it were touching it: close, unknowable, appearing to exist on the surface of the image. By looking at image in a haptic way, we touch the landscape with our eyes. The haptic image is thus "less complete", requiring the viewer to contemplate the image as a material presence rather than set of easily identifiable "features".

The haptic visuality is about lack of depth, lack of distance, it is about closeness, intimacy and touch. Haptic view is subjective view of the world. Haptic visuality focuses on the "stuff" of landscape rather than things in the landscape. Haptic visuality is mode of vision that "understands materiality" (Sobchack 1992, 133).

Digital images, with their capacity of manipulation, can be viewed in a haptic view by zooming in, enlarging, filtering and other processing techniques that emphasise richly textured surfaces over objects in an image.

**Surfaces and textures**

Our senses engage the world around us at the surfaces of objects, things and landscapes. Surfaces are the interface between things and senses. And all surfaces have certain properties.

Texture refers to surface characteristics and appearance of an object and is a combination of the size, shape, density, arrangements and proportions of its elementary parts. Texture is thus a perceptual quality of surface, a result of fine structural details. The world is rich in texture: the surface of any object is textured at certain scale (Klatzky and Lederman 2010, 211).

A texture is, as its Latin root texere (to weave) reveals, a characteristic of anything which is woven together, made into a fabric, and comprises a combination of parts or qualities which is neither simply unveiled or made up. Texture is at once the cloth, threads, knots, weave, detailed surface, material, matrix and frame (Vasseleu 1998, 12).

Texture is a material trait, the quality of surface roughness of an object, and thus a property that falls within the domain of touch (Klatzky and Lederman 2010, 212). Think about the archaeological excavation where deposit texture is directly experienced through trowels and
fingers. Haptically perceived textures may be labelled by properties, such as sharpness, stickiness, or friction. However, texture is not restricted to the sense of touch, is multi-sensory. Visual texture arises from the pattern of brightness of elements across a surface. Visual texture can pertain to pattern features such as grain size, density, or regularity (Klatzky and Lederman 2010, 212). When it comes to sense of hearing, texture arises from mechanical interactions with objects, such as rubbing or tapping. Rhythmic cracks and scratches are sounds that reveal surface properties (Klatzky and Lederman 2010, 212).

So the sound of a plough breaking the soil, scratching the stones, gives a key to the texture of soil, either stony, sandy or clayey. This, plus the rich smell of fresh, moist, disturbed soil all come together to give a unique multi-sensory experience of ploughed landscape. These perceptions trigger a spectrum of feelings, memories and past experiences. Texture offers access into the richness and immediacy of the perceivable world and allow us to enmesh with it. Textures offer a gateway into haptic way of looking at the images.

Archaeology of textures
Much of our lives is about texture. We are surrounded by textures and actively create texture around us, in wall surfaces, flooring, clothes and landscapes as did people in the past. It is at the surface that we are in constant, immediate and close physical contact with landscape. People relate to places also through tactile and visual experience of textures under their fingers or beneath their feet. The texture of the ground is experienced directly through the feet, especially if people moved around bare footed as most people in the past probably did.

Often we think about landscape textures in terms of agriculture. But other kinds of surfaces have equally-significant textures, like woodland, meadows, floodplains, our towns and villages.

In mountains, for example, where rocks are exposed, they weather and decay according to many factors, ranging from their basic classification (igneous, metamorphic and sedimentary), their composition, and more general physical properties such as porosity, creating many different interesting textures (Figure 1). In limestone, the chemical dissolution of carbonate rocks creates a pattern, a large scale texture of doline sinkholes, which act as sediment traps, structuring the texture of vegetation and human activities (Figure 2). The textural properties of rocks and stones may be deliberately explored in creating new landscapes and new features that evoke symbolic and material links between them.

In temperate Europe, the land surface is covered with vegetation. There are places where the soil and geology show through, as with tree-throw pits and landslides, but in general the vegetation-covered surface is unbroken. In woodland, soil is close, since it easily exposed beneath a litter of dead vegetation and mould. However there is intactness about these woodland surfaces because of the stability of the crumb structure of the soil (Evans 2003, 62).
Figure 1. Rough texture of mountains (Mt. Rombon, Slovenia).

Figure 2. Doline karstic landscape. (Bela Krajina, Slovenia).
Walking and trampling change physical soil properties. Regular trampling by people or livestock keeps trails devoid of vegetation and this new texture, results in increased surface runoff along trails. During the dry season, trampling loosens surface soil, providing a ready source of sediment during the rainy season. Thus trails become both conduits for surface runoff and sources of sediment. Water erosion speeds the hollowing process and made some lanes muddy and impassable. When this happens, alternative routes are taken by people travelling along them, leading in some place to textures akin to river-like branching and converging braided channels (Figure 3; Mlekuž 2013).

Slicing into the forest surface, as Neolithic people did, with flint knives or wooden ards, creates entirely different texture: a clear contrast between the textures of forest floor and open soil. In Northern Europe, the earliest tilling of the land is associated with people who constructed monuments. This might suggest that barrows were sited in relation to previous land-use, but another possibility is that the disturbance of the soil took place not for growing crops but for the creation of the textures themselves (Evans 2003, 57; Cummings 2002).

Under natural conditions, vegetation and litter conceal even the stoniest of soils, and the stones are hidden beneath the surface. Overgrazing by goats and sheep and clearance of woodland and scrub create a texture of grassy pastures and exposes the soil in places. The underlying geology, which was previously masked by soil and vegetation is revealed (Figure 4).
Stones can be collected from the surface and piled into cairns, low banks or dry-stone walls at the edges of the cultivated areas in order to make them more distinct and the soil more tillable. Moving, collecting and sorting stones not only created new agricultural or pastoral land, but created new landscape textures. In this way, concepts of social relations between people became materialised in the texture of the land. Textures were indices of work and of ancestors. Textures not only changed the surface properties and freed new land for farming and pasture but changed the way people related to landscape and each other (Figure 5).
Where soil is thin, it can be scraped together, and by adding material, like dung and kitchen garbage, a pattern of raised beds or gardens is created. Gardens were worked, manipulated, changed, and curated. They need constant daily maintenance and a flow of substances to replenish the nutrients in the soil. Through middening the discard from houses is incorporated in the matrix of the garden, making the soil more organic, fertile, and darker in colour. One of the consequences of this practice, is that there develops an increasing disparity between the high fertility of the soils near the settlements and the low fertility of the soils further away. This can create a fine-grained topographical pattern of cultivated land and marginal land around it. This accumulation of substances and residues also incorporates the identity of people in the soil of the garden plot as traces then encountered during daily work. Tilling, for example, exposes the buried pottery or bones from the midden, making visible the work of the ancestors (Mlekuž in press).

Ploughing leave distinctive textures which strongly contrast with the textures of the forest floor, floodplain or mountains. Ploughing as a means of fragmenting and aerating the soil results in a distinctive texture, which has been deliberately created for the properties of the texture itself. It creates a smooth, continuous, landscape that contrasts strongly with the surrounding pastures, floodplains, mountains or forested slopes (Figure 6).

Figure 6. Soft landscape of fields versus rough landscape of forest (Vrhnika, Slovenia).
The forested, stony, wild untamed landscape, slowly transformed into soft rolling landscape, evokes ideas of culture, order, and tradition. But cultivation creates many different textures. People create textures together with landscapes they are part of, using technology like mattock, ard, plough, and animals such as oxen teams. Social order, ideas how things should be done, how things were done by ancestors become woven into the texture of landscape. Ploughing produces social ties as much as it transforms the material world. And these ties are woven into the materiality of the land.

Once established, textures, play roles in other activities, for example, open fields were arenas of communal decision making and cooperation, but also used by young men for ploughing matches, and the opened-up river valleys for fishing and hay meadows or maybe gypsies (Evans 2003, 69).

**Discussion**

It is at the surface that we are in constant, immediate and close physical contact with the land. Textures are not only passive marks that people leave in the landscapes, but also a medium of social reproduction. The world of our experience is continually and endlessly coming into being as textures around, as we weave them into landscape. As in in weaving, a texture is slowly built up rather than transformed in a single act (Ingold 2011, 210-219).

Textures thus incorporate time; they are result of a slow but constant change of the very texture of surface. Mundane practices which might have a minimum impact on the surface can in a long term combine to form a distinctive texture.

Thus, the rhythmic structure of social time emerges not only from the interweaving and mutual responsiveness of human movements, but also from the way these movements resonate to the cycles of the non-human environment: seasons, floods, catastrophes…

The rhythm of time is translated into space. In the ploughing, digging, grazing, pillaging, walking, trampling, clearing, cutting wood, adzing, hammering, regularity of form and rhythmic repetition of the same movement are necessarily connected and incorporated in textures. Thus textures are never designed, never finished, but forever in the making. While building features, such as houses, ramparts, castles, roads, comes to an end with the completion of a work, weaving of textures continues as long as life goes on, punctuated but not terminated. This is close to the original of *texere* meaning to weave, fabricate, to thatch, which has a deeper Indo-European root, *tek* , which means to fabricate, be busy, to be active.

Understanding the landscape as a process of weaving, texturing, through daily activities gives us a richer understanding of the past, indeed it adds texture to the past. It help us to understand the landscape that was busy with people moving around, doing things, being in permanent, direct contact with the landscape using their hands and feet.

Rhythmic temporality of life is gradually built into the texture of landscape. And textures become deeply sedimented in the bodies of those who weave; as Tim Ingold says (2000, 193), "…body and landscape are complementary terms: each implies the other, alternately as figure and ground".
Conclusion
When we interpret landscape imagery, we look at the things in the image. We pick out features from the background. There is of course nothing wrong with this – far from it. It is, and will stay, the main way we acquire knowledge about the past.

But there are also other ways of looking that might be worth exploring. Textures offer access into the richness and immediacy of the perceivable world and allow us to enmesh with it.

When we turn the eye in the organ of touch, we are able to see the "stuff" of landscape rather than its "things". It is a highly subjective, embodied view of the world, but one that helps us to "understands materiality" of the landscape.

Dwelling in the landscape is about the rich intimate, ongoing "togetherness" of beings and things which make up textures and which, over time, bind together nature and culture. Textures blur the nature/culture divide and emphasise the material and temporal nature of landscape. In this way, landscape is a never-finished process of weaving, an "entanglement" of materials and activities.

And they can perhaps to help us to reflect what we really see when we interpret aerial photographs and lidar imagery.

References


Between eye and the mind.
Technology, cognition and knowledge development – eye-tracking study report

Tomasz Michalik¹

Introduction

The relation between technology and mind is one of crucial issues undertaken in modern cognitive science. As Andy Clark and David Chalmers (originators of the extended mind conception) noticed, technology in many cases supports our cognitive processes (Clark, Chalmers 1998). Microscopes extend the resolution of our sight, infrared cameras allow us to see at night and 3D glasses enable us to experience new realities. Also in archaeology (especially in non-invasive survey techniques) new technologies significantly support detection of archaeological sites. For example, through the use of LIDAR scanning system, previously inaccessible areas (forested areas) may be analyzed for the occurrence of archaeological heritage. In a similar manner GPR techniques extended our cognition by showing that what is invisible for our eyes – the artifacts/features hidden in the ground.

Although undoubtedly technological development is related to the development of science it is worth noting that the most important elements of the process of knowledge creation is not technology but our mind. The relationship between the two is not reversible: technology without mind cannot create knowledge but mind without technology can. Therefore to practice science consciously we should ask about the relation between technology and mind analyzing these elements equally. In this context three problems are particularly noteworthy: (1) what is the impact of the new types of data (which are a result of new technologies) on our mind and knowledge which we produce? (2) How does our cognitive system analyze artificial representations of the world produced by different devices used in the research process? And finally: (3) what happens when technological modernization does not correlate with ‘modernization’ of thinking?

In this article on the basis of the eye-tracking study related to the problem of perception of aerial photographs I will address the issue of the relation between technology, mind and knowledge in the case of visual perception. Especially, I will discuss the role of previous knowledge (Heidegger’s pre-understanding) and our expectations in the ways in which we perceive aerial photographs as well as the importance of nature of visual data in the process of their interpretation.

This paper consists of five sections. In the first I present basic information about human visual system with reference to the problem of the relation between reality and the internal world created in our mind. The second section includes discussion of the perception model proposed by Bruce Goldstein (2010, 5-10). The third section contains the presentation of an eye-tracking experiment created on the basis of Goldstein’s model. In the results (fourth section) the role of top-down and bottom-up processes in the construction of knowledge about the past is presented. The last section contains a description of a model of cognitive process in archaeology taking into account the psychological processes.

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The mindless eye

In his famous paper *What Is it Like to Be a Bat?* Thomas Nagel (1974) stated that our biological make-up significantly affects the ways in which we perceive the world. Due to the fact that different animals have various types of senses we can claim that, although we inhabit the same world, in practice we live in different realities. The perception of the environment based on echolocation system (as in the case of bats) and the perception grounded on eyes responding to wavelengths between 390–700 nm (as in the case of humans) can result in radically different models of the world created in the mind. To fully understand the process of perception both in everyday life and in the creation of scientific knowledge we should pay attention to the possibilities and limitations of our visual system.

Analyzing the structure of the human eye it should be noted that what specifically affects our vision is the organization of our photoreceptors. Due to the fact that cones and rods are not distributed in a homogeneous manner (the highest density of photoreceptors is in the fovea) and that they have different functions, what we can see in focus is only a small part of the visual scene (around 2 degrees) (Palmer 1999, 39). For this reason in order to maintain a high-resolution image of the world our eyes must move in a fast way and gather the information from different points of the visual scene. The moment in which eyes stop moving and gather data from environment is called *fixation*, whereas the rapid eye movements are termed *saccadic movements* (Fig. 1). During saccadic movements brain does not receive any information from the eyes (this phenomenon is referred to as *saccadic suppression*) which results in that we perceive reality not in a continuous but in a diachronic way (Palmer 1999, 520-531). Our perception is highly depended on the fixations – where they fall, how long they are, and how often they are performed.

![Figure 1. Fixations (circle) and saccadic movement (lines) during an analysis of an aerial photograph. The larger the diameter of the circle is the longer fixation in a given place was performed.](image)

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2 This article refers only to some selected issues in the field of the human visual system. A detailed discussion of this problem can be found in *Vision Science: Photons to Phenomenology* by Stephen Palmer or in *Sensation and Perception* by Bruce Goldstein.
Eyes are just the beginning of a complex process of visual information processing. Goodale and Milner’s discovery concerning the processing of the visual data by our brain is particularly important for the present article. Their study of a patient called DF confirmed results of earlier studies on rhesus macaques (Ungerleider, Mishkin 1982, 549-586), which suggest that in our brain there are two different systems for analyzing visual data. The first (ventral – “what pathway”) is responsible for object recognition, second (dorsal – “where pathway”) is activated when we cooperate with the objects – it is the so-called vision-for-action (Goodale, Milner 1992). Other studies on this phenomenon show that in some cases the “what system” is susceptible to illusions, but the “where system” is not (Aglioti 1995). These results indicate that our perception of the world can be not only prone to errors (illusions) but it can also differ with respect to the function which it fulfils (object recognition or action).

In addition to the data from the field of neuroscience, philosophical and psychological reflection on the process of perception also indicates the differences between the external world and our internal – mental – model of it. The commonly known rabbit–duck illusion suggests that our perception is not only grounded in the biological make-up but is also related to our psychological disposition and knowledge. One and the same thing in the external world (picture of rabbit-duck) at one time appears to us as a duck and at another a rabbit. Thus, something that has one ontology in the world, in the mental reality creates two entities – duck or rabbit. The opposite situation can be observed in children who do not have reading skills yet. While looking through the books with fairy tales children who do not have the concept of the alphabet yet treat the letters in the book as a part of a picture. In this case although in the external world there are two categories of beings (pictures and letters) in children’s minds (due to their lack of knowledge) they seem to be one and the same.

Summing up, it should be noted that perception is a complex phenomenon, whose task is not to create a faithful representation of the external world, but such a representation which is appropriate for performing a given cognitive task. Models of the world created in the mind depend on many factors (biological and psychological). Some of them are performed unconsciously others are available to our consciousness. Although perception as the element of the process of knowledge creation seems to be a conscious practice (as is scientific practice in general) it also depends on cognitive processes which are not always accessible to conscious reflection.

**Seeing vs. knowing**

Bruce Goldstein in his work *Sensation and Perception* distinguished four main aspects of the perceptual process: a relation between the reality and the focus of our attention (the physical stimulus), the processes of transduction of the physical stimulus to the ‘neural language’ understood by the mind (the electric transmission), elaboration of the information received from this stimulus (knowledge) and high cognitive processes. The combination of all four results in the formation of the conscious visual experience (experience and action) (Goldstein 2010, 5-10).

As is shown in Figure 2 we are dealing with the transformation and reduction of information from the very beginning of the process of perception. Among the many stimuli that are generated by objects in the environment only part of them potentially can be perceived. It is the result of both biological limitations of our senses (their sensitivity) as well as restrictions on the amount of information that can be processed at one time. In the diagram
these aspects are specified as: \textit{environmental stimulus, attended stimulus} and \textit{stimulus on the receptors} (Goldstein 2010, 5-7). The second stage of the perceptual process is associated with the qualitative change. The physical characteristics of stimuli are translated to the neural code, which is further processed by the brain (in the diagram these processes are termed as: \textit{transduction, transmission and processing}) (Goldstein 2010, 7-8). Knowledge and experience, which we have, also have an impact on the emergence of conscious visual experience. Knowledge ultimately affects \textit{perception, recognition} and \textit{action}, which is a response to the perceived stimulus from the external world (Goldstein 2010, 8-11).

On the basis of the model proposed by Goldstein we can claim that what we perceive depends on two elements: incoming data (bottom-up processing) and knowledge which is already located in our mind (top-down processing) (Goldstein 2010, 10). These two ways of processing of visual information are crucial in the creation of a conscious visual experience.

\section*{Experiment design}

As can be appreciated, in the model proposed by Goldstein our perception comes under various constraints. Due to their biological nature, some of these limitations, for example the eye movement, are more or less universal for all people. Others, like knowledge and experience are factors which result in individual differences between people. In the contexts of science development, it is an important question to ask how these two elements (biological aspects of perception vs. knowledge) influence perception during the process of knowledge creation.

My experiment, the results of which are presented in this article, relates to the ways of analyzing the aerial photographs by two groups of people: students who have completed an aerial archaeology course (called \textit{experts}) and cognitive science students who have never had a contact with aerial photographs analysis (called \textit{non-experts}). Each group consisted of 15 subjects. The main research question was: how do people with similar biological make-up but different knowledge perceive and categorize information on aerial photographs?

Images used as stimulus in the experiment contain representation of five categories of archaeological features/sites: strongholds, barrows, long houses, sunken houses and pits. In addition to these photographs in the experiment also photographs which did not contain archaeological features/sites were used (‘hoaxes’). Each category of archaeological feature
was presented in five photographs. Features appeared in five different zones: the four corners of the picture and in the centre (Figure 3). This procedure was designed to maintain an even distribution of archaeological features/sites in the stimulus.

![Figure 3. Five zones of occurrence of archaeological features/sites in the aerial photographs.](image)

Each person analyzed 30 photographs. Before starting analyzing the images the fixation point in the central part of the computer screen was presented. The task of the subjects was to focus their eyes on it. After one or two seconds the fixation point disappeared. Then, automatically, the photograph was presented. Each person had maximum of 15 seconds to analyze the stimulus. Subjects could decide if they needed all 15 seconds to analyze the picture or if they wanted (by pressing the spacebar) to respond more quickly. After seeing the photograph, subjects provided a categorization answer (Fig. 4). Their task was to name the archaeological object, which they perceived or to state that the photograph did not contain archaeological features/sites.

![Figure 4. The experimental scheme.](image)
Due to the data types which eye-tracker offers, this method was considered to be the most promising in relation to the research question. In particular, differences in length, distribution and frequency of fixations between the two groups of subjects were taken into account. As a number of studies shows fixation can be indicative of visual attention, complexity of visual processing as well as the level of interest of particular fragment of visual scene for the viewer (Duchowski 2007, 137-153; Handerson 1999). This type of information seems to be particularly important for the understanding of the role of perception in the process of analyzing aerial photographs and creation of knowledge on that basis. Three types of data presentation illustrated in Figure 5 are used to gather material for the analysis.

![Figure 5. Selected types of eye-tracking data: scan path (a), heat map (b), area of interest with statistical data (c).](image)

**Results**

In the present research, three indicators of the level of task execution were taken into account: time spent on analyzing particular images, the correctness of the answers (the number of perceived and identified objects) and distribution of fixation (as indicator of visual attention). The results obtained by the test groups have become the basis for reflection about the role of bottom-up and top-down processing in the process of aerial photographs analysis.

The research results show statistically significant differences in both the correctness of responses and the time of photographs analysis between the two groups. Experts needed on average 4 min 9 sec to analyze 30 photographs while non-experts needed on average 5 min 26 sec to perform this task. Of the 25 images that contain archaeological features/sites experts correctly named 61.84 % on average while non-experts only 3.44 % objects on average.

In addition to the situation in which subjects correctly named the objects contained in the photographs it was also observed that in some cases persons participating in the experiment reported the presence of the object, but could not name it. Therefore it should be noted that there is a difference between object recognition (giving the name) and object perception (noticing an object without identifying it). In the case of experts the difference between object recognition and object perception was 9.8 %. In non-experts group this difference was 11.68 % (Fig. 6).
The results presented above suggest the following conclusions:

- participation in the aerial photography course brings approximately a 50% increase in recognition of archaeological objects/features;
- knowledge significantly contributes to task execution;
- low-level capacity allows the perception of around 15% of the objects;
- gaps between the visual and language modes (recognition vs perception) have been observed.

In the context of the relation between technology and science it should be noted that the knowledge significantly affected the perceptual processes. Therefore new technologies without development of our knowledge will not bring improved results. Non-experts although they were able to perceive 15% of archaeological features/sites in most cases couldn’t name them. This shows also that the process of learning air photo interpretation does not only pertain to the skills of detection of archaeological features/sites but also include practice in creating links between visual representations of the objects and their linguistic representation.

In addition to data on the length of time devoted to an analysis of the photographs and the data on correctness of response, also the differences in distribution of fixations between research groups was examined. In particular the focus was on the issue if there is a difference between experts and non-experts in performing their first fixation. In other words, if knowledge acquired during an aerial photography course can influence our low-level cognitive capacities.

The analysis identified five types of first fixations (depending on where the fixations were performed): (1) on geometrical pattern, (2) on high contrast areas, (3) on contemporary objects (buildings), (4) on archaeological features/sites and (5) free fixations. For example, fixation on a geometrical pattern means that immediately after the presentation of the aerial photograph on the screen, the gaze moved from the central part of the photo (which was the fixation point for all stimuli) to a geometrical pattern visible the photo (such as lines of tractor tracks). In some cases, first fixations fell on places not characterized by any specific features. These fixations were called free fixations.
Figure 7. Selected types of first fixations: on a geometrical pattern (a), on high contrast areas (b).

Statistically significant differences between experts and non-experts in performing the three types of first fixations: on geometrical pattern, on high contrast areas, and on contemporary objects have been observed. Experts (15) were the most susceptible to geometrical patterns (this type of fixation occurred on average 7.53 times) and in the second place on high contrast areas (on average 7.26 times). This group rarely paid attention to the contemporary objects (average of 1.48 times). Non-experts (15) focussed their attention most on the contrastive elements (average of 10.53 times) then on the geometrical patterns (average of 5.2 times). They were also more susceptible (than experts) to fixate on the contemporary objects (average of 2.8 times).

The results obtained indicate that training (or knowledge acquisition) has resulted in changes in the patterns of visual attention in the group of experts. The results of the non-expert group suggest that naturally they are the most vulnerable to contrasting elements, whereas experts became more susceptible to geometry. Through the knowledge gained during the course on interpreting aerial photographs, experts changed their visual attention pattern to focus on geometrical patterns rather than high contrast areas. While there was no statistically significant difference in the first fixation on the archaeological objects/sites, it can be claimed that fixation on geometrical patterns facilitates the recognition of archaeological objects and sites. And there was a statistically significant difference in recognition. Figure 8 illustrates such a case. This example shows that in some cases knowledge can influenced low-level cognitive processes namely the performance of first fixation.

Data derived from the performance of the first fixation can be interpreted in two ways. On the one hand we can say that learning processes take effect. Students become more vulnerable to the new types of archaeological object indicators – geometrical elements. On the other hand these data suggest that our knowledge and experience can influence cognitive processes which we are not aware of. In some cases this may lead to the excessive schematization of the process of perception. For example if someone initially learned aerial photographs interpretation followed by LIDAR data analysis, it is likely that s/he uses the same mental algorithms as in the case of aerial photographs. In this case, although we have new types of archaeological data, they cannot be fully used, because the researcher’s mind is already biased towards one specific way of analyzing visual data. This hypothesis, emerging from the
present study, requires further research. The follow-up studies should focus on testing the durability of our mental algorithms in the contexts of analysis of similar data.

Figure 8. Differences in the perception of the same aerial photograph by experts and non-experts: stimulus – long houses in the center (image on the left), experts – visual attention is paid to the archaeological object (image in the upper right corner), non-expert – visual attention is paid to the high contrast area on the photograph (image in the lower right corner).

In the present experiment, the relation between ways in which our eyes analyze visual representations of archaeological objects and the linguistic categories which we use to name them has been examined. The results concerning the visual analysis of pits have been particularly interesting. In contrast to other types of archaeological features, pits were perceived in more holistic ways – as a group rather than single objects (this is evidenced by the number of fixations and their arrangement). It turned out that in the case of pits, subjects more often used abstract category of settlement to describe them, than the more concrete category of pits. This result indicates that in the recognition process not only our knowledge plays a crucial role but also the visual nature of data is important. More holistic way of analysis of visual representation of pits was correlated with more abstract category of settlement used in their linguistic categorization (see Figure 9).

Figure 9. Example analysis of pits: eyes analyze the pits in a holistic way.
The evidence from pits perception shows that the new type of data – in this case aerial photographs – can influence the researcher’s unconscious categorization processes and the linguistic labelling of archaeological objects. Here the holistic perception of pits resulted in categorizing them as settlement rather than pits. Thus, the type of data produced by new technologies is highly relevant to the process of the construction of scientific knowledge. For example, their resolution as well as the form of representation of the archaeological objects can influence the ways of analysis of this data by our eyes and this, in turn, may be relevant in the selection of the linguistic categories (bottom-up processing). This may be further related to the cognitive sensitivity to MASS/COUNT distinction (cf Lakoff 1987 and Langacker 1999), which is carried over from the style of processing of the perceptual data to its categorization and linguistic description.

Discussion

We often think that archaeological features and artifacts are the source of knowledge about the past (empiricism). It is worth noting that in today's archaeology (inter alia, through the development of technology) archaeological objects are increasingly being replaced by their different representations. Recently these representations are more often the sources of our knowledge about the past than are the real artifacts. This change is not without significance for the process of knowledge construction.

As I tried to show in the example of aerial photographs analysis, different types of archaeological data can not only be the sources of information about the past, but also a challenge for our cognitive system. Our knowledge about the past is based not only on the provided information but also on our mental processing. Before information from archaeological data becomes available to conscious reflection in our mind, and becomes the basis for the creation of complex knowledge about the past, it is subjected to a number of unconscious psychological processes. Therefore, we can claim that our data interpretation process is two-step. Primary – unconscious – interpretation is influenced and limited by the biological nature of our senses as well as by our existing experience and knowledge. The secondary – conscious – interpretation is related to the higher cognitive processes, which are based on representations already available to our awareness and contributes to the creation of more complex knowledge about the past.

![Figure 10. Scheme of interpretation process in archaeology.](image)

Our cognition is similar to a theatrical play. What we see onstage (our conscious experience) is a result of many of the processes that are happening behind the curtain (not available for us as an audience). In a play created by an archaeologist we usually admire artifacts, archaeological features and the past. But is it not time to finally draw the curtain open? Get to know the mechanism hidden behind it? It is high time for the new actor to appear on the stage – our mind?
References


Gradina – detecting variability and diversity

Neda Ocelić¹, Jasna Jurković, Natalija Miklavčič, Iva Perković, Suzana Puhar

The Aerial Archaeology in the Karst Region (AAKR) workshop was held at Zadar, Croatia in October 2013. It was headed by D. Grosman (University of Ljubljana) and R. Palmer (Air Photo Services, Cambridge and AARG) to whom we would like to express our gratitude for organizing the whole proceedings. The primary goal was to present basic methods of aerial prospection and aerial photos interpretation with special emphasis on karst regions. A second task was for participants to prepare their own project. Ours will be described in this report.

The focus of our study was a type of site which represent the first monumental architecture in this region and are known in the archaeological literature as gradina. These monuments, built in a drystone technique, were constructed mostly during bronze and iron ages on highly visible locations, such as hilltops from which they dominated the landscape, as they still do in the present.

Gradina is a vernacular term which is now used to signify, a hillfort, refuge, a lookout or a livestock enclosure. Therein lies the problem which can be traced back to a culture–historical theoretical framework. According to this theoretical framework, gradinas were constructed in precarious times of constant wars and mass migrations. Therefore, archaeologists interpret these monuments as, for the most part, places where people and livestock hide behind their walls (Batović 1983; 1987; 1987a). Leaving the problems of a culture–historical interpretation aside, this framework was instrumental in, not only structure identification, but also in documenting and presenting gradinas in texts and archaeological drawings.

The Kutlovica gradina site offers a striking example. Fig. 1:1 shows the site of Kutlovica from the vantage point of a traditional archaeologist (Batović 2004). A self–standing wall is depicted, fortifying a hilltop. Fig. 1: 2 on the other hand, conveys a completely different situation. Terraces are now clearly highlighted as distinct features, as well as walls (Chapman et al. 1996). This was the very first time terraces were depicted on gradina plans in Croatia. Their plan served as a cue for our project idea.

Fig. 1: The Kutlovica gradina site (1: Batović 2004: 774, Sl.26, 2: Chapman et al. 1996, 134, Fig.103)

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Terraces had not been depicted, either in sketches or more ambitious archaeological drawings, before Chapman’s plan. However, these structures were not altogether unknown as they were occasionally included in gradina descriptions with phrases like "the gradina is divided into several terraces by multiple ramparts" (Batović 1971; 1990; 2004). Gradina sketches, not to mention proper plans, are extremely rare to begin with. Even when such documentation does exist, the only features depicted are reconstructed walls interpreted as ramparts. The problem of non-identification of all archaeological features present is self-explanatory. It is also quite clear that what archaeologists saw on these sites was what they wanted to see. This is evident in the very terminology used to describe gradina sites, such as ramparts. This terminology is employed universally, regardless of what was actually found on a given site.

It should be obvious from this discussion that the very presentation of gradinas is extremely biased. Our project attempted to turn the wheel back away from these interpretationist practices and identify, describe, document and present gradinas in terms of features that were actually built on these sites. The starting point of this paper is that gradinas should be described in terms of architectural features represented on a given site with a reference to the specific context of their building program. Gradinas combine several architectural features, namely walls, terraces and cairns. Walls and cairns are self–explanatory, but terraces might need some clarification. Terraces are geotechnical structures consisting of retaining walls and earth fills. Retaining walls exhibit different properties than self–standing walls in terms of the physical forces at work on either feature. The skills and knowledge required to built them is quite distinct from self-standing walls and cairns.

The underlying assumption in devising such a typology is that each of these features required a different set of activities, structural requirements and consequently, implied different uses and purposes.

The next step in our thinking was to map these sites according to the composition of features unique to each site. The desired outcome is a map of gradina sites showing variation of architectural features, rather than lumping them together in a single gradina category. Last but not least, aerial archaeology is the most efficient and cheapest way of gathering a vast amount of data. Furthermore, aerial archaeology just might be the only way of surveying many of these sites due to a clear and present danger of land mines and other explosive devices. This part of Croatia has indeed seen its share of war.

The name of our project was TeGoBe, an acronim in Croatian meaning terraces, cairns and ramparts. In English it translates as hardships. Our study area was limited to mid and eastern Ravni Kotari region in Dalmatian hinterland. The major terrain features in this area include alternating poljes and karst ridges, parallel to the Adriatic sea. Gradinas were placed along these ridges creating an apparent linear distribution which is probably due to the terrain. We began our project by mapping all readily-visible and known gradinas in QGIS, based on available aerial photos (geoportal.dgu.hr, arkod.hr, Google Earth). The study area covers roughly 330 km², with 44 gradina sites (Fig. 2.).
Once all of the known and visible sites were mapped, we could move on to comparing plans of terraced *gradina* sites Chapman et al. (1996) with available aerial photos of the same sites. This procedure was designed as an attempt to establish a set of indicators that would help us identify terraces as a distinct feature in *gradina* architecture. Using these indicators, we would then be able to identify terraces on sites that were not included in Neothermal Dalmatia Project study (Chapman et al. 1996). Comparing these plans and available photos enabled us to ascertain at least two indicators, mostly focusing on earth fills themselves. The first indicator is vegetation (Fig. 3.) which displays different colour and density characteristics than typical karst maquis vegetation. The second indicator can be described as regular "green zones" visible as patches of land with distinct colour and vegetation. These "green zones" tend to be related with wall tumbles.2

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2 We consulted geographer U. Stepišnik, University of Ljubljana, on numerous such sites. He pointed out several issues concerning the question of structures artificiality and suggested several indicators that would help confirm or reject this supposition. The direction of bedrock strata on many of these sites is parallel to the direction of terraces. Therefore, it is not plausible that the terraces are the result of a natural slope processes. The second issue pointed out to us is that, to quote Dr. Stepišnik directly "dissolution of limestone does not result in formation of soil due to high percentage of calcium carbonate in limestone bedrock". In layman's terms, pure limestone is not the kind of bedrock that produces soil. Whenever extra soil is found in a developed karst region, human activities or impurities of bedrock are the most likely cause. We would like to thank U. Stepišnik for providing this information.
Fig. 3. A rectified aerial photo of the Kutlovica site, the arrows mark the terrace and vantage points of photos depicted in Fig. 4. (source: TeGoBe, taken during the workshop)

Kutlovica was visited after the workshop to further illustrate the points made above, so this report would not simply be a speculative enterprise. The question is whether the proposed indicators can serve as a basis for the identification of structures used in *gradina* architecture. Fig. 4: 1 shows a wide terrace, identified during survey at Kutlovica. A tip of a retaining wall is clearly visible, as well as an earth fill covered with thick grass. The same terrace is shown along its long axis on Fig. 4: 2. The relationship between the bedrock slope and the terrace itself can be distinguished and it is clear that the bedrock slope is broken by the flat surface of the terrace.

The next phase of our project included aerial survey and data processing. Six sorties were completed in two days. Our group took a total of 2131 photographs. A data base was created in CataThumb program, followed by georeferencing and rectification of selected photos in QGIS and AirPhotoSE respectively. Additional categories were included in the data base, namely wall, terrace and cairn. The basic analytical unit was a single site. Data concerning the presence or absence of structures was joined with individual sites using a binary system, 0 for absence, 1 for presence of structures (Fig. 5). We were fully aware of the difference between self–standing and retaining walls, but unfortunately not all can be distinguished by aerial survey alone. Therefore, walls were treated as a single category although it is reasonable to assume that the walls related to earth fills are in fact retaining walls.
Fig. 4. Terrace on the Kutlovica site (location marked on Fig. 3.)

Fig. 5. A segment of our archive, flight tracks and QGIS data base
The sites were mapped using the same set of principles. Both retaining and self–standing walls were presented using a single category, wall, while terraces were presented as boundaries of earth fills (Fig. 8.).

Four gradinas are presented for the purposes of this report, most of which are distinguished by their monumentality: Kutlovica, which served as the starting point for our project, followed by two gradinas in minefield areas, Gradina near Vukšić and Mijovac. The fourth site to be presented here is Velika gradina near Kličevica (Figs. 6 and 8).

Fig. 6. Oblique aerial photos of gradina sites (source: TeGoBe, taken during workshop)
Fig. 7. Our group in hardship

Fig. 8. Gradinos as interpreted and mapped from aerial photographs.
The aim of our project was to deploy resources and methods of aerial archaeology to identify, map and document gradina sites in the Ravni Kotari region with reference to the variability of architectural features displayed by these sites. Structural features in gradina architecture include terraces, walls and cairns. The problem our project attempted to resolve is whether gradina features can be distinguished on aerial photographs. Identifying terraces presented the greatest challenge. Two sets of indicators were defined to identify these features. The first set concerns vegetation alone, while the second is defined on the basis of feature shape and its relation to walls and hill slopes. Using these indicators, we were in a position to divide gradina sites according to architectural compositions they display. Naturally, all this will have to be confirmed by field visits. A map was produced showing the spatial distribution of different architectural and structural compositions of gradina sites (Fig. 9.). Regardless of slight reservations we might have as to the validity of our results, the map is a vivid representation of stunning diversity and variability gradina architecture has to offer. The aerial archaeology, both as a resource and as a method was absolutely instrumental in achieving our goal.

![Gradinas mapped according to their diversity of structures](https://example.com/gradinas-map.png)
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Can you catch a shepherd from an airplane?
Interpreting aerial photographs of Bukovica

Filomena Sirovica¹, Mario Bodružić, Ivan Huljev, Iva Perinić and Ante Purušić

In the period from 16th to 26th October 2013, the city of Zadar was host to the Aerial Archaeology in the Karst Region (AAKR) workshop. The first part of the workshop introduced aerial reconnaissance and air photo interpretation as tools for archaeological studies of Karst landscape through time. After this, for the second part, participants were divided into two groups with a task to formulate different research questions which can be studied with tools presented during course introduction (Figure 1).

Our research focused on a central part of Bukovica, an area situated in deep Zadar hinterland, between Southern Velebit and area of Ravni Kotari (Figure 2). Bukovica is a region with an almost continental climate, scarce water sources and rare karst fields (Batović 2004: 7). These conditions led to the emergence of a special kind of animal husbandry characterized by seasonal migration of herders between Bukovica and Velebit, the longest mountain ridge in Croatia. Research conducted during AAKR course focused on the natural pathways located between higher hills in Bukovica that were until recently used for this kind of seasonal migrations (Marković 1980; 2003; Miletić 1993; Čače 2007). In the background of our research was a presumption that in Bukovica, economics based on pastoralism can be traced during not only historic but also prehistoric times and that evidence for this special way of life, usually hardly traceable in the archaeological record (Miracle, Forenbaher 2005), can be implicated by the analysis of the location pattern of archaeological sites. For this type of landscape research, aerial reconnaissance represents a significant type of approach which allows detailed documentation and study of site’s structure and location.

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Fig. 2: Study area with locations of contemporary settlements and roads that mainly follow natural pathways through Bukovica.

Fig. 3: Potential archaeological sites mapped during desk based assessment.
In our research area, which covers almost 600 km², we expected to conduct several flights with the main goal to identify and then photographically document locations with larger drywall structures which could represent archaeological features, presumably prehistoric enclosures. In order to successfully complete this procedure, the first part of the research was focused on conducting a desk-based assessment which included mapping larger structures visible on aerial photographs that can be found on different Internet portals, such as GeoPortal, Arkod, and Google Earth. Each observed structure was marked by a point in QuantumGIS program and included in our database where they were classified in two main categories: enclosures and barrows. During this procedure we mapped 72 locations with archaeological potential, 58 of which were categorized as enclosures and 14 as barrows (Figure 3).

Next day we had four flights over the research area during which we took 1675 photographs that documented many of the locations mapped during our desk-based assessment (Figure 4).
Photographs were transferred to previously prepared archives and included in the list of photographs with the help of CataThumb program. From the basic set of photos we selected those of the highest quality and then the ones which were most suitable for rectification and georeferencing. Oblique photographs of six locations were selected for mapping and were rectified and georeferenced in AirPhotoSE before being imported into QGIS. Photo interpretation was done on screen, making reference to the original oblique pictures, and features were mapped and results imported into our database (Figure 5).

This new information was then analyzed and interpreted in relation to the known data about archaeology in Bukovica and assumptions about possible way of life in this area in prehistory. Analyzing positions of sites documented in the research area we identified several concentrations of different enclosures on the higher plateaux situated near the natural pathways between higher hills in Bukovica. One of these pathways crossed the center of our research area and linked the small villages of Bruška and Medviđa. It is a natural path that, in the broader area of central Bukovica, represents the only possible way towards Velebit (Miletić 2004: 17). Its route is marked by the previously known large enclosures: Brgud, Jerebinjak, Otavac, and Samograd (Figure 6) overlooking its southern entrance, and big Medviđa hillfort (see below) on its northern side. All of these locations were photographed from the airplane, and all four enclosures on the southern side of pathway were rectified, georeferenced and mapped (Figure 7). As prehistoric material has been found on all of them (Sirovica, Burmaz 2011; Sirovica 2013) we can assume that they represent prehistoric enclosures, some of which can easily be considered hillforts.
Fig. 6: Brgud, Jerebinjak, Otavac and Samograd – enclosures located on southern side of pathway that connects Bruška and Mevida.

Fig. 7: Mapped enclosures.
Medvida (Figure 8), on the other hand, is widely known prehistoric hillfort that probably had its peak during the roman period. It is situated on the crossroad of two main paths towards Velebit. One of these leads to the North and crosses Velebit through its lowest part and the other goes West towards the biggest pastures on Velebit (Čače 2007). Analyzing the pattern of site location in the northern part of research area (Figure 3) we can see two concentrations of enclosures which are likely to relate to known pathways that were until recently used for seasonal pastoralism.

Analysis and interpretation of gathered data clearly suggests that the location of documented sites is directly connected with the natural pathways through this area (Figure 9). The possibility that documented sites represent prehistoric structures could be important evidence showing that a special kind of economics highly connected with seasonal pastoralism has its roots in prehistory. Although the study of this problem needs more long-term and intensive
research, we hope that our project shows that aerial reconnaissance and air photo interpretation represents a necessary part because it enables detailed documentation and study of site structure and location pattern in wider landscape framework and provides an irreplaceable tool for broader studies of relationship between people and landscape in the past.

References
Between 24th and 28th of June 2013 I had a chance to participate in the LiDAR – innovative technology for archaeology (LITA) training school held in Poznań, Poland which was organized by Institute of Prehistory of Adam Mickiewicz University with the cooperation of ArchaeoLandscapes Europe project. The training school was addressed to MA and PhD archaeology students and also professional archaeologists, particularly those from Central Europe. The main goal of LITA was for students to get better knowledge about collecting, processing and visualizing LiDAR and derived LiDAR data. The first goal was achieved by a series of lectures and the others by practical workshops in a computer laboratory.

Fig. 1. Tutors and participants of “LiDAR – innovative technology for archaeology” training school in Poznań, Poland (photo by Tomasz Michalik).

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2 A LiDAR-derived DTM visualization (extracted from the poster of “LiDAR – innovative technology for archaeology” training school in Poznań, Poland).
One of the big advantages of this training school, from my perspective, was a chance to learn about collecting LiDAR data and processing not only from the archaeologists who work with this data, but also from the software developers. Learning from people who collect the data and use them in projects, who have goals other than managing the heritage, gave us an idea of the potential of this technique for archaeology.

On the first day we were introduced to the LiDAR concept by Martin Isenburg (rapidlasso GmbH), the creator of LAStools software for processing LiDAR data. The idea of full-waveform data was described and we were shown how a LiDAR point-cloud can be efficiently compressed in to laz format [some of M. Isenburg’s lectures can be found on his You Tube profile]. Later we had our hands in action working and processing point cloud data in LAStools. Unfortunately, due to other obligations, Martin Isenburg could not stay with us longer.

The second day started with lectures about the use of LiDAR in archaeology and how aerial gathered data can be interpreted. This session was conducted by Rebecca Bennett (South Downs National Park Authority) and Simon Crutchley (English Heritage), afterwards we moved to computer laboratory to start learning the workflow of different techniques and the possibilities of LiDAR-derived data visualization in QGIS and GRASS, open-source GIS software.

The third day started with presentations by Simon Crutchley of a series of case studies using LiDAR data. These were followed by talks about interpretation of aerial photographs by Włodzimierz Rączkowski which gave us a broader background into survey techniques. Later, Piotr Wężyk, from the Agricultural University of Cracow, shared his experience of using airborne data in forest management and his work with the Polish government to collect LiDAR data for the whole country (ISOK project).

After this, in the computer laboratory, we were able to upgrade our skills in techniques of LiDAR-derived data visualization using QGIS, GRASS GIS and Lidar Visualization Toolbox (LiVT) and to use Cumulative Viewshed, Principal Component Analysis and Local Relief Model to perform different types of analysis.

On the last day we were working in pairs with our own data or that provided by the tutors. The goal was to use the skills we learned during the training school and to present our own case studies as a way of summarising those five days of learning about LiDAR data.

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3 LAStools can be downloaded from http://rapidlasso.com/lastools/
4 http://www.youtube.com/user/downtownfarm/videos or http://rapidlasso.com/category/tutorials/ for tutorials and downloading the software (both accessed 31.12.2013)
5 LiVT can be downloaded from http://sourceforge.net/projects/livt/
6 All the LiVT lidar tutorials for QGIS and GRASS can be accessed at http://www.pushingthesensors.com/teaching-materials/
My partner, Leszek Gardela (Rzeszów University) and I had access to LiDAR data bought from the Polish Government – Geodesic and Cartography Authority (ISOK project\(^7\)) and to aerial photographs taken by Włodzimierz Rączkowski. The LiDAR data covered the area of an archaeological site located in Mutowo, Wielkopolska Region (40 km north of Poznań) which was first recorded by Włodzimierz Rączkowski during an aerial survey in 2006. The site is the original location of the town of Szamotuły which was abandoned after a fire in 12\(^{th}/13\^{th}\) century during which the city got burned down (some called it the Polish Pompeii). After the discovery of this site it has been constantly observed and studied using non-destructive remote sensing techniques from sky and ground\(^8\). The site is listed and has been excluded from any forms of invasive archaeology techniques.

The problem with this particular archaeological site (from LiDAR data perspective) is that, although from air it can be seen through cropmarks, it has been ploughed out and is relatively flat. It might seem this is not the best situation in which to use the LiDAR data if our intention was to use micromorphology to detect archaeological remains. Our goal was to answer the question: can this kind of data, collected at 4 points/m², help to detect such an archaeological site? The first view of the LiDAR-derived data did not seemed to be too promising.

The first thing we did with the data was a quality check in lidarinfo (part of LAStools) before merging different tiles together (las. data is stored in a format of 1x1 km²). Sadly Szamotuły is on the edge of two tiles. Connecting these is not easy for a beginner and may influence the results. The visualization we produced has a “scar” where the tiles join which is noticeable as a line of interference running across Fig. 5. Next the data needed to be “cleaned” form all the
points that where registered to high or too low by deleting all that were above 20 and below -5 m.

Although the las data provided from the ISOK project were already classified, using LAStools it was possible for us to reclassify them to match our own needs and to have control over the characteristics of the algorithms for surface extraction. After that it was possible to extract a DEM to bil (Band Interleaved by Line) format, which is a very light format for saving spatial data and is for the moment the only format that can be processed in LiVT.

Getting familiar with LiVT to process and visualize LiDAR-derived data was one of the goals of this training school. This standalone software provides an easier and faster way to expose archaeological remains through different techniques than using different open-source software (such as Saga GIS or GRASS GIS). The second biggest advantage of this Lidar Visualization Toolbox, from my perspective, is that it is very easy to use and the layout of the program is very intuitive. One only needs to know the effects of different processing algorithms (i.e. sky-view factor, local relief model or trend removal), and how they may change the image that we later perceive

![Fig. 5. Local Relief Model of archaeological site in Mutowo processed in LiVT and visualized in QGIS. On the left the image without interpretation, on the right with pits and the line of the road vectorised on an interpretation of an aerial photo. In my opinion it may seem like the local relief model "excavated" the pattern of pits that are visible on the aerial photography.](image)

LiVT is an open-source software which is, hopefully, still being developed. Right now, in my opinion, the biggest disadvantage, is the need to use the bil format as the only one that we can work with in this software, and which is not so popular in GIS software. Although it might require only basic skills to convert other formats in to bil format, still it is something that requires some knowledge to be able to do that. The second biggest disadvantage is that LiVT does not have an implemented viewer, after processing the data we need to use some other software to view the results. Of course those two things are just suggestions of further development I would like to see in this software. In its present version it makes a lot of things faster and easier than other programs.
We processed Mutowo data in LiVT using most of the algorithms and manipulated with different variabilities, but the one that produced the most interesting image was the Local Relief Model with the program’s default input options (Fig. 5). Although without seeing the aerial photo it would be almost impossible to recognize the patterns of the pits, it may look as if there are some kind of micromorphological forms of the ground that indicate the shape of the market place and the line of houses that were standing by the street that lead to it. The results we came up with may not seem spectacular as we would like them to be, but still in my opinion we managed to show that there may be a potential of using LiDAR data while using different kind of algorithms for studying landscape which is relatively flat or ploughed away.

![Image of LiDAR data processing](image)

**Fig. 6.** Grzegorz Kiarszys from the University of Szczecin presenting his work (photo by Włodzimierz Rączkowski).

After few hours of processing LiDAR data, making visualization of LiDAR-derived data and discussions about how we can perceive and interpret them we had a chance to present our work to other participants of the training school. Although our outcome may not have shown that the data from the ISOK project are effective for such archaeological sites it has shown that there may be a potential of studying such a landscape using LiDAR data and, as has been suggested by others, that a more detailed survey with more points per meter might bring better results.
It may look as if it’s becoming a small tradition in Poznań that, with the help of the ArchaeoLandscapes Europe project, we are having chances to attend workshops focusing on bringing new remote sensing techniques to archaeologists from Central Europe (this time from Romania, Czech Republic, Montenegro and Poland). The previous one was on the “Potential of satellite images and hyper-/multispectral recording in archaeology”9. I hope that more similar events will be organised, as they provide opportunities to learn new techniques and to integrate with people interested in remote sensing from different parts of Europe.

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“In one week learn how to prepare and fly your drone to survey in 3D your Cultural Heritage”

Nina Heiska

In September 2013, around 30 participants and instructors interested in the use of unmanned aerial vehicles (UAV) for cultural heritage and archaeology gathered at Certosa di Pontignano in Siena for one week. There we participated an international summer school “Drones Applied to Cultural Heritage & Archaeology” organised and coordinated by Stefano Campana (University of Siena-LapetLab), Sofia Pescarin (CNR-ITABC), Fabio Remondino (FBK-3DOM) and Livio De Luca (CNRS-MAP).

I went to Siena because UAVs have been rising trend for several years now and this school offered a wonderful opportunity to experience different types of flying platforms and cameras. The equipment was provided by the organizers and commercial service providers, so we did not get any hands on experience in flying and data acquisition (camera), but we did get to see how the flights are planned, how they were flown and eventually we got the data to manipulate in our own computers to create 3D models. Our targets were historic buildings in the region.

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The lessons we learned were not only about practical flying and related photogrammetry, but also about regulations and operational costs. The regulations vary in different countries so, before you start your own UAV experiments, check out the local rules first. In general the rules are more restrictive in urban areas, where accidents can cause greater damage to human lives and property. In Europe each country is responsible for their own air space, although a common EU regulation is planned as well. A roadmap for this regulation was published in June 2013 and it has four timeframes in 2013, 2018, 2023 and 2028 to harmonize the rules for systems < 150 kg within the EU. While the media talks about drones and UAVs, the EU, to confuse things even more, uses the name Remotely-Piloted Aircraft Systems (RPAS) instead. Thus the current regulatory thinking emphasizes that a vehicle always has a pilot somewhere, if not in the air then on the ground.

The second interesting issue are the operational costs. An in depth view was provided by Renato Saleri (CNRS-MAP), who is a trained pilot and has several years of experience of flying UAVs as well. The hardware itself costs from a few hundred euros to hundreds of thousands, depending on the budget and requirements. Then the software, sensors such as a camera, pilot and training need to be added and also transportation costs, if the UAV is flown in a wider region. Since accidents are currently likely, some spare parts and a maintenance contract with the manufacturer may be useful as well. Finally, insurance is also needed, because the system may cause damage to outsiders.

In conclusion, if you use a small, low flying UAV to document your archaeological excavations (or a small limited area), it does not cost much to get started if you know what you are doing. If you want your UAV to carry a heavier camera or even a Lidar scanner, you
need more payload, more expensive equipment and in the end even a trained pilot. It takes two persons to do the flying anyway, because one can concentrate on flying and the other is needed to watch out for any kind of disturbances.

Future
The UAV/RPAS boom is still growing and it has been fascinating to follow global commercial business ideas and of course the military development, because it all affects our future use of drones. Commercially there is a lot pressure on regulators to lax the rules, so that e.g. freight and parcels could be transported in small drones. Amazon, DHL and several food chains have announced that such systems are currently under development. Also surveillance and search-and-rescue people have used UAVs already and now UAVs equipped with SAR radars are tested on ships to detect ice and icebergs on route. The latter application is related to the future use of Northeastern passage in the Arctic sea for sea transport. At present I am slightly sceptical of the search-and-rescue and ice detection use, because drones are affected by wind and bad weather. So it would be very difficult to use light and cheap UAVs in this kind of work where the service is needed 24/7.

In the military side, the US is leading the development of drones, but China and others are working in this field as well. In fact the US air force has trained more drone pilots than regular pilots since 2010 and currently the drones constitute a major expense in the military budget. Therefore the US Department of Defense published its own roadmap for the future use of UAVs, where they want to save money by making the drones more intelligent and
getting rid of the people who currently operate them. By comparison, the Finnish army published a report last year in which they stated that current military drones cannot effectively be used when the enemy is as advanced or more advanced than we are: the drones are basically too dumb and can be shot down easily. If we think about the commercial use, the same applies here as well, as e.g. radio links can be disturbed and GPS can be spoofed.

Beside the aerial vehicles, maybe even more intensive “unmanned” development is happening on our roads: every major car manufacturer and Google are developing driverless cars at the moment. In US, there are now several states permitting driverless cars and the experiments are starting elsewhere too. Sweden will go first large scale, as the Swedish traffic authorities and Volvo will test 100 driverless cars in Gothenburg starting 2017. At the same time tests using driverless pods may also start at Milton Keynes, UK.

Why are driverless cars important to the UAV development? Many of the components and software used for object detection and navigation are the same or similar, so current heavy investment in research and development will also help to create better UAVs. Like cars, UAVs will be more automated in the future. Secondly, one of the main issues in either case is the insurance. Our current legislation and international agreements have problems in dealing with any kind of vehicles without drivers and even remotely guided vehicles without a line of sight are often a problem. Acknowledging the problem, car manufacturers have recently began a big campaign promoting the safety of driverless cars compared to human guided vehicles [or ‘ones’]: according to statistics, more than 95% of accidents are due to human errors. If the insurance issue and international agreements are dealt with, the use of automated UAVs will be easier as well.

Robots are really coming now in massive scale, but are we ready for them?

**Further reading:**


Cropmarks

Interpreted by Rog Palmer

Early Riley aerial photographs on-line
While searching for pictures of Riley-the-person, I discovered that the Ashmolean have his 1940s aerial photos on line, along with those of Major Allen – as mentioned previously.
http://www.ashmolean.org/ash/objects/?mu=575

Do we need a new name for AARG?
Satellite Sarah has written a short article in which she lumps airborne survey, ALS, and use of satellite images all as ‘Space Archaeology’. Do we now need to become SARG?
http://www.slate.com/articles/technology/future_tense/2013/10/spac_archaeology_this_is_the_best_time_ever_to_be_an_archaeologist.html

‘Golden Age’ of archaeology
A piece looking at current (mostly US) uses of satellite data and ALS for archaeology. Includes notes on work in Egypt, Cambodia, Middle East, Easter Island and Guatemala. The article also notes the need (expressed by Devin White, Oak Ridge National Laboratory) for machine learning and use of computers to handle the mass of data.
http://mashable.com/2013/11/06/space-archaeology/

Aerial Photographs
Any of you who like ‘different’ aerial photos may be interested in the work of Polish photographer, Kacper Kowalski: http://www.kacperkowalski.pl/gallery

ALS in New England, USA
Use of ALS to survey Connecticut’s Pachaug State Forest in which were remains of farm walls, roads and homesteads that date to the 18th Century and were abandoned in the 1950s. Which surely means they’ll be on a map or aerial photos…?

… and sets of paired aerial-ALS and ground-ALS photos for anyone needing more teaching examples: http://www.livescience.com/42638-lost-new-england-archaeology-lidar-photos.html

DigitalGlobe’s WorldView-3 satellite
WorldView-3, is scheduled to launch from California’s Vandenberg Air Force Base in summer 2014. It is the first multi-payload, super-spectral, high-resolution commercial satellite for earth observations and advanced geospatial solutions. Operating at an expected altitude of 617 km, WorldView-3 will collect 31 cm panchromatic resolution, 1.24 m multispectral resolution, 3.7 m short-wave infrared resolution, and 30 m CAVIS resolution.

Which will be lovely if the US government lets us have images at that resolution.

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Books of interest?

Rog Palmer


Many copies of this book were handed out at the ArcLand meeting in September, so you may already have a copy. It is a combination of papers by students, ex-students and staff at the University of Bohemia and the results are outcomes of two major projects including the partnership with ArcLand. Martin Gojda has been good at attracting students to work on aerial and/or landscape themes and their associated problems and this volume carries a generous range of papers; some dealing with general approaches, analytical methods and problems while others tackle specific sites, feature types or landscapes. Dates of sites/landscapes range from the Neolithic to Cold War although the majority are medieval in origin. The book is written in Czech but has English summaries at the end of each chapter and captions and contents are in both languages so it is relatively easy for non-Czech speakers to get a reasonably good idea of the gist of each contribution.

As would be expected of projects under Martin’s leadership, there are many examples in which results of analysis of ALS are compared to data from other non-invasive methods. This is good and this is necessary. During the past 10-15 years (at a guess) we have seen ALS mature from the initially spectacular ‘seeing through trees’ device to one in which we are fortunate to have some dedicated algorithms and methods for analysing the data to provide output that helps archaeological understanding of past landscapes. This book demonstrates, as others have before, that there are several ways of working towards an optimum interpretation of ALS data and thus being able to make an archaeological interpretation. These are two related, but different, aspects.

The next book I would like to see would be one in which ALS is used as one of a battery of techniques to study a landscape, as can be seen in some contributions in this book. Now that we’ve got over the initial sexiness of this new toy it is essential, I think, that it does not become a stand-alone method as seems to have happened to use of satellite images by GIS-centred archaeologists. Best practice in image analysis remains what it has always been, which is to examine all available ‘photographs’ (we can change that to ‘sources of data’) and to base our archaeological interpretation on consideration of the different views they provide of the same field or area. This is no criticism of the book, just thoughts that have arisen from perusing it. We look forward to seeing more books or publications deriving from the ArcLand initiative.

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Results of a four-year survey (2009-2012) of the Middle Mureş Valley and adjacent areas that extends the work of Hanson and Oltean by recording known and new sites of all dates. Features recorded range from the Copper Age to Roman periods and include fortifications, barrows, roads, additions to the Roman landscape and undated stuff. Illustrations include plans of archaeological features and aerial photographs with little arrows indicating the features on them — something that makes it far easier for readers to follow than the lengthy descriptions used by aerial photographers who think it is blasphemous to overwrite an aerial photograph.


*From the publicity blurb:*
This book is a celebration of the history, archaeology and landscapes of Radnorshire as seen from the air. The book is illustrated with numerous colour images which have been specially chosen to show how traces of the county’s history, from the earliest times up to virtually the present day, are etched indelibly in the landscape.

...and on other works of Chris Musson:

*Flights into the Past*. Chris Musson, Rog Palmer & Stefano Campana. 2013. ISBN 978-3-00-044479-1. The first *ArcLand* eBook, available free as an iBook or pdf from an assortment of web addresses including ArcLand and AARG.

The renowned *Bloody Book* (2005) translated back into English with some modifications and updating by Chris, plus two new sections — and all turned through 90 degrees to fit a computer screen. Enough for now — we hope to bring you a full review in the next issue.


The blurb says this book:

- Presents the state of the art in archaeological diagnostics
- Related to the major European-funded project Radio-Past
- Covers the full range of archaeological diagnostics

...and so it may but it seems to have been let down by Springer’s usual inept editing and the fact that English is not the first language of many contributors (nor of the editors to judge from one contributor’s comment to me). The first chapter, available as a free preview on the

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2 I’ve no idea what *APVLVM* is — chase the paper on Academia if you’re interested — Ed.
web site, has not been well translated from what I guess is an Italian original and other contributions may have suffered similar fates. However, if you want to find out what archaeological diagnostics are or keep up to date on topics such as aerial photography, orthorectification, active aerial photography, hyperspectral RS, various geophysical methods, minimal interventions [good one that, in a book about non-invasive surveys], DTM’s geoarchaeology, etc, etc, this may be the book to save up and buy.


This is a fairly technical paper that’s more about algorithms, their effects, tweaking and output, than archaeological results. The targets are fairly small High Circular Tombs, of which there are thousands, set in rugged terrain – and identification of these, their locations and distribution can help answer archaeological questions. The sheer number of the things plus problems of access make use of image examination via autodetection a logical first step.

Circles, as we have seen from past work (eg Trier, et al, *Archaeol Prospection* 16), make ‘easy’ targets for autodetection. Images used were from QuickBird (0.6m pan, 2.4m multispec resolution) on which HCTs were visible via contrast, shape and size.

If anyone needs a reason to turn to autodetection, here are some figures. A QuickBird scene covers about 256 sq km within which the area of interest for this project was 69 sq km, or about 200,000,000 pixels (p 5). Within that, a 4-5m diameter HCT could be defined on a 0.6m resolution image by an 8 x 8 square of pixels. Even automatically, that is a time-consuming calculation and will become more so on the latest higher-resolution images (GeoEye-1 = 0.41m, WorldView-2 = 0.46m).

From this point the technical details take over but include processes, including use of landform classification, to try to eliminate false identifications and to better-confirm the possibles. Comment on training (via 76 HCTs) is also given and how that information was fed into the detection algorithm.

Interesting stuff, and a great help to eye and brain in these conditions.

Chris Going left me two books on one of his visits. Both can be related to aerial photographs if you try hard but not to archaeology (unless it’s of recent buildings).


A curious book using contributions from Seppe Cassettari, Chris Going, Peter Jolly, Peter Jones, Dr Alex Kent, and Nick Millea to present a series of double-page spreads (one of UK, one overseas) for each year from 1963 to 2013. I like maps and (usually) enjoy looking at them, reading them, and admiring the skills that have gone into their design and creation – but this book provides little of that. Why? The yearly themes frequently demand news-worthy stories and are often accompanied by newsy maps that provide information on those themes. OK – maybe I just don’t like news-style maps (many of which just stick a pin in the relevant
place) but my other, perhaps main, reason is that many of them are reproduced at too small a scale to be readable.

But please buy the book if you want to help BCS celebrate 50 years or to read in the *Short History* introduction of their response to the introduction of, and wide-scale takeover by, GIS—something that is similar to GIS-users’ takeover of uses of aerial images.


This is a little more relevant to aerial photographs (or ‘aerial photography’ as they annoyingly call pictures) as vertical surveys have been used to date and classify building types and open spaces—supported by a certain amount of ground inspection—that form components of Geoinformation’s UKMap. For the past few years Chris has been dropping in and telling me about use of APs for dating and classifying buildings and the work that was being done on city maps and the uses for this information. The finished maps are a new way of showing urban land that are no doubt useful to someone because Geoinformation is a commercial company. As far as I can make out from Chris, the interpretation is done by eye and humans but the criteria he mentions (house shape and layout of estates, chimney type—for example) could surely be more rapidly categorised by some kind of automatic or semi-automatic program…? The book’s illustrations include some vertical aerial photos, lots of layers of UKMap and some supporting ground photos. Add it to the ‘uses of aerial photograph’ list.


This volume is badged by ArcLand, so possibly of interest, and combines papers from three different conferences. Judging by unfamiliar author names the contents are mainly geophysical prospection although there are one or two aerial and ALS contributions.

Oxbow’s 2014 *Bargains Catalogue* includes at least four reduced price aerial-related books (http://www.oxbowbooks.com/oxbow/). In order of appearance:

  *Populating Clay Landscapes*. Mills and Palmer, 2007
  *North-East Perth*. RCAHMS, 1990
  *Ancient Jordan from the Air*. Kennedy and Bewley, 2004
The Aerial Archaeology Research Group

AARG provides an international forum for the exchange of ideas and experience on archaeology and landscape studies using all forms of remote sensing, especially airborne and satellite based techniques.

AARG is actively involved in promoting the collection, interpretation and application of remote sensing data in fostering research, conservation and public understanding.

Since its foundation in the early 1980s AARG has vigorously encouraged discussion and cooperation through its annual conferences, workshops, specialist publications and biannual newsletter, AARGnews.

Membership is open to all who have an interest or practical involvement in aerial archaeology, remote sensing and landscape studies.

AARG is a registered charity: number SC 023162.

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Student bursaries. AARG has a limited number of student bursaries for attendance at its annual meeting. These are aimed at supporting bona fide students who are interested in aerial archaeology and who wish to attend.

Anyone wishing to apply should write to Oscar Aldred (aargchair@gmail.com) with information about their interests in archaeology and aerial archaeology, as well as their place of study. The annual closing date for applications to the annual AARG conference is 31 May, other meetings for which bursaries may be available will be advertised on an ad hoc basis.