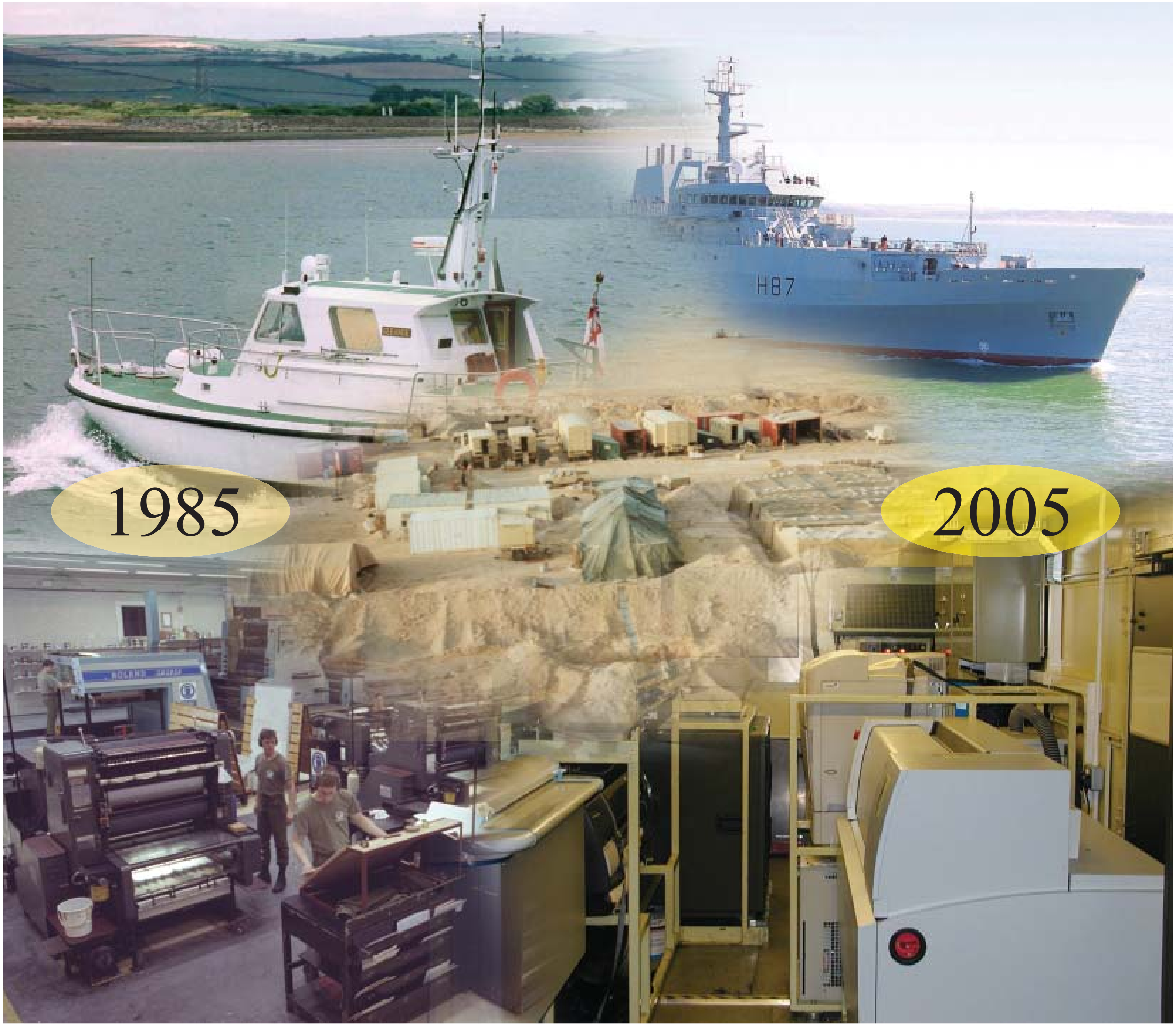
THE RANGER

2006

Journal of the Defence Surveyors' Association
Winter 2005

Volume 2 Number 12



Defence Surveyors' Association

Registered Charity No. 221816

Sponsored by BAE SYSTEMS

Contents - Winter 2005

Designed and typeset by David Johnson.

Printed by 1 Aeronautical Information Documents Unit RAF.

This edition of Ranger...

….we record the astounding changes in the technology and the hydrographic and geographic organisations that have taken place over the last 20 years – 20 of the most tumultuous years in history as almost nothing – political, commercial or technical is as it was in 1985.

In the past much of our business, defence geomatics, has gone relatively unrecorded or at best given scant attention in official histories therefore future generations will have little or no means of knowing what we did or why and how we did it. Ranger is now recognised as an authoritative publication to the extent that copies are lodged for posterity with the national Legal Deposit Libraries and hence, the information recorded will be available to those in the far future who might be interested in the military surveying, mapping and charting of our time and earlier. With the exception of occasional articles published in the Hydrographic and Cartographic Journals, this leaves Ranger as the best source for recording current and past defence geomatics matters. With that thought in mind, this special issue aims to record the amazing changes that the last 20 years have witnessed.

The idea for a special issue examining these years came when I was given a copy of the exhibition catalogue for the 1985 Survey and Mapping Exhibition held at Reading University. A quick skim through its pages instantly highlighted the stupendous changes that have occurred over a period that is the average soldier or sailor's military career. Almost none of the companies advertising are still in business, two three-letter abbreviations – GPS and GIS - virtually unknown in 1985, now govern almost all aspects of the geomatics business and on the military front talk is now of Shaibah and Basra instead of the Minden Gap and the Einbeck Bowl. I travelled extensively in the former East Germany in the mid-70s and there was a depressing feel of 'permanence' about the entire regime that appeared, like the Berlin Wall, to be "cast in concrete". Even the most optimistic crystal ball gazer in 1985 would not have foreseen that the Berlin Wall, and with it the entire Communist Empire, would fall in only four years time. Today many Army Survey Course students come from former Soviet territory and erstwhile Warsaw Pact members are now partners in NATO - quite amazing!

To balance the issue, the final article is a crystal ball gaze into the future by Brigadier Nick Rigby.

Enjoy looking back and muse on the future.

Alan Gordon

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DEFENCE SURVEYORS' ASSOCIATION

Formerly the Field Survey Association

The Defence Surveyors' Association (DSA) publishes the Ranger journal on a periodic basis and organises various technical visits and social events for its members. These meetings provide an ideal opportunity to meet a wide range of people, all of whom have a connection with some aspect of the geomatics profession.

Membership is open to personnel who are engaged, or have been engaged, in Defence related geomatic disciplines at a management level. In addition, a candidate for membership must also be known personally to at least two Members, who, as sponsors, must satisfy the Council that he or she is suitable for membership. The cost of membership is a modest £15 per year payable by standing order on the 1st January. New members joining while still serving get free membership for the remainder of the year in which they join.

Anyone wishing to apply for membership should contact the Association at its registered address or e-mail the Membership Secretary at membership@defencesurveyorsassociation.org

DSA's NEW WEBSITE

The Association will be launching its new website in January 2006. This new site has been designed and built by David Johnson, the graphics expert who also designs and typesets Ranger. The intention is that the site will be updated on a monthly basis so that there will always be something new to attract browsers. Please note the new domain name of www.defencesurveyors.org.uk which is also reflected in the email addresses of the officers of the Association.

AGM and Visit to Chicksands

By David Wallis

There was a record attendance for the AGM which was held on the 25th June at the Defence Intelligence and Security Centre, Chicksands. The event was arranged by our new member Wing Commander Mike Mockford, also the Hon. Secretary of the Medmenham Club who we must sincerely thank for a most interesting and informative visit as well as a first class buffet lunch.

After the formal business the President, Major General Pat Fagan presented the Association's annual prizes to WO2 (SMIG) S.L.J. Oliver RA and WO2 (QMSI) J. White RE. The recipient of the Royal Navy Prize, Lieutenant Commander Derek Rae RN, was unable to attend as he is serving at sea as skipper of *HMS Gleaner*.

After lunch members were able to visit the 12th Century Priory and the two exhibitions, one of which, the Medmenham Collection, is devoted to photographic intelligence and the second covering the history of military intelligence from the time of Queen Elizabeth the First up to today.

Bereavements
It is with regret that the Association announces the deaths of AJ Herbert CBE, SM Kimber and SF Smith TD.

Colonel Wilfred (Freddie) Hore TD, DL, MA, BSc, FRGS

By Ken Joels

At the 2005 Annual General Meeting of the Association our Chairman, Colonel John Croft, presented a bottle of vintage champagne to Freddie Hore to celebrate his 9Oth birthday and show appreciation for his long service to the Association. In making the presentation, John Croft remarked upon the regular support given by Freddie both at the Council meetings and in attendance at events over many years.

Freddie Hore, having been a member since the days of the Field Survey Association, has been and still is, a stalwart supporter of the DSA contributing significantly through the changes of name and direction of the Association. He has served on Council from the 1960s, progressing to Chairman and then continued serve on Council after his period in office. Throughout his time on Council Freddie was able to use his considerable experience in education and military survey towards the development of the association in line with the evolution of survey and mapping in both the civilian and military fields.

Freddie's career has run very much in parallel with the activities and development of the FSA/DSA.

His early education was at Torquay Grammar School followed by 3 Years at University College of the South West at Exeter. From 1937-40 Freddie read Geography at Selwyn College Cambridge through an Open Exhibition and acquired his Post Graduate Certificate in Education. He was also a member of the Cambridge University OTC and was commissioned in November 1940. He then joined the forces and served with the 14 Corps Field Survey Company before postings to 1 and later, 4 Air Survey Liaison Sections RE, both of which he commanded. In the former unit he was closely involved with the preparations for D-Day, events described in the summer 2004 issue of Ranger.

Post war he took up his career in education and progressed from being a teacher at Plympton Grammar School to Senior Geography Master at Portsmouth Grammar School. En route he became involved with the CCF and progressed to Military Survey as OC of 338 Cartographic Squadron RE (TA) followed by appointment as CO of 135 Survey Engineer Regiment RE (TA) (1951-56)

At this time he was appointed Headmaster of BEC (Grammar) School Tooting (1956-66) and latterly was appointed as Head of The Royal Grammar School Guildford (1966-75). At various intervals during this part of his career he acquired a Territorial Decoration, a Deputy Lieutenancy of the County of Surrey and Honorary Colonel appointments with 5th Cadet Battalion Surrey ACF, 135 Field Survey Squadron RE and The Royal Grammar School Guildford CCF. He was also promoted to the honorary rank of Colonel.

Each part of his career has in some way benefited our association but there has been one trait in Freddie's character that I suppose may be attributed to his professional life and that has been his invaluable skill and tenacity in negotiation. Whether it may be against manpower cuts or persuading senior staff the benefits for exercising in interesting locations, his powers of persuasion have rarely been rebuffed.

Follow The Sapper

An Illustrated History of the Corps of Royal Engineers

The Institution of Royal Engineers has just published a superb "coffee table" book telling the story of the Corps from its early origins through to today. Written by Gerald Napier, former Director of the Royal Engineers' Museum and author of Sapper VCs, it is lavishly illustrated and includes many of the Corps' paintings and photographs of items from messes, the museum and library including one showing the Military Survey 250th Anniversary Silver Centrepiece that was presented to Military Survey jointly by the DSA and the Corps. The text tells the story in a simple, clear and very readable fashion, this is the book for those who would probably not consider reading the official Corps History but who, nevertheless, have an interest in the Sappers.

Survey and 'Geo' get a very fair representation appearing both in the chronological chapters, as fits the story, as well as having two dedicated chapters. Among the many maps included is the one drawn by Ranger designer, David Johnson, to commemorate the end of the Gulf War. This book should be on every Ranger reader's Christmas list. Details for purchasing it are included in the advert elsewhere in this issue.

Defence Surveyors' Association Prizes 2004

The DSA awards a prize each year to a serving member of the Royal Navy, the Royal Artillery and the Military Geographic community who has made a significant contribution in their particular field of defence geomatics. Royal Artillery winner WO2 (SMIG) Simon Oliver RA and the Military Geographic winner WO2 (QMSI) John White RE were both able to be present at the DSA AGM to receive their awards personally from the President, Major General Pat Fagan. Unfortunately the Royal Navy winner, Lieutenant Commander Derek Rae, was unable to attend the presentation as he was at sea in command of *HMS Gleaner*.

ROYAL NAVY PRIZE

Lieutenant Commander D G Rae RN

A highly experienced and capable surveyor, Lieutenant Commander Derek Rae has been instrumental in the commissioning of the new surveying systems fitted to the Royal Navy's latest surveying vessels *HMS Enterprise* and *HMS Echo*. With previous experience of multibeam echo sounder operations gained whilst on exchange with the New Zealand Navy, he was able to introduce and update the operating practises for the new systems as the ships prepared to enter service.

Bringing a new ship into service is always a challenge. As the Operations officer of *HMS Enterprise* he had the particular responsibility for getting to grips with several new surveying systems on an untested platform. Using his own resourcefulness and deep specialist knowledge, he successfully developed and integrated new methods for data gathering, processing and quality control. At the same time he was careful to ensure that the people onboard received the guidance and training they needed to cope with the new systems and ways of working. In the wider context of Fleet Operations he has continued to develop tactical procedures for the conduct of Rapid Environmental Assessment, which were successfully used during the ship's first NATO exercise in late 2004.

Throughout the year of 2004 he maintained strong links with the original equipment manufacturers, the training school and the prime support contractor so that there was a continuous programme of software and hardware updates to the systems. All these efforts have greatly assisted both new ships to develop and deliver their advanced hydrographic and oceanographic capabilities that now set them apart in a world class of their own. They are ships to be proud of and they have already made a significant impact in support of naval operations in the Gulf and Mediterranean. Derek Rae's important and lasting contribution to the commissioning of these ships and their complex systems make him a very worthy winner of the DSA annual prize for the RN.

ROYAL ARTILLERY PRIZE

Warrant Officer Class 2 (SMIG) SLJ Oliver RA

Warrant Officer Class 2 (Sergeant Major Instructor in Gunnery) Simon Oliver has been employed as an Artillery Tactical Group Instructor within Targeting Branch at the Royal School of Artillery. He was especially selected for this role in which he delivers employment training for all officers and NCOs who are appointed to Close Support Artillery Tactical Groups.

In addition to conducting his daily instruction duties in an exemplary manner he has introduced numerous training initiatives and systems that exploit the cutting edge of information technology and hugely improve operational capability. He has, on his own initiative, researched and adapted emerging technology solutions to trial new methods of providing interactive instruction with the use of a SMART Board, an interactive electronic whiteboard capable of being manipulated by both instructor and student using software applications projected onto the screen. He has identified digital Ordnance Survey mapping that could be manipulated to give third dimension representation of the ground and has advanced survey use by linking maps with photographs of Salisbury Plain Training Area Observation Posts as well as the two Artillery Indirect Fire Control simulator systems. This new technology allows the instructor to interact with students whilst linking lessons directly to artillery simulators, dry tactical exercises and live firing. The training benefits are enormous and have already led to improvements in the standard of artillery training of all ranks.

Simon Oliver has also produced a range of other Observation Post training aids the most notable being the adaptation of mobile phone technology to activate and deactivate targets for artillery tactical groups. He has also developed a number of improvements to the current range of artillery observation equipment, all of which have been submitted to industry through the Capability Branch at HQ DRA.

MILITARY GEOGRAPHIC PRIZE

WO2 (QMSI) J White RE

WO2 John White is employed as the QMSI of the Navigation Section in the Geodesy Department of the Royal School of Military Survey. His principle role is the teaching of hand-held GPS and traditional navigation techniques to All Arms courses. He also teaches the Army Survey Course, soldier foundation degree courses and a variety of ad hoc courses within the School. He won the prize due to his commitment to the art and science of navigation and his enthusiasm to deliver high quality training. With hand-held GPS, rightly or wrongly, rapidly becoming a navigation tool on which many people solely rely, instructing the correct use of these receivers, and their limitations, is of key importance in the military arena. John White implicitly understands these problems, and ensures that every course he manages and instructs is taught comprehensively, clearly and with the utmost rigour.

Throughout his tenure as QMSI Navigation he has developed his own personal knowledge of the subject and produced an outstanding set of course lessons, notes and supporting material hence, his effectiveness as head of this section has grown enormously. His work has required a significant amount of external liaison with field units in an advisory capacity, as well as promoting the section and the courses on offer. His endeavours to bring GPS Navigation to as wide an audience as possible has been a particular strength, supported by articles he has written for Army Training News and advertising literature distributed through the map supply chain.

His work has involved him in the design of new training courses for GPS Instructors and to support the geographic technician foundation degree courses, with modules in navigation and map awareness. WO2 White has also been in demand to provide support to operations; he has produced and delivered specific training packages for troops deploying to Iraq as well as more specialised courses for requirements in Northern Ireland.

His work both in and out of the classroom has received extremely praiseworthy feedback, which is fully justified; many of the soldiers on the four different courses he runs have applied because of personal recommendation from previous students. His enrolment on a teaching course at Newbury College has underlined his strong desire to teach and pass on his skills, and despite being utterly confident in the role, he remains committed to improving and ‘fine-tuning’ every course.

BCS Historical Military Mapping Group Seminar

Wednesday 24 May 2006

The Historical Military Mapping Group (HMMG) is staging a seminar in the Historic Dockyard at Portsmouth on Wednesday the 24th of May 2006. This event will build on the successful seminars held over the last few years at Greenwich and is once again supported by the DSA.

The Seminar will consist of two sessions with the main theme being covert mapping. Although the programme has not yet been finalised presentations are planned on subjects as diverse as the Soviet mapping of Great Britain, mapping of Anatolia in the 19th century, the secret survey of Sinai in 1914 and mapping East Germany for the Military Missions to the Soviet Forces.

Final details are not yet firm therefore, as this is the last issue of Ranger before the seminar, readers considering attending should register their interest with the editor who will arrange for details to be forwarded to them nearer the date.

The editor can be contacted at alangordon17@tiscali.co.uk or on 01264 359 700.

Introduction to the 1985-2005 Issue

By Alan Gordon

In 1985 the current secretary of the DSA, David Wallis, was managing director of the most successful survey equipment suppliers in the country, the Survey and General Instrument Company Ltd. As one of the chief 'movers and shakers' in the surveying and mapping sector – yet to renamed 'geomatics' - he organised the Survey and Mapping Exhibition which was held in conjunction with the UK National Land Surveying and Mapping Conference at Reading University. A copy of the exhibition catalogue recently came to light and a skim through the small A5 brochure, nothing very glossy in the pre-desktop publishing era, immediately highlighted what tremendous technical changes have occurred in such a relatively short space of time. Industry giants such as Wild and Zeiss that seemed set to dominate the business forever are names long gone, no mention of GPS or GIS and the latest IT was headlined by Hewlett Packard proclaiming loudly that its HP75 boasted 22k of user RAM. However, steel tapes were still a big enough seller to warrant a full page spread.

It is also of note that RE Military Survey's standing in both the public and commercial sectors was such that the Director General, Major General Jack Kelsey, was the conference director and wrote the catalogue foreword.

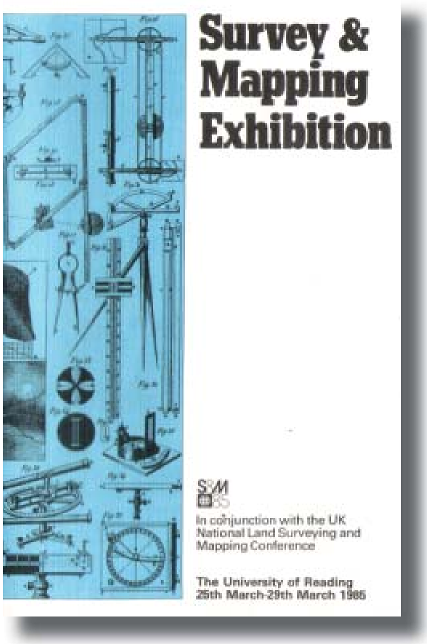
A review of the companies, services and products advertised in the exhibition catalogue provides a fine vehicle to illustrate what has happened to the commercial survey and mapping world over the last twenty years. Of the 24 advertisers only three, BKS, Intergraph and LaserScan, are still operating under their original name and carrying out business similar to that in 1985. Cartographic Engineering were part of the original Cartographical Services Group and are still going strong and Hall and Watts survive as a name but are no longer involved in survey instrument production. The rest, some giants of the day like Wild and others more minnows such as former Military Surveyor Dave Herriot's company, have long gone, swept up in mergers in the former case and out of business in the latter. In the case of Carl Zeiss Jena, not only does the company no longer exist but neither does its parent country, the German Democratic Republic.

Take-overs and mergers accounted for many companies, some long established names such as Clarksons others relative new comers like Eclipse, Ferranti and Geotronics. The giant strides in the development of technology left others like Klimsch, the large format process camera manufacturers, and measuring tape specialists Rabone Chesterman, who only the year before had celebrated 200 years in the business, high and dry.

A number of small companies based on the use of the new desktop computers blossomed for a while but for either technical or financial reasons were unable to build a sustainable business. Newbury-based Map Data Management who had sold a system to the School of Military Survey and GEMS of Cambridge who produced a remote sensed imagery display system were all leaders in their field for a short period but were unable to stay the course.

The grouping of various manufacturers into larger companies with their own sales networks, such as Leica GeoSystems and Trimble, took business from major suppliers like Survey and General Instruments who had built up a very profitable business based initially on the Kern agency.

The industry organisation of the day was the UK Land and Hydrographic Survey Association whose stand represented its 31 members of which only 10 are still in business. Today the sector has two major industry organisations, The Survey Association (TSA) and the Association of Geographic Information (AGI) whilst the nearest events to the 1985 Survey and Mapping Exhibition are the annual 'World of Geomatics' which leads on 'survey' and the AGI conference and exhibition which is the GIS showcase. At a time when 'integration' is a driving factor it appears that in some ways the business is now going in two different directions.



Front cover of the 1985 Exhibition catalogue

1985 - 2005: Twenty Tumultuous Years
An Overview

By Alan Gordon

The World in 1985

A soldier or sailor technician who completed his basic technical training twenty years ago in 1985 will now be finishing his time in the Armed Forces and having to start a second career as a civilian, a totally different life, hence twenty years is indeed a lifetime – a generation.

The world in 1985 was a very different place from the one we are in today. However, as 1985 dawned on New Years' Day it looked very much as it had twenty, or even almost forty years earlier; a world divided into two huge, armed ideological camps glaring at each other across what was known politically as the Inner German Border (IGB) but was to the public – 'The Iron Curtain'. The Cold War was now nearly 40 years old.

The Soviet invasion of Afghanistan in 1979 had signalled an end to the policy of 'détente' and brought about a significant downturn in East/West relations. This chilling of the temperature of the Cold War was then exacerbated as a result of President Reagan subtly changing the US government's aim as set by his predecessors when, instead of having "the *containment* of communism" as his goal, he stated it to be "the *defeat* of communism". In this he found a firm ally in Margaret Thatcher and so 1983 saw the USA planning their 'Star Wars' initiative and deploying a whole new range of tactical nuclear-armed intermediate range missiles, Pershing and Cruise. The Soviet Union under its elderly and ailing Stalinist leaders responded by moving its mobile SS20 missiles into East Germany thus directly threatening 1st British Corps. However, the increase in tempo was made by the USA in the knowledge that they and their western allies had the economic strength and technology lead necessary to support the move whilst a matching increase in defence spending by the Soviet Union could well result in financial meltdown.

By 1985 the cruise missiles based at RAF Greenham Common, albeit surrounded by the very vocal 'Greenham Women', were fully operational with more to be based at RAF Molesworth the following year. 13 Squadron, under Operation MOCCASIN, were busy identifying the deployment routes and launch sites for these mobile missiles. The world was indeed a very tense place in January 1985.

1985 was also a year when terrorism was not restricted to the long running 'troubles' in Northern Ireland. Small groups in Spain and throughout the Middle East resorted to kidnappings, bombings and hijackings, not only of aircraft but also the cruise ship *Achille Lauro*, to achieve political aims.

Looking at the world in general and the UK in particular, in January 1985 the view appeared to be fairly bleak and seemed destined to continue indefinitely in the same vein. Whilst major events are dotted throughout history, a milestone event is considered as a turning point that led to a change in an overall situation. As it turned out, 1985 was to become a 'milestone' year as regards the domestic political front, events in Northern Ireland and the Cold War.

The Berlin Wall – classic image of the Cold War

In March Margaret Thatcher's government won its long struggle with the unions when the year-long Miners' Strike eventually collapsed thereby allowing the government to proceed with radical political reforms which included introducing business concepts into the public sector. In November the Anglo-Irish Agreement was signed with the aim of bringing peace and stability to the Province and, in the same month, the Soviet leader Chernenko died and was replaced by the far younger and reformist Mikhail Gorbachev. Surprisingly, by the end of the year he had met, and got on with, President Reagan hence, by December 1985 the temperature was definitely rising…. such was the world twenty years ago.

Milestones to the End of the Cold War

1987 was also to become a milestone year. In January Gorbachev announced sweeping changes to the way the USSR was governed with two Russian words, *perestroika* (restructuring) and *glasnost* (openness), highlighting how it was to be done. The aim of the radical changes was to revive the stagnant economy and eliminate the corruption that riddled the political system. He was soon to discover that people given a little openness and freedom quickly demanded considerably more! East/West relations slowly improved throughout the year culminating in the signing of the Intermediate Range Nuclear Forces Treaty (INF) in December which led to the removal of all land-based nuclear missiles with a range of up to 5,500kms and set out conditions for inspections to verify that the missiles and their launchers were destroyed.

Throughout 1988 and 1989 there were ever increasing calls for liberalisation and moves towards democratisation within the communist bloc culminating in the most symbolic vision of the sudden collapse of communism, the fall of the Berlin Wall on the 9th of November 1989.

The winds of change swept quickly through Eastern Europe and soon Czechoslovakia, Hungary, Romania, East Germany and Poland were free and on October the 3rd 1990 the two Germanys were united into a single state. Throughout this turbulent period the Soviet Union itself was rocked by internal dissent particularly in the Baltic States. Boris Yeltsin replaced Gorbachev and then immediately resigned from the Communist Party. The final collapse of communism came in 1991 when the Warsaw Pact was dissolved, a communist coup in Moscow failed and finally on the 3rd of September, the USSR ceased to exist – the Cold War was over, the West had won.

Balkan Strife: Fallout from the End of Communism

The euphoria over the end of the communist threat and the subsequent vision of a peaceful world was short lived as the ethnic and religious differences held in check by the brutal regime run by Moscow erupted into a series of regional insurrections and wars. The conflicts with the greatest impact on the UK were those arising from the break-up of the Federation of Yugoslavia, events that were to give the world a new phrase, *"ethnic cleansing"*, although the divides were actually along religious lines.

Democratic elections in 1990 brought nationalists to power in each of the states of the federation with all wanting self rule except Serbia who, under Slobodan Milosevic, wanted to keep Yugoslavia together but under Serbian rule, in all, a recipe for civil war. In response, Slovenia and Croatia ceded from the union declaring themselves independent states.

The Serb dominated Yugoslav Army went into action but Slovenia successfully managed to force their withdrawal. However, the situation in Croatia descended into all out war that was halted briefly by a UN-brokered cease fire in January 1992. Fighting soon erupted again and the conflict spread to Bosnia-Herzegovina with a level of barbarity not seen since the Russian Front in the Second World War. Initiatives from the UN and the EU during 1993 and 1994 all failed with UN forces proving to be ineffective until 1995 when attitudes in the West changed and they received heavy weapons. Decisive action against the Serbs including air strikes and artillery attacks finally led the protagonists to agree peace terms in November 1995 at a conference in Dayton, Ohio. NATO Forces were then deployed to ensure maintenance of the terms.

42 Group surveyors working with the UN in the Balkans

Several years of relative peace in the Balkans followed until 1998 when Milosevic initiated what amounted to ethnic cleansing of the ethnic Albanians in the Serbian province of Kosovo. Once again all attempts to halt proceedings failed and so in March 1999 NATO launched air strikes against Serbia which continued until June when Milosevic finally accepted peace terms. NATO and Russian troops initially deployed into Kosovo to ensure all Serb forces left and security was then passed to KFOR, an international peacekeeping force.

Macedonia was spared the inter-ethnic violence that raged elsewhere in the Balkans following the break-up of Yugoslavia but it came close to civil war a decade after independence. Rebels staged an uprising in early 2001, demanding greater rights for the ethnic Albanian minority. The conflict set off a wave of refugees and the rebels made territorial gains. After months of skirmishes, EU and NATO forced a peace deal that still survives today.

After ten blood stained years the Balkans states have since maintained a relative peace.

Desert Wars

Nobody gazing into a crystal ball in 1985 would have forecast that within twenty years the UK would have been involved in two wars in Iraq and would have deployed troops to the land best remembered for Kipling's stories, Afghanistan.

In the summer of 1990 the Cold War appeared to be won and MOD was thinking of what the future might hold when unexpectedly Iraq invaded and brutally occupied Kuwait. The response from the West and allied Arab nations was to deploy a large force into Saudi Arabia to deter further expansion by Saddam Hussein. Despite UN resolutions and frantic diplomatic efforts the Iraqi forces remained in Kuwait making war inevitable. During the night of the 16/17th of January 1991 a huge and sustained series of air attacks started which continued until the 24th of February when the land assault was launched. Within only 100 hours the Iraqi forces were completely defeated and Kuwait liberated.

Despite the brilliant military campaign, Saddam Hussein remained in power and almost immediately crushed two uprisings without real intervention. He was to remain a thorn in the side of the Western powers, particularly over the issue of his 'weapons of mass destruction', to the point of provoking Anglo-American air attacks in 1996 and again in 1998.

From early 2002 the level of US pressure on Iraq over the 'weapons of mass destruction' issue increased until finally on March the 19th 2003 USA and Britain launched operations against Iraq that lasted until Baghdad fell on April the 9th. However, the post war situation quickly deteriorated in one of continual insurrection and US and British forces remain in Iraq two years later.

Twenty Years of 'The Troubles'

Whilst there were positive signs on the world front in 1987 the hopes raised by the Anglo-Irish Agreement were dashed when the IRA exploded a bomb at a Remembrance Day Parade in Enniskillen which signalled an increase in violence in the Province. The violence spread to the mainland in 1993 with bombings in Warrington and in the heart of the City of London but the following year the IRA announced

14 Squadron's desert base during the Gulf War a cease-fire and protracted negotiations continued until 1996 when a series of devastating explosions rocked London and Manchester.

The change in government in 1997 led to another IRA cease-fire and all-party talks which resulted in the Good Friday Agreement of 1998. Despite periodic outbreaks of violence this Agreement slowly brought the province to a more peaceful existence culminating in the IRA announcing in 2005 the end of its ‘armed struggle’.

A Broadened Terrorist Threat

Other than the Northern Ireland situation and the bombing of the jumbo jet over Lockerbie in 1988, the majority of terrorist activity was centred on the Middle East. All that changed on the 11th of September 2001 when Muslim extremists crashed aircraft into the twin towers of the World Trade Center and the Pentagon killing more than 3,000 people. This introduced Osama bin Laden and the Al Qaeda terrorist network to the world at large. Further attacks linked to Al Qaeda and the Muslim extremist community took place as far afield as Bali, Spain and this year in London where, for the first time, suicide bombers operated in the UK. Just as the Irish terrorist threat appeared to recede so the UK is faced with the start of another possibly long-term ‘war on terror’.

One immediate impact of the World Trade Center atrocity was to concentrate US and British attention on Afghanistan, long seen as the base for Al Qaeda. Bombing raids on training camps took place and active US support for Afghan factions opposing the ruling Taliban brought about the fall of that regime in December 2001. British troops were deployed to help secure the country and have been involved there to some extent ever since.

Domestic Political Milestones

The twenty year period has been remarkably stable in that there has only been three Prime Ministers and one change of government. The major milestones were the ousting of Margaret Thatcher in 1990 and the sweeping victory of the Tony Blair’s reformed Labour Party in 1997.

The collapse of communism and the end of the Cold War quickly prompted a political demand for a “peace dividend” as it was perceived that defence spending of the level required to counter the Warsaw Pact was no longer necessary. The result was a massive cut in the size of the Armed Forces that was carried out under the title ‘Options for Change’. This proved to be the first of a series on initiatives such as the introduction of agencies, the Defence Costs Study and the Strategic Defence Review of 1998 and its New Chapter in 2002, all aimed at improving efficiency and the cost effectiveness of the Armed Forces.

Twenty Years on: The World Today

Whilst the world of 1985 seemed a threatening place, in retrospect it was fairly stable with the major threats well understood and plans in place to counter them. 2005 sees a far more volatile world where the threat comes in the form of an individual suicide bomber bolstered by extreme faith rather than an armoured division representing a political creed. If anything, the world is now a far more dangerous place. The Armed Forces are spread more thinly and over a much wider geographical area facing an enemy that is difficult to recognise from a potential friend.

Many former enemies are now partners not only in the EU but also in NATO, the very organisation set up to counter the threat they posed.

It was not solely the political changes that have impacted so comprehensively on daily life. Tremendous technological advances, often fuelled initially by defence needs, have totally changed much of what we do and how we do it. The few who knew of GPS in 1985 would have laughed at the suggestion that in twenty years time modest family cars would include a satellite navigation system. The PC, mobile phone and the Internet that are now such common everyday items were not even a dream only twenty short years ago.

One phrase encapsulates this twenty-year period – “the only constant was change”.

The Last 20 Years
A Personal Reflection

By Captain Ian Turner OBE RN, The Hydrographer of The Navy

Introduction

As Captain HM I am at the head of a specialisation that has transformed itself almost out of recognition compared with what it was 20 years ago. The Surveying Squadron looks smaller but is far more effective and efficient than before. HM officers are salted around the Fleet in Battlestaffs providing environmental advice during planning and operations. HM teams deploy in Frigates and Destroyers to provide both aviation forecasting and surveying expertise to the Command. HM training is provided in Devonport using the very latest equipment.

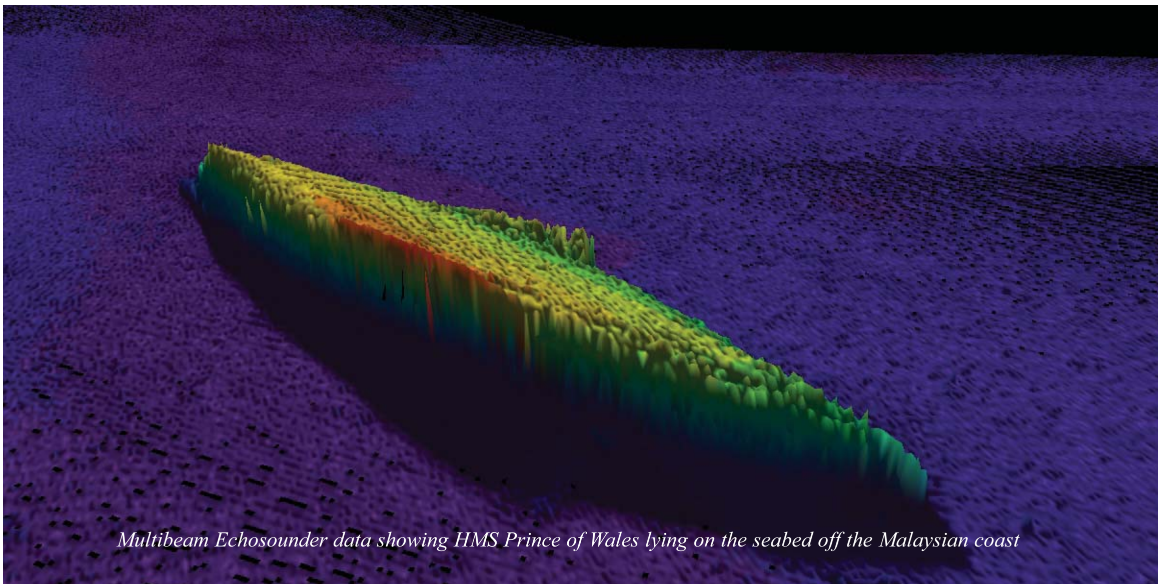
HMS Hecla in the traditional Hydrographic white and buff livery

Transformation

Ironically this transformation has partly been driven by MoD cost savings measures that have demanded we 'do more with less'. This has forced us to seek more innovative ways of manning and operating our ships and training our people. The transformation has also been made possible by changes in technology. Some of the decisions taken may not go down well with those who remember "the way things were". However, I am old enough to remember the frustration of trying to gather dubious quality data with failing equipment in an ageing surveying ship, as well as the general tendency of the 'White Navy' to run its own routines and consider itself a separate arm of the Senior Service. I'm quite happy to consign those days to history and embrace the winds of change.

Something Has Happened To Our Ships

20 years ago the backbone of the Hydrographic Surveying Squadron was four *Hecla* Class Ocean Survey Ships and four *Bulldog* Class Coastal Survey vessels. The ageing trio of *Echo* Class Inshore Survey Ships were being paid off, whilst *HMS Roebuck* and *HMS Gleaner* were just coming into commission. The *Heclas* had been built from the mid-1960s. All four saw service in the Falklands War, while *HMS Herald* also served in the Gulf War and as a temporary Antarctic Patrol Ship in 1991 and 1992. They were gradually decommissioned between 1986 and 2001, whilst *HMS Scott* was introduced into service in 1997. The *Bulldogs* were also phased out between 1992 and 2002, making way for the new *Echo* Class Hydrographic/Oceanographic ships *HMS Echo* and *HMS Enterprise* that were commissioned in 2003 and 2004. These ships are substantially different from their forerunners. Operated under a Contract Logistic Support arrangement with Vosper Thorneycroft, they are lean-manned with a watch-rotation system that allows the Navy to make the



Multibeam Echosounder data showing HMS Prince of Wales lying on the seabed off the Malaysian coast most of their high platform availability. *HMS Roebuck* was due to pay off in 2003 but following her vital shallow water surveys in support of operations during the Gulf War the ship has been given a complete overhaul and is fit for service until 2014. *Gleaner* also remains in service today and has recently been updated with new surveying systems. Over the last 20 years the hydrographic ships of the Royal Navy have more than halved in number but the current squadron of ships is fully modernised and far more capable than ever before.

Supporting the Fleet

During this period our surveying ships have become much more integrated with the Royal Navy. Since the mid '90s they have lost the traditional white and buff livery, and now sport battleship grey like the rest of the Fleet. Their programmes are prioritised to support Fleet operations around the world and they regularly exercise their contingent roles such as hosting a Mine Countermeasures Tasking Authority or carrying out Rapid Environmental Assessments to support amphibious operations.

Changing People

The Officers of the Hydrographic specialisation merged with the METOC specialisation in 1996 to form the HM Branch. This forward-looking move rationalised the way the Navy is supported by warfare specialists who understand the environment from the bottom of the ocean to the top of the atmosphere. The HM officer is initially trained in hydrography, meteorology and oceanography, and later specialises more deeply in one or other of the areas. The HM structure was also introduced for our naval ratings in 2004. The existing specialist branches for Survey Recorders and Naval Airmen (METOC) will continue right through to about 2020 by which time the new HMs will be fully established at all ranks.

Changing Techniques

Surveying techniques and technology have moved on over the last 20 years, although most of the principles remain the same. The equipment for measuring distance and angles is much more accurate and reliable. HMs are taught how to handle large quantities of digital data with an emphasis upon statistical evaluation and data management. All our ships are equipped with Multibeam echo-sounders, supported by accurate motion sensors, differential GPS, digital sidescan sonars, modern magnetometers, and Electronic Chart Display (ECDIS) systems for navigation. The surveying data is collected, processed and rendered in digital form. It has to be - the quantity of information and the complexity of the processing techniques are so great. Nonetheless, the surveyor still plays a crucial role in the planning and execution of the surveys and making sure the results meet the requirement.

The Hydrographic Squadron 2005

Current Operations

A snapshot of current operations illustrates the impact of all these changes. At the beginning of this year *HMS Scott* propelled hydrography onto the front page of newspapers around the world with her surveys off Sumatra after the Tsunami disaster. This demonstrated our ability to work with the civilian scientific community at short notice and also revealed the exceptional deep-water surveying capability onboard *Scott.* During the post-Tsunami relief efforts by *HMS Chatham* off the coast of Sri Lanka, an HM specialist provided weather forecasts for a busy flying programme and also ran rudimentary hydrographic surveys to reopen the devastated port of Batticaloa. In May of this year *HMS Enterprise* returned from 8 months in the Mediterranean where her oceanographic data-gathering equipment proved to be a step change in capability. *HMS Echo* returned to Devonport in July this year after an 18 month maiden overseas deployment. The ship had spent some 80% of that time surveying at sea, mostly in the Northern Arabian Gulf under the direct control of the UK Maritime Component Commander in Bahrain and operated as far abroad as Singapore. The success of this lengthy deployment has caused the rest of the Navy to take note.

Personal Reflections

On a personal note, I had just completed my Hydrographic Long Course in 1985. I recall struggling with ancient theodolites and tellurometers, spherical trigonometry and least squares adjustment. Calculations were completed using the latest Hewlett Packard calculator, loaded with programs stored on magnetic cards, but checked by hand using logarithms (these new machines were not to be trusted, and you had to be able to have a fall back method in case the batteries failed!). From Long Course I took Command of *Gleaner* as a Lieutenant and spent most of a very happy year surveying on the west Coast of Scotland. Trisponders were deployed to lighthouses, church spires and any prominent points that provided the line of sight needed to position the launch. Remote stations powered by batteries were a particular problem to sustain. Often only two Trisponder signals could be received and there was no redundancy in the fix. A foul smelling echo sounder provided depths on paper trace that was manually reduced for tide before soundings were read out for inking in on the working sounding sheet.

Gleaner, shown in 2005, was Captain Ian Turner's first command

Production of the Fair Sheets was very time consuming and involved a laborious checking system to ensure they had been correctly compiled from working tracings. A temperamental sidescan sonar provided seabed texture data and it was more of an art than a science to interpret the fuzzy paper traces and manually construct a texture and contact plot. The report of survey was but a few pages long. Oh what halcyon days! However the days were also frustrating at times and highly inefficient compared to what can be achieved with GPS and Multibeam sonars today. Recently I was being shown a sample of dense sounding work onboard *HMS Echo* which contained over a million individual soundings in an area on the seabed the size of just a few football pitches; all were positioned with centimetric accuracy and they provided a fantastic image of the seafloor. That sort of comprehensive data set would have been a dream 20 years ago, which leaves me wondering where the next 20 years can possibly take us.

The Evolution of Technology for Multibeam Echo Sounding
A Story of Dramatic Technological Progress

By Dr. Freddy Pøhner, Kongsberg Maritime AS Norway

During the last twenty years the Multibeam Echo Sounder (MBE) has gradually taken over the role as the preferred instrument for mapping of the seabed from the single beam echo sounder. The MBE has revolutionised our capability to produce detailed and accurate maps of the seafloor and has contributed significantly to important sectors of the modern society. Examples of such sectors are charting for the safety of navigation, offshore oil and gas exploitation and marine geology. During the same period, the MBE performance has improved concerning efficiency, accuracy and resolution while the system cost has dropped.

A limited number of companies specialising in acoustic technology have been, and still are, competing to be the leading supplier of MBE's. The author of this article has been the leader of the Simrad and more recently Kongsberg Maritime's activity in this field, and the story as presented here is without doubt to some degree biased and would be different if written by one of the competitors.

Echo Sounding

An echo sounder is an acoustic survey instrument for underwater use that emits a pulse of sound, analyses the backscattered energy from the sea bottom and outputs a numerical result. Echo sounders are used for measuring the depth of the sea but can also be used for fisheries or fisheries research purposes. A multibeam echo sounder is an echo sounder that makes use of several acoustic beams organised as a cross-track fan so that several depth soundings are produced to cover a swath. As the survey vessel sails forward, it maps an area on the bottom – as opposed to the sounding profile which is the result when using a single beam echo sounder.

Pioneering Activities

The **SAS** system was the first true multibeam system that we know about. It was developed by a specialist group within the US Navy and supplied the first full ocean depth system for the US Navy.

General Instruments Corp (later Seabeam Instruments) located in the USA was the first commercial company to put a MBE on the market in the 1960's. Its Seabeam Classic was a deep water instrument using 12 kHz frequency, employing 17 acoustic beams covering a swath of 45º or 0.8 times the depth of water. The system price was high and export of the system was limited by US export regulation laws, so mainly this system was sold to US research institutes plus a few selected institutes in Europe and Japan.

1980-1990

Atlas Elektronik in Germany in 1986 launched its Hydrosweep 15kHz MBE, which offered a much wider swath width of 90º corresponding to a swath coverage of twice the depth of water. The wider swath means that refraction of acoustic beams caused by variations of the speed of sound over the water column becomes a factor to take into account. The Atlas system offered a solution to this by interswitching of the transmit and receive arrays for some pings, to obtain a depth profile also in front of the ship. By sailing over the area, beam refraction as function of angle could be analysed and corrections applied.

Simrad in Norway decided to build a MBE suited for the North Sea environment, where the water depth is less and a higher acoustic frequency can be used. The first attempt was at a frequency of 300kHz, which turned out to be too high, so the system had to be redesigned for a lower frequency. The EM 100 MBE at 95kHz was launched in 1986, offering a 90º swath and 32 beams. The EM 100 transducer measured a modest 80 centimetres and could be mounted on a retractable hull unit with mechanical stabilisation of the beams for the ship's pitch movements. The whole system was much smaller and of less cost than the deep water systems which were on the market up until then. EM 100 also introduced roll stabilisation of the beams, as well as the combination of ***amplitude and phase processing*** to produce accurate soundings even for oblique beams. The higher sounding accuracy obtained by EM 100 meant that the beam switching principle employed by Atlas was not sufficiently accurate and was replaced by compensation based upon separate measurements of the sound velocity profile. EM 100 was taken into use by survey companies working for the oil exploration industry (Geoconsult 1986) and by national hydrographic institutions (Norway 1987, Canada and USA 1988/89, Rijkswaterstaat 1988).

In the late 1980's Atlas Electronik GmbH developed the first of the shallow water multibeams, the Fansweep.

1990-2000

A significant next step was the construction and delivery of **Simrad's** first deep water MBE EM 12D for Ifremer's research vessel *l'Atalante* in 1990. The system was a radical design, allowing for a swath width of up to 150º or 7.5 times the water depth. With this system it became possible to survey a swath of more than 15km at 12knots speed and good accuracy, thus making it possible to map large sections of underwater terrain rapidly. EM 12 introduced also simultaneous ***acoustic imaging*** of the seafloor, so that co-registered datasets of topology and high resolution backscatter of the seabed could be obtained. The imaging was done beam by beam in order to improve the signal to noise (S/N) ratio, a principle that was later adopted by the Danish company, **Reson** which named it "Snippets". Another technological advance of EM 12 was the ***FRDT*** (fast rotational direction transmission) principle, by which the transmission pulse was composed of several simultaneous frequencies within the bandwidth of the transducer arrays and transmitted in different sectors making up the complete swath. The benefit was a higher transmitting source level and thus improved S/N ratio and a wider effective swath width.

In 1991 the EM 1000 was launched by **Simrad** to replace EM 100 in the 100kHz class of systems, extending the swath width from 90º to 150º and offering new functionality such as seabed imaging for marine geology applications.

Based upon input from users, Simrad improved their beamforming concept in 1992 by the ***equidistant beam forming***, a way to steer the receive beam directions so that the sounding pattern on a flat seafloor has the same density over the whole swath. Both EM 1000 and EM 12 became favoured instruments in their separate application sectors during most of the 1990's.

In 1993 **Simrad** was awarded the contract for a series of 1º x 1º MBE systems for the Naval Oceanographic Office in the USA. This design, EM 121A is still in service for the T-AGS 60 class of survey ships.

Reson located in Denmark and USA, launched its Seabat 9001 system in 1993. This was a small water- and pressure- proof MBE suited for deployment on ROV's and small boats, using a 455kHz frequency. It had simple signal processing, no beam stabilisation and a simple bottom detector only giving acceptable data only within a 90º sector. Nonetheless it was a significant contribution to the development of MBE technology, and it found widespread use. The 9101 was followed by the 8101 system in 1996, a 240 kHz system employing a curved transducer array and a better bottom detector using amplitude/phase processing.

Simrad took up the challenge on compact, high frequency MBE's by launching its EM 3000 system in 1995/96. EM 3000 had a compact sonar head such as the Seabat 9001 and offered better sounding accuracy and thus a wider effective swath by using the combined amplitude/phase bottom detection principle.

Simrad was acquired by the Kongsberg Group in 1996, and the name was changed to Kongsberg Simrad and later Kongsberg Maritime.

Kongsberg Simrad launched a 30 kHz MBE for medium water depths to 5-6000m, EM 300, in 1996. This system was the first to implement ***yaw stabilisation*** of the beams, based upon a more advanced utilisation of the FRDT principle. EM 300 was also the first system that automatically could adapt its operation to fit the water depth, adjusting transmit pulse length, receive filter bandwidth, and adjusting the beam angles to fit within the achievable swath. This system was also the first to offer a choice of different array sizes and beamwidths to suit the requirements and the budget of the user, models ranging from 1º x 1º to 2º x 4º. EM 300 is much used for marine geology investigations world wide.

2000-2005

Kongsberg Simrad had its EM 120 system ready for the market in 2000. EM 120 was the system to take over for EM 12 for deep water mapping, and implemented the same modularity and functionality as EM 300. With a single array system it maps a swath of 140º or up to 25 km. The timing coincided with a peak in the demand for deep water mapping systems and became immediately a commercial success.

The same year **Reson** introduced its 8125 MBE, based upon a contract for development of a high resolution sonar for mine detection. 8125 introduced near field focussing of receive beams, transmit beam of 1º and 240 receive beams each with a beamwidth of 0.5º. The 8125 has since been the leading instrument for detailed, short range inspection and mapping work, only challenged recently by EM 3002 by **Kongsberg Maritime**, launched in 2004. A major advance in signal processing was introduced by the ***high density processing*** of EM 3002. With this processing several soundings are generated from each acoustic beam. The high density processing solves the problem of acoustic footprints becoming quite large even for narrow beams in the outer parts of a wide swath, by using phase processing inside the beams to define the acoustic footprint for each sounding. In this way the resolution is limited only by the available bandwidth and the S/N ratio, and EM 3002 is thus capable of achieving a resolution corresponding to 0.1º - 0.2º in the outer parts of its swath.

The Situation Today

Kongsberg Maritime has just launched the EM 710, a broadband MBE in the 70-100kHz range, While MBE with simultaneous seabed imaging was introduced as early as 1990, the newest models from **Kongsberg Maritime** also offer simultaneous water column imaging to be able to perform combined mapping of both seafloor and biomass. **Kongsberg Maritime** has also broadened its product range for seabed mapping by developing and producing the HUGIN family of Autonomous Underwater Vehicles (AUV's). The HUGIN 1000 and 3000 systems are stable instrument platforms which can bring custom built multibeam echo sounders and other instruments closer to the seabed and produce survey results that have a much higher quality than was previously possible from a surface vessel.

The MBE evolution has led to the development of much improved motion sensors, and software, several good solutions are now available for processing and visualisation of MBE data, tailored for different applications. The GPS positioning technology has improved during the same period, and we now see the first applications of kinematic GPS replacing or supplementing traditional monitoring of tide level variations. The pricing for the users has been reduced to a much lower level than during the early years making the MBE technology for seabed mapping affordable and available to a much wider user group.

Useful IT Definitions: The "Bong"

A "bong" is defined as a group of pings sent sequentially to gather statistical information such as latency and packet loss. A bong typically consists of one pilot ping and five data pings. I wish I'd thought of it!

Swings and Roundabouts

Military Survey - Some Organisational Aspects

By Roy Wood

This article is based on personal memory of events up to 1993. If readers wish to pick up the inevitable errors and omissions or to bring the story up to date then the editor may be willing to provide space in a future issue. (Major General Roy Wood was DAD Svy1A in 1975-7, OC 14 Squadron 1977-79, Commander 42 Survey Engineer Group 1985-87 and Director General Military Survey 1990-93.)

George Orwell, "1984" and All That

By 1984, George Orwell led us to believe that our lives would have changed out of all recognition, controlled through "Newspeak" by Big Brother who would watch our every move. Alan Gordon's research into the state of survey and mapping in 1985 indicates that methods and ideas in our field by then were not significantly different from the time Orwell was writing his novel in 1949. Enormous changes in technology have of course taken place since 1985 and these are documented elsewhere in this issue. But what was happening to the organisation of Military Survey?

Director General Ordnance Survey Civilianised

The first great change was the decision to civilianise the Director General of the Ordnance Survey. Until the early 1970s this was the senior post in Military Survey and with two out of the then three Brigadiers also serving there, it was inevitable that the OS took the prime place in career aspirations and the focus of Military Survey as a whole. The move of the Major General post to Feltham as Director of Military Survey (Director General from 1988) was the start of a change in emphasis that proved vital in later years. However it was not until 1983 that the last of the military officers left the OS and, through some far sighted and wily staff work, all the posts were transferred to Military Survey at Feltham.

These new military posts, together with some senior civilians from the Joint Survey Service and the Science Group, enabled the formation of the Systems and Techniques Unit (STU) which was crucial in the development and application of new technology and the Production Planning and Control Unit (PPCU) which brought the planning and management functions out of the Mapping and Charting Establishment and established them at a proper corporate level.

Estate Machinations and Defence Cuts

The uniformed part of Military Survey was also feeling the winds of change but in this case they were blowing in a rather random way from other parts of the MOD. A decision in 1975 to close some RAF stations in UK gave the Estates staff the opportunity to relocate a number of Army units still in hutted camps. 42 Survey Engineer Regiment at Barton Stacey was in that category and so was

"Just Temporary"

In the summer of 1963 the editor of Ranger and half a dozen other newly qualified Surveyors Topographical clambered out of an SMS green minibus (seats along each side so that you travelled sideways – guaranteed travel sickness) outside Block 100 in A Camp Barton Stacey to join the advanced party of 42 Survey Engineer Regiment who were setting up the camp after moving from Cyprus. They were welcomed by Tony Crighton, the SSM of 47 Cartographic Squadron, with the clear, crisp words "Don't make yourselves comfortable – we are only here temporarily before moving to a better camp"

January 1986 saw the editor once more at Barton Stacey but this time as Officer Commanding 13 Map Reproduction Squadron (Rear) and tasked with the job of overseeing the final clearing out of the dilapidated huts before they were handed over to the demolition contractors. 23 years – that really was temporary!

RHQ 42 Survey Engineer Regiment at Barton Stacey. (Photo: Nick Collins)

on the list. After some "big hands, small maps" staff work in MOD with no reference to Military Survey, 42 was allocated to RAF Hullavington between Swindon and Bristol. It then turned out that the RAF were expecting to retain a large parachute packing unit on the base and that they and the RN stores unit which occupied some other hangers, wanted an Army unit to provide their administration. Sense prevailed in the end and RAF Thorney Island near Portsmouth was the next suggestion. However, it seems that MOD turned its focus to other matters and 42 remained in its huts for a few more years until another estate rationalisation plan applied pressure from another direction.

When the School of Military Survey at Hermitage had its well deserved rebuild in 1980 the living accommodation was based on the "scales" of the time. These calculations gave the Officers' Mess a number of rooms which was far more than the practical requirement for living-in officers. This came to the notice of MOD staff looking for a new home for the Joint Services Staff College which was to move from Latimer and would need officer accommodation and classrooms. Hermitage was an obvious candidate and SMS could move somewhere else. Another battle was fought and led eventually, as part of another MOD review, to the formation of 42 Survey Engineer Group in 1985 with 42 Regiment leaving Barton Stacey to join the School at Hermitage. However, one of the very sad effects of the formation of the Group was the loss of 42's Regimental status. The staff battles were fought but cuts were being made across the Army and this was our share. However, it was very good to see that, as the MOD wheel rolled on again, good staff work at Hermitage and Feltham enabled 42 Regiment to be re-formed to meet the enormous operational challenges of recent years.

Exercises and the Introduction of Taciprint

In the 1970s and 80s, we were, of course, still locked in the Cold War. 14 Squadron in Germany was still focussed on the lumbering tractors and semi-trailers of the "Train" until about 1978 and, although the mobilisation plan called for them to move forward to support 1 (BR) Corps, no Commander wanted them around on Corps or Divisional exercises. So exercises tended to be survey only affairs culminating in the AFCENT Dominate series. Things improved significantly with the introduction of the 4-tonne Taciprint vehicles and the relegation of the "Train" to an in-barracks production role. In Germany, the Taciprints and the Map Supply Points – also on special 4-tonne vehicles - lived with 14 Squadron and joined their Divisional HQs, and sometimes Brigade HQs, for their exercises. As well as providing the "Miss .." exercise posters, the Taciprints introduced the concept of operational support to the Survey Technicians and were soon welcomed by Commanders and their staffs. There was a fairly steep learning curve on both sides with, for instance, Divisional ops staff getting their minds around terrain analysis but, more particularly, for the Survey Technicians appreciating that OS production standards are not needed for a tactical overprint and that, if it is not ready for the 'O Group' at 0200 hrs, it will be wasted effort. But the lessons were learned paving the way for the crucial operational role now played by Geographic units and staffs.

However, back in UK up to the mid 1980s, military exercises were few and far between. The Falklands War in 1982 required intense production activity but, apart from a map store on Ascension Island, no Military Survey personnel deployed. There were field survey tasks in Kenya and Norway; the air survey/carto element were producing maps for the Norwegian 1:50,000 series and other regular mapping and revision while the printers took on part of the routine print load from the Mapping and Charting Establishment. All this produced very good results and practised skills but had little military context.

Mobilisation Roles

This came into sharper focus when another round of MOD cuts essentially said that all those in uniform in the Army must have a verifiable mobilisation role. This was quickly followed by a requirement for an extra Military Police Battalion in Northern Ireland. As the total size of the Army was fixed as a political decision, a corresponding cut had to be made elsewhere. About 500 posts were needed and it seemed to the planners in MOD that Military Survey could be sacrificed with the easy alternative of buying maps from the Ordnance Survey. Good staff work saved the day again but it was clear that the emphasis had to change to ensuring a proper – and practised – mobilisation role. This mobilisation role requirement was the reason for the disbandment of 19 Topographic Squadron in 1993. The logical role for the Squadron was still to provide position and direction for the artillery surveyors who would then carry it forward to the guns. However, because the RA had introduced inertial navigation systems and could not envisage operating outside the well controlled areas of Germany, they would not provide an operational requirement for our field surveyors. Faced with having to lose one Squadron in that round of cuts, 19 had to go with just an STRE retained to keep the skills alive.

Agency

In 1982 what seemed at the time rather like Orwell's "Newspeak" hit MOD, including Feltham when Michael Heseltine, the new Secretary of State for Defence, introduced management methods from the commercial sector with the aim of increasing efficiency and economy. This developed through the "MINIS" reporting system and culminated when Margaret Thatcher launched the "Next Steps" programme of Agencies in 1990.

Inside a TACIPRINT

The Agency idea was simple. Why should those running organisations such as the Passport Office or the Vehicle Licensing Office which provide a service for a fee be run as civil service departments? Make them run on business-like lines with Chief Executives, targets, personal responsibility and published accounts. The Ordnance Survey was one of the first batch and it clearly made sense. Initially this all seemed all very interesting but definitely not something which would affect defence but suddenly MOD was required to introduce six Executive Agencies by 1 April 1991. Military Survey was found to be on the list as, just like the OS, it could of course sell its products to its customers.

This caused frantic activity with rather bewildered MOD staff who were scrambling to set some rules and a number of rather tense meetings in the Treasury. After much discussion, the Treasury eventually agreed that maps were combat supplies and that infantry COs, RAF squadron commanders etc should only have to pay for them if they also paid for their bullets, bombs, fuel and rations. Operating on a pseudo commercial basis meant financial delegations and more meetings in the Treasury and MOD secured a surprisingly generous arrangement including personnel, equipment and estate matters. As part of the process Corporate Plans and Framework Documents had to be prepared and, as a novelty at the time, but of great value, Mr John Bridgeman, MD of British Alcan Enterprises was appointed a non executive director. The Military Survey Defence

Support Agency was launched on schedule and the Director General took on the additional role of Chief Executive of the Agency. Although Agency status has now been lost, it proved, at least in the early years, to be an excellent vehicle enabling Military Survey to reduce the normal MOD bureaucracy and respond much more quickly and flexibly to the mushrooming operational demands from the Balkans onwards.

The First Gulf War

The preparation for the Agency in 1990 coincided with another major event which, although not involving a change in organisation, did set the pattern for the following years. This was the first Gulf War. Although maps and air charts were prepared in great quantities by the coalition including massive work at Feltham, it was agreed quite early on that deploying a UK Division to Kuwait would mean deploying Geographic support. 14 Squadron was given notice to move, Taciprints and Map Supply Points were earmarked for Divisional and Brigade HQs, but something rather more substantial was also needed. By great good fortune, the semi-trailers of the 14 Squadron "Train" were still in use and, although their tractors had gone long ago and they had not been on the road since the late 1970s, they formed the core of the first survey unit to deploy to war since the Aden and Borneo campaigns of the 1960s.

In addition to the terrain analysis and production capability it was soon realised that the network of control points required by the artillery inertial navigation systems was not available in the desert and that field surveyors would be essential. Fortunately the capability had been retained and Military Surveyors were with the guns into Iraq. Military Survey advisers were also established in HQs at all levels including a Chief Geographic Officer in General Schwarzkopf's coalition HQ.

The Move to the Defence Intelligence Staff

One of the effects of the Finance Management Initiative and Agency was to highlight the sources and application of funding. Military Survey had traditionally been part of the Army Department

Field surveyors using GPS for an artillery raid during the 1991 Gulf War in MOD (with DG Military Survey reporting to the Assistant Chief of the General Staff) but was responsible for geographic support above the high water mark for all three services. As more than 60% of the overall effort went towards RAF requirements, the Army finance staffs became increasingly difficult about this arrangement and, as the system seemed to have insufficient flexibility or imagination to cope, it was necessary to move to a "purple" area in the MOD Central Staff. The first choice was to move up the Operations ladder to come under the Vice Chief of the Defence Staff (VCDS). However, this did not work and the alternative of the Defence Intelligence Staff, which had very good logic in many ways, was adopted. This achieved the pressing need to find purple money for purple commitments but others will be able to judge whether it was successful in the long term.

Since that time Military Survey as we knew it has changed its name several times, JARIC has come into an expanded Agency and more recently Agency status have been withdrawn. 42 Engineer Regiment has reformed and there have also been important changes in MOD including the establishment of the Joint Environment Directorate.

However, despite, or perhaps in some instances because of, all these twists and turns in the road from Military Survey to Defence Geospatial Intelligence, the organisation is now better known and respected throughout defence than ever before. The fact that it received the highest percentage increase in manpower in the Army in the latest defence review against significant overall cuts says it all.

Geographic Engineer Group HQ at Hermitage

Career Opportunities in The Military Geographic Branch of The Royal Engineers from the 1980s onwards

By Brigadier (Retired) Peter Walker OBE

My first experience of the then 'Military Survey' was a tour with 512 Specialist Team Royal Engineers in 1975-76, which provided an exciting year tracking satellites from a variety of countries across three Continents. As a result I attended the Army Survey Course in 1978-79, with a tour in Germany with 14 Independent Topographic Squadron following. At that time the British Army was highly focused on its Cold War mission, although Military Survey was also undertaking a variety of survey and mapping tasks around the world. As a junior officer at that time it seemed we had old and unreliable equipment, much of it developed in the 1950s, and that any opportunities for work in far-flung parts of the world were steadily diminishing. Furthermore, employment as a Surveyor, whilst professionally very satisfying, left us largely outside the mainstream of the Army, often being viewed as rather strange specialists, necessary but to be kept at a distance by the Teeth Arms.

Military requirements for geographic information - mapping in its most basic but essential form – have always been accepted as a fundamental need. Hence the principal role of what was then the largely Civil Service manned Mapping and Charting Establishment at Feltham (now the Defence Geographic Centre) has never really been an issue. Whether it was the supply of standard series mapping in the past (and indeed still a vital requirement today), or the rapidly changing need for up-to-the-minute accurate and comprehensive digital geospatial databases inherent in today's routine outputs for mission planning systems, weapon platforms and command and control systems, the need for base plant and geographic library facilities to support military operations and training has been always been well understood. However, the same cannot be said for the role of our uniformed Surveyors. During the Cold War the focus on static facilities, with our principal fighting role being in North-West Europe, meant that we were constantly being pressured to find reductions and it was very difficult to generate any support for the introduction of new capabilities. As a consequence, both 42 Survey Engineer Regiment in the UK and 14 Independent Topographic Squadron in Germany lost their ability to deploy, the majority of their mobile systems being grounded or dismantled.

I have become aware since then that senior officers in Military Survey at that time well understood the need for a more integrated approach, where our specialist skills could support operational requirements in a much more direct and proactive manner and where our officers and soldiers would play a critical role in operational deployments. As a consequence, a variety of measures to modernise Military Survey, and bring it into the mainstream of the Armed Forces, were initiated. These measures have had a fundamental impact on how our officers and soldiers are now employed. We, quite rightly, are still viewed as specialists, but it is now difficult to imagine an operation occurring where our officers and soldiers are not involved, from the initial planning phase through to direct participation during deployments. And we now have the capability to participate meaningfully during all of these phases, through both much wider employment of our officers and soldiers across Defence and also extensive modernisation of our deployable capabilities. Additionally, the higher echelons of MoD are now well aware of our existence and the fundamental importance of effective geographic support. I accept that in a highly resource constrained environment this means we do not always get what we need nor are we always listened to fully, but at least we are routinely involved in the decision making process and have the opportunity to put our point of view.

Production work in the print room at Hermitage. (Photo: Nick Collins)

So what has changed since I completed my Army Survey Course in 1979? Firstly, a number of fundamental differences in the way we support Defence have occurred:

- Operations are often now conducted with reduced warning, our forces requiring a mixture of off-the-shelf readily available geographic information, coupled with rapidly tailored outputs to meet specific mission requirements. For our staff this has meant that operations are now the norm; for example, since the first Gulf War in 1991 the Geographic Engineer Group at Hermitage has continuously had personnel deployed on operations. And this can be a heavy burden; at its peak over 280 soldiers were deployed in 1996 and current support in Iraq, Afghanistan and the Balkans is routinely more than 40 personnel who change over every 4-6 months. Furthermore, the need for up-to-date geospatial information in rapidly changing situations means that it has become necessary to embed military geographic staff in formations right across the Services, from Brigades right up to Corps Headquarters. Indeed, there has been pressure for some lower level units, such as Regiments equipped with the Apache attack helicopter also to have dedicated integral geographic support. This has resulted in a large number of RE (Geo) officers and soldiers spending a fair proportion of their careers working directly for the operations and intelligence staff, something that has increased awareness across the Armed Forces of our capabilities and allowed us to gain much better experience of how the Armed Forces work during operations.

- Advances in technology, particularly in computing and remote sensing, have revolutionised how geographic support in provided. Processes that could only be considered within static locations in the 1970s are now commonplace on the battlefield. Our soldiers are expected to be able to support their commanders with high resolution, accurate and comprehensive geographic databases which can be updated as operations proceed and interrogated in three dimensions to provide detailed analysis to make best use of the terrain. Whilst we had already introduced new small format printing vehicles – TACIPRINTs – during the 1980s, the first Gulf War in 1991-92 saw a step change for us in this area. 14 Squadron had to take elements of their 1950s obsolete and grounded mobile capability to Saudi Arabia, which emphasised the need for modern mobile capabilities. As a result 14 Geographic Squadron in Germany and 13 Geographic Squadron in the UK were completely re-equipped over the period 1993-95 with mobile cartographic and printing capabilities, and for the first time, with computer based terrain analysis systems - TACISYS. This was very timely as both Squadrons deployed into the Balkans in 1996. Furthermore, elements of these new capabilities, including TACISYS and new TACIPRINTs, were provided for staff in Corps and Divisional Headquarters and lightweight portable computer systems were procured for Brigade Geographic Sergeants. Since then we have continued to take advantage of the rapidly developing computer industry to ensure our units and our staff working within formation headquarters remain well equipped, introducing technology such as the digital pre-press system within our deployable capabilities to ensure we remain one of the most technologically advanced organisations within the Army.

- In recent years there has been increased emphasis on cooperation across the Armed Forces. Operations are managed on a Joint Service basis, with the Permanent Joint Headquarters (PJHQ) providing a single point of direction. During operations the need for a Recognised Environmental Picture (REP) means that extensive cooperation is required between our personnel and those from the Hydrographic Office, the Meteorological Office and the Air Information Documentation Unit. As well as having RE (Geo) staff embedded directly within PJHQ, an MoD Directorate responsible for the Joint Environment, currently headed by a Brigadier from RE (Geo), has been established in Whitehall.

- In 1990 Military Survey became a Defence Agency, the new Agency becoming part of Defence Intelligence. This recognised the extensive value that geographic information has in supporting intelligence analysis, where the boundary between what is geographic and intelligence data can be very indistinct. Subsequently, in 2000 Military Survey and the Joint Air Reconnaissance Intelligence Centre (JARIC) combined into a single new Agency, the Defence Geographic and Imagery Intelligence Agency (DGIA). Extensive interaction by both Military Survey and JARIC with the United States imagery and mapping community was one of the factors behind the formation of DGIA. Since then, in 2005, DGIA has been renamed as Defence Geospatial Intelligence (DGI). This strong linkage with the Intelligence Community has led to RE (Geo) officers and soldiers serving both within the Defence Intelligence Staff and within the Intelligence Branches at many field headquarters.

The second change has been a difference in the way that careers for officers and soldiers within the RE (Geo) specialisation are managed and developed. With our personnel often now interfacing much more directly with the rest of the Armed Forces, there is a fundamental requirement to ensure that they have sound career development opportunities within this broader Defence environment. Following a specialisation may inhibit these opportunities however it is important that our officers and soldiers have a satisfying career which allows them to develop their potential but which also means that they are able to operate effectively in all-Arms and tri-Service environments. A number of changes have been made, and others are still in development, to enable this to occur:

- The chart shows some of the posts where our officers and soldiers are employed and gives an indication of the broad opportunities that exist for a varied career within the specialisation.

TACIPRINT and TACISYS in Kabul

HEADQUARTERS AND ORGANISATIONS WHERE ROYAL ENGINEER (GEOGRAPHIC) OFFICERS AND SOLDIERS ARE EMPLOYED	
MoD Directorate Intelligence Joint Environment	Permanent Joint Headquarters (Northwood)
MoD Directorate Strategic Plans/ISTAR	Supreme HQ Allied Powers Europe (Mons)
MoD Directorate Joint Capability	HQ Air North (Ramstein)
MoD Directorate Equipment Capability ISTAR	Regional HQ Allied Forces North (Brunnsum)
Defence Procurement Agency	Regional HQ Allied Forces South (Naples)
Air Warfare Centre	Joint HQ North (Stavanger)
Naval Aeronautical Information Centre	Allied Forces Europe Rapid Reaction Corps (Rheindahlen)
Defence Imagery & Geospatial Liaison Staff (USA)	HQ NATO Rapid Deployable Corps (Italy) (Milan)
HQ Defence Geospatial Intelligence	HQ Northern Ireland
Defence Geographic Centre	HQ 8 Infantry Brigade
Joint Air Reconnaissance Intelligence Centre	HQ 39 Infantry Brigade
HQ Geographic Engineer Group	HQ Land Command
HQ 42 Engineer Regiment (Geographic)	HQ Theatre Troops
13 Geographic Squadron	HQ 1 Armoured Division
14 Geographic Squadron	HQ 4 Armoured Brigade
16 Geographic Support Squadron	HQ 7 Armoured Brigade
135 Independent Geographic Squadron (V)	HQ 20 Armoured Brigade
Royal School of Military Survey	HQ 3 Division
33 (Ordnance Explosive Disposal) Regiment	HQ 1 Mechanised Brigade
22 Special Air Service Regiment	HQ 12 Mechanised Brigade
Special Boat Squadron	HQ 16 Air Assault Brigade
Special Reconnaissance Regiment	HQ UK Support Command (Germany)
Mapping & Charting Establishment (Ottawa)	HQ 101 Logistic Brigade
Reconnaissance Intelligence & Geographic Centre	HQ 3 Commando Brigade
Land Warfare Centre	HQ British Forces Falklands Islands
Central Training Group Battle Group Training Unit	HQ British Forces Cyprus
Ops Support & Command Development Group	HQ Engineer-in-Chief (Army)
HQ United Nations Forces in Cyprus (UNFICYP)	HQ Signal Officer-in-Chief
	HQ 1 Military Intelligence Brigade

The very extensive range of appointments, ranging from central MoD posts dealing with equipment development and intelligence matters, through a wide range of formation headquarters positions, to direct support of Special Forces, means that there are good opportunities for career development. That said, we are not always successful in all of our ventures, but our officers and soldiers can compete in a much larger pool. For example, in recent years, a Lieutenant Colonel has headed a Branch on the Engineer-in-Chief (Army)'s staff, two RE (Geo) officers have commanded Training Regiments, a number of officers have commanded Squadrons in the mainstream of the Royal

Engineers, and two RE (Geo) WO1s have completed RSM tours in University Officer Training Corps. Furthermore, the Royal Engineer Regimental Colonel appointment is currently being filled by a RE (Geo) officer. Late Entry officers are also employed widely in staff and technical posts, as well as in the more traditional Quartermaster's roles, with three RE (Geo) Late Entry officers now being Lieutenant Colonels.

- For officers, completion of the Army Survey Course (ASC) to a standard acceptable to Cranfield University results in the award of a Masters Degree in Defence Geographic Information. As well as Direct Entry officers attending this course, as has been the norm for many years, a Late Entry Captain has just successfully achieved his Masters qualification on the ASC. Some officers also have additional opportunities to develop their expertise on further Masters courses in specialist areas such as remote sensing, geodesy and data management, where extra qualifications are needed to meet Defence requirements. A number of RE (Geo) officers have also attended the Army and Royal Navy Staff Courses (now the Joint Service Command and Staff Course), providing them with the opportunity to extend their experience both during these courses and when selected for appointments outside the RE (Geo) specialisation after completion of these courses.

- For soldiers, successful completion of their Class 1 Geographic Technician courses results in the award of a Foundation Degree in Applied Computing (Defence Geographic Information) from Sheffield Hallam University. Currently, as for the officers, some soldiers also go on to complete Honours and Masters Degrees where these qualifications are required for their employment. It is also planned to develop a scheme that will provide opportunities for all RE (Geo) soldiers to progress to an Honours Degree by the time they reach Warrant rank.

In conclusion, the employment and professional development opportunities for RE (Geo) officers and soldiers have expanded significantly over the last 20-25 years. Following a specialisation will always inhibit career developments to some extent, especially in such a small employment group. Some will draw attention to the loss of senior tied appointments within the specialisation; however, most of these losses relate to the draw-down of the Armed Forces following the end of the Cold War which had a major impact on careers right across the Services. However, we now interface much more directly with the mainstream of the Armed Forces, particularly with the operations and intelligence staff. As a consequence, both our officers and soldiers can gain a much better awareness of Joint Service and all-Arms activities, particularly in the environmental area, enhancing their value to the specialisation and to Defence as a whole, but also giving them better opportunities for self-development.

Geographic technicians in Basra

Twenty Years of Commercial Production

By Trevor Burton and Lorna Greer, BKS Surveys Ltd

The technical solutions and achievements of a company such as BKS Surveys Ltd. have evolved and changed considerably over the past 20 years through a combination of global market forces, technological advancements and corporate objectives. In 1983, BKS were awarded the Queens Award for Export and at that time export sales accounted for over 80% of all revenues but by 2004 export sales accounted for less than 40% of turnover. However, this certainly does not represent a failure on the company's behalf. In fact, whilst the mid 1980's saw the demise or sale of all the other major UK aerial survey organisations, BKS have not only survived, but prospered. The company has developed to provide a total solution to the acquisition of geospatial data, that includes the core business offerings of twenty years ago (photogrammetry and land surveying) and now embraces the use of GIS and the emerging technologies such as airborne laser scanning and satellite interpretation. In 2006, BKS will celebrate 50 years of business and will do so positioned as one of the most successful and well-established organisations within in the industry.

The early years of the1980's coincided with the infancy of the Thatcher Government and the massive explosion of development in the Third World. This was all good news for the surveying and mapping community. Britain was also embarking on the largest road building programme ever with new motorways, trunk roads and bypasses being built the length and breadth of the country and urban development was being conducted on an unprecedented scale. The oil rich nations of the Middle East were developing new cities and infrastructure to support their new found wealth and new mapping was in constant demand. In this period, almost 75% of BKS's business was Middle East based.

In 1985, BKS completed their largest project to date. This involved producing a full municipal database in the city of Al Ain in the United Arab Emirates. The City required a comprehensive set of information covering 4,836 square kilometres (3,300 map sheets), which necessitated production scheduling of 130,000 man hours. Services included original photography, survey control, photogrammetric compilation and underground utility survey location. BKS provided topographical, utility, cadastral, demographic and planning datasets, comprising over 30,000 topographic/utility drawings. This project illustrated not only the global aspect of business at this time, but also the increasing demand for digital map data. Up until this point every survey or map was supplied to the client as hard-copy on paper or film.

The Computer Room at BKS Surveys in 1985

Photogrammetric mapping was produced as pencil machine traces on mechanical plotting tables, land survey observations were booked by hand and coordinates transferred to drawings which were then sent to the drawing office to be fair drawn in ink before being reprographically produced as final drawings. However, now with the increased use of computers in the design environment, survey and mapping needed to also be provided as a digital product. To this end BKS embarked on the biggest re-investment programme in the company's history. In 1981, BKS laboratories in Coleraine were fully equipped with the largest fully computerised mapping system (WILDMAP) in operation anywhere in the world. The system could record survey map information direct from the aerial photographs or ground supplied data in digital form and store the data on disk or magnetic tape. This method of map production provided flexibility for data storage analysis, map reconstruction and future map revision. This also enabled cartographic editing and drawing to be undertaken in a CAD environment with automated routines for 'map finishing'. These routines included squaring, curving and snapping, that eliminated the use of set-squares, ships curves and erasers. This investment saw an immediate transition from a highly labour intensive to semi automated activity and shaped the future development of the company.

In tandem with the introduction of computerised mapping and editing tools, BKS undertook a phased upgrade of its stock of traditional analogue stereoplotters. These analogue stereoplotters, which combined high-grade optical systems with mechanically driven hardware, were replaced with the newer analytical stereoplotters that combined the same high-specification optical systems with computer driven photogrammetric technology.

In the early 1990's, Ordnance Survey (OS) decided to outsource a share of its photogrammetric production and BKS were named as one of the preferred contractors. This project was to move the company into a new era, where digital data was a standard deliverable and as computing power increased and software became more sophisticated, clients' demands for more complex, highly attributed and topologically structured data rose the thresholds of technical competence to new levels. OS responded to the Nation's requirements for up-to-date, detailed and intelligent large scale mapping by formulating a number of initiatives to upgrade the mapping scale of developing towns, revise its rural mapping, improve the positional accuracy of the large scale map base and present the data as structured digital data tiles. BKS and a number of other UK survey and mapping organisations have continued to support OS in its mapping production to this day.

In conjunction with the OS project, other National Mapping Agencies and Governments invoked extensive and ambitious programmes to establish cadastral systems, large scale mapping databases and orthophotography that has provided a regular flow of project opportunities. European Community initiatives have also added to demands for mapping, such as the Section 105 requirement for floodplain analysis and environmental legislation which calls for more detailed analysis of the impact of new development.

By the mid 1990's, the requirement to deliver hard-copy survey and mapping was restricted to preliminary mapping, with final deliverables almost exclusively comprising of 3D survey data and orthophotography, although high-resolution hard-copy orthos were still commonplace. It is also true to say, that in this period the UK aerial mapping industry was being transformed from a traditional local authority county based commission flying programme to a frenetic national, regional and city based multi-temporal market driven industry.

In 1999, BKS decided to proceed with the acquisition of a new aerial survey camera to support its photogrammetric operations. This major capital investment was required to facilitate acquisition of aerial photography and improve the quality and clarity of the acquired imagery as the demand for orthophotography grew. The camera selected was a Swiss made Leica RC30 unit which incorporated forward motion compensation and a fully gyrostabilised mount. The new camera had the added bonus of enabling the company to acquire photography in marginal light conditions, an important factor when obtaining imagery within the British Isles and its inherent weather peculiarities.

To further facilitate the production of digital orthophotography which was gradually succeeding hard-copy orthos as a standard deliverable, the company also decided to purchase a geometrically and radiometrically precise photogrammetric scanner to convert aerial film to digital imagery. The Z/I Imaging PhotoScan TD scanner is capable of producing ultra-high resolution imagery as fine as 7micron pixel size. The unit also includes a roll film attachment that permitted continuous operation even at night, which greatly enhanced the productive capacity of the scanner.

Mrs Thatcher and husband Dennis take a keen interest in the photogrammetric plotting instrument of the time, the Wild A8, when they visited BKS Surveys in 1988

To complete the transition from the analytical age to the digital workstation age, BKS commenced a phased replacement of its once 'state of the art' analytical stereoplotters with digital photogrammetric workstations (DPW) that benefited from the use of directly scanned aerial imagery and fully automated aerial triangulation and photogrammetric functionality. In 2002, BKS finally retired its last analogue instrument that dated back to the mid 1960's. This once proud piece of Swiss engineering had sat idle for the past ten years and had merely served as nostalgic reminder of the founding years of the company. An instrument that once commanded a purchase price of nearly £100,000 was now worthless metal and was finally sold for scrap.

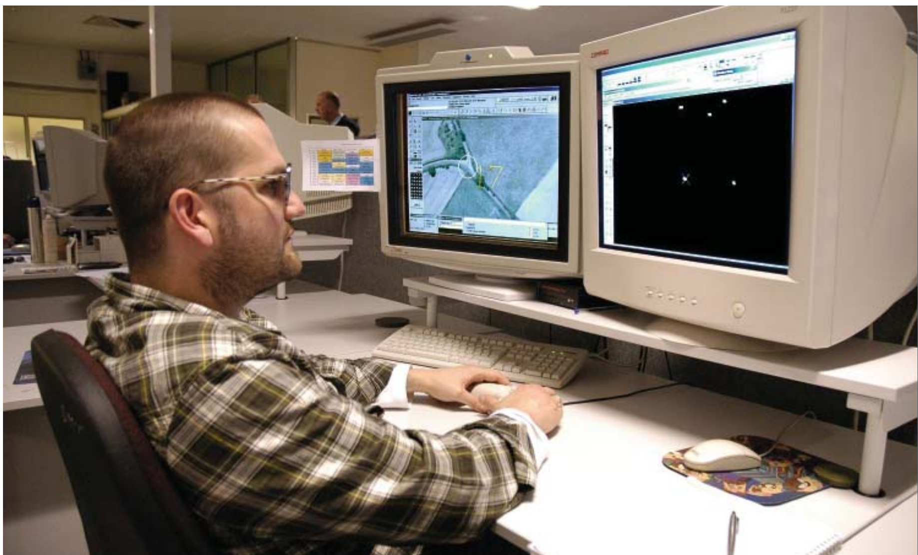
The new breed of DPW that now constitute the current state of the photogrammetric art enables more automation in some of the tasks such as aerial triangulation and digital terrain model collection that were previously more labour intensive.

All these changes are supported by the fact that the market was now demanding change, with users being more diverse. Whilst the photogrammetric industry has reacted positively to the needs for providing more cost-effective, more intelligent and richer data, customers have strived to achieve best value. The mapping organisations have responded by the use of off-shore labour to reduce costs, however, this needs to be undertaken with considerable diligence as issues regarding quality continue to be of concern. As photogrammetry had done in the 1960's when the science offered faster and easier survey acquisition to that of more traditional land surveying methods, so photogrammetry is now suffering at the hands of the emerging remotely sensed technologies of airborne laser scanning (LiDAR) and radar.

LiDAR sensors mounted in fixed wing aircraft offer very rapid data acquisition over wide areas and is ideal for the generation of digital terrain models in wide area subject matters including floodplains, albeit at slightly lower levels of accuracy than its photogrammetric counterpart supplying data of a few points per square metre. The technology if operated from a helicopter at low altitude provides an excellent solution for corridor mapping yielding as many as 12 points per m2 with vertical accuracies as good as those derived by photogrammetric means. The high point density produced from the helicopter mounted sensor enables the extraction of detail mapping as is now being used to provide the equivalent of 1:500 topographic mapping. BKS have been quick to see the benefits of these technologies and have forged strategic business partnerships with LiDAR data acquisition organisations and is currently engaged as a framework contractor for the UK Highways Agency for the supply of LiDAR data and mapping. Additionally, we have completed nearly 1,000km of mapping of the Environment Agency's river embankment asset for condition monitoring and flood risk assessment. The company's photogrammetrists and data engineering technicians are now equally adept at mapping from a LiDAR point cloud as an aerial photograph.

In 1985, the key factor in determining whether a survey was conducted in the air or on the ground was the site size, with small areas being surveyed on the ground. This has changed with technological advancement. Global Positioning Systems and electronic survey equipment has made ground survey much more efficient allowing larger areas to be undertaken. In 2005, the level of accuracy required is the key deciding factor.

In 1985, BKS were renowned as an aerial survey provider. However, twenty years later the company has evolved and developed to be a supplier of geospatial survey data using a wide range of technologies to acquire survey information whether it be by land survey, photogrammetry or remote sensing. The challenge for the future is to maintain our position at the leading edge of technology, retain a competitive edge, and to ensure quality and best practice.



The modern day photogrammetric work environment

20 Years of Field Survey – How Times Change?

By Simon Mears, Leica GeoSystems Ltd

Looking back over twenty years of human endeavour can bring up some surprises – some pleasant, some less so. If we narrow the subject area to technology, the effects can be truly scary – a condition that applies to surveying as much as any other. Take out the technology, though, and has that much really changed?

It was 1985 and the reflectorless EDM had yet to make itself felt as a force for change. The computer was a rare and expensive beast of little memory - we had a lot to look forward to, if only we knew it (did anyone else buy shares in Microsoft?). Nevertheless, generally speaking, we still to this day traverse our control into site, compute and adjust it quite arbitrarily using time honoured fudging techniques, then use that control to observe the myriad of detail points that make up the plan, or to set out the construction work as demanded.

What about GPS? Well, that was just, only just, becoming visible as a surveyor's tool, though at $150,000 or so each – and a pair was needed - it was not an investment for the faint-hearted. GPS in 1985 was used by research bodies for geodetic applications and perhaps some of the more progressive oil exploration companies. At one point per day (given the limited satellite constellation), there had to be no alternative before GPS became a viable proposition. Nevertheless, GPS was a dramatic improvement over Doppler Transit, its predecessor – that took three days for one decent control point! It is more than interesting to note that GPS has made huge leaps in all areas of its application, except the most important one – accuracy. Once dual frequency receivers became available in 1987, the reliable mantra of 'one centimetre plan, two centimetre height' has not really changed. Yes, it can be bettered but not without a lot of effort for a diminishing return, and yes, it is magnitudes faster, lighter, cheaper and so on but, not really more accurate. The next twenty years will certainly see the situation change, with the upgrading of the GPS constellation, the revival of Glonass and the introduction of Galileo. What will all that do for us (apart from cost us more money; Galileo for one will not be free-to-air to use modern jargon) – well, perhaps 'half a centimetre plan, one centimetre height' – that's progress!

Let us agree that GPS can bring in high quality control which is consistent and without accumulated errors - now, what's happened to the humble theodolite to exploit it? Until1985 most of what we now call 'Total Stations' - weren't. They were generally theodolites with add-on distance meters. All sorts of errors were made, and sometimes never discovered, in the hazy issue of instrument/target height offsets and prism constants. The survey market was waiting for an integrated Total Station – a Coaxial Total Station no less (even though the purists still felt the EDM should be modular, so that it could be dismounted when not in use…. remember?). With the arrival of the Wild TC1000 range the arguments were over – coaxial was the way to go and we never looked back.

By the time the problems of fully integrating a convention EDM (using corner-cube reflectors as targets) into the Total Station had been solved, more innovative opportunities appeared. First, we went reflectorless and then in the mid-nineties, we added motorisation.

In 1985, if we looked closely into the manufacturers' product brochures we would have found the Wild DIOR, the first of the reflectorless EDM's. Though capable of being mounted atop the Total Station, its size meant it was not ready for integrating into the optical train of the instrument. The early reflectorless EDM used a pulsed laser to measure the time of flight of the signal, picking up the coherent light that was returned from the target surface as backscatter. The problems with this approach were the high power levels, the short range and, most importantly, the wide measuring beam that was created. Any misalignment of the unit could give large errors as there was no physical indication of what the target was and, even when perfectly aligned, a fine target such as the corner of a building was subject to the averaging error of backscatter from the wall running away from the corner itself. It has taken a long time but with the advent of phase laser measurement came the small beam footprint, compact size and low power that has enabled the reflectorless EDM to be offered as a coaxial component of the Total Station.

The motorising of the Total Station's horizontal and vertical motions has been as big a factor in advancing the science and versatility of the instrument as was the addition of the integrated EDM to the theodolite. As with most innovations in surveying equipment, there was a fair degree of initial scepticism about the value of motorisation – we do seem to be a conservative lot! The early use for


Leica SmartStation
What if...
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motorising was to enable rounds of angles to be taken more efficiently – to see an instrument turn the telescope vertically through 1800 while itself turning horizontally through a half-circle at the same time was quite a party-piece!

As we nowadays come to expect, the on-board intelligence that enabled the 'rounds of angles' routine was just the beginning – a modern Total Station probably has the computing power to pick the National Lottery winner, never mind the usual 'getting men on the moon' comparison! The final (to date) innovation inside the Total Station was to put a CCD camera in the telescope and use the on-board intelligence to discern the strongest point of the EDM's return signal. The result? Self-seeking automatic target recognition, which allows the surveyor to operate alone without an assistant (is that progress?). The implication of one-man operation is not only a cost saving in manpower terms but now the surveyor himself is at the sharp end, picking up the right detail, in the right manner and, of course, coding it correctly for himself. For the setting-out engineer, this one-man capability is just as important though he probably still keeps his assistant to carry the pegs, spray paint, hammer, etc.

So where have we come, these past 20 years? The surveyor has been dumbed-down somewhat – the skills acquired over years on the end of the telescope are largely redundant, replaced by point and shoot techniques from wholly digital instruments. Where once a fair days work was three hundred detail points and a good sketch to back them up we can now see three thousand points a day, coded for immediate translation into a meaningful drawing (though how often does one actually see a drawing these days?) back at the office. Indeed, there is no reason why the plot shouldn't be building up in realtime as the surveyor takes the readings (sorry, the instrument takes the readings – the surveyor is scampering around with the prism!) and sends them back by GPRS communications as they happen. And that's what its all about; time and efficiency equals money.

What are the current trends? Without a doubt, the most impressive recent innovation has been to integrate GPS and the Total Station (we are waiting for a generic name for such a beast) and what do we get? The best of both worlds – the ability to set up the instrument in the position best suited to picking up the detail yet not constrained by the need to carry the traverse through that station. GPS gives the position - the Total Station gives the detail. Already the most marked effect of this combination is to bring surveying skills back into play; position is all very well - the GPS does that - but how about orientation? There are a host of 'old-fashioned' techniques that take simple geometry to the limits of the surveyor's ingenuity all of which have a place in determining orientation from a known position.

Where will we go in the next twenty years? One thing we can do is to make GPS more capable. We know that the main limitation at present is that GPS cannot pick up detail where it can't see the satellites, so under the eaves of a building, in urban canyons, under tree cover, indoors of course – are all stumbling blocks preventing GPS from taking over the world. However, GPS's rival, Galileo, will certainly give stronger signals as will the GPS upgrade to the new L5 frequency – these will give better coverage but still not a universal solution. The final link in the chain is to add Inertial Navigation (INS) capability - in a greater or lesser degree of sophistication according to purpose. A small module on the surveyor's GPS detail pole could sense the direction and inclination of the pole away from the vertical allowing lazy surveying (no need to hold the detail pole upright!) but more importantly, the surveyor could stand out from, say the building corner, and 'point' to the target. The software knows the length of the pole, its position, direction and attitude – voila - the coordinates of the point! How much would that cost? As ever - a lot to start with but a lot less soon after.

Finally then, back to our Total Station: let us see what's next. Take a look at 3D scanners or High Definition Surveying - these instruments have a motorised horizontal motion and a laser that can track vertically from below the horizontal plane to the zenith and beyond. It is possible to scan a scene of everything in view out to a distance of more than a hundred meters with an accuracy of a few millimetres. Points are measured at the rate of many thousands of points per minute. At present Scanners are expensive, large and power-hungry but all these limitations will succumb to the relentless progress of technology and, of course, in a surprisingly short time. How difficult will it be to integrate such technology into our humble Total Station? Easy! At that point, will our Total Station still be a Total Station – it won't even need a telescope!

From Eisenhower to Google Earth and Beyond -

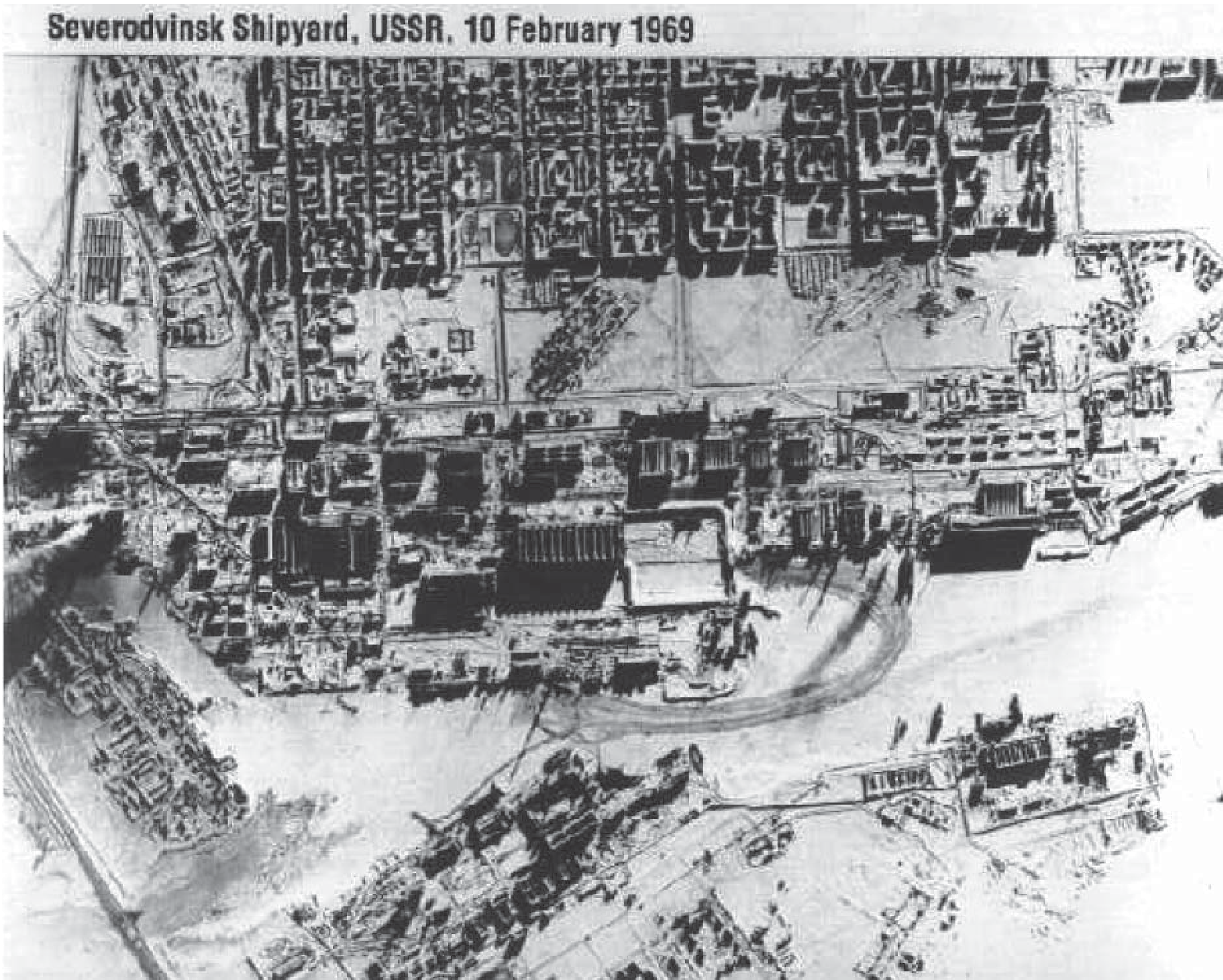
The Development of Military Remote Sensing and What the Future Holds

Jonathan Shears, Infoterra Limited

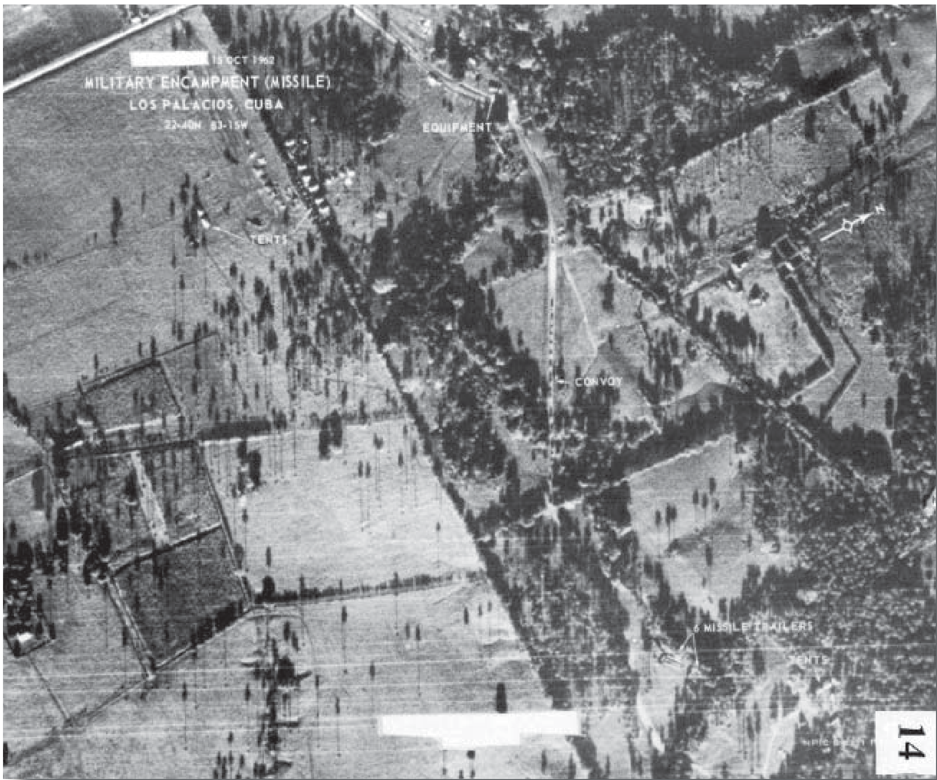
The Original 'Open Skies'

Recovery of Corona film canisters

To put the story of remote sensing over the last 20 years into perspective we must briefly return to its genesis 30 years before our start date. Back in 1955 with Cold War anxiety skyrocketing, Eisenhower made a remarkable proposal to Premier Nikita Khrushchev his Russian counterpart. He suggested that each nation allow the other to conduct reconnaissance flights in the air and from space over the each other's country and that the imagery obtained to be given to the United Nations. The Soviets rejected this "Open Skies" idea and from that point onwards both the United States and the Soviet Union proceeded both separately and in secret.



Corona image of Severodvinsk Shipyard, USSR acquired 10 Feb 1969

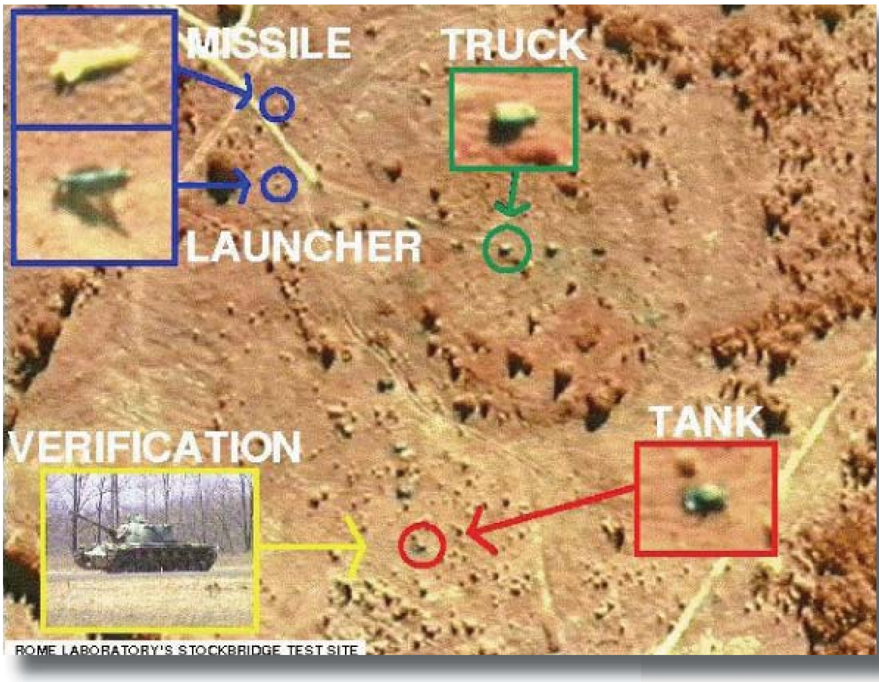


First image of Russian missiles on Cuba – October 1962

For the United States the ensuing programme was a high altitude 'air breathing' system that was to be able to fly undetected above Soviet radar and collect information on their current military power. A contract was eventually awarded to Lockheed who duly wheeled out the U2 for its maiden flight in August 1955. With a payload consisting of a single forward-looking RC-10 and four rear looking Vinten cameras, the U2 began operational service in 1956. The following year Russia launched Sputnik-1 and for the Americans the development of space became a national priority. In 1960 the US Corona program was the first to take a photograph from a satellite. After the Corona cameras imaged the world from polar orbit the exposed film was jettisoned back to earth in a capsule fitted with a parachute designed to be snagged by special recovery planes.

As crude as the system sounds now, Corona was the backbone of defence intelligence and the staple diet for creating maps for until 1972, when it was replaced by more advanced systems, such as Big Bird, which used digital imagery. From a cartographic point of view Corona made it possible for the first time to validate the content of communist state maps and prove that many were deliberately falsified to mislead and deceive the real disposition of settlements, airports, transportation lines and military facilities.

Test airborne hyperspectral imagery over an area of UK tank ranges



Hyperspectral imaging is able to spectrally discriminate material types from background spectra

Size Does Matter

The imagery was acquired primarily for intelligence purposes, although it was also used for mapping given the sufficiently high geometric fidelity of the sensors. Being panchromatic, its value was in being able to map features with a high degree of accuracy and currency to create standard series topographic maps.

In those days it was all about resolution. The ability to identify features on the ground with a high degree of certainty was the *raison d'être* of satellite imaging. This was famously illustrated in the Cuban missile crisis of 1962, one of the first very public and high profile cases of using 'secret' imagery assets. The image in Figure 2 is a U2 photograph showing a convoy approaching a deployment of Soviet Medium Range Ballistic Missiles and, although it meant the US had to effectively show its hand, it nonetheless did provide irrefutable evidence that eventually led to the Russians removing the missiles.

And So Does Colour

Image interpretation was limited to shape and texture, sufficient at the time for intelligence and mapping. However, spectral analysis would have to wait until the 1968 Apollo 9 mission when four Hasselblad cameras were mounted in a frame that the crew could hold with the trigger rigged to all four cameras so they would all expose at the same time. The multispectral images acquired during this mission were digitised and used in the development of Landsat, which was launched four years later (as ERTS-1).

This was an important development for military mapping since it allowed land cover analysis and the creation of both additional mapping layers (such as vegetation) and intelligence information (such as target identification) with greater impunity. For the UK MOD the investigation into the use of multispectral imagery for production mapping began in 1985. A pilot study was undertaken to establish the feasibility of using multispectral imagery as part of its emerging digital map production flow line for areas where source mapping was otherwise denied.

The Map Research and Library Group (MRLG) study used GEMS remote sensing hardware based at the National Remote Sensing Centre, then part of the DTI and now absorbed within Infoterra Ltd. Using Landsat TM imagery, it successfully proved the ability to extrapolate a supervised land use classification across a national boundary (from Malawi to Mozambique) using ground truth from available source mapping from adjacent Malawi national mapping series for the purposes of TPC (1:500,000) and JOG-G (1:250,000) mapping. By definition, ground truth validation was not possible but in the absence of any vegetation information on previous edition mapping, it was deemed a useful additional tool.

USAF Eagle Vision

However the main use of multispectral and hyperspectral imagery within defence has been for intelligence and terrain analysis applications and also its ability to contribute to Materials and Signatures Intelligence (MASINT). This form of intelligence collection is critical in providing information on future weapons threats and strategic and tactical targets. Few MASINT systems fielded prior to the Gulf War in 1991 used embedded libraries, signatures or templates to perform autonomous detection, classification, tracking or engagement functions. This however changed markedly in successive years, with the fielding of new aviation and fire support weapons. Numerous MASINT-based systems were subsequently used in roles as varied as intruder detection, strategic missile launch warning, active missile detection and countermeasure, fratricide prevention, vehicle survivability, and intelligence gathering operations and nuclear weapons test monitoring. Many remote sensing tasks, which are impractical or impossible with a multispectral system can be accomplished with hyperspectral. For example, detection of chemical or biological weapons, bomb damage assessment of underground structures, and foliage penetration to detect troops and vehicles based on an ability to discriminate, classify, identify as well as quantify materials as in Figure 4.

Satellite based hyperspectral imagers however have had a chequered history. Although fewer in number, they have had a disproportionate amount of program failures and space borne capability is consequently far behind where it was originally envisaged to have reached by now. The 5-metre resolution Lewis satellite (developed by TRW) launched in 1997 entered a flat spin in orbit and the 384-band sensor re-entered the atmosphere a month later without any successful acquisitions. To continue a bad year, in December NASA pulled the plug on the over budget and delayed Clarke mission, the total investment for NASA amounted to $55 million.

That said there are some military space-borne hyperspectral imagers such as Warfighter-1 which is a NASA funded mission focused demonstration of a tactical hyperspectral imaging remote sensing system. Developed to support MASINT applications including the detection of vehicle and troop movements and countering concealment material types (e.g. camouflage), it has more recently been used for counter narcotics in an attempt to disrupt its illegal manufacture and the global terrorism and arms trade that it is suspected to fund.

Up Close and Personal

Such has been the increased capability of commercial imaging systems that its use in defence mapping has supplanted dedicated military imaging systems. Spurred on by the US government's

Canberra from 39 Sqn (1 PRU) and typical medium altitude oblique imagery

endorsement and recognition in 2003 of commercial satellite imagery as playing a part in satisfying the majority of their mapping needs, we have consequently seen the main satellite vendors today vying for a share of the lucrative US NGA contracts to supply high-resolution imagery (as part of NGA's Clear View contracts – see later). These support the creation of standard image products (Controlled Image Base) and source material and control for standard series mapping products.

Not only can the likes of IKONOS and QuickBird achieve sub-metre resolution colour imagery, but with sufficiently precise orbital and attitude control systems to support mapping without additional ground control down to +/- 15m horizontal RMSE at 90% CE. Furthermore with their ability to swivel up to 50 degrees on their axis, enables them to collect imagery of nearly any point on the Earth's surface every two to three days.

And the ability to resolve to greater resolutions than 0.50-metres is only limited by licensing rather than technology. In November 2002 Space Imaging applied for a 0.25-meter license with the National Oceanic and Atmospheric Administration (NOAA), which will permit them build and launch an imaging system that will be able to see objects on the ground as small as a quarter meter in size. However, whilst the U.S. government has granted licenses for quarter-meter resolution there are no immediate plans by the commercial vendors to use them. One of the vendors, ORBIMAGE, has come clean about their plans for the next generation of satellites announcing that their $437 million award from NGA provides them with the financial support necessary to build and launch a commercial 0.41-meter imaging satellite by early 2007.

However mapping is only one side of the coin. We all know that even with digital maps, no sooner are they output then they are out of date. The Ordnance Survey charter aims to achieve the most current national spatial database and estimates that their Mastermap™ database incurs over 5,000 changes daily. To map such a dynamic world requires on almost real time feedback loops to ensure the time between collection and use is as short as possible. Whether this is for tactical military operations or response to a natural disaster, timeliness assumes greater importance than resolution. Hence the development of low latency solutions such as in-field down linking, which in the case of satellite-acquired imagery by-passes primary ground stations and the inevitable delay in transmitting it to theatre. The most developed of these is the USAF Eagle Vision system which is licensed to receive raw imagery direct from the over passing satellite and all necessary processing is done much closer to the point of use.

For the same reason and to provide even lower latency imagery, tactical reconnaissance imagery is collected from air breathing platforms, mostly low flying fast jets, which in the case of the UK is the Tornado, although the Jaguar also still operates a reconnaissance role. The Tornado is equipped with a long-range optical DB110 sensor developed by Goodrich capable of acquiring sub-metre imagery from over 30 nautical miles stand-off range. This will eventually replace the mainstay of the RAF's imagery collection platform the Canberra. Equipped with high speed low level, high altitude panoramic and vertical survey cameras the Canberra started operational service with 39 Squadron in May 1951 and is due to leave service in 2006. With its ability to fly at over 70,000 feet and long range, it was ideally suited to reconnaissance imagery, both strategic and limited tactical. For most of its operational life it was equipped with the F49 Mark IV vertical camera to produce photography for mapping purposes.

The Shape of Things to Come

The shape is very much smaller and unlike any of its predecessors - has no pilot. Unmanned Airborne Vehicle (UAVs) have proved their worth in several military campaigns and with each one the reliance on them has increased with the maximum amount of flown sorties over Iraq in 2004 than in any previous military operation. Like the Canberra before it, the USAF's Global Hawk is a long endurance platform and in April 2001, it made aviation history when it completed the first non-stop flight across the Pacific Ocean by an unmanned, powered aircraft, flying a distance of 13,840 km from Edwards AFB, California, to the Royal Australian Air Force Base, Edinburgh, South Australia.

It has a synthetic aperture radar (SAR) and an electro-optical and infrared sensor system. A 10-inch reflecting telescope provides common optics for infrared and electro-optical sensors. In spot collection mode the coverage is 1900 spots per day with spot size 2 km x 2 km to a locational accuracy of +/- 20 metres CE. In wide area search mode, the swath is 10 kilometres wide and the coverage can be up to 40,000 square nautical miles per day.

Northrup Grumman's Global Hawk UAV approaching the main runway at Edwards Air Force Base in California

A Full Circle

Having been the driving force behind space-based imaging, defence organisations are still the largest consumer of satellite imagery and they still remain the mainstay of the industry they helped create. Satellite imaging has since reached a point in its evolution that it now has a momentum all of its own, witnessed by the fact that it has become ever more capable in terms of resolution, agility and absolute accuracy. Whereas programs like U2 and Corona were hitherto the exclusive preserve of the defence organisation that developed them, and their outputs similarly jealously guarded, it is now the case that defence mapping and intelligence requirements can be met from erstwhile commercial imaging platforms. Whilst commercial might be lower resolution than national assets, its value it is that it is unclassified and it also allows government departments and nations to share information with coalition partners, local governments and other agencies without the overhead associated with operating at a high security level.

The vast majority of defence mapping and intelligence organisations, including the US National Geospatial and Intelligence Agency (NGA), have issued policy edicts that mandate to a vast extent the use of commercial imaging systems to meet the majority of their mapping and intelligence requirements. Although, for NGA this is ostensibly business as usual since where they previously underwrote the development of satellite imaging systems on an exclusive basis, under the Next View contract, NGA are still doing exactly the same thing except that the outputs are also available commercially.

The fact remains that it would be inconceivable to plan any military operation without the use of satellite imaging. Its use in precision targeting, information superiority and rapid response mapping is not just undeniably significant as military systems are now inextricably reliant on them.

And this has hit mainstream production too. In January 2003, the NGA (then NIMA) committed to spending up to $500 million on high resolution commercial satellite imagery each from Digital Globe and Space Imaging over five years, under what is known as the Clear View contracts with, already, a follow-on contract called Next View. With Next View NGA is effectively investing in a next-generation imaging systems and getting investor-level pricing in return.

A Level Playing Field

But Open Skies and the use of commercial remote sensing is a double edged sword, since it becomes harder to control the distribution of imagery and the intelligence information it contains once it is in an uncontrolled domain. The new policy encourages US commercial remote sensing companies to bolster the industry via export sales and develop increasingly capable systems – albeit it under NOAA licence restrictions - and there is a strong case for saying we are merely arming our potential adversaries such as Al Qaeda, by creating a level playing field. In the case of nano-satellite technology, it is now more accessible and more affordable for any nation or organisation to design and build capable space assets. Ultimately the permissiveness of the policy still requires appropriate control measures and government-to-government bilateral agreements tightly control the release of imagery but it places a higher reliance on export controls than ever before.

As demand for imagery has increased, so more programs can exist as privately owned ventures, such as Digital Globe, Orbital Sciences Corporation, Space Imaging and ImageSat International. It is fair to say that the decision by US Department of Defense to leverage commercial imagery funding to improve national geo-spatial readiness and responsiveness has created the market conditions that all commercial imaging operators have been waiting for. However, despite the funding streams coming from Next View it is the commercial imagery companies that are applying the brakes as they don't have sufficient profit margin to contemplate beyond-next-generation technology. Whilst the government would love to have more capability if it could, the commercial industry is more of the opinion that less resolution with more capacity is what is commercially sustainable. The industry is so capital intensive that without a business case any venture would be sure to fail.

Will it Continue?

So it would seem that despite the current successful collaboration between industry and government, both sides of which are reaping the benefits of such a marriage, a time might come in the future where it is not possible to have a similar convergence of defence aspirations with sustainable commercial business. Hyperspectral imaging is at that crossroads where there is insufficient commercial demand to justify the cost of hyperspectral sensors which is effectively a speculative technology as far as commercial enterprises are concerned. It is known that the NGA is getting more funding and it has been upgrading its tasking, processing, exploitation and dissemination processes for classified imagery. But unclassified imagery has lagged, so perhaps this point is closer for intelligence and mapping grade imagery too than we might otherwise think.

Finally, it is important not to lose sight of the fact that Google Earth and the commercial satellite imagery market that exists today would not be in its current form had it not been for the quest for military superiority 60 years ago. Rather like Formula 1 technology acts as the forerunner for ABS, lean burn engines, etc, so military requirements have driven and continue to drive satellite imaging technology.

DOS Memories Required

The British Empire and Commonwealth Museum in Bristol has one and a half million aerial photographs dating from 1946 to 1999 and a large volume of associated survey materials which it has inherited from the Ordnance Survey International Library. To complement this archive the Museum is planning an oral history project to interview those who served with the Directorate of Overseas Surveys. Anyone wishing to become involved in this project should contact the Museum on 0117 925 4980 or email admin@empiremuseum.co.uk.

Change of Title for The Military Works Force

The Military Works Force changed its title to 170 (Infrastructure Support) Engineer Group at a ceremony at its headquarters at Chetwynd Barracks on the 29th of March this year. The new title has its roots in the Second World War when 170 Chief Engineer Works was an infrastructure support unit that served with distinction in North Africa, Sicily and Italy with the 8th Army. It comprised works, well drilling, oil storage etc and so had cleared links to the MWF.

BOOK REVIEWS

Members knowing of newly published books that might be of interest to readers are asked to let the editor know the details so that a review can be published in Ranger.

Twenty Years of Photogrammetry

By Stewart Walker, Director of Marketing, BAE Systems [1]

Fig 1: Wild B8 with DAT-EM, a customised version of MicroStation attached

In autumn 1985, your author travelled to Enschede for the European launch of Intergraph's Intermap Analytic (IMA) stereoplotter. Modern design, optical superimposition of the digital map over the stereoscopic image and an ergonomic hand controller were striking characteristics. Shortly thereafter he attended presentations of Wild's innovative System 9, a GIS with impressive looking workstations configured for digitising, photogrammetry (S9AP) or editing. These events were illustrative of two trends: analytical stereoplotters superseding analogue (figure 1); and the integration of photogrammetry with GIS (figure 2).

Photogrammetrists working in the profession these twenty years are privileged. We have witnessed paradigm shifts that have revolutionised productivity and workflows as workstations have moved from analogue to analytical to digital. No less remarkable has been the evolution from film to digital imagery.

The transformation from analogue to analytical was in full swing by 1985. Uki Helava published the concept of the analytical plotter in 1957. Numerous models were introduced during the 1960s and 1970s, mainly for defence applications. Cost and computer capacity were constraints and it was not until 1976, with the launch of the Zeiss C100 Planicomp, that a solution sufficiently economical for the commercial market arrived. The ISPRS Congress in Hamburg in 1980 buzzed with analytical plotters even more than Helsinki in 1976: the Kern DSR1's lower price level sounded the death

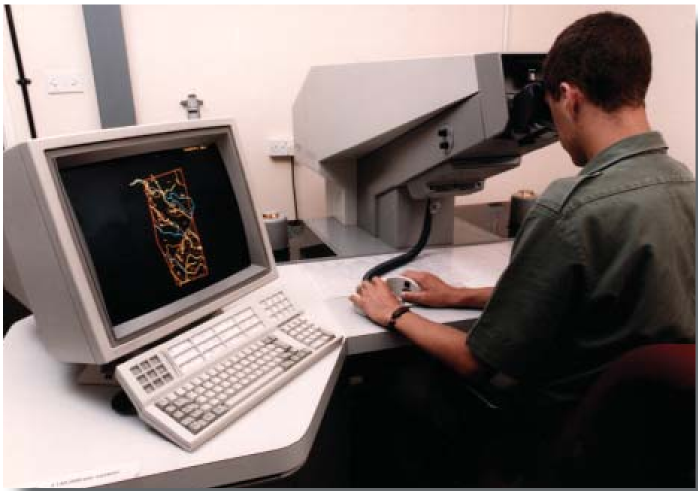


Fig 2: 13 Squadron's Intergraph Intermap Analytic in the late 1980s

knell for the analogue plotter (figure 3). Nevertheless, analogue plotters were sold in their hundreds during the 1980s; the last notable model to be introduced was the Wild AG1 in 1984.

We have witnessed the culmination of the aerial film camera (figure 4). Aside from incremental developments in mechanics, optics and electronics, for example the gradual improvements of lenses to the point where radial distortions are below 2 mm and the introduction of electronic components, gyrostabilised mounts, forward motion compensation and GPS then IMU technology have increased image quality and estimated the position and attitude of the aircraft. The enormous National Agriculture Imagery Program projects in the US, with entire states flown, scanned, triangulated, orthorectified and mosaiced in a few weeks, bear testimony to the film camera at its zenith.

In the last five years this comfortable situation has been overturned. Airborne digital sensors at commercial prices capable of performance better than film cameras have arrived. Articles and debate continue voluminously; suffice it to say that products from several suppliers – best known are those from Intergraph, Leica GeoSystems and Vexcel (figure 5) – have demonstrably produced geometrically accurate results and greater bit-depth than film, ensuring imagery of dramatically high quality. Several of these, such as the Leica ADS40, use a strip rather than frame approach, yet this radical change has been widely accepted. Workflows without chemical processing and scanning are becoming ever more popular.

In 1985 orthorectification was analytical. The complex, unwieldy orthophotoprojector accessories for analogue plotters had been replaced by the computer-assisted Wild OR1 and Zeiss Orthocomp Z2, which used digital input such as digital terrain models (DTM) or contours and orthorectified single photos by computer controlled, differential optical rotation and magnification. These devices were expensive and could not mosaic, so they sold in limited numbers. Mosaicing was an art practised by humans: "feathering" was careful tearing and glues, a science in themselves.

Changes in image acquisition precipitated our second paradigm shift. Satellite imagery - almost entirely digital - had existed since the 1960s. Towards the end of the 1970s, the US government decided to carry out much of its image acquisition for surveillance using satellite-borne digital sensors as opposed to airborne film reconnaissance cameras. The requirement for workstations to process the new imagery occasioned contracts let to General Dynamics Electronics Division, which recruited Detroit-based Helava Associates for photogrammetric expertise and large numbers of workstations were delivered to the Defense Mapping Agency (DMA) from 1982. The advantages of the digital workstation were overwhelming. Not only could images be easily manipulated (analogue and analytical plotters could vary only magnification and brightness), but the user could effortlessly move from one stereo model to the next as orientated stereo models could be reset almost instantly. Image matching facilitated high levels of automation in triangulation, the extraction of digital terrain models and the generation of orthophotos. Human intervention remains necessary for quality control of triangulation and DTMs, feature collection and editing, and radiometric dodging and balancing.

In 1990, BAE Systems, via Helava Associates, entered the commercial market with its SOCET SET digital photogrammetric workstation. Intergraph competed with ImageStation, also with its roots in defence (figure 6). These products have evolved and have set the pace in digital photogrammetry.

Figure 3: The Wild BC2 and Zeiss P3 set attractive new price levels in analytical plotters

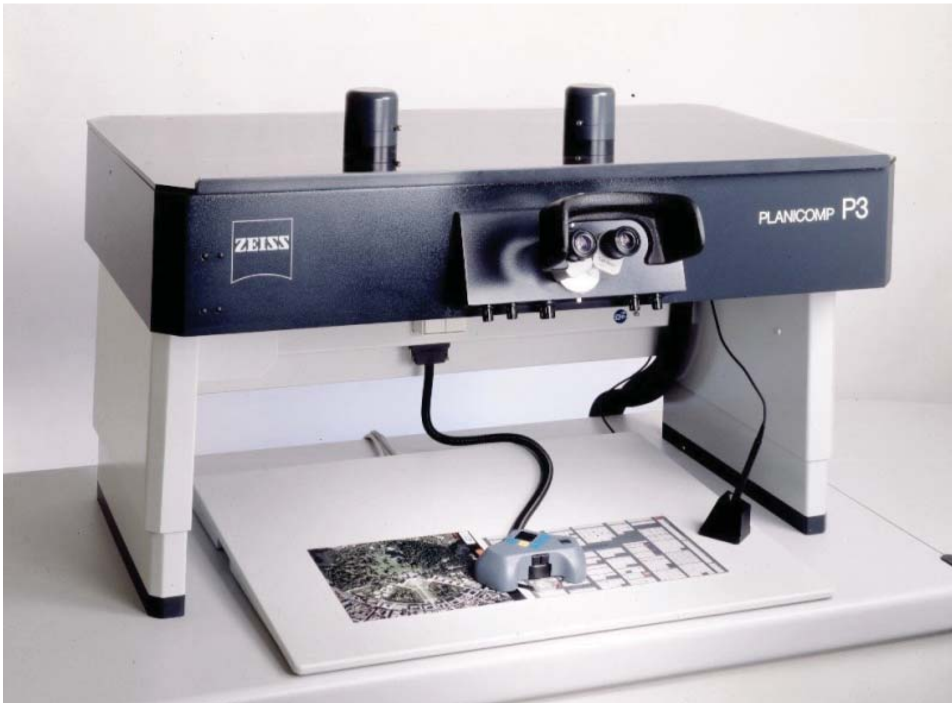


Figure 4: The Wild/Leica RC30 and Zeiss/Intergraph RMK TOP and their predecessor models have served the industry superbly through several models over more than 50 years

Figure 6: Digital workstations as a response to defence requirements. BAE Systems and its predecessor companies: SOCET SET as a microcosm of developments in digital photogrammetric workstations: its roots in workstations developed for DMA in the 1980s; its evolution through the 1990s from Interactive UNIX to Solaris and Windows, with a variety of control devices and approaches to stereoscopic viewing

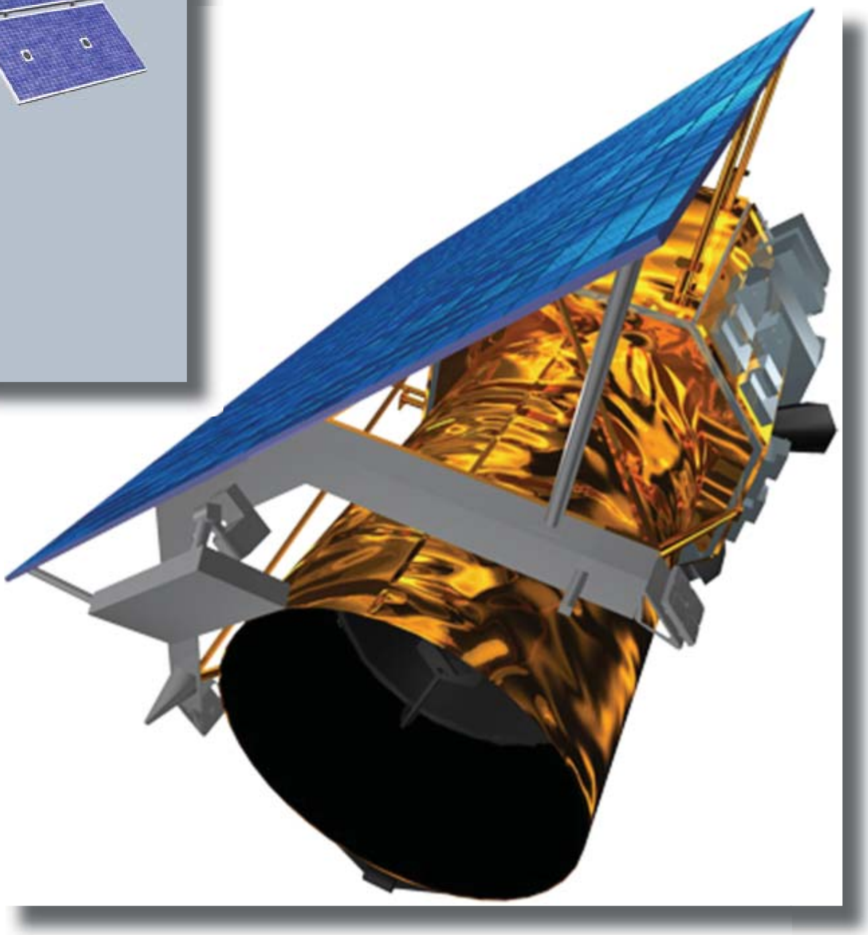
Launched on Interactive UNIX on 80386/80486 PCs, SOCET SET soon settled on Sun workstations and has used numerous variants of SunOS and Solaris over the years. In 1997 the product also became available on Windows NT. UNIX versions for DEC, HP and SGI workstations have come and gone. Platforms seem less contentious today. In the early 1990s, configuring hardware was almost a form of sorcery, mastered by few, but today's off-the-shelf components are more amenable. Fifteen years ago graphics cards were bottlenecks: each new model engendered heartache and software development. Today's require rather little rework. Standards help.

In the 1990s, stereoscopic viewing excited the same passionate dichotomization as operating systems. Adherents of active eyewear from StereoGraphics took to their soapboxes against the Tektronix passive systems. Equally vigorous was the debate between single and dual monitors. We likened it to analytical plotters in the 1980s, when whole benchmarks could swing on the size, opacity or translucence of the floating mark. Now customers can enjoy whichever viewing system they prefer. The familiar active and passive approaches, available from both MacNaughton (which grew out of Tektronix) and StereoGraphics (now a Real 3D Company), been joined by innovations such as Planar Systems' StereoMirror. There have been opinion swings on control devices: should digital photogrammetric workstations have traditional hand wheels and foot disks, or something more modern? All sorts of trackballs, force sticks and 3D mouses have been introduced for ergonomic, accurate, 3D control. Further emotions were spent on image compression, whether it should be done at all, whether in hardware or software, whether it affected image geometry. This is not irrelevant today, as images are huge and affect performance, but software compression is fast and output formats follow standards. In every case, the customer is in control, and the debating chamber, quiet. Digital photogrammetry has grown out of its tempestuous youth into a mature, productive, wage earner…

The evolution of the suppliers is interesting too. The big European photogrammetric suppliers found it difficult to compete in the software world. Many of us have not forgotten Armin Grün's stinging remark that Kern's digital yodelling soon died down, when its DSP1, launched so excitingly at ISPRS in Kyoto in 1988, came to nothing. While Leica flirted briefly with DVP, Zeiss pursued their PHODIS range on attractively presented SGI workstations. But Leica could not find the impetus to develop its own product and began distributing SOCET SET for General Dynamics in 1991, leading to the formation of the LH Systems joint venture between Leica and GDE Systems in 1997. Shortly thereafter, Z/I Imaging appeared as a joint venture between Intergraph and Zeiss. Both of these were sold back to one of the partners – Leica GeoSystems and Intergraph respectively – an intriguing parallelism. Other vendors of digital photogrammetry software include firms with their origins in feature collection software, originally written in the 1970s and 1980s for microcomputers interfaced to analogue plotters, but we now see suppliers of remote sensing software offering more photogrammetry. Others still are new entrants. On the customer side, there has been consolidation, resulting in the bigger competitors offering worldwide services from multiple offices and investing regularly in new technology, while the small shops occupy niche or sub-regional markets and also act as sub-contractors to the big firms.

Figure 5: The Intergraph DMC, Leica ADS40 and Vexcel UltraCamD airborne digital sensors, introduced during the first five years of the twenty-first century, at last bringing to the market digital solutions able to outperform the aerial film camera

Figure 7: The NextView project, involving the US National Geospatial Intelligence Agency and the commercial satellite operators DigitalGlobe and Orbimage, will result in WorldView and OrbView-5 satellites capable of acquiring imagery with resolution as high as 41 cm panchromatic and 1.64 m multispectral



Defence expenditure has been pervasive in photogrammetric development. SOCET SET's approach reflects this. Many commercial photogrammetric projects involve very large numbers of images taken from a single film camera, then triangulated, usually with some ground control. Smaller projects typify the defence workflow, but each can include a wide range of image sources without ground control. SOCET SET reads each image with its meta data (ephemeris for a satellite, GPS or GPS/IMU for airborne) and triangulates the project, treating images as entities from different sources. Many sensor models are provided, with numerical differentiation for the design matrices and normal equations. This is appropriate today: multi-source imagery is often available in libraries or from vendors without commissioning new photography. The increasing resolution of commercial satellite imagery, soon to break the 50cm barrier, is another driver towards multiple source imagery. Thus SOCET SET and some other defence-oriented products are well suited to modelling not only new satellites coming on stream but also modern airborne digital sensors, hyperspectral scanners and thermal imagers.

In commercial photogrammetry, nevertheless, today's most popular workflow is, in a sense, traditional, based on scanned aerial film and digital workstations. We have seen the advantages of digital photogrammetry in terms of productivity through automation. It is natural to seek these benefits while using aerial film cameras, which represent huge investments and have lifetimes of decades. Film scanners have reached their peak of development, rapidly evolving from hesitant offerings at the beginning of the 1990s to today's models with superb radiometry, geometric precision and scanning speeds. This workflow will remain popular for some years: sales of new film cameras will peter out soon, but usage will persist. Scanner sales will echo camera sales, with an element of lag.

An element of continuity is software for feature collection and editing. Today's programs support meticulous work by human operators and were first written for minicomputers or microcomputers interfaced to analogue stereoplotters in the 1970s. Despite ardent research, operational automatic or semi-automated feature extraction remains elusive. Perhaps the focus has shifted as the emphasis in production has moved towards orthorectified imagery rather than the large-scale vector maps that for so long were the lifeblood of our industry. The early part of our 20-year study period marked the evolution of these mapping software products from proprietary to CAD-based and GIS-based. Today's workstations can be equipped with the specialised software with native data stores, with major systems such as Bentley Systems MicroStation or Autodesk AutoCAD, or with GIS such as ESRI ArcGIS or Intergraph GeoMedia. Other systems are more focused on feature collection for visualisation or urban modelling. BAE Systems' SOCET SET demonstrates that the customer is king by offering VrOne for high performance commercial production of vectors, its own Feature Extraction strong for modelling buildings, or SOCET for ArcGIS® for collection and update directly in the ESRI® Geodatabase.

We could not have chosen two decades more telling in photogrammetry. These 20 years have witnessed the end of the analogue plotter, encompassed most of the analytical era and welcomed digital photogrammetric workstations as the industry's workhorses. Where do we go next? Airborne digital sensors will supersede the faithful film camera sooner rather than later. In commercial work as well as defence, the range of image sources, both airborne and spaceborne, will grow. UAV-borne sensors will play a central role. Hyperspectral/multispectral and radar will be the norm rather than the exception. Resolution, spectral range and bit depth will all increase. OrbView's acquisition of Space Imaging as we anticipate NextView (figure 7) is big news.

BAE Systems' vision that image analysis (IA) and geospatial analysis (GA) will coalesce into a single market requiring a single software solution with a single user interface, for all tasks from simple image exploitation to sophisticated deliverables and targeting, will be vindicated imminently. Tough tasks such as image matching for DTMs, automated and semi-automated feature extraction and radiometric dodging and balancing will receive close attention and prove somewhat tractable when addressed by clever new algorithms. Data fusion of airborne or satellite or terrestrial imagery and LIDAR will become effortless as algorithms are refined and computer power grows. Standalone workstations and client/server models will give way to Web services, defined by Open Geospatial Consortium standards, with imagery and software physically separate from the workstation of the user. Fresh project management approaches will emerge, prescribing efficiency and supervising software from many suppliers, with end-users viewing their jobs' progress on simple browsers. We have not quite seen the end of the index map on the wall with coloured markings indicating the status of the project; but we are breathless from progress! Our 20 years have been a period of remarkable advances, driven by remarkable people, working their magic in academia, defence and commerce.

Images courtesy of BAE Systems, DigitalGlobe, Intergraph, Leica Geosystems, Orbimage and Vexcel.

[1] *BAE Systems, as used herein, refers to BAE Systems National Security Solutions Inc., formerly known as BAE Systems Mission Solutions Inc., Marconi Integrated Systems Inc. and GDE Systems, Inc. GDE Systems was created when the General Dynamics Electronics Division was sold to Tracor Corporation in 1992. Tracor and GDE were subsequently acquired by BAE Systems in 2000.*

20 Years of GIS in Defence – How Things Have Changed!

By David Swann, Defense Business Development, ESRI

In the Beginning

Change is a good thing… right? But constant and rapid change gets a little bewildering – it's good to look back and take stock. So I'm going to pause for the next few pages and look back at 20 years of geographic information systems in defence. Then we can return to the fast-paced change!

State-of–the-art 20 years ago was a 386 PC or a Sun 2 Unix box, with the Gunners waiting expectantly for the 8086-based BATES. The Internet came into being in 1983 – but no World Wide Web and connectivity, outside the US scientific community, was scarce. Microsoft Windows 1.0 was about to augment DOS.

And GIS… GIS was a paper map to 99.9% of all defence users. But a revolution had started… a quiet revolution that would have profound impact on the battlespace. It started in Military Survey with the realisation that emerging computing techniques could automate the age-old process of terrain analysis.

Digital GIS is Born

1(BR) Corps implemented the first COTS GIS in a deployed UK headquarters with the Pilot TERAS project which used Laser-Scan's LAMPS2 with an object-oriented database. At least two DSA members were involved – Peter Wood was the overall Project Officer and Chris Dorman was the S02 Geo in 1(BR) Corps responsible for the demos. As a demonstration of potential the project was a great success… unfortunately data collection costs and limited computing power doomed the system almost as much as the crumbling of the Berlin Wall in 1989.

Another revolution in GIS had started two years earlier in the US Defense Mapping Agency – the implementation of the $2.5Bn Digital Production System (DPS). This was the first digital end-to-end map production system and key concepts rehearsed in this system would sweep UK Military Survey into the brave new world of digital production in the years to come. Although firmly a government software program, many COTS GIS software capabilities emerged from DPS (BAE Systems' SOCET SET is a notable example)

Ironically, the same political change that made Pilot TERAS irrelevant as a capability was to expose unforeseen limitations of DPS despite the magnitude of the investment. Political change swept away the geographic certainties of the Cold War and introduced radical new challenges. The new areas of interest could no longer be pre-planned years in advance. New crises popped up off the edge of the mapped world – "thar be dragons!"

Into New Territory

The emerging GIS of 1985 processed spatial information in a 'stand alone' context. Specialists handed off the resulting products as maps to the decision support environment… so time and space ended up being handled as intermittent bursts of information. That was fine if you knew the ground you were going to fight on!

But nobody knew the Gulf in the autumn of 1989. And it wasn't the comfortable, landmark-filled terrain of Western Europe. There were challenges:

- Chris Dorman was still the SO2 Geo in 1 (BR) Corps and well recalls having to do his Terrain Brief and Intelligence Preparation of the Battlefield (IPB) based on books from the Bielefeld Library plus information from the Map Libraries at Military Survey and the Royal Geographic Society (RGS). Terrain knowledge was clearly not pervasive.

- As maps were trickling into theatre at the beginning of Desert Shield, planning boards in HQs were missing some map sheets. In many cases, a blank sheet of paper could be substituted without missing a single major landmark! This was fine for chinagraph on talc operations… it was unlikely to work for emerging defence systems requiring digital geographic information.

- The GPS constellation was up… just! Wealthier young cavalry officers came into theatre with their own GPS receiver and wondered what a grid and datum were… perhaps some education was required.

So the paper map, once again, was the main bearer of geographic knowledge to the warfighter… made smarter with the new Precision Lightweight GPS Receivers (PLGR) which enabled the user to put a very small dot in the middle of a very big sand box.

This pretty much brings us to the middle of our story – the mid 1990s. Some highly specialised niches firmly established GIS.… but the technology had little impact on the battlespace.

Remember the context, in 1995, the Sun SPARC 20 or Silicon Graphics Max Impact is a state-of-the-art workstation and the PC world begins the move to Windows 95…

Across the Atlantic at the US Army Topographic Engineering Center (TEC), a major effort was underway to implement powerful new terrain analysis systems based on COTS GIS – ESRI's ArcInfo (v6) and ERDAS's Imagine (v8.2). This work was a continuation of the Digital Topographic Support System (DTSS) program that had first deployed ArcInfo 4 on Vax workstations in the early 1990s.

The Field Support Office

A dawning realisation grew in the Operational Support Project Branch (OSPB) at Feltham that undertaking a parallel GIS development effort was probably unaffordable. More progress would be made by arranging a government-to-government transfer of the DTSS software. As part of the assessment visits, access was also provided to the DRAWLAND terrain visualisation program – a truly state-of-the-art software application running on Silicon Graphics hardware.

The very first Drawland system being trialed in 1995 – 22 systems eventually became operational by Dec 1996

To bring these systems into service, the OSPB disbanded and the staff moved to Hermitage to establish the Field Support Office (FSO) – a development / support office established at the heart of the geographic support user community. Given that the Commander of 42 Survey Engineer Group at the time was Colonel Peter Walker, this author can confirm that user interests came first, second and last in the work of the FSO!

The author weightlifting with the Explorer 'portable' computer – son of the Cougar career boat anchor

Hardware was an issue as two stories illustrate:

- The FSO acquired a state-of-the art 'laptop' Sun SPARC workstation – the 'Cougar'. During the prototype phase, users compiled a list of 100 uses for the unfortunate 70lb Cougar. Boat anchor and Challenger up-armour were two suggestions. The author seems to recall Colonel Peter's suggestion was 'career stopper'… it didn't go into service.

- The TACISYS vehicle contained a large format plotter carefully mounted on a system of vibration mounts. The design engineers considered this sufficient. The plotters had 0.5 litre CMYK ink reservoirs capped

The first prototype TACISYS operating in Bosnia in mid 1996

with loose fitting rubber bungs. As the first TACISYS rolled into Sarajevo it was discovered that the splashing of the ink early on in the journey had popped the bungs out. It is staggering how much coverage 2 litres of ink can achieve – the tie-dye TACISYS!

At this point perceptions split into two camps. For the change averse, the years from 1995-97 were an out-of-control dash to throw untested, untrained systems at the unsuspecting geo staff. For the drivers of change, the ability to use defence agency-status money to rapidly solve user problems was a refreshing change.

In the space of one year, the count of ArcInfo and Imagine licenses went from 3 to 75 – suddenly the FSO became the largest GIS user in the United Kingdom at that time!

In hindsight, the rapid technology refresh boosted geographic support capabilities and reputations tremendously. The learning curve was steep. Young Sappers, fresh out of training, were introduced to command-line ArcInfo running on less-than-stable Solaris operating systems. The point-and-click user interface was there… but somewhat fragile! But after 6 months on operational tour an amazing expertise developed – expertise which continues to serve Defence Geospatial Intelligence (DGI) and specifically the Geographic Engineer Group (GEG) very well.

The Leap into COTS

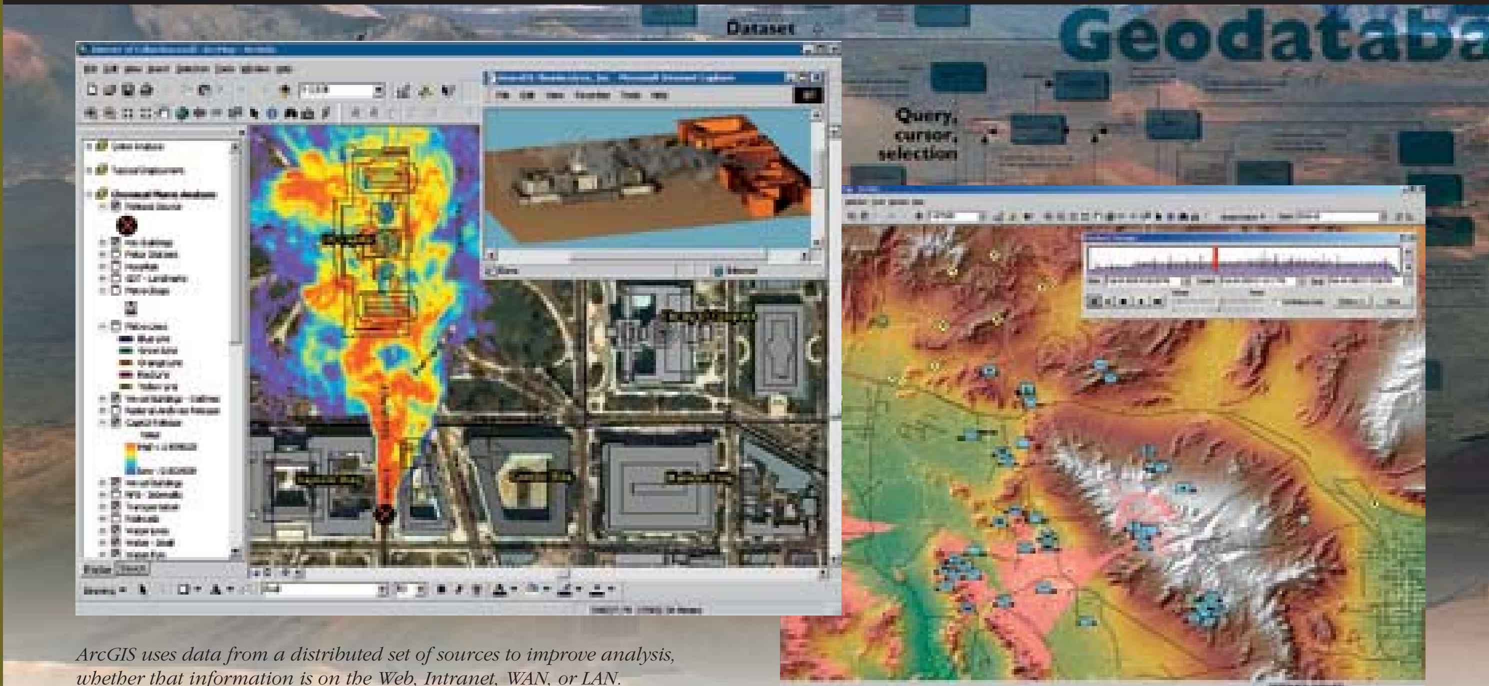
All of this activity grew from the use of GIS… but still contained within the narrow geographic support niche. But in parallel to the work at the FSO, work was underway in HQ LAND to deliver the GP3 command and control system for Digitisation Stage 1[1] … using COTS GIS to provide the Map Display (ESRI's Map Objects and Spatial Database Engine).

This development recognised the need for modern defence systems to handle time and space within the decision support processes – the map display isn't just a scanned map thrown into the display, it is a fused display of the battlespace environment. This enables unfamiliar terrain and fluid, rapidly evolving situations to be readily understood – true situational awareness. It also marked a significant move from government software to COTS – from expensive one-off development to affordable, reusable developments.

But a GIS isn't just about software – it's about hardware, data, organisations and, above all, people. So as the work on defence systems such as GP3 progressed, there was growing awareness that geographic support has a more expansive role than the traditional provision of geographic advice to commanders. The military requires geographic skills to design and develop defence systems and to ensure the safe and consistent use of geographic capabilities when deployed.

Within the last 5 years, this requirement has been institutionalised in the US with the fielding of the Commercial Joint Mapping Tool Kit. This National Geospatial-Intelligence Agency (NGA) initiative provides all US DoD C2 systems with a common suite of geospatial tools based on ESRI's ArcGIS platform. So, a map display in an Army command and control system is the same as the map control in an Air Force mission planning system is the same as the situational awareness display in a Navy force protection system.

GIS Is Making Defence Information Systems Spatial



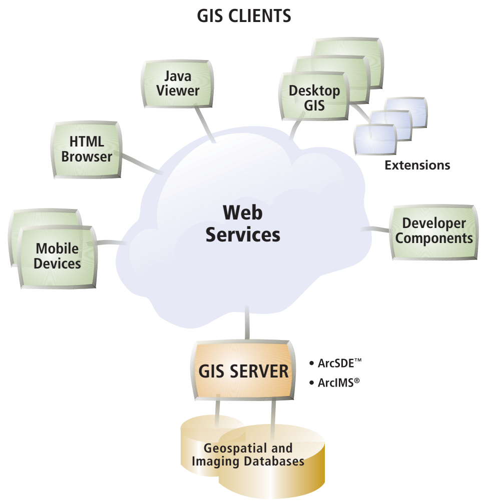
ArcGIS uses data from a distributed set of sources to improve analysis, whether that information is on the Web, Intranet, WAN, or LAN.

ArcGIS offers a MIL-STD 2525B solution that provides unit symbology and tactical graphics.

Make Better Decisions Faster

Geographic information systems (GIS) have become more than just a specialist's tool. ArcGIS™ from ESRI is being used by defence organisations around the world to create powerful spatial information infrastructures. Commanders are discovering that digital maps and spatial analyses help users make better decisions faster.

Built upon modern standards, ArcGIS integrates into the IT infrastructure and can be used to create entire enterprise solutions or stand-alone applications. The same IT that delivers information to your desktop can now deliver and integrate spatial content. This includes situational awareness and decision superiority tools that help achieve battlespace dominance.



DEFENCE AND INTELLIGENCE USERS EMPLOY GIS TO

- Provide terrain analysis.
- Display a Common Operational Picture.
- Create effective facility management systems.
- Integrate battlefield operational systems.
- Perform visibility analysis.
- Develop contingency plans.
- Visualize data in 3D.
- Provide timely decision support.
- Track explosive ordnance removal.

In the United Kingdom contact:

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info@esriuk.com
www.esriuk.com
+44 (01296) 745 500

Worldwide inquiries:

defense@esri.com
www.esri.com/defense
+1 (909) 793 2853

The Modern Era, GIS as a Critical Defence IT Infrastructure

In providing this degree of commonality, the issues of supportability and sustainability are greatly eased… and suddenly, GIS becomes a ubiquitous and critical infrastructure for all defence systems.

Looking back is fun… but many of us are working to deliver the systems of the future. So what's coming? What will we look back on when we're as old as the editor of this publication?

At this point, we break out the crystal ball... huddle round and watch spellbound as the oracle starts to rant…

- All defence systems will be based around high-performance real-time displays of the battlespace. Information will be automatically filtered and operators will be cued into anomalies.
- Real time video feeds will be automatically georegistered into the display.
- Raw images will be orthorectified and mosaiced into the display in real time.
- Targets will automatically be identified from static and video imagery and integrated into the Common Operational Picture as features.
- Decision support staff will work around a digital display that they will control with gestures and that automatically synchronises with displays in remote headquarters. The display will automatically morph into a 3D terrain surface when examining key ground.

Sadly for the cynics amongst you, all of this was demonstrated at ESRI's 25th International User Conference in San Diego in July 2005 - which just shows how fast change is occurring!

It is worth adding that at the 2005 User Conference, the Geographic Engineer Group (GEG) was awarded a Special Achievement in GIS award in recognition of 10 years of innovative GIS work. The award recognises the years of broad-based GIS education and training conducted at the Royal School of Military Survey (RSMS) as well as the deployment of innovative GIS applications. Above all, it recognises the skill of the officers and soldiers of the GEG who push GIS technology to the limits to ensure commanders can make better, faster, battle-winning, life-saving decisions,

[1] *http://www.mod.uk/dpa/projects/ds1.htm*

Major John Tate, SI TERA at RSMS, receives the SAG award on behalf of Commander GEG

1985 – Then and Now, a Laser-Scan Perspective

By Peter Woodsford, Chairman and Non-Executive Director, Laser-Scan

1985 – Horizons Still Constrained By Hardware

Looking back at computing in Survey and Mapping in 1985, the key factors were the struggle to cope with the limitations of hardware and systems and the conceptual and 'evangelising' tasks of getting people to come to grips with the potential of the emerging technologies. Mainframes in production agencies were still the exclusive domain of the IT priesthood, UNIX and VMS workstations were limited by memory and software constraints and PCs were not much more than toys. Thinking and practice were very much map-dominated, so another characteristic of the times was very large, very ingenious and to the present eye 'clunky' special purpose hardware – scanners, flatbed plotters, digitising tables, dual-head screens, disc arrays and jukeboxes….. A prime example was the award-winning Laser-Scan Lasertrak automatic digitising system, see figure 1.

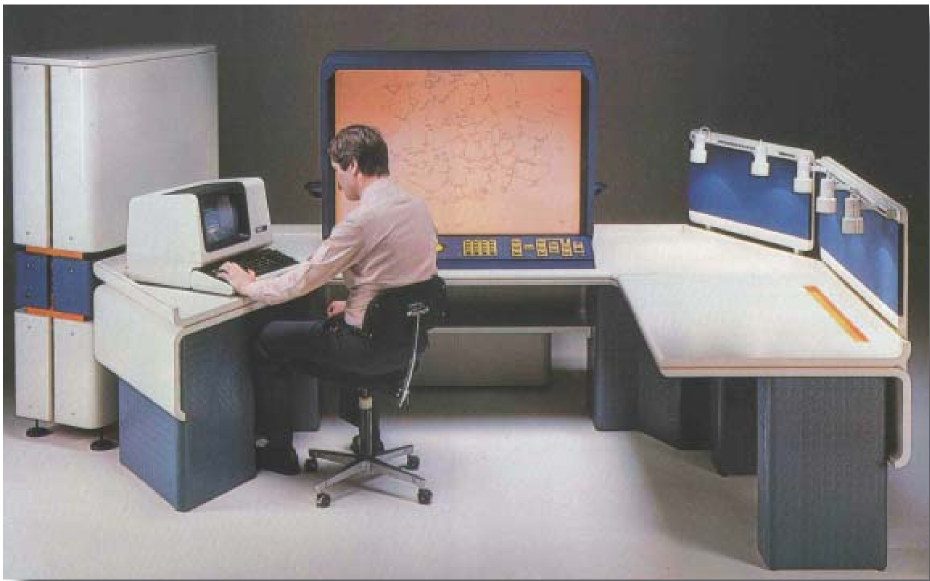


Figure 1. The Lasertrak line-following automatic digitising system

Software was often bespoke adaptations of CAD packages, although the first specialist digital mapping and GIS packages were becoming available. A strange characteristic of the times was the absolute plethora of competing 'standard' data formats. In retrospect that situation in which every discipline, every country and every vendor had its own jealously guarded and incompatible format contained the seeds of a big problem, of which more later.

Laser-Scan's Roots in Defence Mapping

Laser-Scan was a spinoff of two Cambridge University departments – High Energy Physics and Computer-Aided Design – set up to exploit a very versatile and high precision computer controlled laser-deflection system. Early on the company presented the possibility of a laser line-follower for map data to the Joint Advisory Survey Board, beginning informally at the 1971 Commonwealth Survey Officers Conference. We soon learnt that the established technologies were becoming untenable, for reasons of economics and diminishing skills. Perhaps the most cogent example was the time-honoured use of copper engraving at the United Kingdom Hydrographic Office (UKHO).

A series of informal proposals followed by a tendering process for a 'Fast Digitising System' by MCE(RE) Feltham led to the development of the Fastrak system, which was extensively and successfully used for contour and DLMS data capture. It featured a large interactive screen (1.0m x 0.7m) on which the operator could see the source map, direct operations, monitor the line-following laser beam and intervene to make decisions the controlling software was unable to make. By 1985 it had been re-styled to the Lasertrak of figure 1. There was some limited capability for adding attributes to the vector data captured. For example, for the PACE project (Production of Automated Charts Europe), for air chart production a single bit in the data distinguished features to be suppressed at the smaller scale (1:500K) – an early nod in the direction of multi-scale data, of which more later.

The alternative approach to mass vector data capture from mapping sources involved raster scanning the whole source, applying an automatic raster-to-vector conversion algorithm and then using interactive editing to correct errors and do the attribution. This approach was used by companies such as Scitex, Intergraph and SysScan. There were quasi-religious debates between exponents of the two approaches, now largely subsided. SysScan became SysDeco and since 2003 has been part of Laser-Scan.

Raster or Vector

The raster/vector debate subsided not because one side won, but because new factors emerged, primarily powerful PC's with large memories, and because it became evident that raster data was suitable for some purposes, vector for others. Raster maps (or charts) became viable products in their own right, for viewing, location and overlay purposes. Large format scanners and high performance graphics workstations became more capable and more readily available to enable the production of raster products. Laser-Scan was (and is) deeply involved with the Directorate of Military Survey (now Defence Geospatial Intelligence) at Feltham in the production of Arc Standard Raster Product (ASRP) data, a process given a boost by the demands of Desert Storm. The company also worked closely with UKHO on both vector and raster chart flowlines and the Admiralty Raster Chart Service (ARCS) product. Interestingly the raster chart production line involves a digital realisation of the old copper engraving technique. Detail is erased (but not with a hammer) and new detail constructed as vectors and 'burnt-in'.

There have been other major factors, primarily the explosion in the availability and level of detail of imagery. Existing maps are still an important source, although much of the important content has been digitised. The issue in vector data provision now is not more and more intelligent software to capture map data, but more and better feature extraction and change detection from imagery. The same principles of the right balance between machine and human intelligence – algorithm and operator – still apply.

A further factor, only just visible in 1985, is the widespread use of outside contractors, particularly to low cost off-shore operation. From all military data having to be special, and captured inside the magic circle, requirements are increasing being met from civilian and commercial sources.

The World is 3D!

It was a natural progression from the capture of contours and ridge lines to the generation of Digital Terrain Models. In the early 1980s Laser-Scan made the Panacea DTM software package originated by Dr. Mike McCullough of Nottingham University available to MCE for evaluation. Nobody took very much notice until the Falklands conflict arose, when our expert was summoned to Feltham and retained on site until full competency was gained by the MCE staff. Maybe he did work out later that the one area he was not asked to work on was Goose Bay!

The next step was the Terrain Validation and Exploitation System (TVES), which was a first step into 'realism' in terrain models (see figure 2), with shading and draped imagery and symbology overlays. It pushed the Digital VAX VMS workstations of the day to the limit and was the company's first experience of working with a system integrator, Scicon.

An excursion into laser-addressed liquid crystal displays for Command and Control, working with RARDE Fort Halstead and RSRE Malvern, proved to be a blind alley. Industry standard graphics workstations and then PC's proved quite sufficient for the task, as the Pilot TERAS (Terrain Analysis) system established. This used the company's LAMPS2 software linked to an object-oriented database and was successfully

Figure 2. Very early output from the Terrain Evaluation and Exploitation System (TVES)

deployed with BAOR in Germany. The way in which the goalposts for TERAS moved is described by David Swann in his article. The abiding lesson for Laser-Scan was the importance of clean and well-structured data in such applications. The original data for Pilot TERAS was full of minute errors, visually insignificant but which undermined goings and routing calculations to an extent, which made decisions unreliable. Cleaning the data was an early and demanding test for the company's topology engine, which is a key product to this day.

Many users have moved on from LAMPS to its Object-Oriented successor, LAMPS2, but the LAMPS/ Lites2 editing system as used in Pilot TERAS is still in use for atlas production (Philips Maps), hydrographic chart production (UKHO) and air charting (CAA and EAG). Business process aligned software has a long life.

In the 1990s, working with the US Corps of Engineers, the Laser-Scan Gothic Object Database was extended to 3D and the LAMPS2 system closely coupled with the BAE Systems' SOCETSET photogrammetric workstation, to provide a very efficient 3D data capture and maintenance environment. The Gothic environment was also used by several system integrators to develop mission support systems, the most notable being the Merlin ground support system for the Harrier with Computing Devices (later IBM).

The Impact of Open Industry Standards

Laser-Scan received an important research contract in the USA from NIMA in 1997, to define and prototype a Spatial Object Transfer Format (SOTF). The specification for this was that it should be vendor independent, support 2D and 3D objects, optionally with topological structure, and supporting change only (incremental) update and preserving value-added data. The decision was taken to use the mainstream eXtensible Markup Language (XML) even though this was then still in its infancy. The prototype successful demonstrated all the requirements and the results were fed into the OGC (now Open Geospatial Consortium) standardisation process. From this emerged Geography Markup Language (GML), which is rapidly gaining industry acceptance. GML (and XML) data are self-describing, with XMLSchema which are machine-readable manuals for the data. Instead of every format and every format change requiring significant software programming effort, as was the case in the 1980's generation of formats, competent GML/XML software can read and understand the XMLSchema and adopt to any valid data without programming. This is but one example of the benefits arising from open standards based on mainstream IT.

Laser-Scan's Position Today

Laser-Scan has long since dropped out of hardware manufacture, although a small team of our engineers still deploy their optical, mechanical and electronic skills in maintaining scanners and other complex and critical systems (including at Feltham).

Alongside its reliance on open industry standards, Laser-Scan has migrated its proprietary software technology to a mainstream environment based on the Oracle RDBMS. An example is the topology engine, which has been much refined and tested over the years on many heavyweight projects. Perhaps the largest and most successful was the conversion of 225,000 sheets of Ordnance Survey LandLine data (points and lines) into 0.5 billion clean structured area objects in a continuous database. This was completed in under a year by a near automatic process which left less than 1% of objects needing manual editing, probably the largest such data re-engineering project in the world to date.

The topology engine, which had its early testing in Project TERAS, has been made available in an Oracle environment, using standard interfaces and providing server-side topology maintenance to any client. The result – Radius Topology - is widely used by companies such as Intergraph, MapInfo and Autodesk who were once competitors. An application of particular importance currently is in Positional Accuracy Improvement (PAI) – bringing historical data to the accuracy standards required by modern GPS whilst retaining consistency of structure and attribution (see figure 3).

A current R and D focus for Radius Topology is support for 3D topology. 2.5D functionality is well supported but full 3D remains a future goal.

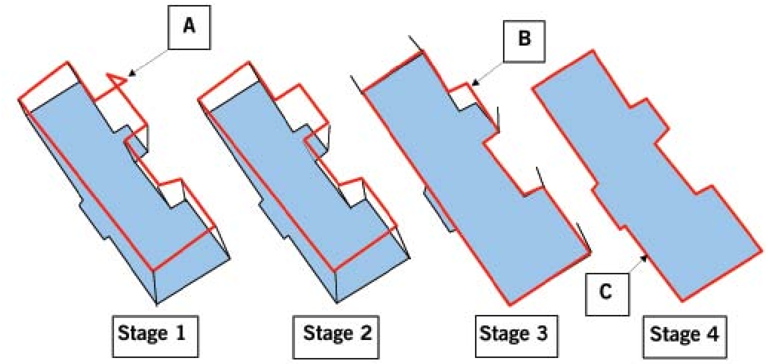
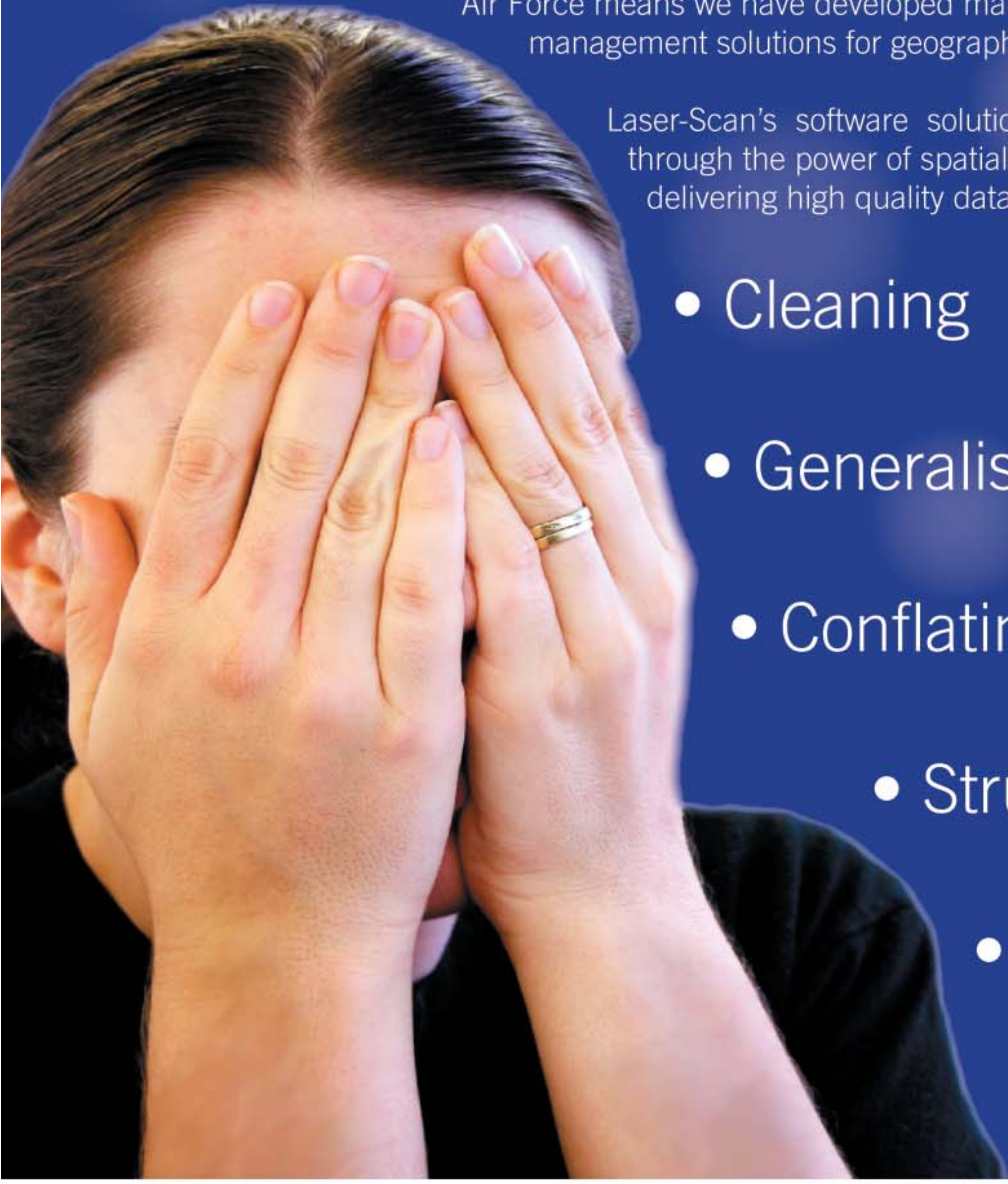


Figure 3. Radius Topology in use today for Positional Accuracy Improvement (PAI). Topological snapping of the utility asset data (red) to the shifted basemap (blue) after a rubber sheet transformation ensures registration and data quality

Another important application of the Laser-Scan rules-based processing environment is in Generalisation and the provision and support of multi-scale data. Enormous strides have been made since the PACE approach, when such dependencies were laboriously hand coded. It is now possible to generalise data across scale factors of at least x5 (eg 1:10K to 1:50K or 1:100K, or 1:50K to 1:250K) with a limited need for human interaction, and to propagate changes from the base scale to the derived scales. So the long-standing goal of a multi-product database is within reach. Laser-Scan's Clarity product, which is the successful commercialisation of EU-funded research with IGN France and three universities, is used in generalisation projects in many countries including France, Germany, Belgium and Great Britain. In Denmark it is used to generate the 1:50K mapping for the military from the national 1:10K framework data (Top10DK).

2005 has seen the introduction of the rules-based processing technology in the mainstream database environment using Application Server technologies. Radius Studio is a J2EE architecture, which enables non-programmers to author and edit spatial data business rules and have web access across the organisation. Studio is particularly used to assure and maintain data quality across an enterprise.

As the above account demonstrates, in Laser-Scan's experience substantial capabilities originating from Defence requirements have been deployed, applied and extended in the wider geospatial marketplace. The pace of technical change has been remarkable and hardware no longer is a limiting factor. However by far the greatest change has been in business practice, particularly in the adaptation of open standards and the move to partnership solutions. The Defence enterprise is no different than other complex enterprises. No vendor has a monopoly on solutions. Meeting the ever-evolving requirements and escalating complexities demands open vendor-neutral architectures and best of breed components. Partnership and the avoidance of lock-in is the only way to succeed.



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Cartographic Engineering

From Simple Photogrammetric Instruments to Digital Imagery in 35 Years

By Roberta Payne, Manager, Cartographic Engineering Limited

35 years ago Cartographic Engineering was formed as a company to manufacture the CP1 Plotter, which was designed by the late Professor EH Thompson of University College London. Continuous development took place on this instrument and over a period of years more than sixty CP1s were delivered worldwide. Some readers of this article will have painful memories of operating this instrument and it certainly was not the easiest photogrammetric instrument in the world to set up and operate but it served the purpose originally intended by Professor Thompson.

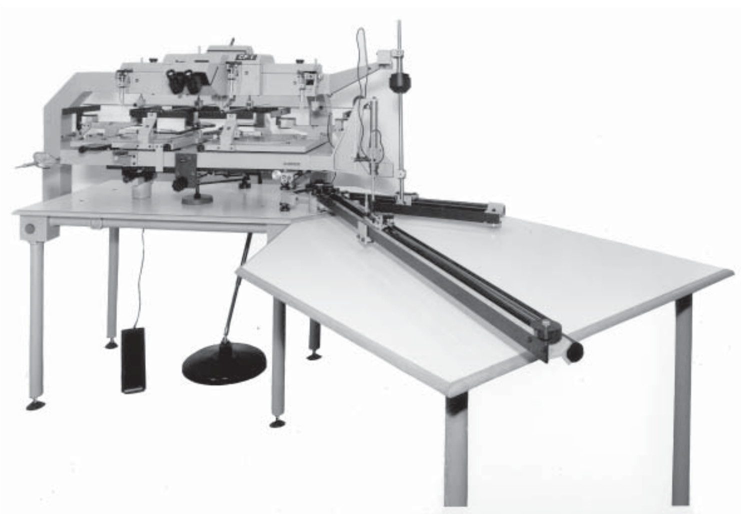
Soon after the company was formed we were offered the opportunity to purchase the rights to manufacture the SB 180 Modular Mirror Stereoscope range, the Radial Line Plotter and SB 115 and 215 Zoom Stereosketches originally manufactured by Hilger and Watts who ceased to trade in the 1970s. The Mirror Stereoscopes had a faithful following worldwide and there was a constant demand for them well into the 1990s. They were a well-made, robust instrument that benefited from a unique parallax measuring unit. There would not have been many photo interpretation courses run within Universities and other teaching establishments which did not use mirror stereoscopes as a basic teaching instrument and a lot of those used were thankfully produced by Cartographic Engineering.

The last instruments developed by us were the AP 190 Analytical Plotter, the CP2 Analytical Plotter and the HS1 Heighting Mirror Stereoscope. However, by the early 1990s we were already seeing a reduced requirement for this type of instrument and we were forced to make the decision to cease manufacturing nearly all of the traditional instruments apart from the Mirror Stereoscopes and Analytical Plotters. During the next few years we watched the demise in demand for these also as the new digital systems gained ground.

But if you can't beat the system join it, and we have now developed our own dual digital camera system, complete with stabilised mount and forward motion compensation. At the present time we are using this ourselves to undertake photography for a very healthy order book.

This shows how far the industry has changed. Unfortunately Cartographic Engineering, the last surviving European manufacturing company of photogrammetric instruments, has decided that we can no longer economically afford to manufacture conventional instruments for the very small demand today and so have reluctantly parted with our workshop and assembly areas to concentrate on the buoyant digital photography market.

Hopefully Cartographic Engineering will be able to continue to ride the waves of change within the industry and develop in the ever-changing market place.



Professor Thompson's CP1 Plotter: one of these instruments has been preserved in the Science Museum store at Wroughton

The SB 185 mirror stereoscope, a long-running product for the company

Squadron Production 1985 – 2005

By Cyril Wright

Thanks are due to Nick Collins, Paul Sleep, Keith Fenton and WO1 Marc Lewis for their help in compiling this article. Photographs provided by Nick Collins.

The author with Nick Collins viewing the Display Print semi-trailer at Barton Stacey and noting that it could well do with a coat of paint

In 1985 13 Map Production Squadron was stationed at Barton Stacey as part of 42 Survey Engineer Regiment, operating, as its title suggested, in a base plant map production role. The print shop was equipped with two double colour Roland Ultra VIs (RZ U VIs), two Heidelberg SORDZ (double colour), two Heidelberg SORD (single colour) and a Heidelberg SORD housed in a semi trailer complete with wind out sides. The semi trailer was painted a fetching Corps blue and used for displays.

Pre press was divided into Photo and Helio and was largely analogue with the notable exception of the Hell Scanner located at Hermitage. The scanner, one of only 4 or 5 in the country at that time, was large format enabling it to scan TPC size map sheets. It had a computer controlled attachment, the Map Data Processor (MDP), which provided a data manipulation facility that was programmed by punched paper tape.

Both 13 and 14 Squadrons were equipped with darkroom cameras (14 had one in a semi trailer and another ground mounted), associated processors, flip top exposing frames and point light source exposing frames. The films used were mainly orthochromatic (line negatives and monochrome halftones) and panchromatic (for colour separations).

The event that dominated 1985 was the move of 13 Squadron to Hermitage. The printing commitment was transferred to Feltham, the Roland Ultras were decommissioned and the printers moved 20 miles up the road into purpose built, air conditioned, technical accommodation that held a brand new Roland 804 (four colour) printing press. The Roland 800 series was, at that time, the largest sheet fed press manufactured by any company in the world - it arrived in 56 crates! The Heidelbergs were floor mounted giving the unit an excellent production capability.

Sapper Tennant and Lance Corporal Walker operating the Roland 804 at Hermitage

The move was not without difficulties; Staff Sergeant Nick Collins (the Squadron Equipment Movement/Procurement Liaison Officer, or SEMPLO) was required to get three quotes to move the equipment. Nick duly went to Vanguard, Heidelberg and another company whose bid came in way below the other two. 'A N Other' was duly awarded the contract but none of the Heidelbergs would function after reinstallation. Eventually Heidelberg were called in to remedy the situation which they did at great expense and with just as great glee. The Squadron became operational in March 1986 with the Heidelbergs working well but the transition from basic Roland Ultra VIs to the state of the art 804 was troublesome, after all, the 804 had proper bells and whistles! Pre press also modernised that year with the acquisition of rapid access films and processors.

In 1990 14 Squadron, based in Ratingen on the outskirts of Düsseldorf, were still equipped with the 30-year old mobile reproduction train housed in six large semi-trailers which included two SORDs and separate camera and dark room 'wagons'. This was the year of OPERATION GRANBY when the Squadron deployed to Saudi Arabia. They took, due to an imposed ceiling on manpower, a total of 51 personnel and, among other equipment, a TACIPRINT with a Rotaprint RA2S press and a TACICAM comprising a Dai Nippon V6500 vertical camera, Agfa ECORAP film processor and

Corporal Graham Sykes operating the Hell scanner

a 35mm film processor. The Rotaprint was designated as RA2S as the cylinder had been especially enlarged in circumference (they were already wide enough) to take the map face of the German M745 1:50,000 series. By Christmas, with the manpower ceiling removed, the initial deployment had been reinforced with almost 50 extra personnel, a freshly painted, desert camouflaged semi-trailer housing a SORD press and the Helio semi-trailer which contained a flip top print down frame, processing sink and a light table. The original prime movers were long since defunct and so the trailers were pulled from the port to the Squadron by Port Handling Units. Then, from somewhere there appeared, and it is still not certain from where, two Seddon Atkinson tractor units with the all-important fifth wheel and desert camouflage which were then driven by Squadron personnel throughout the Operation. In addition to going to war, 1990 also saw the introduction of daylight working film for contacting that could be used in Helio.

During 1993 and 1994 the press in the TACIPRINT was changed from the RA2S to a Roland Practica PR01 and rehoused in a 14-foot ISO container along with a Parker Graphics print down frame, a movable sink and an AO size Plain Paper copier. The latter was later removed as it was not sufficiently robust. The copier has since been replaced with a PC workstation and an Epson 7000 A2 size plotter. The plotter can be used for individual or very short-run monochrome or CMYK products or for plotting onto film to produce positive repmat for printing plates.

The "Ramp" at 14 Squadron in Ratingen

OPERATION GRANBY was the catalyst that saw 13 Squadron's role change in 1995 from base plant production to mobile 'Just in Time' field printing. The Roland 804 was sold to a commercial printer and the five SORD presses from the disbanded Apprentice College at Chepstow were installed into 20-foot widened ISO containers giving birth to a new production train called the Geographic Support System (GSS). The new facility comprises two print wagons, a paper store, a guillotine wagon, a data preparation truck (drawing office) and a Helio truck containing two print down frames and a

The Helio wagon arriving at Hafar-al-Batin towed by a Port Handling Unit

Roy Camp at Hafar-al-Batin

film developer. With the exception of the print wagons, which due to their extra width require Police clearance for road travel, the train is contained in standard 20-foot ISO containers. 14 Squadron also re-equipped with a GSS and 13's SORD and SORDZ were later sold.

1995 also saw 14 Squadron move from Roy Barracks to the 'home' bank of the Rhine, locating at Ayrshire Barracks in Mönchengladbach in April. The move was swiftly followed by a full deployment to Bosnia with the GSS in the December.

The School obtained an image setter in 1996/97 which produced positives but only of Practica size and also in 1997 the RLC printers 'came over' to 'Geo' bringing with them 16 personnel and 24 posts.

The brick factory at Kiseljak, home of Geo in Bosnia in September 1996

The large darkroom cameras remained until they could no longer be maintained as commercial pre press had gone digital. TACICAM filled the repmat/pre press role in the field for a further few years, the difficulty being that it was too small to service the Heidelbergs and eventually it went the same way as the darkroom cameras. Wet processing ended in 1999. Trials were conducted by plotting positive images onto clear film however, the resulting positives were not dimensionally stable and lacked the density necessary for lithographic platemaking, this effectively brought to an end decades of working with negative material.

The School therefore investigated the Agfa Freeway thermal system. The density of the resulting plot was much better but the resolution was not good enough for our requirements. The concept of inkjet to polymer plate was also investigated and does appear to have possibilities for the future but, even to date, it is still in the experimental stage.

The closure of the Survey Production Centre RE in Mönchengladbach in September 1999 saw the end of 54 years of production work in Germany.

A quantum leap forward was made in 2002 when Paul Sleep and Major Julian Brammer were tasked with investigating and acquiring a digital pre press system 'to provide a digital workflow to press from geographic data'. In total three systems were required, a reference system in the School and two mounted in 20 ft ISO containers for the Squadrons.

The system consists of two ruggedised computer stacks containing among other components: two workstations, a data store, a back up library, RIP computer, plate setter computer and uninterruptible power supplies. Output peripherals including AO size HP 1050 plotter, AO Agfa Sherpa Proofer, HP 5500n Printer, input scanners, a plate punch and a Dimension 800 Platesetter. This exceptionally powerful tool has seen pre press revolutionised and brought right up-to-date. The system not only produces digital plates but it is also used for proofing and low volume output for all manner of products.

Finally, the trade groupings and training content have changed considerably over the twenty year period; from Photographic and Print Technicians through Reproduction Technicians to Production Technicians who now encompass the cartographic element of the old trade structure.

The interior of the digital pre press wagon

Twenty Years of Aeronautical Cartography

By WO Andy Fuller, No 1 AIDU RAS

Introduction

No 1 AIDU is about to deploy the first modules of its new, second-generation digital chart production flowline. In order to fully appreciate the radical vision that led to the conception and development of this high technology system, it is advantageous to reflect on the changes and advances over the last twenty years in chart production methods at No 1 AIDU.

A cartographer plots amendments on to the chart 'bible' master copy

The source data for all of No 1 AIDU's Flight Information Publications (FLIP's) comes from national Aeronautical Information Publications, or AIP's. No 1 AIDU takes the textural information in the AIP's and converts it into user friendly formats for use by aircrew, i.e. charts and supplements. Aeronautical information is highly volatile, and the Unit receives over one thousand changes a day, which have to be implemented across its entire product range of publication on the 28-day Aeronautical Information Regulation and Control (AIRAC) cycle. Such a demanding publication cycle requires a highly flexible production system, such as No 1 AIDU has today. But that was not always the case.

The techniques employed twenty years ago were more akin to technical drawing and engraving, and the use of computers was only an emerging aspect of what was to come. Aeronautical charts would start their lives as hand drawn compilations in coloured pencil, which would act as a trace in the production of a master set of 'fair drawings', from which the chart would be photographically processed and printed. Chart 'fair drawing' techniques broadly fell into two main techniques, Stripping Film and Scribing.

Stripping Film Techniques

The first employed a technique which used a material called stripping film. This was essentially a clear membranous film on which text and symbology had been photographed. A dilution of wax and ether was thinly applied to the back of the film to form a photographically transparent adhesive that was firm enough to bond the stripping film to a clear plastic sheet which formed one of the colour separate 'fair drawings' for many years, but which was easily removable when the information required amendment. These drawings had to be maintained in pristine, almost clinical conditions due to their fragility, especially during hot summer months when the wax adhesive softened, therefore enabling unintentional movement of the stripping film patches. The clear plastic 'fair drawing' would be overlaid onto the hand drawn compilation base containing the aeronautical information, which would then be used as a trace for the application of the stripping film imagery.

A positive mask being produced using Cut and Strip techniques

A set of 'fair drawings' would contain literally thousands of individual stripping film patches in order to build up the full aeronautical picture. When a chart was due to be printed, the 'fair drawings' would be individually photographically exposed in contact onto film, thereby creating a film negative. Any imperfections in the image such as spurious spots or scratches would need 'painting' out with a photographically opaque liquid; a process known affectionately as 'duffing'. The 'duffed' negatives would then be used to photographically expose the image onto printing plates, which would be used on the printing presses to mass produce the charts.

Scribing

Scribing was a technique which employed patience, accuracy, and technical skill. A perspex tripod tool which employed three legs, each with a ball bearing as 'feet' had a tool head which carried an industrial sapphire engraving head. A set a sapphire heads enabled line work to be constructed in a variety of line thicknesses measured in thousands of an inch. The tool was used on a material called Scribecoat, which was a clear plastic medium with either a white or orange lacquer layer. Again, using a hand drawn compilation base as a trace, the scribing tool would be used to 'engrave' the line work image by accurately guiding the head along the trace line work. When used on orange Scribecoat, the drawing became a photographic negative; since the orange lacquer was opaque. A white Scribecoat drawing would be mounted on a black board carrier and photographed with a camera to form a positive image. Additional aeronautical information such as stripping film symbology and text could be applied to a white Scribecoat drawing to complete the chart for printing.

Products such as En-Route Charts would be constructed using a mix of the techniques already described. The chart graticule and coastline drawings would be constructed using negative scribing techniques. Photographic masking techniques would be used to produce the coastal vignette blending. These elements formed the 'master' chart drawings from which other components would be compiled. The graticule and coastline drawing would be used to produce compilation bases on which the aeronautical information would be plotted in coloured pencil. These formed the trace drawings from which the stripping film 'fair drawings' would be constructed. The complete construction of a brand new chart could take a team of two cartographers upwards of six months, so the construction of a whole series of new charts was a process that could last many years. It is worth noting that these techniques were not peculiar to No 1 AIDU, or aeronautical cartography. Stripping film and scribing techniques were the industry standard practices of the day and were used prolifically by major mapping agencies such as UKHO, Ordnance Survey and Military Survey. Even today, master drawings produced using these techniques are still in production around the world.

Computers and Cartography

After a period of prototyping and experimentation, No 1 AIDU deployed its first automated cartography system in 1985. The chosen system was Laser-Scans LITES2 software, and it was initially used for the construction of En-Route Chart coastline and graticule film drawings. The output device was a Ferranti Flatbed plotter, a machine which featured a travelling gantry which moved in the x and y axis, and had a circular rotating tool head armed with an array of negative symbology discs through which line work and imagery could be exposed onto film. At around the same time, two Laser-Scan Laserplotters were deployed which enabled the production of A4 and A5 products such as Terminal Approach Procedure charts and Helicopter Landing Site graphics. At this time, aeronautical information was still compiled by hand in pencil, and then digitised into the LITES2 system. The individual A4/A5 graphics where trimmed to size and mounted on plastic carriers called Signatures from which they were exposed onto negative film, 'duffed', and then printed. From this time, the Air Cartographers experienced a fundamental shift in their skill sets from traditional manual techniques to those of computer operators and software programming. As these skills increased, the working practices evolved and improved to gradually increase the levels of automation and capability.

Aeronautical Databases

In parallel to the cartographic advances being made, the Unit was developing a joint capability with the United States to produce a military aeronautical database called DAFIF (Digital Aeronautical Flight Information File). The development of this system introduced FORTRAN programming, SQL, and database design and development skills, and so the provision of aeronautical information as data made its debut.

GRAPHIS

In 1996 a link was formed between the cartographic system and DAFIF whereby for the first time charts could be constructed with information extracted from the database. This in-house written software was called GRAPHIS (Graphic Information System), and enabled the rapid construction of major products such as En-Route Charts, Low Flying Charts, and Maritime Tactical Pilotage Charts. Suddenly, charts that would previously take upwards of six months to construct could now be built in a matter of days. This increased the Units ability to respond to user requests and operational requirements significantly.

Output Devices

The final missing piece in this capability was an output device capable of producing A0 sized film images of the charts, which the Laserplotters were not able to do. This was resolved with the procurement of a BARCO Megasetter film plotter which enabled the production of the large format charts. No 1 AIDU now had all the assets in place to form an end-to-end digital production line all under one roof, from initial compilation to printing and finishing. It is believed that No 1 AIDU was the first agency in the aviation business to achieve that. This flow line is still in place; the major difference being the procurement of two BARCO Viking CTP (computer to plate) output machines which enabled chart data to be produced directly onto printing plates, thereby eliminating the film stage in the process. The entire flow line has enabled No 1 AIDU to greatly increase the range of products and services it offers to UK military users, and even today it is still technologically ahead of many of its sister organisations in its field.

The Gothic Aeronautical Production System (APS)

Each chart's files are maintained separately by a data maintenance team. Since numerous charts overlap one another, one change to the source data could impact many charts. Other paper and digital products are also affected in the same way. Updating the charts involves much duplication of effort and leads to possible inconsistencies between the products. No 1 AIDU's vision was to implement a system that could produce and maintain a variety of digital and paper products, including En-Route charts, using a single main data store; an Aeronautical Object

Oriented Database (AOODB).

No 1 AIDU also wished to automate its chart production process. Although digital, this was originally a highly interactive task as, although the features and objects on each chart had been digitized, they contained no intelligence. If features have intelligence they can decide how to represent themselves depending on the type of chart and their interaction with other features on the chart. The vision and requirement was to continuously model the whole world within a single geographical dataset. This allows aeronautical features to cross the International Date Line as well as the North and South Poles. Temporal functionality overcomes the production constraints placed on No 1 AIDU by the 28-day AIRAC cycle, and the APS allows amendments to the database at any time, regardless of the amendment's activation date. This allows air cartographers to make updates beyond the current cycle and spreads the workload more evenly.

Data Quality

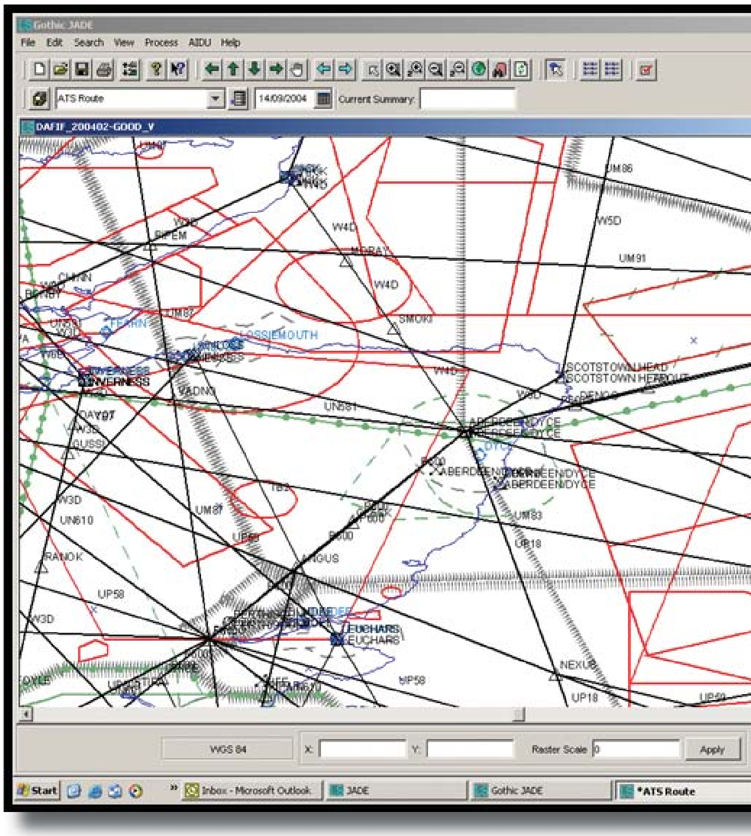
The DAFIF specification contains an extensive set of validation rules, and the APS is the first system to fully implement these rules. Aeronautical data can be amended using a suite of purpose built user interface screens, and each amendment validated against the rules prior to being committed into the database. Invalid data will be rejected thereby ensuring excellent data quality. Features in the database have intelligence, and know how to display themselves when interacting with other aeronautical features. For example, airspace boundaries use different symbology depending on whether or not they share a boundary segment with another feature. This intelligence is achieved though a combination of attribution, spatial relationships and topology.

Real World Context

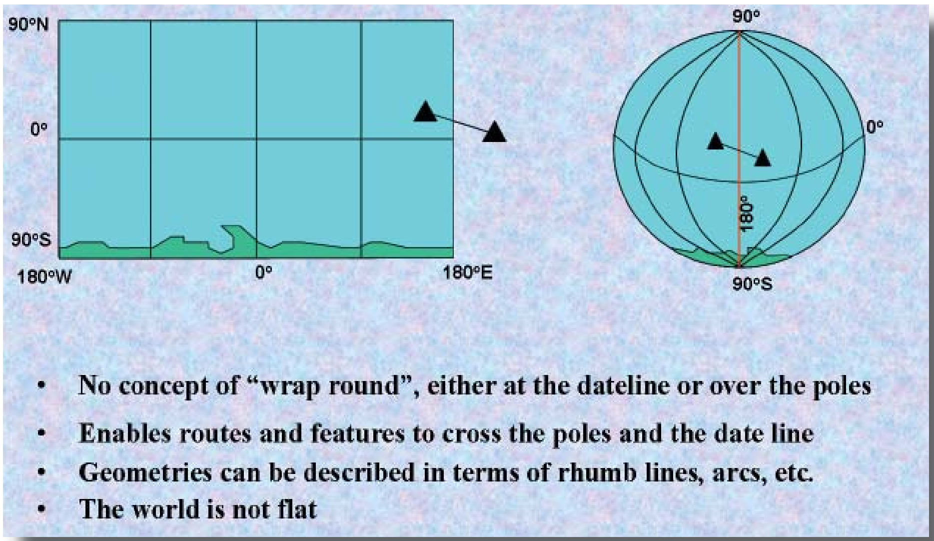
Data in the database is stored in a seamless WGS84 spheroid model called 'Whole Earth', which enables the data to be stored and handled in a real world context. There is no concept of 'wrap around' either at the date line or over the poles, and it enables features to be described in such real world contexts as Great Circles, Rhumb Lines etc. The system stores and handles data under the obvious presumption that the world is not flat.

Multi-Product Database

The Gothic APS is a single database of aeronautical information, which will produce chart products such as En-Route and Low Flying charts, text documents such as En-Route Supplements, and pure data which will be used on Mission Planning systems, and Flight Management Systems on board aircraft. The data will actually fly the aircraft, and so the quality assurance and validation aspects of the system will be of obvious importance. As changes occur to the data, they will be automatically reflected across the entire product range, thereby eliminating the need to repeatedly amend dozens of files. The APS features a highly effective automated text placement system which enables the rapid assembly of charts anywhere in the world.



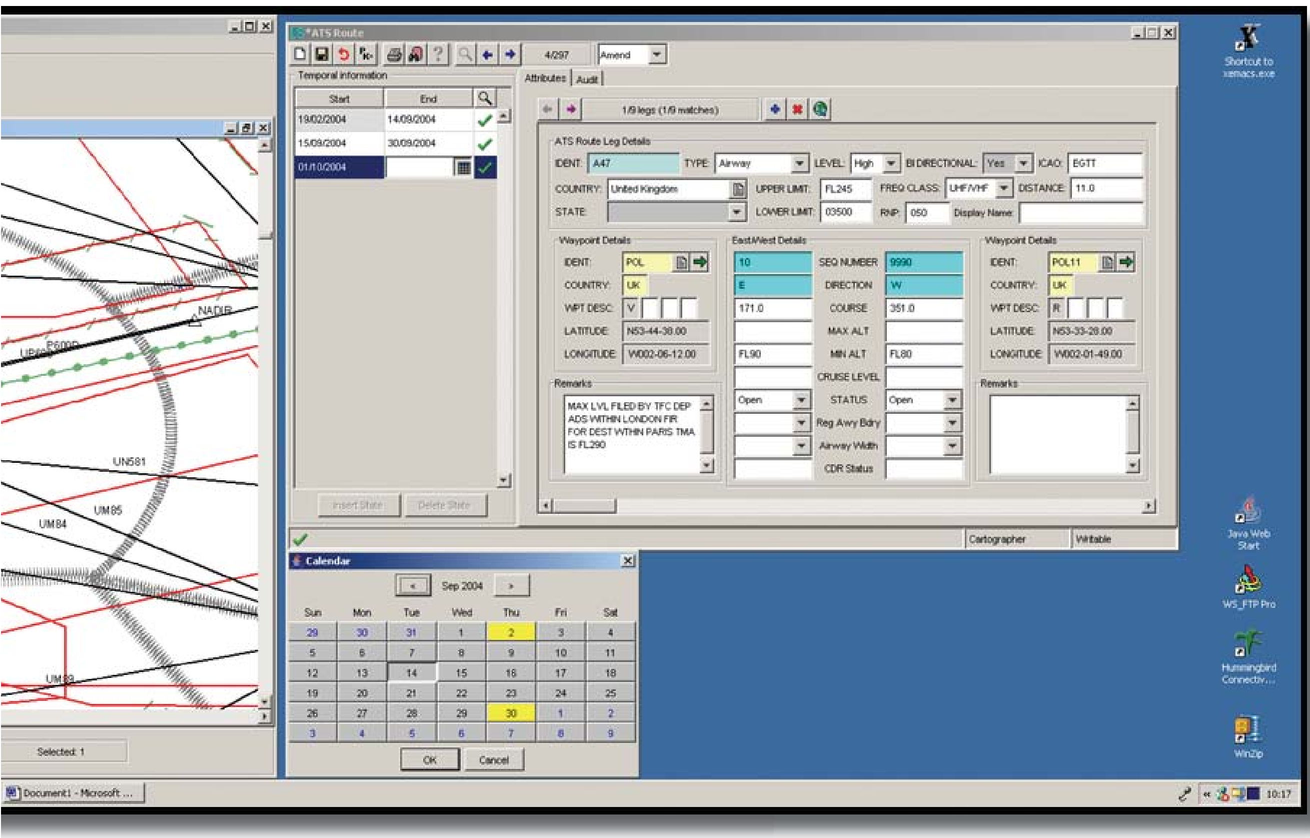
Screen shot from the Gothic APS



The 'Whole Earth' concept

Twenty Years of Technological Advances

The Gothic APS is an exciting technological leap forward, and is a world leading system that is a far cry from the tools and working practices of twenty years ago. The APS is actually the accumulation of the knowledge and experience acquired during the last twenty years or more, and its realization is a credit to the staff of both No 1 AIDU who designed the concept, and Laser-Scan who built it. The increased utility, responsiveness, and data integrity that the system provides will make a significant contribution to flight safety and will enable No 1 AIDU to meet the needs of the Royal Air Force for the future.



Twenty Years of Map Supply

By Rod Siggs, Head MOD Map and Air Chart Depot

The aim of the UK's military map and air chart supply function is:

"To put the right map, in the right place, at the right time – every time"

Ah! Then there's been no change during the last 20 years because that's been the functional aim ever since I can remember? If that's what you think then you can be forgiven for being misled. The aim and functional principles of map supply have not changed and although there are similarities in the way the business is still undertaken, there have been many significant changes over the period.

8 Map and Air Chart Depot at Guildford

The Cold War still raged in 1985 and map supply was a major part of every contingency plan and training exercise held, as is still the case today. Since 1985 there has been a procession of large operations that have required the deployment of Geographic troops to undertake all the normal geographic support functions including that of map supply. Many of those operations, and some from even earlier times, are still ongoing today and still require direct map supply support which has been honed to a fine art. Examples are: Northern Ireland, the Falklands Islands and Cyprus, Former Republic of Yugoslavia (FYR) and more recently both Afghanistan and Iraq.

The Depots

The principal MOD depot was 8 Map and Air Chart Depot RE (8MACD) housed in a fairly dilapidated former vehicle depot at Guildford. In 1985 it was commanded by a major with a WO2 as the only other military presence. The other major depot was 3 BAOR Map Depot, part of 14 Topographic Squadron since 1977, which was located at Ratingen near Düsseldorf and there was a Corps Map Depot (CMD) for wartime use at Herford.

Interior view of the Map Depot at Guildford

Returned stocks at Guildford after the Gulf War

A 'War Reserve Map Depot' (WRMD) holding 3 millions sheets was maintained jointly by Northern Army Group (NORTHAG) and Second Allied Tactical Air Force (2ATAF) which also had numerous unmanned map stores throughout their regions storing a further million sheets. HQ UK Land Forces maintained a WRMD holding stocks to meet specific joint theatre plans. It was initially with 42 Regiment at Barton Stacey, moved to Hermitage then onto Guildford to collocate with 8 MACD and was disbanded finally upon 8 Depot's relocation to Feltham.

Upon activating mobilisation plans stocks were fed forward to Corps units via Map Distribution Points that were set up in the Corps Replenishment Parks and the Map Supply Points.

September 2000 saw the map stocks from Guildford moved to Feltham with 8 MACD disbanded and replaced by the MOD Map and Air Chart Depot (MOD MACD), a branch of the Defence Geographic Centre.

The Map Supply Point (MapSP)

Map supply in the field was carried out from MapSP vehicles. These were 4 tonne trucks equipped with racking to support approximately 66 map cartons each with a total capacity of 1,000 maps. The sides could be dropped to the horizontal to form a working platform or walkway around the racking. The canvass sides were pushed out to provide some weather protection and the vehicle carried stores for self-sufficiency.

The MapSP has survived and looks very similar today to that which existed 25 years ago. Still mounted on a 4 tonne Bedford Flatbed and with a crew of two Geo soldiers but now fitted with modular racking which enables different configurations depending upon support requirements. It is capable of holding 70,000 maps easily, has better field support stores, a vehicle mounted 110 volt generator, lighting kit, emergency lights and even a heater and, depending upon configuration, there is even space for the crew's bunk beds. The vehicle is normally part of an HQ packet and will be looked after administratively, militarily and defensively but is still very capable of operating as a standalone function. MapSPs are currently held by 13, 14 and 135 Squadrons.

The Map Supplier's Trade

In order to appreciate map supply and its development it is necessary to briefly look back before 1985. Historically map supply was strictly the task of the 50-strong Storeman Survey trade group who were employed mainly in 3 BAOR Map Depot, 42 Survey Engineer Regiment, 8 Map and Air Chart Depot and the School of Military Survey with a few posts in various formation headquarters. Unfortunately, the recruitment and retention rate for the Storemen had never been good and their career structure appeared limited hence it was decided to try and re-vamp the trade by changing both the syllabus and title. In October 1980 the Combat Surveyor trade was launched. Gone were many of the peripheral skills and knowledge such as bookbinding, paper manufacture and map mounting as the new employment concentrated on map supply and guillotine operation.

Every adult entrant Geo soldier undertook the Class 3 Combat Surveyor training and then practised those skills for a number of months, often at 14 Squadron, before undertaking any other primary technical employment training. There was a now career structure to progress as a Combat Surveyor for those who chose it or who failed to meet the requirements of other Geographic technical employments. This employment category continued until 1992 when a major review of the employment structure reduced the geographic employments down to three, all of which included a common module on map supply. And so, a function that was originally the poor relation and practised by only a few became, and still is, a function carried out by all Geo soldiers.

'Bibles' and Plans

The map supplier's 'bible' was NATO Geographic Policy which was augmented in 1983 by two very distinctive, yet integrated, map supply policies for land mapping and air charts – NORMAP 80 and

A MapSP supplying UN Forces in Bosnia

The MOD Map and Air Chart Depot in Clough Building at Feltham

AIRCHART 81. These two policies remained virtually unchanged until the collapse of the end of the Cold War when all such plans were no longer applicable. All plans were based on a 30-day war with stocks for days 1 to 7 printed and reserved on the Depot shelves as prepared Map Supply Point (MapSP) packs. Contingency printing plans to satisfy days 8-30 were practiced regularly under Exercises DOMINATE and PRINTDOWN (held on alternate years) when UK-based technicians including TA Soldiers from 135 Squadron reinforced both 14 Squadron and the Survey Production Centre RE. The distribution of the printed stock was acknowledged to be a major undertaking and had only been fully practised, using mock maps known as SIMMAPS, in 1980 on Exercise CRUSADER80 and again in 1984 during Exercise LIONHEART. These two huge exercises were the largest peacetime mobilisations held during the entire period of the Cold War. Smaller exercises were carried out on a regular basis right through until the reunification of Germany.

Change of Stock Policy

Map stocks were produced and stored on a 'Just in case' basis against possible operational options. This resulted in very large numbers of sheets and product lines sitting on shelves, the vast majority of which only moved upon replacement by a later edition. In 1995, 8 MACD at Guildford held approximately 27 million map sheets of 21,000 different products. Even this huge figure was a reduction of some millions on the holdings of 1985. When the Depot moved from Guildford during September 2000 the count was approximately 11,500,000. The latest count for the National Audit Office at the end of March 2005 was approximately 6,900,000 maps of 26,000 different line items. This has been brought about by the change to a 'Provision on Warning' policy introduced in 1997. Basically the principle is that if you do not have a regular and/or recognised requirement to physically store a geographic product, and you can provision it within stated availability criteria, then there is no need to store it. Put another way: "If we don't store it, we know a man that does".

Post-Cold War Operations

During the first Gulf War 1990 - 1991, 8 MACD receipted in more than 19 million items of geographic material and more than 13 million were dispatched. More than 620 tons of mapping was airlifted to the Middle East and Map Supply specialists were seconded from 14 Squadron to the USA's Middle East Theatre Map Depot to assist with the American's map supply process.

Many more maps were produced in the Gulf Theatre by the deployed 14 Sqn, and a quote from the Daily Mail – Thursday January 10th read:

"With possession of large scale maps of the desert kingdom a capital offence under Saudi law, the Royal Engineers have been working overtime to provide their commanders with the charts for war. Now their formidable task has been completed with astonishing speed and accuracy. The finished products are much sought after by the Saudis and other allied military leaders."

For Operation TELIC, the Iraq War, the MOD MACD receipted in approximately 7 million items and dispatched 4.5 million. Again, experienced Map Supply specialists were seconded to the USA's Middle East Theatre Map Depot from 13 and 14 Squadrons to assist with the map supply process and remain there currently. Personnel from 135 Squadron (TA) were also mobilised and deployed to the Forward Map Distribution Point (FMDP) in Kuwait, later moving into Basrah to run front line map supply. Two other TA soldiers have also supported their regular map supply colleagues for Operation TELIC 2 in the FMDP.

Depots Today

The MOD MACD handles 14.5 million maps annually although this rises dramatically during periods of high operational support. It now supplies CD ROMS, is the focal point in the DGC for digital requests as well as paper and is the largest provider of geographic data in the Defence Geospatial Intelligence organisation.

14 Squadron still maintains a map depot in Germany to support the remaining 25,000 or so UK Forces still based in NW Europe. Staffing has been greatly reduced through the years and consists of only 1 military post and 4 locally employed civilians. Six MapSPs are still based there although many are still deployed on current operations. So business is very much reduced but exists for the foreseeable future.

The two map depots store and maintain sufficient quantities of geographic products to meet the every day requirements of:

- Tri-service Regular, TA and Cadet Forces
- Other UK map stores worldwide.
- Other Nations with exchange agreements.
- Other UK and Foreign government departments and organisations
- International organisations
- The maintenance of a 24/7 supply capability

When will digital products completely replace paper? – Not completely for some time yet, although the pace has recently quickened with the USA's introduction of remote plotting/printing on demand of some of its products. The Defence Geographic Centre's own Rapid Replication capability is also now in full swing and has resulted in another map stocking policy re-think. Reductions are likely and the way in which the 'customers' are supplied with their geographic data is a moving feast. Only one thing is certain - The next 20 years will move at a much faster pace than the last 20 years.

And Finally.....

Even the subject of 'map supply' goes under a different name these days, now being referred to as 'Geographic Information Dissemination' or GID, a term which more accurately reflects the diverse nature of the role today.

The Whitehall Crystal Ball

The Next twenty Years

By Brigadier Nick Rigby, Director Intelligence Joint Environment

I write this brief for the Editor as usual at the last minute and whilst on Eurostar to attend a meeting in the European Commission discussing the EU Satellite Centre budget and work plan for 2006 and beyond. Thus I find myself staring out of the window at the Belgium countryside for inspiration. For those reading who like the Editor and myself have spent too much of our mis-spent youth on military exercises on such terrain, usually in rain or drizzle conditions as is today, you'll agree that such required inspiration is a tad difficult to say the least. Yet one thought does come to mind as we are about to celebrate Remembrance Sunday, that all those years ago in 1914, we the Armed Forces, were 'about' expeditionary warfare. We then entered a period of static operations – trench warfare, and the style and tempo of warfare ebbed and flowed over the next 80 years or so until we saw the end of the Cold War. Since the late 1980s and early 1990s the Armed Forces has slowly begun to alter its doctrine and strategy to that again, funny old thing, of supporting expeditionary operations, yet now throughout the spectrum of conflict, from peace keeping to armoured warfare. This doctrine, strategy and new concepts will continue apace to support evolving foreign policy. What goes around, comes around!

Another paradigm shift I think we are in is that no longer does the military drive technology as it has done for the last 40 years or more. We are now in a period, where, we the military, find ourselves adapting and reacting to modern technology. Indeed, currently in some areas technology is developing at a pace such that our tried and tested means of assessing the new capabilities, formulating a requirement and ultimately procuring/acquiring the technology is so slow that the new capability has moved on.

I thought I'd try and look into the future regarding where do we think we shall be, using the Tasking, Collection, Processing, Exploitation and Dissemination (TCPED) process, interwoven with some of the defence equipment and non-equipment lines of development.

Tasking

We are already witnessing the development of RE (Geo) support not merely to the land component but becoming a truly 'defence' asset. Tasking, and therefore support to it, is becoming rich and diverse and this trend will be set to continue with RE (Geo) becoming a very much 'joint' enabling capability. This tasking will not only be vertical in nature but also horizontal and by that I mean, part of the tipping and cueing process. The Recognised Environmental Picture (REP) will be a fundamental building block supporting Networked Enabled Capability (NEC) therefore all operational planning and execution will involve either large or smaller elements of the REP which will contain all, or only part, of its various components. This embedded technology will be served up as the geospatial layer to the intelligence community allowing the signal intelligence operators to see what they are hearing, to help precisely mensurate targets for the targeting community. This tasking will be multi-functional and multi-dimensional and, if nothing else, rapid. It will be tasked to an environmental or geospatial cell which is multi-skilled and multi-cap badged. Whilst an operation may be land centric, if tasking is to include meteorological data, aeronautical information, supported by aviation assets from a carrier strike force, then tasking will be to a truly joint geospatial cell.

Perhaps a brief word on structure and by this I mean both the structure of geospatial support and the structures being supported. If we are talking of multi-tasking in the battlespace then our current structures in terms of processing, exploitation and dissemination have to change and this predominately affects the land components. We shall no longer be deploying to the rear areas of formations a large support group, rather we shall be increasing the organic geo support to specialist units and formations with access to the home base via a range of technologies. Our technicians, with database skills more akin to an information manager will, because of their understanding of data/information, proliferate throughout the battlespace – not in large numbers but in discreet packages, providing subject matter expertise as the interface between the geo cells and the intelligence customer. Again they will be multi-disciplinary, meaning they could be X(HM)'s, RE(Geo) or in the current parlance, air cartos or, perhaps in 10 years time they will be a single geo int specialist! They will be working hand in glove with other intelligence specialists either in small numbers or as part of operational intelligence support groupings. What I have described are structures that support

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operations and training. Peacetime structures may well remain for different reasons such as career opportunities, command and control, esprit de corps and so on. Thus perceptibly there could still remain the RN Surveying Squadron, Geo Regiment, the Mobile Met Unit and AIDU, though they may be more purple rather than green, dark and light blue.

Finally on people and structures, a word on collaboration with other nations and predominately the Commonwealth. Across the geospatial domain we have much in common with the Americans/Canadians, Australians and Kiwis. This I believe will continue and develop further through collaborative tasking and ultimately exploitation and production. Likewise, though perhaps to a lesser extent, with our NATO/European partners. Here I judge and hope that the Commonwealth and NATO/European divide will lessen because of our ability to work closer together and trust each others processes and ultimately, outputs and services.

Collection and Processing

In the TCPED process I shall briefly look at collection. This again will develop into a multi-disciplinary business with all collectors able to feedback to the operational and strategic levels. Tasking plans and priorities will involve all sensors available be they space based, air breather, land based, sea or sub surface.   This means a greater degree of transparency and sharing of information under the maxim of collect once, share many times! A satellite imagery collection should not only produce IMINT but also help provide the geospatial layers for SIGINT; for feature extraction for the topographic community and in littoral areas produce bathymetry. That is one of the nirvanas we are working towards and we are not that far away.

Further, although the collection may be overt or covert, the processing is undertaken strategically, operationally and tactically and the data passed to the home base, not withstanding the ability to undertake first phase analysis at the point/area of collection. The more in-depth post processing and population of databases for exploitation will be done in the UK. First phase analysis needs to be undertaken immediately upon collection in case the information is either perishable or of strategic interest i.e. the bridge is blown or the road is impassable; there is a sea mount previously not published and boats are operating in the area or there is a piece of level terrain that with some basic engineer assistance can be developed into a forward operating base. Thus there will be a process for both updating in-theatre databases as well as passing the collected information to the home base. Such technology already exists to a greater or lesser extent. Yet that collection technology is moving on apace because now we can collect and import SAR, LIDAR, ONIR, multi beam, high resolution Commercial Satellite Imagery and so on. This will require new skill sets to assimilate and exploit.

Exploitation

In the area of exploitation more and more will be undertaken automatically; auto feature extraction; broad area search; auto change detection techniques will all exist because of the plethora of data sources and their collection. There are not enough trained technicians to undertake these tasks and therefore technology will enable and help solve the information deluge. Exploitation workstations will be completely agnostic in the source material they ingest and the toolsets used will be truly joint, combined and universal in application across defence and amongst our major coalition partners.

The work of Digital Geospatial Information Working Group, Geospatial-Intelligence Standards Working Group et al has successfully migrated to using ‘open standards’ in the military/civilian domain and as a consequence the Specialist Environmental Centres (SECs) UKHO, AIDU, DGC MetO will become information brokers. They will only themselves exploit to produce niche data/productions, the rest will be outsourced and the effort placed on data accuracy and authenticity, guaranteeing to the user community the quality of the data/products and services. It may have been produced by OS, NGA, ESRI, Intergraph or the Republic of China, the user doesn’t care, as far as he/she is concerned it has been authenticated by DI JE and is therefore ‘good to go’.

Dissemination

'To go' is the operative expression. The issues of data dissemination, or rather lack of, in the decade 1999 to 2009 will have long since disappeared in 2025 as 'comms' pipes proliferate everywhere, broadband is now gigantic band, whilst compression techniques/ratios abound and the real issues of the day are those of information management and trusted info/sites. The geospatial community has long understood this and, via influence at the senior levels, has assured the defence community that as long as they listen and heed the specialist advice the mission planning systems will continue to function; people and platforms arrive at the designated areas precisely in space and time; and ultimately planning, training and operations continues because somebody has ensured that the geospatial information is timely, relevant and accurate.

The People

Perhaps the last word should go to people in the community that make all this happen. Certainly the skill sets will undoubtedly change; the training to deliver this will; they will be more integrated into the communities they serve and they may have different cap badges/civilian trade/professional groups than that which currently exist today. I envisage that which will not change is the calibre of individual, be it military or civilian, that is required to do the work nor the professional dedication again which exudes today. What sets the UK Defence Capability aside from all others is the professionalism that people, individually and collectively, demonstrate. Whilst the doctrine, equipment, training, dissemination may change, those personal qualities will endure for another generation for they have served defence diplomacy well for past generations and they will, if nurtured, do so for the next.

N.B. *Views expressed are those personal of Brig Rigby and are not official MOD policy.*

Christmas Cards

Many Military Survey units and RN Hydrographic ships, particularly during the Second World War, produced their own Christmas cards. These cards were often of a very high quality as they were drawn by cartographers who also had considerable artist skill. The editor would like to borrow any examples of ship/unit cards that readers may have in order to produce an article for next winter's issue of Ranger. All cards will be very well looked after and quickly returned to the owner. Cards should be sent to Alan Gordon, 1 Majorca Avenue, Andover, SP10 1JW. Any queries - please call him on 01264 359 700.

RE Survey in India: 1943-1947

Donald Thyer, a former RE Survey sergeant, has written a fascinating account of his time with 72 Base Map Reproduction Section RE and later with GSGS GHQ India Command. The article details his training at Ruabon, background to 72 BMRS and other Survey units in India at the time. He includes very interesting descriptions of life as a BOR (British Other Rank) in the North West Frontier, Dehra Dun and Delhi, where he was serving when India gained independence and was partitioned. The article can be found at www.britains-smallwars/India/Survey.