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AARG in Poland. An assortment of test prints of students, staff and instructors from sneaky photographs taken during the training week at Leszno: July 1998. (These and other training week photos in this issue by Dave MacLeod, Rog Palmer, Fiona Small)
All change...
It seems likely that the aerial world as we know it in Britain is on the verge of some major changes. David Wilson’s retirement from CUCAP coincides with a review of the Department by the University and the future of the collection that for many years was synonymous with archaeological air photography in Britain has yet to be decided (see Conversation, p39, this issue).

More of a surprise (for some of us) was the recently announced merging of RCHME with English Heritage. It is far too early (I’m told) to comment on possible repercussions arising from this as regards the survey work of the English Commission or to wonder about any effects this ‘consolidation’ may have on government-funded archaeology in Scotland and Wales. Making predictions would be a waste of time, but I hope that AARG will be kept informed of any changes and will – if necessary – act as a pressure group if there seems to be any suggestion of reducing staff or funding from the present pitiful levels.

Polish thoughts
Elsewhere in this issue are contributions and statistics on aspects of the training week that was run at Leszno with AARG involvement in July this year. The ‘staff’ enjoyed themselves (despite the early morning sore throats resulting, we decided, from lack of acclimatisation to the local beers) and had an extremely eager crowd of students. Many of these were from the Polish Inspectorate and it was good to be able to get across the messages that a) the aerial view can record sites otherwise unseen and b) if you map these you can begin to build up a landscape and develop an efficient monitoring programme.

As one of the ground-school teachers, I was delighted to see so many people peering through stereoscopes and tackling photo interpretation and rectification. Thanks to the efficiency of the Polish organisers (namely Paul Barford on behalf of Państwowa Sluzba Ochrony Zabytkow – the Inspectorate – and Włodek Raczkowski from Poznan) we were able to obtain colour prints from students’ photography within 24 hours and thus were able to put them to work on their own material.

On our last working day I was lucky enough to be given a flight in a Wilga (see also Anthony Crawshaw’s comments in AARGnews 7, 11) and therefore a taste of the aircraft likely to be used by the Poles for their own reconnaissances. Unlike Anthony, I was in the back seat where my first impression was that it was considerably more spacious than a Cessna 172/182 with room for a camera bag on the floor, a camera between my legs on the seat and my favourite Polish student next to me. A rapid second impression was how uncomfortable it was as there seemed to be a horizontal bar cunningly positioned to jab me in the bottom of my spine. However, we don’t necessarily expect to enjoy ourselves and be comfortable – but maybe on a second flight I would have taken an old cloth to stuff down behind me. Sock-wearing aerial photographers may also be at advantage in a Wilga as there was a howling gale blasting through the bottom of the door on to my naked ankle. This was deflected by moving the camera bag between me and the door. The Wilga has a single door on each side that provides access to front and rear seats (see below). Each door is a huge and
plus the usual muck that accumulates on aircraft. I haven’t noticed any distortion due to perspex curvature, but I tried to keep my camera centrally placed. I was taking photos out of both sides and none of the prints show any reflections – in fact I got more from the back seat of Otto’s Cessna. Was this maybe because I was using lens hoods in the Wilga but not in the Cessna? Despite having to work through perspex I think the Wilga is a good aircraft for archaeological reconnaissance which will, with care, allow good-quality working and record shots to be taken.

I was impressed by the keenness of the students who, despite having to listen to and respond in English, joined in the ‘round the class’ discussions and coped with the unfamiliarity of UK maps and air photos. Ground and air schools seemed more separate than during our 1996 week in Hungary and I remained largely unaware of where people had been flying, who was happy, who was sick, and any local problems. This perhaps reinforces my comment to Wlodek when we first discussed the possibility of a training week in Poland, ‘Why bother with the flying?’ However, I hope we showed that air photos could be taken, interpreted and mapped by the same person, although I was aware that some, as elsewhere, preferred one to the other.

Judging by the list of addresses, each inspector has its own patch and, funds permitting, could presumably work that on a ‘local flier’ basis. In fact, we have been told that some began their own surveys soon after the training week. This is wonderful news, not only because it proves the value of these schools, but because it means there is the money and interest in Poland to follow through some of the things that were taught.

And the sites? It seemed a better year in Poland than in England, with responses seen in, mostly, cereal crops. These ranged from the ‘strongholds’ (I think we’d call them motte and baileys) to clusters of pits. During my flight with Otto we also visited some possible long houses situated in, or on, former watercourses (presumably then silted and ‘high ground’ as in the East Anglian fens?) and a few other small-sized ditched features.

Happy birthday ...?
Those of you who want to add to the recent collection of 30-year anniversaries (AARGnews 12, 4-5; 14, 9-10) may be interested to note that a date sometime between the last AARGnews and this issue, probably in June or July, marks thirty years since I joined RCHME’s Air Photographs Unit. At that time RCHME employed about 100 people (I think the actual figure quoted was 102½) with one administrator and maybe two managers – many of the rest did the survey work for which RCHME was then renowned. The APU was John Hampton plus two people and maybe half a dozen racks of red boxes. Initially we shared a small room at Fielden House with Tony Pope, a highly-skilled illustrator, who smoked vile stinking cigars all day and objected to the window being opened. Our map chests still stank of cigars for years after we moved away. My main memory of the five years with the APU is of siting photos and putting them in red boxes, but I know I managed to map a few sites – all done using proportional dividers in those pre-computer days.

... and happy retirement
No, not me – sorry – but Roger Featherstone who left RCHME amidst what seemed to be a roomful of presents in June this year. Others are better placed to fill in details of the years he was employed in Air Survey (about 20 years??) where he initially took over flying duties from John Hampton and was eventually in charge of ‘special projects’ – which seemed to involve managing RCHME and regional flying as well as the large-scale mapping projects undertaken by AS. Roger’s management of RCHME’s flying programme was sufficiently flexible to allow them to drop in at Cambridge and pick me up for a
number of flights over the East Anglian fenlands. The idea – and I think it worked – was to use the knowledge I’d gained from mapping to fill in gaps and help answer questions, etc with new flights. Roger’s eyesight is incredibly acute and his ability to spot a crop mark anywhere within about a kilometre radius of the aircraft left me very few instances of ‘I saw it first’. It was during his time with RCHME that the collection began to include more illustrative photographs resulting (maybe) from his broadening perceptions of the ground as well as the opportunities to be in the right place during the right atmospheric conditions. Internal shuffling has placed Damian Grady in Roger’s flying boots. Worrying boots to fill, but ones I hope he enjoys wearing as much as Roger seemed to.

This issue
Africa? Where’s that? I suppose it’s expected that this (probably) crop-mark-free land has been neglected by most ‘serious’ aerial photographers although there was a fair bit of early morphological work done in its southern parts. So I was extremely pleased when Patrick Darling offered a contribution on work that he has been doing (more or less as a hobby) in Nigeria where there are extensive walled systems waiting to be discovered. His note is a superb demonstration of the use of existing aerial photos in archaeological survey. Our telephone conversations have skimmed the use of satellite imagery and the possibility of microlights (fancy a break from Peterborough, Ben?) as Patrick is now seeking funding and volunteers. You’ll find his address at the back...

I see links between this African work and the contribution by Sam Redfern because both writers are pursuing new directions – one in survey and the other in analysis – and both have the potential to upset ‘the establishment’. Sam’s work, utilising automated classification, was aired in AARGnews 14 and his present paper is condensed from chapters of his recently successful PhD thesis. It doesn’t matter whether we believe in auto-classification as a way forward, what is more important is that Sam has had the conviction to try it as a method and has developed his work to produce a set of monument classes that may now be tested. Technology permitting, I hope that Sam will continue to at least keep in touch (and keep us in touch) with this side of the game in the same way that Martin Fowler (alone among AARG members?) is exploring the archaeological uses of satellite imagery.
Chairman's Piece

Cathy Stoertz

(Subtitled AARG's Further Adventures in Europe, or What the Committee Did on Their Summer Holidays.)

In the last issue, I mentioned the disappointing failure of a bid for Raphael Project funds to support an aerial archaeology training course in Poland during the summer of 1998. It gives me great pleasure, therefore, to report that this earlier setback was transformed into a success by the continued commitment of the principal sponsors: the State Service for Protecting the Historical Monuments of Poland, and the Institute of Prehistory at Adam Mickiewicz University, Poznan. As a result, AARG's second European training course took place in early July in Leszno, western Poland, primarily designed to meet the needs of the Polish Inspectors of Archaeological Heritage.

Assisted by a grant from the Association for Cultural Exchange, with moral support from RCHME and RCAHMW, the AARG Repertory Company and Travelling Circus (two performances daily) was able to take to the skies, and to wield the stereoscope, once more. Most of the usual suspects were involved: the Ground School comprised Rog Palmer, Toby Driver and Fiona Small from the AARG committee, Dave MacLeod from RCHME (winner of the 1998 Golden Phrase Book Award) and Michael Doneus from the University if Vienna, with your Chairman as Ringmaster (or Headmistress?). Otto Braasch co-ordinated the Air School and provided plane, piloting and air-borne instruction; a second aircraft and pilot, courtesy of the Czech Academy of Sciences, was arranged and accompanied by Martin Gojda. A number of logistical challenges were introduced by factors such as fewer aircraft and more students than on the 1996 course in Hungary, coupled with an ‘interesting’ runway and initially uncooperative weather conditions. Bob Bewley mastered the fiendish complexities of juggling 23 students into 2 (and later 3) aircraft on a daily basis, whilst also managing to solve ‘Braasch’s equation’ (Long-range fuel tanks + short runway = lightweight passengers on first flight) with the utmost tact and diplomacy.

The practical organisation and advance preparation carried out by Paul Barford of the Polish Inspectorate and Wlodek Raczkowski and his students from Poznan University enabled the whole project to run remarkably smoothly and lightened the tasks of the AARG team in all respects. Among other things, support had been obtained from various sources in Leszno: films were supplied by Kodak, and local fast processing and printing allowed students to examine the results of earlier flights whilst waiting for their next sortie. The loan of 3 computers by a local firm enabled the Ground School to cover aspects of digital transformation and mapping more thoroughly than before.

There were the usual challenges and adventures: Northern European weather has defied even the most ingenious powers of organisation this summer, and virtually all flights were rained off during the first 3 days. Additional flights in a Wilga hired from Leszno airfield later in the week made up for lost time, but were firmly placed in the ‘adventure’ category by some students.

The official statistics - numbers of flights, air hours and photographs - are recorded elsewhere in these pages, but of course tell only part of the story. The long term achievements will be of much greater importance. Information received from the Polish Inspectorate indicates that
several Inspectors have already organised funds and started flying, so the national air photographic archive is expanding even now. The task of integrating air photo information within a hitherto site-based Monuments Record is being faced: the almost philosophical questions of what constitutes a ‘site’ and how to deal with landscapes produce eerie echoes of discussions still taking place within organisations which have had far longer to address the same issues.

Once again I am reminded that archaeologists are in the communication business - and, especially in the case of aerial archaeology, in the translation business as well. A great deal of translation was practised during the week in Leszno - sites into photos; photos into drawings and records, and thereby into accessible information. Of course in an international group, literal translation and communication was also much in evidence, demonstrating as always that the informal achievements of a meeting like this are at least as important as the formal ones. From a personal point of view, it was the sort of experience that reminds me just how much I enjoy aerial archaeology and the community that surrounds it. It was a tremendous privilege to be given yet another opportunity to spread the propaganda a bit further.

More European news items to end with - Zsolt Visy of Pecs University in Hungary, who was instrumental in setting up the first training week in 1996, was recently awarded the title of Professor, and has also been appointed Second Secretary of State in the Hungarian Ministry of Culture. AARG sends him our warmest congratulations on these achievements, and our best wishes as he meets the challenges and opportunities of the future.

Otto Braasch has made contacts in Romania with a view to exploring the aerial archaeological possibilities in another new region.

And finally another fringe benefit of the week in Leszno. Enough AARG members were able to get together with a computer and enough ideas to design, compile and install the AARG web page at last! The chief culprits were Michael Doneus, Darja Grossman and Toby Driver: now it is up to members to comment, add, enhance, and above all keep in touch.

Leszno 1998: our Chairman points...
At last ... the AARG homepage

Thanks to Michael Doneus, Toby Driver, and Darja Grosman; possibly Fiona Small, definitely Rog, Hotel Akwawit (Leszno), Vobis Microcomputer (Leszno), HotDog, Institute for Prehistory (Vienna), and Wlodeck’s organisation we have finally got together the various bits and pieces that make up the AARG homepage. Our address is:

http://RS6000.univie.ac.at/AARG/

Treat the page as a first edition which will sometime be tidied up and periodically updated.

The main outstanding need on the page is the addition of a few aerial photographs (even Rog agrees). Some to illustrate points made in the text but others, we thought, to be displayed in a gallery of photographs. Here is an opportunity for you to show your favourite crop mark, be artistic, or ask the world a question [remember Wazzat? in the early issues of AARGnews?].

Contributing to the AARG homepage

All members are invited to send photographs, drawings or other information that may be used in the page. We ask that all of you sending contributions do so under the following conditions:

1. We retain the right not to use your contribution.
2. Contributions must be accompanied by a letter stating that we have permission to publish and citing the author/photographer and copyright details which we will include if/when it is used. A copyright line can be overprinted on an image if required.
3. Unless absolutely impossible, please submit contributions in digital form.
4. We retain the right to adjust image size to suit ease of downloading.

We await your contributions and also ask that we are informed of any relevant web sites that you discover and think ought to be linked to our AARG page.

More from Leszno:

Polish inspectors with stereoscopes... Our Chairman helping Monika Toby, Dave and that dictionary
AERIAL ARCHAEOLOGY IN AFRICA: THE CHALLENGE OF A CONTINENT

Patrick Darling, African Legacy

Africa’s archaeology is piecemeal. Much of the work has been done by Europeans and Americans, whose countries suffer from a ploughed-out, truncated archaeology and whose consequent technology is so lop-sided that excavation is often assumed to be the only ‘real archaeology’. So Africa, too, has been afflicted by an undue emphasis on capital-intensive excavation, which has largely neglected the cost-effective, pioneering survey priorities of a continent rich in surface remains and living traditions. Civil wars have left a diagonal swathe of archaeological near ignorance from southern Sudan to Angola, largely divorcing studies in West Africa from those in East and South Africa and leading to regional anomalies. For every ton of carefully sifted soil in Egypt less than a teaspoon of soil has been glanced at in West Africa: and even that is skewed by an inordinate interest in art history - arguably the precursor to today’s mass looting of 2,000 year old terracottas. Consequent to these and other factors, fieldwork survey of Africa’s most extensive archaeological phenomena has been sorely neglected. Africa’s largest single monument (Sungbo’s Eredo, see below) is only part surveyed, despite being close to Lagos; only 10% of Benin’s 16,000 km long network of ancient earthworks are mapped; just a few dozen of Hausaland’s hundreds of past town and city walls are surveyed; and about 250,000 unrecorded tumuli, tell sites and past walled settlements lie from the Atlantic right across West Africa up to the west bank of the Nile.

The challenge is indeed immense; and only Aerial Photography and Satellite Remote Sensing (SRS) offer sufficient extensive data to begin meeting this challenge on the scale at which it needs to be addressed. This article focuses on the use of past aerial photography to examine archaeology in the main vegetation zones in Nigeria, which typify those in most of Africa, and aims to give a flavour of Africa’s more total archaeology by relating this imagery to ground features and associated traditions. It will then examine the main known sources of African aerial photographs in the UK, and determine the cost-effectiveness of using them compared to using SRS data such as CORONA: and present the challenge of immediate and long-term action to remedy the gross anomaly of what is, archaeologically speaking, the world’s most neglected continent yet arguably one of its richest.

Swamp forest: Aerial photographs of the world’s largest single block of mangrove swamp forest on the Niger Delta must have been scrutinized many times by the oil companies without, as far as I know, any resultant archaeological publication. Two major types of data - deserted settlement sites and shrine groves - should be distinguishable on good resolution aerial photographs. A third type - shell middens - may be less discernable from the air. Political sensitivities inhibit the use of aerial photographs in this area, but recent pressure on oil companies for more extensive Environmental Impact Assessments of the Niger Delta may finally lead to fuller examination of its aerial archaeology.

Freshwater swamp forests occur mainly in the coastal areas and fringe rivers and streams well back into the rainforest. Map 1, (drawn from 1:25,000 aerial photographs) shows how near impassable swampland fingers have interrupted and affected the course of Sungbo’s Eredo (3°48’-4°05’E, 6°40’-7°00’N) - the massive 160 km long, 20 metre high, thousand year old boundary rampart of the Ijebu Kingdom. Physically, these swampland barriers forced those constructing the concentric course of the Eredo to measure radially down the interfluves, not along the course over the swamps. Metaphysically, these swamplands were perceived as the abode of evil spirits: the Eredo and its salients were often dug right to the edge of the swamp water and, on long stretches of gently sloping interfluve, its great ditch was baulked to retain seasonal rainwater as moats replicating swampland conditions -
envisaged, perhaps, as encouraging the spirits to surround and protect the Ijebu kingdom from invaders. Plates 1 and 2 show swamp forest and the Eredo, and a moated section of the Eredo. The tree-covered Eredo bank and ditch is obvious in cleared farmlands, but the freshwater swamp forests are uncleared and fully obscure the Eredo. Similarly, freshwater swamp-forest in quite different areas also obscures all other archaeological features - such as the ancient canoe canal in the Ikpoba floodplain east of Benin City - the old fort at Ughoton, and the Nana canal.

Tropical Rainforest: Few zones have been imbued with so much western mythology as the tropical rainforest which, all too often, has been described as the 'lungs of the world', an exotic 'pristine' wilderness of 'primary' rainforest trees. More accurate biology, phytoliths, charcoal, pottery sherds and ruins are beginning to dispel such myths and reveal a far more compelling and exciting story of man's past interaction with the rainforest in South America and South-East Asia; and to this must now be added the massive and spectacular earthworks of the African rainforest. Plate 3 shows one junction of the Eredo from the air: again, the tree-covered ramparts contrast with the cleared farmland - these surrogate features are more visible than the Eredo itself. Yet the Eredo has spectacular ten metre high vertical-sided ditches of indurated laterite in several places (Plate 4). Tree cover has been crucial in protecting these near-pristine sections, but no less important was the strength of sacred belief associated with the deepest vertical sections, as this was the key factor in maintaining tree cover over the centuries since the Eredo was dug.

The rainforest has brooded silently, too, over the world's longest and most extensive ancient earthworks in Benin and Ishan, Edo State, some 200 km further east at 5°20'-6°30'E 5°50'-7°N, a vast 6,500km² (2,000 sq. mile) cluster of linear earth boundaries up to 18m (60 foot) high and 16,000 km (10,000 miles) long. These reflect intricate territorial patterns from Benin's past state formation processes or, perhaps, a migratory ring front of early nucleated settlements colonizing the rainforest. The massive, 18 metre high Benin City Wall (Plate 5) was the only earthwork that Federa Survey (FS) cartographers identified from early aerial photographs in this forest region. The size of this fourteenth century dump rampart has been explained in terms of physical defense. However it is the only earthwork dug deep enough in the porous Benin Sands to be moated in the rainy season, and it has a salient down to the swamps; so it might have a metaphysical rationale similar to that for the Eredo moats. Benin traditions claim that, after the construction/deepening of the main rampart, charm pots were buried beneath each gateway and obi (poison or magic) was applied to the wall: this obi was so powerful that one oba (divine king) died when he slipped and fell on it. Today, an annual ritual 'feeds the spirits' at each gateway, and sacred 'chalk' (kaolin) is still cast into the deep ditch by those returning from funeral outside the City; and there is much other evidence indicating that all the other earthworks were perceived as boundaries between the real world and the spirit world. The great depth of the Benin City moat which renders it so visible on aerial photographs may relate to a quest to reach the water-table so that spirits could surround and protect the City, rather than just to the needs of physical defense. As visibility was a more serious constraint to defense in the rainforest than in the savannah, this would have once made good sense.

Most of Benin's rural earthworks (Plate 6) have been almost impossible to discern from early aerial photographs, when forest and thick fallow covered much of the area. In recent decades extensive clearance of the forest canopy and higher farm to fallow land-use ratios have facilitated aerial photograph inspection of the Benin earthwork cluster. However, this is a limited window of opportunity, as the heavy rainfall is rapidly eroding the newly exposed earthworks and rendering them relatively invisible from the air, as thick Awolowa weed fallows and secondary forest regrowth obscure all but the steepest and deepest slopes. Comparative studies of aerial photographs and CORONA declassified intelligence satellite imagery from the 1970's to date may be the key to begin unlocking the unique survey challenge of this exceptionally large and complicated cluster of ancient earthworks.
Map 1. Sungbo’s Eredo and freshwater swamp-forest.

Plate 1. Aerial photograph of Eredo and swamp forest.

Plate 2. Eredo moat - spiritual protection for a kingdom?

Plate 3. Eredo junction: rainforest zone near Erunwen.

Plate 4. Smooth vertical-sided ditches of Eredo.

Plate 5. Benin City Wall - moat and dump rampart - 18 metre deep barrier to the spirit world.

Plate 6. Benin’s rural earthworks - note figure for scale.
Plate 7. Earthworks in savannah-forest mosaic: former no-man’s-lands between Uromi, Ivue and Iluwa, c. 1:18,000.

Map 2. Progressive mapping of Old Oyo Walls.

2a FS Maps 2b Soper’s 2c Field survey additions by Soper and Darling

Figure 1. Typical pre-colonial West African town with high wall, two stockades and deep ditches.

Figure 2. Under European bombardment.

Figure 3. Storming the breach.

Figure 4. Destruction and burning.

Map 3. Burunbunam 8°44’E 11°24’N 1:25,000

Plate 9. Deserted stream side settlement wall. 1:16,000
**Forest-Savannah Mosaic:** The abrupt boundary between the rainforest and savannah has a complex configuration, which relates more to soil types than to man's activities, such as burning; and concepts of 'derived savannah' and 'ectones' are now controversial. Open savannah juxtaposed to forest creates patchy visibility of linear archaeological features on aerial photographs. Plate 7 shows a northern part of the Benin earthwork cluster: here is some exposure of the wide bands of former no-man's-lands between adjacent agricultural settlement territories, in which outward facing banks and ditches (ditches outside the banks) run more or less parallel over long distances. Extreme expressions of this phenomenon, narrow strips of *cordons sanitaires* are found further south. Walled sites also occur in forest-savannah mosaic in Liberia and Guinea: and aerial photograph studies of this ecozone may uncover many more archaeological features elsewhere in West Africa.

**Guinea Savannah (and 'Derived Savannah'):** This covers most of the savannah vegetation of middlebelt Nigeria. FS maps based on aerial photographs show little archaeology across this vast zone. Yet, to the east, Kwaranrafa's ruined town wall encloses the past stronghold of the Jukun Empire, and Igala hillforts run south to Igboland. Across the west, ruins of past Yoruba walled towns - Kosso, Olle, Altoro Kobai and numerous others - lie strewn across the landscape. Almost the only such ruin shown on the FS maps is the main wall of Old Oyo (13°-14°E, 7°30’-8°30’N). From the same aerial photographs, though, Soper also discerned part of the inner palace wall, a vast northern loop and the north-eastern trade route. Using these clues, ground surveys discovered an even fuller concentric wall complex and odd fragments of free-standing mudblock wall (Map 2). Teasing out the street pattern of this powerful past Yoruba empire capital will be a problem, be it done from the air or on the ground, for thick growths of *Acacia ataxacantha* thorn trees have sprung up over the soils enriched by past organic intake in and around the compound ruins. From the Old Oyo experience, many other linear features are likely to be distinguished in the Guinea savannah from aerial photograph studies, particularly if these are linked to ground surveys.

**Sudan Savannah - history:** Cleared farmlands over the densely-populated areas of northern Nigeria provide aerial photograph images similar to many of those in Europe and the USA. This open savannah is rich in history, which underlies its visible archaeological features. Only a century ago, engravers noted some of West Africa's magnificent walled/stockaded towns (Fig. 1); and, as war artists, they recorded their destruction (Figs. 2-4). Similar harsh reality lay behind the *ribats* (forts) of the nineteenth century *Jihad* during which, for example, the walled towns in Kwiambana and Kona were razed to the ground and, in Adamawa one afternoon 5,000 men were executed - bled to death by incision of their femoral arteries. In previous centuries, life was no easier: when Burumburum walled town (Map 3) was captured survivors' throats were cut; and, 600 years ago Kano destroyed even the walls of the pagan stronghold of Santolo, so that no discernable trace of them remained. Cavalry, archers, slings, muskets, fire and digging under thin walls were all part of the arsenal of attack - the grim rationale for constructing thick high walls parapets, castellations and loopholes. Nevertheless, high status was attached to the *birane* and *ganiuwa* (walled cities and towns) of Hausaland (4°-10°E, 9°-14°N) and, paradoxically, it was often the best defended settlements that wreaked the most havoc elsewhere. Historical records name only a few hundred walled towns, usually those of the winners (Plate 8). The history of the losers lies in the mute testimony of deserted settlement walls (Plate 9): and the extent of this is best perused by examining aerial photographs.

**Plate 8:** Kano City Walls: 1903.. and 1983, eroded ruins flanked by borow-pits full of stagnant water.
**Sudan Savannah - ruins:** Today, wall ruins from these past era are presented better in the western Basement Complex areas, where the soil tends to be more clayey than the sandy Chad Deposits to the north-east (where Nigeria's examples of fired brick structures have been found). *Tubali* (pear-shaped, sun-dried mud bricks embedded in mud mortar) were used commonly in construction (Plate 10); but the constant repair of a replica of the massive 18 metre high Kano City wall at Jos Museum demonstrates that this technique was practical only in areas of low rainfall. A little cited technique - natural coursed rubble - employed alternating layers of stone and subsoil to create ramparts more resistant to erosion (Plate 11). Stone walls occur in many hilly areas, such as the magnificent Xidi palace at Sukur: and are most substantially expressed in the massive structure of Surame where, 400 years ago, it is said that labour was requisitioned from afar to make mortar using water passed up an 8 km long human chain from the local river (the tardy Nupe had to use shea butter); but no mortar is obvious today. On many sites, such as Kwiambana, Old Rano and Old Ningi, different combinations of these techniques occur. The past distribution of these techniques, including the free-standing, coursed mud-block walling found further south, is poorly understood: it is one of those issues which, by being clarified during ground truthing of aerial photograph work, would add almost another dimension to our knowledge of West Africa's rich cultural history.

**Sudan Savannah - aerial photos:** Examination of 1:25,000 aerial photographs for a few sheets in Nigeria's Sudan Savannah in 1984 served to highlight the incompleteness of past data sources. Early explorers' accounts, military route reports, and indigenous histories noted only a fragment of the total walled settlements; the fieldwork efforts of numerous observers have been dwarfed by the vast areas; and even Federal Survey (FS) and other maps based on ground surveys or aerial photographs are far from complete - town walls were identified on sheets where the FS maps showed none; and on the sheet with the most town walls depicted (19 on FS sheet 80), over four times that number (94) were discerned from aerial photographs. Only line tracing was possible for the 1:25,000 photographs examined in Nigeria; but a recent UK loan of 1:32,000 photographs enabled quality photostat enlargements to 1:25,000 and 1:5000 to be made (Plates 12-13). Apart from 'discovering' many new sites, enlargement of these photographs enabled more accurate assessments of past wall dimensions, area enclosed, settlement size, orientation, alterations and the environment, all factors relating to past settlement history.

Many rural walled sites were deserted, testifying to this area's past traumas, as well as to the impact of modern roads and urbanization. On some sites, such as Gaya, Dal, Sheme and Old Rano, two or more phases of construction could be seen - even old stockade lines were discernable from today's field boundaries at Gaya (Map 4). Working back in time from what is known, the sequence of these phases can be reconstructed. Nineteenth century ribats were rectilinear and orientated at about 75° to face Mecca: they were usually sited away from the hills where *iskoki* (spirits) were thought to dwell. Pre-Islamic rectilinear settlements on the plains were cadastrally orientated north-south/east-west. The earliest settlements were around lateritic mesas, quartzite ridges or granite inselbergs e.g. Kwartakwashi and its 2000 year old terra cottas; and it is around such features that the extensive walls of Sheme (the antecedent of Kano), Kano itself, Zaria, Dutse, Santolo. Kwiambana and many other urban centres were built. Rockshelter sites indicate that perennial rivers were important for earlier settlers of the same culture 3,000 years ago.
Plate 12. Dan Janku, 7°42′E 12°40′N. 1:8,000

Plate 13. Bindawa, 7°49′E 12°41′N. 1:8,000

Map 4. Gayo 8°52′E 11°59′N, Sheme 8°12′E 12°02′N, Old Sumaila? 9°02′E 11°35′N, two phase site 8°25′E 11°25′N
1:100,000: occupied part occupied 1:25,000 deserted deserted

Plate 14. Auyo, 9°55′E 12°20′N, with triple/quadruple outer ditch lines and inner rectilinear settlement walls. c.1:35,000

Inset: 1:5,000 enlargement of wall/ditch lines invisible on the ground
Sahel: The only area of true sahel in Nigeria lies on the sandy Chad Deposits. A century ago observers noted the rapid erosion of the grey/white mud walls of Kukawa (Borno Empire capital) after Rabeh’s conquest of it only a decade before. At Auyo, the courses of its past town walls can be seen on aerial photographs (Plate 14) but, on the ground, these are invisible in the level sandy fields: subtle, linear, subsoil discolourations evidently show up better from the air than on the ground. Triple concentric walls for a deserted settlement near Bartna (Map 5) also showed up clearly. When traveling through this region 150 years ago, Barth noted numerous small, stockaded villages, but finding the physical evidence of even known past stockades is very difficult. As preservation of ruined buildings in sahelian and saharan conditions is much better than in moister areas, photographic enlargements would be useful; though high costs and formidable registration problems arise when dealing with vast areas of large-scale imagery, and enlargements might best be targeted after ground survey.

Map 5. Deserted settlement at 13°04'E 11°2'N. c.1: 80,000

Overview of Nigeria: A gazetteer of all Nigeria’s past walled settlements is being compiled from early explorers’ accounts, military route maps, indigenous documents, a Bayero University questionnaire, various studies and publications, scattered areas of fieldwork, a wide range of maps, and aerial photographs. So far, 1,600 named sites have been listed (Map 6) but initial plotting of their configuration and extent needs to be done from aerial photographs. In the sudan savannah, this challenge is more logistical than technical and, given sufficient time and resources, a few thousand new sites will be identified. Technical problems become more important in the guinea savannah and savannah-forest mosaic.

In the rainforest, mapping of the several hundred different settlement boundaries in the 6,500 km² Benin Earthwork cluster remains, possibly, the world’s most significant and technically difficult challenge for those with aerial photography/remote sensing, expertise. Multi-temporal superimpositions at high magnification will uncover several hundred kilometres of linear earthworks: most of these may be frustratingly fragmentary. The optimal results await the use of one to two metre resolution radar imagery at wavelengths of a metre or more which can effectively penetrate the rainforest canopy - but pigs might fly before this happens.

Map 6. Frequency of known earthworks, walls and stockades in Nigeria per FS map sheet.

Key: E = Eredo, B = Benin Earthworks

Map 7. Nigeria: vegetation zones and places in text
Africa's Visible Archaeology: Half of Africa's population lives in West Africa and nearly half of that again live in Nigeria; and these higher past densities over the last 2,000 years led to more sedentary settlement patterns than those experienced by the Bantu migrants over much of Central, Eastern and Southern Africa. This may explain the frequency of extensive visible linear archaeological features, such as those described for Nigeria (above). Earthwork's have been reported from Uganda, western Kenya (Bukusu forts) and elsewhere; but these appear to be much less extensive than those being reported from Senegal, Mali, Guinea, Liberia, Ghana, Burkina Faso and Nigeria. Popular attention has focussed on stone structures - Egypt's great pyramids, Zimbabwe's stone ruins, Axum stella, Ethiopia's subterranean Coptic churches, and coastal forts in Ghana and East Africa: it has largely ignored the millions of man hours that Africans once put into creating extensive earthen structures in the stoneless soils where most farming took place and, therefore, where most people lived. Most archaeological research practice, too, ignores systematic survey of these features and, instead, insists on costly excavation to meet western academic criteria and further western careers. Is this in the best interests of African history and prehistory? Whose agenda is being addressed - western or African? In other words, are matters being prioritised correctly?

African Legacy thinks not. This organization seeks to present a more balanced picture of Africa than that too often given by the media, aid agencies and vested interest groups. A mobile museum display 'African Update' is in preparation, lectures are given on various African topics; and it frequently uses Africa's pre-colonial indigenous history and culture to forward its aims. Recently, it stated:

"The survey of Africa's visible archaeology is an end in itself, not just the means of finding excavation sites. Clearance, erosion and urban growth have increased the urgency of the task of comprehensively mapping Africa's rich archaeological landscape. Remote sensing techniques increase the range of 'visibility' and now make possible the survey of extensive new areas. African Legacy intends to focus on Africa's visible archaeology because, compared to excavation-based work:  
- it is more threatened by destruction
- it is more cost-effective in Africa
- it is of more interest to Africans
- it often links to the living culture
- it yields different, wider insights
- it covers the chronological spectrum
- it leads to archaeological discovery
- it is less destructive than excavation
- it does not encourage treasure-seekers
- it provides a better total picture."

This continental challenge gauntlet is flung down to all those interested in aerial photographs and other remote sensing techniques in archaeology.

Aerial photographs of Africa in the UK: Those picking up this bauble can choose their weapons. Most available aerial photographs were taken in the 1940's to 1970's. The three most important collections are stored at SOAS, the OS and the University of Greenwich. At SOAS, there is incomplete coverage of The Gambia, Sierra Leone, Ghana, Uganda, Tanzania, Zambia, Zimbabwe and Botswana: the scales range from 1:50,000 (Kenya) to 1:500,000 (Botswana) with small areas at 1:12,000 - there are some maps of African countries, but correspondence with the photographs needs to be checked. The OS has coverage on most of Britain's past African colonies, flight plans, relevant maps and stereoscopes: an d their charge of £50 + VAT per day can be made financially easier if groups of up to six attend at the same time, but photographs cannot be taken away for leisurely examination and enlargement. The University of Greenwich has copies of the OS photographs in almost inaccessible temporary storage: flight paths are around somewhere, but there is no guarantee of finding related maps to aid registration.

Commercial companies have odd coverage: one company had strips along the courses of new roads in Nigeria, Sierra Leone and Liberia, but few flight plans or corresponding maps. Africanist academics often have small collections, e.g the 1:32,000 photographs. Other sources are more fragmentary or lost, but efforts are being made to trace them.
Aerial photographs elsewhere: At the Federal Surveys in Lagos, Nigeria, is possible to have 1:25,000 and other scale aerial photographs, printed, provided that a suitable letter of authority is produced and all developer chemicals and paper costs are paid for in advance. Some of the negatives have faded badly or are pitted with mould spots: but most are still useful. Survey Departments and Agricultural Development Agencies are the most promising sources of aerial photographs, but sourcing them can be problematic.

The declassification of high resolution USA intelligence photographs covering most of Africa in the 1970's is, therefore, welcome. CORONA strip negatives covering 100km along the ground can be pre-viewed on the Internet. This enables selection of photography unobscurred by rainy season (April to October) clouds or dry season (November to March) harmattan dust. However, the need for high resolution print enlargements is a major hidden cost: the usual commercial price is about £5 per 8”x 10” print: deals on bulk processing can halve this, but further economies depend on previous ownership of an enlarger. Economically speaking, the OS works out cheaper than CORONA if several people work simultaneously; but one loses the advantages of leisured perusal and enlargement. Working solo, CORONA is more economical. Ideally, if multi-temporal comparisons are to be made there will need to be complementary use of both data sets.

Your role in Africa's Aerial Archaeology: If you have read this far, you might consider what role you could play in discovering and recording much of the visible archaeology of a whole continent. African Legacy is in touch with various interested institutions in the USA and UK to help coordinate efforts for this challenge. If you are interested in picking up the gauntlet by examining imagery and/or doing fieldwork, please contact: Dr Patrick Darling, African Legacy, 46A Ophir Road, Bournemouth, Dorset BH8 8LT. England. Tel: 01202 554735, OR Coralie White, African Legacy, PO Box 3842, Augusta. Georgia 30914, USA. Tel: 00 1 706 796 3828 OR John Godwin, Legacy, 27 Boyle Street, Onikan, Lagos, Nigeria, Tel: 00 234 1 2600845. African Legacy can help avoid duplication of effort; identify key areas of research interest and help supply select bibliographies including 'grey' literature. Why go on repeating 'more of the same' in UK's anaemic archaeology when, with a little imagination and effort, you could help pioneer significant new discoveries in Africa's full-blooded archaeology?

Select Bibliography:


Lloyd P 1959 Sungbo's Eredo Odu No 7 15-22.

INTRODUCTION

The last issue of AARGnews included a number of references to the potential use of satellite-borne imaging radars in the prospection for archaeological features. This article aims to summarise the nature of the imaging radar product and to review briefly the uses to which space-borne radar images have so far been made in archaeological studies.

IMAGING RADARS

Table 1 provides brief details of satellite-borne imaging radars together with links to the World Wide Web where further information can be obtained.

Unlike aerial photographs and conventional satellite images which passively detect sunlight reflected from the Earth's surface, an imaging radar is an active sensor that uses microwave radiation to illuminate the imaging area (Sabins, 1996). By providing its own source of illumination, an imaging radar can remotely sense a target area at any time of day or night. Since radar wavelengths are much longer than those of visible or infra-red light, an imaging radar can "see" through cloudy or dusty conditions that would otherwise obscure visible and infra-red sensors.

When operating, the radar imaging antenna alternately transmits and receives short radar pulses at a particular wavelength (typically between 3 and 25 cm) and polarisation. At the Earth’s surface, the energy in the radar pulse is scattered in all directions with some reflected back to the antenna. The backscatter returns to the antenna as a weak echo which is then converted into digital data for storage and subsequent processing. Since the radar pulse travels at the speed of light, the distance from the antenna of the surface reflecting the pulse can be calculated from time taken for the pulse to complete a round trip. As the radar moves along the orbital path, the area illuminated by the radar moves along the Earth's surface in a swath and the radar image is built up.

<table>
<thead>
<tr>
<th>System</th>
<th>Nationality</th>
<th>Launch date</th>
<th>Wavelength (Band)</th>
<th>Polarisation*</th>
<th>Spatial Resolution</th>
<th>WWW address</th>
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<td>USA</td>
<td>1978</td>
<td>23.5 cm (L)</td>
<td>HH</td>
<td>25 m</td>
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<td>SIR-A</td>
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<td>HH</td>
<td>38m</td>
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<td>23.5 cm (L)</td>
<td>HH</td>
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</tr>
<tr>
<td>ERS-1</td>
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<td>5.7 cm (C)</td>
<td>VV</td>
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<tr>
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<td>Europe</td>
<td>1991 1995</td>
<td></td>
<td></td>
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<tr>
<td>Almaz</td>
<td>Russia</td>
<td>1991</td>
<td>9.6 cm (S)</td>
<td>HH</td>
<td>15 m</td>
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<tr>
<td>JERS-1</td>
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<td>1992</td>
<td>23.5 cm (L)</td>
<td>HH</td>
<td>18 m</td>
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</tr>
<tr>
<td>SIR-C/</td>
<td>USA/Europe</td>
<td>1994</td>
<td>3.0 cm (X) 6.0 cm (C) 24.0 cm (L)</td>
<td>Multiple</td>
<td>Variable 10-200 m</td>
<td><a href="http://southport.jpl.nasa.gov/desc/SIRCdesc.html">http://southport.jpl.nasa.gov/desc/SIRCdesc.html</a> <a href="http://isis.dlr.de/XSAR/welcome.html">http://isis.dlr.de/XSAR/welcome.html</a></td>
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<td>HH</td>
<td>Variable 10-100m</td>
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</tr>
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</table>

HH = horizontally transmitted, horizontally received; VV = vertically transmitted, vertically received.

Table 1 Space-borne radar systems (after Sabins, 1996).
The spatial resolution of the radar image is determined by the dimensions of the ground resolution cell which in turn are governed by the respective resolutions in range and azimuth. Range resolution (cross-track) is determined pre-dominantly by the radar pulse duration and the angle at which the target is being viewed. Azimuth resolution (along-track) is determined by the wavelength of the radar and the length of the radar antenna; the longer the antenna, the finer the azimuth resolution. A Synthetic Aperture Radar (SAR) can be used to synthesise a very long antenna by combining the echoes received by the radar as it moves along its orbital track and can produce radar images in which fine detail can be resolved. Typical spatial resolutions of satellite-based systems are of the order of 10-40 m.

**IMAGE INTERPRETATION**

A radar image is made up of individual picture elements (pixels) representing the radar backscatter for that area on the ground. Bright areas on the image correspond to high backscatter, dark areas correspond to low backscatter. For a particular radar wavelength, the backscatter from an area will vary according to the roughness of the area (surfaces approximating to the size of the radar wavelength appearing rough and vice versa), the moisture content of the surface, the polarisation of the radar pulses and the observation angle.

In general, the brighter the image the rougher the surface being imaged. Flat surfaces, such as roads, calm water and dry lake beds, which reflect little or no energy back to the antenna appear as dark specular surfaces. Vegetation is generally rough at radar wavelengths and therefore scatters energy in many directions and appears grey on a radar image. Steep slopes and scarps facing towards the antenna reflect much energy back to the antenna and appear as bright highlights. Conversely, steep slopes and scarps facing away from the antenna appear as very dark shadows as no energy can reach the terrain. Man-made features such as bridges, buildings and cities possessing intersecting planar surfaces (corner reflectors) strongly reflect energy back to the antenna and appear as very bright features.

A characteristic of radar images when they are enlarged is that homogeneous areas appear speckled. This noise is caused by the antenna transmitting many minor pulses along with each major pulse. Individually these pulses are insignificant but when they reinforce or suppress the backscatter of the major pulse, then speckle is the result. Whilst speckle can limit the interpretability of fine detail, digital image processing can be used to reduce it but at a cost of some reduction in the spatial resolution of the image (Fukuda & Hirosawa, 1998).

**ARCHAEOLOGICAL APPLICATIONS**

"Radar Rivers"

The flight of the Shuttle Imaging Radar-A

Figure 1. Combined LANDSAT/SIR-A image of the South East Sahara Desert covering an area of some 150 by 250 km. Sub-surface palaeodrainage systems are visible on the radar image but are not visible on the LANDSAT image. *Image courtesy of NASA JPL.*
(SIR-A) on the Space Shuttle Columbia in 1981 vividly demonstrated the ability of the radar to detect subsurface features in arid or hyperarid regions (McCauley et al., 1982). On radar images of the South East Sahara Desert in Egypt, ancient river systems now covered by sand were apparent but were absent on LANDSAT images (Figure 1). Such features, termed "radar rivers", were covered by layers of dry sand up to 2 m in depth. Excavations to verify the palaeodrainage system uncovered numerous Stone Age artefacts apparently in association with the river system.

The subsequent flight of the second generation SIR-B sensor in 1984 over the Sahara provided further data to support the initial findings from SIR-A (McCauley et al., 1986). Similarly, a study using SIR-A imagery covering China's Taklamakan Desert has shown the ability of SIR-A imagery to detect "radar rivers" on a scale of tens of metres under hyperarid sands (Holcome, 1992). Despite being unable to detect directly any archaeological features, the discovery of the Saharan "radar rivers" has contributed to the understanding of the palaeodrainage of the Eastern Sahara and the archaeology of the region from the Acheulian to the Neolithic (McHugh et al., 1988; 1989).

The Great Wall of China

Portions of the Great Wall of China can be readily detected on a SIR-C radar image flown on the Space Shuttle Endeavour in 1994 (NASA JPL, 1996; El Baz, 1997). The steep, smooth sides of the wall provide a good surface for the backscatter of radar pulses to the antenna. The course of the wall can be traced as a linear feature on the left hand image of Figure 2 which covers an area of some 25 by 75 km centred on 37° 42’N 107° 30’E. The four images on the right correspond to the area outlined by the white box covering some 3.1 by 2.2 km and represent the four radar channels of the SIR-C radar. They are sensitive to different aspects of the terrain and to the presence of two generations of the Great Wall.

The upper L-band image (24 cm wavelength, horizontally transmitted and horizontally received (HH) polarisations) is the clearest image of the two wall segments. The bright continuous line running from top to bottom is the younger wall, built some 600 years ago in the Ming Dynasty, and which is now some 5 to 8 m high. To the right of this wall is a discontinuous line that is the remnant of an older version of the wall built some 1500 years ago in the Sui Dynasty. The two generations of the wall are seen less well in the second L-band image (HV polarisation). However, as this channel is sensitive to complex vegetation structure, orchards and trees lining a road running parallel to the younger wall can be seen to the right of the wall as light rectangles. The third image shows a C-band image (6 cm wavelength, HH polarisation) on which the course of the younger wall can be traced as a prominent linear highlight. However, no trace can be seen of the older wall. On the final C-band image (HV-polarisation), which exhibits considerable speckle, neither of the walls can be traced; the
linear feature that is present on this image appears to correspond to the orchards and trees lining the road parallel to the younger wall rather than the wall itself.

The ability to detect upstanding archaeological features, albeit of large proportions in the case of the Great Wall of China, demonstrates the potential utility of imaging radar in prospecting for some types of archaeological features.

**Angkor, Cambodia**

A SIR-C image of the area surrounding the ancient city of Angkor in Cambodia has revealed details of the huge ceremonial complex and city that dates back to the 9th Century (Anon., 1995). Despite being shrouded under a dense rainforest canopy, an extract from this radar image (Figure 3) shows clearly the system of reservoirs and canals that surround the temple complex. The principal complex, Angkor Wat, is the bright square surrounded by a reservoir that is visible as a thick black line. The large bright square above Angkor Wat is another temple complex, Angkor Thom. On either side of the temples, two large rectangular reservoirs can be discerned as dark features and throughout the area; the vast canal system that was used for irrigation system and transportation can be discerned as a combination of light and dark linear features.

**West Africa**

In an attempt to examine Africa's archaeological legacy in a coherent way, *African Legacy* intends to use conventional aerial photographs together with appropriate satellite remote sensed imagery to systematically survey the extensive archaeological features of West Africa (Darling, 1998). In a preliminary study, SIR-C imagery covering part of northern Nigeria was shown to have some potential to identify upstanding rectilinear walls associated with present-day and deserted settlements. An example SIR-C image covering the walled town of Kibiya (11° 46' N 8° 26'E) is shown in Figure 4. Despite the presence of considerable speckle, the outline of the old town walls that encompass the present-day settlement can be discerned as a fine linear highlight on the image although this is nowhere as clear as on conventional aerial photographs. The longer wavelength L-band product was found to be able to show up known earthworks better than the shorter wavelength C-band product. HH-polarised L-band imagery was also found to tend to pick out tree cover whilst its HV polarisation counterpart picked out other vegetation. The shorter wavelength HV-polarised C-band imagery tended to pick out water and moist soil.
A second SIR-C image (Figure 5) shows the area to the south of the Kano river (11° 53' N 8° 27'E). A railway bridge crossing the dark river can be seen as a prominent highlight at the top of the image. To the south of the river, several curvilinear features can be discerned which are not present on aerial photographs of the area. Although the nature of these features has yet to be determined, they may depict an enclosure close to a former meander of the Kano river to the north.

Whilst this preliminary study of SIR-C imagery showed that it was considerably inferior to conventional aerial photographs for surveying archaeological sites in West Africa, it was notable that some features that were not visible on the aerial photographs were found on the radar images. However, the archaeological significance such features has yet to be ascertained.

CONCLUDING REMARKS

Imaging radar has the advantage over conventional aerial photography and optical satellite imagery of being able to image an area irrespective of the time of day and the degree of cloud cover. With an ability to penetrate vegetation canopy and, under arid conditions, to image subsurface features, radar imagery has undoubtedly some potential in archaeological prospection. However, the nature of the radar product, the problem of speckle, the ground coverage available and the current low resolution of the imagery are considered to be major constraints on the wider archaeological utility of imaging radars. Particular problems are:

a. Whilst upstanding linear features such as walls and other geometric features can be detected on radar images, relatively small, poorly reflecting, features that lack a strong linear component are most likely to be lost amongst the background noise of an image.

b. An imaging radar is unlikely to be able to detect archaeological features that are now only visible as crop- and soil-marks on aerial photographs because of its low resolution and sensitivity to surface roughness rather than other attributes such as colour etc.

c. High resolution imaging radar coverage of the Earth's surface is very limited 1. Given that the SIR-C sensor has only flown for two short missions, has a swath width of 30-60 km and is limited by the orbital constraints of the Space Shuttle, it is likely that a given area of archaeological interest has not been imaged in the past.

d. Although imaging radars have been shown to have the ability to penetrate hyper-arid

Figure 5. SIR-C image of the area to the south of the Kano river, Nigeria. The image covers an area of 1.5 by 3km. Image courtesy of NASA GSFC.

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sand to "see" for a few metres beneath the surface, under more temperate conditions, in which the radar pulse will be greatly attenuated by ground moisture, the ability of imaging radars to detect subsurface archaeological features (e.g. Brown, 1998) is highly unlikely.

Notwithstanding the above, for those inhospitable geographical areas that are prone to continual cloud cover and those areas that are extensively covered by vegetation canopy, imaging radar may be the only form of imagery of the ground surface that is readily available to the archaeologist. Future advances in digital image processing and radar technology will no doubt present improved radar imagery for exploitation. In the meantime, for many areas of the globe, relatively high resolution satellite products, both optical and radar, will continue to be the only readily available remote-sensed images that are of potential use in archaeological studies (Fowler, 1997).

For further information on the application of satellite remote sensing to archaeology, check out the "Satellite Remote Sensing and Archaeology Homepage " on the WWW at the following URL: http://ourworld.compuserve.com/homepages/mjff/homepage.htm.

ACKNOWLEDGEMENTS

_African Legacy_ thanks Dr Jon Ranson of NASA Goddard Space Flight Center for kindly providing the SIR-C images shown in Figures 4 and 5. Other images courtesy of NASA JPL via their Web site.

REFERENCES


Fowler, M.J.F., 1997. "It may not be done well ... but it could be the best that is available" _AARGnews_ 15, 33-35.


Aerial archaeology in Jordan 1998

David Kennedy and Bob Bewley

Both authors have had an interest in the Middle East for over twenty years and David Kennedy has been studying the archaeology of Jordan, with a particular interest in the Roman frontier (Kennedy and Riley 1990). Aerial photography for archaeology has not been possible in Jordan since Sir Aurel Stein's last flights in April 1939, but Jane Taylor's books have shown that aerial photography is possible ... and its potential (Taylor 1989, 1993). The vertical photographs taken by Hunting Ltd in 1953 provided a valuable source of information and these have been archived in Western Australia in a collection under the patronage of Crown Prince Hassan of Jordan. Examination of them has yielded in excess of 25,000 sites from the western half of Jordan which the survey covers (Kennedy 1996; 1997a; Web 1; cf Kennedy 1997b for a recent application) - the whole country which is c.90,000 sq km (mainland Britain, for comparative purposes, is c.218,000 sq km).

For many years the first author has been trying to carry out aerial reconnaissance and in 1997 a first trial flight, provided by the Royal Jordanian Air Force (RJAF), in a helicopter, proved very successful (Kennedy 1998a; b). In 1998 there was the promise of an unlimited number of flights for the project (again in military helicopters) to carry out a select survey of specific sites throughout Jordan; this promise became a reality. From May 6th to 20th May there were 10 sorties, in which over 33 hours were flown and over 175 targets photographed (Kennedy, Web 2).

Prior to arriving in Jordan there was no certainty that the conditions (political, climate, financial) would be favourable so it was impossible to predict what to expect. Equally our collective experience in helicopters was low; it is amazing how quickly you learn even with only a few hours sleep and a 5.45 am take off. Fortunately none of the possible pitfalls materialised and the dedication of the pilots, crew and squadron commanders was impressive - without the support of the RJAF the project would, literally, have not got off the ground.

What did we learn?

The purpose of the project was to test the feasibility of archaeological aerial photography in Jordan, using the helicopters provided by the RJAF. If this proved successful the aim in the first year was to compile enough photographs for a book on Ancient Jordan from the Air. One of the reasons we received the generous help we did was to assist the promotion of tourism through advertising the vast and varied cultural heritage Jordan has to offer.

From this first season of aerial photography it became abundantly clear just how effective aerial photography can be in Jordan and that such work should continue. Surveying the landscape during the flights a number of reasons for continuing aerial surveys became apparent. The density and distribution of sites means it will be a very cost-effective technique in future surveys, which is no surprise but it has to be proven in every new situation. The 25,000 sites already identified in the examination of the 1953 photographs indicate a high density of sites in large areas of the country. Not surprisingly these are the areas where there are also the greatest threats to the landscape and sites.
Plate 1. South Theatre at the Roman city, Jerash, Jordan.

Plate 2. The Roman city of Jerash, Jordan. The theatre is bottom left. The eastern part of the city was built over by a Circassian settlement in the late nineteenth century (bottom right).
At the individual sites level there is also a need for individual sites plans, for example at the Roman city of Jerash (Plate 1 and 2); this is one of the Decapolis cities, has been extensively excavated and is the object of a major tourism project. Ground plans exist but a full and detailed city plan could be produced from the aerial photographic evidence as some examination already suggests (Kennedy 1998c). This is but one example of hundreds of sites which require further work.

In terms of promoting tourism there is no doubt that Jordan would make a fantastic holiday destination for a wide variety of people (young, old, families) and it is becoming renowned for its cycling holidays. If you get the chance go there - if you can't get there then buy the book when it's out (about 2 years hence!).

References:
Air Archaeology Training Project in Poland  
Leszno 3-9 July 1998  

Official course statistics

46 participants from 14 countries:

(23 students; 15 tutors, pilots and guest lecturers; 8 staff)

28 Polish  1 Russian
2 German  1 Romanian
2 Czech  1 Slovenian
2 Lithuanian  1 Austrian
1 Estonian  6 combined British (3 English, 1 Scottish,
1 Latvian  1 Welsh, 1 mid-Atlantic)

Aircraft time:

<table>
<thead>
<tr>
<th>Pilot</th>
<th>Sorties</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Otto Braasch</td>
<td>23</td>
<td>33 hrs 19</td>
</tr>
<tr>
<td>Tomas Janicek</td>
<td>16</td>
<td>19 hrs 05</td>
</tr>
<tr>
<td>Micolai Zdun (Wilga)</td>
<td>6</td>
<td>10 hrs 05</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>45</strong></td>
<td><strong>62 hrs 29</strong></td>
</tr>
</tbody>
</table>

Total student air time 138 hrs 15

Total films 108
Total frames 3888

Approximately 160m of film was exposed - according to our calculations, this is equivalent to three times the length of the long water-chute at the Hotel Akwawit, Leszno (although to the best of our knowledge this comparison was not experimentally verified by the early-morning swimmers).

Students with most air time:

Male: Jacek Nowakowski (5 flights - 7 hrs 17)
Female: Agnieszka Martyniuk (4 flights - 5 hrs 44)
Reflections on the Leszno aerial archaeology school

Paul Barford

Aerial archaeology in Poland celebrated its nominal fiftieth anniversary this year: the first concerted work for archaeological purposes (inspired by publications of Crawford et al) took place in the Poznan region in 1938. It is thus fitting that, in early July this year, the area was the venue for a training school for central European archaeologists run by a multi-national group of tutors. Despite the relatively long tradition, aerial photography had been rarely used as a survey tool in Poland for several reasons. Primary was the extreme difficulty (even for archaeologists working for state institutions) in gaining access to aircraft, another problem was the lack of familiarity with the technique and its results. Although most archaeologist had heard of the technique, and most students are taught how crop marks form, etc, and many archaeological publications include illustrations of the results of foreign work, there seems to have been an unvoiced opinion that as a survey technique it was not applicable to Poland. A primary aim of the school was thus to break down the mental barriers that had arisen around this subject.

The school was in fact several concurrent events. First was the training sessions for archaeological monument inspectors in techniques of oblique aerial photography, photo interpretation, and the archiving of results. This was organised by Dr Zbigniew Kobylniski, Poland’s chief archaeologist and representing the Office of the Conservator-General of the Republic of Poland. The archaeology section of the Office has been instrumental in promoting aerial photography in Poland over the past three years. Second was the workshop organised by Wlodek Raczkowski for archaeologists from central and eastern Europe [see official statistics] which was financed by the Stefan Batory fund and several sponsors. Both events were centred around the teaching and other help supplied by the staff of the English and Welsh Royal Commissions plus other foreign guests. The school(s) had two main components: ground school and airborne.

The area around Leszno had been reconnoitred by Wlodek and Otto Braasch a week or so before the course began, and a number of sorties in the 1980s had revealed the area to be cropmark-sensitive. However, the number and range of sites revealed in this first week of July was a surprise to all of us, including Jacek Nowakowski the local inspector of monuments. The first few days produced a possible cursus (?) and a double-ditched circular feature, perhaps a henge. There was another large circular enclosure over 150m in diameter, and several possible rectangular post-built structures. The picture produced by all the flying was in fact much closer than we were expecting to that further west in the Rhine region and western Europe in general. Despite many decades of excavation, this was to a large degree unsuspected, and hints at the huge potential of further survey in the area. Another feature of the survey was the number of levelled strongholds (mostly Early Medieval, 7th to 12th century AD) which were found. Many had fallen victim to the 19th century Prussian landowners’ attempts to increase profits from the farming of the fertile soils of the region. Some had been discovered by previous work; others were new discoveries. The main category of ‘sites’ discovered were ‘blobs’ representing the ubiquitous pits. Some seem to be infilled gravel-extraction pits, perhaps of relatively recent date, others seem to identify prehistoric settlements which, despite intensive field walking of the area, had not previously produced archaeological finds.

One feature which the British team noted was that the crop marks were showing in barley as light against a dark background far more frequently than had been experienced in England. This may be a feature of local soil conditions or related to local crop strains or climate.

All students had a chance to fly several times. For many it was their first encounter with light aircraft and there were, of course, predictable problems. Most students flew at
least once with Otto, many however preferred the reputedly gentler approach to first-time passengers of Martin Gojda’s pilot, Tomas Janicek. Some more reckless Biggles wannabees opted for the local pilot in his Wilga with no doors – which guaranteed an exciting flight. For those who had been more concerned with health matters during the flight than looking out of the window, Martin Gojda had bought his video camera which allowed us to talk through some of the flights in an evening session. This seems a useful teaching tool that may be worth expanding (though in a more closely-edited form) in any future schools. It is much cheaper than actual flights and can be used, before flying begins, to explain some basic issues (such as the importance of angle and position to what can be seen on the ground).

The ground school was a great success in introducing methods of photo interpretation and mapping. One problem facing the students was in relating British examples to their own very different archaeology. Polish – and much Continental – settlement archaeology is still primarily concerned with sites in a landscape rather than the total landscape approach more typical of British field archaeology. During the several rainy days when flying was impossible, several impromptu lectures were delivered by a number of guests. An additional treat was Major Dabrowski, of the state secrets section of Polish Army HQ, who came especially from Warsaw to brief us in detail on what one could and could not photograph from the air in Poland. This seems to be the first time that a senior Polish army official has addressed an archaeological meeting on such matters. It turned out – much to our surprise – that the restrictions were much less than they had been a few years ago due to the significant post-Cold War official admission that anyone who had access to satellite photos had more than enough information on many sites of strategic significance!

The course had a direct effect on the Polish participants, in that any doubts of any kind that any of them had about aerial photography were dispelled. It is almost certain that each of the participants will attempt to organise programmes of aerial survey in their regions next year. However, Andrzej Prinke – the inspector for the Poznan region – was already in the air a week after returning home, and was reporting similar successes. Wieslaw Stepien, another participant, is in the process of arranging joint flights with Otto Braasch along the lower Oder valley in the areas of Poland bordering Brandenburg where Otto has had some spectacular results in recent years but, for logistic reasons, had previously been prevented from crossing the modern political frontier to extend his search area to the terraces on the river’s eastern bank.

This year was the first time that any area of Poland had been so extensively flown: the results far exceeded our expectations and the number and range of new sites was impressive. It is hoped that the means will be found to continue this international cooperation in some way, using the Leszno areas as a sample of lowland Poland. It is hoped that in future years we can arrange return visits of the instructors and others to organise repeated flights of the area to provide information that can be combined with results already existing from intensive field walking. The aim should be to produce a monograph on settlement patterns and landscape development.

One problem which was revealed in discussion generated by the schools was that of the unsuitability of the existing SMRs in Poland to include data generated by aerial photography. The format of these records was designed with ploughsoil scatters and single monuments (ruins or earthworks) in mind. It is hoped that these issues can be discussed in the near future while there are relatively small archives of aerial photographs in Poland.

Also of potential future interest are the World War II Luftwaffe photographs of Poland, now in Keele and Washington. We should be thinking of ways for Poland to raise money to acquire copies of this valuable material which has relevance to much current work. As well as being historical documents in their own right, those photographs are potentially a useful tool for heritage management of archaeological, industrial, and landscape concerns.
An Approach to Automated Morphological-Topographical Classification

Sam Redfern

Introduction

The Aerial Archaeology System (AAS) is a Windows 95 software package that provides in an integrated manner, a variety of digital 'tools' for use by archaeologists studying stereo pairs of vertical photographs. Primarily, the software assists in the detection of archaeological monuments and the objective measurement of their morphology and topographic contexts, through the application of digital image processing and photogrammetric techniques. Recently, the AAS has been extended in order to provide automated, and therefore objective, classification of monuments as they are discovered.

The basic techniques underlying the extraction and measurement of monuments are dealt with in a previous AARGnews paper (Redfern 1997), while the AAS itself is presented in more detail in the Computer Applications in Archaeology-1997 conference proceedings (Redfern 1998). A rolling demonstration in Video for Windows (avi) format, and the Windows help (hlp) file for the system are both available for download at http://it.ucg.ie/sam/psi/aas/aas.html

The aim of the current paper is to describe the approach used in the AAS for automatically classifying monuments, based on their morphological and topographic measurements.

The Case for Automatic Classification

The technique of numerical, morphology-based typological classification has been applied to archaeological artefacts since the 1960s, and more recently to monuments. While the published classification schemes have tended to primarily incorporate ground survey evidence, there have been convincing arguments made for classification schemes based entirely on evidence from aerial photographs. The validity, or lack of validity, in attempting to classify monuments in this way has been heatedly discussed in the aerial archaeology literature for a number of years (see for example Edis et al. 1989; Whimster 1989; Startin 1992; Walker 1997). The primary weakness of the morphological classification technique is that it produces archaeologically abstract classes, and it is also argued that this classification may disregard other important information about a site, such as cultural affinities. Morphological classification of monuments in general, and from aerial photographs in particular, is however regarded as being useful in a number of ways:

- As a means to produce at least some useful information from sets of raw morphological data, particularly in the case where no other information regarding a monument is available;
- In order to allow effective querying of large (regional or national) monument databases, through the selection of monument groups by class;
- To alleviate the problem of subjectivity in recording, which occurs inevitably when many different archaeologists contribute to a database (this point is valid only when the classification scheme is implemented in a truly objective manner);
- As a first step in the progress towards dating, function designation and the deeper understanding of monuments;
- As an effective technique for use by widearea discovery-oriented surveys from aerial photographs.

Without the attachment of any (even abstract) meaning, monuments discovered through aerial photographs are of little use. Morphological classification, however, allows database queries to extract sets of 'similar' monuments, which provides the strongest argument for the development of classifications, even if they are abstract in an archaeological sense.

The primary classification scheme that has been applied to monuments extracted from aerial photographs is the Archaeological Assessment Record (AAR) developed by the RCHME and implemented in the computer package MORPH. This scheme provides generic attributes by
which monuments are recorded: the intention is to promote standardised description (Bewley 1991), though it has been shown experimentally that objectivity is not necessarily an end result (Home & MacLeod 1991). The intention of this paper is to illustrate the way in which image processing and artificial intelligence can be used to increase this objectivity, and therefore provide a means for successors of MORPH to overcome some of its weaknesses.

It is generally agreed that, in order to improve archaeological understanding, there is a need to carry the information generated from aerial photographs into the context of wider landscapes: studies covering limited areas are regarded as being 'artificial' (Fenner 1995; Walker 1997). This has been used as a source of criticism for morphological classification: however, it also underlines the need for regional/national co-ordination of data, which is the context in which morphological classification can be most useful. This type of classification should be seen as a tool which has the potential to assist archaeologists studying regional phenomena, rather than as an end in itself.

**Automatic Morphological-Topographical Description**

While a wide variety of factors is considered relevant to the classification of archaeological monuments, only unambiguous and reproducible measurements can be used for the purposes of fully automated and objective schemes, especially when these are to be applied to monuments known only from aerial photographs. The wide range of monument preservation states precludes incorporation of information such as entrances, and bank and ditch heights, widths and depths. While this is undoubtedly useful information, from a classification stance it is simply too subjective and affected by outside factors.

The 6 measurements provided by the AAS are circularity, rectangularity, elongation, area, slope and aspect. The first 4 of these are generated from the objective outline tracing of a monument provided by the AAS, while the last 2 are generated from the digital elevation model (DEM) of a monument, which is created by the AAS through the application of digital photogrammetry techniques to stereo images.

**Development of the Classification Scheme**

In order to develop a typology of archaeological enclosures and sub-circular features visible in vertical aerial photographs, a set of 125 monuments were selected from the *Bruff* survey¹. A set of morphological and topographic measurements regarding each of these monuments was generated, using the AAS. In the case of the aspect (facing) measurement, the data were vectorised into a north component and an east component on the unit circle, since a simple angle is clearly not useful as it is not a continuous numerical measurement. Any monument on a ground slope of less than 1 in 100 (0.01) was considered to have no aspect value.

The data generated were submitted to an agglomerative cluster analysis using Ward’s method² (see Ward 1963; Everitt 1980), in order to objectively define typological groups. This resulted in the definition of 6 groups, 5 of which were further divisible into sub-groups: see figure 1. Sample tracings of monuments from these groups are provided in figure 2, while table 1 summarises the characteristic features of the groups.

¹The Bruff Aerial Photographic Survey was initiated in 1986 by the Office of Public Works (OPW) and the Dept. of Archaeology, University College Cork. The aim was to assess the potential of medium altitude vertical aerial stereo photographs for the recording of hitherto unknown archaeological sites (see Doody 1993). The study covers a 70 km² area centred on Herbertstown, Co. Limerick, and extends slightly into Co. Tipperary.

²Cluster analysis is a statistical technique of numerical taxonomy that is commonly employed in an exploratory manner for the identification of structure in complex, high dimensional data sets, for which there is no prior knowledge of groups or their characteristics. As a classification procedure, cluster analysis seeks to determine natural groups (or clusters), which reflect the underlying structure of data sets by relating similar measures of observed variables. The results of cluster analyses are often portrayed using dendrograms, which are graphical depictions of the clustering process: they present, in a hierarchical manner, the linkages defining group and sub-group membership.
Figure 1: Dendrogram resulting from cluster analysis of the 125 monuments from the Bruff survey. Monuments are presented along the top axis. The distances at which linkages are made from this top axis are inversely proportional to the strengths of those linkages, i.e. the similarity between the groups being linked. Resulting classes are shaded.

Table 1: A summary of the 6 typological groups resulting from cluster analysis. ‘Tightly defined’ measures are those that unify a group (i.e. have low standard deviation) without actually being of unusually high or low mean value.

<table>
<thead>
<tr>
<th>No</th>
<th>Radius</th>
<th>Circularity</th>
<th>Rectang.</th>
<th>Elongation</th>
<th>Slope</th>
<th>Facing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>11</td>
<td>high</td>
<td>high</td>
<td>low</td>
<td>low</td>
<td></td>
</tr>
<tr>
<td>Group B</td>
<td>20</td>
<td>high</td>
<td>high</td>
<td>low</td>
<td>low</td>
<td>not N</td>
</tr>
<tr>
<td>Group C</td>
<td>26</td>
<td>tightly defined</td>
<td>low</td>
<td>low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group D</td>
<td>29</td>
<td>low</td>
<td>tightly defined</td>
<td>low</td>
<td>N or NW</td>
<td></td>
</tr>
<tr>
<td>Group E</td>
<td>28</td>
<td>SE, E, or NE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group F</td>
<td>11</td>
<td>low</td>
<td>high</td>
<td>low</td>
<td>SE, E, or NE</td>
<td></td>
</tr>
</tbody>
</table>
The following general observations may be made:

- The larger monuments (group A) also have highest circularity, lowest rectangularity, and lowest elongation. Since circularity and elongation are negatively correlated (Pearson's $r = -0.46$), this last observation is not surprising;
- The largest monuments (subgroup A2) face NW or SW;
- The monuments on steep slopes (group B) do not tend to face N;
- The monuments on the flattest ground (subgroup C1) tend to face S;
- The smaller monuments (group D) lie on a small range of slopes of just below the average value for the entire data set. They also tend to face N or NW;
- The highly elongated monuments (group F) tend to lie on flat ground;
- In 4 of the 5 groups which have subgroups, facing is a significant factor in differentiating these subgroups.

Verification of Statistical Significance

A coefficient, $C$, that measures "tightness of clustering" was defined as follows:

$$C = \frac{\left( \sum \frac{D_g}{P_g} \right)}{\left( \sum \frac{D_a}{P_a} \right)}$$

where $\sum D_g$ is the sum of Euclidean distances between each of the within-group pairs of objects, $P_g$ is the number of within-group pairs of objects, $\sum D_a$ is the sum of Euclidean distances between each pair of objects disregarding group membership, and $P_a$ is the number of pairs of objects disregarding group membership. This coefficient measures the average ratio of the distance between objects in the same group, to the distance between objects disregarding grouping, and is minimised by a strongly clustered classification.

Without proof of statistical significance, any numerical classification scheme lies on shaky ground. Therefore Monte-Carlo simulation was performed, in conjunction with the use of the $C$ coefficient, in order to verify the statistical significance of the Bruff monument classification. In order to carry out this simulation, 500 sets of test measurements were generated, where each set comprised 125 "fake" monuments, whose measurements were selected randomly from correctly distributed data³. The 500 sets of simulated data were submitted to cluster analyses, and $C$ was calculated in each case. It was found that just 13 of the simulated sets produced stronger clustering than the real Bruff data. The classification scheme described may therefore be accepted at a 97.4% level of statistical significance.

Clearly there is a difference between statistical significance and archaeological significance. Statistical significance allows this paper's morphological and topographic observations to be made with some conviction; however, that is not to say that the factors causing these observations are necessarily archaeological - "statistical significance is a necessary but not a sufficient condition for [archaeological] type designation." (Adams & Adams 1991, p.177). Though some archaeological analysis of the current classification scheme has been carried out, further research is clearly required in order to determine the archaeological significance (if any) of the groups.

Automatic Determination of Monument Class Membership

Artificial Neural Networks (ANNs), which are essentially complex transfer functions based on simplified emulations of biological neural networks, have been well proven in the area of numerical classification, particularly in cases of 'noisy' data, where other classification approaches are more susceptible to error. The basic operation is to train an ANN, using data for which inputs (in this case, morphological measurements) along with corresponding outputs (in this case, typological classes) are known. The ANN learns the underlying patterns in the data, and will then be capable of accurately determining the classification. However, the distribution of measurements for each variable was taken from that of the real Bruff data.
predicting a typological class given only a set of input values.

Following investigations into the most suitable ANN architecture for the task, it was found that a hierarchical collection of ANNs was most useful. This is considered to be particularly suitable to the current classification task, since the groupings resulting from cluster analysis were inherently hierarchical in definition. The discrimination task to be trained for each network was derived directly from the classification dendrogram (figure 1). The top-level ANN concentrates on separating monuments according to the three weakest linkages of the dendrogram, which distinguish (i) groups A and B, from (ii) groups C, D and E, from (iii) group F. On the second level of the hierarchy are two networks: the first separating group A from B, and the other separating group C from D from E. The bottom level of the hierarchy consists of a network for each of the groups A to E, which determine subgroup membership. Group F does not have any subgroups, and is identified by the top level network, since it is quite different to the other groups (the very last, i.e. least significant, linkage of the dendrogram is the one that joins group F to all of the others).

Application and Analysis of the Classification Scheme

A study encompassing a 20km x 20km region west of Strokestown, Co. Roscommon, was carried out using the AAS and its automatic classification scheme. Near the centre of this region are two distinct complexes of archaeological monuments: Rathcroghan and Carnfree.

Rathcroghan is a complex of monuments, situated about three miles north-west of the town of Tulsk, Co. Roscommon, and incorporates an impressive mound of some 5m height and 90m diameter. The ancient Celtic significance of the area is well known\(^4\), though its exact role(s) remain open to debate (see Waddell 1988) - some ritual purpose, probably royal inauguration and assembly, is presumed.

The Carnfree complex is located on high ground some four miles to the south-south-east of Rathcroghan. This complex is named after its imposing burial cairn, which, as the royal inauguration site of the O'Conors in historical times, probably took over in function from Rathcroghan.

Over 800 monuments recorded in the Sites and Monuments Record (SMR), were extracted, and supplemented by 69 probable monuments newly discovered through use of the AAS software. In order to determine which of these represented previously undiscovered monuments, a program was written which calculated the distance between each AAS-identified monument and each monument of relevant type in the SMR database\(^5\). The nearest monument extracted from the photographs, if any, within a 50m radius of each SMR monument was assumed to be the same monument. The remaining monuments were considered to be newly discovered.

In order to assess the significance of monument types, a number of analyses involving monument classification and other environmental data were carried out. In most of the analyses involving the SMR classification, monuments were designated as 'Ritual' (mounds, cairns, barrows and tombs), 'Domestic' (ringforts), 'Enclosures' (enclosures of all types except ringforts), or 'Other'.

Figure 3 illustrates, for the monuments represented in both the SMR and AAS databases, the correspondence between class designations. There appears to be an association between AAS class A and SMR 'ritual' monuments, and between AAS class D and 'domestic' monuments. No AAS class appears to be associated with SMR enclosures: however, since the term 'enclosure' is somewhat ambiguous in that it may refer to both domestic and ritual monuments, this is perhaps not surprising.

\(^4\)Rathcroghan figures in the epic literature the Táin, and is presumed to be the royal site of the Celtic kings of Connaught, similar to Tara in the East and Emain Macha in the North of the country.

\(^5\)Monuments considered relevant were those classified as ringforts, any types of enclosure, or any types of mound or barrow, since these are the types of monuments dealt with by the AAS.
Conclusions

As noted above, AAS class 'A' monuments often appear to represent ritual sites, i.e. mounds, cairns, barrows, and tombs, while AAS class 'D' monuments often appear to represent domestic sites, i.e. ringforts. It is therefore suggested that the AAS software may be useful for the initial assessment of the degree to which a previously unsurveyed archaeological landscape may be described as 'ritual' or 'funerary'. There is for example a marked difference between the two studies discussed in this paper: Rathcroghan/Carnfree appears to have a stronger ritual emphasis and a correspondingly lesser domestic emphasis than Bruff:

Clearly this abstract classification of Irish monuments can represent only a first step towards archaeologically meaningful morphology-based classification: in order to advance further, extensive field survey and excavation of selected monuments would be required. While the Rathcroghan study served to apply some initial archaeological meaning to the classification scheme, this scheme in its current state of development is perhaps most useful as an illustration of practical techniques by which objective and automatic measurements may be extracted from monuments in aerial photographs. These are important objectives when seen in the context of regional or national databases, which can often be difficult to query since they consist of subjective and descriptive entries made by many different archaeologists. The techniques used also provide a contribution more generally to the process of morphological-topographical classification of archaeological sites: in particular, they show the way forward for fast, accurate and objective measurements, incorporating topographic metrics derived from stereo photo information.

There are a number of ways in which further research and development efforts have the potential to improve the AAS as an archaeological research tool:

- Field survey and selected excavation work could improve the abstract classification scheme and generate archaeological 'meaning'. A field survey project could also be used in order to provide the AAS with a set of unambiguous monuments and another set of unambiguous 'non-monuments', in order to 'teach' its ANN-layer to tell the difference;
- The application of the AAS to more photographic surveys would also provide the potential for the refinement of its classification scheme;
- In order to prove the consistency and objectivity of description provided by

![Figure 3: Frequency histogram illustrating the correspondence between the AAS and SMR classification schemes in the Rathcroghan/Carnfree study.](image)
the AAS, it would be useful to carry out experiments, similar to those described by Horne & MacLeod (1991), in which archaeologists independently made use of the system;

- The expansion of the AAS software in order to allow oblique photographs to be used would be useful, since obliques are an important archaeological resource and often low contrast, low relief sites are more clearly visible in them than in vertical images;
- It would be useful to expand the AAS in order to allow the detection and mapping of linear features as well as sub-circular features;
- The accuracy of estimated monument locations could be improved by developing full-photo DEM and orthophoto generation capabilities;
- The AAS could be modified in order to make a system useful for single-site analysis. Aerial photography has proved to be very useful in determining excavation sampling strategy within a site (Barker 1986) - the computer assisted generation of this 'pre-exavation information' could therefore prove to be valuable. Such a system could potentially make use of platform based vertical photography (see Barker 1986), or even aerial photography using model aeroplanes⁶ (see Walker & De Vore 1995).

References


⁶ The use of model planes for archaeological aerial photography has already been demonstrated by Jenk (1997).
Plus ça change....

Anthony Crawshaw

Whilst reading through the indices for RAF files in the Public Records Office, Kew, I came across the following (AIR 2292/672483/26), which dates from 1926.

**Taking of aerial photographs (Including those of archaeological interest) by the trade or by the RAF**

This file was started as a result of a complaint, of 19th. February 1926, by The Aircraft Operating Company Ltd., 8 New Square, Lincoln's Inn (operating subsidiary - Aerofilms Ltd.), that the RAF were doing photography in Northern Ireland for the Northern Ireland government. The firm said that they were able to do the work and would send a machine across, as soon as they had sufficient work to justify it. The company objected to the unfair competition from the RAF, particularly as the latter had earlier said that they would not compete in this way..

There followed a review of existing policy and precedents, followed by a decision that the RAF should not compete directly with civil aviation. However there was to be continuing cooperation with the Army and Navy and the RAF reserved the right to work for Government departments, but not local authorities. In this context the Northern Ireland Government was defined, by the RAF, as a local authority.

The question of archaeology as a special, penniless, case was considered; the making of a particular exception was rejected, but I get the impression that the, then, existing practice of looking carefully at such requests was to be retained.

Examples of earlier archaeological photography were quoted in the file, as follows:-

April 1925, Somerset Archaeological Society asked Chief of Air Staff, personally, for assistance of RAF. RAF did, and was still doing, the work (RAF file reference 591473/25).

July 1923, First Commissioner of Works, Sir John Baird, (presumably the Ministry of Works, the forerunner of English Heritage) asked the Secretary of State for photographs to be taken of ancient monuments. The RAF did so, and was still doing the work, as opportunity permitted (438656/23).

3rd. November 1923, the Society of Antiquaries, supported by the Director of the British Museum, asked for photographs of an excavation at Park Brow, Cissbury. The RAF obliged with one photograph, the society paying only for negative and print. (636322/25)

One might be tempted to think that the common denominator of the photographic missions was a friend in high places, but this does not always seem to have been the case. For example, the RAF refused a request from the Ordnance Survey for aerial photographs of Bournemouth and the same treatment was given to the Duke of Westminster, who wanted shots of a stately pile.

It seems that none of the three RAF files mentioned above have been kept, although it is difficult to work from the RAF file references to those of the Public Records Office, so I can not be sure. The reason for the present file being kept seems to be that it served as a definition of policy.

My conversation with David Wilson was provoked partly by his impending retirement from CUCAP. Most AARG members are familiar with at least some of David’s academic work, but it seems timely to remember that he also was instrumental in getting AARG off the ground [sorry!], has successfully seen CUCAP through the difficult transition from a funded research unit to its present commercial viability, and (I imagine) has had a large input into considerations for its future. The conversation touches on some of these themes and also includes a section on the CUCAP subject index – something I consider to be one of its most important assets.

The conversation took place in David’s office at CUCAP, so any references to ‘here’ mean there! Our original conversation has been quite severely cut in places and edited (by both of us) to ensure that the facts, especially about the future of CUCAP, are correct and not misleading.

RP – A reasonable starting point might be to talk about the beginnings of AARG, because that’s getting on for 20 years ago now and the letter from Paul Ashbee was addressed to you. [Ashbee’s letter, dated 13 November 1980, suggested the need for a small group of people to meet to expand issues touched upon in the 1974 CBA conference (Wilson 1975).]

DRW – We had one (or was it two?) meetings of people by invitation here in Cambridge, which we had at Wolfson, at which we talked about all sorts of different aspects of aerial archaeology, and various people made presentations .... I remember making remarks about indexing and classification and the associated problems. These were my first thoughts on the subject which eventually re-emerged in a late chapter in my book (Wilson 1982). Things like: if you’re too pernickety, every enclosure is the only example of its type – gets you nowhere! On the other hand, enclosures classed as enclosures doesn’t get you very far either, although it gets you further than ‘cropmarks’. So with any classification you have to consider what it’s for, but in relation to that there’s an optimum level at which it is serving a purpose. If you take it further than that you are just making too much work for yourself and will never get finished.

RP – But the early meetings, from what I remember (and I’ve got odd bits of paper at home) were about what to do with air photos rather than taking them, weren’t they?

DRW – Yes, I think so, because that’s what we felt needed addressing. I think there were two meetings ... but it was very much as a follow up from those that Rowan Whimster really got AARG going. Quite consciously as a successor to the meetings that we had, which we felt were successful. We circulated summaries – minutes, so to speak – to more people than were there because we thought it really very important that it shouldn’t seem that there was this clique that was now going to run aerial archaeology. Because that would be very counter-productive. So although, to get a fruitful discussion we felt it was necessary to limit the number of people and to select who was going to come, at the same time we didn’t wish it then just to remain within that particular group. I think it was as a logical development of that that Rowan suggested having a regular discussion group where we can take up all of these things. Of course, this was open to anybody who wished to come: at first it was only a couple of dozen people and then it grew. I seem to remember that we met a couple of times a year and it was only when it started getting bigger, and it became more of a conference than a discussion group, that it then settled into a once-a-year meeting, apart from specials.
Certainly one of the things that we were concerned about was how to use the photographs, mapping, and what conventions to use in mapping – which also produced your and John Hampton’s paper (Hampton and Palmer 1978).

RP – And *Aerial Archaeology* 11: that dealt with the mapping element. But was Rowan around right at the beginning? We were both doing our MSC schemes here [CUCAP] in 1983-4, but I’m not sure if he was here before that.

DRW – He was here, funded jointly by RCHME and DoE, to facilitate getting out information about archaeological sites to county archaeological offices. St Joseph maintained that this kind of work had grown to such a point that it was impossible to cope, and to get the information out they put somebody in to process it. That particular phase of subvention stopped rather sharply not long after I was in position here [as Curator following St Joseph’s retirement] and they re-deployed Rowan to do his project on archaeological crop marks – the thing that became *The Emerging Past* (Whimster 1989) ... eventually! So he was around for quite a long time.

RP – Yes. He’s on that Anglia TV programme [*History from the Air*] which I think was mid- to late-1970s.

DRW – Well yes, it must have been because that was St Joseph’s film and all the cine film that was used was taken by St Joseph. He wouldn’t let any of us touch the cine camera!

RP – Well, anyway, that’s put Rowan in position. I remember him from when I was coming in as a research student [1976-1979] and he was always a good person to throw ideas backwards and forwards with.

DRW – Rowan really sort of blossomed in the early 1980s because anybody who works under St Joseph is pretty well flattened under the thumb and you don’t really have too much scope except to do what you’re told. When St Joseph retired, Rowan then got his new project and a free hand as far as I was concerned – and he came up with more and more ideas ... he’d come up to me and say, ‘You may think I’m utterly mad, but I’ve thought that what we really want to do is have a big exhibition at the V and A [Victoria and Albert Museum, London].’ And, I agreed with him. I thought about it and said, ‘Why not?’ I wrote to Roy Strong [then Director of the V and A] who replied that he knew of our work, but was terribly sorry but ... policy decisions, programmes, priorities – usual sort of stuff. It wasn’t on, but we got some way towards designing what I suppose would be a fairly spectacular national exhibition. We thought that the V and A would be a place where this could be done – it made sense in relation to some other exhibition – but there’d been a change of policy.

RP – I know there was an exhibition of mainly your photos at Fortress House.

DRW – Oh yes, that was in the spring of 1976. It was to display what we had achieved in the summer of 1975, in the drought, because we had received special money from the DoE to enable us to continue working. St Joseph had used all our own money but had seen that it was happening everywhere and so they pushed in quite a lot of cash because this was obviously a special occasion. In response it became necessary to show that we’d actually made good use of it. An exhibition was good publicity for us but, from their point of view, it was justifying what they’d put into it and showing what had been achieved.

RP – I’m not sure if I ever saw that. I remember it particularly because Bob Downey, who used to work with John Hampton [RCHME’s Air Photography Unit] told me that somebody had come in just after the exhibition had been taken down and said, ‘I want to see my father’s photographs.’ And this was one of the baby St J’s.

DRW – That took quite a lot of work. I chose most of the photographs and did the captions ....

RP – So you were allowed to decide which photographs were used?

DRW – Well no, I was allowed to put forward a provisional list – but I was never allowed to decide anything.
[there followed some selected memoirs of St Joseph]

RP – I don’t want to spend all of this talking about St J. One of the things that I’ve noticed in the last twelve months, looking through the photographs. I was doing some work near Maxey – on the Welland gravels anyway. My view of the collection is that St J was fairly ... sparse with the amounts of film he used. He would take two or three photographs and unless it was something really special, or maybe a Roman site, then that would be it. But in 1949, one of the dry years, he’d come to the gravels and just gone mad over it. I got an impression from that of what it must have been like – here is somebody seeing all this information for the first time.

DRW – Exactly, I’m sure that’s right. In the end he was so exhausted that he said, ‘You’ve just got to go away and leave it’ – I remember him saying so – ‘and come back another day.’ Which, of course, he did. It had never been seen like that before: one knows now that it can happen. But it was particularly good then and I think he was completely overwhelmed.

RP – It’s so different from the normal run of his photos – you know something special is going on there. But that was just my reading of it.

DRW – But 1949 in general was a pretty amazing year and the Maxey area was very special because there was so much of it and it just went on from field to field [see RCHME 1960].

RP – So he could actually ... I was going to say, be human, but that’s a bit unkind isn’t it. He had almost, I suppose, a sense of wonder with what was going on.

DRW – Absolutely. If that was less apparent later on it was because he’d seen so much. I remember Graham [Douglass: CUCAP pilot 1962 to 1981] telling me ... I can’t remember which site it was, but he said, ‘I think there’s something over on this side’, pointing right under his chin. And St Joseph reacted in his usual rather composed sort of way until he looked down, and Graham said he was almost – that window didn’t open – that he was almost out of the window with excitement.

I know the feeling from Graham’s point of view because, one time up in Scotland we were doing a survey for the Nature Conservancy (as it then was) of Flanders Moss. Flying up and down in straight lines across this very large area of boggy ground. And I saw, at the western end of the Lake of Menteith a rather striking rectangular collection of crop marks and when the survey was over and we were two or three miles away, at least, I said to St Joseph, ‘I think there’s something you ought to look at by the west end of the Lake of Menteith.’ ‘Oh’, he said, ‘what is it?’ I said, ‘It looks like a Roman fort.’ ‘Oh, I think that’s most unlikely’, he said. And then, of course, it was! He had totally to revise his ideas of where this line of forts might have run.

On the other hand, when I was flying on my own with Graham Douglass and we were south-east of Doncaster, we looked out of the window and saw a very large Roman fort [Rossington] which seemed to be new. I said to Graham that I expected it was something St Joseph saw twelve years ago and never bothered to photograph. Because you never ever actually found something yourself, it was always something he’d seen before. Graham said, ‘I think you may be doing him and injustice.’, and it was, in fact, something new.

RP – Let’s jump back a few years. Why did you come here in the first place? Because it was ‘a job’?

DRW – I was asked. I was head-hunted ... I’ve never actually had to apply for a job in my life. I’ve applied for other things, but not jobs. Richmond [Ian Richmond, then Professor of the Archaeology of the Roman Empire] head-hunted me to be his assistant in Oxford and then the job here was created, or became available, in 1965. I already knew St Joseph, or he knew me, because he was co-director of the excavations at Inchtuthil which I went to because Richmond was the other director. I wasn’t the only candidate – the others were Pat Carter [later Assistant Curator (Palaeolithic Archaeology), Museum of Archaeology and Anthropology, Cambridge] and ... I think Lawrence Barfield [now lecturer in European prehistory, University of Birmingham] was the third one.
Anyway, St Joseph wrote to Richmond first and asked if it was all right to ask me. I'd been with Richmond for five years and I was very happy with it, simply love to stay... but I thought, one has to move on, I was already looking for things – I'd applied for a research fellowship at Leicester University and they never even answered my application, nor did they answer my letter when I asked them what was happening. So that was no good... so when St Joseph suggested this, I knew a bit about aerial photography, I'd even lectured about it!... in a pretty ignorant sort of way. So I said, 'Well, you'd better take me up in your aircraft, because I might not be able to take this.' So I was taken for a flight around the locality.

I was given a one-inch map [1:63360], but I wasn’t told where we were starting from. We got in the car, we drove out to Marshall’s [Cambridge Airport]... but I didn’t know what direction that was in, and it wasn’t marked on the map. So it was a long time before I understood what was going on. When we flew past Ely cathedral I knew that from visual recognition. I then found where I was on the map and could follow what happened after that. Anyway, for some reason I wasn’t... didn’t feel sick (probably the only time I flew in the Auster and didn’t!) and was rather exhilarated and thought that was something worth doing. So I said all right. We didn’t have a proper job interview. The three of us, the three candidates, arrived in this large room somewhere in Cambridge and were given a glass of sherry each. We circulated around the room, at carefully managed intervals, making small-talk to members of the Committee. That was it!

RP – So it was actually to do some of the flying duties as well?

DRW – Oh yes. I didn’t do much flying in the first year. During that time I learned about how the card index was classified... I did do some flying, but was usually not too happy – I didn’t like the Auster. If I was flying with both of them, I was sitting on a seat behind them facing sideways, and for somebody who finds it difficult to cope with motion anyway it was pretty horrible. But apart from that, it had this perspex roof so you always had the sun, and I had to be very careful to wear loose clothing and... it was fairly nasty. There was one occasion when I asked if we couldn’t possibly go down – at Cirencester or somewhere – but it was so much better when we got the Cessna with its opaque roof. I actually felt moderately comfortable for the first time.

RP – You mentioned the card index earlier... which I think is one of the most important parts of the collection. Of course, you need the photographs first, but the way that the subject index is devised, and the way that it works – even if people do laugh because it’s on cards (it would probably take just as long to search on computer). This has developed, presumably from St J initially but from both of you actually perceiving different phenomena (for want of a better word) that can be categorised and which become a subject on the card. Is that more or less right?

DRW – Obviously the card index is intended to enable you to find things that you want to find again. You’ll see something and say, ‘We ought to have some kind of category to cover this. We’ve got this photograph, what the hell are we going to call it (in terms of a category)? Obviously this is important: you’ve not recorded this before, but you aren’t going to lose sight of this particular one. What can we call it (in not more than three words, preferably one) that’ll make sense and that we’ll actually remember what it was?” We used to have brain-storming sessions that sometimes went on for days.

Once we’d reduced it to a concept that seems to make sense, then you can carry on. It gets into the index, and you have to remember that it’s there. There are all sorts of rather strange and rather abstract categories that are in there. That is because it’s the only way to find the things you want. All the things that we put on the cards normally fall into one of two classes – very broad classes – the ones where you put down every example that we’ve got, even if it’s only a tiny little bit of it (and crop marks is one of these); and the ones that we put on only when they show well, and we say, ‘That would be a good example’. We don’t try to provide the materials for a complete study of sewage works, but if somebody wants to
illustrate sewage works of the following five different types, then we’d be able to find them. We would only want for that purpose, good reasonably photogenic examples. So they’re selective. If it’s there in the foreground, or it is sensibly related to the local topography, that’s what we’re going to put in. But if it’s in the distance or you’ve only got one part of it – what use is that to anyone? If that were a crop mark, we would say, ‘That might be important for research.’ It’s just a matter of different criteria that applies to virtually everything. We put it in if it’s a good example, or we put it in if we see it. And crop marks we sometimes put it in because you can’t see it. It’s part of the evidence for the site.

RP – Yes, but not very often. I’ve spent quite a lot of time looking for examples of crop marks when they’re not showing. Not, necessarily, in your photos, but in mine. But, of course, you don’t take them because most of the time you forget that there’s something in that field.

DRW – The same applies to ‘obviously posed’ photographs – deliberately taken either because somebody asks you to take it, and there’s nothing there but you need to have something to show them, or because you feel it’s important to the history of the site. Or that it was a Roman fort in Scotland! But that goes on the card, because that’s when we couldn’t see it.

RP – You know your way around the index. I tend not to use the subject side all that much, and when I have it’s usually for something fairly obscure. Then either you or one of the girls has helped me, because there’s a lot of what I suppose are ‘sub-categories’ – I can’t think of an example – but remember when I was looking for something or other and you said, ‘Oh, that would be in interpretation.’ Which is where you have, not quite all the problems, but some of the interesting things.

DRW – Things that are interesting are things that you can’t solve. That’s not something which is kept up to date. It was there and was added to as and when things occurred. We had a go at rationalising the card index. It had grown gradually from 1945 to 1965 (when I arrived) and at the beginning it wasn’t done strictly by parishes. You actually have to understand the ways things interconnect and how this index has developed over a period of more than fifty years. Things that were being written in the 1950s were not being done to the same rules as the things being written in the 1970s, which at a glance you don’t quite appreciate. There is, for example, a mixture of place names and parishes (especially in the Fens, where St Joseph knew, and often used, convenient place names) which need to be brought together.

I did quite a lot of trying to straighten things out. Up to a point, the system is the one that we started with. There was a phase when I was positively managing it and you had decision to make as to whether, for example, it’s a nonsense to have these four things which are very close to each other dealt with separately, it’s better if they were brought together. There’s an example I was looking at only this morning on the island of Arran. You’ve got Goatfell, which is the really high peak, with lots of others all around it: important mountains in their own right. Are you going to deal with them separately or do you just say, this is the Goatfell area? It produced some very elaborate cards which said Goatfell area: corries with individual corries listed in the lower part of the card with footnotes identifying them by name and by grid reference plus the photographs, but it was better than having that number of separate cards, each under their own names (or the names of the nearest peak). At least we knew we’d got them all there next to each other. It was quite obvious that, if you were doing any photography of that area, any one photograph would show three or four of these things. So the number of photographs written across the top of the card was relatively small, but there was an awful lot of analysis underneath. But it meant that you didn’t have to write the same photograph numbers on ten different cards. Every now and then you’d come to something like that and say, ‘This is just silly. We get into such a mess with all these cards, why don’t we just consolidate it?’ And we had a sit down and we said, ‘Right, we’ll do it’, but nobody’s done that sort of thing to the index in the last twenty years! There’s a lot more things to do nowadays. There isn’t anybody who is a Senior Assistant in Research and who does the things that other people don’t have time to do.
RP – I got the impression as a visitor – I suppose when we were doing the MSC schemes [1983-84] – that things were getting a bit bogged down once you started taking a fair number of verticals, and the index was designed for the obliques really, wasn’t it, or the subject index. I remember the girls sitting there with verticals thinking, ‘What have I missed on these photographs?’ You could spend days with a few prints.

DRW – Exactly. And we had to devise an acceptable accelerated means. We first faced up to that when we did a county survey of Buckinghamshire [1985]. I think in Nottinghamshire [1984] we didn’t really face up to it, we tried to do it on the old system. We’d got to have all the parish villages indexed as a matter of course, because then if you go to that name in the index – even if there aren’t any other cards – then you’ll see these lines of green writing [CUCAP code for vertical photographs] that tell you there has been some survey there and you know that anything in that parish will be covered. That’s fine for anything you know exists, on the other hand with crop marks and earthworks (if they’re previously unknown of course), unpredictable things, it isn’t really very helpful to know that there is coverage of Buckinghamshire because you don’t know which crop marks may be there. If there’s something that’s showing remarkably well – maybe you can see beautifully the outline of this park – it’s always useful to index really nice photographs of parks that look like parks. So, again selective – picking out things that you really want to be able to find again.

RP – That’s sensible, rather than indexing everything – which is impossible now anyway unless you take on a lot more people.

DRW – Of course, we now have a very substantial backlog, as we always did 25 years ago. This has grown because we’ve had a whole succession of staff which didn’t stay for very long (from six months to fifteen months: for perfectly good reasons they’ve gone) and then you have to start again. Staff don’t really get really productive until they’ve been in place for a couple of years. What’s more we had a situation where both the girls left at the same time, so there wasn’t anybody to maintain the continuity – you had to start again. Since then, in fact, nobody’s really achieved anything like the standard that people like Ann and Margaret had [library staff between 1974 and 1985] because continuity of information is lost and we aren’t passing it on to each other.

RP – It also needs you to have the time to check everything.

DRW – That’s it you see. In principle, we check everything. So, in practice, there’s a pile of stuff that’s not been checked, so there is no feedback and no possibility of getting effective training. So, here I tend to sit upstairs, doing accounts and financial reports and statements, and documentation for review committees and all that sort of stuff – while downstairs there’s this pile of stuff waiting for me to look at it. I’m now retiring, with two people not fully trained, and a new person coming in this very next Monday. So I’ve got exactly eight half-weeks to try and get her, at least, on the way. So I’ll be spending time with her rather than polishing up the others, who also, in fact, need more attention.

RP – Is it ok to talk about what might happen – as we did the other day?

DRW – What, to this Department? The General Board are taking the trouble to examine a few possibilities. The Review Committee is going to report early next term [ie ?October 1998] to the General Board – but we don’t know what form that report will take. I’m sure there will be three or four different options discussed, and what the General Board will be seeking to do is to make a decision between those options – either following the advice of the Review Committee, or not, as the case may be.

Now, what are those options going to be? One of the options is obviously what we have put forward as being what we want to do, and that is that there should be a University Centre for GIS and Remote Sensing which would bring together both the acquisition of spatial data from the air (by photography and other means) and the processing of the data that we get. These things are more and more coming together, not only academically, but
commercially, and when we go out and do a survey these days the client is very liable at least to want to have it all put on to CD-ROM. The more demanding would also like to have it all ortho-rectified, but we don’t reckon to do that. But there are a lot of people who are quite happy to have it just so that they can call it up on their computers.

That is something that is coming together as what seems like a composite discipline. It is becoming integrated and what we’re trying to say is that it wouldn’t cost the University much, it’s just a question of redistributing what’s already here. I think there are twelve different Departments in this University in which this kind of work is being done. But they scarcely talk to each other. Geography is the principal place for GIS and so forth and maintains a University facility and a GIS lab. Obviously, Computing Services are very much involved ... but then there are lots of other people who are studying spatial data in various ways. If they could be brought together, in some sense, and at any rate, if people on research projects got in touch with each other, this would lead to quite a lot of exchange of information. It would also make it much more practical to apply for money for doing large projects using GIS and Remote Sensing. So that is one option. Inter-disciplinary centres are not as popular in the University as they used to be because they’re administratively tiresome, but the suggestion is that this proposed Centre would, in fact, be a kind of sub-department of Geography. It would be the responsibility of the Head of Department of Geography, not with some inter-faculty board, which is a thing that everybody wants to avoid.

So that’s one thing. On the other hand, we can continue much as we are, but can enhance perhaps some areas – like the fact that we are trying to do work with other types of sensor than photographic ones (electro-optical and thermal infra-red). Or ... there are things that are less exhilarating and one would be sorry to see – including, I suppose, at the other extreme, closing us down. On the other hand, I hope that they recognise that they’ve got a collection of photographs there which needs preserving.

RP – A GIS and Remote Sensing centre would cover the flying side, but not necessarily the library side so adequately. Would it be seeking new techniques and developments rather than saying, what are we going to do with these fifty-year old photos?

DRW – Certainly, this was a criticism that was made of the discussion document we originally produced as we were concentrating so much on what was new that we had to be careful to write in how important the existing collection of photographs was – which we were taking for granted but realised that the readers might not.

The present review is triggered by several things. Obviously, in part, my retirement – though that’s come two years earlier than they’d arranged. Partly by concerns about funding and affordability, especially when, two or three years ago we weren’t able to earn as much money as we needed to balance the books. Since then, we haven’t had any surplus beyond the surplus that we are required to get. The General Board put in a certain amount of money every year. That covers, at present, three-fifths of our staff costs. The rest of the staff costs, and all the other costs of the Department (other than what is covered by special equipment grants) has to come from our earnings. If we can do better than that we can use that spare capacity on work such as archaeological reconnaissance.

We have what in effect is a trading account and anything that is left over after we’ve made a transfer to balance the salary figure is carried forward in that account. It provides, if nothing else, a cushion against having a difficult year in the next year. This year we have got something in reserve which I’m very anxious not to use because I think it’s very important politically that we should succeed in achieving the target without having to delve into the pockets of the Board. That hasn’t been easy, given the weather [historical note: summer 1998 in Britain has been mostly overcast]. The amount of flying that we’ve done in the last three months is extraordinarily little, but it has just been enough to get us where we want to go. Fortunately! We’ve got a lot of work in hand – and if we could do it we’d be very well set up for next year.
RP – We’d talked about the possibilities that were opening. The research potential seems enormous to me, but then it’s a subject that I barely know anything about – the way that air photography and its uses, outside archaeology, have gone in the last few years.

DRW – Of course, all the effort nowadays is going into interpreting satellite imagery. Almost everything in the International Journal of Remote Sensing is to do with the statistical treatment of particular kinds of data. You have to decide what data it is that is going to give you the sort of results you want, and then you have to decide what sort of filters to use to really make use of what’s there, and then train the computer. And that’s only the beginning.... It’s usually for areas where there’s really no other way of dealing with it. A lot of work of this kind has been done in India which is absolutely vast. The only way to get serious understanding of many areas is to do it through satellite imagery. So there’s all that kind of work.

RP – It was the prospect that you mentioned, of the twelve different departments that are interested. You mentioned Geography and Computers. I know it’s difficult to get people in one discipline interested in the research of another, but the potential of – lets say, a computer person and a geographer working on the same problem should give a tremendous boost to the research.

DRW – The kite that we’re flying, suggested that students working on research projects would all be working in this Centre – which should have enough space to do that. Any teaching and supervision would be done principally by the people who do it at present, who would remain in their own Departments but would come into this Centre and do things there. So it would be a place where these people did come together. It was quite obvious that the greater part of the teaching and supervision would be done by people who were currently working in their own Departments. They would continue to stay in those Departments but they would, nevertheless, have another sort of connection in the Centre and would come in as need be. And it would have a very big tea room – where all the serious talking would go on.

So we are saying that this isn’t going to need extra staff – we’ve got the staff already, it’s just that they’re all scattered; can’t we bring them together in this way? This is the same thinking that led to the setting up of the Cambridge University Remote Sensing Group which was an informal discussion group. In due course it fathered the GIS and Remote Sensing M.Phil course that was run through Geography, and has been for some years now. At that point the Remote Sensing Group really stopped doing anything because it felt it had achieved a major thing that it wished to achieve; but it hadn’t achieved everything that it was talking about at the beginning. People from that group are still involved with the teaching – which is Geography teaching but nevertheless has a whole group of people doing it (such as Colin Shell teaching the archaeology). So although it is run and administered by Geography, much of the actual teaching is done by staff from other Departments. So that, in miniature, is the sort of model that we’re looking for – a bit more formalised.

RP – So you’ll need a building, and probably a new aircraft...!

DRW – Geography’s GIS lab needs more space: it isn’t operating very efficiently at the moment. There’s an adjacent building which is being vacated, into which Geography is going to expand. It [the GIS and Remote Sensing Centre] is definitely being considered as a serious possibility – and comments are being considered by this Review Committee – and is on their agenda.

RP – It would be nice to see. I’m not sure if it’s where I’d like to see the library go – I’m used to it being itself and independent.

DRW – The two people on the Committee who have been asking how the Centre will deal with the collection of air photographs are Adrian Olivier and Bob Bewley, as you might expect. They insisted that a lot more stress and discussion should be directed towards the future of the collection of historic photographs and recognition of its importance. I’d been so busy putting in all the new ideas and trying to convert them into English that, it’s true, what’s here already did not get all that prominence.
RP – Can we go back to the catalogue again? This collection has always seemed to be the major one that people from outside use, will use, because it’s easy to find something by subject. The other libraries haven’t got a subject index – or certainly one that works so well.

DRW – There you’re speaking as an archaeologist, and are absolutely right.

RP – No, I’m speaking as somebody from the press, a picture researcher.

DRW – On the other hand the thing that has become painfully obvious in the last five years is that if you’re doing advanced research in geography you expect to get that information in machine-readable form. So from the point of view of somebody doing that sort of research this collection virtually doesn’t exist. So that is a very strong reason – a strong academic reason – for transferring all of that on to computer, which we’re going to start simply by digitising all the last five years of vertical photography. You have to start somewhere, and it is obviously helpful in the commercial zone, as well as the academic side, to have this in the form in which you could make it available on-line. In a few years everybody will expect it to happen, at the moment only a few people expect to find it. I’m sure that, in due course, we’ll have consulting in that way of the library, so people can find whether we’ve got cover of a certain area on-line, and will be able to place an order. To begin with it won’t go back very far but we believe that, by a modification of our program which channels the new photography we can digitise the old photography by persuading it that it is, in effect, new photography. This will be exported to a separate data base, separate from the primary data base which should remain inviolate, which can be manipulated into whatever shape we want. It should be possible to start digitising in the course of the coming academic year. I’m terribly pleased that we’ve got that far. We have a computerisation scheme awaiting a nice endowment: it’s in the portfolio of projects that they have in the Development Office, on the assumption that we will do all of this and put it in a system working a more up-to-date version of PHOTONET. The cost has now crept up to something over £1,000,000 – which we could do with an endowment – but there are on-going costs that have to be covered somehow. We’ve reached the point where at least we can start digitising. We can’t do any of the rest until you’ve got the data digitised, but you’ve got to do something in the meantime.

My calculation, including computerising the card index – and we’re not ready for that yet – was that it would take five person-years, including quality control.

References


News from Europe

Hungary
In July this year Zsolt Visy (Janus Pannonius University, Pécs) was made professor and also took up the position of Second Secretary of State in the Ministry for Culture in Budapest. You may remember that Zsolt was a primary organiser of our first training week in Hungary (1996) and I’m sure that all AARG members who met him there or know him through his academic work will be pleased to pass on their congratulations. His appointment gives considerable hope for archaeology and aerial survey in Hungary.

[information: Otto Braasch]

We have also learned that use has already been made of some of the photographs taken during the 1996 training week. Csilla Arardi obtained copies (which I seem to remember she persuaded Otto to divert to take?) relevant to one of her field projects – although comments on their use and usefulness are presumed to be forthcoming.

[information: Rog Palmer]

Romania
Bill Hanson (University of Glasgow) started a flying programme in mid June 1998.

[information: Ioana Oltean]

Germany
Irwin Scollar has recently increased the number of sites from which AirPhoto, now at beta version 1.22.0, may be downloaded (see AARGnews 16, 37-8):

There are two ftp sites available:

ftp.uni-koeln.de /pc/basp {Cologne, Germany}
ftp super3.arcl.ed.ac.uk, /ftp/pub/baspmirror {Edinburgh, Scotland}

You may also download via the following Web pages if you prefer:

http://www.uni-koeln.de/~AL001/basp.html {Univ. of Cologne, Germany}
http://super3.arcl.ed.ac.uk/baspmirror/basp.html {Univ. of Edinburgh, Scotland}
http://wings.buffalo.edu/go?basp or {Univ. of the State of New York at}
http://wings.buffalo.edu/anthropology/BASP {Buffalo, N.Y., USA}
http://borealis.lib.uconn.edu/basp/basp.html {Univ. of Connecticut, Storrs, CT, USA}

See the file update.txt which is installed with AirPhoto for a cumulative list of all changes since version 1.00 of 1 January 1998 was released.

[information: Irwin Scollar]
Poland at 1600 asa

Rog Palmer

A flight at the end of the training week at Leszno this year provided the opportunity to make a rough comparison between Technical Pan and T-Max 400. I’d been using the latter, rated at 1600 asa, for sneaky pictures in the ground school, and there was about half a film left in one of my cameras. So... all photographs were taken on 35mm cameras through the Wilga’s perspex window on an overcast day. Details were as follows:

**T-Max 400**: rated 1600 asa: 85mm lens, UV(0) filter (ie none!)

**Technical Pan**: rated 100 asa: 50mm lens, yellow filter

Both films were developed normally (for Tech Pan see Palmer 1996: T-Max at 1600 asa gets 8 minutes at 24° in T-Max developer 1+4) and 5 x 7 inch prints made of all frames. For more reasonable comparison I made 8 x 10 inch prints (my usual working size) from selected frames – one pair to compare crop-marked features, another of a town, plus a couple of ruined buildings (which provided detail of beams, rubble, etc) that I’d photographed only on T-Max. All 8 x 10s were printed on multigrade paper filtered to grade 2½ or 3 (Tech Pan) and 4 (T-Max).

**Tonal range and contrast**

**T-Max at 1600 asa.** Uprising film increases its contrast (ie under expose and over develop: see Riley 1987, 55) but I know from my dance pics that full tonal range is achievable at 1600 asa in most lighting conditions. The tonal range on the APs is fine and shows information in the light patches and detail in shadows. This is clearest on structures, which have a wider tonal range than farmland, although all photographs show a general flatness that is probably due to the overcast conditions. The crop mark photos are slightly disappointing but I think this is due more to the poor lighting than the film. Even printing at maximum harness (using the internal filters in my enlarger that’s a bit more than 4½ but not quite 5), there is little contrast.

**Technical Pan.** Wonderful contrast but difficult to print the full tonal range. Slight changes in crop colour appear to have been enhanced by this high-contrast film and there is a clarity of detail in both light- and dark-toned crops. The incredible tonal range in crops [for which you need to compare it with the T-Max pictures] is likely to be due to the film’s extended red sensitivity and shows some of the advantages of Technical Pan for recording from the air.

**Grain**

**T-Max at 1600 asa.** What grain? This is much better than I expected (and therefore vastly better than you would think!) with a slightly coarse appearance to the prints but nothing (to me) that detracts from their interpretative or pictorial qualities. At 6x magnification on the 8 x 10s it is possible to make out tiles on buildings and, with no magnification, electricity or telephone wires can be seen (ok, I know that is not a good thing to judge quality by). Textures of different crops remain clearly defined.

**Technical Pan.** Virtually none.

**Comparison**

Really there is no comparison – not only were films at opposite ends of refinement, but the different lens and filters cancel out most other similarities! However, there remain two films taken at about the same time and viewpoint of the same subjects, so what can be learned? The first point has to be, don’t be afraid of the grain. These T-grain, or flat-plate emulsions (Kodak’s T-Max 100 and 400 and Ilford’s Delta 100 and 400: see Horne and MacLeod 1997 on Delta 100) have a more regular structure than conventional silver-based films and are less prone to clumping or unevenness – although (from an artistic point of view) almost all modern emulsions are too fine to produce nice grainy pictures! I doubt if any of you will need to rate film as fast as 1600 asa but I hope that this note, the reduced-quality illustrations below, and the samples on display at AARG show you that it is possible to uprate film...
to what may be thought of as unacceptably fast and coarse. All labs and many high-street shops offer appropriate developing. As an interpreter I’d be quite happy to work on 8 x 10s similar to those from this one flight – I’ve seen much worse from conventionally exposed 35mm FP4 – including some of my own.

References
Horne, P and MacLeod, D, 1997. Ilford Professional Delta 100 – a note. AARGnews 14, 10.

Two photographs taken at virtually the same time on 9 July 1998.
Above. T-Max rated at 1600 asa, printed at grade 4. Whole frame 8 x 10. (98.129/8)
Below. Technical Pan rated at 100 asa, printed at grade 3. Part frame of 8 x 10. (98.136/20)
Books of interest?


In *Essex from the Air* we have a book that will please, and be understood by, the non-archaeological public but which also is written and illustrated in such a way as to have good educational (by which I mean schools) value. From the first page onwards, this book takes the trouble to *explain* what can be seen from the air and, through a series of (usually) single page spreads, assists the reader to link photograph to map to fact. This is helped in many cases by use of a simple oblique sketch which is easily related to the photograph from which it has been traced and has been lettered to link with the text. Ground photos and reconstruction graphics are sometimes used to clarify or expand the explanations. *Essex* has a four-part introductory chapter, including some curious history, cropmarkology, and interpretation and mapping. The latter section uses a concise few hundred words to outline why we map and what we do with it and is well- and logically-illustrated through use of a single air photograph, its interpretative sketch, and mapping of the same site/area at 1:2500 and 1:10000.

The meat of *Essex* is in four period-based chapters, each of which is briefly introduced and then dealt with using a series of photo-sets with extended captions and, usually, accompanying illustrations. Introductions could, but don’t – except in one case (p 70) – link comments to the following photographs so that the reader could visualise points made and identify specific types of feature. But by themselves, the page spreads hang together extremely well – they make sense, text and photographs are easy to relate, topography is noted when relevant, as are features in the photographs that are not necessarily the main subject (for example, although page 17 is primarily to describe the barrow cemetery at Langham, text and photographs also identify medieval elements in the landscape and a 1920s pump house). This is excellent photo reading and shows just what could (?)should have been done in the *common past in Europe* catalogue (reviewed in AARGnews 16, 42-3). It’s nothing new – Crawford did it in the 1920s as did St Joseph in (at least) many of his *Antiquity* ‘recent results’ – but it is perhaps the most effective way to transfer the slide, screen and pointer to the page. I learned a fair bit from *Essex*, especially from parts dealing with the later periods and the inter-tidal and marshland areas.

But I can’t be nice all the time.... *Essex* is printed in A4 landscape format and the wide-page layout is used to good effect a number of times by allowing photographs to spread across the page width. The bad points of this format (in order of my discovery) are that reading it on a desk seems a bit like watching a tennis match (left, right, left, right....) and that reading it in a train is impossible or, at best, anti-social (the average bum – well, mine – sits on c.35 cm; this book opens flat at 60 cm). Proof reading seems hasty in places and has let in (or not let out) a few scrappy sentences with repeated phrases and at least one case where the coloured letters which guide the reader around the oblique sketches are not coloured in the text. I sometimes got annoyed when the large page numbers, set in big green boxes, were over-printed on photographs – but really, so what? I was made curious by the fact that the county of Essex appears to be an island – none of the maps show adjacent bits of England. I know from my association with Cambridgeshire, that County Councils tend to buy maps of only their own county, but I think a tiny bit of context would not have been out of place in a book which is likely to be more than just an internal document (see how to do this properly in *Grampian’s Past*). An index of place names would also have been useful.

*Essex*, I think, ranks high in the *somewhere from the air* series. It’s a fortunate county for such a study – it has a coast line and the Thames estuary, good examples of most of the main types of archaeological site, lots of more recent military presence, lovely

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1 Special price to AARG members ordering within a month of the York conference: £12.00
squidgy-muddy sites, the M25 and even some crop circles. The photographs are good and have been well reproduced (even in the pre-production review copy) and – for the unbelievers – are all from Fujicolor 400 asa negative material. I’m pleased to see Essex County Council supporting and publishing Essex from the air which seems likely to become a popular and educational guide. Essex cannot fail to promote a broad range of uses of aerial photography and – perhaps – will encourage funding for continued recording from the air of all aspects of the county’s past and present land use. Good one Davy!


This piece begins with a nicely-argued question arising from Simon Crutchley’s PI. This was followed by a field visit and persuasion of a friendly mate to dig holes and find out. The work described presents an ideal situation that many of us often hope for but so rarely achieve (lucky man, Simon!). If/when RCHME get rich, maybe Air Survey could employ a small team of diggers to help answer other similar, and (possibly) easily answered, questions.

PS: Possibly the recent merge with EH has provided just that team!

[When I was working at Hambledon Hill I realised that my questions, resulting from survey, were not the same as the site-based excavator. Survey-derived questions are often simple (what is it?) and crude (when was it?), and may be out of fashion too, but often can be solved by a small hole. From my point of view, it’s what the Danebury area needed and maybe Cathy feels the same way about the Wolds? There is another set of questions that the air photographer seeks that is rarely answered by the conventional digger. This was one of Derrick Riley’s frequent comments relating, usually, to certain whys concerning ditch fill and crop marks. But they were not the excavator’s questions so, without a site visit by Derrick, remained unanswered.]


These four volumes arrived through the post in a parcel the size and weight of a couple of house bricks. They provide what is essentially an index (on County and District basis) of ‘...the nature and extent of archaeological investigations carried out in England ... within the ... context of development control...’. As such, this is a most welcome contribution and is likely to serve as a basis for any future academic syntheses as well as for more trivial, perhaps day-to-day, consultations. However the depth of coverage in these volumes for each investigation is far from constant (eg some reports were inaccessible, others have very comprehensive summaries and note all contributing specialists) and, as with BIAB itself, the authors recommend consultation of the original reports by future users.

I was amazed at the amount of work that has been undertaken in the period covered and cheered by the fact that a lot of this is reasonably accessible to anyone prepared to travel to (usually) the relevant County’s SMR. I’m told that there is a fair bit of duplication in these volumes (sometimes, for example, one site appears under more than one site names) and I know, from my own contributions to AP assessments, that a fair bit of work has remained invisible to the editors and their research team.

It amused me that this brick-load of books arrived within a few days of the CBA’s circulation of a detailed questionnaire about electronic and digital publishing. Here surely was the ultimate demonstration of the appropriateness of either CD-ROMs or the Web as media for the publication of this kind of information.

[All reviews/comments in this issue by Rog Palmer]
Pssst .... Wanna see an AP of Baghdad....

.... dating from 1918? If so, go to the Public Record Office and ask to see the file AIR 10 1001. This 97-page book is called *The Interpretation of Aerial Photographs in Mesopotamia*, and was published in Baghdad in 1918. The example photographs were taken in the First World War, during warfare with the Turks. Most of the prints are verticals and a number show archaeological remains, which are recognised in the interpreter's comments. The quality of the printing is excellent and the photographs are well worth a look.

If you are not already registered as a reader at the Public Record Office in Kew, you will need to take an ID, such as a passport, to get a reader's ticket. To check opening times, telephone the PRO on 0181 392 5200. While you are in the PRO, look at the file AIR 10 200, which is an interesting Royal Flying Corps manual about interpretation of aerial photographs of trench warfare. Published on the 2nd January 1917, the illustrations are taken on the Western front and clearly reproduced.

Anthony Crawshaw

Leszno 1998: training week weather...
‘Obliques or Vertical?’ AARG working party: second note

The full working party met once in Cambridge between electronic communications.

Pete Horne compiled a selection of 10 possible 5 km x 5 km target blocks chosen on the criteria of NMP mapped area, varied geology, known potential for cropmarks (but generally not already intensively photographed), not within ATZ, and not containing extensive woodland/urban areas. However, the abysmal crop mark development in England this summer led to cancellation of the flying programme. These blocks remain valid for summer 1999 as does CUCAP’s offer of vertical photography.

Anthony Crawshaw, Pete Horne, Rog Palmer, David Wilson

For sale...

WALES FROM THE AIR
Patterns of Past and Present

Chris Musson 1995

.. now available from RCAHMW for the reduced price of £9.99 (+ £2.10 p&p)

160 pages, c125 plates, many in colour; numerous diagrams.

This interesting, profusely illustrated and well written book should be on everyone’s shelves, whether resident in Wales or not! The introductory section, ‘Air Photography and aerial archaeology’, runs to 16 pages and covers topics such as how air photography works, national and regional air photography, interpretation and mapping and the impact of aerial photography on site discovery in post-war years. The bulk of the book is an aerial tour of the archaeology and history of Wales arranged by region and includes examples of sites and landscapes of all types and periods. Buy it now!

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a) price £9.99 plus £2.10 p&p. Cheques payable to ‘RCAHMW’.

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Copies will be available at the 1998 AARG conference in York.
List of contributors

Paul Barford
Panstwowa Sluzba Ochrony Zabytkow
ul. Ksawerow 13
02-656 Warszawa
Poland

Bob Bewley
Aerial Survey
RCHME – NMRC
Kemble Drive
Swindon SN2 2GZ
email: survserv@rchme.gov.uk

Anthony Crawshaw
15 King’s Staith
York YO1 1SN
email: acrawshaw@yorkarch.demon.co.uk

Patrick Darling
African Legacy
46a Ophir Road
Bournemouth
Dorset BH8 8LT
email: 113270.3314@compuserve.com

Toby Driver
RCAHMW
Crown Building
Plas Crug
Aberystwyth
Ceredigion SY23 1NJ
email: Toby.driver@rcahmw.org.uk

Martin Fowler
60 Harrow Down
Badger Farm
Winchester
Hampshire SO22 4LZ
email: mjff@compuserve.com

Professor D. L. Kennedy
Classics and Ancient History
University of Western Australia
Nedlands
Perth
WA 6097
Australia.
email: dkennedy@cyllene.uwa.edu.au

Sam Redfern
I T Centre
National University of Ireland
Galway
Ireland
email: sam@it.ucg.ie

Cathy Stoertz
Aerial Survey
RCHME – NMRC
Kemble Drive
Swindon SN2 2GZ
email: survserv@rchme.gov.uk

David Wilson
CUCAP
Mond Building
Free School Lane
Cambridge CB2 3RF
email: drw1000@hermes.cam.ac.uk
Leszno 1998

‘What? Another eight-hour flight with Otto...’