ISSN 0035-8878

THE ROYAL ENGINEERS JOURNAL

Volume 101 SEPTEMBER 1987 No 3

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ISSN 0035-8878

THE ROYAL ENGINEERS JOURNAL

© *Published Quarterly by The Institution of Royal Engineers, Chatham, Kent ME4 4UG. Telephone Medway (0634) 42669* ©

Printed by Staples Printers Rochester Limited, Love Lane, Rochester, Kent

Volume 101 SEPTEMBER 1987 No. 3

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Authors alone are responsible for the statements made and the opinions expressed in their papers 4,250

Editorial

THE AVRE SAGA

THE focus of this issue is on a major Sapper success story, the arrival in BAOR of the Chieftain AVRE. Old hands who remember the part played by AVREs in World War 2 might wonder what the fuss is about but the fact is that, as the articles explain, our declining ability to render proper support for armoured formations has been a matter of much concern over the last two decades.

It is particularly gratifying that the rectifying of this position has come about by the coordinated efforts of the whole Sapper organisation. Commanders in 1 (BR) Corps should be relieved that the "one base" concept economies of the 70s did not throw the baby Willich out with the bath water.

Those who have brought the new AVRE to fruition are to be congratulated. It is worth remembering, too, that their success owes much to the vision and determination of their predecessors whose consistent advice to commanders prevented the species from extinction, despite its apparent sacrifice for the admirable CET, so that the firm base was built up at Munsterlager without which the new development would have been difficult if not impossible.

* * * * *

Visit of Her Majesty The Queen to the Corps at Chatham on Wednesday 20 May 1987

LIEUT COLONEL R J B WILLIAMS RE–SO1 RE 200 PLANNING TEAM

Two hundred years ago, in April 1787, the Corps of Engineers, which consisted at that time only of officers, received a Warrant from King George III authorising the style and title of Corps of "Royal" Engineers. In October of the same year the Corps of Royal Military Artificers was formed: although separate from the Royal Engineers they were officered by them and were the antecedents of the Royal Sappers and Miners who were absorbed into the Corps in 1856. Thus in 1987 both the officers and the soldiers of the Corps have held their Royal title for 200 years, which explains briefly the justification for this year's many bi-centennial celebrations.

The climax of the RE 200 celebrations took place on Wednesday 20 May when, on a bright spring day, Her Majesty The Queen, Colonel-in-Chief of the Royal Engineers graciously visited her Corps at Chatham. She was entertained by many excellent displays and demonstrations illustrating the enormous range and variety of Royal Engineer activities throughout the ages and Her Majesty concluded her visit by officially opening the Royal Engineers Museum in its new quarters in the Ravelin Building.

The Royal visit commenced at 1035 hours when The Queen arrived at Chatham railway station where she was received by the Right Honourable Robin Leigh-Pemberton, the Lord Lieutenant of Kent, and other civic dignitaries.

The first Sapper problem to be overcome was to ensure that Her Majesty had a dignified route by which to leave the station. Those who know Chatham railway station well may recall that the siding immediately adjacent to the car park no longer has any track. The Royal railway carriage could not therefore be shunted into this siding, as had happened on previous Royal visits, nor was it deemed appropriate for her to climb the steps and depart through the usual barriers. The Civil Engineer Wing, the Sir Walter Raleighs of the RSME, therefore volunteered to manufacture a bridge to span the disused siding from one platform to the other. A most elegant bridge it was too and an excellent example, at the beginning of the visit, of the quality of workmanship available in the Corps today.

The Royal Party drove from Chatham railway station, through streets lined with cheering crowds, into the main entrance to Brompton Barracks at 1045, to be received on behalf of the Corps by the Chief Royal Engineer, General Sir Hugh Beach GBE KCB MC DL. (It was coincidentally the Chief Royal's birthday that day and the Corps Band had previously noted that fact by playing "Happy Birthday" for him together with their own version of "When I'm 64"!) With the Royal Standard now flying proudly over the Crimean Arch the Engineer-in-Chief, Major General C J Rougier CB, and the Commandant RSME, Brigadier D A Grove OBE, were presented. The Guard of Honour, consisting of sixty soldiers representing all parts of the Corps, presented arms in a Royal Salute before the guard commander, Major N E Robinson RE, invited Her Majesty to inspect them.

The Guard and the Corps Band having been inspected, The Queen was then escorted through the South African Arch to the Headquarters RSME building. En route the Commanding Officer of the Depot Regiment, Lieutenant Colonel D R Humphrey RE, was presented and Miss Tanya Fenn, the 11 year old daughter of Staff Sergeant A Fenn, gracefully presented Her Majesty with a posy of flowers. Inside the Headquarters building the Deputy Commandant RSME, Colonel R M Stancombe, briefed Her Majesty, using some very interesting historical engravings and photographs, on the development of the RSME from its inception in 1812 until the present day.

Members of the Corps Regimental Headquarters organisation were then presented—the Regimental Colonel, Colonel W T Dennison OBE, the President of the Institution of Royal Engineers, Major General (Retired) P C Shapland CB MBE, and the Chairman of the Royal Engineers Association, Major General (Retired) C P Campbell CBE. The President of the Institution presented Her Majesty with the latest volume of Corps History to complete her collection and she was then invited to view photograph albums recording previous Royal visits to the Corps, in which she showed great interest.

The Queen then walked from the Headquarters Building, along a route lined by soldiers in period Royal Engineer costumes of 1787, 1837, 1887, 1937 and 1987, to the Construction Engineering display set up at the Gibraltar Avenue end of Pasley Road. Lieutenant Colonel D I Reid, Chief Instructor Civil Engineer Wing, escorted her through a Construction Engineering "Tunnel of Time" commencing with an engineer park of 1787 engaged in work on siege operations. Her Majesty was shown various tableaux depicting different aspects of the Corps' early history including the Survey of Great Britain and Ireland in the early 18th century, construction tasks in

Photo 1. Her Majesty The Queen was taken through a construction engineering "tunnel of time". Here "Practitioner Engineer and Ensign" S J Beck briefs Her Majesty on the work his artificers are doing in Gibraltar.

France, Canada, the NW Frontier and China, and RE involvement in the design and construction of public buildings in India and UK. Other tableaux explained the more recent works of the Corps in support of operations from the Boer War through the First and Second World Wars and all subsequent conflicts.

The Construction Engineering display was brought right up to date with a simulated construction of a modern Security Forces Base, demonstrating to Her Majesty Sapper tradesmen at work on typical engineering tasks of today in Northern Ireland and the Falkland Islands. The opportunity was taken to present to Her Majesty an oak park bench expertly made by Sapper tradesmen on an RSME course—a rather special but none the less representative example of Sapper craft skills.

From the Construction Engineering display Her Majesty walked through enthusiastic spectators to the Brompton Study Centre for a Reception. Here the aim was to give the widest possible cross section of the Corps an opportunity to be presented to The Queen and to become involved in the day's activities. The RSM of the Depot Regiment, WO1 V A McDonald, presented to Her Majesty selected soldiers and their wives representing BAOR, UK, the RE Individual Training Organisation and the Territorial Army. Representatives of the Royal Engineers Association were also presented together with civilians working for the Corps, and officers and soldiers involved in adventurous training activities. Her Majesty graciously spoke to everyone.

No Royal day is complete without a "walkabout", and so it was on this visit. Her Majesty walked slowly across the square from the Study Centre to the Officers Mess giving pleasure to the many families gathered for the occasion by stopping frequently to talk to them.

Nearly one hundred and seventy officers, regular, TA and retired, had gathered in the Officers Mess for the honour of lunching in the presence of their Colonel-in-Chief. Of these, forty officers were selected and gathered together in pre-determined groups in the lower ante-room for presentation to Her Majesty before lunch. When The

Visit of Her Majesty the Queen to the Corps at Chatham (1)

Photo 2. The porcelain sculpture, commemorating RE 200, which was presented to Her Majesty. The Chief Royal Engineer's Committee has commissioned a silver version, using the same moulds, to add to the Corps silver collection.

Queen arrived in the Mess the Chief Royal Engineer gave her a gift from the Corps—a beautifully elegant porcelain sculpture made by Mr Michael Sutty depicting two soldiers, dressed respectively in 1787 and 1987 uniform, standing either side of a symbolic piece of rock. The whole sculpture is mounted on a highly polished mahogany base manufactured in the RSME workshops. Members of the Corps who have been unable to see the original will shortly be able to see a replica because the Corps Silver Committee is commissioning a silver version to add to the Corps collection. It will be a fitting memento of RE 200.

Lunch was a light but flavoursome menu chosen personally by The Queen—an entree of Quails eggs in Aspic, a main course of Chicken Villeroi which was followed by Normandy Tart. It was a special honour after lunch for the members present to rise and drink the loyal toast to "The Queen, our Colonel-in-Chief".

After a very brief rest Her Majesty left the Mess by car, escorted by the Chief Royal Engineer, and drove to the Combat Engineer activity display area. The Commanding Officer of 12 RSME Regiment, Lieutenant Colonel P J Williams RE, was presented and he then escorted Her Majesty through a packed display demon-

Visit of Her Majesty the Queen
to the Corps at Chatham (2)

Photo 3. During her visit to the combat engineering display Her Majesty was invited to authorise, and then fire, a bridge demolition. Everyone was well pleased with the result!

strating some aspects of the many modern operational roles of the Corps including Support to the RAF, Explosive Ordnance Disposal and Search, Military Survey, Bridging, Demolitions, Squadron operations, Diving and Postal. Her Majesty declined the offer to drive the remotely controlled "Wheelbarrow" on the EOD stand but enthusiastically fired the bridge demolition having first authorised the action, as the senior officer present, by signing the AFW 9811—the bridge Demolition Order proforma. On the Military Survey stand Her Majesty was given copy number 1 of the limited edition RE 200 Commemorative Map of Chatham, and on the Postal Stand she received a first day Commemorative Cover.

A team of runners from The Queen's Gurkha Engineers had recently completed a sponsored run from Vancouver to Chatham (New Brunswick) and then from Glasgow to Chatham (Kent). The Colonel Queen's Gurkha Engineers, General Sir George Cooper GCB MC and the Commandant, Lieutenant Colonel P W Cook RE, were

Visit of Her Majesty the Queen to the Corps at Chatham (3)

Photo 4. The new Royal Engineers Museum in the Ravelin Building was officially opened by The Queen during her visit.

presented to The Queen together with leading members of the running team, who handed over to Her Majesty a cheque for £52,000—the proceeds of their sponsorship—to be donated to the RE Museum. Mention should be made of the very generous contribution of £32,000 made towards this total by Rochester City Council.

The Queen was then escorted into the Ravelin Building where a number of distinguished guests connected with the Museum were gathered. The Chairman of the Museum Foundation, Colonel P E Williams TD ADC, the Secretary of the Institution of Royal Engineers, Colonel (Retired) G W A Napier, and the Museum Curator Ms C M Reed were all presented. The Regimental Colonel then briefed The Queen on the extent of the Museum today, and proposals for its further development, before inviting her to perform the formal opening ceremony. Her Majesty was then taken on a guided tour of the Museum starting first in the Medal Room where she met relatives of the late Staff Sergeant Prescott and Sapper Tarbard who were killed in action in the Falklands and whose medals their families have presented to the Corps on loan. During the tour the Project Officer, Major H A Caulfield RE, was presented whilst other members of his team continued with their construction. Thus Her Majesty saw at first hand the extremely high standard of workmanship being achieved in the project.

Whilst this tour was taking place the guests invited for the opening ceremony gathered together in pre-arranged groups in a marquee erected in the courtyard of the Ravelin Building. When The Queen then joined them for tea she circulated amongst these groups.

After signing the Museum visitors book Her Majesty bade farewell to the Chief Royal Engineer in front of the Ravelin Building and departed by car, through a throng of cheering spectators, to her train now waiting at Rochester station. The 1987 Royal Visit had ended. It had been a memorable day for all concerned. In the words of her Private Secretary "it had given The Queen much pleasure to find her Sappers in such heart".

Visit of Her Majesty the Queen
to the Corps at Chatham (4)

St Paul's Cathedral 18 March 1987

On 18 March 1987 a Service of Thanksgiving and Rededication took place in St Paul's Cathedral in the presence of the Chief Royal Engineer, the Lord Mayor of London, serving and retired members of the Corps and invited guests from overseas countries, from the government and political parties and from the Royal Navy, the Royal Air Force and other Arms and Services of the Army.

After an opening hymn and the Bidding, by the Canon-in-Residence, and the General Thanksgiving, the Chief Royal Engineer read the first lesson from Ecclesiasticus Chapter 38.

An Act of Remembrance then took place as the sixteen Rolls of Honour of the Corps and of Engineers of other Commonwealth countries were borne to the chancel steps. An anthem and the second lesson, read by the Canon-in-Residence then led to the sermon by the Bishop of Rochester, The Right Reverend Richard David Say, the text of which is reproduced below.

Prayers were then said by a junior officer and a soldier of the Corps and these were followed by the Rededication led by the senior Chaplain to the Royal Engineers. The service was concluded by the singing of the National Anthem.

The Band of the Corps of Royal Engineers was present throughout playing before and after the service as well as sounding the Last Post and Reveille inside the dome of the Cathedral and joining with the organ in the final hymn.

The congregation left the Cathedral greatly moved by the occasion and conscious of the privilege thay had enjoyed in participating in an historic event.

The text of the Bishop of Rochester's sermon follows:

Ecclesiasticus 38–34—the last verse of the first lesson just read to us from the *Jerusalem Bible* and which in the Revised Version reads:

'They will maintain the fabric of the world and in the handywork of their craft is their prayer.'

Thirty-three years ago, in the course of a speaking tour in Canada, I visited the town of Arvida which had grown up around an enormous aluminium plant on a tributary of the St Lawrence River. I remember driving north from Quebec City for a hundred miles on a dust road through the forest, and staying overnight on an outpost of the Royal Canadian Air Force. The next day I preached in the local church at Arvida but saw all too little of the town and of its one great industry. However, two things are indelibly printed upon my memory.

The first was the massive power of water which has been harnessed for the purposes of manufacture; whilst the other was that every single item of furnishing and decoration in the church was made of aluminium. In that small remote place, beyond which there was only uninhabited territory, the local craftsmen were not only maintaining the fabric of the world with the manufacture of an essential metal, but the handywork of their craft was around them in their house of prayer.

Another such craftsman, who was both an eminent engineer and a man of prayer, was my predecessor, Gundulf, the 30th Bishop of Rochester, one of those brought over from Normandy to England by William the Conqueror in 1066. He had been Clerk of the Works at Rouen Cathedral before becoming a monk and, in London, Canterbury and Rochester he acquired a reputation as a designer and constructor of great buildings.

I have a feeling that some of the professionals of his day might have passed the same strictures upon him as those of the writer in the December issue of the *RE Journal* who asked, "Are we playing at being a Technical Corps?"

But if Gundulf's technical qualifications were few, his craftsmanship born of experience was outstanding, and it is not for nothing that he has a bridging pool named after him at Upnor. But Gundulf was not only a builder in wood and stone. He built up living communities of God's people. There were five ill-kempt monks at

Rochester in 1077 and a fine praying and serving community, sixty strong, when he died thirty years later.

As a craftsman and a man of prayer, Gundulf has always been an example to all Sappers who have to strive in the dual capacity of being good professional soldiers and good professional engineers.

The Sappers' church at Chattenden is dedicated to him, and the Gundulf Tower stands today as a monument to him in Rochester Cathedral, where there are many other Sapper memorials and where the Corps comes every year for its Memorial Service.

Not long ago we commemorated Glubb Pasha, of whom the King of Jordan wrote that "he was a down-to-earth soldier with a heart, a single style of life and impeccable integrity." More recently, we gave thanks for that Sapper centenarian, Sir Clarence Bird, who lived in six reigns and who brought something of the culture and musical skills learnt in the 19th century into the 20th century.

For such great characters as these we give thanks today as we do here in St Paul's for Gordon and Kitchener, whose memorials are here along with the Corps Rolls of Honour that are on show for all of us to see today. And here in St Paul's we also remember those members of the bomb disposal units who in the Second World War won the George Cross, including Major Robert Davies, whose bravery in September 1940, contributed to the miraculous preservation of this great church from total disaster.

The Chief Royal Engineer has said that "every so often an opportunity arises in any family to celebrate together past events, present bonds and the promise of the future."

We are all here today for just such a celebration. And it is a happy thing that here in this parish church of the Commonwealth, the scene of so many great national occasions, all those Engineers who rejoice in the title "Royal", including The Queen's Gurkha Engineers, the Territorial Army Engineers and the Royal Engineers' Association, can unite for this Service of Thanksgiving and Rededication, as they did last month for that exciting musical evening in the Royal Albert Hall.

I realised on that occasion, as I had not done before, the significance of what the Corps History calls "The Progeny of the Corps"—the fact that the Sappers were flying for fifty years before the founding of the Royal Flying Corps and that Sappers pioneered developments that led to the founding of the Corps of Signals, Transport and Army Service. Small wonder that that industrious Quartermaster-historian, Captain Connolly, wrote over ninety years ago that a Sapper is "the man of all work of the Army, astronomer, geologist, surveyor, draughtsman, artist, architect, traveller, explorer, antiquary, mechanic, diver, soldier and sailor, ready to do everything and to go anywhere—in short he is a SAPPER."

So we look back with thanksgiving to 1787 when Prime Minister William Pitt, then aged twenty-eight, caused King George III to grant a Royal Warrant to the Corps to take the name and style of Royal Engineers and to rank in his Army with the Royal Regiment of Artillery.

We give thanks today for two hundred years of service to successive Sovereigns, from George III to Elizabeth II, the present Colonel-in-Chief.

We give thanks for the contribution which the Corps has made to the other Services of the Crown and for all that Sapper skills do to make for the betterment of conditions in under-developed countries, because for Sappers, Peace has her victories far more enduring than War.

Lastly, we give thanks for the family spirit of the Corps, so apparent at the Albert Hall, and for the "present bonds", as Sir Hugh has described them, which bind all together so closely today.

Perhaps only Gundulf's present day successor, who has been around among Sappers for almost as long as he was, can presume to suggest that we should also give thanks for the loyalty, the love, the patience, and the practical service of successive generations of Sapper wives. They are often denied a settled home for long years; sometimes

domestically upskittled at short notice by the demands of the management; and yet for ever are turning up smiling and resilient. How much the Corps owes to the wives and the children of officers and men. They are, indeed, an important part of the Corps family.

So today for all these things we give thanks and if, here, we cannot sing even my granddaughters' expurgated version, we can say whether or not "we're working very hard down at Upnor Hard or marching on to Laffan's Plain. Hurrah for the CRE".

But we are here not only for thanksgiving and celebration, but also for prayer and re-dedication.

"They will maintain the fabric of the world and in the handywork of their craft is their prayer." Or as the *New English Bible* translates it, "Their prayers are about their daily work."

The distinctive character of today's event is not parade but prayer, and in a moment we are going, in our prayers, to give thanks for those who have brought knowledge out of ignorance, joy out of sorrow and order and structure out of chaos and ruin. And then a serving member of the Corps will lead us in praying that every Royal Engineer may be granted courage which does not admit defeat or despair; patience with which to face disappointment and frustration; and at all times the sure knowledge of God's abiding and supporting love which makes no task too difficult or too hopeless.

I hope that many of you will want to make these prayers your own in the days to come and not just to leave them as a memento in the Service paper.

We live in a fast moving and violent world. Not even the brightest of politicians can ever dare lay claim to be even a minor prophet. We none of us know what the future holds.

But those of us who grew up in the twenty years between the Great Wars, know that the last forty-two years have been different in ethos. If we must continue to be vigilant, we need not be without hope. We heard in the second lesson St Paul's challenge to the Thessalonians: "Rejoice evermore. Pray without ceasing ... Prove all things; hold fast that which is good. And the very God of peace sanctify you wholly."

The world is not static, however much those who build walls between nations would have us think it is. God is not dead. His Spirit is a living and renewing Spirit, who will lead us into all truth and into the way of peace. We must not expect to be led back into former glories or to quieter days. We must be ready to be led forward into a new day and if one thing is certain in the world of technological advance and mass communication, in which many of you move with confidence, it is that we are on a moving escalator all the time. Change is the order of the day.

The YOs of 1987 (from whom will come the Engineer-in-Chief of 2012, the year when the RSME will celebrate its 200th anniversary), will be serving in a world as different from that of today as we are from the world of 1945. But it will be their world and they will be strengthened and enabled for its service.

The great Russian writer, Pasternak, has described the way in which spring comes in Siberia: "The ice is so thick by the end of the winter that nothing seems to happen for many weeks. Only when the air has warmed up sufficiently does the ice suddenly give way and the huge ice floes float down the river. Nobody can tell when it will happen. Everybody knows that it will happen."

So it is with the Christian hope. Because God is our father, because Jesus came to save us from ourselves, because the Holy Spirit is the spirit of renewal and new life, we can dare to say today in penitence, confidence and abounding hope:

Lord God forgive what we have been;
sanctify what we are; and order what we shall be.

So may you be able to continue to maintain the fabric of the world and may your prayers be about your daily work, as you follow, Royal Engineers—*quo fas et gloria ducunt*—where Right and Glory lead. Thanks be to God.

The New Concept of Providing Engineer Support to Armoured Divisions

BRIGADIER P J SHEPPARD OBE

Brigadier Sheppard was commissioned into the Corps in 1962. He gained a 1st Class Honours Degree in Civil Engineering at London University in 1965, and since then has filled a variety of posts, both at Regimental Duty and Staff. These posts have included Troop Commander in BAOR; Engineer Intelligence Officer in a Divisonal Headquarters; Second in Command of a UK based field squadron; Staff Captain at MOD AG7; SO2 British Army Staff Washington; Officer Commanding 29 Field Squadron; SO2 Engineer Branch HQ 1(BR) Corps; SO2 MOD MO1; Commanding Officer 35 Engineer Regiment; Deputy Chief of Staff HQ 1(BR) Corps. Brigadier Sheppard was awarded the OBE in 1982 and assumed the appointment of Commander Engineer 1(BR) Corps in August 1986.

Introduction

For a number of years, many officers in the Sapper command chain have been well aware of the problems over the provision of sufficient mobility support to 1(BR) Corps. Various organisations have been tried and I drew attention to some of the problems in an article I wrote for the *Journal* four years ago. In the end, most officers would acknowledge that a capability gap still exists, largely because insufficient funds have been available to provide the additional specialist vehicles required. Now at last, an opportunity has arisen for us to improve our capability in this area.

The purpose of this short article is to outline the background to the requirement for greater mobility, to explain how we intend to progress towards providing this capability, and to give some idea of how the future might be shaped. In doing so I will only consider engineer support to armoured divisions.

The New Army Group Concept and its Implications

The Northern Army Group concept, developed by the current CGS General Sir Nigel Bagnall during his tenure as COMNORTHAG, is based on the premise that a 'thin red line' of defences can and will be breached by the large, powerful and increasingly high quality Warsaw Pact forces. Such penetration must be expected and can only be defeated if large and powerful reserves are held in depth and under the hand of the Army Commander. Such a reserve has now been identified, with a major British contribution, which is designed to destroy any significant penetration achieved by the enemy first operational echelon at the point, or points, of his main effort. Thus the balance between the primarily attack forces and primarily defence forces within the Army Group has been substantially altered.

The effect of this new concept on the engineers in support of 1(BR) Corps is considerable, if unremarkable. The thinning out of the shield dictates an even greater need for counter-mobility work—in particular the preparation of the initial obstacle plan. The establishment of stronger reserves, designed to destroy major enemy

Brigadier PJ Sheppard OBE
New Concept of Engineer Support

penetration, requires the provision of considerable mobility support—more than is currently possible. Adequate provision is vital if they are to reach their start lines and objectives, perhaps in another Corps area. At the same time the shield or FEBA formations will themselves be conducting the defensive battle in a more mobile aggressive way, and will also need mobility support.

Given the current financial and manpower constraints, the problem is how to increase the mobility capability of the engineers in 1(BR) Corps without reducing their counter-mobility capability significantly, and to achieve this within the current establishment. I do not wish to explain the figurework in detail but a number of studies in recent years have reviewed the need for engineer tanks (AVRE and AVLB) in the contact battle. Taking account (somewhat empirically!) of the needs of the larger reserve, and of the likely size of our cheque book, a minimum requirement of engineer tanks for the Corps has now been established. This is some 30% more tanks than planned for the fully expanded 32 Armoured Engineer Regiment. But more tanks involves the redeployment of men, including those needed for logistic support, from other engineer units. Some reshuffling of our present organisation will therefore be inevitable.

The Current Dilemma

Such a reshuffle, forced upon us, could give us the opportunity to rectify the problems that have developed in the way we presently provide support to all arms.

Brigade and Battlegroup Level. The speed of the enemy thrust and the general tempo of enemy activity will dictate the speed at which brigades and battlegroups must act and react in the contact battle. My experience (admittedly only on FTXs) suggests that commanders at this level will be juggling with a matter of only a few hours when making their appreciation. Penetration either on a major scale or locally must be expected. This implies that the opportunity for regrouping or redeployment of one or two or even a troop of engineer tanks over large distances (between divisions?) on their own will be extremely risky if not impossible. It also highlights the difficulty of resupply or resource provision, already difficult enough in view of the air threat, and which must involve well prepared and protected convoys moving probably at night. What price tippers of hardcore, M&E trucks, MGB trains and Crusaders carrying spare bridges in this environment? A brigade, and to a degree a battlegroup, must therefore be capable of rapid action and reaction when in contact using its own brigade units, principally armour, infantry, artillery and engineers. The brigades must have available the necessary Sappers who have the ability to respond to mobility and counter-mobility tasks in this same situation and in the same timeframe. They must have the protection and mobility to match that of supported battlegroups and must have sufficient resources to hand, ideally in highly mobile and protected vehicles. Naturally the engineer commander will be able to anticipate some of his resource requirements but he cannot afford to be over-reliant on support from the rear. It is an obvious conclusion that engineer support at this level in the contact battle must comprise more battlefield machines and be capable of carrying out traditional mobility and counter-mobility tasks quickly. I see no reason to change the established squadron level of support at brigade level.

Compare this with the current situation of APC mounted Sappers in support of brigades who are heavily resource dependent and need considerable time to complete largely manpower intensive tasks. The mobility component is currently provided by Chieftain AVLBs and insufficient obsolescent, unreliable Centurion AVREs.

Divisional Level. At the divisional level there is likely to be more time to react to events in the contact battle. Moreover the division is the first level where significant reserves are held and the committal of them, and the associated engineer support, will have to be considered by the GOC well in advance. Divisional engineers can therefore afford to undertake more manpower and time intensive tasks relying to a greater extent on the provision of resources through the support organisation. They will be able to construct major obstacles in depth, open and maintain routes and take on

Photo 1. Chieftain AVRE with plough and three fascines.

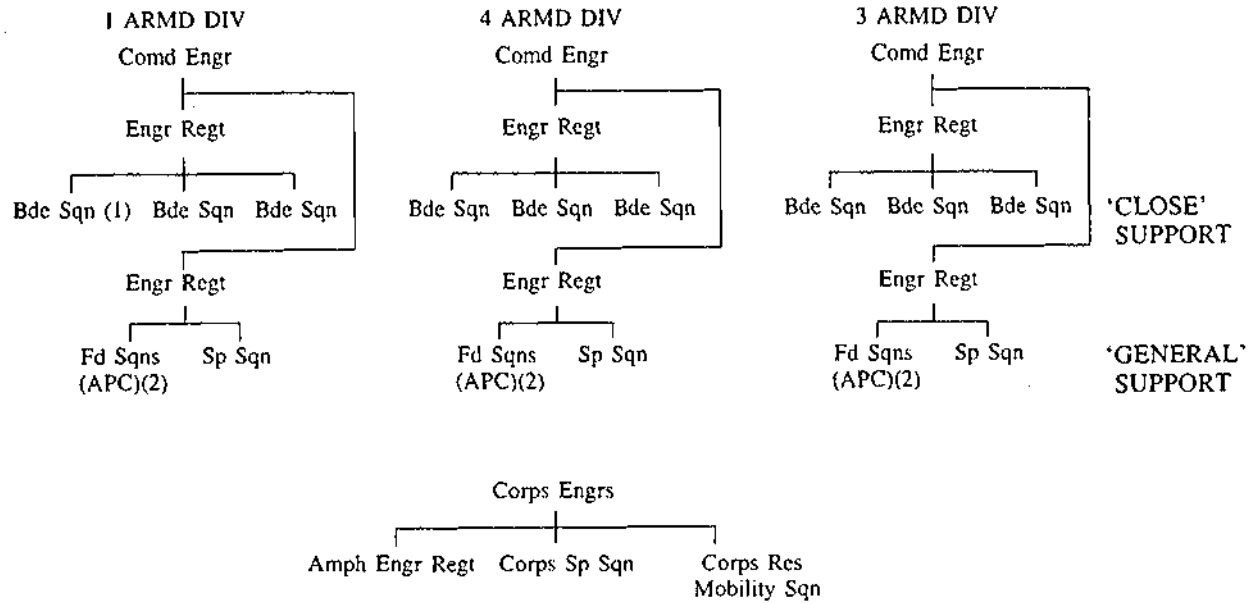
general combat engineer tasks in the divisional area. They will require mobility and protection against indirect fire but at a lesser level than brigade engineers. Prior to the contact battle they will play a major part in the construction of the initial obstacle plan. APC mounted engineers, much like the current divisional engineers, are well suited to this role.

Equipment to Match the Concept

My general conclusion is that we need a 'close' support engineer regiment and a 'general' support engineer regiment in each division. The former would comprise a squadron for each integral brigade and would be largely armoured, mobile and equipment intensive. Regrouping at the outset of operations between squadrons and within squadrons will remain possible—even likely. Concentrating assets at brigade level will also ease the possibility of regrouping as local tactical requirements dictate. The general support regiments would comprise APC mounted engineers supported by a field support squadron per division. It will not have escaped many readers that, given three armoured divisions, our present organisation can be easily adapted to meet this requirement. Including 32 Armoured Engineer Regiment we have six regiments, broadly speaking in the right place. What we lack is adequate and sufficient machines with which to equip the three close support regiments. The requirement, in the most general terms, is for modern engineer tanks equipped with buried and scatterable mine clearance devices (GV successor(?), plough), short and medium gap crossing equipment and other machines such as scatterable mine launchers, armoured dozers and so on.

The prospects in this general area are already improving, albeit slowly, with the advent of the mine plough and Chieftain AVRE. The latter (see *Photo 1*) is based on a turretless Chieftain with a fascine rack built on top, a winch (also mounted on top) and the ability to mount a mine plough or a dozer blade. Some Chieftains are being converted in 40 Army Engineer Support Group, Willich[1], and will be issued to us in lieu of the balance of the 105mm Centurion conversions. Sadly we must wait until the

[1] See article "The Chieftain AVRE Project" page 185.



Note:
(1) Bde Sqn should ideally be integrated but might have to be grouped into Sqns by discipline.

(2) The number of Fd Sqns per Regt is to be confirmed. Total number at least 7.

Figure 1. Proposed organisation of the new concept for Engineer support.

early 1990s for the balance of the Centurion fleet to be replaced by fully developed 'Willich' tanks from Vickers. The scatterable mine system seems to be coming along too and is now more than just a gleam in the eye. Nevertheless much more work is needed to really improve our capability in this general area—work which must take account of severe resource constraints and the difficult competition with other more obviously 'shop window' equipment also badly needed in the 1(BR) Corps/NORTHAG battle.

Equipment for divisional or general support engineers is currently adequate and will be improved with the advent of the new barmine fuzes, 'Bridging for the 90s' and the rapid demolition devices. In due course the ageing FV 432s will be replaced by the Future Light A Vehicle (FLAV). I would hope that the vehicle issued to engineers will possess one or two add-on devices such as a pusher beam and/or a lifting arm through which a winch could be reeved. Such tools would add enormously to the capability and flexibility of the section that the vehicle will transport.

To summarise this section, there has been wider recognition that we have been unable to provide the mobility and counter-mobility support for the Northern Army Group concept of operations, especially at brigade and battlegroup level. The concept for engineer support outlined above allows us the opportunity to define more clearly our re-equipment policy and be more specific about the equipment capabilities necessary to match the concept. In turn, this should lead to more timely introduction of appropriate and effective engineer equipment in the future.

An Organisation to Match the Concept

The pressure to improve mobility support by purchasing extra engineer tanks therefore provides the opportunity to distribute AVREs and AVLBs to squadrons in support of brigades while retaining some support to meet the extra requirements of the reserve. These close support squadrons will be regimented in peace, and a further APC mounted (general support) regiment will be provided to each division. The proposed organisation is shown in *Figure 1*. I would stress that, in the short term, this will simply mix Chieftain tanks with FV 432s. To critics I would point out that such a mix is simply a stepping stone to a longer term vision where close support squadrons are equipped with a whole new range of armoured machines designed to cope rapidly with mobility and counter-mobility tasks at brigade/battlegroup level.

Validation

I am clear that the new concept is the only satisfactory way forward if we are to retain our rightful place on the battlefield and remain able to provide to other arms the engineer support that they will need in war. I am still very concerned that BAOR CPXs and FTXs by their very nature fail to highlight the real problems that will arise. In peace, battlefield damage—to villages, towns, woods, roads, bridges, defiles—cannot be properly represented and the real effect of obstacles, especially minefields, are nearly always over-looked or under-played. The reasons for this are obvious and, with the current pressures on training time, we must acknowledge that FTXs must allow all arms to practise their war role. But this often leads to Sappers with insufficient to do and the danger of all arms commanders misappreciating the need for Sapper support. Perhaps to some extent this is the reason that our present equipment is not up to the mark.

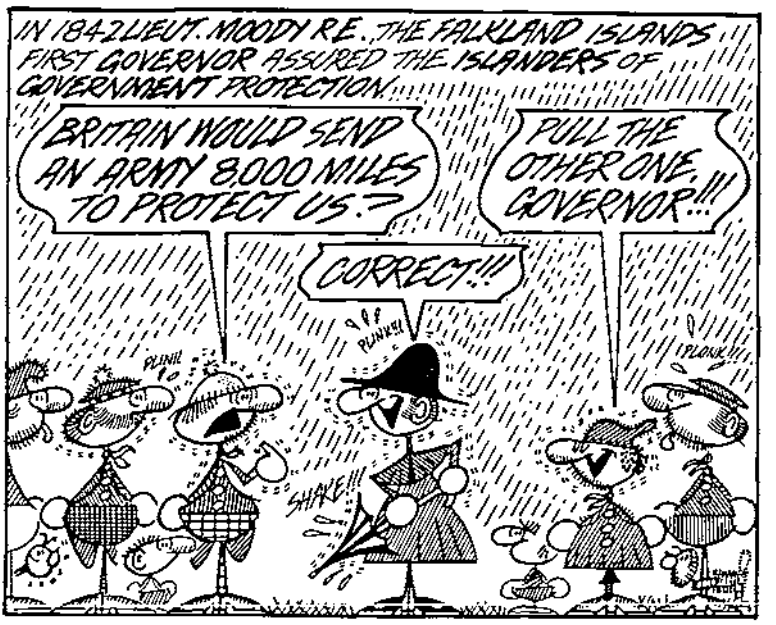
Nevertheless there is now a general feeling of sympathy (and understanding?) within the Army at large that something needs to be done. Unfortunately it has come at a time when resource constraints are particularly severe. We have therefore embarked on a MOD sponsored trial, more properly a validation, of our new concept which we hope will provide appropriate collateral and emphasis to our needs. It is to take place in two phases. Phase 1 in 1987 is to validate the close support squadron in the context of support to an armoured brigade during a divisional FTX (12 Armoured Brigade on Exercise *KEYSTONE 87*) and phase 2 in 1988 will validate the full divisional engineer organisation including both types of regiment and command

and control aspects. Both phases of the validation are to be undertaken by 23 Engineer Regiment at Osnabrück which is currently in the throes of converting its airportable and mechanised field squadrons into two close support squadrons. To do so, it is receiving nine of the new 'Willich' Chieftain AVREs and six AVLB from 32 Armoured Engineer Regiment. In short the Phase VI expansion of the armoured engineers is being applied to '23' instead of '32'! The enthusiasm for the changes both within the two regiments concerned and elsewhere within 1(BR) Corps (both Sappers and others) is most encouraging and heartening.

There are, not surprisingly, many problems inherent in the implementation of the new engineer concept. Such matters as the nature of support to 19 Infantry Brigade from UK, whether or not to integrate tanks and APCs in the same squadron, which barracks can accommodate tanks at least cost, the impact on trade training and the need for more AFV crewmen, the need to minimise turbulence among squadrons and the problems of logistic support all spring readily to mind. But these are all matters that will be examined carefully and validated during the next two years. I am confident that they can and must be overcome.

In Conclusion

Over a number of years, we have reorganised the engineers within 1(BR) Corps in order to provide the necessary support to field formations. But most RE commanders will admit that a capability gap has grown in our ability to support mobile operations, and also in the speed with which we can mount engineer operations in support of brigades and battle groups. The new NORTHAG concept has made these deficiencies clearer. At last, with the availability of Chieftain hulls, an opportunity has arisen for us to restructure our engineer support to provide greater mobility to 1st British Corps. At the same time we can restructure so as to provide more appropriate and quick response engineers at brigade and battle group. Before we actually embark on the necessary reorganisation we will undertake a trial over the next two years to validate our new concept. There are problems but the enthusiasm to overcome them exists in both the general staff and engineer units.



The Chieftain AVRE Project

LIEUT COLONEL J F JOHNSON OBE BSc(ENG) C ENG MICE RE

Lieut Colonel James Johnson was commissioned from Sandhurst in 1963. His training has included three years attendance at RMCS Shrivenham reading Civil Engineering, two years on the long Civil Engineering Course and fifteen months at the Staff College. His regimental duty in the UK has been as a troop commander and squadron second-in-command and in BAOR as a troop commander, squadron commander and regimental second-in-command. Other appointments have been as an instructor at the RSME and as COS HQ NW District. He recently commanded 40 Army Engineer Support Group and is now SO1 (DS) at the Department of Air Warfare, RAF Cranwell.

BACKGROUND

FEW with practical experience in BAOR would deny that APC mounted field squadrons are inadequately equipped to provide the full range of engineer support required by armoured brigades. In particular their capability for assault bridging, assault minefield breaching and assault obstacle crossing is negligible. These are armoured engineering functions, but with only one regiment to support the whole of 1(BR) Corps the assets are thinly spread on the battlefield. But it is not only a question of numbers; the speed of deployment of the equipments largely determines their usefulness in a supporting role, and here there is a significant capability gap because, although the AVLB is a Chieftain variant and well matched to battlefield mobility, the Centurion based AVRE is not. Since it is the preferred vehicle for minefield breaching, with plough and Giant Viper, and for obstacle crossing, with dozer blade and fascine, it is imperative that it has sufficient mobility to be in the van. With the introduction of Challenger this becomes less and less credible and there is an urgent need for an improved AVRE.

Whilst Challenger was the catalyst for action it also indirectly provided a solution to the problem because as it replaced Chieftain so some of those tanks became available for other uses. It was reasoned that Chieftain stripped of its 12 ton turret provided a base vehicle with a power-to-weight ratio much more closely matched to Challenger's and from this a new AVRE could be developed. The RE Wing at Bovington was the first to investigate the feasibility of Chieftain AVRE and the idea was enthusiastically adopted by 32 Armoured Engineer Regiment. Displaying great initiative and with a minimum of external assistance the regiment produced a concept demonstrator, and whilst it was a very basic and uncomplicated machine its early practical trials convinced all who witnessed them that here was an equipment of the greatest potential which could be developed into the robust, reliable and agile AVRE the Corps so clearly lacks.

Some intensive lobbying by 32 Armoured Engineer Regiment helped to give the project considerable momentum and there was a consensus that the machine should be available for evaluation during the 1987 FTXs. The requirement was for a total of seventeen AVREs, twelve for troop trials in BAOR, two for BATUS, two for Bovington and one for Vickers Defence Systems. But how to get all seventeen completed in about eighteen months? Industry cannot be made to produce new

Lieut Colonel JF Johnson OBE BSc C Eng MICE RE
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equipment at that pace and the REME could not help because the base workshop at Wetter had no spare capacity. Only one option remained; the Sappers would complete the conversion for themselves, and the task was given to 40 Army Engineer Support Group. What follows is an account of the project.

Design and Manufacture

The concept demonstrator had the following capabilities:

To mount either the mine plough or a dozer blade.

To tow either Giant Viper or AVRE trailers.

To carry four men; commander, driver and two crewmen.

To load and carry either three fascines of six rolls of Class 60 trackway and to launch some of these from under cover.

To carry sufficient G1098 equipment to allow the crew to operate in a secondary role as half a field section.

It was decided at an early stage that the production model should also be capable of loading, carrying and unloading the No 9 tank bridge even though the concept demonstrator was not able to do so.

A team was assembled at Willich tasked with producing an "engineered" version of the concept demonstrator incorporating all the design criteria listed above. It was a joint venture by 32 Armoured Engineer Regiment and 40 Army Engineer Support Group, the latter providing the Project Manager (myself), a Clerk of Works (M) (WO1 Logan), specialist welders, fitter machinists, fitters, painters, draughtsmen, labourers and workshop facilities, and the former contributing an expert on armoured engineer equipments (WO1 Clegg), tank drivers, vehicle mechanics, vehicle electricians, storemen and combat signallers. Not all the tradesmen were needed at the outset but were called in as needed.

The start of the project was slow and deliberate. The design team had the concept demonstrator as a model and a turretless Chieftain MBT to work upon and piece by piece they translated the "sticks and strings" solution as represented by the concept demonstrator into a properly designed and constructed equipment. The design process was by committee, Mr Clegg provided the user's requirements, Mr Logan suggested engineering solutions and I, as project manager, decided which approach to adopt. This committee of three almost always convened as required on the top of the tank and much use was made of string, measuring tapes and chalk (with which every flat surface was soon covered with diagrams and calculations) to aid our decision making. Once a solution was agreed the part was manufactured and then drawn up by the draughtsman so that it could be replicated for the production run. By mid-August 1986 AVRE No 1 was completed.

In the manufacture of the production models some of the design criteria caused interesting problems, others were uncomplicated:

Dozer Blade. AVRE has the standard Chieftain dozer blade so, in theory, all blades fit all tanks. In practice however Chieftain hulls are manufactured to such coarse dimensional tolerance that this cannot be guaranteed. (The variation in dimensions on different hulls caused complication and delay during the production run.)

Mineplough. The mineplough is designed to fit Chieftain AVLB but this has a different shaped hull from Chieftain MBT. Thus it required minor modifications to make it fit AVRE.

Giant Viper and AVRE Trailers. A special towing bracket was required to enable Chieftain AVRE to tow Giant Viper and AVRE trailers.

Crew Accommodation. The AVRE driver and commander are seated in the same positions as in Chieftain MBT, the commander having the cupola immediately above his head. The remaining two crew members' positions are on either side of the commander and here they have very limited headroom, and so to gain the maximum clearance their seats are fixed at floor level. Thus they travel seated but with their legs horizontal and straight; not an ideal solution but one forced upon us through lack of space.

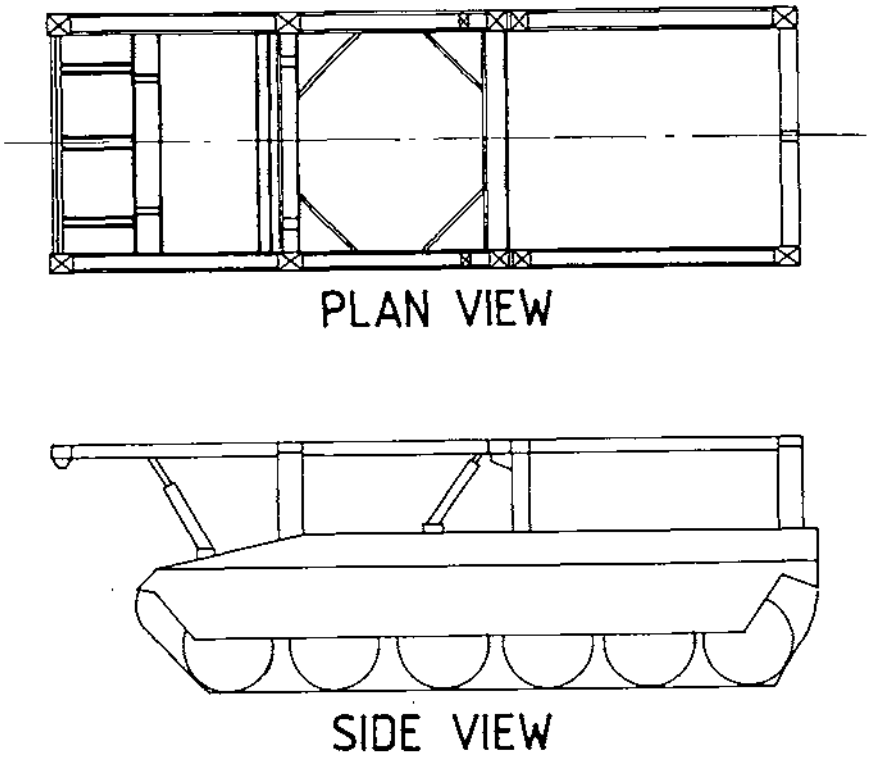


Figure 1. Schematic diagram of Chieftain AVRE Hamper.

Load Carrying. The concept demonstrator was fitted with what was called a "roof rack" to enable it to carry fascines and trackway. This graphic term aptly describes the appearance of the structure, the geometry of which was retained on the production AVRE but here retitled the "hamper". In plan (see *Figure 1*) the hamper has three rectangular sections (the front, centre and rear hampers). These are supported by six legs rigidly welded to the tank hull. The front hamper is pinned to the front legs and can be rotated below the horizontal plane whilst the centre hamper, also pinned to the front legs, can be rotated above the horizontal plane. This change in profile to form a ramp greatly facilitates the loading and unloading of the hamper.

Internal Stowage. The concept demonstrator had ample space behind the crew seats for stowage of G1098 equipment, and when the roof plate was designed a large rectangular hatch was positioned immediately behind the commander's cupola to allow access. As AVRE became increasingly complex more and more of this volume was filled with fittings and equipments until eventually stowage space was at such a premium that the production AVRE has only sufficient to allow it to fulfil its primary role.

There is little doubt that had the requirement been to produce an exact replica of the concept demonstrator the task would have been simple, but two additional, related enhancements ensured that the task was considerably more complex and therefore presented a greater challenge. The first was the capability to load, transport and

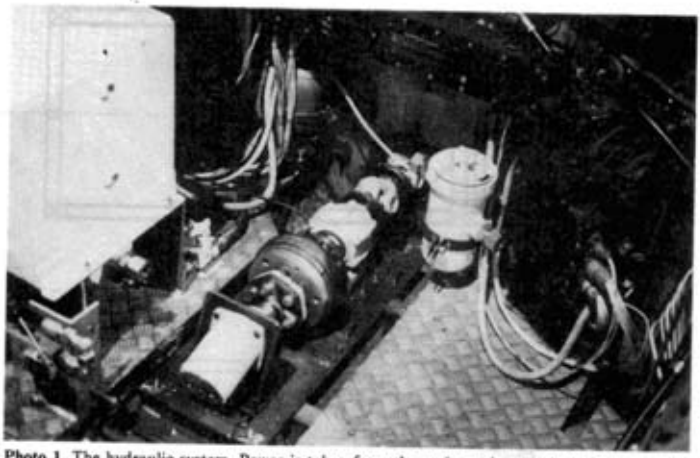


Photo 1. The hydraulic system. Power is taken from the main engine crank shaft through the bulkhead (*centre*). The train comprises two universal joints, a pedestal bearing, an electric clutch and the hydraulic pump. The white rectangular shape (*left*) is the reservoir. Pipes and protective covers yet to be fitted. Note the electrical control box (*right*) which had to be relocated.

unload the No 9 tank bridge and the second required the design of a reliable method of rotating the front and centre hampers.

The prototype had been fitted with an electric winch mounted on the rear of the hull. Whilst this was adequate to pull fascines and rolls of trackway up onto the hamper, the greater loads involved in handling the tank bridge were beyond its capabilities. There are many advantages in using electric power and considerable market research was done to find a suitable replacement, but it proved impossible to find one of the right size and pull which matched the electrical output of Chieftain. The only feasible alternative was a hydraulic winch but there was no obvious source of power for it.

Chieftain has a hydraulic cold-start system for the main engine driven from its auxiliary engine and first thoughts were that this could be intercepted, but discussions with the manufacturers eliminated this option. Next it was thought that by dispensing with the cold-start system altogether the auxiliary engine could be used to power a custom made hydraulic system for the AVRE. This solution, although technically simple, had the twin disadvantages of making AVRE less reliable in very low temperatures than its MBT counterpart, and creating its own special pack. These operational and logistic penalties pre-empted further progress on this solution. The solution finally adopted was in essence to extend the crank shaft of the main engine through to the crew compartment and use this rotating shaft to drive a hydraulic pump.

This technique was not without its own penalties:

The requirement to cut a hole in the bulkhead separating the crew and engine compartments necessitated a pack lift.

The two large "black boxes" controlling the electrical circuitry, which were positioned on this bulkhead, had to be relocated.

The hydraulic pump and associated components (including a very large hydraulic reservoir) were now in the space previously earmarked for stowing G1098 equipment.

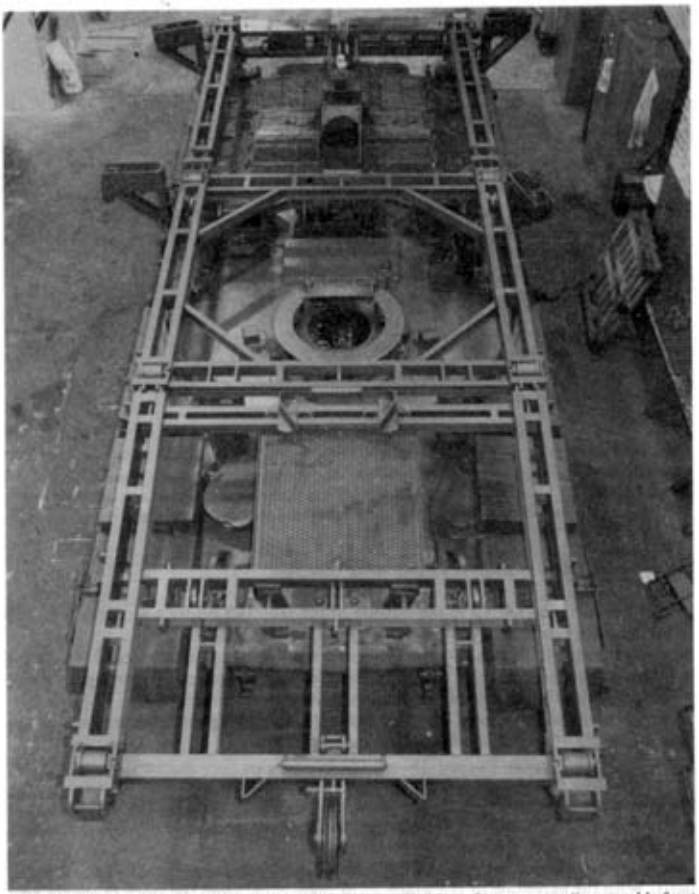


Photo 2. Overhead view of AVRE. Note along the centreline from front to rear: dismountable front pulley, mesh protection for driver, commander's cupola, stowage hatch, winch (partly obscured), No 9 bridge plinth, change of direction pulley on rear beam of hamper. Visible down the sides are the eight MGB rollers and four outriggers.

The next enhancement required to give AVRE its No 9 bridge capability was to incorporate rollers in the hamper to allow relatively frictionless loading and unloading. (The first hamper had been designed only for fascines and trackway; these are rolling loads and sliding friction is not a factor.) Fortunately launching rollers from MGB were available and these were taken into use.

MGB rollers have a single flange (giving them a profile similar to the steel wheel on a railway waggon) and these give lateral stability to the bridge during loading and unloading. They offer little restraint however when the bridge is being transported and the very flexibility designed into the bridge to allow it to accommodate cross-falls on a bridge site make it an exceedingly difficult equipment to tie down successfully.

The Chieftain Ayre Project (2)

Photo 3. AVRE at speed; having launched one fascine the second is ready and will be covered by the Class 60 trackway being dragged behind. Note the tilt of the hamper achieved by the rear rams being fully extended and the front ones fully retracted.

Nevertheless this was achieved using three methods:

Folding outriggers, fitted to the outside of the rear and centre legs, latch onto the outer bridge beams and tie them down with turnbuckles.
A very strong plinth was manufactured and welded to the engine decks beneath the bridge's centreline. One of the main transverse links between the two sections of the bridge locates on this plinth and is securely pinned in position.
Jaws were fitted inboard on the front hamper which swing up, latch onto the bridge inner beams and tie them down with turnbuckles.

The decision to use a hydraulic winch, which circumstances had forced upon us, made it almost inevitable that we would use hydraulic rams to tilt the front and centre hampers. This proved to be a very satisfactory method and presented only a few difficulties which were rapidly solved.

It may be seen that by now AVRE had a considerable number of new hydraulic parts. With the exception of the winch all of them came from the stock of spares held at Willich for the M2 Amphibious Bridge. Fortunately these stocks are most generously scaled and so we were presented with a wide choice of items all of which were immediately available. This expedient resulted in considerable savings of money and time.

Time was very important and often we could not afford to wait for the delivery of parts ordered from Supply. It is only fair to point out that the AVRE project placed demands upon the system without prior warning and many of the required items had a slow turn-over rate. Thus stocks were low, and in order to meet our requests new contracts would have had to be let to industrial suppliers. As a result we were forced to manufacture a wide range of items ranging from crew seats and stowage bins to small control boxes and headlight brackets.

The increased emphasis on local manufacture obliged us to review the holdings of workshop machinery and it was found that some additions were needed, the most important of which were:

A heat treatment system to treat the stainless steel welding of mild steel to the armoured steel hull.
An oxy-acetylene profile cutter to cut complex shaped components from steel plate. The model which was bought did not require the use of a template to guide the cutting head but relied instead on a photo-electric sensor to follow lines on a drawing. This advance in technology saved many hundreds of man hours of template preparation.
A band saw to cut quickly and accurately the scores of pieces of steel channel section used in the manufacture of the hamper.

These apart, there was adequate if elderly machinery to cope with all the tasks which arose. It was even found that we had the capacity to machine armoured steel, an important factor in the modification of the Chieftain commander's cupola to fit AVRE.

The construction of AVRE No 1 taught us many valuable lessons which were applied to the flow-line construction of subsequent vehicles. By far the most important was that having divided the workforce into functional teams (a functional team being responsible for one of the following: general preparation, welding, hydraulics, electrics, automotives or communications), it was counterproductive to attempt to employ more than one team on the tank at one time, there was just insufficient space. The work had to be done off the vehicle and the prefabricated parts brought to it in a strict sequence. Thus on the production line the component parts of the hamper were assembled in sub-assembly jigs, and these parts were fixed together in the master jig. Only then was the entire hamper offered up to the tank for final fixing. By the same token nearly all the hydraulic system was prefabricated and the roof plate had all its attached internal fixtures and instruments plus the loading hatch and the commander's cupola fitted before being welded onto the tank.

Trials and Modifications

AVRE No 1 was given to the AVRE Trials Team in 32 Armoured Engineer Regiment and although its trial proved that the vehicle was fundamentally what was required some forty modifications were recommended. These were discussed in great detail at Willich after which all were incorporated into AVRE Nos 2 and 3. These vehicles in their turn were given an extended trial and about forty more modifications were

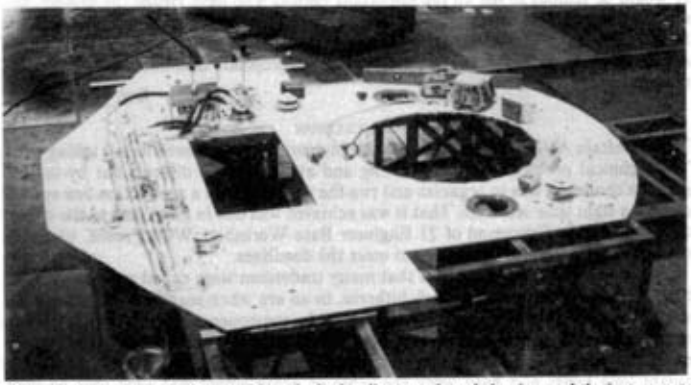


Photo 4. Roof plate manufacture. Note the hydraulic controls and circuitry and the instruments already fitted. The rectangular hole is the stowage hatch. the large irregular circular hole is for the commander's cupola and the two small circular holes can take either crew optics or the control cables for Giant Viper.

requested. These were of a relatively minor nature, indeed some might even be described as cosmetic, but with few exceptions they too were agreed and incorporated into subsequent vehicles. But at this stage the design was declared sealed and no further modification was to be allowed until the end of the production run. Had this decision not been taken each AVRE would have been slightly different from the rest with consequent penalties on the speed of manufacture and crew familiarisation. As it is all AVREs from No 4 onwards are being manufactured to a single standard and when No 17 is finished Nos 1, 2 and 3 will be reworked. Thereafter if modification is required it can be applied to the whole fleet thus retaining standardisation.

Costs and Penalties

The project was allocated £260,000 for the conversion of seventeen Chieftain tanks. Once the additional workshop machinery had been purchased this left something under £15,000 per tank for all materials acquired through local purchase (winches, steel, pulleys, chains and the like). Add to this £5,000 for the cost of M2 spares and another £5,000 for items aquired from Supply and the total materials cost is about £25,000 per AVRE. Costing the labour content of 2,000 man hours gives an additional £40,000 and adding a generous allowance for hidden extras, it can be seen that the unit cost of conversion is some £70,000–£80,000. It is understood that had the conversion been done by industry that cost might have been as high as £380,000. It gives great satisfaction to know that Willich can be economically competitive.

At an early stage in the project a shift system of working was adopted, and although we later reverted to working a single shift extended day, by then we had damaged our sporting prospects because team training and shift working are mutually exclusive. Willich must wait until the 1987–88 season to achieve again its former glory on the football and rugby pitches.

It is axiomatic that Willich does not have sufficient spare capacity to take on a project the size of the AVRE conversion without some penalty, and that penalty is that other tasks which would normally have been completed were either shelved or delayed. A strict priority system has been imposed and by careful management we have been able to ensure that the service offered to units has not diminished, although of course the reserves of fit equipment have been reduced.

Visitors

It would be tedious to list all the important visitors who have visited the project, but special mention must be made of the visit on 15 September 1986 of General Sir Martin Farndale, C-in-C BAOR. He has been a friend and advocate of Chieftain AVRE from its earliest days and so it was most appropriate that he should inaugurate the production line.

Conclusion

The Chieftain AVRE Project has been an invigorating experience for all taking part. The technical problems were interesting and at times quite difficult but by far the greatest challenge was to organise and run the workshops on a production line system against a tight time schedule. That it was achieved was due in great part to the efforts of the Second-in-Command of 21 Engineer Base Workshop, WO1 Preece, who very often worked a 12 to 16 hour day to meet the deadlines.

The scope of the project meant that many tradesmen were called upon to exercise the full range of their skills which hitherto, in an era when manufacture was totally subordinated to repair, had remained unused. In consequence many of the workshop machines which had lain idle were brought back into use. In short, the project expanded our horizons and made clear what our true capability is, and although it meant long hours and hard work the sense of achievement was such that no man employed on it would wish not to have been involved.

Chieftain Armoured Vehicle Royal Engineers

MAJOR D J HOLTBY RE

The author is an experienced armoured engineer and graduate of the Armour School at Bovington. He has variously commanded 26 Armoured Engineer Squadron where he also served as a troop commander, the now defunct 1(BR) Corps Armoured Engineer Cell and the Engineer Wing of the RAC Centre at the time the Chieftain AVRE project began life. He is at present Second-in-Command of 32 Armoured Engineer Regiment.

THE end of the Churchill era of armoured engineer tanks was sadly comic. At the time the Centurion main battle tank was approaching the end of its second decade and Chieftain was already a reality. The new Centurion AVRE offered little pure engineer advantage over the tank it replaced, but it did ensure that armoured engineer support was again timely and that fleet logistics were streamlined. Armoured engineers were still one generation behind some armoured regiments, but on a par with most. As more regiments were converted to Chieftain, support again slipped and the isolation of the Centurion AVRE was soon complete, but not brought into sharp focus until the advent of the Challenger Main Battle Tank; a tank better in all respects than its predecessor. It is better armoured and protected, but, more relevantly and simply, faster and more reliable than anything that has gone before.

Once again, the picture emerged of an armoured force hampered not only by obstacles, but, quite unacceptably, by the inability of its engineers in 40 year old tanks, to provide timely support. Several attempts to secure the generally acknowledged solution of a more modern base vehicle offering more flexible engineer support failed and the prospect looked bleak.

Relief came in the form of a user enterprise project founded jointly by 32 Armoured Engineer Regiment and the Engineer Wing of the RAC Centre. In anticipation of the likely availability of Chieftain hulls, following their replacement by Challenger, a simple armoured engineer platform was devised; the idea being the removal of the turret and the construction of a magazine-like hamper accepting a selection of rapidly deployable expedients with the tank retaining familiar abilities to mount ancilliaries and tow trailers. Further development and much lobbying led to the intramural conversion of Chieftain main battle tanks to AVREs at 21 Engineer Base Workshop of 40 Army Engineer Support Group with the prospect of the final replacement of Centurion AVREs by a commercial conversion in the early 1990s.

Armoured protagonists have long argued the relative importance of the armoured characteristics of firepower, mobility and protection and the sub-characteristic of communications. For Chieftain AVRE, the armoured engineer equivalent of firepower warrants detailed consideration, but mobility, protection and communications generally reflect those of the main battle tank from which the engineer vehicle is derived and can be compared with the improvement that the Chieftain main battle tank enjoyed vis-a-vis Centurion. More particularly, mobility is further improved by a turretless and, therefore, potentially lighter vehicle with a consequently higher power to weight ratio and considerably improved reliability. Protection is similar to the main battle tank with some minor areas of degradation caused by the intramural conversion, but rectifiable during the commercial conversion. Communications are also similar to the main battle tank and, being truly Clansman, are generally an improvement over the hydbrid Larkspur/Clansman harness of the Centurion AVRE with some performance loss caused by lower aerial bases and load screening.

Firepower for AVRE must not be confused with the Demolition Gun. Its equivalent of the impact of 120mm rounds is the ability to provide mobility and protection for

Photo 1. Chieftain AVRE with dozer blade mounted, launching a roll of Class 60 trackway, with two further rolls on board.

Photo 2. Chieftain AVRE, with mine-plough mounted, carrying a Number 9 tank bridge.

our own forces and to deny mobility to the enemy. Accepting the important improvements derived from the Chieftain base vehicle, there is an even more significant improvement in task potential.

The mobility support which Chieftain AVRE can provide represents a quantum leap over Centurion. A Centurion AVRE mounts a single pipe fascine or roll of Class 60 trackway. Further equipments can be carried in the trailer, but these take time to load and the operation would be hazardous in contact with the enemy. A gap wider than 5m, for which a tank bridge is not to be committed, normally requires more than one pipe fascine and, therefore, more than one Centurion AVRE. Indeed, to be sure of success, a reserve of a further AVRE should be to hand. This means three AVREs, a troop's worth, and only one route opened. The Chieftain AVRE can mount three pipe fascines and a troop's worth of three AVREs could certainly guarantee two, and likely three routes, whilst still maintaining a reserve. With each AVRE, two of the pipe fascines are in the ready position and the third can be manoeuvred into position using the applique winch. This winch can also be used to load the AVRE and this obviates the need to employ a second tank. If the pipe fascine carrying capacity of the Chieftain AVRE is linked with its improved automotive reliability, the performance of a single Chieftain AVRE can be compared with that of a whole Centurion AVRE troop. With Class 60 trackway, the performance leap is even greater. The Chieftain AVRE can comfortably mount six rolls of Class 60 trackway and up to nine for short periods. The comparison to one roll for a Centurion AVRE is dramatic, but in keeping with the battlefield requirement.

Chieftain Armoured Vehicle RE (1&2)

Using the top hamper and winch, the Chieftain AVRE is able to load, carry and unload the Number 9 tank bridge; a useful compensation for the limited cross-country performance of the wheeled bridge transporter. In addition to this potential forward resupply of Chieftain AVLBs, it can be used directly for some overbridging tasks and further for bridging short gaps.

As to the front of the vehicle, the AVRE can, like the Centurion, mount either a dozer blade, useful in all areas of battlefield support and particularly in defence, or a mineplough for field and hard surface clearance of conventionally and remotely emplaced mines. The performance of the former being less than the Centurion AVRE, but not significantly so. The interchange of dozer blade and mineplough remains an awkward task, but development work is in hand to make it slicker.

To the rear, the Chieftain AVRE retains the ability to tow a variety of trailers. Tandem Giant Vipers can be used against minefields up to approximately 375m deep and the AVRE trailer is a useful limber for a wide range of engineer stores. In addition to the familiar loads of pipe fascine and Class 60 trackway, the trailer's combination with a barminelayer produces a formidable counter-mobility tool. Crew exposure is certainly a disadvantage when compared with the FV 432 though this is, in part, compensated for by the combined barmine carrying capacity of the AVRE and trailer. Four NATO pallets of mines, or other stores, can be carried on the top hamper and there is further capacity inside the tank.

When necessary, occasional seats allow the crew of four to be augmented by two. Thus, whilst still maintaining an essential crew, a small section can undertake dismounted tasks such as demolition maintenance prior to firing from under armour and nuisance minelaying.

Most of the tactical advantages of the new AVRE follow directly from the technical specification. Overlaying these is the improved flexibility of the troop which derives from the increased reliability and capacity of the system. The level of support does not change, but the speed of response and the options, with proper reserves, are greatly enhanced. Confidence, rather than optimistic incredulity, is likely to be the hallmark of the resultant relationship between battlegroup and troop.

Vehicle logistics are much simplified. Not only is the Chieftain AVRE a more modern tank, known to fitters and with spare parts more readily available; but it is inherently more reliable and, by design, with its power pack concept, easier to maintain. It uses diesel rather than petrol which, linked with the rationalisation of base vehicle types, is a real economy.

It is right to balance the many advantages of the Chieftain AVRE with acknowledgement of its limitations. It remains a workmanlike solution to a pressing need. That said, although many early difficulties, such as load stability and release of expedients, were rectified during trials; others, such as crew visibility and comfort and defile marking, are scheduled for rectification during the commercial development. The solution of further problems, better described as capability gaps, must await further research and development and funding. These mainly concern the mounting of systems for remote demolition and minelaying. Whatever transpires in these areas, it is clear that the platform-like concept of the Chieftain AVRE will greatly simplify their incorporation.

The ability of the Chieftain AVRE to carry additional crewmen forges an important link between field and armoured engineers. The speed of armoured operations has identified a need for more timely engineer support and Chieftain AVRE has provided the catalyst for a new task organisation integrating men and machines; both necessary if support is to be complete. The traditional distinctions are blurred in this sensible concept of close support engineers which points to the future. Soon the idea must be reflected in a new pattern of training and, in time, be developed in a future engineer vehicle, ideally derived from the best main battle tank, and incorporating the attributes now individually associated with the armoured personnel carrier, AVRE and bridgelayer.

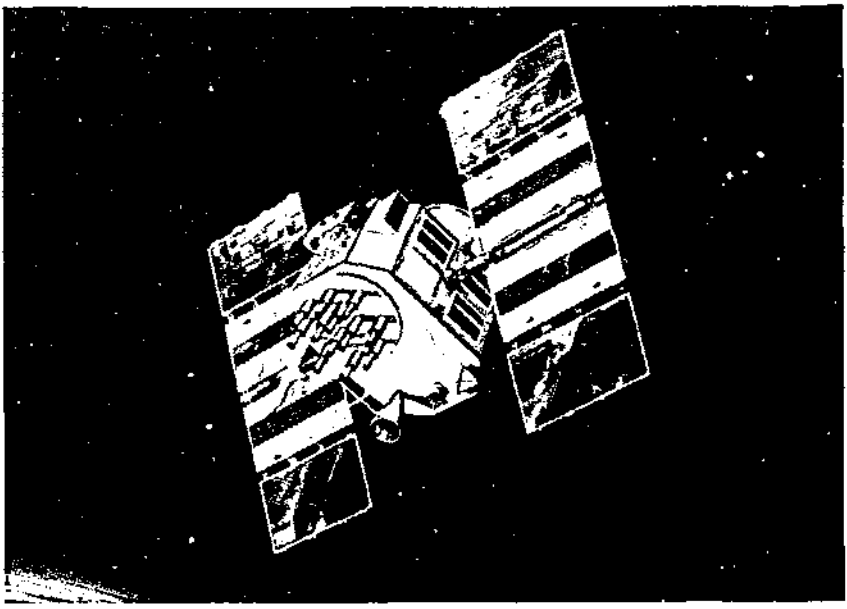


Photo 1. Global Positioning System Block II satellite.

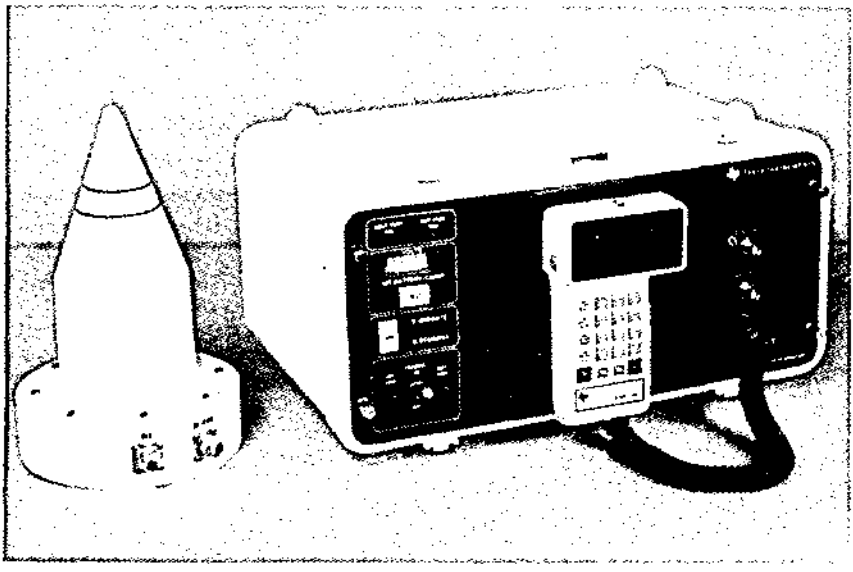


Photo 2. TI 4100 GPS Navigator and Antenna.

The Global Positioning System
or
"Where am I . . . now!"

MAJOR MARK C BREACH MA MSc ARICS RE

The author was commissioned into the Corps from the RMA Sandhurst in 1969 and served in Germany, UK, Cyprus and Kenya as a field and amphibious engineer. In 1976 he joined Military Survey and after the Army Survey Course at Hermitage was on loan to the Directorate of Overseas Survey for a year each in Kenya and North Yemen as a field surveyor. At the time of writing he was Second-in-Command of 512 STRE (Geodetic Satellite Survey) and was based in Washington DC, USA. That posting took him on duty to Ascension Island, Cameroon, Canada, Cyprus, Falkland Islands, Ghana, Guam, Honolulu, Kenya, Marianas Islands, Micronesia, Palau, Qatar, Senegal, Sierra Leone, Uganda and all over the USA . . . and he enjoyed every minute of it!

It is closing time, cold and raining hard as you each dash from the door of the Mucky Duck to your cars. It was with a festive and high spirited village crowd that you saw out, not only the old year but the old millenium too. The car starts first time (but don't they always nowadays) and you drive off down the country lane, headlights picking out hunched but unsteady drinking companions of the past few hours. Half an hour later the countryside has become unfamiliar and what should have been a three mile drive home, wasn't. Rats! You're lost. Too many half litres of real ale perhaps.

But not to worry, your Auto Navigation System will get you home. You press the 'on' button and the little red light shows the system is warming up and displays the preprogrammed default coordinates of your estimated position (the centre of London—that seems to be where you get lost the most). Actually the GPS receiver is computing an approximate update of the ephemeris . . . but wait, let us examine what all this is about and how you can escape from your predicament?

In the next few years the United States will launch a constellation of earth satellites that will enable surveyors and navigators on or near the surface of the earth to determine their absolute positions and velocities to a few metres and decimetres per second respectively, in real time. The system is known both as NAVSTAR (for NAVigation System using Timing And Ranging) and more simply as GPS (Global Positioning Systems). The system is to be funded and controlled by the US Department of Defence (DoD) but will be partially available for civilian and foreign users. The accuracies that may be obtained from the system will depend on the degree of access available to the user, the sophistication of his receiver hardware and data processing software, and his degree of mobility during signal reception.

Major Mark C Breach MA MSc ARICS RE
The Global Positioning System

In very broad terms the sophisticated user in a static location may obtain "absolute" accuracy (ie with respect to the mass centre of the earth within the satellite datum, to be more precise) to better than ± 1 metre. He would also be able to obtain position relative to another known point to a few centimetres over a range of tens of kilometres with data post-processing. At the other end of the scale, a technically unsophisticated, low dynamic (ship or land vehicle) user with limited access to the system might achieve real time "absolute" accuracy of a few hundred metres.

The GPS navigation system relies on satellites that continuously broadcast their own position in space. Theoretically a user who has a clock perfectly synchronized to the GPS time system is able to observe the time delay of a GPS signal from its known time of transmission at the satellite to its time of detection at the user's equipment. The time delay multiplied by the mean speed of light along the path of the transmission from the satellite to the user equipment, will give the range from the satellite at its known position to the user. If three such ranges are observed simultaneously there is sufficient information to compute the user's position in 3-dimensional space. The false assumption in this is that the user's receiver clock is perfectly synchronized with the satellite clocks. In practice, although the satellite clocks are almost perfectly synchronized to the GPS time system the user clock will have an offset. So the user is not able directly to measure his range to a particular satellite but only his "pseudo-range" ie his actual range with an unknown but instantaneously fixed offset which is his clock error times the speed of light. There are four unknown parameters to be solved for in the navigation solution, the x, y and z coordinates of user position and receiver clock offset. A four parameter solution therefore requires simultaneous observations to four satellites. Clearly then, for 24 hrs worldwide navigation solutions in 3-dimensional space at all times and all points on or above the surface of the earth, at least four satellites must be visible. Not only must at least four satellites be visible but they, or the best four, if there are more, must be in good geometric arrangement with respect to the user.

Dilution of Precision

Dilution of Precision is the concept whereby this problem is analysed and a numerical parameter is derived to describe the quality of the geometric relationship between the user's equipment and the four chosen satellites. For those who enjoy that

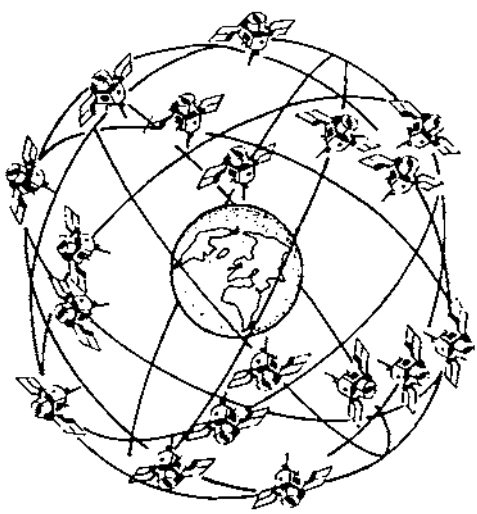


Figure 1. Space Segment.

sort of thing there is a guide to the geometric and mathematical derivation of the Dilution of Precision statistics at Annex A. A full derivation may be found in *Jorgensen 1984*.

Depending upon the user's application there are five interrelated Dilution of Precision (DOP) statistics, Geometrical, Position, Horizontal, Vertical and Time Dilutions of Precision. In each case they are the amplification factor of the measurement error within the system of the pseudo-range from a satellite to a user station due to the effect of satellite and user geometry. The author of this article is a surveyor and therefore most interested in 3-dimensional position and hence the PDOP of the satellites. A sailor navigating on the relatively flat sea would be more interested in HDOP since he will already have sufficient information about his height. If a particular user is using the GPS for time transfer his interest would only be in TDOP since he will not need to know where he is.

We will consider the surveyor's PDOP, but similar arguments can apply for any of the DOPs. PDOP is a dimensionless number which will vary from about 1.6 in the best possible geometrical configurations to much larger numbers when satellites are badly positioned for a particular user. For example, if the system was able to measure pseudo-range from a user set to a satellite to seven metres and at a particular instant the satellite and user geometry was such that the PDOP was 2.5 then the user error of position and clock offset (scaled by the speed of light) would be $2.5 \times 7 = 17.5$ metres. PDOP is independent of the coordinate system employed both in terms of scale (unit of distance) and orientation. It is a means of user selection of the four best satellites from those that are visible. PDOP is also a criterion for designing the Navstar/GPS satellite constellation. The major geometrical requirements of the constellation are that there should be consistently good PDOP worldwide continuously in time. The economic requirements are that there should be a minimum number of satellites in the constellation. Theoretical research has been carried out on the geometry of many possible constellations. The one that best satisfies the geometrical and economic requirements is described below.

Eighteen satellites are placed, three in each of six orbits evenly spaced around the equator. Each orbital plane is inclined to the equator by an angle of 55° and within each orbital plane the three satellites are evenly spaced in an almost circular orbit which has a nominal radius of 26,000km or about four times the radius of the earth.

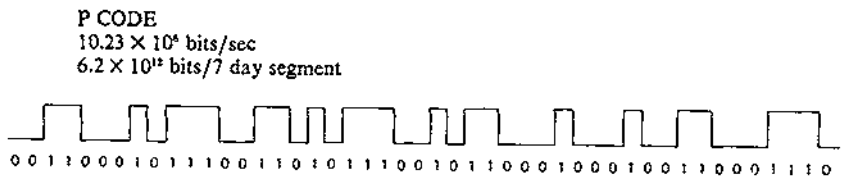
Some satellite statistics:

Weight when in final orbit—1862lbs
Solar arrays—78sq ft
Design Life Goal—7.5 years
Life of consumables—10 years
Launch—by Atlas Rocket or Space Shuttle
Electrical Power—2 sun seeking single degree of freedom solar arrays
—3 Ni-Cd batteries for eclipse periods
Altitude and Velocity Control—3 axis stabilization with yaw steering
—Combined Horizon Sensors
—Passive Nutation Control
—4 skewed reaction wheels
Thermal Control—7 Thermal Control Louvres
—Multilayer Insulation
—Thermostatically Controlled Heaters
—Active base plate thermal control unit
Structure—Rigid body of Aluminium boarded honeycomb panels
Reaction Control—Hydrazine Propellants
—2×5lb trim thrusters
—20×0.1lb altitude control thrusters
Navigation—Dual (with occasional triple) L Band transmission
—Shaped beam helical antennas
—2 Rubidium and 2 Cesium atomic clocks

GPS Signals

As far as the user is concerned each GPS satellite broadcasts on two L Band carrier frequencies $L_1 = 1575.42$MHz and $L_2 = 1227.6$MHz. The carriers are phase modulated to carry two codes, known as the P code or Precise code or PPS (Precise Positioning Service) and the C/A code or Course/Acquisition code or SPS (Standard Positioning Service). The C/A code has a "chipping rate" of 1.023×10^6 bits/sec and the code repeats every millisecond. This means that the sequence that makes up the C/A code is only 1023 bits long. Multiplied by the speed of light each bit is then 960ft long and the whole code about 300kms. By contrast the P code chips at 10.23×10^6 bit/sec and repeats every 267 days. The P code is thus 2.4×10^{14} bits long. Without prior knowledge of its structure the P code will appear as Pseudo Random Noise (PRN). This means that it is relatively easy for the user's equipment to obtain lock onto the C/A code since it is short, simple and repeats 1000 times a second. By contrast without a knowledge of the P code it is impossible in practice to obtain lock because the P code is so long and complex. This is the key to selective access to the GPS system. Only those users approved by the US DoD will be able to use the P code. Each code is further modulated by a 50Hz data stream that contains the following information:

The satellite ephemeris, i.e. its position in space with respect to time.
Its status.
Parameters for computing corrections to the satellite clock.
The Hand Over Word (HOW) for time synchronization that allows the user with access to the P code to transfer from C/A to P code.
Information on other satellites of the constellation including status and ephemerides.



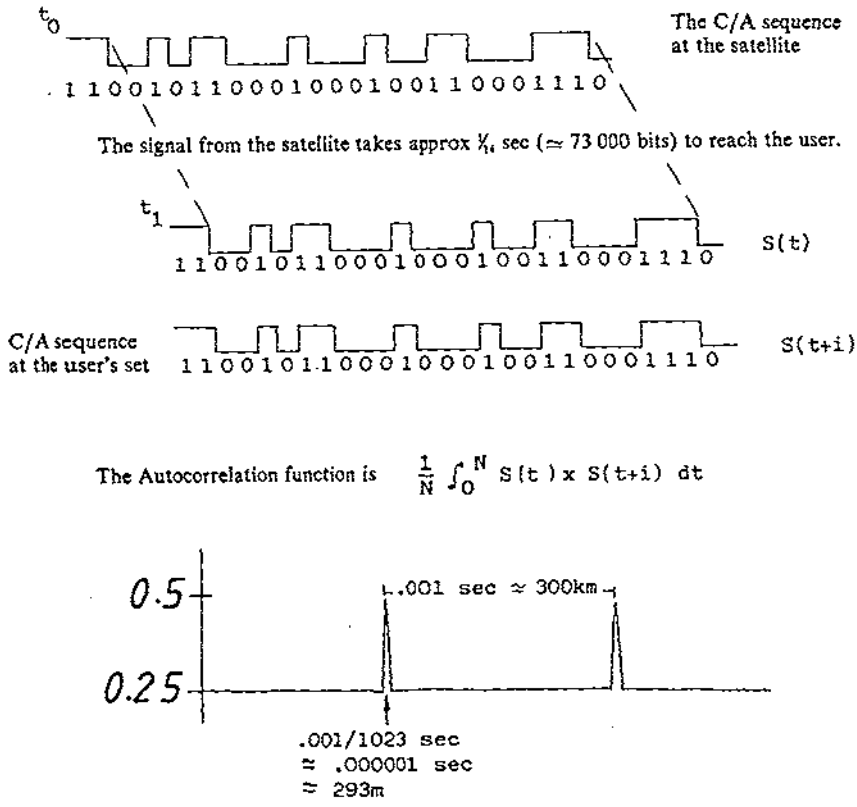
Signal, Phase Modulated by C/A Code (not to scale)

wavelength of $L_1 \simeq 19.1$cm, 1540 cycles per C/A bit
154 cycles per P bit
wavelength of $L_2 \simeq 24.4$cm, 1200 cycles per C/A bit
120 cycles per P bit

Figure 2. Signal Modulation.

How the User Set Acquires the C/A Signal

At a time t_0 say, the satellite starts to transmit another repetition of the C/A code. At a time t_1 the start of the transmission reaches the user set. The user's set generates its own copy of the C/A code and compares it with the received signal by adjusting the time offset between the signals until auto correlation is achieved.



Autocorrelation ≃ .5 when user set C/A signal is time shifted to correspond to received satellite C/A signal by the time equivalent of the psuedo-range to the satellite (with 300km ambiguity). Otherwise it will be ≃ 0.25.

Figure 3. Acquiring the C/A Signal.

The time offset is then a function of the time of transit of the signal from the satellite to the ground station and the user clock error ie the R_1-T of equation 1 divided by the speed of light. Once the user set has acquired lock (auto correlation) onto the C/A code the data stream may be decoded, including the HOW. The user set then has sufficient information to generate its own copy of the P code and likewise obtain lock through auto correlation and hence another measure of pseudo range.

The satellite clocks must be set to run slow by 4.45×10^{-10} MHz to compensate for the effects of both special and general relativity. The measured ranges from the user set to the satellite must be corrected for the delay of effects of both ionospheric and tropospheric refraction. A knowledge of meteorological conditions ie air pressure, temperature and humidity are required to correct for the effects of tropospheric refraction. To a first order the error in the measured range due to signal passage through the ionosphere is a function of the signal frequency squared. The true range

is then a function of the L_1 and L_2 frequencies and the ranges measured on them. Only a receiver that is able to decode the signals on both frequencies is able to make corrections for ionospheric refractions. If the L_2 frequency is only modulated by the P code then only authorized users will be able to obtain absolute geodetic accuracy.

Ground Segment

The satellite navigation message, which describes the satellite positions, is up-loaded to the satellite by the Ground or Operational Control Segment (OCS). The OCS operates as three elements:

Monitor Stations at Ascension Island, Diego Garcia, Guam and Hawaii.
A Master Control Station at Colorado Springs, USA.
An Up-load Station at Vandenberg Air Force Base, USA.

The Monitor Stations are remote unmanned stations with a GPS receiver, a cesium clock, meteorological sensors, data processor and teleprinter with a modem. Their functions are to observe the broadcasted satellite navigation message and the satellite clock errors and drifts. The data is automatically gathered and processed by each Monitor Station and is transmitted to the Monitor Control Station. By comparing the data from the various monitor stations the Master Control Station can compute the errors in the current navigation messages and satellite clocks, and so can compute updated navigation messages for future satellite transmission. These up-load navigation messages are passed to the Up-load Station by modem and are in turn processed for transmission to the satellites by the ground antenna. The Monitor Stations then receive the updated navigation messages and so the data transmission and processing circle is complete. In practice the satellite navigation messages are updated about once every 24 hours or every second orbit.

User Segment

To a particular user his own equipment represents the User Segment. Each GPS navigation equipment will have an antenna, a receiver, an accurate atomic clock of some form, a computer and various input/output devices.

For survey applications the antenna is normally omnidirectional. For the dynamic user, land vehicles, ships and aircraft, special visibility considerations may apply. For example, how do you mount an antenna on an aircraft that can roll or fly upside down and still maintain a full 180° hemispherical view of the sky?

The computer converts the pseudo ranges and other data from the receiver into the 3-dimensional coordinates of position, and/or velocity, and/or computes time. The computer will also correct for the effects of refraction, select the satellites to be observed and will control the input/output devices, such as automatic meteorological sensors, cassette drives and a modem or printer.

The User Community

The potential civil and military user community is enormous. For almost every position and velocity (both relative and absolute), and time transfer application, the current or near future GPS technologies are expected to be able to produce the best solutions. In consequence a number of current navigation systems such as Omega, Transit, Loran C/D, VOR/DME and Tacan are expected to be phased out, for all but a few military users, before the end of the century. After that there will be virtually nothing between the sextant or theodolite and the GPS receiver that is anything like capable of worldwide position fixing.

At present, GPS receivers are scarce and the cost is high, for example Texas Instruments are currently quoting (Bossler 1985) $140,000 each for their TI 4100 models. This is a four channel device which can receive signals on both frequencies of each of four satellites, quasi-simultaneously. Other manufacturers, such as Magnavox, Trimble and Western Geophysical, while recognising that many potential users

Photo 3. Operating the TI 4100 GPS Navigator.

will be denied access to the P code and that the C/A will not be accurate, have come up with instruments that make use of the satellite signals in ways that can give relative positions and velocities extraordinarily accurately by using two or more receivers observing the same satellites simultaneously. The costs of these devices are still high, $10,000 to $100,000, but inevitably must tumble. It was estimated in 1982 that the world GPS civilian user market, excluding individual private users, was for over a quarter of a million receivers, and the estimate is continually rising. As with all high-tech equipment, as unit cost reduces, potential market increases. Again, a 1982 estimate was two billion dollars for world sales for receivers priced from $1,000 to $100,000 each depending on the technical characteristics of each receiver.

System Future

Although there is at present a partial constellation of seven working Block I GPS satellites, these will not form a part of the operational constellation. The Block I satellites were launched for system testing, including user equipments. The 18 operational or Block II satellites were due (Bossler 1985) for launch from October 1986 to December 1988 but it is not unreasonable to suppose that the space shuttle Challenger accident will have delayed the programme a little.

The debate over access to P code continues. In April 1985 US Government policy was stated (Baker and Zedeck 1985). A few brief quotes from the paper outline the problem:

"(Policy) has not been set in concrete . . . (Application for access to the P code/PPS) will be open to all civil users, both foreign and domestic. Among the criteria that will be used to review the application are:

"Is it in the (US) National interest?

"Can the equipment be adequately protected?

"Is this the only way that the required accuracy can be obtained?"

A month later the US Department of Defense put out a policy statement which more or less reiterated the above but also cleared up questions of charges to users of the GPS signals. (Reported in Magnavox 1985).

"This policy provides that DoD intends that the SPS (C/A code) signal will be broadcast in the clear and will be available for use by any properly equipped user.

There will be no annual or other direct fee associated with the use of this signal. The SPS will be made available to civil, commercial and other users on an international basis at the highest level of accuracy consistent with the US national security interests. It should be noted that at the direction of the Defense Sub-committee of the Senate Appropriations Committee, the GPS has been designed and engineered in a manner to protect the user fee option should it be appropriate in the future. If Congress does direct user fee implementation in the future, an appropriate time would be allowed to transition user equipment into a user fee configuration."

Apart from the obvious survey/geodetic and simple navigation uses of GPS the following are examples of anticipated applications.

An airfield rebroadcasts its received GPS (C/A code only) signals to incoming aircraft which can then compute the relative positions of the runway in the order of one metre in real time to enable all-weather/visibility take off and landing.

Military Aircraft, using the P code, air-to-air refuel, or land on an aircraft carrier, at night without lights and in radio silence by flying on pre-programmed flight paths.

Knowing target position and their own instantaneous position and velocity, aircraft "Toss Bomb" from behind cover, in radio silence and without any external aiding.

A cruise missile updates its inertial guidance system while in flight.

Scientific satellites compute and transmit to earth stations their 3-dimensional coordinates in space along with other scientific data.

A supertanker, with antennae at each end computes the relative position of its bow and stern to centimetres and hence its course to minutes of arc.

GPS receivers coupled with radio transmitters are attached to major icebergs in the North Atlantic. Shipping is constantly warned of precise iceberg positions. The GPS sets are recovered when the icebergs have melted.

Taxi fleet control centres monitor their vehicles which are equipped with GPS receivers linked to CB transmitters.

Haulage firms monitor the cross country/continent progress of their trucks by the same means. Hi-jacks are spotted almost immediately.

HOTOL navigates from London to Sydney on its one hour flight/orbit.

Almost unlimited SDI applications.

The future for GPS is technically exciting and the applications will be almost universal. Today few men-on-the-street could tell you about Omega, Transit or Loran but by the end of the century the term GPS will be as common as Hoover.

. . . the GPS receiver is computing an approximate update of the ephemeris for each satellite using the default coordinates of your ground position and the satellite orbital parameters computed last time you used the system. The receiver selects the best four satellites of those available on the basis of PDOP. It also computes an estimate of time offset for C/A code autocorrelation and an estimate of the apparent Doppler shifted satellite frequency for each of the four chosen satellites. The GPS receiver obtains lock and computes its first estimate of the 3-dimensional position and instantaneous velocity of your car. Meanwhile, the inertial system, a set of two ring laser gyros and three mutually orthogonal accelerometers warm up and output data to the GPS computer to enable it to update its estimate of position and velocity while you are moving. It recomputes the best PDOP, time offsets and Doppler shifts for better estimates of your car's position and velocity, which in turn enable the computer to calculate corrections to the gyro and accelerometer outputs. The inertial and GPS parts of the system continue to fine tune each other until the computed vehicle position stabilizes to an acceptable level.

The red light goes out.

Now that the Auto Navigation System knows much more accurately where it is, and how fast and in which direction it is going, the computer calls for the digital

topographic data base for your area, which you previously entered from the solid state memory module. This data enables the head-up display to project your position on a map onto the windscreen. You do not recognise where you are so you press the "panic button". The preprogrammed coordinates of your garage doorway are entered and the system computes your best route home. The rain has turned to snow and the head-up display becomes irritating in the glare of headlights on falling snow, so you switch it off and go to "voice". Using data from the GPS/inertial system and the digital topographic data base the computer generated synthesized voice instructions guide you home.

Although the scenario may sound a little fanciful each of the individual technologies described exists today. What has yet to be achieved is a device that links them all together to produce an integrated system, available at a price that the ordinary motorist is willing to afford.

The mid-Atlantic female voice from the dashboard gently commands, "... in one kilometre, turn left ... in two hundred metres, turn left ... turn left ... Now!

Annex A

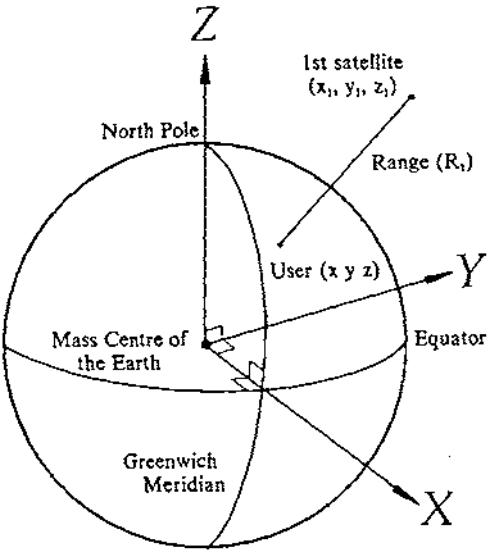


Figure 4.

The basic navigation equation to the first satellite is:

$$((x-x_1)^2 + (y-y_1)^2 + (z-z_1)^2)^{1/2} = R_1$$

from purely Pythagorean considerations. However, since the user's clock is not perfectly synchronised to GPS time the actual measured range is given by:

$$((x-x_1)^2 + (y-y_1)^2 + (z-z_1)^2)^{1/2} + T = R_1 \qquad (1)$$

where $T = c\Delta t$

and c = speed of light, or more precisely the mean speed of the signal between the satellite and the user and

Δt = the user clock error

If there are simultaneous observations to four satellites then the navigation equations will be:

$$((x-x_1)^2 + (y-y_1)^2 + (z-z_1)^2)^{1/2} + T = R_1 \qquad (2)$$

$$((x-x_2)^2 + (y-y_2)^2 + (z-z_2)^2)^{1/2} + T = R_2$$

$$((x-x_3)^2 + (y-y_3)^2 + (z-z_3)^2)^{1/2} + T = R_3$$

$$((x-x_4)^2 + (y-y_4)^2 + (z-z_4)^2)^{1/2} + T = R_4$$

Note that the T term is the same in each equation since it represents the instantaneous user clock error. There are four equations and four unknowns and providing the equations are independent, as they normally are, then a unique solution is possible. However, since the equations are not linear in the unknowns they are difficult to solve as they stand. The software in most receivers linearizes the equations by taking partial differentials with respect to the unknown parameters and iterates to a convergent solution. Such an approach leads to the following (Jorgensen 1984).

$$\begin{bmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} & 1 \\ \alpha_{21} & \alpha_{22} & \alpha_{23} & 1 \\ \alpha_{31} & \alpha_{32} & \alpha_{33} & 1 \\ \alpha_{41} & \alpha_{42} & \alpha_{43} & 1 \end{bmatrix} \times \begin{bmatrix} \Delta x \\ \Delta y \\ \Delta z \\ \Delta T \end{bmatrix} = \begin{bmatrix} R_1 \\ R_2 \\ R_3 \\ R_4 \end{bmatrix} \qquad (3)$$

Where α_{ij} is the direction cosine of the angle between the range to *i*th satellite and *j*th ordinate, Δx, Δy, Δz are corrections to the *a priori* estimates of the user's position, ΔT is the correction to the *a priori* estimate of user clock offset times the speed of light and ΔR, the difference between the actual measurement and the computed measurement (from the *a priori* user values). In matrix terms equation (3) may be rewritten as:

$$\mathbf{Ax = t}$$

For example if the diagonal terms of $(A^TA)^{-1}$ are:

$$\begin{vmatrix} \sigma_x^2 & \circ & \circ & \circ \\ \circ & \sigma_y^2 & \circ & \circ \\ \circ & \circ & \sigma_z^2 & \circ \\ \circ & \circ & \circ & \sigma_T^2 \end{vmatrix}$$

Then:

Geometrical Dilution of Precision (GDOP) is

$$\sqrt{(\sigma_x^2 + \sigma_y^2 + \sigma_z^2 + \sigma_T^2)}$$

Positional Dilution of Precision (PDOP) is

$$\sqrt{(\sigma_x^2 + \sigma_y^2 + \sigma_z^2)}$$

Horizontal and Vertical Dilutions of Precision (HDOP and VDOP) are a little more complicated as they depend on the defined plane of the horizon or direction of vertical at the user's position with respect to the coordinate system.

Time Dilution of Precision (TDOP) is σ_T

Whatever the local definition of horizontal or vertical the fixed relationships between the dilutions of precision are:

$GDOP^2 = PDOP^2 + TDOP^2$ and

$PDOP^2 = HDOP^2 + VDOP^2$

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ACKNOWLEDGEMENTS

Photographs and illustrations are by kind permission of Texas Instruments, Lewisville, Texas, USA.

Photo 1. General view of the phoeboscope. Note the bright spot projected by the lens of the gnomon onto the shadow plate.

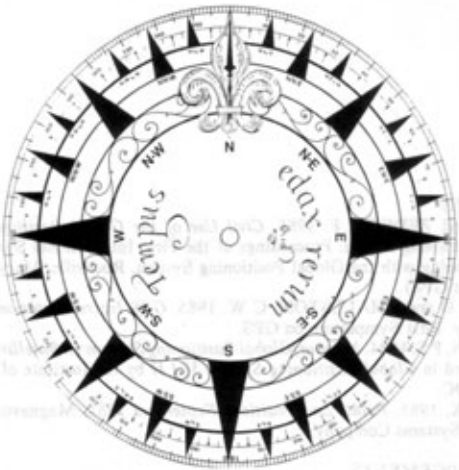

Figure 1. The base plate. As a change from the overworked *Tempus fugit* it bears a Latin inscription meaning 'Time the devourer of all things'.

The Global Positioning System (1 & 2)

The Phoeboscope

H C H ARMSTEAD BSc Eng FICE FIMechE FIEE FCGI

Christopher Armstead was educated at the Royal Naval Colleges, Osborne and Dartmouth and received his training as an engineer at the City and Guilds Engineering College, London. He has held various appointments in India and in England, and for a few years he was a Technical Adviser in the Resources Division of the United Nations in New York. Since the late 1960s he has worked as a free lance consulting engineer. He now lives in Dartmouth, Devon. A sun-compass designed by him many years ago is in the possession of the National Maritime Museum, Greenwich.

A DESCRIPTION has recently been published of a novel instrument called the phoeboscope (*Photo 1*), a device that can be used either for direction-finding or for time-keeping in any part of the world from the Arctic to the Antarctic where the sun shines. It can serve either as a sun-compass or as a sundial with surprisingly good accuracy. Cynics may question the practical value of such an instrument in a world that can provide both the navigating compass and the quartz watch, neither of which is dependent upon sunshine. It is nevertheless undeniable that solar dial instruments hold a fascination for many enthusiasts. Who can view an astrolabe or that superb piece of sixteenth century craftsmanship, Drake's Dial (on display at the National Maritime Museum, Greenwich), and dismiss it as a mere superseded curiosity? And why is it that so many people consider that no garden is complete unless furnished with a sundial—even of the common fixed-gnomon variety that is so grossly inaccurate?

The phoeboscope cannot of course compete aesthetically with Drake's Dial, but it is nevertheless decorative: moreover it is highly *instructive*. It could serve as a useful aid in the tuition of navigation or surveying. When set up for observation it can be used to demonstrate, more clearly than any drawing, many of the basic concepts of observational astronomy—the celestial equator and poles, solar declination, hour-angle, the observer's latitude and longitude, the equation of time, azimuth, local mean time, summer time. All these concepts can quickly be grasped by the eye and understood.

To use the instrument, all that is required is a dead level table or pedestal in a sunny position for mounting the base plate (*Figure 1*), which is 'boxed' in the conventional manner of a compass and also in degrees of angle. Only two semi-permanent pre-adjustments need be made—one for the observer's latitude and one for his longitude. After that the phoeboscope requires no further interference except for a simple correction at the beginning and at the end of the Summer Time period (where relevant) unless the owner moves house or emigrates: that too can be catered for by making a simple readjustment.

After setting up the base plate on its flat mounting a reliable watch is needed, with the aid of which the direction of the meridian can quickly be fixed. Thereafter the phoeboscope may serve as a clock. In theory the watch may be *borrowed* in the first place and returned to its owner after fixing the meridian! Nevertheless, one of the attractions of a solar instrument is the ability to put it through its paces from time

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The Phoeboscope

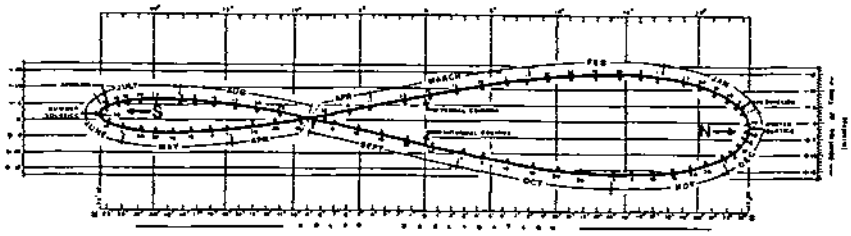

Figure 2. The analemma, or solar locus on the shadow plate.

to time so as to *demonstrate* its capabilities: it is better to use one's own watch for fixing the meridian!

The act of observation is simply to move part of the instrument until a bright point of light, formed by the sun's rays passing through a lens, is brought to coincide with an engraved loop—an analemma (*Figure 2*). This loop takes full care of the sun's irregular 'wobble'—the Equation of Time—caused by the fact that the earth's orbit is elliptical and not circular.

The accuracy of observation depends partly on the quality of workmanship of the instrument, partly on the skill of the observer and also on the *size* of the instrument: the larger the phoeboscope, the greater the accuracy. At present the phoeboscope has been made only in prototype,with an 11-inch diameter base plate and a 5-inch focal length lens. The accuracy with which the meridian can be fixed depends also on the time of day: the lower the sun's altitude above the horizon, the better. The accuracy of time-fixing is virtually independent of the sun's altitude. With the prototype, operating in the United Kingdom, the meridian can usually be fixed to within about a quarter of a degree of azimuth and the time can be fixed to within about one minute. Only within two or three weeks on the solstices is the accuracy somewhat impaired. Larger phoeboscopes could be made to give any required degree of accuracy.

READERS interested in further details of the phoeboscope are referred to *Clocks* magazine, January 1987 issue. (Editor, c/o Argus Specialist Publications Ltd., PO Box 35, Wolsey House, Wolsey Street, Hemel Hempstead, Herts HP2 4SS). Unfortunately the printed article contains a few misprints.

* * * * *

Early Days

MLC

READERS of last year's edition of Early Days may remember that in 1886 the coming centenary of the grant of the Royal title in 1787 was viewed with a marked lack of enthusiasm. The general feeling seems to have been accurately reflected at the 1886 AGM of the Institute, by the speaker who said that the centenary should "not be made too much of", as an officer, already proud to belong to a fine Corps, would not think his Corps the more illustrious because it had been granted the Royal title. This indeed seemed to have been translated into action—or rather, inaction—as there was not one single mention, even of the fact of the centenary, in the 1887 Journals.

It could be said that "Royal 100" was overshadowed by celebrations of the Queen's golden jubilee. The central event of these was an impressive parade in London on 21 June 1887, when the Corps was represented by a large contingent of over 600 all ranks, with the band playing a prominent part in many of the London events. There was also a Jubilee Service in Rochester Cathedral on 20 June. So one can well imagine there could have been difficulties in fitting in another Royal event during that year!

In connection with the Jubilee, there was a presentation to the Queen at Osborne

House by the military and civilian staff of the Ordnance Survey of Great Britain and Ireland, based then, as now, in Southampton. The Court Circular recorded that a delegation of officers, NCOs and men of the Royal Engineers, together with members of the civilian staff, presented a "jubilee offering" consisting of a book illustrative of the history of the Ordnance Survey, with drawings, photographs and engravings. The book is described as beautiful and unique, and from all accounts it was indeed an impressive work of art—from the elaborate binding, the exquisitely produced title page and dedication, to the fifty-eight pages of letterpress, maps and illustrations. Two copies were made, also to a very high standard, but only containing photographic representations of the original, although the title pages were the second and third selections from designs submitted for inclusion in the original. These latter copies were to be kept, one in the Ordnance Survey Library and the other in the library of the Survey Office, Dublin.

The annual inspection and prize givings of the Engineer Volunteers received their usual prominence in the 1887 Journal. The Volunteer movement was started in 1859 and grew rapidly. It was founded at a time when the Regular Army was held in very low esteem and just after the reverses of the Crimean War had led to urgent calls for military reform. The army remained under strength and largely unreformed and was reputedly led by gentlemen officers who gave little sign of the professionalism which was advancing so markedly in other areas of Victorian life. The Volunteer movement served the frustrated, military ambitions of middle class men, who could not aspire to officership in the Regular Army or other auxiliary forces, because of the high price of commissions and high costs associated with an officer's life. The Volunteer other rank was persuaded to join to protect the safety, purity and sanctity of the English home and to demonstrate that old English chivalry still lived. All this was to be contrasted with the unsettled habits and immmorality associated with the regular soldier![1]

Sir Andrew Clarke, late IGF, in addressing the Lancashire Engineer Volunteers in June 1887, and as reported in the *Journal*, congratulated the unit on its improved tone and bearing, and on the cooperation and sympathy that existed between officers and other ranks. NCOs especially were told that they must not only "study their profession but have due consideration for those they were dealing with." He ended on the stirring note that "if England and the men of England were strong and trained to defend their homes, their wives and their little ones, they would have absolutely eternal peace." His talk, needless to say, was enthusiastically received. It would seem that the men of Lancashire, at least, had no doubt that one Volunteer was worth three 'pressed' men!

It has been remarked in previous issues of Early Days, that it was curious how the *Journals* of a hundred years ago did not seem adequately to reflect the doings of an organisation with a great diversity of world-wide interests. Why did the Editor have to fill so many closely printed pages with long extracts from foreign military Journals, let alone with assorted articles from, eg, the *Times, St James Gazette* and the *Broad Arrow*? Readers, one supposes, may have been interested in long accounts of the supply of natural gas to Pittsburgh in the USA, or the provision by private citizens of horses for the King's Service in 1541, but only marginally so! In the latter case it seems that all those "having parkes should keep mares." Those among the more wealthy, but who did not have "parkes", were also expected to do their bit. The King's Commissioners were instructed to check on the latter by the style of the wife's dress. "Gowns of sylke, or those with a frenche hood or bonnett of velvett" were to be adjudged as having the means and duty to keep one trotting horse for the 'sadill' and the King's service!

Of more relevance, but not necessarily of much professional help, was an account of the development of cast iron and wrought iron, with particular mention of St Paul's

[1] "A Military Irony: The Victorian Volunteer Movement", by Professor P Mortow, *RUSI Journal*, September 1986.

Cathedral. The original opinion had been that no respectable or artistic iron work could be produced, other than by a craftsman fashioning in hammered or wrought iron. When Wren's Cathedral had been completed, tenders were invited for the railings. The tender documents did not specify wrought iron, which had been intended, and the contractor produced railings, faultless in design and execution, but of cast iron. This, it seems, was a fortunate error as, being of cast iron, the 'skin' had been left on, so the railings were now, (in 1887) as good as new, "while wrought iron would never have withstood the action of 150 years of English weather without corrosion." A colourful snippet, but not, as suggested, of great military moment!

It is in reading some of the obituaries that one realises afresh the widespread ramifications of the Corps in those days, and the opportunities open to RE Officers. Major General RC Moody, who died in 1887, was a case in point. His early years were spent successively in the Ordnance Survey of Ireland and the West Indies, and as an instructor in fortifications at the RMA. In 1840, while still a subaltern, he was selected to be the first governor of the Falkland Islands. "At the time the colony was almost in a state of anarchy and the young governor was given exceptional powers." After six years he returned home to be CRE Newcastle-on-Tyne. After other RE appointments he became Lieutenant Governor of British Columbia. He then returned to the UK and after a spell as CRE Chatham, he retired. Why he was given the Falklands appointment is not related, although his obituary notes that as a young officer he developed an interest in "political economy and in learning the character and peculiarities of the people amongst whom he was thrown." He must have been one of the more junior officers, if not the most junior, to be chosen for such a task, but there are many examples of senior RE officers being appointed to governorships etc during the Victorian era.

A letter appeared in the August 1887 *Journal* about "the difference in opinion which appears to exist concerning the employment of the letters 'RE' after the names of retired officers of the Corps. Some adopt the term 'late RE', others employ 'RE retired' and a few adhere to the 'RE' pure and undiluted." In the Navy (then as now!) all "retired officers are addressed with the letters RN both officially and by courtesy." The writer asked for guidance. Presumably he never got it, as the subject is still a fairly active one and there was no reply printed in the *Journals* of that year!

The 1887 edition of the *Professional Papers* was practically entirely concerned with fortifications and sieges, including a very long paper on Military Engineering during the Great Civil War 1642–9. This is too long to be commented on in detail here, except to say that one is struck with the frequency phrases such as "the ladders provided for the escalade often proved too short" or "the works of the defence proved too high for the ladders and the storm was not continued with any success." One would have thought that not to have established this vital dimension reasonably accurately, would have been as much as the life of the OC recce party was worth! Perhaps the good honest engineer activities of mining and breaching were the chief items to bother about, and the infantry assault parties, even if accompanied by an engineer or pioneer, got on as best they could. Or, maybe, MEXE had let the side down by not producing a reliable design for adjustable ladders!

To end this review of the 1887 *Journals* it would be appropriate to quote two more examples of not very useful information, although these two examples could quite appropriately be found in a modern newspaper. Advertisers no doubt have always had their eyes on the main chance. Under the heading of "A new use for our Fortifications" it is recorded that an enterprising advertising company had purchased some of the old Martello Towers and that "their round walls were now covered with showy advertisements"! An example, so the report adds, of going from the "sublime to the ridiculous". The other example is that in 1887 the Italians had framed a plan to join the mainland to Sicily by a tunnel under the Straits of Messina. A design for a bridge had also been prepared, but it was thought that that for a tunnel would be adopted. One hundred years later the scheme, like the Channel Tunnel, is very topical, although today the favourite seems to be a bridge!

Breeding Beautiful Butterflies

LIEUT COLONEL J A THORP MBE MA RE

Lieutenant Colonel Thorp joined the Corps from Cambridge University. He has served with The Gurkha Engineers, as Adjutant 25 Engineer Regiment and commanded 4 Field Squadron. He has done staff jobs in MOD, in HQ UKLF, at the Battle Group Trainer Sennelager, at Camberley both as student and DS and recently in HQ BFFI. He is married with two children, a dog and an estate car. When not playing squash or hockey, skiing or windsailing he commands 23 Engineer Regiment.

I SEE that in the fiery debate about the future of the Corps' *Journal* an old, rather charred chestnut is rolling about in the embers: the inability of officers to write good English. What is good English? I will return briefly to that question later. For the moment, consider the following proposition: that the more senior one becomes the better the English one writes. I know this to be true, for it is the task of senior officers to criticise and correct the English of their juniors (and they all do it).

In my brief tours at staff I have seen submissions to brigadiers washed away in rivers of red ink; only to watch their watery product overwhelmed by torrents of purple, mauve, azure and green, as two, three and even four star officers each re-expressed the same thoughts in their own inimitable prose. Thus the education (or do I mean indoctrination?) which starts in the cradle continues almost until the grave.

The cradle for the Army is at regimental duty where education is formalized under the misleading title of "The Progressive Qualification Scheme" (PQS). I say misleading, for many officers make no progress, and those who do are not given any qualification. Perhaps that is why the scheme is about to undergo another mutilation (my draft said mutation but the typist's error is much more expressive!) and assume a less ambitious title: "Junior Officer Training and Education Scheme". I digress.

The PQS Handbook places the onus for improving officers' writing on Commanding Officers. I quote:

> 1. In developing the skills commanding officers may wish to set and correct the work themselves, possibly with some assistance from their own field officers. Alternatively, they may choose from a short list of selected topics (paragraph 0310 refers) in which case they may call for assistance from RAEC officer tutors who are available to help. Some guidance on how to improve an officer's ability in the required skills is given below.
> 2. Writing clear, concise English. The ability of an officer to write clear concise and simple English should be developed both through writing essays and by practice in Service Writing. The amount of written work each officer must do will be for the Commanding Officer to decide; it may vary between individual officers.

You must admit it is a breathtaking concept. First there is the subtle use of "may" in the first paragraph, which clearly eliminates all discretion a CO "may" have thought he had. Secondly one must admire the practical way the burden is shared

Lieut Colonel J A Thorp MBE MA RE

unequally between junior and senior officers. What happens in practice is that a junior officer writes a carefree, highly individual piece of prose on a topic in which he has not the slightest interest; it is read by his CO who corrects it, before passing it up to the CRE, who recorrects it, corrects the CO's comments, adds his own comments before passing. . . . Well, you see how the chain develops; so it is hardly surprising that senior officers write the best English; for the more senior one gets, the more practice one gets correcting bad English. Everyone knows that practice makes perfect. As an aside: it is a sobering thought that all that wisdom distilled in different coloured inks passes across the author's desk some weeks later, unread, on its way to the waste bin. Again, I digress.

When I arrived at my Regiment I found all my subalterns thinking about writing an essay; the CCRE's Prize Essay. My goodness that spurred me to fill the red pen I had emptied on leaving Camberley! The essays were terrible. I knew they would be; they always are. But ever optimistic I was moved to pen my subalterns some advice for the future. Part of it is reproduced below:

"... though much of the research was superficial. The predominant fault was the lack of care editing your essays to produce a polished product which conveyed the meaning as economically as possible. To illustrate the process I attach two short examples which may help you understand how to tackle the process in future. The originals are taken from your essays.

EXAMPLE 1

1. The Original:

Words

Many men serve a full career in the Army and are sad when they have to go. However, along the way there are groans from the dedicated and many others leave because they are not happy with the way of life.

Two problems that often raise their head at troop level are crisis planning and the lack of stimulating training. These are both caused by bad management at various levels. This essay will consider the management faults behind these problems, suggest solutions to each problem and discuss the improvements of management at troop level. 93

2. Get out the brush cutter to remove the undergrowth around the plant you are trying to expose:

Soldiers often complain; some get so dissatisfied they leave without completing a full career. Two recurring problems for field troops are crisis planning and boring training. The cause is bad management. This essay analyses the management's faults, suggests solutions and discusses improvements to troop management. 45

3. Now get out the pruning shears and trim the straggling branches:

Soldiers often complain; some get so dissatisfied they leave early. Two recurring problems are crisis planning and boring training caused by bad management. This essay analyses management's faults and suggests solutions particularly at troop level. 35

4. Now a final run round with the secateurs snipping off little twigs. Check that the words used have the right "emotive value":

Soldiers often complain; some get so dissatisfied they leave. Two frequent problems are late planning and boring training caused by bad management.

This essay analyses management faults, suggesting improvements particularly in field troops. 33

EXAMPLE 2

1. The original:

Words

In my about five year exposure I have had in the Military, my training has been extensive; but has it been what I personally feel I needed? I will say in short, that it has been close to adequate but with two major set backs. I will venture to explain what I mean by capsulising my training in subsequent paragraphs. 60

2. A second draft:

I have had extensive training in my five years in the Army. Do I think it has been adequate? Yes, I do, with two exceptions. These will be explained below as I describe my training to date. 37

3. A final polish:

I have had extensive training in the last five years. Has it been adequate? Yes, with two exceptions. These will be examined as I describe my training. 27"

I know it was a futile gesture, but one has to try, doesn't one? Then, some weeks later the anonymous, subversive text below appeared one morning in my in tray:

SERVICE WRITING

1. *The Philosophy.* It is essential to be able to stifle creative thought before it can lead to a realisation of truth. Therefore the Composition Obfuscater has provided us with a guide to writing which effectively culls all the horrors such as originality and verve and prevents picturesque speech.

2. *The Example.* The attached example shows the step by step method of exposing those facts we want whilst eliminating those we do not:

a. *Original.* Cervis D Ress strode purposefully into the bar. His athletic frame, square jaw and well groomed looks spoke of a successful man in the city. The barman mixed a cool Martini whilst Cervis cast a confident glance around the interior of the rather exclusive establishment. His gaze halted abrubtly on the delicious form of Jenny. "She has to be a model" he thought, admiring her classic full figure and her jet black hair swept back with a hint of rebellious youth. Cervis paused only to wink at the barman before moving smoothly over to Jenny's table. "Hi, I'm Cervis D Ress, may I join you?", he asked with an expectant grin. Jenny swept her eyes over his body taking in every detail and lingered on his deep blue eyes before finally nodding her assent.

"Please do". Her voice lapped over him like honey. "Chanel", he breathed, "my favourite. Tell me how can such a good looking girl be sat alone?" "Maybe I just hadn't found myself a man", she purred, shooting a questioning glance at him. Cervis grinned, his eyes devouring her. She crossed her black stockinged legs nonchalantly and he felt himself burning in the heat of her pouting red lips.

"You have now", he croaked. "I'll take you to the opera then to a pretty French restaurant. Do you like Coq au Vin?" "Mais, bien sur!" She giggled, her laughter bubbling like champagne.

The barman grinned wryly as the couple left chatting merrily arm-in-arm.

b. *Clippers.* At this stage we take the clippers and prune away the undergrowth:
Cervis D Ress was a success. In a nice bar he bought a drink and spotted Jenny. "I fancy a slice of that", he thought and walked over. Jenny watched the smoothie approach.
"Bags of money", she thought, as he sat down. "You smell nice, would you like to go out tonight?" "Why not?" she said as they left the bar.

c. *Shears.* Now we take the shears to expose the trunk:
Cervis D Ress was classy. He saw Jenny in a pub. "Fancy a good time?" he asked. "Not half!" she answered. And they went.

d. *Axe.* Finally we grab the axe and hack away feverishly until we expose the root:
Cervis D Ress, "Bed?"
Jenny, "Yes".

The summary. As the Composition Obfuscater says "Goodspeak leads to clearer comms".

It was signed with a nom de plume (perhaps "guerre" would be more accurate) "The Savage Pencil". As a footnote I must add that though my wife's name is Jenny, she doesn't wear 'Chanel', and spells her name Jennie, so I conclude that the research remains superficial.

Which brings us back to the question, "What is good English?" I cannot answer that for I am not nearly senior enough! I can only observe that the anonymous "Savage Pencil" received an equally anonymous reply which appeared pinned to the Mess notice board and was signed illegibly:

1. The Savage Pencil is to be congratulated on absorbing the instruction given by Composition Obfuscator and applying it so skilfully. He will be aware that the temple at which he worships is in Camberley with a small chapel in Warminster. He will find the priesthood ubiquitous and will never escape their ministry.
2. The Savage Pencil is now ready for the next lesson which is best summarized by the description of the function of another hallowed institution, the Royal Academy of Dramatic Arts, by Peter Ustinov: "The theory which is all too often advanced by the pundits is that there are thousands of wrong ways to write a play, and only one right way. It is nearer the truth to say that, even if there are thousands of wrong ways to write a play, there are hundreds of right ways, on condition that the personality of the writer is allowed to be an ingredient in the result. None of the important dramatists of the century followed the rules laid down by experts. Checkhov would have been told that he lacked action, O'Neill that he must cut, Ionesco that he must clarify, Brecht that he must impose practical limits on his vision. In other words, the academy is, as ever, the temple of mediocrity, and the ideals it imposes are strictly useful only for those with nothing to say."
3. Perhaps then, the ease with which the Savage Pencil has absorbed the teaching tells us something of his abilities?

Finally, there may be some of you who are wondering about the title I chose for this piece of frivolity. There is a delightful childrens' bed-time story called *The Hungry Caterpillar* in which the caterpillar eats his way greedily to indigestion, rests in a chrysalis, before emerging as a beautiful butterfly. Though the author may not know it, it is a striking allegory on how officers learn Service Writing. For a long time I was depressed; most of my caterpillars are extremely hairy and turn out to be moths; but now I know that one of these has become a beautiful butterfly, *Saevus Stilus*, and that somewhere out there he is flying free. . . .

A Question of Style

We are indebted to Lieut Colonel G E P Mulhern OBE for sending the text which follows. It was circulated to all Sapper officers in the Far East theatre during the late 1950s by the Chief Engineer Brigadier (later Major General) I H F Boyd. It seems that beautiful butterfly breeding (see p. 213) has been a well established hobby—Editor

MILITARY WRITING

THIS paper tells how to write about military subjects. It is essential, particularly in peace-time, for officers to know how to wield the pen. The cunning use of the pen may get you into the Staff College; it may help you to write a report that wins the praise of your Commanding Officer; it may help you to convince the Paymaster that you are entitled to extra pay; or it may prosper your Queen and Country in more ways than can be numbered here. You will often have to use your pen, but if you cannot use it properly you are just a scribbler wasting time.

Military writing is subject to rules. Here are some of them.

First, you cannot write anything—a letter, a minute, a memorandum or an essay—unless you have knowledge. Writing betrays a man's brain. If his brain is empty, no felicity with words will fill the void. You must therefore read up your subject and collect your thoughts before you begin. You may have to search letters in a file, or turn up books of reference; or you may have to rummage in the storehouse of your brain. This is where the real work lies. It is for this that editors pay good money, examiners give good marks and senior officers give good reports. Each writer has his own method. For quick and tidy work it is a help to record, as notes, the trophies of your research. Get all the facts into one place. Then you can clear your desk of files and references and turn to the matter of writing. Writing is a mechanical business. It is an art to do it beautifully, but competence can be achieved by obeying rules.

You must begin with a heading. This has two functions. It directs the reader's mind in the way you want, and it focuses your own on what is relevant. Write a heading in block capitals across the top of the paper. Do not just write "Question 6." In the Book of Common Prayer there are ten rules for the conduct of life. There could be no better heading than "The Ten Commandments". Let your heading be like this. It describes the nature of the work in the fewest possible words. Then write your first paragraph. 'Tell the news in the first sentence' is a rule of journalism. It is a sound rule for all writing. Look at the Book of Genesis. The first sentence runs thus: "In the beginning God created the heaven and the earth". Now you know what the first chapter is about. Read on and you will see how He did it.

The remaining sentences of the first paragraph expand or explain the first. The shorter you can keep the first paragraph the better, for it does not directly contribute to the subject. It merely prepares the ground. It is an overhead charge, like levelling the site before you start to build. You cannot avoid it, so do it quickly. Then get to work on the main business.

It is often convenient to link the first paragraph to the rest with a short paragraph of one or two lines. (I have done it in this paper as an example.) It is a trick, an old trick used by Homer in the Odyssey, but it also serves the military writer of to-day. Sentences that form this link are such as these:

The facts are as follows:

The history of this dispute is given below:

The two sides to this question are:

Having forged this link you write down the facts, history or sides of the question. This may well be called the discussion. In writing the discussion, also, there are certain rules. You must stick to the point. Irrelevant facts, unwanted dates or side-issues

must be ignored. Sometimes, however, there are facts or arguments which are a theme in themselves. For the reader who knows this theme, it is boring repetition; for the reader who is fresh to the subject it is important information. Put facts like these into an appendix. The reader may read them or not as he chooses. (For example: I might expound this very theme at length in an appendix.)

Homer's link was "This is the tale I pray the divine Muse to unfold to us. Begin it, goddess, at whatever point you will".

Record the facts in order of time. You may be tempted to record them geographically. You may think it easier to describe what Napoleon was doing before Waterloo, and then to say what Wellington was doing. This may be easy to write; it is seldom easy to follow. It is better to say what both were doing on the first day, then the second, and so on. This leads to a good climax—as, indeed, the events did.

When there are two or more sides to a question there are usually arguments for and against each side. There are then two ways of discussing them. You may first record *all* the various sides of the question. (You may perhaps tabulate them 'a', 'b', 'c', etc.) Then you give all the arguments which affect them. The advantage of this system is that the reader can see the sides of the question at a glance. If those sides of the question are novel this is a good way. The reader approaches the problem with his mind on the wave-length you want. There is one drawback to this way. If you want to refer back to your sides of the question, as you usually have to, you must include such idioms as 'see (a) above' and this deflects the reader's mind.

The other method is to record, after stating *one* side of the question, all the reasons that make you favour or reject it. (It is the system I am using now.) The advantage of this system is that you can give, at the end of your discussion on each side of the question, your opinion of its value. There is a drawback here too. If the sides of the question are, in themselves, obscure the reader will not see what you are driving at until he has nearly finished reading the discussion.

You must use your own judgement in this; although in examinations the sides to the question are well known to the examiner. It is therefore usual, in an examination, to follow each side of the question by its pros and cons before tackling the next.

Having stated the sides of the question and discussed each, as indicated above, it only remains to finish your writing with some conclusion. Your last paragraph should be the complement of your first. If your first paragraph begins: "I have the honour to request that, etc.", your last one might be: "In conclusion I ask that this request may be granted". The reader, one hopes, will write "Yes" and give it to a staff officer to arrange.

If you follow this rule you will avoid two errors. You will not put new matter into your last paragraph. If there is a new fact it is because the discussion is not finished, and you are not ready for a conclusion. You will also avoid leaving the reader in doubt as to your intention. If you want him to do something, or decide something, or learn something, he will see what you want of him. He will not say "Well, what do I do now?". It will be perfectly clear what is required of him.

So much for the structure: the first paragraph, the discussion and the last paragraph. There are a few rules for your style or manner of presentation. The quality of your English is more important in examinations than in everyday life. An illiterate peasant, if he speaks with sincerity, will make his point, even though there are faults in his grammar. An accomplished speaker with soft accents will sometimes fill his hearer with such rage that he is shown the door. The art is to combine the sincerity of the peasant with the polish of the accomplished speaker. To do this you must use short words, short sentences and as few adjectives as possible. Short words are usually from the Anglo-Saxon, long ones from the Latin. Do not say "post-prandial conversations of a bibulous nature"; say "drunken talk after dinner".

It is easier to make your sense clear in short sentences than in long ones. Short sentences add directness to your style: like a straight left in the boxing-ring. Accomplished writers, however, occasionally use a long sentence to relieve the somewhat telegraphic effect of a series of short ones. But there is a danger of long sentences

becoming complicated; and they often lead to mistakes in punctuation. So avoid them till you are sure of yourself.

When you have finished writing, go through your work and cut out all unnecessary words and sentences. You will find that many long sentences become short ones and are much improved thereby.

In some places it is customary to avoid the first person. When in Rome, do as the Romans do. But, before doing as the Romans do, make sure you are in Rome. Avoiding the first person must not lead you to making the sentences complicated and the sense "woolly". For instance: "I advise you to pay promptly" is a good sentence. It is short and the meaning is clear. It would be appropriate in most places. If the first person is taboo in your situation, you must write: "It is recommended that you pay promptly". This is still a good sentence within the limitations imposed by avoiding the first person. The temptation into which many officers fall is to say: "It is recommended that payment should be made with the utmost expedition". This is a "woolly" sentence. Avoid its kind.

Writing headings and sub-headings, numbering the paragraphs, and the use of abbreviations are matters of custom. You must use your judgement. You are compelled to do these things in Orders and Appreciations. If you are in a hurry, as in an examination, well-chosen headings may help you. The examiner may assume you could expand them more than you actually do. Letters and essays are often better without. (It would be easy to put headings into this paper. I think it would spoil it: you may not agree.) Headings and sub-headings help the writer more than the reader; they keep his mind on the subject. Numbering the paragraphs helps you (and others) to refer to particular parts. Abbreviations save trouble in writing. They may be all right in purely military papers but they *must* be translated for civilian readers. For civs, in fact, they are nbg. The military system of telling the time, using a twenty-four hour clock, is not always clear outside the Services. Say: three o'clock in the afternoon, or 3 pm, rather than 1500 hrs. And for ghosts to appear at 2359 hrs is ludicrous.

Some catch-phrases lead you to long sentences. 'In the case of' is such a one. "In the case of officers, their pay will be halved" is a long way of saying: "Officers' pay will be halved". Whenever you see 'in the case of' in official writing (and it is common), consider how much simpler the sentence might be if the phrase were omitted. 'In view of the fact that' is another phrase that leads to long sentences. "In view of the fact that we are an island race, we must have a good navy" is simplified by saying: "We are an island race, so we must have a good navy". The simplification comes at once when you cut out the offending catch-phrase. 'As follows', on the other hand, saves words. Macaulay uses the phrase and he is a prince of words. These last, however, are refinements. They make the difference between a competent work and a work of art. The two essentials are: to found your writing on sound thinking and to write your paper along the lines I have given.

Such are the rules for military writing. Follow them and your pen will be mighty.

* * * * *

Awards for March 1987 Journal

MERIT awards for the March 1987 Journal are as follows:

"The Royal Engineer Commander" by Lieut Colonel R Macdonald MBE, £30.

"Operation JOLE" by Major A S Craig, £20.

Special awards of £20 each were made for "The Building of Protected War Headquarters" by Wing Commander D F Akhurst and "The Bailey Story" by Colonel J H Joiner.

Memoirs

LIEUTENANT GENERAL SIR JOHN READ KCB OBE MA

Born 6 September 1917, died 5 March 1987 aged 69

JOHN HUGH SHERLOCK READ was commissioned into the Corps in 1937. He had been educated at Bedford and the Shop and after commissioning he obtained his degree at Magdalene College, Cambridge.

WGFJ recalled this period in his Memorial Service address: "I will always be grateful to John for the unofficial and entirely voluntary coaching that he gave to the less gifted mathematicians, like myself, of Donald Ross's Young Officers Batch at Cambridge. The generosity of spirit, which John displayed at Cambridge, remained with him all his life. In the fiercely competitive environment of the Army John instinctively avoided one-up-manship, lobbying and petty intrigue. He won his rapid promotion through genuineness of purpose, constructive ability and balanced judgement."

The outbreak of war took him to France as Platoon Commander 1 Bridge Company RASC and he then joined HQ RE 44 Divisional Engineers. Throughout 1941 he was Adjutant of 56 Lowland Division Engineers but returned to 44 Division as OC 210 Field Company in December and took them to the Western Desert. After a tour on the directing staff of the Junior Staff School in Palestine Read was appointed GSO2 Ops 10 Armoured Division in Egypt. In July 1944 he was promoted to become GSO1 46 Infantry Division in Italy "where he distinguished himself as the practical, down to earth man that he was, in that grimly fought campaign in which the infantry divisions bore the brunt of the fighting". He remained with them until after the end of the war when, after a further short spell in command of a field squadron, he became ACRE in Graz in Austria. He returned to the UK in 1947 and after a short spell at SME Ripon, was posted to the RMA Sandhurst where he became a college Chief Instructor.

1952 found him back at squadron command, this time 7 Field Squadron in Germany and from 1954 to 1956 he was DAA and QMG (Plans) at Headquarters Northern Army Group. He was then posted to the Far East and, after a few months in Hong Kong, joined HQ Singapore District as GSO1 Ops. CLR writes: "It was a critical time in the history of the Colony, as the election after which independence was to be granted (except, for defence and external relations) was but a few months away. It was necessary that in the eyes of the polyglot inhabitants of Singapore the image of the large British garrison should be changed from an instrument of Imperial power to that of a welcomed safeguard for law and order. John Read with his instinctive comprehension of political factors, his understanding of public relations, and his genial, imperturbable personality excelled in implementing his Commander's policy. He was able to find common ground with a variety of racial groups at all levels from powerful Chinese civil servants to the humblest Malay soldier: they all admired and respected him".

In September 1959 he was appointed to command 1 Training Regiment and left there to go as a student to the Imperial Defence College and thence to the War Office as Colonel GS MO.

Lieut Gen Sir John Read KCB OBE MA

Although he had a further four years (1963 to 1967) away from the staff, as Commander Training Brigade and Assistant Commandant at Sandhurst, it is probably fair to say that the seeds were sown for Read's later outstanding career during his time in MO and the ground was prepared for what *The Times* called "a reputation for (his) brilliant exposition of strategic problems". All this came to fruition in tours as DMO from 1967 to 1969, as ACDS (Policy) from 1969 to 1971 and, finally, as Director of the International Military Staff at Nato HQ in Brussels in 1971 until he retired in December 1974. As one who worked opposite him in all these later appointments has said: "His skill in handling people was never more heavily exercised than in this last appointment where he re-established a going concern in a cosmopolitan staff where, until he took over, national interests tended to predominate over international requirments. It was always a pleasure to watch him at work—and at play—with a disparate group of Nato colleagues."

After his retirement he became executive secretary of the West Africa Committee travelling extensively to advise British firms trading in the area. ECJ writes: "The main aim of the West Africa Committee is to aid and stimulate the economic development of West African countries through the activities of its international members from outside West Africa, to the mutual advantage of the countries concerned and Committee members. Much of its success depends upon the initiative, common sense and sincerity of the Adviser. John Read used his wide military and other experience to achieve positive influence on the commercial problems of these countries. He established the trust and respect of political, diplomatic, and business individuals in many lands."

He was appointed OBE in 1944 and KCB in 1972. His wife, the former Monica Curtis died in 1985 and he is survived by a daughter and two sons one of whom is still serving in the Corps.

WGFJ, CLR, DJW, ECJ

(Picture courtesy of Universal Pictorial Press London)

COLONEL W REID ERD TD BSc C ENG MIMechE MIEE FCMA

Born 28 February 1908, died 29 January 1987 aged 79

WILLIAM REID (affectionately known as Bill) was born in Edinburgh and educated at George Heriot's School and Edinburgh University, graduating as an engineer. It was here in the OTC that he first joined the Royal Engineers as an Officer Cadet. He was granted his TA Commission in the Corps in 1926. He was always proud of his connection with the Sappers.

In his civilian life he was a member of management of Edinburgh and then Hull Corporations' transport. On returning after his war service he joined AIC Management Consultants becoming their Regional Director for Scotland based in Edinburgh.

In 1939 at the outbreak of war he was called up to join the City of Edinburgh (Fortress) Royal Engineers to command one of its companies. When the searchlights were handed over to the Royal Artillery, he reformed his company into 585 Corps Field Park Company RE which he commanded until 1943. In 1944 he formed 5 Engineer (Base) Workshops at Liphook, in

Colonel W Reid ERD TD BSc C Eng MIEE FCMA

Hampshire, taking them over to Normandy and up through North West Europe into Germany. It was during this time that he was mentioned in despatches. After the end of the war he was posted to command the Engineer Workshops at Fanara in the Canal Zone in Egypt and promoted lieut colonel.

After the war he served in Army Emergency Reserve RE (Resources) until 1961 when he retired with the rank of colonel. He was Joint Honorary Colonel of 432 (City of Edinburgh) Corps Engineer Regiment RE (TA) with the Lord Provost of the City of Edinburgh from 1964 to 1967. On the reforming of the Territorial Army in 1967 he was appointed the first Honorary Colonel of 71 (Scottish) Engineer Regiment (V) until 1972. For some time because of his management expertise he was a member of the RE Advisory Board. He played a very active part in the Reserve Forces Association in Scotland.

He was a Member of the Merchant Company and within the Company a member of the Master's Court, a member of the Education Board, Chairman of Daniel Stewart's-Melville College Committee for one year.

Bill retained a strong and active interest in George Heriot's School where he was a Governor for sixteen years, Vice Chairman of the Board and Convenor of the Buildings Committee. He took a great interest in the Combined Cadet Force and regularly visited them at annual camp.

Over the past two years infirmity increasingly beset him but even over that period, with a clear mind and a good judgement, he continued to give invaluable service to the organisations of which he was a member.

All who knew Bill held him in high regard. He was heard with respect when he spoke expressing his views and judgement on the many things on which he was well informed. He was kind and gracious by nature and we are all the better for having known him.

We express our warmest sympathy to Nan his wife and Nigel his son in their very sad loss.

AM, DNS, TT

BRIGADIER D L STREATFIELD FBIM

Born 18 January 1929, died 14 February 1987 aged 58

Brigadier D L Streatfield

DENNIS LESLIE STREATFIELD was born in London on 18 January 1929. The family moved to Scotland in 1937 where Dennis was educated at Leith Academy Edinburgh and then at North Berwick High School.

Upon leaving school he followed his father into the Post Office until he had his first taste of Army life during National Service. National Service whetted his appetite for the active life, and in 1956 Dennis was commissioned directly into the Royal Engineers (PCC). In so doing he was able to combine his interest and experience in the Post Office with a desire to have an army career.

Shortly after his commissioning into the Postal Service his thirst for action prompted him to apply for the Parachute Course and thence for service with 16 Parachute Brigade. He served as a captain with 16 Parachute Brigade Postal Unit, spending some of this period abroad in Cyprus and Jordan.

He subsequently served in various PCS appointments in the Far and Middle East

and had three tours in BAOR commanding RE (PCS) units. Promoted colonel in 1980 he was appointed to the staff of HQ BAOR as Commander PCS North West Europe and became Commandant of the Postal and Courier Depot RE in 1983. He was elected a Fellow of the British Institute of Management in 1983.

Married to Jeanette in 1951 they had one son and two daughters all of whom are married.

Those of us who had the privilege of knowing Dennis Streatfield, whether for a short period or over many years, will remember him as a man of great enthusiasm, fun and love of life; a man who enjoyed all aspects of service life.

He was kind and caring, sensitive to the needs of others, and above all a man of strength of character. This he displayed so valiantly during the devastating illness that struck him down last year.

All who knew him will miss him and feel a great sense of loss. To Jeanette and all the family circle we extend our deepest sympathy.

RJNK

BRIGADIER D R GUINNESS CBE

Born 24 November 1903, died 20 February 1987 aged 83

Brigadier D R Guinness CBE

DENNIS ROBERT GUINNESS was commissioned into the Corps in January 1924 (10 YO) having been educated at the Royal Naval College Osborne and Haileybury. In 1926 he began a spell of eleven years service in India broken only by two visits home.

His time in India included five years with the Bengal Sappers and Miners, mostly with 6 Field Company and later as Garrison Engineer Abbotabad and SORE 3 in the EinC's office in Simla.

In 1937 he returned to UK for a course at the Staff College which was interrupted by the war. After a brief interlude in France as a GSO 3 he soon became involved in the special operations work which characterised his service for most of the war.

As Director of Plans (Colonel) for Special Operations Executive (SOE) he made two visits to Russia after the invasion of that country; the first, in a Catalina to Archangel, to negotiate an agreement defining the respective spheres of influence for special operations, the second as temporary head of the SOE Mission in Russia.

On return to England to take up his original appointment under Sir Charles Hambro, Guinness was involved in planning numerous operations of which those in Madagascar and *TORCH* came to fruition. This work involved him personally in detailed arguing for the proper logistic support of such operations with the Chiefs of Staff. He flew to Gibraltar with Allied Force Headquarters for *TORCH* and was privileged to broadcast the codeword "Robert Arrive" over the BBC, giving 24 hours notice of D Day.

After a brief attempt to return to normal soldiering (as CRE 7 GHQ Troops Engineers) Guinness was persuaded back to SOE as Military Commander (Brigadier) Force 136. Over the next year the setting up of this in India and turning it into a guerrilla force involved him in continuous travel round the theatre to see Generals Slim, Wingate and Stilwell and the Supreme Commander in Kandy, in the process

of setting up the necessary support stations and training schools. This came to an end in 1945. In Guinness' own words "Unfortunately, the Americans got to learn of a party of free French who had been dropped into Indo-China carrying a message from de Gaulle. This instantly aroused their suspicions and they accused the British of encouraging colonialism. This was reported to Roosevelt and Guinness was sent for by Mountbatten and relieved the situation by agreeing to resign".

He returned briefly to Europe but was back in the Far East by September 1945. He was CRE successively in Burma and Indo-China; and finally in Java. EMM recalls: "Arriving from the war in Europe to join 20 Indian Division in Saigon he soon pointed me in the right direction, in his usual forthright way, of what he required of a squadron commander in the Indian Army . . . we fought from September 1945 to April 1946 when the French took over. The Sappers, under Bobby had to maintain all the essential services for Saigon, as well as the many operational tasks endemic in a guerrilla war. Bobby Guinness due to his personality, and knowledge from SOE, played a leading part in the councils of the British Command as well as forcefully leading all engineer troops in the country. . . .

. . . "Next I was summoned to Bandoeng, in the central highlands of Java, where Bobby had now become CRE of 23 Indian Division. It was an extraordinary situation. The enemy, Soekarno's revolutionary army, had half the city, which was divided by a railway line, and 23 Indian Division had the other half. The enemy held the surrounding countryside, but we had the airfield, through which most of our supplies came. The Sappers had much the same tasks as in Saigon . . . (Later), we got fed up with the enemy's antics and drove them out of the southern half of Bandoeng. Naturally Bobby and I were up with the leading troops. Bobby always led from the front.

. . . "Bobby was a powerful leader with a good old Irish temper. However, once the blast was over he forgave you (if you deserved it) and would return to being his usual charming self. He was a very amusing raconteur and had a fund of extraordinary anecdotes from his interesting life".

After Java he was then appointed Chief Engineer Allied Forces, Netherlands East Indies in Batavia (Jakarta) and became involved in further delicate political missions involving the restoration of the economic infrastructure of the country.

Guinness' post-war appointments were principally as CCRE 1 British Corps from 1952 to 1955 and finally as CRE in Cyprus. Both were demanding appointments; the first included the running of the huge exercises that were customary in Germany at the time: the second involved the great building project at Episkopi and Dhekelia against the background of the developing EOKA crisis.

Although gazetted major general to take up the post of Chief Engineer Middle East, Guinness opted for retirement in 1956 and worked in civilian life for seven years first with Stewarts and Lloyds and later in Tube Investments.

His active life was still not over and in 1963 and 1964 he spent the best part of a year skippering a 50-ton yacht in the Mediterranean for a cousin. However he returned to England and soon afterwards was smitten by arthritis. Nothing daunted he continued to work and only finally retired at the age of seventy-one after seven years as a professional fund raiser.

He was appointed OBE in 1949 and CBE in 1956.

He leaves a widow, the former Elizabeth Howland whom he married in 1931, and a daughter.

EMM, HJCS, REJ

MAJOR GENERAL A H G DOBSON CB OBE MC BA

Born 15 December 1911, died on 12 March 1987

ANTHONY HENRY GEORGE DOBSON, who died on 12 March 1987, was born into a family of strong Sapper traditions. The only son of Colonel A C Dobson (late RE), his grandfather Lt A E Dobson RE had died in the Afghan campaign in 1879, and his godfather was Major W H Johnston VC RE, who died in action in 1915. His great grandfather had been Principal of Cheltenham College, where he himself became a scholar, and whence he took first place in the Army Entrance Exam in 1929, entering The Shop in January 1930. He passed out head of his term, winning the Pollock Medal, and was commissioned in the Royal Engineers in 1931.

YO training at Chatham was followed by two carefree years at Clare College, Cambridge during which Tony Dobson joined other Sapper undergraduates from various colleges, in lodgings which became known as "Toc RE". During this happy time, Dobson and other YOs, inspired by Jim Gavin's enthusiasm, learnt to ski in Austria during the Christmas and Easter vacations.

After graduating in 1934 Dobson was posted to 12 Field Company at Aldershot, whence he returned to Chatham as a party officer in the Training Battalion. After a spell as Assistant-Adjutant he volunteered for the appointment of OC Desert Survey Party with the RAF in Iraq, and went to Habbaniya in the spring of 1938.

During this period in Iraq, and after the outbreak of war as OC Topographic Section of 512 Army Field Survey Company in Egypt, he travelled extensively in the Near East, including a spell in Kuwait and a mission to the Turkish Government Survey Department in Ankara. Life in the Section in an austere camp at Abbassia was varied pleasantly by training exercises in the Western Desert and the flesh-pots of Cairo.

Dobson was next selected for a war-time staff course at the Middle East Staff College, which earned him the qualification "psc". From Haifa he was posted as GS02 on the staff of the Chief Engineer, GHQ Middle East in Cairo, where he was able to make use of his considerable knowledge of the area. Amongst other duties he was sent to Iraq to advise the Indian Expeditionary Force on the problems of denying the oil-fields to the enemy, and visited the New Zealand Engineers building roads in the Kladi Rum, near Aqaba.

In early 1942, Dobson was selected for the appointment of Brigade Major, 150 Infantry Brigade of 50 (Northumberland) Division, then holding an area in the Western Desert forward of Tobruk. In Rommel's offensive of June 1942, the brigade was overrun, and Dobson taken prisoner. Later he was awarded the MC for his part in the operations before the disaster, in addition to the two Mentions in Despatches he had received in 1941 and 1942.

After fifteen months in a POW camp in Northern Italy, the Italian Armistice in September 1943 enabled him to escape, and after nearly three months on the run, being cared for by Italian peasants, he made his way to neutral Switzerland. For political reasons, few of the many escaped prisoners-of-war in that country were able to return home until autumn 1944. Dobson passed the time assisting with the administration of his fellow POWs, and re-learning the art of skiing. One day he met

in a ski-lift a Swiss girl, Noni Homberger, whom he was subsequently to marry as soon as the war was over.

He returned to the UK in October 1944, and after leave and a spell at the wartime SME at Ripon, Dobson was appointed Brigade Major 235 Brigade, in a training role in Yorkshire.

In March 1945, he was posted as GSO 1 (SD) at HQ Second Army, then just about to force the Rhine Crossing, and remained with that HQ for the rest of the campaign until its disbandment in Germany, when he was given a similar post in HQ 21 Army Group. He remained in Germany until 1950, serving in various staff and works appointments and in command of 4 Field Squadron in 7th Armoured Division, until going to the Joint Services Staff College. On leaving Latimer he became AAG, in the Manpower Directorate of the War Office, then coping with the manpower bill for the Korean war, being made OBE in 1953 for his work at this time. In the same year Dobson was selected to command 24 Field Engineer Regiment in Hong Kong. His former Adjutant writes of him at that time: "It was an honour and a pleasure to be his Adjutant. He had a firm but light touch on the Regiment and he was happy to leave his staff and squadron commanders to get on with their jobs without interference, but he was always ready with advice when asked, no matter how small the problem. He was constant in his policies and decisions which made working for him easy."

Another officer of the regiment writes: "To my dying day I shall not forget the strength of purpose, the quiet determination, the warmth and sense of understanding which Tony Dobson personified. These qualities, plus his professional skill brought the General to eminence in his profession, but it was the manner in which he exercised these skills for which he should be remembered. For me the light will continue to shine".

Returning to the UK, he became Colonel (E) in the Engineer-in-Chief's office in the War Office, where one of his former staff recalls him as "a wonderfully educative boss, particularly in teaching me how to manipulate the MOD machine. My everlasting impression is of his ability to think on his feet with great speed and accuracy in a crisis. The main joy of working for him was that he always let one into his feelings about the people he was dealing with; he found it hard to tolerate gladly the fools senior to him, but was always patient and helpful to the fools working for him".

In 1959 Dobson was promoted to brigadier as Chief Engineer, Eastern Command, until in 1962 he was selected for the appointment of DQMG at HQ BAOR. He served in this post for nearly three busy years, engaged in the complete revision of administrative plans for war resulting from the NATO decision to adopt a forward strategy, together with the immense works programme required to house the regular (and much married) Army in Germany. In 1964 he was promoted major-general remaining in Rheindahlen in the dual appointment of Chief Engineer of the NATO Northern Army Group, and of BAOR. In these years his strongly pro-European ideas, extrovert character and gift for languages were a tremendous asset in an international headquarters, and not only as a Sapper.

Dobson retired from the Army in November 1967, and was made CB in the New Year Honours of 1968. He was appointed a Colonel Commandant RE on 15 April 1969, and served until April 1974, being the Representative Colonel Commandant in 1973.

In retirement he joined the Department of the Environment as an Inspector in the Planning and Housing Directorate, where he served from 1968 to 1979, holding many planning enquiries.

During his later year's Dobson's chief sporting interests were skiing and gliding. During his internment in Switzerland he had become a very good skier, and was able to contribute a great deal to the organisation and training of British Army skiers besides reaching the top level himself. He founded the BAOR ski team in 1945, and was a member of it from 1946 to 1950, being given special training for the British Olympic trials in 1949. In 1953 he was awarded a "golden K" by the Kandahar Ski

Club for his services to British skiing. He was Vice-Chairman of the RAF Gliding and Sailplane Association from 1963 to 1967, and an active participant, besides being ex-officio Commodore of the British Kiel Yacht Club during his time as CE BAOR. In retirement he was active in the Lions Club International.

To sum up, Tony Dobson was to his contemporaries effortlessly brilliant and a perfectionist without being a slave-driver, an excellent linguist whose great sense of humour, ready wit and modesty made him immensely popular both in the Corps and in much wider circles. He is survived by Noni and their four children, to whom our deep sympathy goes in their great loss.

MWB, CLR, GWD, RWTB, JHSB, AJL, RF

MAJOR GENERAL S H M BATTYE CB MA FRSA

Born 21 June 1907, died 17 April 1987

STUART HEADLEY MOLESWORTH BATTYE was born at Meshed, Iran in 1907 where his father, an IMS Surgeon, was on the staff of the distinguished Consul General, Brigadier General Sir Perry Sykes. His grandfather Richmond was one of the celebrated ten Battye brothers whose exploits with the Corps of Guides and Gurkhas became legendary in India during the second half of the last century. The family had been closely connected with India since the 18th Century and it was small wonder that Stuart was also dedicated to service with the Indian Army.

Stuart was educated at Marlborough, RMA Woolwich and Sidney Sussex College, Cambridge. He was commissioned in 1927 and was posted to the Bengal Sappers and Miners in 1930 with whom he served continuously until 1944. He was soon engaged in frontier operations, serving with 3 Field Company against the Afridis on the Khajuri Plain in 1930 and 1931. Much of his subsequent service with the Bengal Sappers was with one or other of their two field troops, still in those days having half the troop mounted. As a keen polo player he could hardly have asked for better; but in fact, during a short posting to the Training Battalion, he did get something better, namely inclusion in a visiting party of inspection to the fort at Gyantze in Thibet. A special dispensation had to be obtained for this visit to a country then normally closed to Europeans. This long trek gave him a lasting interest in things Thibetan.

After a course at the Quetta Staff College in 1940, he took over command of 1 Field Company which, as Corps Troops in Iraq, was involved in bridging the River Tigris, a project in which he nearly lost his life. In January 1943 he returned to Roorkee and became CRE 39 Indian Division in the following year.

In 1944 he had to say goodbye to his beloved Indians and to the opportunities for *shikar* and fishing which India had to offer and returned to the UK as AQMG Control Commission in London, later going to Germany as AQMG 21 Army Group (QAE). From 1947 to 1949 he was back in the UK as AA and QMG HQ Northern Ireland before going to Marchwood to take command of 17 Port Training Regiment. DMRE writes: "The impact of his arrival on one young officer in the Regiment was profound. Firm but fair with a marvellous sense of humour, Stuart had that rare knack of being

Major General S H M Battye CB MA FRSA

able to communicate with all ranks and, above all, he lead by example. He was a man of strongly held principles and a practising Christian."

In 1952 he was promoted and went to Egypt as Colonel E, Middle East Command; returning to London in 1955, again on promotion, as Deputy Military Secretary. His final tour was as Director of Movements in the rank of major general. During this time he initiated the construction of the Landing Ships Logistics (LSL) of which *Sir Galahad* which was lost in the Falklands War, was the first to be built.

In retirement he became Director of the Rural Industries Bureau (later the Council for Small Industries in Rural Areas) which post he held until 1973.

He continued his association with the Indian Army by serving some twenty years as Chairman of the Bengal Sappers and Miners Officers Association and succeeded General Sir Ouvry Roberts as President in 1985. The same year he led a party of three officers and their wives to attend the 182nd Reunion at Roorkee and was able to report the next year how high the standards achieved by the Bengal Sappers were.

Stuart was always ready to help in any matter involving the former Indian Army. He was an outdoor man who became an amateur painter of talent. MCP-P, whose service with the Bengal Sappers paralleled Stuart's in so many ways writes that he felt him almost a relation; yet one that, unlike his actual relations, he never fell out with. Not that Stuart ever relaxed his standards or principles for the sake of peace.

He is survived by his wife the former Evelyn Desiree Hartford whom he married in 1940 (who became the chronicler of *The Fighting Ten* published in 1984) and their three children.

MCP-P, WBA, DMRE

MAJOR GENERAL F M HEXT CB OBE FI Mech E FIEE

Born 5 May 1901, died 1 May 1987 aged 85

FREDERICK MAURICE HEXT was commissioned in to the Corps in 1921 after being educated at Portsmouth Grammar School and The Shop. Apart from a two-year spell attending the E&M Course in 1929 and 1930, all his early career was spent in India and Burma. He was with MES India from 1925 to 1929 in Kohat and was detached to Rangoon to build the new barracks. From 1931 to 1934 he was at HQ Madras District, Bangalore, as ACRE (E&M). Thus the groundwork was laid for a future E&M specialist. This was further developed in his next tour as E&M officer at the Experimental Establishment at Shoeburyness.

The outbreak of war found Hext at the SME Chatham as an instructor and he remained there until 1942 when he went to Northern Command in York as GSO1 Technical Training. He was master of the RE Beagles during his time at the SME.

In March 1943, along with a number of other E&M trained officers, Hext accepted an offer to serve with the newly formed REME for the rest of the war. He was appointed CREME 53 Welsh Infantry Division and was with them initially in England and then throughout the campaign in North West Europe from Normandy to

Hamburg. In 1945 he transferred to REME and was promoted colonel and appointed DDEME 1st British Corps.

In 1946 Hext returned to his old haunts in Burma as DDME 12th Army and became Commodore of the Rangoon Sailing Club. He returned to England in 1947 for tours in Aldershot and, as AAG AG 21, at the War Office. In 1951 he was promoted Brigadier and appointed DME BAOR at Bad Oeynhausen. He returned finally to England in 1953 to complete his service as Inspector REME at the War Office in the rank of major general, in which appointment he attended the Coronation of HM the Queen in Westminster Abbey.

General Hext is remembered by those who served with him as a kindly quiet man with a splendid sense of humour and much charm. He had the sort of knowledge and ability that gets quickly to the root of a complex problem. As his record shows he was a man of wide interests and achievements. He did much good work for REME and played his part in helping to get the new Corps started.

In retirement General Hext settled in the Isle of Wight with his wife and took a leading part in local affairs. He was a member of the Wessex Regional Hospital Board for ten years and Chairman of the Isle of Wight Hospital Management Committee from 1960 to 1971. He was also a governor of Ventnor Middle School and Sandown Comprehensive, and a churchwarden at Niton Church. A few years before his death he and his wife moved to Hinton St George in Somerset.

He was appointed OBE in 1945 and CB in 1954. He married in 1924 Kathleen Goulden who survives him together with their son.

DAKR, DMR, MFS

GIFTS AND BEQUESTS TO THE CORPS OF ROYAL ENGINEERS

INTENDING benefactors of the Corps may like to know the various Funds which welcome gifts and bequests and the advantages which may be obtained, both by the Funds and by the donors and their estates, under current legislation. Certain Funds, managed by Trustees on behalf of the Corps, are recognized by the Inland Revenue as being devoted to charitable purposes only. Broadly speaking these are Funds which are applied exclusively to the relief of sickness or poverty, or the advancement of education. The Funds at present recognized as being "charitable" for this purpose are:

(a) Royal Engineer Officers. Charitable Fund.

(b) Institution of Royal Engineers (including RE Kitchener Scholarships Fund).

(c) Royal Engineer Association (incorporating the former RE Benevolent Fund).

(d) Royal Engineers Museum Foundation.

(e) Samaritan Fund—RE Officers' Widows Society.

In the case of the last named, this purely Charitable Fund is for the relief of widows and orphans of RE officers. Subscriptions and gifts to it have no connexion with members' subscriptions to the RE Officers' Widows Society and grants made from it are over and above any benefit paid by that Society.

Annual subscriptions to any of these Funds which are made by a deed of covenant, whereby the subscriber binds himself to pay the amount of the subscription annually for a period not less than four years out of income which has suffered tax in his hands at the standard rate, are treated as net payments and the Fund concerned can recover tax paid from the Inland Revenue.

Suitable forms of deeds of covenant can be supplied by the Secretaries or Treasurers of the Funds concerned.

Correspondence

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A Technical Corps

Sir,—As my parthian shot in the debate on technical expertise in the Corps, may I make the observation that many Military Engineers have no great desire to be Civil Engineers and, no doubt, vice versa. The way forward would then appear to be for Military Engineering to be more widely recognised as a profession in its own right, with its own Institution (perhaps the Institution of Royal Engineers, suitably reconstituted), fully represented on the Engineering Council. Why not "CEng, MIRE"? Yours faithfully,—R D Thomson.

(As many older members will know, this proposal was made in 1978 as a result of a detailed study into the Institution's role. "M Inst RE" etc was preferred to Captain Thomson's "MIRE", for obvious reasons, but the principal was the same. The proposal foundered on the difficulties that would have been experienced in selling the idea to the Council of Engineering Institutions when the only qualification required for membership is possession of a commission in the Corps. Members' views on Captain Thomson's ideas now would be welcome—Editor.)

J Richardson BSc(Eng), FICE, FIMechE, FIEE, ACIArb, FBIM, FInstD
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The Bailey Story

Sir,—I read with interest and enjoyment Colonel Joiner's articles on the development and history of Bailey Bridging. He mentioned the Hamilton Unit Construction Bridge as a forerunner up to the Second World War.

It is perhaps of interest to add a little with regard to Archie M Hamilton, BE, MICE, MIMechE, MSocCE (France) particularly as the then Donald Bailey was an interested observer during Hamilton Bridge tests at EBE about 1937 while his concept of the Bailey Bridge was taking place.

Archie Hamilton was, in 1928/32 building a portion of a "new Asiatic motor road from Iraq to Iran" through the Zagros mountains, the road being for military and civil purposes. (It would give vehicular access to the most outlying British Unit in the Middle East where the First Battalion Iraq Levies guarded the RAF landing ground at Diana.) The route crossed many tributaries of the River Tigris. He found that the progress of the work was badly inhibited by the delays in making bridges. No standardised civil bridging existed and the 120 foot Hopkins and 60 foot Mark II were the only military bridges generally available and, although used, were found to be very limiting.

Archie set about sketching something more suitable in his mud and stone house at Razenok camp, filing British Patents in 1933/34, whilst at the same time offering the proposals to the War Office. In 1933 the Royal Engineer Board arranged for tests at its Experimental Bridging Establishment, Christchurch. Thus the Army's Hamilton Unit Construction Bridge arrived. The essence of the bridge was:

a. The concept of "unit construction" and method of stocking.

b. Building up for the span requirement by duplication of trusses alongside each other and/or the super-position of trusses.

c. Standard erection methods together with kits of all the equipment necessary for construction. Launching over roller bearings with the use of a skeleton nose was commonly adopted though the Army used what was termed the "derrick and preventer" method only.

The single/single or "single truss" form for 40–80 ft spans is seen in Plate I and the double/single or "double truss" form for 90–140 ft spans in Plate II of the 1939 *Military Engineering Vol III—Part II, Pamphlet No 7, Unit Construction Bridge.*

Colonel Joiner mentions the need for a new 40 ton capacity bridge. A paper published in *Engineering*, January 8, 1937, by courtesy of the President of the Royal Engineer & Signals Board described tests carried out at EBE in 1936 on a 140 ft double truss Callender-Hamilton Bridge. The test loads used were a 43 ton tank at the centre of the span plus a 17.3 ton tank at 42 ft from an abutment (a photograph seems to indicate that this was the position when the 17.3 ton tank butted against the 43 ton tank in the centre of the bridge) as generally the maximum of the static load combinations tested plus both tanks crossing as close together as possible at top speed. The tests generally examined any initial deflections from the total dead load (93.5 tons including decking and loading from approach ramps). Some degree of faulty erection was allowed for by the omission of two members, from the centre of the top chord and from the end compression diagonal, though not being in the portal bay.

Seven extensometers were attached to the critical members and bridge deflections were read including near the abutments to record any settlement there.

Generally the tests showed average stress in shear members as calculated though non-uniform, with much more uniform distribution in the chord members and at lower stresses than calculated (thought to be in part to the effective depth of the truss being greater than the nominal) and a surprise that the outer truss chords were more highly stressed than the inner.

All components were examined after dismantling and the general conclusion was that the bridge was quite satisfactory for carrying 12 units of BS loading over the 140 ft span. It was also considered that there would be some stress relief during periods between bolt tightening by maintenance gangs. Permanent centre span deflections were found only to be occasioned by initial bolt bedding.

The change of name to Callender-Hamilton (CH) referred to at the above test was as a result of the parallel development of a civil bridge in conjunction with Callenders Cable & Construction Co Ltd (merging later to form BICC plc). The civil bridge was adopted by the Ministry of Transport for emergency stocking with erection gear and with training schools set up for development of erection methods, the results of which became available to the Army. This civil stocking (about 9000 tons produced pre-war) was also seen as a further military reserve.

The British Army entered the war with a lead over other nations with the new unit construction bridges and special purpose assault bridge developing (Bailey).

In 1940 the Supply Department of the Government of India also commenced manufacture under the supervision of Archie Hamilton, trial erection and tests were carried out by the Calcutta Fortress Company of Indian Engineers (site engineers from the under construction Howrah bridge being temporary members). By 1942 the bridging to be used to the Assam–Burma frontier had been made in India. India together with South Africa probably produced up to 200 spans of 140 ft by 1943 (approximately 5 miles).

Both the Bailey and the Callender-Hamilton Bridges have continued in development and use in the civil market to the present day. Until the late 1970s I was a Divisional General Manager with Balfour Beatty Ltd (a BICC Group Company), one of whose businesses is the CH bridge. A particularly successful contract during that time being the supply of what would be at today's prices some £50m worth of CH bridging to Indonesia.

The CH Bridge was never comparable as regards speed of erection with the Bailey

Bridge as an assault device but was more a complementary bridge of perhaps a more permanent nature and has often been referred to in military terms as a "Line of Communication" bridge.

It is hoped to obtain some Callender-Hamilton footbridging for the Ravelin Museum, to complement the model of the Callender-Hamilton Road Bridge already held there.

Whilst in the process of writing this letter I have had the opportunity to discuss the subject with Mrs Bettina Hamilton, Archie's widow, now 80 years old and living not too many miles from Brompton, in the course of which I learned that Archie was commissioned by Edward VIII into the Corps in 1937 and served for two years in the Middle East with 7 Field Company (commanded by Lieut Colonel (General) Hutson who still keeps in touch with Mrs Hamilton. Yours sincerely,—J Richardson.

Emeritus Professor Sir Alan Harris, CBE, BSc(Eng),
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Hardened Defences

Sir,—To supplement the admirable paper by Captain Taylor on this subject, a word about the actual material used by the Germans in the Atlantic wall might not come amiss.

My first acquaintance with it was at Port en Bessin where two lengths of wall, 3m high, 2m thick and each about 15m long needed removing to permit vehicle access to the jetties. While we had maps showing all the weapon positions, obstacles, etc, we had no information as to the constitution of these walls.

I assumed they were mass concrete—how wrong I was! A first attempt to demolish them by blowing holes with beehives and loading them with polar blasting gelatine did no more than crack what was revealed as concrete reinforced by 10mm bars at 100mm centres in three orthogonal directions. Once cracked, of course, the walls were little damaged by further explosives—the shockwaves were dissipated in the cracks. Our compressors were ashore by now and we got to work with jack hammers working along the cracks and burning the bars as we came to them. It took hours.

On the other one, we did a borehole job. It took nearly as long because we could not find clear paths for the drills—for every hole reaching the right depth we started two or three which hit reinforcement.

Concrete reinforcement (even better if prestressed) in three dimensions is of quite remarkably high resistance to impact and shock—the energy to rupture is enormous; concreting is easy as well. The reason why so much German concrete remains in Northern France is that the available means of destruction are unacceptable. My friend David Shennan (then Captain RE) demolished a gun emplacement at Calais by dozing earth into the embrasures and then detonating twelve naval depth charges inside. That blew the roof off all right, but it is not an expedient to be recommended in peace time! (The reinforcement there was 15mm bars at 150mm centres.)

It is also of interest that the *Wehrmacht* had several factories mass-producing prestressed concrete beams to serve as soffit formwork, particularly for U-boat pens. The beams were pretensioned after the style developed by Hoyer using wires of 2 or 3 mm diameter. There was one such in Paris, which I knew well; after the war it was taken over by a workers' co-operative but, sadly, they found that the factory could turn out only one product—and one which had very little market in peacetime.

Concerning the battery at Longues, my memory is that a near miss from a big bomb had substantially tilted the whole structure. It did not stop them firing; that shell through the embrasure left behind two grisly detached hands still gripping the training crank. Yours faithfully,—Alan Harris.

Major (Retd) A G Marsden
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Hardened Defences

Sir,—In his most interesting article (June 87), Captain Taylor mentions the camouflage of pillboxes in 1940. There were two dangers here. In battle the ice-cream kiosk or whatever might catch fire and burn the defenders, or it might collapse and block the loopholes.

In a lighter vein, a machine-gun post at Bognor Regis was built inside a white beach hut, one in a row of identical white beach huts. Some NCO decided that it ought to be "camouflaged" and set about it with green and brown paint. He was ordered to get a pot of white paint and uncamouflage it forthwith. Yours faithfully,—A G Marsden.

Lieut General Frederick J Clarke
US Army (Retd)
Honorary Colonel Corps of Engineers
Washington, DC 20016

A Special Relation

Sir,—I want to thank you for sending me the March 1987 issue of the *Royal Engineers Journal* and the accompanying monthly *Supplement*. I find it to be a thoroughly competent journal which brings back many memories of earlier associations with the Royal Engineers and/or the areas of the world where we served.

Early in 1942 I found myself a battalion commander in the US Task Force which built the airfield on Ascension Island, which served as a staging area for the 1982 operations in the Falklands. In the late 1950s I was in charge of a US funded military construction program in Pakistan building airfields in Peshawar and Quetta and other facilities throughout the country. The article by PAE "In at the Deep End" almost made me long to be back among the Pathans.

In the mid 1960s, I was the host for the Quadra-Partite meetings at Fort Belvoir and the Engineer School of which I was the Commandant. Then, in 1972, I was the guest of the Engineer-in-Chief at Chatham for the Corps Annual General Meeting, where I was given the warmest of receptions and was permitted to address the assembled officers on the lessons we Americans had learned in military engineering in Vietnam.

Now I feel even closer to the Royal Engineers in that the US has adopted the British regimental system. Our Corps of Engineers has elected to have only one traditional unit under the system—the Corps. I have been honoured to be selected as the "Honorary Colonel of the Corps" with the mission of fostering and passing on to later generations the traditions of which we are all so justly proud. Since the heritage of the US Corps of Engineers is so closely linked to that of the Royal Engineers, I consider myself to be a full relative of those in the Royal Engineers.

I have hopes that the adoption of the regimental system by the Corps of Engineers will lead to an even closer relationship of the two services.

Please accept my congratulations on the professional quality of the articles and comment in the *Journal*.

With all best wishes for your continued success. Yours sincerely,—Frederick J Clarke.

Book Reviews

AN IMAGE OF WAR
MARK HENNIKER

(Published by Leo Cooper—Price £18.00 ISBN 0 85052 2811)

THE author of *An Image of War*, Brigadier Sir Mark Henniker, Bt, CBE, DSO, MC, DL, late Royal Engineers, is to be congratulated. For he has surpassed what not only many of his contemporaries in the Corps, but a far more widely spread readership in this country and the USA would have expected from his pen when he decided to write and have published memoirs encompassing his experience in World War II.

In action Mark Henniker was far more than an extremely cool and courageous front-line Sapper officer who as far as possible never allowed the lives of his soldiers to be risked unnecessarily. Although at times unconventional, he was an outstanding and much loved leader of men. Additionally he is an exceptionally well educated, deep thinking, perceptive and lucid writer, who is always ready to share with his readers his dry sense of humour. He obviously enjoys putting pen to paper. As a result, whatever he writes on subjects which are not too abstruse, is invariably easy and a pleasure to read, whether by soldier or civilian. *An Image of War* is no exception.

His new book of memoirs contains quite a lot of raw material for serious study by soldiers of all arms and ages; for example on the limit of stress every soldier can endure before breaking down. But it is also an exciting and readable book for all interested in an uninhibited down-to-earth view of front-line soldiering during World War II through the eyes of a captain, major and lieut colonel in the Royal Engineers. Several times in these candid memoirs he acknowledges the source of his ability to overcome fear as stemming from his religious faith and trust in God. He also describes how he, and under his encouragement, his men fortified themselves through prayer.

Mark Henniker begins by vividly portraying some of his experiences as a Divisional Sapper Adjutant and then Field Company Commander in France and Belgium during the "phoney war" in 1940, and up to and including Dunkirk. This part of his book develops into a masterpiece of gripping narrative.

It is followed by an account of a brief period in the UK on Home Defence and simultaneously reforming and training the excellent men in a largely Lancashire TA unit which he had commanded prior to and during Dunkirk.

His ability to think logically was probably a major factor considered in his selection in 1941 to be one of the earliest members on General 'Boy' Browning's staff to help him originate Airborne Forces in the British Army. Mark Henniker thus soon became the Commander, Royal Engineers, of the Sapper units in 1 Airborne Division, responsible for the evolution of their airborne equipment as well as their training.

His tale reveals how nearly three years were spent preparing Sapper parachute and glider-borne units with the rest of 1 Airborne Division for war. This period included two briefly mentioned raids in 1942 (already written up in detail by others), the successful Bruneval raid, followed by the ghastly failure—NOT Henniker's fault—to destroy the German Heavy Water Plant in Norway, in neither of which he was allowed to take part[1]. Then, in the summer of 1942, came the bigger teething operations for the Division in Sicily and Italy. At last 1 Airborne Division was considered ready to be used in battle as a complete formation. But it sadly found itself in a reserve role for the D day assault in Normandy in June, 1944.

After the break out Mark Henniker took part in planning airborne operation after operation, each to be aborted because the Allies advanced too fast. It seems clear to your reviewer that he was now beginning to become impatient for a more active part in the war before it was all over. He became disgruntled. As a result, a month before 1 Airborne Division was at last launched into battle, he was posted away as CRE to one of the most aggressive formations, 43 Division, in 30 Corps. Fortunately, however,

for his many airborne friends, he joined the Division in time to extricate to safety across the Rhine 2000 survivors of his old formation from the outskirts of Arnhem; an intrepidly and brilliantly handled Sapper operation, witnessed in part by your reviewer.

The next part of his book covers selected personal experiences during the defence of the "Island", between the Rhine and the Waal; the German counter-offensive in the Ardennes in the winter of 1944; and the gradual clearance of a still obstinate enemy from the west of the Rhine.

Henniker's Division took no part in the assault across the Rhine in the spring of 1945. But its subsequent advance with battle groups of all arms, including armoured engineers, during the final phase of the war in Europe, makes interesting reading. Mark Henniker had reached Cuxhaven, at the mouth of the Elbe, before news of the unconditional surrender of the Germans reached him.

As one would expect from a book written and supervised by Henniker it is well produced. All the maps are clear and helpful.

To sum up, this is more than an unusual and entertaining book of uninhibited military memoirs by a comparatively junior commander who can write lucidly. Much of it is instructive for professional soldiers of all arms and it is an enjoyable read for all interested in some of the trials and tribulations of front-line soldiering in the Royal Engineers in World War II.

ECWM

[1] See review *Journal* September 1986.

CHRISTMAS ISLAND CRACKER
Air Vice Marshal W E Oulton CB CBE DSO DFC

(Published by Thomas Harmsworth Publishing—Price £14.95 ISBN 0 948807 04 0)

This book tells the story of the first British H-bomb trial, and is written by the Task Force Commander, Air Vice Marshal Wilfred Oulton. It is a remarkable story, not least for the speed at which the operation was organized, mounted and brought to a successful conclusion, in which the Corps played a vital part. The book is written almost in the style of a novel, with conversations repeated verbatim, which certainly enlivens what could have been a rather prosaic record.

The task force comprised the four elements of the Navy, the RAF who had the major role, the AWRE Scientists, and 28 Field Engineer Regiment and supporting services. All elements faced a demanding task to be carried out against time which was both technically and logistically near the limits of possibility.

Air Vice Marshal Oulton, with his scientific background, quick understanding and great determination, was an ideal choice for such a command. One of his earliest decisions was to divide the operation up into phases and appoint the senior officer of the Service which had the major role in each phase as Senior Officer Grapple Area with command over the other Services. Thus for the initial arrival by ship, Commodore Peter Gretton was in charge. He then returned and I took over for the construction phase from July to November 1956, when the airfield was completed. The RAF build up then began and Air Commodore Weir took charge, until the arrival of the Task Force commander and the scientists.

The book gives full credit to all those taking part, and to the Corps in particular, and brings out some interesting points. Task Force HQ was relatively small, completely unbureaucratic, and full authority was delegated to all of us to get on and get results. The organization of the Corps at the time had not yet suffered from too many peace-time economies, and the Engineer Stores Organization in particular was able to function with great efficiency and speed. Technical backing from E-in-C's branch was readily forthcoming and the Transportation Organization at that time was under Corps control. Liaison with the Civil Engineering industry was good and we had a lot

of help with training, whilst AG7 (as it then was) and Records did their best to give us the manning we needed.

The contacts amongst middle-piece and senior officers at the various staff colleges proved a great initial help in establishing mutual confidence and understanding, but there is still room for more liaison lower down. It was surprising to us, as Air Vice Marshal Oulton brings out, to find that some airmen and scientists considered living in a tent on a tropical island to be a hardship, and that the robust meals essential for hard working Sappers were not appreciated by those in more sedentary occupations.

For us in the Corps, who were lucky enough to be able to take part in such an interesting operation, the necessity for sound engineering knowledge on the part of the officers, and for sound trades training and skills on the part of the sappers, NCOs and WOs were again highlighted. The engineer stores and logistic organization also had the capability to play a vital part. It is to be hoped that those concerned with looking for economies will read this book and take note.

JCW

THE FOG OF WAR

DERRICK MERCER, GEOFF MUNGHAM AND KEVIN WILLIAMS

(Published by William Heinemann Ltd—Price £15.95 ISBN 0 434 46400 7)

The Fog of War, written by three members of the Centre for Journalism Studies at University College Cardiff, is based upon a recent study, undertaken on behalf of the Ministry of Defence, into relations between government, the armed services and the media in times of armed conflict. The bulk of the book consists of four case studies: the Falklands War, Vietnam, the 1982 Israeli campaign in Lebanon and the invasion of Grenada.

The first half of the book, which concentrates on the Falklands War, is fascinating reading. It describes in frank terms, and with the benefit of considerable research, the inadequacies of the public information arrangements 'cobbled together' in haste for the war in the South Atlantic. Drawing upon examples from the Falklands campaign, the book highlights—in a commendably even-handed manner—the conflicts that will inevitably occur as a result of having the media on the battlefield. How can the reporter's appetite for information be reconciled with the military commander's need for security? How can the government's responsibility to be honest with its own population be met without, upon occasion, undermining the soldier's wish to deceive the enemy? Although there are no easy answers to these and many other similar questions, it is clear that in the field of public information there is much to be learnt from the Falklands War. Therefore, as the media are going to be on the battlefield of the future—whether the armed services like it or not—the first 210 pages of *The Fog of War* deserve to be read by every serious soldier.

In contrast, the second half of the book is slightly disappointing. Without the access to the key participants which they so obviously had for the Falklands study, the authors have had to rely more heavily on secondary sources. The resulting case studies are, therefore, somewhat bland and contain little that is surprising. Furthermore, minor mistakes begin to creep in towards the end of the book. For example, on page 358 the book mentions the public information problems associated with NATO laying 'defensive nuclear land mines'—as *Jane's Defence Weekly* noted in October 1986, such mines no longer exist in Allied Command Europe. On page 360 Allied Command Europe is said to have five subordinate commands—in reality it has four. There is, also, a certain amount of repetition: on page 329 the reader finds the same arguments, the same quotation and virtually the same sentences as he read earlier on page 279. Whatever the academic advantages of producing a weighty volume, the authors of *The Fog of War* should be confident they have produced an important book on an important subject—they have no need to resort to 'padding'.

SCG

NARROW GAUGE AT WAR
KEITH TAYLORSON

(Published by Plateway Press—£5.75 ISBN 0 9511108 1 0)

ANY student of the First World War will find this book fascinating, let alone the railway buffs. It does not purport to be a definitive history, but rather it seeks to present in words and pictures a portrait of the War Department Light Railways as they developed to meet the need of a war effort that had strained existing modes of transport to breaking point.

The layout of the book is a short history of the WDLR with a debt of gratitude to earlier authors whose painstaking research it does not endeavour to emulate.

This volume deals exclusively with operations on the Western Front (France and Belgium) which of course represents only a part of the story and the intention is that future volumes will portray military light railways on the Home Front and other theatres of war.

Perhaps it could be considered expensive, but nevertheless I thoroughly enjoyed reading it and found the style clear and easy to assimilate. Many of the excellent illustrations have not been published previously. There are three appendices listing all known locomotives delivered for use by the WDLR and the current location of all surviving ex WDLR locomotives.

MGW

CANALS AND CAMPAIGNS
An Engineer Officer in India 1877–1885

MAJOR GENERAL SIR GEORGE SCOTT MONCRIEFF

(Published by the British Association for Cemeteries in South Asia (BACSA)—Price £7.50 ISBN 0 907799 20 5)

GENERAL SCOTT MONCRIEFF left the UK at the age of twenty-one and *Canals and Campaigns* is the account of the next eight years in his life as a young Sapper Officer. Later in life he became Director of Fortifications and Works at the War Office during the Great War. He wrote this portion of his autobiography for the benefit of his children from his original diaries and his daughter has now edited the manuscript and presented the book.

What a wealth of experience this officer obtained. Regimental service at Roorkee with the Bengal Sappers and Miners with all its opportunities for sport and *shikar* was followed by a period in charge of construction of a nine mile section of a major irrigation work, the Swat Canal and this largely without direct supervision. During this period he joins in active operations in Afghanistan almost without the permission of his superiors. He then has a longer period on the bread and butter works of the Corps, building barracks, all kinds of civil works and hill roads in the Simla area and Lucknow before transferring to railways with the glorious title of Deputy Consulting Engineer for Guaranteed Railways and the saga completes with his transfer to the construction of the Sinde-Peshin railway. The size of this project was staggering—the railway rose 6000 feet in 120 miles and involved a work force of some 15,000 men which included an Engineer brigade of Sappers and Miners and Pioneer Battalions. The logistics involved in working in a virtual desert are considerable and one gets some idea of the scale when it is realised that five hundred camel loads were needed daily to provide the rations for the force.

One is filled with breathless admiration for the audacity and achievements of Sapper officers in India in the 19th Century, especially considering the natural disasters, the extremes of temperature and the cholera and fevers that beset them. The author is

revealed as a most human, christian and adventurous man who arrives in India naive and green from his training courses at Chatham. He not only learns his profession to perfection, but is able to enjoy all the sub-continent has to offer with its diverse cultures, religions and natural and architectural wonders. One is equally fascinated by his contacts with his horses, his observations on the many characters he met, both European and Indian, and the technical details of bridging and tunnelling.

This is the ninth of a series of books published by BACSA, not only for BACSA members, but with a wider public in mind which cover many diverse facets of life in India during British rule. Although a paperback produced in typescript the quality is excellent and the layout and editorial work accurate and attractive. Profits are used to help maintain the many memorials erected all over South Asia during two hundred years or more of contact with this country. Apart from this very worthy cause to be supported this is a book not to be missed. On a small point of detail the delightful cover includes the Prince of Wales crest which was not granted to the Bengal Sappers until 1906 well after the General had left India for the last time.

MBA

CONTROL SURVEYS IN CIVIL ENGINEERING
M A R Cooper

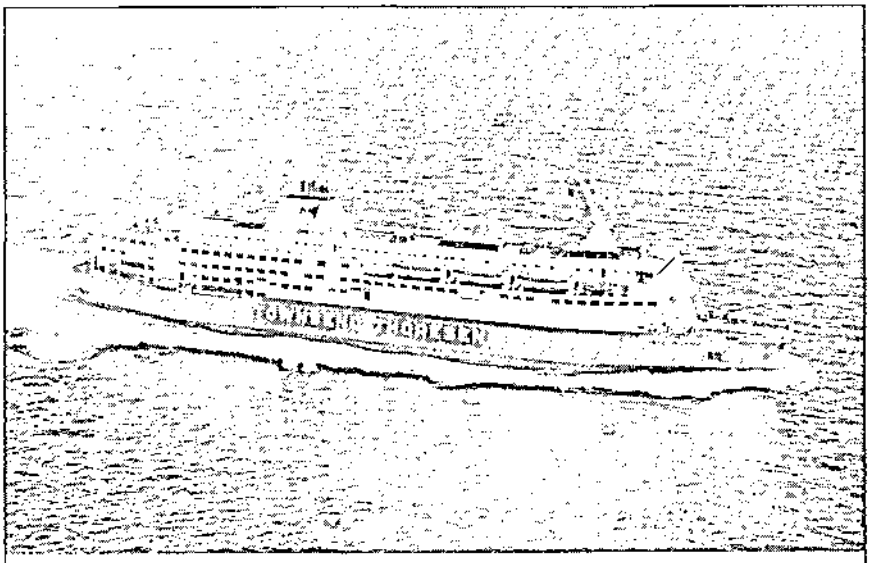
(Published by Blackwell Scientific Publications Ltd—Price £37.50 ISBN 0 00 383183 3)

The increasing complexity, extent and cost of civil engineering work have led to greater demands on the control surveys and a change in emphasis from traditional observational skills to design analysis and processing. Greater demands are being placed on the surveyor's ability to assess the quality of data and to process it to produce consistent and reliable results.

The development of automated processes now provides an opportunity to satisfy these demands with economy and accuracy. If proper use is to be made of the new instruments and methods available, an understanding of the principles of positioning in a civil engineering context is vital. *Control Surveys in Civil Engineering* certainly provides this knowledge and, by concentrating on principles rather than instrumentation or site control, demonstrates how to apply these fundamental rules to the design and computation of efficient control networks.

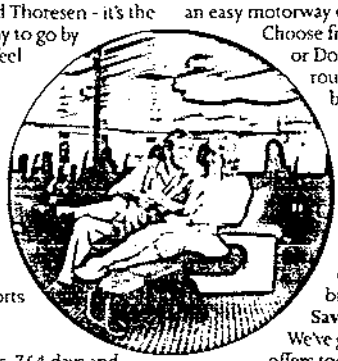
The value of the book, however, to the military engineer or surveyor is limited. It is written for practising civil engineers with a sound mathematical knowledge. Nevertheless it would provide the professionally qualified engineers and the advanced surveyor with useful background knowledge to developments in engineering surveying. For them, therefore, the book will be a reference to which they will turn on occasions with profitable results.

DIR



The fastest way to feel at home

Nip home with Townsend Thoresen - it's the fastest and the friendliest way to go by ship. Drive aboard and you feel more than half way home already. For a start, you're among friends. There's a cheerful, English speaking crew on all our smart, modern ships. And with the good food, comfortable easy chairs, videos on the longer sailings, and even a friendly 'Local', you're surrounded by all the comforts of home!



The fast routes home

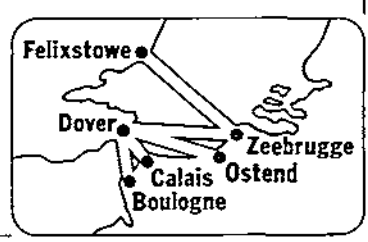
With thousands of sailings, 364 days and nights of the year, there's always a Townsend Thoresen ship ready and waiting to speed you home. We've got the handiest routes too - all an easy motorway drive from Germany. Choose from Zeebrugge to Felixstowe or Dover. Or take our most recent route, Ostend-Dover, operated by our Belgian partner Regie voor Maritiem Transport (RMT), with car ferry and express Jetfoil service for foot passengers, both linked to the European rail network. Or cut the crossing time even more and speed over Calais-Dover in a record-breaking 75 minutes.

Save your DM's

We've got some very friendly bargain offers too. Special passenger discounts for Forces every trip and reductions for vehicles on most sailings. Plus some great short break bargains at up to 50% off.

TOWNSEND THORESEN

Check out the bargains on the fast way home. Get the Townsend Thoresen Forces Brochure from your travel agent or Townsend Thoresen, Graf Adolf Strasse 41, 4000 Dusseldorf 1.

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