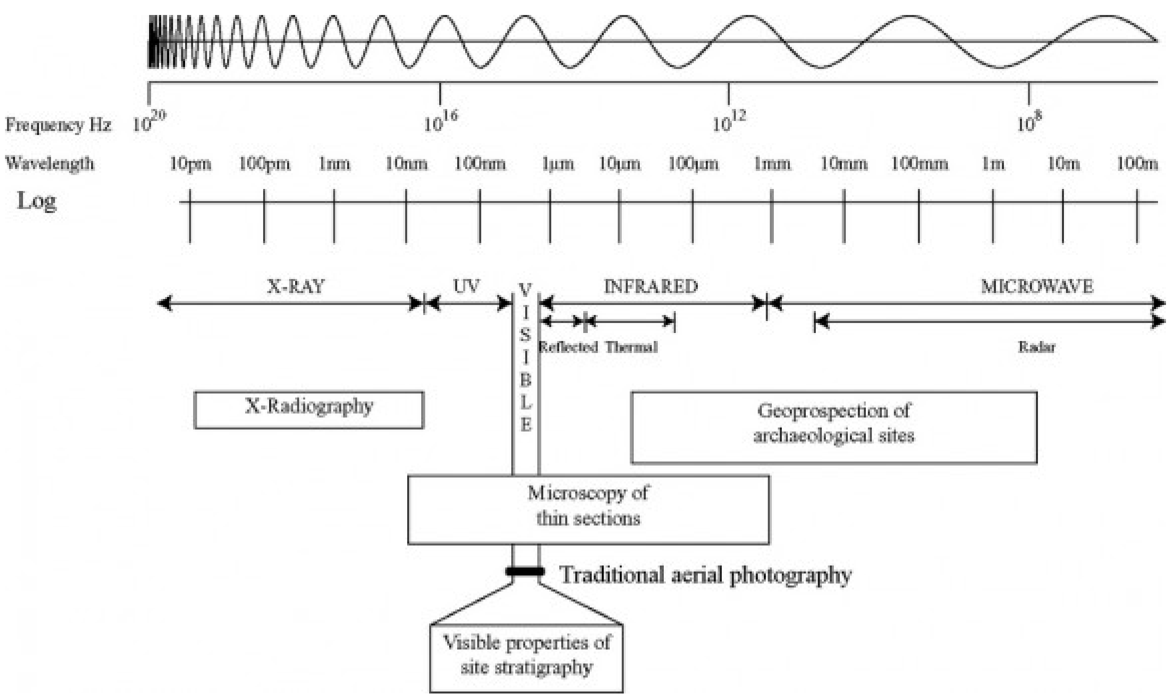
WRITING A PRESS PACK FOR THE BRITISH SCIENCE FESTIVAL

July 29, 2011 Ant Beck Archaeological Media, Archaeological Prospection, Day of Archaeology 2011, Journalism, Science Anthony Beck, archaeological prospection tools,Archaeology, British Science Association Press Office, Color, Cropmark, dielectric, Earth sciences,Geophysical survey, Hyperspectral imaging, Imaging, journalist, Materials science, Multi-spectral image, Narrow band spectral imaging, online software tools, Physics, radiation, remote sensing,remote sensing technologies, representative, satellite surveys, School of Computing, sensor technologies, Social Media, Soil, thermal imaging, United Kingdom, University of Leeds,www.comp.leeds.ac.uk/dart

I've spent most of today writing the press pack for the British Science Festival. Engagement with journalists is important. Journalists provide the opportunity for you to get your information out to a wider audience. The challenge is to take complex data and interpretations and find a way to present it to journalists in a way which is both accessible and allows them to weave a narrative which is interesting to their readers.

Here it is…. Apologies to those who do other archaeological prospection work: you may think it's a bit biased towards aerial approaches. It is, but that's the very issue for a press release.

This draft will be sent through to the University of Leeds press office prior to submission to the British Science Festival.



The Electromagnetic Spectrum. Re-used under a creative commons share-a-like licence from DART_Project.

I'm sure I left it somewhere: discovering our heritage through scientific prospection

Anthony Beck – School of Computing, University of Leeds

A presentation for the British Science Festival in Session 56: Exploring new archaeological worlds, 12 September 2011.

CAN YOU PROVIDE A BRIEF INTRODUCTION TO THE TOPIC OF YOUR PRESENTATION?

Guidance: This should be more than an abstract or one-paragraph summary of your research. We would anticipate the summary of your presentation to be in the region of 1000 – 1500 words. Two to three sides is ideal. It is an opportunity to introduce the main findings of the work/research described in your presentation, as well as to include relevant background information and to fit your work within the wider context. It should contain specific information (e.g. data, number of people included in any studies, etc) that would enable a journalist to accurately write a story about your work, without them having to hunt around for details elsewhere. Due to time constraints journalists are rarely able to attend the talk itself, which is why press papers are so important – therefore the details you provide shouldn't assume that the journalist will be attending your talk.

Summary/Abstract (174 words): Multi-spectral and hyper-spectral sensors offer immense potential as archaeological prospection tools. The sensors are sensitive to emitted or reflected radiation over different areas (wavelengths) of the electromagnetic spectrum. Their two major advantages are that they have the potential to detect archaeological sites and monuments (henceforth archaeological residues) that are undetectable in the visible wavelengths and that they may extend the window of opportunity for their detection. For example, localised crop stress and vigour variations, which underpin crop-mark formation, are sometimes better expressed in the near-infrared than in the visible. In addition, multi/hyper-spectral data collected from different platforms (aerial and satellite) under different conditions can be used to generate ancillary themes that aid interpretation (e.g. soil, geology and land-use layers). However, multi/hyper-spectral sensors are relatively expensive and require

systematic surveys under ‘appropriate conditions’ in order to be successful. It is this latter point which is critical: there is a poor understanding of the spatial, environmental and seasonal contrast dynamics that determine an ‘appropriate condition’ and therefore whether features of archaeological interest can be detected.

Text (1423 words): Although there are many examples of upstanding architecture, the vast majority of archaeological residues are expressed on the ground surface or buried and essentially invisible to the human eye. However, traces can be identified via changes in chemical, physical and biological attributes (either directly or by proxy) through, for example, changes in phosphorous content, clusters of artefacts and cropmarks. In the UK, the practice of using remote sensing techniques for detecting archaeological sites and visualizing archaeological landscapes has traditionally been based on low altitude aerial photography using film emulsions sensitive at optical and sometimes near-infrared wavelengths. The underlying premise of remote sensing is that interpreters can extract information about objects and features by studying the measurements from a sensor system. Both oblique and vertical aerial photographs have been used extensively for archaeological reconnaissance and mapping all over the world. Early aerial photographers helped to refine the instruments and establish methods that are still in use today. O.G.S. Crawford in particular established methods of site classification and wrote about the effects of weather, season, soil moisture and crop type on photographic return. Today, these aerial approaches are accepted as a cost-effective, non-invasive technique for the reconnaissance and survey of monuments.

However, recording using traditional observer directed reconnaissance and aerial photography is not without its problems. The reliance on a small component of the electromagnetic spectrum raises a number of issues. The small spectral window can introduce a significant bias as only certain residues under specific conditions express contrasts in these wavelengths. The over-reliance on the visual component of the electromagnetic spectrum has had a significant impact on data capture. The collection technique and technology mitigate against using any other sensor (peripatetic surveys are directed by visual observation from a plane and collected using an optical system, a camera out of a window: this technique will never allow the detection of the multitude of archaeological residues whose contrast expression can not be seen by the human eye – i.e. is outside the optical). This presentation will introduce multi and hyper-spectral remote sensing (including the important resolving characteristics of the sensors) and the nature of the archaeological problems to which they can be applied. This is followed with a brief description of the DART project: a UK research project designed to improve the understanding of the application and the factors underpinning archaeological detection.

The main advantage to multi and hyperspectral imaging is that more of the electromagnetic spectrum is sampled at potentially finer spectral granularity; hence, there is more information about the objects under study. The main disadvantages are cost and complexity. Unfortunately the archaeological application of this technology is under-researched: there is little understanding of the physical, chemical, biological and environmental processes that determine whether archaeological residues will be identified in one or any sensor. Hence, knowledge of which techniques will detect which components of the archaeological domain and under what conditions is poorly understood. Most multi and hyperspectral analysts use spectral signatures to accurately identify different vegetation and geology types. Unfortunately archaeological sites do not exhibit spectral signatures that can be used for generic detection purposes. Archaeological sites and features are created by localised formation and deformation processes. For example, as a mud-brick built farmstead erodes, the silt, sand, clay, large clasts and organics in the mud-brick along with other anthropogenic debris are incorporated into the soil. This produces localised variations in soil particle size and structure. This impacts on drainage and changes localised crop stress and vigour responses, which in turn changes reflectance characteristics.

Multispectral sensors address some of these problems because they are able to ‘look’ simultaneously at a wide range of different wavelengths. Wavelengths in the near and short-wave infrared add important collateral information to the visual wavelengths and improve the ability to discriminate vegetation stress and soil, moisture and temperature variations than either the human eye or photographic film. Narrow band spectral imaging can often help to enhance or distinguish different features on the ground or provide information on their state of health or ambient conditions according to their particular absorption and reflectance properties or their spectral signature.

This increased sensitivity is crucial for contrast detection. For example, cropmarks are an instance of localised variations in vegetation stress or vigour correlated with subsurface archaeological features. Wavelengths outside the visible are also sensitive to changes in vegetation health. Theoretically, exploiting relevant areas of the electromagnetic spectrum at the appropriate degree of granularity will mean that crop stress or vigour relating to subsurface archaeological residues can be expressed more clearly and also that it can be detected both earlier and later in the growing cycle. Therefore, the window of opportunity for detecting archaeological features can be dramatically extended by using wavelengths outside the visible. This increased sensitivity means that archaeological contrasts can also be detected in soils and crops that have been traditionally categorised as marginal or unresponsive to aerial archaeological prospection. This is a significant improvement over traditional techniques.

We can hypothesise that archaeological residues produce localised contrasts in the landscape matrix which can be detected using an appropriate sensor under appropriate conditions. However, little is known about how different archaeological residues contrast with their local environment, how these contrasts are expressed in the electromagnetic spectrum, or how environmental, and other localised factors such as soil or vegetation, impact on contrast magnitude (over space and time). This requires an understanding of both the nature of the residues and the landscape matrix within which they exist.

The Detection of Archaeological residues using Remote Sensing Techniques (DART) project (www.comp.leeds.ac.uk/dart) will focus on analysing factors that influence archaeological residue contrast dynamics. DART aims to determine how different remote sensing technologies detect contrast caused by different underlying factors under dynamic environmental conditions. This understanding will allow the optimal deployment of the different sensors. By combining the results from a battery of sensors, each optimally deployed when the archaeological residues have the greatest likelihood of being detected, the maximal knowledge of archaeological residues can be achieved.

DART will address the following research issues:

What are the factors that produce archaeological contrasts?

How do these contrast processes vary over space and time?

What causes these variations?

How can we best detect these contrasts (sensors and conditions)?

The key will be to understand how archaeological residues differ from, and dynamically interact with, the localised soils/sediments and vegetation/crop and how these differences can be detected. Archaeological residue interaction models will be developed and tested under a range of different environmental, seasonal and crop conditions. In-situ measurements will be taken using probes and sensors, and samples will be taken for laboratory analysis. Standard geotechnical tests will be conducted such as density, grain size distribution, organic content, magnetic susceptibility, dielectric permittivity, geochemistry, pH and conductivity. Permanent in-situ probes will measure temperature gradient, density and soil moisture variations through a soil profile. In addition, each site will be visited regularly for measuring earth resistance, soil colour, conductivity, dielectric permittivity, hand-held spectro-radiometry, GPR transects and ambient climatic data. Traditional aerial flyovers and bespoke hyperspectral surveys will be commissioned.

Remote sensing can provide an impressive picture of the archaeological landscape without the need for invasive or expensive survey methods. The true potential of multispectral remote sensing, including thermal imaging, is still not clear and needs to be evaluated to test responsiveness under a broad range of climatic and ground conditions. Further research is likely to produce sensors capable of resolving relatively small features such as post-holes and shallow pits. When used appropriately, remote sensing provides a basis for testing hypotheses of landscape evolution that may be further explored by ground survey, geophysical survey or excavation. Large-scale airborne and satellite surveys can provide the framework on which planning policy and excavation strategies can be established. In addition, computer enhancement and the increased spectral resolution of the digital data places less dependency on the time of year for revealing archaeological features.

Remote sensing is increasingly important to many areas of archaeological enquiry from prospection through to management. It is therefore essential that it is not applied inappropriately. The inappropriate application of a single sensor could produce minimal results or the dogmatic application of that sensor will have diminishing archaeological returns. The combination of different sensors with different characteristics can produce profound interpretative synergies. Multiple sensors should be evaluated on the basis of ‘fitness for purpose’. Fitness for purpose in this context refers to the cost/benefit returns of each sensor and should be based upon an understanding of the nature of the archaeological residues, the sensor characteristics and the environmental characteristics of the landscape

WHAT IS NEW AND INTERESTING ABOUT YOUR WORK?

Guidance: This should clearly summarise the main conclusions of your work, the key findings. This helps journalists (and the British Science Association Press Office) quickly identify key outcomes and is an important section to fill out. I’d suggest 100-200 words for this section.

Text (338 words): Geophysical and Aerial survey have substantially increased our understanding of the nature and distribution of archaeology remains. However, there is variable understanding of the physical, chemical, biological and environmental factors which produce the archaeological contrasts that are detected by the sensor technologies. These factors vary geographically, seasonally and throughout the day, meaning that the ability to detect features changes over time and space. This is not yet well understood. The DART project is a three year AHRC/EPSRC funded project with 25 partners from a range of disciplines.

Detection techniques rely on the ability of a sensor to measure the contrast between an archaeological residue and its immediate surroundings or matrix. Detection is influenced by many factors – changes in precipitation, temperature, crop stress/type, soil type and structure, and land management techniques. DART will increase the foundational knowledge about the remote sensing of sub-surface archaeological remains. To determine contrast factors, samples and measurements are taken on and around different sub-surface archaeological features at different times of the day and year to ensure that a representative range of conditions is covered. Field measurements include geophysical and hyperspectral surveys, thermal profiling, soil moisture and spectral reflectance. Laboratory analysis of samples includes geochemistry and particle size. This will result in a comprehensive knowledgebase.

During analysis the key will be to understand the dynamic interaction between soils, vegetation and archaeological residues and how these affect detection with sensing devices. This requires understanding how the archaeology differs from, and dynamically interacts with, the localised soils and vegetation and how these differences can be detected.

DART is an Open Science project. Open science is the idea that scientific knowledge of all kinds should be openly shared as early as is practical in the discovery process. By scientific knowledge "of all kinds" we include journal articles, data, code, online software tools, questions, ideas, and speculations; anything which can be considered knowledge. The "as is practical" clause is included because very often there are other factors (legal, ethical, social, etc) that must be considered prior to opening access.

WHAT IS THE KEY FINDING OF THE WORK/RESEARCH DESCRIBED IN YOUR PRESENTATION?

Guidance: What is it that would make someone sit up and listen? One way to approach this question is to imagine that you are talking to a journalist about your work – what are the key pieces of information that you would want to convey? Please do fill this out. Even if there is no 'new' research in your presentation, what message do you wish to convey, or what new angle will you present? Remember that whilst the research may not be new to you, there is every possibility that the journalists won't have heard it before. I'd suggest 100-200 words for this section.

Text (317 words): The DART project is producing foundational research which will ensure that heritage/archaeological curators and policy makers are prepared for the challenges of the 21stCentury and beyond. Current landscape detection techniques can be either too small scale or biased. For example, traditional aerial survey is biased in that it is mainly responsive on well draining soils. This means that difficult environments, like clays and pasture, have not been targeted. It is also possible that after a century of flying, in different environmental conditions, a point of saturation has been reached: no previously unobserved features are being detected – this does not mean that there are no new archaeological residues to discover, rather that no more can be detected with that particular sensor configuration. The DART knowledgebase will allow more effective decision making and management.

This work is particularly timely given the advances made in precision agriculture remote sensing and the application of Unmanned Aerial Vehicles (UAVs). Precision agriculture approaches are being used to increase yield by regulating crop growth to ameliorate extreme and non-ideal conditions (the very conditions under which 'never before seen' archaeological features are observed). Advances in precision agriculture have the potential to significantly reduce the overall impact of traditional aerial archaeological approaches. An understanding of the underlying processes and dynamics in key crops and soils will help policy makers understand the potential impact of these developments and so determine curation and land-management policies more effectively. This will underpin the development of a framework for improving the detection of archaeological features through the more complete understanding of soil change, species phenology and the impact of different stress conditions on detection.

As an alternative: we have managed to exploit the new technology during the driest spring in Cambridgeshire since 1910. Whilst we are still analysing the results, the hyperspectral images have the opportunity to revolutionise our understanding of the buried landscape particularly in the clay areas.

WHAT IS THE RELEVANCE OF YOUR WORK TO A GENERAL AUDIENCE?

Guidance: Think about in what way(s) the work is relevant to the general population, why it's important. I'd suggest including around 100-200 words for this section.

Text (153 words): The DART project is all about improving the underlying knowledge about process so that more archaeology can be detected. This will lead to better information and knowledge (for the public, for industry and for managers), which will lead to better decision making and policy formation.

In addition the DART Project is an Open Science initiative. Where practicable all science objects (data, algorithms, illustrations etc.) will be made openly available. An open license means that the outputs can be reused in a broadly unfettered way (be that for research, teaching and learning, personal edification etc.). Initiatives like Open Science in conjunction with the internet and social media are changing the research landscape. Research is become ever more open and collaborative. Consumers of research are participating in a conversation, not listening to a lecture. This more sophisticated form of engagement can increase impact and engagement dramatically. This will significantly change the way universities 'do business'.