THE ROYAL ENGINEERS JOURNAL

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Jubilee of Royal Corps of Signals

FORMATION OF THE CORPS (LATER ROYAL CORPS) OF SIGNALS

THE following Birth Certificate was issued by Royal Warrant and published with Army Order 275 of 2 July 1920:

GEORGE RI

Whereas We deem it expedient to authorize the formation of a Corps to be entitled "Corps of Signals".

Our Will and Pleasure is that the Corps of Signals shall be deemed to be a Corps for the purpose of the Army Act, and that the words "Corps of Signals" shall be inserted in Our Warrant of 7th July 1916, defining the expression "Corps".

Our Further Will and Pleasure is that the rates of pay for officers, warrant officers, non-commissioned officers and men of the Corps of Signals shall be as provided in the Schedule attached to this Our Warrant.

Given at Our Court at St James's, this 28th day of June 1920, in the 11th year of Our Reign.

By His Majesty's Command,
WINSTON S. CHURCHILL

ARMY ORDER 276 OF 2ND JULY 1920

Corps of Signals:

1. With reference to Army Order 275 of 1920, the Corps of Signals will consist of such Signal units, Royal Engineers, as are now in existence, those of the additional personnel now serving with the Signal Service, Royal Engineers, who wish, and are accepted, for transfer, and such other Signal units as may hereafter be formed.
2. The establishment of the corps as regards officers, warrant officers, non-commissioned officers and men will be notified in due course.
3. The officers required for duty with the corps will consist of:
   (*a*) Officers on the permanent establishment.
   (*b*) Officers of other arms of the Service seconded to the Corps of Signals to complete the number required additional to the permanent establishment.

. . . . . .

10. To complete the initial establishment of the corps, officers now serving in the Signal Service, Royal Engineers, may have the option of transferring to the Corps of Signals provided vacancies exist in the permanent establishment of the corps, and they are accepted for such transfer. Officers for whom no such vacancies exist, but who are wanted to complete the number required with the corps may continue to be seconded from their own arms of the Service provided they have not already been seconded for more than four years. Those who have already been seconded for four years may be seconded for a further period not exceeding two years from the date of this Order.

. . . . . .

13. To provide the numbers required on the formation of the corps, those warrant officers, non-commissioned officers and men who are now serving with the Signal Service, Royal Engineers, and wish for transfer, will be transferred from their present corps to the Corps of Signals provided vacancies exist in the permanent establishment of the corps. Warrant officers and non-commissioned officers will be transferred in their present permanent rank.

. . . . . .

The Corps of Royal Engineers send their congratulations and best wishes to their offspring on her fiftieth birthday.

UBIQUE
Everywhere

CERTA CITO
Swift and Sure

Military Aid to the Civil Community in Scotland

COLONEL J. E. WELLER, MC. MA, MBIM late RE
Chief Engineer Scotland 1966–69

WHEN Lieut-General Sir Derek Lang arrived as GOC-in-C Scottish Command, he was extremely concerned about the repercussions of bringing the Army home from its traditional overseas posts. I am not attempting to reproduce the interesting talks on this subject which he has given. To my mind there are two main points: Firstly, a standing Army has historically never been popular with the civil population in the UK, therefore something must be done to integrate the Army more closely with the civil population. Secondly, if the Army is not given useful and interesting things to do when it is at home it will become a second-rate profession.

Within forty-eight hours of his arrival in Scotland General Lang dined at my home and we talked long into the night. I recollect that my part in this conversation was to emphasize the difficulties which confronted any large-scale attempt by the Army to do useful and interesting things in Scotland. In retrospect the majority of the difficulties I foresaw all materialized in varying measure, but due to the determination to get things done and the goodwill that existed at a high level in Scotland, they were nearly always overcome.

There were two main avenues of thought:

Firstly Projects. The Sappers had been doing civil projects in Scotland as part of their training for some years. This line of country offered the best form of not only integrating the Army with the civil population but also giving the Army useful and interesting things to do. The problem was (*a*) to exploit the stationing of more Royal Engineers in the UK by increasing the number of projects that were being undertaken annually, (*b*) to try to get other arms to take on projects that would require a less high standard of technical skill.

Secondly Youth. The Army can provide leadership and organization. There is a youth problem in Britain today. It was required to use this leadership and organization to try to help the youth of Scotland.

As Chief Engineer I was primarily concerned with projects and the Commander of the Recruiting and Liaison Staff was primarily concerned with youth. I was nevertheless closely concerned with the young people and so in the course of this article I will try to cover both aspects.

The first requirement was to have at my finger-tips a large number of projects that needed doing so that, as soon as I heard that a unit wanted training in any particular subject or in any particular area, I could offer something. The Op Macc Consultative Council was thus born. This was an assembly chaired jointly by the Permanent Under-Secretary of State for Scotland and the GOC-in-C, and attended by some thirty senior representatives from such organizations as Scottish Development Department, the Association of County Councils, chief constables, trade unions, employers' associations, education authorities, youth organizations, National Trust for Scotland, Highlands and Islands Development Board, etc. At the first meeting of the Council the GOC-in-C explained his policy and the PUS invited the civil authorities to give every assistance, as the results should be to the mutual advantage of both civil and military. I tried to outline the sort of projects both the Sappers and other arms might like to undertake and invited without making any promises people to write to me with suggestions of what they wanted done. I got some 300 requests for work as a result of this meeting.

At the same time as this was going on I was having my staff ruthlessly cut from three officers (two SO II and one SO III) to one SO II, and the establishment people were trying to cut me out, too. It was incumbent upon me to set about reconnoitring

300 possible projects throughout the length and breadth of Scotland. My friends the Chief Engineer of the Strategic Reserve and the Commander of 12 Engineer Brigade came to the rescue and loaned me a GE and a Clerk of Works. These two journeyed tirelessly throughout the country. Their job was to establish the feasibility of the Army doing the task suggested. If it was feasible and a simple task, they made a plan and stores list on the spot; if it was a major task, the outline was sent to 62 CRE of 12 Engineer Brigade for a detailed recce and plan to be made.

My next task, which ideally occurred in October, was to consult with those responsible for training, on the types of task which they wished their units to carry out the following summer. The main customer was naturally the Chief Engineer of the Strategic Reserve, but I also got in touch with the TAVR Engineer Brigade Commanders for their units to do tasks at week-ends and at annual camp. The RE troops from University OTCs also made a useful contribution. Against the wishes of some in authority on plant matters I arranged a short course to train Infantry pioneers to operate the Light Wheeled Tractor. This proved the most enormous success, particularly with the Royal Highland Fusiliers, who did a tremendous amount of useful work. They achieved a high standard of skill in operating the LWT and not only benefited Scotland but also themselves in that in return for their labours they were frequently offered areas over which they could train which otherwise would not have been available.

There is a certain suspicion in some circles that in work of this kind the Infantry would be used as a form of cheap labour for the Sappers. This suspicion is quite groundless. Many projects were completed by Infantry sometimes with technical advice from the Sappers sometimes entirely on their own. The Infantry (and Gunners) visited on this type of work were invariably and without exception enjoying being constructive and doing something quite different to their usual routine.

Having got a unit wanting training and having got the projects to choose from, I was then in a position to marry up the Army training requirement with Scotland's need.

The next problem was to clear the project. The plan as prepared by my GE, or by 62 CRE, was sent to the sponsor of the project: he was normally given a few weeks to study it and a meeting was then held in my office. At this meeting all interested bodies from the Civil side [eg for an airfield the County Council, the Board of Trade (Civil Aviation) and the Highland and Islands Development Board] and the officer who made the plan, the OC of the unit to do the work and the Command Secretary assembled. The plan was explained by the officer who had prepared it; the OC of the unit to do the work would present the administrative problems involved and the Command Secretary advised on the financial arrangements.

The finance of Op Macc projects sounds difficult and complicated in the various DCIs, but in practice we got it down to a simple matter of four separate headings.

1. *Movement.* In most cases as work was being undertaken for Government Departments and local authorities and provided excellent training together with valuable community service, only additional cost in moving the unit to the site would be borne by the sponsor. This was frequently nil, as for example the move of a unit and plant to the Isle of Unst to build an airstrip was done by LSL, which, being required to undergo trials coupled with amphibious training, enabled us to secure the service without charge.

2. *Administration.* It was desirable in the wet weather conditions so frequently met in Scotland for the troops to be accommodated in schools, barns or other dry buildings rather than tents. The bill for the loan, heating and lighting of these buildings had to be paid by the sponsor, who also had to pay the telephone bill. (This was no small item: one field squadron in Scotland building a road ran up a telephone bill of £500 in four months.)

3. *Materials Incorporated in the Work.* When work was done for county councils or other local authorities, the normal arrangement was for them to supply all the

materials to the site so that no accounting was necessary by the Army at all; as a result we were rarely aware of what our projects actually cost the sponsor. For organizations such as the National Trust for Scotland we ordered the stores, but passed the bills direct to them for payment, so that again nothing went through Army accounts.

4. *Additional Contribution to Army Funds.* The Command Secretary would balance the training value of the task with the benefit accruing to the sponsor and to the community in relation to the estimated commercial cost and invite the sponsor to make an additional contribution to Army funds—generally about 5 per cent of the commercial cost.

Having sorted out the specification and finance, agreement had to be obtained from employers and trade unions and the sponsor had to sign an indemnity. I recommend that negotiations with unions and employers should be done by personal contact at as high a level as possible rather than by letter. I never experienced any major difficulty in this—I had alternative tasks to offer units if objections were raised, and I could frequently tell the unions and employers that because most of the jobs were in out-of-the-way places, if the Army did not do the work nobody would.

During the three years 1966–9 some 150 projects were completed. These varied from major tasks done by a whole field squadron for some months to week-end tasks done by TAVR units.

I do not propose to go into details of these projects, but I would like to reflect on what effect our efforts may have. I will restrict myself to a few construction tasks.

Firstly. Domestic air flights. It takes a long time to travel round Scotland by car or train: domestic flights by light aircraft such as the Islander run by Loganair cut the time enormously; the advantages to those needing hospital treatment urgently, to tourism, and to business people, of an internal airways system in Scotland is obvious. Unfortunately there is a chicken and egg situation: county councils will not build airstrips (they cost a lot of money by contract) unless the airlines will buy more planes so that they have the prospect of reasonable service from them; and the airlines will not buy more aircraft until there are more places for them to land. I think the RE have made a significant contribution to the solution of this impasse; we have built airstrips on the Isle of Mull, at Plockton near Kyle of Lochalsh, and at Unst, the northernmost of the Shetland Islands, only 400 miles from the Arctic Circle. We have made landings practicable on the Isles of Col Oronsay and Colonsay and we have started construction of an airstrip at Broadford on Skye.

Secondly. Roads. Those who have skied in the Cairngorms at Aviemore will know that enjoyment is considerably impaired by the enormous number of people who invade the limited available snow in the Coire Cas at week-ends. To the west of the Coire Cas lies Coire na Ciste—a steeper coire which holds the snow longer than Coire Cas and is more suitable for those interested in racing. The Coire na Ciste was inaccessible from the bottom. By building a road approximately 1,000 yds long to county council specification the RE assisted by the Black Watch have been responsible for a whole new area of ski-ing being opened up; new ski lifts are planned; I think we have made a useful contribution to one of the winter tourist attractions in Scotland.

Thirdly. Drain of the population from the Highlands. This is a problem which the Highlands and Island Development Board are struggling to solve. Villages are dying as the young depart for the imaginary Utopia of London and South East England. The village of Strontian was one of these; it was planned to make it an attraction for those who like the quiet holiday, but nobody would make a start. The RE built a 400-yd loop road and a car park in the village. One year later, when one of the Ministers of State visited the village to open the shopping centre and tourist information centre he was kind enough to say that of all those who had played a part in reviving Strontian he would only single out one—the Army—who had started the whole resuscitation process by building the road.

At another village of about thirty houses there was no piped water supply and a complete waterworks system and mains was installed by the RE.

The effect of our efforts in these places may be to have shown the way to be followed in stopping the drain of the rural population to urban areas.

Fourthly. Hostels. The National Trust for Scotland are landowners of large tracts of country which people have donated for the benefit of the community. Unfortunately due to limitation in accommodation the numbers that can enjoy these areas are extremely small. A worry for the Corps for some time due to the military training needs in BAOR, has been the lack of opportunity for the construction tradesman to use his craft. On the Isle of Arran and at Morvich on Loch Duich, hostels have been designed and built entirely by the Corps. The carpenters, bricklayers, plumbers and electricians have had a real opportunity to show their skill. Accommodation with all modern conveniences, kitchen, drying rooms, etc, have been provided for twenty-four people and four staff on Arran and at Morvich. If there is a weekly turn round of twenty-four people at each hostel from April to October (thirty weeks), the effect of our work is that it is possible for another 1,500 people every year to enjoy the peace and the beauty which only Scotland can offer.

There are many other construction tasks, but I must now turn to the Op Macc activities in connection with youth.

In the winter of 1966 a WO II of the Royal Engineers in charge of an Army Youth Team organized a camp on the lower slopes of the mountains at Glenshee. The youth team went on a ski instructors course. Every Friday evening thirty-six boys and girls were transported from an urban area to this camp. They received ski instruction on Saturday and Sunday and were transported home again on Sunday evening. The success of this was phenomenal and only a fraction of the number of youths who applied to go could, in fact, be accepted. This project has expanded and accommodation has been organized at Glenshee and Glencoe in buildings rather than tents; last winter over 1,500 youths had a week-end in the mountains and snow.

In summer a similar camp was organized on the shores of Loch Rannoch, which is within motoring distance of Edinburgh, Glasgow, Dundee and Aberdeen. The summer activities included canoeing, sailing, fishing, mountaineering, archery, etc.

The original concept of Army Youth Teams was that they should go round youth clubs, etc, assisting them in their activities. In Scotland we reversed the process, the Army Youth Team provided the camps and the youth clubs came to Army Youth Teams. The Army Youth Teams organized the activities, provided instruction and equipment. This ran into snags: there was no vote of money for Army Youth Team activities of this nature. To solve the problem the Rannoch project was launched.

The Rannoch project was conceived on the basis that the Army can supply leadership organization and instruction, but cannot, since defence funds are not allotted for this purpose, supply accommodation and food for the young. The Rannoch project was launched when the Duke of Edinburgh visited the Army Youth Team camp last summer when youths were living in tents. During his visit leading authorities in the education and youth field in Scotland were invited to purchase and erect hutted accommodation at the site. The huts would provide sleeping accommodation, feeding facilities, showers, etc, at the site and would be maintained by the authority or club who had erected them. The authority or club would allot the vacancies each week-end. The Army Youth Team will live on the site, organize and instruct in the various activities. It is hoped this will enable more youths to get out of the towns at week-ends and enjoy the "loch" and "rock" which is Scotland's heritage.

Another youth project concerned the gang warfare which was rife amongst boys in Easterhouse, a suburb of Glasgow. The suburb was a postwar one and it is likely that the gang warfare developed because the boys had sat all day in school and on returning home were anxious to get rid of their exuberant energy, whereas their parents having been to work all day were content to watch the TV. The entertainer Frankie Vaughan started to raise money for the building of a Youth Centre. The mere fact that this money was being collected was enough to establish an armistice; the Chief Constable of Glasgow was, however, very conscious that it would take two

years to build the "Frankie Vaughan" Centre and the armistice could not last that long. He wanted somewhere for these youths to go in the evenings, somewhere where they could fight with boxing gloves instead of knives, and where they could dance and otherwise amuse themselves.

Perhaps partly due to the high standing of the Corps in Glasgow as a result of our efforts during the hurricane earlier in the year, the difficulties of getting trade unions' and employers' agreement, planning permission, etc, were overcome in a remarkably quick time and permission was obtained for the Sappers to build two Romney huts as a temporary youth centre. We started work in September and completed the shell, foundations, gable ends and adjoining passages by early November. The interior fittings were done by contract arranged jointly by the Frankie Vaughan Trust and the Glasgow Corporation. This side of the work took about three months and in early February the temporary Centre was opened by Lord Kilbrandon. There was a distinguished collection of individuals at the opening, including Mrs Ewing, the Scottish Nationalist MP, the E-in-C and the Chief Constable of Glasgow.

In spite of gloomy forebodings from some quarters at the time the project was conceived, the gang warfare except for one minor outbreak last spring has been largely curtailed.

Perhaps the most interesting youth activity of all was the Almond Walk project. Midlothian County Council wished to make a County Park in the Almond Valley some seven miles south west of Edinburgh. They owned the valley, which was overgrown by trees, brambles, bushes and undergrowth, and was quite inaccessible and impassable. In close co-operation with Midlothian County Council and Enterprise Youth the Army drew up a plan for two miles of footpath to be built last summer. The footpath was to have a proper 4-in stone base and 2-in surface.

The Army provided organization and technical supervision; this comprised one Infantry lieutenant-colonel, one captain RE, one clerk of works RE, six RE junior NCOs and two RA NCOs and four Infantry NCOs. The Army produced working parties from the Army Cadet force at annual camp, which over the six weeks totalled 300. Enterprise Youth produced working parties which totalled 500 youths (boys and girls) over the six-week period from fourteen different countries, including Nigeria, Czechoslovakia, USA, France, Spain, Scandinavia. The numbers on any day varied considerably, the maximum being somewhere between 250 and 300. There is now a splendid footpath for two and a half miles along this very lovely valley, but I think the most inspiring part of the project was to see youths from all parts of the world learning to be constructive together, working with a common object. I like to think this augurs well for the future.

In conclusion on a personal note may I say that I found that my appointment as Chief Engineer in Scotland was the most fascinating, exciting and rewarding appointment that I had since the war ended. On a general note may I say that Scotland is a paradise for the Army and the Royal Engineers in particular, and that what has been done to the mutual advantage of Scotland and the Army is only a start. The years ahead may well show that the Army, if it seizes fully the opportunity, will have made a significant contribution to the future prosperity of Scotland.

Sheet Explosive SX2

MAJOR D. O. VAUGHAN, RE

INTRODUCTION

SX2 sheet explosive was originally developed by the Royal Armament Research and Development Establishment for use in the explosive forming of metals, but it has obvious applications as a specialized demolition explosive, especially useful for cutting metal. Although approved for world-wide service use, it is not yet available for general issue.

This article describes the explosive, the most suitable methods of initiation, and also considers some of its possible applications.

DESCRIPTION

Composition. SX2 is an RDX-based explosive with a detonative performance similar to that of PE3A and PE4. It has the following composition:

RDX (Cyclonite)	88 per cent
Polyisobutylene	8·4 per cent
Diethyl-hexyl-sebacate	2·4 per cent
Polytetrafluoroethylene	1·2 per cent

Characteristics. SX2 is supplied in the form of sheets 3 mm in thickness, each measuring 465 mm × 250 mm and weighing 0·57 kg. These sheets remain flexible down to −40°C and can easily be cut into precise shapes with a sharp knife, scissors or shaped cutters.

Packaging. Forty sheets, interleaved with waxed paper, are packed in a wooden box No B183. The box also contains an accessories tin holding 120 detonator holders and 100 joining clips.

Preparation of charges. The sheets must be cut with a sharp knife or scissors on a non-sparking surface. They may be butted together, or built up in a sandwich to form thicker charges. Detonator holders have two prongs which can be bent to secure the holder and detonator to the explosive as illustrated in Figure 1. The joining clips may be used to join a strip of explosive to a sheet or to hold together adjoining sheets.

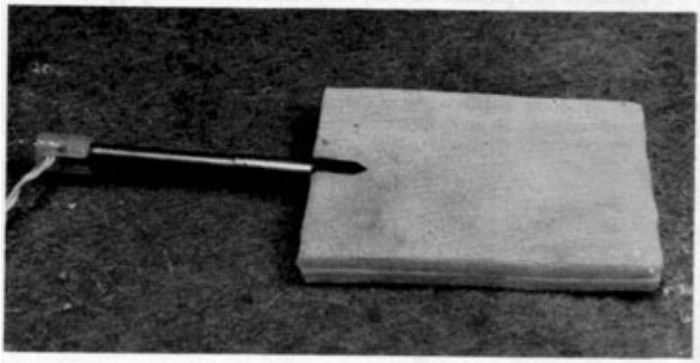


Figure 1. Detonator held in position by detonator holder.

Sheet Explosive 1

METHODS OF INITIATION

Sheet Explosive SX2 may be initiated by detonators or detonating cord. With detonators, either "end-on" or "normal" initiation may be used.

For "end-on" initiation of a single sheet of explosive there are three possible ways of fixing the detonator to the sheet:

(*a*) With a detonator holder as shown in Figure 1.
(*b*) With part of the sheet wrapped round the detonator.
(*c*) With an extra patch cut to cover the detonator, as shown in Figure 2.

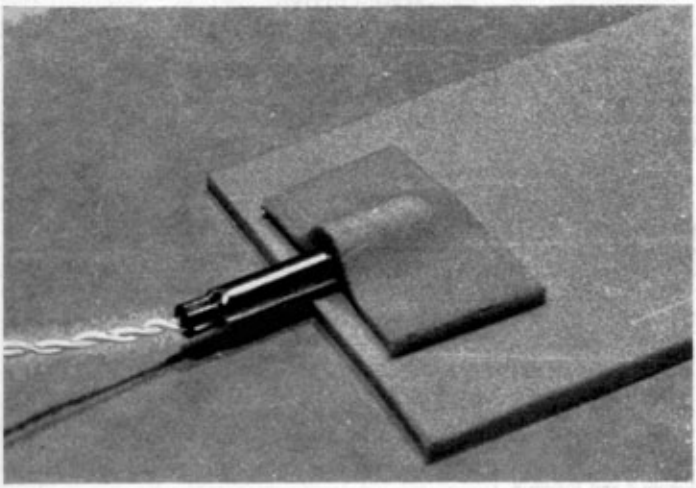


Figure 2. Patch cut to cover detonator.

For "end-on" initiation of two or more layers, the detonator should be sandwiched between the sheets.

For initiation in the direction of the target ("normal" initiation), a detonator holder should be used with the prongs pressed through the sheets and bent back. If no detonator holder is available, a small lump of PE4 may be used to retain the detonator (see Figure 3). Generally, "normal" initiation should only be used for charges two or more layers thick.

Detonating cord may be used for "end-on" initiation of sheet explosive, but this method is somewhat unreliable. There is a better chance of successful initiation if four 50-millimetre lengths of detonating cord are taped alongside the main strand and these are sandwiched between layers of SX2.

Figure 4 shows a strip of sheet explosive 6 mm to 7 mm wide used in conjunction with a detonator and a detonator holder for the simultaneous detonation of two corners of a charge.

APPLICATION

Sheet explosive can be so cut and arranged as to give the minimum demolition effect required to defeat a target. Thus, unwanted demolition effects such as excessive shock wave and noise can be avoided. The bulk and weight of stores can also be kept to a minimum.

SX2 is particularly suitable for demolition tasks where economic use of explosives is necessary, using specialist techniques such as diamond-shaped charges. It also has applications for sophisticated service tasks such as explosive ordnance disposal.

Some examples of demolition techniques using SX2 are given in the following paragraphs. A user should be able to develop and refine his own techniques for particular tasks by means of preliminary trials.

STEEL CUTTING

Three charges will be considered: ribbon charges, diamond charges, and plate cutting charges.

(*a*) *Ribbon charges.* These charges are used to produce a longitudinal cut in steel, as shown in Figures 5 and 6. Combined with a common point of initiation, they are used to cut steel beams, as shown in Figure 7. The formula for calculating a ribbon charge is:

Charge thickness = ½ target thickness
Charge width = 2 × target thickness

provided that the rear surface of the plate is free. If it has any form of backing, depending on the material of the backing, it may be necessary to use a heavier charge, so it would be safer to double the charge thickness.

(*b*) *Diamond charges.* Diamond charges take advantage of colliding shock waves to produce a tensile fracture cut in steel bars and rods as shown in Figures 8 and 9. The formula for calculating a diamond charge is:

Long axis = circumference of target
Short axis = ½ circumference of target
Thickness = 4 layers for 50 mm of high carbon steel
= 2 layers for 50 mm of mild steel

They should be initiated simultaneously from both short axis ends, as shown in Figure 4 and Figure 8.

(*c*) *Plate-cutting charges.* When detonated in close contact with a steel plate, a disk or square of sheet explosive will tear a slab of metal from the plate. The slab will be roughly the same shape as the charge, as shown in Figures 10 and 11. This effect can be applied for the rapid punching of holes in steel plate thus eliminating the need for a cutting torch in certain situations. The remarks in the paragraph dealing with ribbon charges concerning free surfaces will also apply to the punching of holes in plate.

RANGE CLEARANCE

SX2 provides a convenient and economical alternative to PE4 for use in range-clearance work.

TREE FELLING

Sheet explosive may be used as an external charge for tree felling, using a diamond charge calculated as follows:

Long axis = circumference of tree
Short axis = ½ circumference of tree
Thickness = 2 layers for trees up to 150 mm diameter

Highly specialized techniques have been developed employing sheet explosive for low-order detonation. The uniformly thick sheet enables the shock-wave profile transmitted through the casing to be maintained within close limits, avoiding high order detonation of the filling. SX2 can also be used for cutting and entering explosive ordnance without detonating the explosive contents.

Sheet Explosive SX2 has an explosive performance similar to ordinary service plastic explosives. Its main characteristic is its sheet form, which enables it to be cut into precise shapes. The resulting charge can be initiated with either detonators or detonating cord.

Sheet explosive is useful for precise work where only a minimum shock wave or noise level is acceptable, and for special operations where the bulk of stores is a critical limitation.

Typical tasks are cutting steel, cutting holes in steel plate, tree felling and clearing blinds. A more specialized task is low-order explosive ordnance disposal.

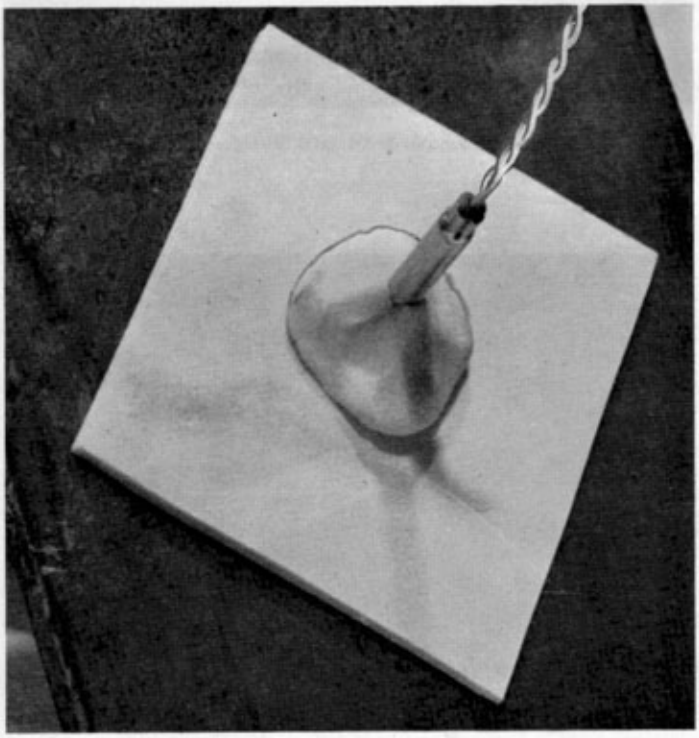


Figure 3. Initiation "normal" to target.

Sheet Explosive 3

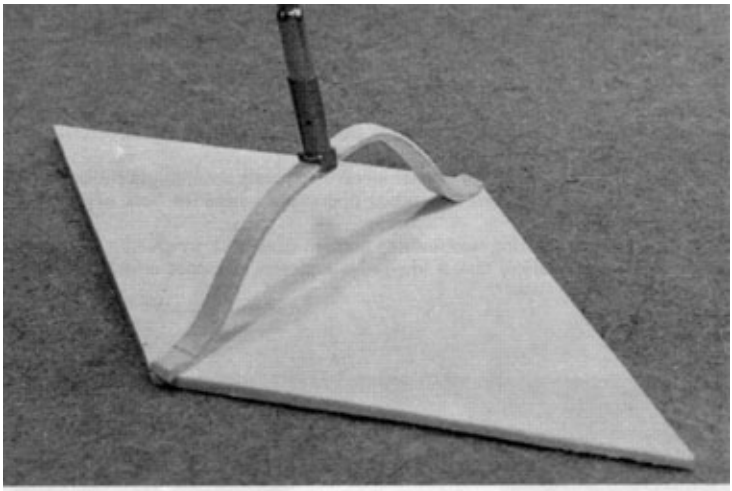


Figure 4. Simultaneous detonation at two corners of charge.

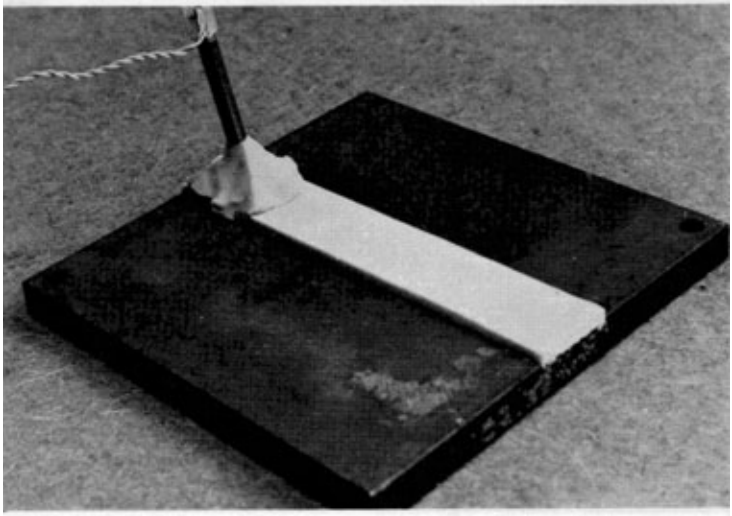


Figure 5. Prepared ribbon charge.

Sheet Explosive 4 & 5

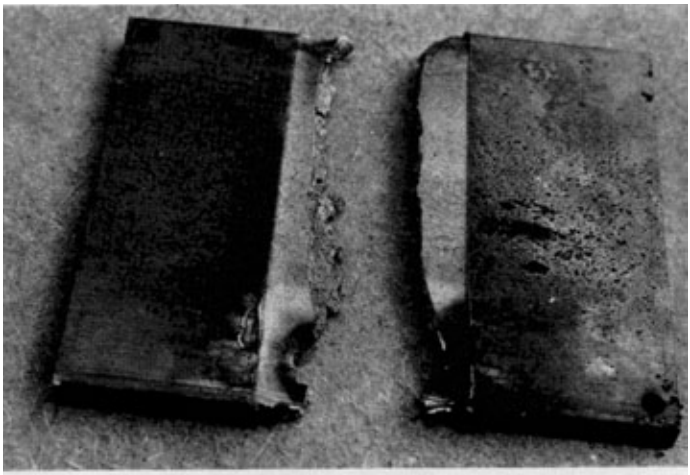


Figure 6. Effect of ribbon charge.

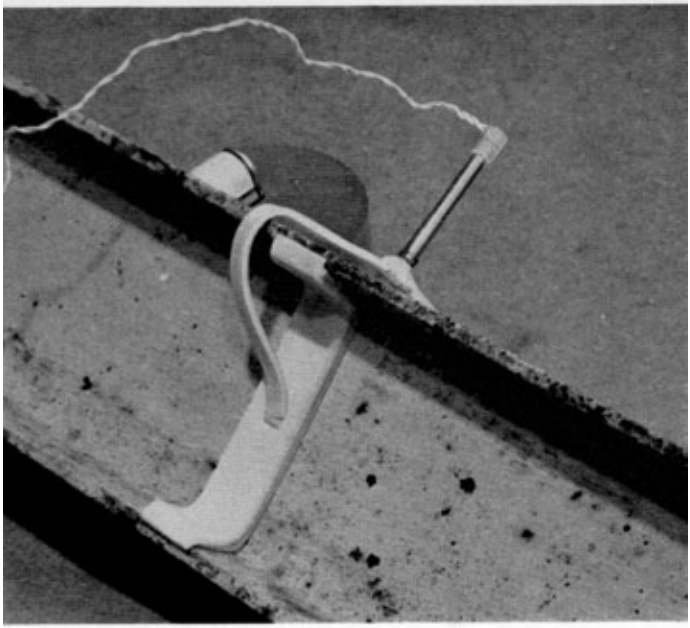


Figure 7. Ribbon charge used in cutting steel beam.

Sheet Explosive 6 & 7

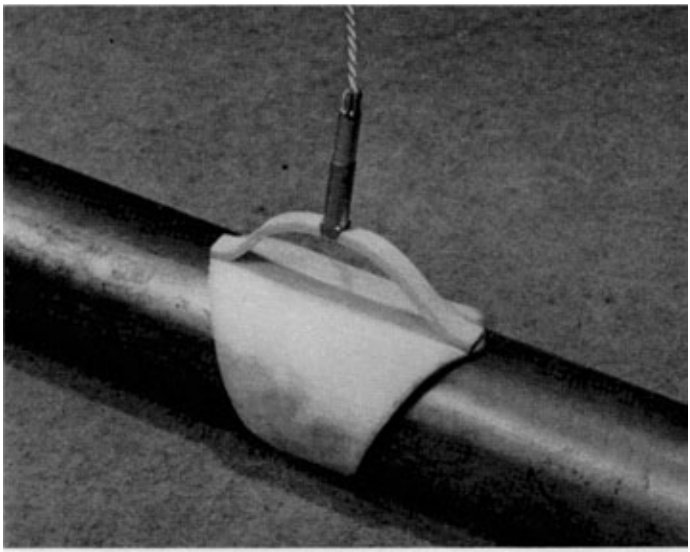


Figure 8. Diamond charge on steel rod.

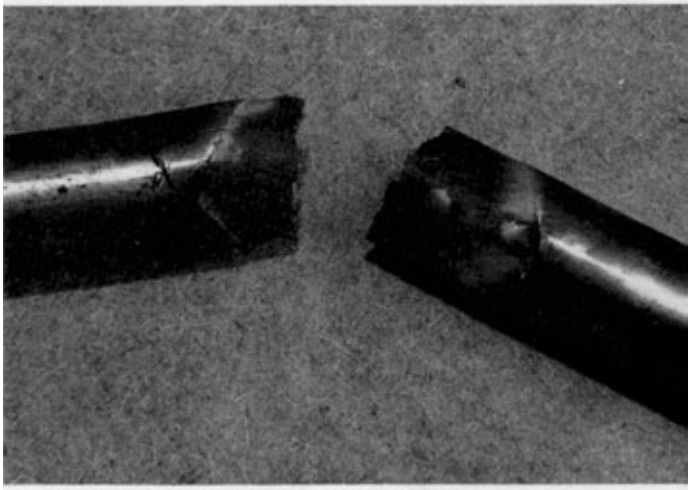


Figure 9. Effect of diamond charge on steel rod.

Sheet Explosive 8 & 9

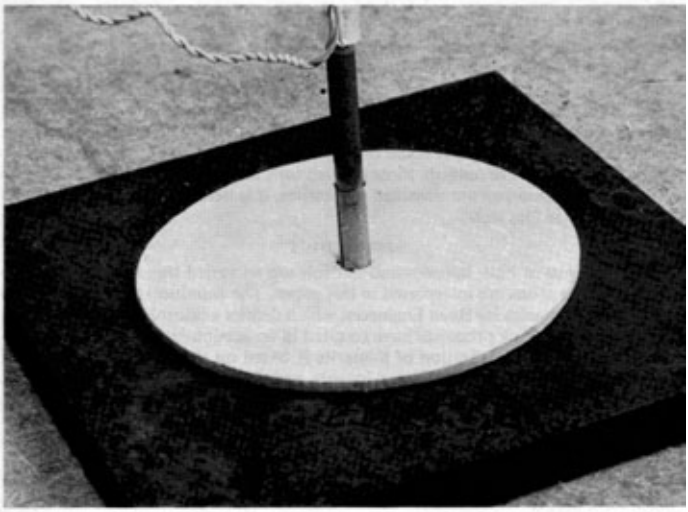


Figure 10. Disk charge.

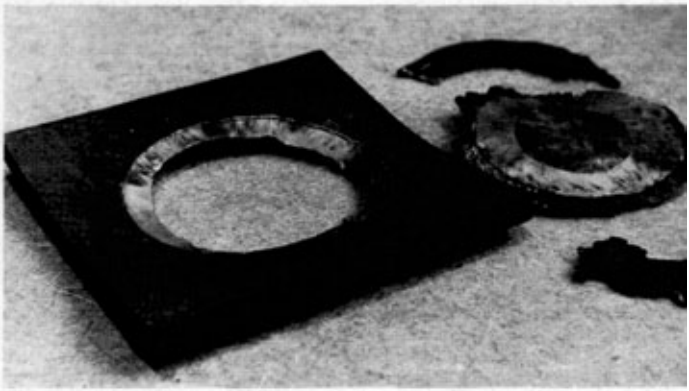


Figure 11. Effect of disk charge.

Sheet Explosive 10 & 11

Laterite and Lateritic Soils (Latosols)

MAJOR R. B. DOWNS, RE, FIPlantE, MICE, AMBIM

INTRODUCTION

THE word "laterite" originated in India in 1880 as a description of a reddish soft rock. When first quarried it could be cut easily to form blocks, but on exposure to air an irreversible hardening took place and a very useful building block was formed. Since then the word has been widened in application and is used all over the world by engineers as a description for many types of soil. The classification of a soil as a laterite has often been made on the basis of its red colour. Unfortunately, though most laterites are reddish, most reddish soils are not laterites. Since different soils in different countries are classified as laterites, it is better to describe these soils as lateritic soils or "latosols".

DEFINITIONS

The definitions of both laterites and latosols are so varied that it is necessary to define how these terms are interpreted in this paper. The definition of latosol is that given in **Soil Mechanics for Road Engineers**, which defines a latosol as a "tropical soil in which the weathering processes have resulted in an accumulation of sesquioxides, particularly iron". The definition of a laterite is based on the practical necessity of talking to engineers in any particular locality and defines laterite as "that latosol which is locally accepted as laterite". It should be remembered that latosols can have many local names such as Murram, Terra Rosa, etc. For this reason the term "latosol" should be used in all general discussions, whilst the term "laterite" should be confined to local discussions in a particular area.

ORIGIN AND COMPOSITION

The mechanism of latosol formation has been hotly debated for years. One popular theory is that laterization starts by rainfall leaching out iron and aluminium salts from parent bedrock near the tops of hills. These salts are carried down the hillside, and under alternating wet and dry conditions tend to crystallize out and concentrate in areas on the slopes and at the base of the hills. Here they oxidize from the soluble form to sesquioxides mainly of iron and aluminium. In oxidizing, nodules are often formed, and some cementation and bonding occurs in the parent soil. The nodules formed during this laterization are very variable in size and hardness, but normally consist of a hard reddish iron oxide skin round a softer and lighter coloured core. The aluminium oxides and some minerals in the clay particle size seem to be mainly responsible for the cementing action.

DISTRIBUTION

The mechanism of latosol formation clearly requires both heat and alternating wet and dry conditions. This restricts the occurrence of latosols to the tropical areas which have a monsoon climate. The world map at Figure 1 shows the general distribution.

DESCRIPTION AND IDENTIFICATION

Latosols vary so much that no general description can be given. When classified in accordance with the Casagrande system, they range from GP through SW and SM to CH. In colour they range from very dark purple to pale yellow. The only certain identification is a chemical analysis of the SiO_2/AL_2O_3 ratio, which should be less than 2·0. However, from these ranges, practical experience gained in many countries has enabled the better latosols to be classified locally as laterites which exhibit a more limited range of properties. Generally they contain hard nodules up to 1¼ in in size, and less than 30 per cent passes the BS 200 sieve. The colour is usually in the red to purple range and the SiO_2/AL_2O_3 ratio is less than 1·33.

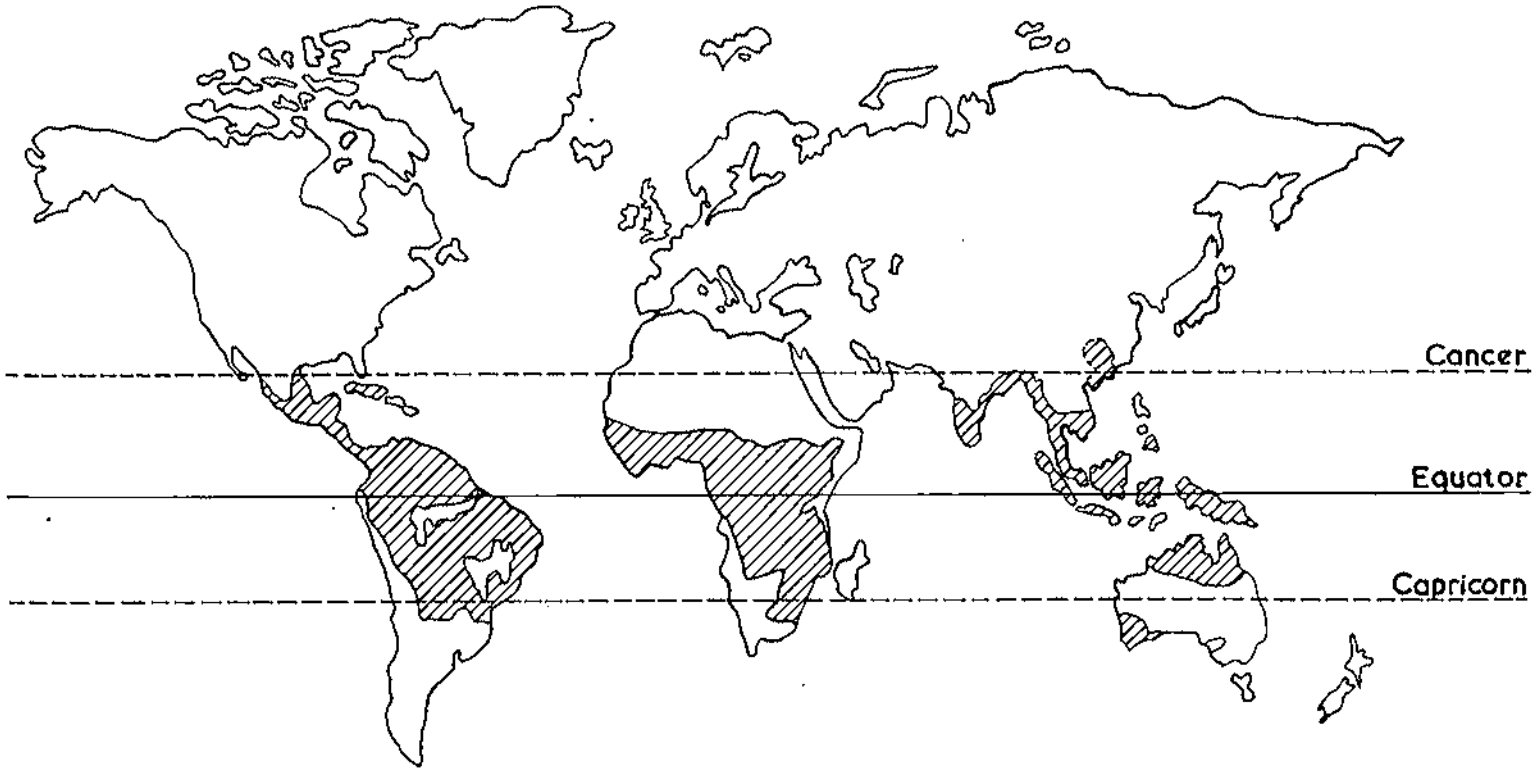


Fig 1 -Geographical distribution of lateric soils

CHARACTERISTICS

The characteristics which make latosols different from temperate climate materials are the tendency towards re-cementation and the hard skins round soft centres in the nodules. It is essential not to overcompact the materials otherwise excessive crushing will occur and remoulded strengths will suffer. It is also necessary to use laboratory results with caution, since the re-cementation often does not occur within the time scale of laboratory tests. Field tests and application of local experience are essential when using latosols as construction materials.

USE OF LATOSOLS IN PAVEMENT CONSTRUCTION

Most latosols can be used in all parts of a pavement provided some care is taken to check their physical properties. A guide to their use is given below:

(*a*) *Subgrades.* Provided overcompaction is avoided and there is good drainage, most latosols can be used in the subgrade.

(*b*) *Road bases.* For use in road bases, latosols should preferably be of nodular material with a plasticity index (PI) for the fines not exceeding 20. If used under a bitumen seal the PI should not exceed 10.

(*c*) *Surfacing.* Gravelly latosols can provide a low-grade low-cost surface and are frequently used as such in the tropics. There are two conflicting requirements in a surface. For use in dry weather a high clay binder content is needed to reduce the unravelling of stone, whilst in wet weather a low clay binder content is required to reduce the wetting up. It is essential to obtain local advice on the percentage of fines required, and the desirable PI.

(*d*) *Stabilization.* All latosols are improved in strength and resistance to water by stabilization. Lime stabilization is frequently adequate, when the fines content is clay, though a mixture of lime and cement will give higher strengths at an earlier age. Some nodular latosols in the GP range give better results with cement alone. The percentages required are often as low as 3 per cent and stabilization is therefore a economical method of producing good pavement materials.

BIBLIOGRAPHY

The main references for these notes are:

US Army Engineer School, Student Reference Section I,

Soil Engineering, Volume III, Chapter x and xI (Reference 5002).

This publication contains a very extensive bibliography to which reference for further reading can be made. The Road Research Laboratory can also supply much useful information, and their Overseas Bulletins No 5 "Nyasaland Laterites", No 10 "Nigerian Soils" and No 12 "Central African Soils" are particularly useful.

Winter Training

LIEUT-COLONEL W. COOK, RE, BSc, MICE, MINucE, MInst,HE

THE Norwegian School of Infantry and Winter Warfare was established in 1861 and for the last seventy-four years has been located at Terningmoen, near Elverum, at the head of a valley some one hundred and fifty kilometres north of Oslo.

Shortly after the end of World War II a British Officers' Winter Course was run at the school to teach officers how to live and fight in the Arctic. The first course was so successful that it became an annual event, and from this the present Allied Officers' Winter Course for officers of NATO countries was developed.

A prerequisite for the course is that the student shall be a member of an active army, be well trained and in *good physical condition*; the italics are mine.

Towards the end of 1969 I was warned for duty with the ACE Mobile Force and told to get some winter training prior to exercise "Arctic Express". Trying to look young and in good physical condition, I persuaded the School of Infantry to accept me for training with the Allied Officers' Winter Course, where I hoped to learn how to exist in the Arctic and also to carry out sapper tasks under Arctic conditions.

The block programme for the course is shown in Annexe A and the Outline Syllabus in Annexe B. The aim of the course is to give students knowledge of, and training in, winter warfare, and to make them understand the possibilities and limitations of infantry units operating under extreme winter conditions.

On arrival at the School each student is issued with a complete set of Norwegian uniform and equipment suitable for use in the Norwegian winter. He is then taught how and when to wear or use each item.

The Norwegian cold weather uniform is unsophisticated, but is warm and serviceable. Starting at the skin and working outwards, the soldier wears a string vest, then a heavy woollen vest with long sleeves and long woollen pants. Depending upon the temperature and expected physical exertion, a shirt and woollen jersey may go on top, followed by trousers and jacket of similar material to combat uniform. The jacket buttons up to the neck and has a hood attached. When it is particularly cold a "headover" is worn. This is a woollen tube which can be used as a scarf or as a combined scarf and cap comforter.

On the feet are worn two pairs of woollen socks, one thick and one thin; then leather ankle boots with heel grooves for ski bindings, canvas gaiters to prevent snow from entering the boots, and toe covers for the boots for extra protection. Two pairs of mitts, woollen inners and waterproof outers, are worn on the hands, and a cap with fur ear muffs for the head completes the uniform.

Major items of equipment are: cross-country skis, a bergen-type rucksack, a sleeping bag, a reindeer skin to be placed between the snow and the sleeping bag, and a tent sheet. The latter item is triangular in shape with press studs around the edges to permit almost any number of tent sheets to be joined together to form a communal tent.

The only efficient method for troops to move over the snow is on ski, and so ski training begins on day one, continuing daily until the final day of the course. The Norwegian ski instructors are experts, and by week three expect students to cover a ten-kilometre cross-country course in sixty-two minutes. By week five the students are expected to compete with Norwegian troops for the Norwegian Soldier's Ski Badge, over a thirty-kilometre cross-country course carrying pack and rifle.

Once the student was properly clothed to protect him from frost-bite and capable of moving on skis, the rest of the instruction followed. Emphasis naturally was put on infantry subjects: firing weapons at sub-zero temperatures (usually between −20°C and −30°C), platoon and company attacks, defensive positions, patrols, and utilization of the support company weapons in heavy snow. Other subjects, including engineer ones, were also covered: the construction of obstacles, digging in the snow and frost, and mine-laying and demolitions, all with their special problems posed by the extreme cold and the deep snow.

Obstacles constructed in the traditional way one night may well be completely covered and neutralized by the next day's heavy snowfalls. Because of this, obstacles must be so constructed that they can be raised each time the surface level is raised by a fall of snow.

Mines are also affected by heavy snow and may require lifting and re-laying after each snowfall. In addition, the mine must be laid in such a way that it is detonated by an AFV, and not merely pressed into soft snow by it. This is usually achieved by the provision of some kind of dunnage under each mine—a cross of branches or timber under the mine is satisfactory.

Digging in the frozen ground presents a much greater problem than digging in frozen British or German terrain. The frozen zone is usually one and a half metres thick and it will require explosives or heavy machinery to break through the crust

and enable the soldier to complete his underground protection with hand tools. Unless the defensive position is near a slow-cleared road, it is unlikely that any heavy equipment can be moved on site, and it may also be impossible to move up over-snow vehicles. The only method left to transport explosives and tools is man-power. The simplest way is by carrying in or on the pack, but a bigger load can be moved on a sledge (Norwegian—pulk), pulled by two men on skis, and braked by two others on skis. These two can also act as reliefs for the pullers.

Living in a tent or bivouac in the snow at low temperatures is comparatively comfortable if a rigid drill is followed.

Once the tent or bivouac or igloo is erected, the snow floor is tramped firm and covered with branches or straw to give some insulation. On this is laid the reindeer skin and on this the sleeping bag. When turning in for the night the day clothing should be taken off and replaced by dry clothes carried in the pack. The clothing which has been removed is put inside the sleeping bag to dry. It is also very essential to put the boots inside the sleeping bag, otherwise they could be frozen in the morning and therefore impossible to wear until thawed out. On rising the reverse procedure takes place—the night wear is removed and replaced in the pack and the day clothing put back on.

By adhering strictly to this drill troops can live in field conditions for a number of days, the key to the problem being one complete change of dry clothing always being available.

At the end of my stay at the School, having bivouacked out in the snow and having covered many kilometres on skis at a rapid rate with or without pack and rifle, I certainly felt in good physical condition and capable of being an effective sapper in the Arctic.

Annex A

MAIN SUBJECTS

	Subjects	Hours
1	Organization	1
2	Weapon training	9
3	Engineer and pioneer technique	8
4	Transportation	9
5	Bivouacs	12
6	Survival and medical aspects	7
7	Ski drill	1
8	Map reading	2
9	Ski equipment, maintenance, etc	4
10	Ski-ing	30
11	Physical training	28
12	Infantry tactic and technique	76
13	Administration	5
14	Opening and closing address	2
15	Reserve	9
	Total	203

OUTLINE SYLLABUS

Training week	1						2						3						4						5						Total
Weekday	M	T	W	T	F	S	M	T	W	T	F	S	M	T	W	T	F	S	M	T	W	T	F	S	M	T	W	T	F	S	hours
1 Organization		1																													1
2 Weapon training		1	2	2						4																					9
3 Engineer and pioneer technique					2		4				2																				8
4 Transportation													4	2			3														9
5 Bivouacs									4					4					4												12
6 Survival and medical aspects			1		2	2		2																							7
7 Ski drill			1																												1
8 Map reading				2																											2
9 Ski equipment		2					1																1								4
10 Ski-ing		4	4	2	2		3		2		2				4		3		4												30
11 Physical training								2		4			4		4					4			2							8	28
12 Infantry tactic and technique					2	2		4	2		4					8	2				8	8	4		8	8	8	8			76
13 Administration	2																												3		5
14 Addresses	1																												1		2
15 Reserve				2										2						4			1								9
Total	3	8	8	8	8	4	8	8	8	8	8		8	8	8	8	8		8	8	8	8	8		8	8	8	8	8	4	203

Photo 1. Sledge team on skis pulling sledge up slope.

Photo 2. Preparing to lay mines in snow.

RE Surveyors of Works 1 & 2

RE Surveyors of Works

MAJOR (QS) W. A. CHAPMAN, RE (Retd), FRICS

AT the Annual Dinner of the RE Surveyors of Works Club in January it was apparent that some confusion exists over the use of the title—"Surveyors of Works Course"—to describe the current six weeks' course at RSME.

It is considered that an explanation may be useful.

The old-style "Surveyors of Works" were officers drawn from the ranks of young Clerks of Works (Construction) who had passed an examination set for the Corps by the Surveyors Institution (as it then was). These Surveyors of Works were the direct heirs and successors to the old "Inspectors of Works" (and of the earlier civilian WD Surveyors), and in 1948 they were redesignated as "Quantity Surveyors, RE".

After the civilianization of Army Works in 1959, the QS Other Rank element of the Corps disappeared, and the QSRE themselves were run down to a mere dozen officers. This cadre proved not to be viable, however, and in 1966 the last serving QSRE left the Corps, which then found itself virtually bereft of personnel with QS training and experience.

At about this time, also, it became apparent that the Corps had still a very real "Works" function in supporting a field force, whenever one might be raised for a particular operation, in a way that the Ministry of Public Building and Works (the successors to the civilianized Army Works Branch) demonstrably could not. However, it also became apparent that a CRE Construction or a Specialist Team RE (Construction) executing Works in support of a field force was very much in need of an officer with specialist training in contract law and practice and Works procedure.

The Corps decided, therefore, to train a small cadre of experienced QM Garrison Engineers, and to earmark them for employment in a contingency as outlined above.

The title for the course which was to provide this training was "Surveyor of Works", and at the time this seemed to be a logical descriptive title compatible with the aim.

The first (new-style) Surveyor of Works Course was held in 1966, and a course now runs every autumn for eight volunteers with the appropriate background and experience; it lasts for six weeks, and is run on the lines of a management seminar with an appropriate emphasis on contract law, procedure and practice and Building and Civil Engineering Quantities.

The type of officer selected for this Course is a junior QM (GE), but warrant officers in the promotion zone to commissioned rank are also eligible. In general a "Construction" background is looked for, allied, if possible, to an interest in Quantities, but the occasional E & M applicant is also acceptable, mainly in order to broaden the general experience of the Class.

The "Surveyor of Works (new-style)" is not, of course, professionally qualified like the old-style Surveyor of Works and QSRE, and the Corps must be quite clear that they do not derive in direct succession from their predecessors, nor do they always find continuous contract work to exercise their new-found skills with Works Units under non-operational conditions.

However, MPBW have expressed an interest in our new-style Surveyors of Works, and two officers have already spent a year in QS Tech 1 appointments with MPBW. Further attachments, possibly to include civilian firms, are being considered.

The Institute of Quantity Surveyors has also taken our new-style Surveyors of Works under its wing, thanks largely to the generous advice and assistance of their Director, Brigadier F. H. Lowman, CBE, DSO, a retired Sapper officer, and the IQS have accorded our protégés substantial exemptions from their professional examinations having regard to the full scope of their career training and experience.

To some extent, therefore, the Corps has succeeded in bridging the "skills gap" occasioned by the run-out of the QSRE. It is appreciated that the interim solution may not be an ideal one. In particular there is a feeling that the non-professional status of the new style GE/SW may militate both to his own disadvantage and that of the Corps generally.

Consideration is being given at this moment to a change in title of the six weeks course to eliminate any possible confusion between old- and new-style Surveyors of Works, and some such designation as "Works Contracts Officer" may eventually be adopted. At the same time the needs of the Corps for professional-status Quantity Surveyors is being re-examined.

The Management of Trade Training in the Royal Engineers

LIEUT-COLONEL S. H. CLARK, RE

GENERAL

It has always been accepted that we need skilled tradesmen in the Corps and from time to time as more sophisticated equipments and more complex techniques are taken into use we need either to alter the content of our trades training or to change the trades themselves.

The aims of trade training management in the Royal Engineers must be to determine or review the requirement for tradesmen of various sorts and to decide what skills are required in each trade. In so doing we must aim to minimize the length of time spent in the training organization, to train men to the required level as early as possible in their service and to provide progressive training throughout the man's service to fit him for a second career in civil life.

THE TRADE TRAINING REQUIREMENT

The Standing Committee on RE Trades (SCORET) is tasked with determining the tradesman requirements of the Corps for both numbers and skill. The former is based on a calculation of established posts plus a reserve, the manpower target, wasting out at a rate which we know from experience.

Class I tradesmen normally act in a supervisory capacity and the general need for artisan tradesmen is satisfied by the Class II man. In general Class III men have neither sufficient skill nor experience fully to satisfy unit requirements for tradesmen. We are therefore aiming at a target of 80 per cent of all tradesmen to be trained to Class II standard or above. The corollary to this is that increased skill can only be obtained by having more men given longer training. However, we intend to produce our Class II tradesman within about two years of enlistment and thus expect a longer period of service from fully trained Class II tradesmen.

To get the best output from the training organization courses must be filled. This is one of the reasons why central direction to courses is needed and why RE Records now nominate all men for trade training. We have to plan courses two years in advance; for example in March 1970 we forecast our trades training requirements

and plan the courses for the training year 1971/2. This enables the RSME to complete their programme by September 1970 and unit commanders have plenty of warning before soldiers are called forward to a course at RSME. Reliefs can then be properly planned.

This long-term planning is necessary to avoid the peaks and troughs to which the Training Organization has been subject in the past. Inability to fill courses is one of the prime reasons which start this sort of motion, so courses must be filled. However, long-term planning involves a reduction in the ability of the Training Organization to react to an emergency. We have therefore to retain the ability to set up courses in units of the Strategic Reserve and BAOR to meet any sudden requirements. The size of the workshops and staff of the RSME is designed to deal with a carefully calculated load and it is tasked to produce to within 85 per cent of its capacity.

MAN MANAGEMENT

Trades training is an important recruiting factor; we must be careful not to mislead recruits or fail to fulfil our promises. The penalty of doing so will be high unnecessary wastage. So long as the primary role of the Corps is combat engineering we shall never be able to employ an artisan tradesmen full time at his trade. Although recognized by the trade unions, most of our artisan trades do not fully meet civilian skill requirements when it comes to competing for a job, certainly in the lower trade classes. To obtain the greatest advantage from trade training both for the Corps and for the individual we must equate the military artisan trade with the nearest civilian equivalent. Where possible the soldier's attainment should be recognized by a certificate of competence recognized by the construction or engineering industries.

To keep more men in the service we must show that we plan a sapper's growth as a tradesman from the day he enters the Army. This involves giving him an introduction to the trade of his choice immediately after recruit training for a short period before he joins his first field unit. Before he finishes his basic course he ought to be told when he will attend an upgrading course, perhaps a year later, and his unit must be warned at the time he is posted to them.

The selection of the right trade for a man and programming his further training poses many problems. Many men have only a vague understanding of what is involved when they ask for a specific trade as a recruit. In the mechanical trades we propose to give a man an insight into them by making him pass through a feeder trade at an early stage so that he can select his final trade more surely. This gives us an opportunity to balance the intake to the Corps requirements of tradesmen.

We cannot afford to train many more men for a "popular" trade than the Corps needs or our training capacity is overloaded and elsewhere it is running light. Happily men are influenced by what they do in their field unit and often change their minds to be trained in a "short" trade. However, the reallocation of trades by the SPSO amounts to about 600 per year in the first two years of a man's service, which represents 40 per cent of our annual intake. There is therefore an urgent need to influence a man during this period of indecision for the benefit both of his future and the Corps. An important aspect of this is to be able to give him clear training objectives in the trade of his choice.

TRAINING OBJECTIVES

In examining our training objectives we have had to analyse all aspects of each trade and reduce them to writing. They must state in detail the functions a man must carry out. This is a very considerable labour, but it is the foundation of all training planning. Many instructors claim that they "know" what has to be taught and therefore see no reason why they should set out their objectives in this way. However, one has only to look at the Regulations for Army Trades and Employment to see that the objectives of training are often stated in extremely vague terms. A typical example is that of the Engine Fitter (IC & Pumps) who, it is stated, "must have a fair practical

knowledge of the principles of . . ." One is bound to ask what is meant by "fair" and for that matter what is meant by "practical". Training objectives must state clearly and unambiguously what a man must be able to do. They must cover the conditions under which he is to carry out his duties, the tools and equipment which he is to use, the standard of accuracy or efficiency required and the time during which various tasks are to be completed if these factors are relevant. Most training objectives will require that the trainee must successfully carry out a certain action such as, select—make—start—stop or adjust. If a valid objective is that a man should acquire a stated body of knowledge then the objective must also indicate what action the successful trainee must be able to carry out in order to show that he has acquired that knowledge. Objectives stated in vague or generalized terms are not usually acceptable; for example, if a fitter is required to carry out a "top overhaul" the objectives must state the detailed tasks which go to make up this activity.

As an illustration Annexe A shows one Broad Trade Requirement for an Electrician RE which is subdivided into a number of Topics of which one is shown. This again is divided into a number of duties so that it can be broken down into a typical range of tasks with the associated conditions and standards required. It is most important that training objectives should define what a man must "do"; this is true even though the requirement may be that he should "know" a particular fact or group of facts.

When we have stated the training objectives in this way we can make up questions which will show that the objectives have been attained. The type of question chosen is immaterial provided it tests the student's knowledge and capability and not necessarily his ability to write an essay or draw elaborate diagrams. These, of course, are general rules applicable more to the manual trades than to the design trades, where subjective criteria are sometimes employed to assess whether an objective has been attained. Where objective questioning is used the establishment of an efficient Quality Control system is possible, which means that the subjective element in testing is eliminated and it is possible to test a much greater proportion of the syllabus than would be possible in any other way.

The continuous monitoring of fortnightly test results shows up weaknesses in instruction and enables adjustments to be made in the instruction at once. The preparation of training objectives for the combat trades is well advanced and has, in some cases, been completed. There is much work still to be done to prepare artisan trade training objectives, but even so it is estimated that trade dossiers will be completed for all RE trades within two years. Recent developments in training in civil industry, in particular the Engineering Industry Training Boards Modular system for the training of engineering craftsmen and technicians, are influencing the development of training objectives for Royal Engineer tradesmen.

CIVILIAN QUALIFICATIONS

The Industrial Training Boards (ITB) have developed schemes for the training of employees in the industries for which they are responsible. In devising these schemes there has been a tendency to group similar trades together and to provide basic training to a common syllabus for these tradesmen. A good example of this is the modular system of the Engineering Industry Training Boards (EITB) which has led to the development of the City & Guilds of London Institute (C & GLI) 500 series. Under this system, all mechanical engineering fitter tradesmen receive a common basic training, so do potential fabrication tradesmen, ship building workers, electricians, etc. Much of this training will be provided "on the job", but purely theoretical instruction and some practical workshop training will be provided by the technical colleges on a day-release basis. The basic phase is expected to last one year. In the second phase of training the trainee begins his craft training proper. Again training is provided both on the job and by day release. By this method training to the standard of a craft certificate should take about three years and to a full technological certificate about six years.

One of the outcomes of the EITB modular system and the 500 series CGLI courses has been the development of a large range of craft courses many of which match our needs in the Royal Engineers. By slightly adjusting our training objectives and allowing for the fact that soldiers enjoy the advantage of full-time training, we expect that by passing their Army trade tests soldiers will become eligible for the award of appropriate CGLI certificates in a much shorter time. Where the EITB and C & GLI have not yet developed courses suitable to the needs of our tradesmen, we propose to ask for recognition of our syllabuses so that these tradesmen also can enjoy the advantage of receiving a nationally recognized award for the skills they have obtained. In order to obtain this recognition we must, so far as possible, conform to the pattern of training evolved by the ITBs. This has given added support to our proposals to introduce feeder trades.

FEEDER TRADES

The feeder-trade system for the mechanical engineering fitter trades, metalworking trades and the design trades are shown in the diagram Annexe B. The object of basic feeder-trade training is to provide the trainee with a good background knowledge and some elementary hand skills, not only of his own intended trade but also of the other trades within the group. He will therefore not attain the same degree of skill as the present Class III tradesman, but he should be able to assist a Class II tradesman more efficiently, since he will have a deeper understanding and a wider basic knowledge.

Towards the end of his basic feeder course the soldier will be invited either to confirm his original trade selection or to choose another trade within the group. At this stage his choice will be more "informed" than it could possibly be during the basic training stage at Cove. Whilst the wishes of the individual are, of course, of great importance Corps manning requirements are paramount. Careful and informed advice will be necessary at this crucial point in the soldier's career to meet the Corps requirements and satisfy the soldier.

When the final selection of a trade has been made it will be possible to allocate the man a vacancy on a Class II course. The upgrading course will not, of course, follow immediately after the basic course, but the interval between basic and upgrading training should not exceed one year depending on the frequency of upgrading courses. On completion of the basic course the soldier is posted to a unit and all concerned, including his future OC, can be informed of the plans for his future training.

In due course the soldier will return to the RSME to undertake his Class II training. If he successfully completes his upgrading course he will not only be classified as a Class II tradesman but will also acquire a C & GLI craft certificate.

SUMMARY

Under this system the soldier will reach Class II (Journeyman) standard about one year earlier than is possible at present. The Army will have the services of the fully trained artisan tradesman for longer than would have been possible previously. In addition the general level of trade competence in the Corps will be high. Unit Commanders will know exactly where they stand with regard to manning and will be able to plan ahead more effectively.

This system will increase the difficulties of manning, because more men are to be trained to Class II standard and because basic tradesmen will be trained at RSME before being posted to field force units. However, the advantages of more efficient training, more accurate selection of trainees, training exactly to meet Corps requirements, the increased motivation which this system will generate and the benefits of planned, progressive training are the most important considerations.

ANNEX A

TRAINING OBJECTIVE—ELECTRICIAN RE

A *Broad Requirement*	To be able to maintain and operate service battery charging equipment, lighting sets and arc flood-lighting equipment.
B *Topic*	To operate and service unit AFG 1098 Electrical equipment.
C *Duty*	To charge batteries using 1260W generating set.
D *Tasks*	Recognize types of battery, determine state of charge of battery, remedy state of electrolyte, calculate duration of charge and current, carry out routine maintenance, stop and start generator, run generator on load, removing and adding batteries as required.
(1) Conditions	In the open with reference books.
(2) Equipment	Generating Set 1260W, tools, batteries and instruments appropriate.
(3) Standard Practical	Must demonstrate ability to carry out correctly all the actions in (D) above.
(4) Standard Written	Answer correctly at least six out of ten questions on battery characteristics and charging procedure.

ANNEX B

FEEDER TRADES

MECHANICAL A TRADE—FITTER RE

	Fitter Engine (EOM)
	Fitter Machinist
	Fitter Plant
Fitter RE	(Plant Mechanic)
(Class 3)	Fitter Refrigeration and Steam
16 weeks	(Refrigerator Mechanic)
	Fitter Petroleum
	Well Driller
	Class 2 and Class 1

MECHANICAL B TRADE—METALWORKER RE

Metalworker RE	Blacksmith
(Class 3)	Sheet Metalworker
13 weeks	Welder
	Class 2 and Class 1

DESIGN A TRADE—DESIGN ASSISTANT

	Design Draughtsman
Design Assistant	(Draughtsman C & S)
(Class 3)	Surveyor Engineering
22 weeks	Construction Laboratory Operator
	Class 2 and Class 1

Note: Trades in Brackets are Present Equivalents

Rationality Ratings in Management

"FIAT LUX"

BACKGROUND

THE sixties will be remembered by many people as the decade of the permissive society, of the protest, of the aggressive younger generation. It was the decade of mass communication, where jargon really came into its own and ensured that the message to be communicated was meaningless to the very masses it was aimed at, and was used as a cloak of respectability to cover a miscellany of immature views. It was the decade of the emotive argument and vociferous minority.

It was also the decade in which a determined effort was made to show that management was a science and not an art.

Those who taught management tried hard to make it appear a more rational and systematic activity than it really was. The successful managers reacted by emphasizing their intuition and flair and ability to handle men. It was argued that an organization run entirely by intuition and flair limped from crisis to crisis and could be described as "Management by Ulcers". It was also argued that an organization run on an entirely rational basis was close to death or "Management by Monotony".

It is my contention that successful management reflects a blend of the rational and the intuitive. It should be accepted that this blend usually produces tension and sometimes open conflict. Success in management, military or otherwise, depends on strong decisive men on the spot. Such men believe in themselves more than they believe in systems. It is not surprising that tension is inherent when the blend is made.

The manager is concerned with complex situations all the time and basically endeavours to break down these complexities into a number of relatively simple facets in an effort to make correct managerial decisions at least most of the time. In this process he applies a series of techniques, generally rational, to provide himself with the basic information on which he can base his judgement. The judgement is required to assess the effects of the interplay between the different facets. In any situation certain characteristics dominate this judgement, these dominant characteristics change on different projects and, indeed, on any one project can change with time. Time, cost, resources, quality of work are typical of likely dominant characteristics.

Let us consider a construction project as a vehicle for the discussion.

At all times a manager must retain control. From the moment he starts to set up a project the manager is thinking ahead and endeavouring to institute a system by which he can maintain control.

Let us consider some of the main aspects which will be exercising the manager at the beginning of a project:

Delegation of authority
Resources—men, machines, material, money
Project planning
Cost control
Working drawings and specifications
"Statutory" returns.

For each of these aspects one can deduce a rationality rating, 100 per cent being completely rational and requiring no intuition, 0 per cent being completely intuitive requiring no rational process. In short the lower the rationality rating of any aspect the more it will be coloured by the personalities involved.

DELEGATION OF AUTHORITY

The delegation of authority is at the root of most management problems. Management pundits draw glorious organization charts based on functional con-

siderations regardless of who is to fill them. Such charts completely ignore the realities of power. No two managers control their staff in quite the same way and it is my belief that delegation is a highly personal intuitive matter. Suggested guide lines to be used when considering the delegation of power are:

1 Power feeds on itself and expands until it meets a countervailing power.
2 An organization chart should be drawn to suit the men available and not the other way round.
3 Any organization chart is permanently out of date as a representation of responsibilities because of guide line 1.
4 The prima donna is often indispensable, but he always produces special problems.
5 Men can be divided into Mild Steel (MS) and High Tensile Steel (HTS) types. MS types when overloaded yield and shed load to others until they are supported or replaced. HTS types take a great overload without signs of distress, but are liable suddenly to collapse.

Based on these considerations I consider delegation of authority has a 10–20 per cent rationality rating. Having delegated authority it is then a rational process to build in sufficient controls to ensure that the system can be monitored and effectively managed.

RESOURCES

Resources in this sense includes men, machines, material and money. More managers fail in their purpose through their inability to utilize available resources in the most effective way than through any other single aspect. The management of resources is essentially rational, as is the interplay between the sub-aspects. Machines can replace men, men cost money, materials cost money, time costs money, material X costs more than material Y, but can be incorporated in work in less man hours. Management of resources is demanding, it requires a rational examination of a series of rational options. This is a field wherein intuition is a real hazard unless carefully controlled. I give resources a 99 per cent rationality rating.

PROJECT PLANNING

Planning has been defined in many ways, but I believe, quite simply, that its object is to ensure that people can and do do things before the failure to do so creates crisis. In this sense "can" is controlled to a large extent by resources, "do" is controlled by man management. If this is accepted, then successful planning immediately becomes a delicate blend of the rational and the intuitive.

The preparation of a plan is an entirely rational process which should start at the moment a project is mooted and ends when the final bill is paid. Planning is a continuous process and, because of constant change in circumstances, any plan is out of date to some extent as soon as it is completed.

My general rules for planning are simple and obvious.

1 Choose the correct planning system for the particular project.
2 Keep eyes and ears on the job and the men doing it.
3 Take great trouble over the presentation of your ideas. The best scheme in the world is useless unless you can "sell" it both to those who have to make it work and to those who have to authorize it.
4 Try to make junior staff feel that they are taking important decisions and that the plan depends on them.
5 Don't plan further ahead than is absolutely necessary except in outline. No project goes according to plan, why depress yourself needlessly when detail goes awry.
6 Remember compromise is the rule and not the exception, be a realist.
7 All projects have a natural rhythm—find it as soon as possible.

Choosing the correct system is becoming increasingly difficult as more and more systems are developed. It is my belief that "networks" provide the best basic systems provided that there is a logical inter-reaction of activities, as there generally is, and that updating is a viable proposition. Some managers have problems with networks, but these are generally problems of their own making; they lack the discipline required, they fail to understand the need for ground rules when preparing a network, they tend to use the network inflexibly and they misinterpret the concept of float. Because of their own failings, or because of the misapplication of networks (no logical inter-reaction of activities), some managers refuse to use networks, but this is an unfair condemnation of the system.

On this basis I consider project planning has about an 85 per cent rationality rating.

COST CONTROL

As a confirmed landlubber in a Corps of sailors, it is with some trepidation that I use a nautical analogy, but I believe that planning and estimating provide the chart and the course for a project while cost control equates to dead reckoning position. The principal troubles in cost control grow out of a confusion in people's minds between accounting and control. Accounting tells you where you are after you have tied up to the quay at the end of the fog-bound journey. Control should tell what is likely to happen if the current plan is allowed to run its course. Cost control is, therefore, the yard-stick against which the effectiveness of the manager should be judged. Any fool can look back at a project and locate overexpenditure and can generally determine why. It is the managers' job to control costs and to ensure that unavoidable overexpenditure is minimized and counter-balanced by underexpenditure elsewhere unless he can recoup the overexpenditure by other means at his disposal. Rational techniques may well provide the raw figures for cost control, but it is intuition, flair and appreciation of relative risks which manipulate these raw figures to give purposeful cost control.

I give cost control a 50 per cent rationality rating.

WORKING DRAWINGS AND SPECIFICATIONS

Within the parameters defined by the client, in terms of permissible expenditure, the function of the facility to be provided, location, inherent characteristics required, etc, the preparation of the working drawings and the specification is basically a rational process. The designer (who should also prepare the specification, as he alone knows the properties required of the materials used in the design) is attempting to optimize the resources at his disposal to produce an efficient design which will effectively meet the demands of the client. He will at the same time be concerned with both the aspect and prospect of the facility which he is designing. This will incur some intuitive effort, but this should not be overrated. In practice there are few basically new ideas, most designers tend to draw on the works of others and apply the appealing (to them) features to their current design.

I award a 75–100 per cent rationality rating to working drawings and specifications.

STATUTORY RETURNS

The civilian construction world is plagued by returns, monthly and annual "Return of Employment", annual "Employment Return" (not the same!!), quarterly and annual "Return of Work Done and Persons Employed", monthly "Return of Contracts and Orders for New Construction" and a multitude of others. Fortunately, in Military Engineering there are fewer. All returns are completed by a rational process. There may be some imaginative, often inspired, entries due to lack of information or due to intent to deceive, but essentially completion of returns attracts a 100 per cent rationality rating.

CONCLUSIONS

You may disagree with the ratings I have suggested (the ratings will invariably be coloured by the personalities involved); if you do disagree, I would ask you to deduce your own ratings of the many possible subjects.

Do you still believe that management is entirely a science or entirely an art?
You do!!
Then with due respect
either
You have never managed a project!
or
You managed badly: you may have got away with it, but you were lucky!

The Unified British Standard Code of Practice for the Structural Use of Concrete

S. R. ARNOLD, BSc(Eng), MICE, MINucE

INTRODUCTION

AT the moment three Codes of Practice are issued by the British Standards Institution to cover the use of concrete in structures. These are CP 114, "The Structural use of Reinforced Concrete in Buildings"; CP 115, "The Structural use of Prestressed Concrete in Buildings", and CP 116, "The Structural use of Precast Concrete". In September 1965 work started on the task of investigating those subjects which were common to all three Codes. As a result of these investigations, a Committee was convened by the Institution of Structural Engineers, on behalf of the BSI, with the object of combining all three Codes into one Unified Code of Practice for the structural use of concrete.

What is now hoped to be the final draft has been circulated for comment and we can look forward to the comprehensive document being available in the not-too-distant future. It is not the aim of this short review to criticize each paragraph in turn, but to look at the wider implications of the Code as a whole.

MATERIALS AND WORKMANSHIP

Sections 3 and 4 of the Code bring in many new ideas which have already caused some controversy. "Nominal Mixes" are now out, and the engineer is left with "Designed Mixes" as before, and a new series of "Standard Mixes" for the lower-strength ranges. In addition, there are new grades of concrete specified by their tensile strength.

There has been a general move towards stricter specifications, and even the "Designed Mixes" leave the engineer very little scope to vary his materials and so achieve an economic mix. The type of cement, nominal maximum size of aggregate, and minimum cement content are now to be specified, and with the optional information which may be specified by the engineer, the site engineer will have little room to manoeuvre. For example, an inexperienced consultant could specify a maximum cement content, a minimum water cement ratio, and a workability which it would be physically impossible to achieve.

Of course, the cube strength is still with us, much to the disgust of some authorities, but we no longer have a *minimum* cube strength. This is replaced by the "Characteristic Strength", and the concept embodied in the new Code is that the strength of concrete is predictable only by the laws of statistics with a probability of a certain strength being achieved. The rules allow for two cubes in forty to fall below the specified twenty-eight-day strength. After the third cube has failed, it appears to the author that the conflict between contractor and resident engineer (pull it down or let it stand) will remain unsolved. The Code allows some room for both parties to manoeuvre in the case of disputed strengths. Opinions are sharply divided between those who would like to see more freedom and those who would like to see strict compliance with rigorously detailed rules.

Workmanship, throughout, is much more thoroughly covered, with (at last) more emphasis on durability, and quality control on the site has been given its proper place in the order of priorities. Supervision must be by a properly trained technician with suitable City and Guilds certificates. Industry has followed the lead given by the Corps in recognizing that a concretor is a tradesman.

What are the implications of all this? Firstly, better site control with due emphasis on durability and hence better-quality concrete. Secondly, even with the higher design strengths allowed, this quality will not be achieved without some increase in cost, and a recent writer in the *Contracts Journal* has already warned that in future concrete is going to be more expensive to produce to the strict requirements of the Code. Thirdly, an important factor that should not be overlooked, a shortage of suitably qualified concrete technicians.

DESIGN

The design of reinforced concrete to the new Code is essentially simple and straightforward. It starts off with the concept of Limit State Design. The first paragraph is worth repeating and states: "The purpose of design is the acheivement of acceptable probabilities that the structure being designed will not become unfit for the use for which it is required, i.e. that it will not reach a Limit State." This could be taken to mean, when seen from another viewpoint, that two out of every forty concrete structures will collapse, but in fact it does not work out like that.

A Limit State can be achieved in many ways. It can be by collapse, excessive deflection, or local damage (cracks wider than 0·3 mm). The designer is now required to consider additional factors in loading such as fatigue, vibration, fire and explosive forces. Section 5 sets out all the principles to be followed and may be described as the designer's bible.

Section 6, on reinforced concrete, spells out in detail the design procedure for avoiding a Limit State reinforced concrete. The mechanical process for determining the size and shape of section, and size of reinforcement is changed only little, the simplified equations still being included, but based on the yield stress of the steel and the cube strength of the concrete.

Design for deflection, however, now takes a new significance, and it is anticipated that this will represent the Limit State in many cases. Design strengths are now up to 2,180 lbf/in² for a 6,000 lbf/in² concrete, but Young's Modulus for concrete cannot be appreciably altered. In addition, creep and shrinkage take on a new significance, particularly with finer cements in richer mixes, and these contributions to total strain must now be considered even in reinforced-concrete work. The author believes that the result may often be that the designer cannot make full use of the higher strengths allowed in design. Past failures have shown that shrinkage and creep can lead to very expensive faults appearing in finishes and cladding.

Design remains a complex mass of rules even when the over-all shape is found. There is a maze of rules for minimum steel, cover, shear, torsion, bond, anchorages, cracking and numerous other factors to be considered. There is no doubt that the Cement and Concrete Association will be inundated with requests for vacancies on their courses on design, and textbook writers will have a field day in producing

extensive manuals to help the poor bewildered engineer find his way through sixty-one pages crammed with assorted regulations.

Prestressed concrete design (only twenty-two pages) is well covered in Section 7, but, of course, many of the rules refer back to earlier sections, and it must be remembered that the whole idea of one Code was to avoid repetition. The reader is left, however, with the feeling that it may not be such a good idea when he reads: "The requirements of Section 7 apply to flexural members prestressed with tendons complying with 4.2. The requirements of 6.1.1–6.1.6 are applicable to prestressed concrete." After referring backwards and forwards, he is left wondering whether the Code was drafted by engineers or lawyers.

Section 8 is an important section dealing with composite construction and connections. Shear connection is covered in detail, and it is pointed out in this context that differential creep and shrinkage must be considered. The Ronan Point failure stressed the need for continuity and adequate connections between precast concrete units.

INSPECTION AND TESTING

Some structural engineers would have liked to see more than a mere four pages in Section 9 on inspection and testing. Some of the more recently developed methods of non-destructive testing are only briefly mentioned. The result will be that if these tests are required by a consultant, then the procedure and limits will have to be detailed in the specification. As techniques are developed BS 4408 "Recommendations for non-destructive methods of test for concrete" will be expanded and will, it is hoped, fill a gap in the proposed Code.

MISCELLANEOUS

Section 10 is devoted to the subject of fire resistance, and the tables for minimum cover, minimum dimensions, and thickness of finish are self-explanatory. Fire resistance may sometimes be ignored by a designer, but it is never ignored by a local authority when giving planning permission.

The use of autoclaved aerated concrete has developed to the extent of calling for its own section (Section 11). Industrialized systems produce such units for floor slabs, roofs and wall units, and their needs have not been overlooked.

Last but by no means least of the major sections is one devoted to High Alumina Cement. Section 12 looks at this cement from the point of view of concrete practice, and details the precautions to be taken in using this cement whose behaviour is so unlike that of Portland Cements.

APPENDICES

As with most documents of the nature of this Code of Practice, much of the useful meat is in the appendices. The first one (Appendix SC) deals further with the statistical approach to the mechanical properties of concrete, and its quality control. It lays down a simple procedure to be followed for the analysis of results, and since it is a system which can be presented to a computer, sets of results can be analysed in seconds. It also gives an excellent subsection on general advice on quality control, which is now measured by "standard deviation" instead of the old "control factor".

The subject of movement comes in again in appendix MJ. Much more emphasis is placed on movement throughout the Code, and this appendix gives the rules for joints.

Appendix CU stresses the need for proper curing. This is one workmanship technique all too often ignored. Good concreting is often ruined by lack of adequate curing, resulting in cracking and distortion.

Other appendices follow covering safety precautions in prestressing, more rigorous methods of analysis and classification of reinforcement for bond strength, but the last appendix will prove one of the most popular. In this (Appendix DC) Design Charts are provided to assist the designer in beam and column design against

the Limit State of Collapse. These charts are prepared by the Cement and Concrete Association and the draft Code includes only a few samples of the large number which will be included in the final Code.

CONCLUSIONS

Before the final Code is published, there is no doubt that there will be a lot of argument over wording and presentation. There are some major steps forward, however, which will generally be applauded:

(*a*) A more rigid control over workmanship on site.
(*b*) The adoption of the Limit State concept.
(*c*) The statistical approach to material strength.

These are not all new, but they are set out in the draft Code in clear, concise terms.

The Code is not an idiot's guide to concrete design, nor is it in itself a textbook. It is a useful document only to a trained and qualified engineer, and even such engineers will find it takes time to become familiar with this rather massive document.

The Code is not intended to replace the application of basic principles of engineering and design. There is a danger, however, that the Code could be used as handcuff's instead of handrails. Let us all hope that this never happens, or research and development in the field of reinforced concrete will inevitably suffer.

The Dahlak Quest

MAJOR J. N. BLASHFORD-SNELL, MBE, RE

A BEAUTIFUL Italian girl, her skin tanned a superb shade of brown, sprawled at the feet of an Adonis from Milan. Soft music issued from their yacht's gramophone as they sipped their frosted Martini. Overhead the gulls were flying home and on the rocks the osprey stood guard on its nest. The turquoise sea reflected the dying tropical sun and not a breath of wind disturbed the warm evening air. The Italians—they were very rich—and their sun-worshipping friends came here every year, just to be away from the busy industrial scene of Northern Italy. They believed that in the Dahlak Islands of the Red Sea they had privacy and peace.

The shockwave reached them before the sound and as they started up there came the dull roar of an explosion across the bay. Rocks and earth cascaded skywards from a wadi bed. To their amazement and horror the tourists realized that they were not alone. As they watched they saw a number of men emerge from the wadi and heard them singing some strange native song which sounded like "Good morning, Mr Stephens; its a lovely day today . . ."

Later Staff Sergeant Mansley, RE, explained at great length to Signorina X exactly how he found water and why he needed to shatter her paradise with thundering explosions.

Set in the Red Sea off the coast of Ethiopia is a group of low-lying coral islands, scattered over an area about the size of Devon and Cornwall. They are the Dahlak Islands and there are about 130 of them. Barren and almost waterless, they support only a scanty population of fisherfolk, of more Arab type than African, who win a hard living under the blazing sun. Although the economy, such as it is, is based on the sea, there are no harbours. There are only two or three rough tracks, and few of the buildings are in good repair. No village has a population of more than 300. The inhabitants grow no crops, but keep large numbers of goats, sheep, donkeys and camels, whose voracious appetites help to account for the sparseness of vegetation on the islands as a whole.

Set against this harsh lack of modern amenities, however, the Dahlak Islands

offer a brilliant array of natural attractions. The average winter temperature by day is about 82°F. Gazelle browse among stunted acacia trees, and striped geckos hide under the hot coral outcrops. In the air there is a colourful variety of bird life, including reef heron, Caspian tern, tropic bird, osprey and Arabian bustard.

The greatest wonders, though, are in the shallow seas and among the coral reefs and gardens which surround most of the islands. Here countless species of marine life occupy the warm waters. Known to inhabit the area also is that rare and gentle creature, the massive Dugong, whose almost human appearance gave rise to the legend of the mermaid.

Last year the Ethiopian Government asked the Scientific Exploration Society[1] to send a team of experts to explore the little-known Dahlak Islands with a view to their being opened up to tourist traffic. Thus the Society organized a group of twenty-six divers, engineers and scientists to spend four weeks in the Dahlaks around the year's end after a two-man reconnaissance team had established the project's feasibility. The main body's task was to investigate the all-important questions of fresh-water supply, communications, landing facilities, wild-life conservation, underwater conditions and all matters affecting the safety and comfort of future visitors. The team included former members of the Army's Great Abbai Expedition which made the first conquest of the Blue Nile in 1968, and once again this Expedition was partly sponsored by the *Daily Telegraph*.

Our advance party arrived by air in Asmara, capital city of the Ethiopian province of Eritrea, on 11 December 1969. Its job, during the following ten days, was to make the complex but necessary administrative arrangements before the main body arrived. A motor vessel, capable of carrying all twenty-five expedition members and their equipment from Massawa to the islands, and between the islands, had to be chartered. Local stores had to be purchased before establishing the main base, which was to be in the prison buildings left behind by the Italians on the island of Nocra. Throughout the project the expedition received the most generous help and support from the Mitchell Cotts Group Ltd, a British company with branches in Ethiopia.

On 21 December the main body duly arrived at Asmara, but without the freight that should have come from the UK on the same aircraft. Such are the hazards of expeditions! (The freight did, in fact, turn up later.)

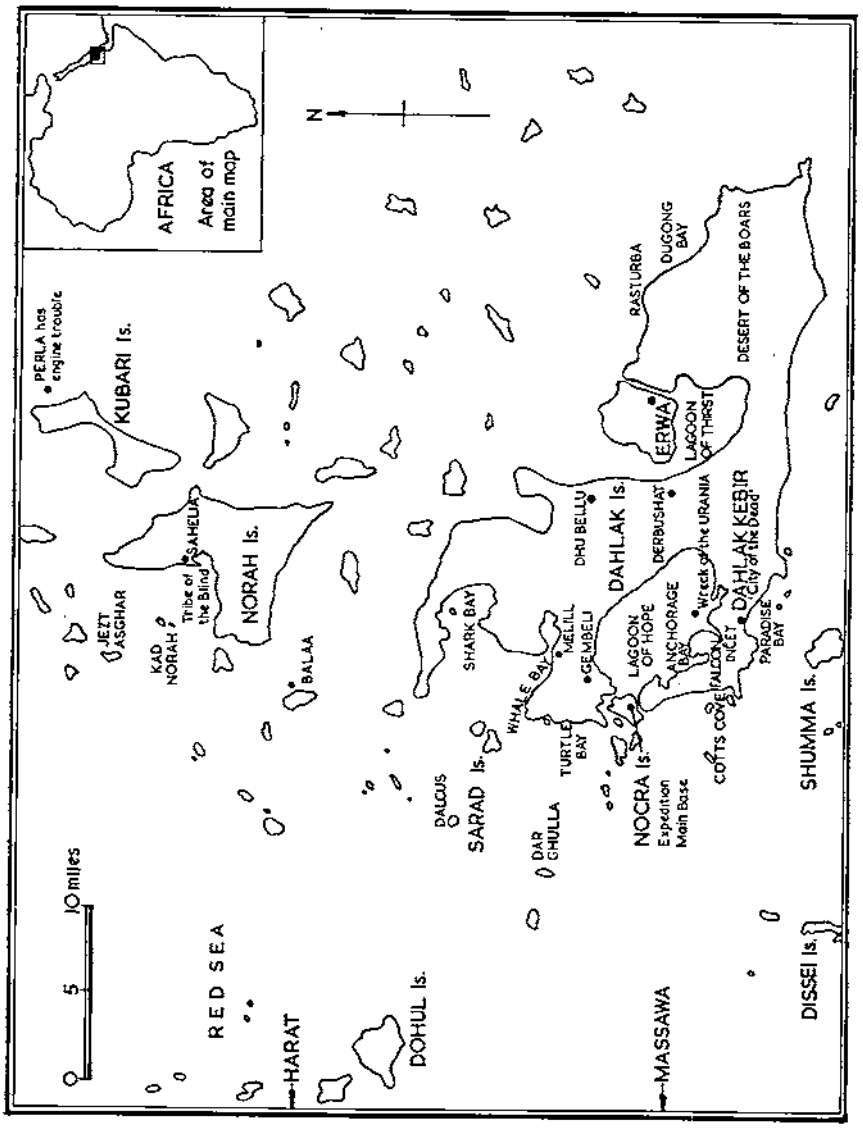
After a brief stop in Asmara, the main body motored down the brilliantly engineered, Italian-built road, which coils precipitously from Asmara (7,500 ft) to Massawa on the coast 112 kilometres away.

While the party were hairpinning to Massawa two of us made an air reconnaissance of the islands of Dissei, Shumma and the main island, Dahlak Kebir. The flight brought home the difference between the hilly island of Dissei, which geologically and topographically resembles the mainland, and the over-all flatness of the outlying Dahlak Islands. We saw large numbers of gazelle and birds on Dahlak Kebir, and two uncharted inlets, fringed with mangrove. Before returning we flew low over the headquarters site on Nocra and saw the expedition's Chief Engineer, Captain Jim Masters, RE, at work with his advance party. The scientists had arrived from Addis Ababa, and the complete expedition was now assembled.

We sailed on the following day. At first the sea was calm and progress good. Then the wind blew up from the south-east and the ship began to battle her way through heavy seas. Eventually, at 2100 hours, with the wind at gale force, the ship anchored in the narrow channel by the prison. In these difficult conditions we unloaded the vessel and ferried the stores ashore.

Later that night we heard the beating of drums from a village to the south—not a signal for attack by a war party, but in celebration of the visit of the chief of the Dahlaks, Sheikh Seraj, who had come with us! The Sheikh has ruled the islands for thirty-five years and has seen masters of differing nationalities come and go. He lives

[1] The Scientific Exploration Society is a recently formed group of soldiers, sailors, airmen and civilians dedicated to encouraging and carrying out scientific exploration worldwide. The Society includes a number of Royal Engineers and the Chairman is Major J. N. Blashford-Snell, MBE, RE.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KUBARI Is.
JEZT ASGHAR
KAD NORAH
Tribe of the Blind
SAHELIA
NORAH Is.
BALAA
RED SEA
HARAT
DOHUL Is.
DALOUS
SARAD Is.
SHARK BAY
WHALE BAY
MELILL
GEMBELI
TURTLE BAY
DAR GHULLA
NOCRA Is.
Expedition Main Base
DHU BELLU
DAHLAK Is.
LAGOON OF HOPE
DERBUSHAT
ANCHORAGE BAY
Wreck of the URANIA
FALCON INLET
COFFS COVE
DAHLAK KEBIR
City of the Dead
PARADISE BAY
ERWA
LAGOON OF THIRST
RASTURBA
DUGONG BAY
DESERT OF THE BOARS
SHUMMA Is.
MASSAWA
DISSEI Is.

at Gembeli, a village on the main island, and runs an old Italian car and a 40-ton "sambukh" boat. Speaking no English, he used his scanty Italian to confirm that pearl-diving was one of the local industries and that there was a high incidence of blindness in some places. He mentioned, too, the presence of the Dugong, locally known as the Aroussa, although he could not say just where these rare sea-mammals could be found.

Our first task was to make a reconnaissance of the area to decide exactly where our efforts could best be directed in the time available. Our transport consisted of four boats, two motor scooters and two bicycles. One of the boats, motor ship *Perla*, was a 50-ton fishing vessel, hired in Massawa to carry ourselves and our stores. *Perla* had a good capacity, but was rather old, and her speed averaged only 5 knots. The other craft were Avon inflatable sportboats. *Solomon* was a 16-footer with a 35-hp outboard motor; *Sheba* was a smaller version, carrying a 20-hp motor. Our smallest boat was a two-man inflatable of unknown manufacture and questionable seaworthiness.

The Avon inflatables were ideal for fast inshore work and yet could cover considerable distances. They were particularly useful when approaching islands with extensive shallows. *Solomon* was fitted with a Silva boat's compass, echo-sounder and log, especially for this purpose.

The Lambretta scooters, kindly provided by Mitchell Cotts Ltd, were invaluable for negotiating the rudimentary tracks in the northern half of Dahlak Kebir and for driving across the stony desert in the island's centre. On Nocra itself they were used mainly by the survey group. The occasional breakdown always attracted vultures who would hop about near by, stretching their long, unsightly necks to see if there was a chance of a good meal. On one occasion, when Colonel Shepherd broke a spark plug, the revolting creatures took several smart steps forward!

We spent the first three days exploring Nocra and the Lagoon of Hope.[1] Besides the prison buildings, Nocra also boasted the only police station on the islands, and this had a radio link to the mainland, which was useful to us on a number of occasions. The expedition radio net was maintained with A14 radios, kindly provided by the Royal Marines. These sets worked very well and proved a boon.

As it seemed likely that part of the prison complex might finally be selected as the nucleus of the tourist establishment, the architect, Gerald Batt, started the lengthy task of measuring the buildings and planning their re-use, while Colonel Shepherd began the topographical survey of all Nocra.

Other parties, in the inflatables, examined the Lagoon of Hope, both above and below the surface. The lagoon is well protected on all sides, so is spared the worst of the strong Khamsin wind that blows for several days at a time from the south-east. Along the edge of the lagoon there are numerous small coves and, particularly on the north shore, many attractive sandy beaches. Anchorage Bay has such a beach—with a large colony of land crabs; and Falcon Inlet is of interest, having a land-locked salt lake at its end. The area is rich in wild life, on land, in the air and in the water; we saw Soemerring's gazelle, osprey, pelican, and manta ray, while a large school of dolphin played at high speed under the boat's bows.

The wreck of SS *Urania* lies in the lagoon and is the home of many exotic fish, and our underwater team spent a lot of time examining this former 7,000-ton Italian cruise liner, sunk by fire in 1951. Quite how it came to be in the lagoon is a mystery, but Lloyds tell us that *Urania* was bombed by us in Massawa, later towed to Tobruk and after the war returned to the Red Sea. The author would like to hear from anyone who can give any information on the ship.

On Christmas Day a party using the Sheikh's boat visited the island of Sarad to the north-west of Dahlak Kebir. They also looked at Whale Bay, Turtle Bay and Shark Bay. Sarad is a particularly pleasant place, with varied scenery: beaches and cliffs and even its own inland lake, which is slightly brackish.

[1] Owing to the lack of established place-names, the expedition coined its own in a number of cases. (See Map.)

Recce team in the new Avon fast inflatable *Solomon*. *Left to Right:* Staff Sergeant K. Mansley, RE (Water Resources); Mr S. Macdonnell (Chief Diver); Captain J. Masters, RE (Chief Engineer); Captain J. Cuthill, RAEC (Geologist).
Daily Telegraph Photo.

The islands were surrounded by extensive shallows and the Avon boats frequently had to be carried long distances. The boats were extremely tough and rarely punctured.
Daily Telegraph Photo.

A larger group travelled south to Shumma and had its first view of sharks, notably black tip and shovel nose. The island has a fine natural anchorage called Porto Smyth, but was otherwise disappointing. The remains of wartime gun positions can still be seen, while a few live 4-in HE shells are still lying about.

That evening, back "home" at Nocra, we had our Christmas dinner, prepared with care by Kay Thompson and her band of cook boys. Here we had cause to bless many of our sponsors, whose gifts were much appreciated. Although much of the meal had been brought from Massawa, we relied heavily on Batchelor's dehydrated foods, while Tate and Lyle added the essential sweetening, and the whole was washed down with Merrydown Sparkling Apple Wine or James Buchanan's Black and White Whisky, according to taste. The few smokers among us enjoyed free Wills's Three Castles.

The Royal Engineer Group now began in earnest to hunt for water. During the next two days two wells were blasted out of the hard coral limestone. The first well produced brackish water at a depth of 4 ft, perhaps through hydraulic or capillary action from the sea near by. The second, further from the sea and close to the police station, yielded potable water at 7 ft 6 in.

The sappers were temporarily short-handed due to Staff Sergeant Mansley falling and breaking his collarbone. However, within a few days he was back, wrapped in a huge plaster jacket.

Others of us, armed with compasses, visited the villages of Gembeli, Dasco, Melill, Dhu Bellu, Derbushat and Dahlak Kebir—all on the main island.

On this trip we were presented with a rare tusk of the male Dugong and later saw some teeth and a skin drying in the sun. This, at last, was confirmation of its existence in the area. Its principal home is probably among the weed in the shallows to the north-east of Dahlak Kebir island.

The village of Dahlak Kebir provided a good example of a pattern of life found elsewhere in the islands—a sizeable, stone-built village being deserted, as it gradually collapsed, in favour of poorer, ruder dwellings of branches and matting. Here, also we found a vast necropolis. Grave-slabs of a blue-grey stone not found in the islands, with highly decorative Cufic (formalized Arabic) inscriptions, were much in evidence.

A small entomological group spent a night in the mangrove swamp on the island of Erwa, east of Derbushat. They were happy to report later that the area was not malarial. A surprise find was 250,000 cigarettes, hidden in a genuine smuggler's cave, but as Captain Brocksopp said after he had made the discovery: "Pity it wasn't whisky—I don't smoke."

The first major excursion beyond Nocra began on 29 December. Leaving behind a small rear party, the expedition set off in *Perla* and headed northwards to the island of Norah. The plan was to spend four days in examining Norah and circumnavigating Dahlak Kebir.

Solomon, fitted with the echo-sounder, went ahead as a recce boat. The native crew of the *Perla* did not trust this device, however, and insisted on choosing their own route through the maze of coral outcrops. It came as no surprise that, while crossing the reef near Balaa island, *Perla* ran aground. Fortunately, she was undamaged and cleared the reef at the second attempt.

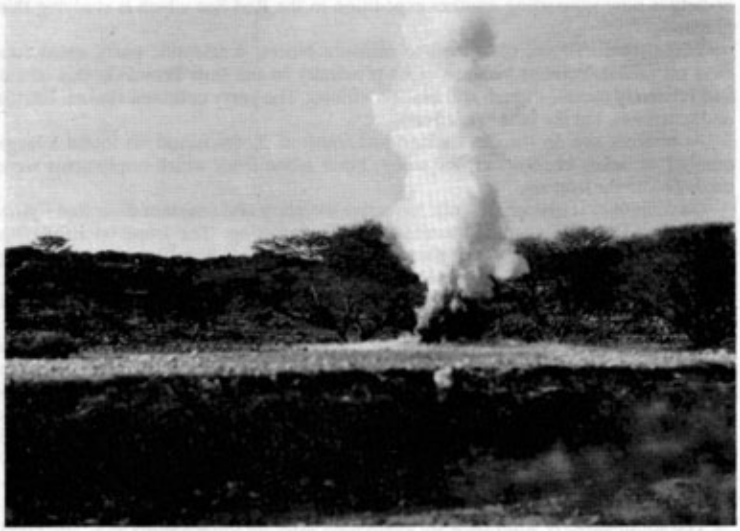
We anchored finally in the Bay of the Blind about half a mile off shore. The shallows here are so extensive that the outboard motors could not be used on the inflatables, which had to be pushed for 300 yards. The fact that poisonous sea snakes are known to inhabit the shallow waters did not encourage us.

Sahelia is the near-by village of sticks and matting where the legendary Tribe of the Blind was reported to live. And so it proved, although, in fact, only about half were affected. The cause was probably trachoma and not a chemical in the sea water as had been suggested. The villagers were a pitiful sight, as even the young children were affected.

The next three days were profitably spent in investigating many of the smaller

Major J. N. Blashford-Snell, RE, questioning the islanders on the whereabouts of their water supply.

Daily Telegraph Photo.



Blasting through the limestone in an effort to find water.

Daily Telegraph Photo

islands such as Kad Norah, Jezt Asghar, Dalcus and Dar Ghulla. They all had good sandy beaches with deep approaches leading over coral reefs. There were large colonies of Hermit Crabs, and birds in profusion.

One of the commonest birds was the osprey, a protected rarity in Britain. Others included pink-backed pelicans, flamingoes, Caspian and other terns, Goliath and reef herons, several varieties of lark, desert wheatears and Arabian bustards, making the region a birdwatcher's paradise.

On many of the islands we noted an attractive yellow flowering plant called Cistanche. Our botanist, Mike Gilbert, also found an example of Caralloma Vittata, the first recorded in Ethiopia. In general, however, he was disappointed by the paucity of plants. Heavy rain was needed to bring them out and only a few drops fell while the expedition was in the field.

Throughout, the small VHF Mitre and SARBE radios that we carried proved of inestimable value in providing boat-to-boat and boat-to-shore links over considerable distances. We also maintained, morning and night, a link with the rear party at Nocra using our A14 radio.

The various groups now spent a few days on their own particular tasks. The underwater team went to the reefs off Sarad and Kundabilu and obtained some good film of manta rays, including a group of five flying below and above the surface. The chief diver also caught a 400-lb black bass, 5 ft 10 in long and estimated to be 75 years old.

The divers found that, generally, the sharks were timid, although to see a 7-footer for the first time as it glides past 10 ft away is a trifle unnerving. Only one shark became too inquisitive and he was despatched with our powerful underwater gun that fired a harpoon with an explosive warhead. Nevertheless, as the creature thrashed about on the deck its rows of gleaming teeth and its sandpaper-like skin did nothing to lessen our respect for the species.

Along the reefs our marine biologists identified the "Crown of Thorns" starfish. The effect of these creatures on the world's reefs is now reaching disastrous proportions, as they destroy the coral and expose coastlines to erosion by the sea. The Society is now supporting another expedition in the Red Sea which is studying this plague.

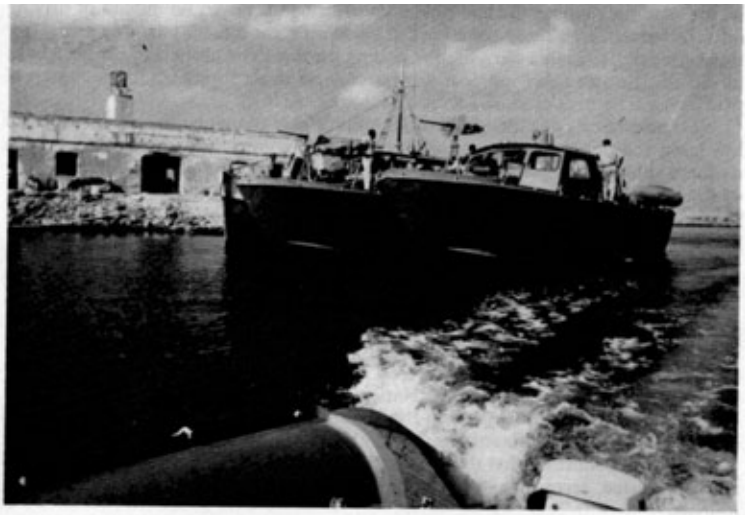
While the surveyors continued to measure Nocra, a scientific party spent two days on Dissei. Perhaps because of its proximity to the Buri Peninsula this island had relatively more—though still limited—fauna. The party collected snakes, lizards and scorpions, but the bats evaded capture.

At another site on the main island just south of Nocra island we found a large number of flakes of obsidian, the shiny, black stone from which implements were made before the iron age.

On 5 January it seemed that our attractive secretary and assistant diver Sue Fyson had suffered a spontaneous pneumothorax from diving. The Imperial Ethiopian Naval Base at Massawa reacted splendidly to our plea for immediate help by rushing two gunboats to Nocra. Fortunately her condition was found to be not so serious. At the same time several other members of the expedition developed high fevers and mild septicaemia from their brushes with the sharp coral. Most recovered quickly.

The final task was to look at some of the larger outlying islands, and we chose Dohul and Harat to the north-west. Once again *Perla* was used, with *Sheba* in attendance. Seven hours' sailing brought *Perla* to the Sheikh El Abu lighthouse on the southern tip of Harat, a long, narrow, low-lying island almost cut in two by a salt-water mangrove swamp. It boasted two settlements. One, of stone, had ten good wells in daily use, but was uninhabited. It lay inland, while near by on the sandy eastern beach the people now lived, in wood, tin and matting huts of a more sophisticated construction than we had seen hitherto.

The south-easterly wind blew up again and, after an unpleasantly hot, wet night on shore, the party returned to the *Perla*. As Jim Masters, on his own in *Sheba*, was heading for the shore through the breakers, a particularly large roller curled up 200



Imperial Ethiopian Navy gunboats came to the rescue when Miss Sue Fyson, the expeditions' assistant diver, was taken ill.

Daily Telegraph Photo.

Expedition main base was on the island of Nocra, the old "Devils' Island" political prison. Many buildings were still sound and may be used for tourism.

Daily Telegraph Photo.

yards from the beach and flicked the dinghy on end. He was thrown out, but the motor went on running: he had pulled the steering arm over, so instead of driving into the beach *Sheba* raced round in circles. With great difficulty he was able, after three attempts, to grab a stern lifeline, feeling the threshing propeller near his feet as he did so. It was a nasty moment, for his chances in a choppy sea, on a coral reef with its usual number of sharks, would not have been high.

Next port of call was the island of Dohul, roughly triangular in shape, and more low lying and unrelieved, if possible, than anywhere previously visited. Dohul, with its three villages, was found to support a relatively large population—about 700—of fishermen and boatbuilders. In the centre of the island were five large artillery pieces—one French and four Italian, of 1914 and 1936 vintages, still in their emplacements.

On our return to Nocra all that remained to do was to pack up and return to Massawa.

What had the expedition achieved? We had made a thorough survey of the more important islands, to enable a detailed report on tourist prospects to be compiled. There were the scientific results, too, which are being evaluated in Addis Ababa and London. While producing no major new discoveries, the collections will add considerably to those already in the National History Museum and the National Herbarium in Addis Ababa, and in the Natural History Department of the British Museum and the Royal Botanic Gardens at Kew.

It was also confirmed that the islands present no biological hazards of any serious nature—marine, terrestrial or airborne—which might inhibit their use by future tourists.

Desert islands in a turquoise sea, they may well now become thriving resorts. It will be interesting to return in ten years and sip a cool beer on the verandah of a luxury hotel where once we were jolly thankful for a mouthful of lukewarm, brackish water from an Army waterbottle.

THE EXPEDITION

Headquarters Group: Major John Blashford-Snell, MBE, RE, Leader; Captain Nigel Sale (late RGJ), Deputy Leader; Captain Garth Brocksopp, Royal Irish Rangers, Quartermaster and Signals Officer; Mrs Kay Thompson (late ATS), Treasurer, Catering Manager and PRO; Richard Snailham (Sandhurst lecturer), Historical and General Studies; Anthony Haden-Guest (late Rifle Brigade), representative of the *Daily Telegraph Magazine*; Ato Tigist Kebret, ETO Liaison Officer, and three Ethiopian assistants.

Royal Engineer Group: Captain Jim Masters, RE, Chief Engineer; Lieutenant-Colonel Philip Shepherd, RA, Survey; Staff Sergeant Hank Mansley, RE, Water Supply; Captain John Cuthill, RAEC, Geologist; Gerald Batt, Architecture, Archaeology and Botany.

Photographic Group: Johnny Johnson (late RA), Director, Ornithologist and Land Cine Filming; Slim Macdonnell (late RAF), Underwater Photography; Miss Sue Fyson, Assistant Underwater Photography; Stuart Heydinger (late PARA), *Daily Telegraph Magazine*, Still Camera Work.

Scientific Group: Dr Malcolm Largen of Haile Selassie I University in Addis Ababa, Director; Mike Gilbert, Botanist; Dr Woodbridge Foster, Entomologist; Mrs Molly Hill, Conchologist; Miss Gunnel Lindstrom, Algae; Richard Barnes and John Hooper, of the Project Trust—general assistants.

Kirkee Revisited

P.A.E.

AFTER the Declaration of Independence of India and Pakistan in 1947, British officers of the Royal Bombay Sappers and Miners established an Association in the United Kingdom to maintain touch with their old Corps, now termed the Bombay Engineer Group, and to revive old memories at an Annual Dinner. A few years ago I took over the job of Secretary to the Association.

In August last year Colonel Jogelkar, the present Commandant, wrote to tell me that celebrations were to be held in February this year to mark the official 150th anniversary of the Group. Delighted with this tribute to the past history of the Group, the Association contributed to a gift of silver to mark the occasion. As it was thought that no British officer could possibly be in India at the time of the celebrations an official presentation was made in London to the High Commissioner for India in December 1969. A short description of this ceremony was published in the *RE Journal* of March 1970.

The fact that no British officer would be in Kirkee, the home of the Group, at the time of the anniversary caused much disappointment among all officers of the Group, and in December I received a kind invitation from Colonel Jogelkar to visit Kirkee for the festivities connected with it, together with the news that he had already arranged an air passage which he hoped I would be able to accept. Having served with the Bombay Sappers for a long period, this invitation was not only a matter of great personal satisfaction, but was also a great honour and privilege, as I would be representing the British officers.

Ten minutes past five in the morning is not the best time of day to arrive in any country and the sudden change of climate from a blizzard in Kent on the previous day to a temperature of 71 degrees and a high humidity at Santa Cruz airport made matters worse. However, the appearance of a Indian Sapper major to welcome me and to see me through the formalities of arrival was a foretaste of the thought and consideration towards my comfort that was to be a feature of my entire visit.

The trip by plane from Bombay to Poona is a short matter of thirty minutes, and at 7.15 am we arrived at the civil airstrip which is only a couple of miles from the lines of the Group. Here I was met by a small reception party of the Deputy Commandant and a major with orderlies and cars. Major B. S. Bath was to be my "ADC" throughout my visit, which was made doubly enjoyable by his tact and attention in ensuring that I arrived at the right place at the right time, and by his interesting commentaries on the activities of the group.

Immediate impressions were both curious and interesting. The past twenty-two years seemed to have been telescoped into as many weeks; at the same time, however, there was a deep sense of change. On arrival at the "Workhouse", the name given years ago to a block of single officers' quarters, these impressions were strengthened. Looking towards the married officers' bungalows nothing seemed to have altered, but in the other direction double-storeyed barracks and a grassed hockey pitch accentuated the sense of change, so did the "pull-the-plug" in my bathroom.

However, I was not allowed much time for self-analysis as a selected Mahratta orderly was asking—in Hindustani—what clothes should now go to the dhobi. Fortunately memories from earlier years remained and I was able to deal with this intricate and domestic problem. Something in this first conversation triggered off some facet in my brain and, as time went on, I found that I was able to converse in Hindustani, although often with poor grammar and lost for a particular word or idiom.

It was a kindly thought that prompted the suggestion that I should have breakfast in my room, which had been specially furnished for me, but clearly the sooner that I got into the swing of things the easier re-acclimatization would be.

The strength of the Group was ten times that of prewar days, so, of course, there had been changes in the Mess. The dining room has been doubled in length, but the style of building and decoration are the same. The billiard room has been converted into a second ante-room, but still in the previous style. A silver room and library have been constructed from the old butler's pantry and the wrought-iron gates in front of the Mess silver showed that the standard of workmanship is still very high. A special room for ladies has been built adjacent to the Verandah and at a short distance from the Mess is a fine guest house for married visitors.

Half a dozen young officers were having breakfast in the Mess and this was my introduction to the new India. Nothing could have been more kindly and welcoming than the manner in which I was greeted by them, making me feel really at home even at breakfast-time. Two Mess servants alleged that they had been Mess servants during my time and offered me the traditional eggs and bacon.

A formidable list of engagements was handed to me by Bath when I returned to my room. "We are letting you down lightly for the first two days, but there will be some more." However, there was a date for lunch. Entering the sitting room of my kindly host and hostess the fact that the furniture so resembled that of "our time" again stressed the feeling of the telescoping of the years. Here we were joined by Colonel and Mrs Jogelkar and I partook of the first of the many delicious curries that were to be my main diet for the seven following days.

In addition to the official list of engagements there were two of my own. Over many years there had been a great struggle to overcome prejudice and custom and to arrange for the wives of Indian ranks to have their babies born in hygienic surroundings where there could be proper care and attention. About forty years ago this had culminated in the building of a families hospital, complete with wards and equipment, and it had been enlarged from time to time. Not only did I find that this is still a flourishing concern which has been even further enlarged, but that another hospital has been built in the lines of the second training battalion at Dighi, some four miles away. My second personal visit was to the Garrison Church of "All Saints, Kirkee", and I was fortunate in being able to find someone to escort me inside. The brass plate to the Fallen of the British Ranks of the Bombay Sappers of World War I is still bright and the stands of Colours of two disbanded Regiments of the old Indian Army are still *in situ*. There were, of course, many personal associations and memories. It was interesting to learn that a congregation of about fifty attended a Sunday service, but an acute shortage of funds makes maintenance difficult.

After these two unscheduled visits my tour took me on 20 February to the College of Military Engineering. Here I was welcomed by Major-General M. M. Nath, whom I had last met in his subaltern days. A beaming major welcomed me on the steps of the very fine Officers' Mess. He had been my jemadar-adjutant in a training battalion during the war. Before the college had been built this area had been a dry and rocky part of the Deccan. Now there were grass lawns and flower beds and even a grassed cricket pitch, thanks to the sinking of tube wells.

An explanatory digression is now necessary. In addition to the British officers of the Indian Army there used to be an intermediate category of Viceroy's Commissioned Officers, now termed Junior Commissioned Officers. Carefully selected Indian other ranks received a commission from the Viceroy, becoming platoon, etc, commanders and a most valuable link between the other ranks and the British officer, whom they advised on all matters concerning the Indian ranks. There were three ranks in this category and on the senior VCO of the Regiment or Corps lay the great responsibility of advising the Commandant on all matters affecting the well-being and discipline of the troops in his command.

The morning of 21 February witnessed the final of a basket-ball competition that had been in progress for ten days between teams from units of the Group throughout India. A large crowd, including not only troops but officers and their wives, awaited the outcome with excitement. Here I was able to meet for the first

time a number of officers of the Group and to chat with their wives, to whom I was introduced by Mrs Jogelkar. As I left for my car there were cries of "Sahib, Sahib", and a small gathering of pensioner VCOs greeted me with obvious pleasure.

The main feature of the day was to be a double event. Pensioner VCOs were due to come to the Mess at 11 am and after this there was to be a move to the lines, where pensioner other ranks were to have a "barra khana". As I entered the Mess some three hundred pensioners surged towards me and for some days I could still feel the "pump-handling" of my arm when my hand had been seized and wrung with excitement. Many were the enquiries regarding British officers of past days and many apocryphal stories were retold regarding their many idiosyncrasies. An old pensioner VCO, proudly wearing the Indian Order of Merit awarded in World War I, stood slightly aloof. At 88 years of age the noise and excitement was almost too much for him. I had visited him in his village years ago and was fortunate in remembering his name. Another took my hand in both of his own and slowly bowed his head until his forehead touched the toe of my shoe. The expressions on the faces of the Indian officers of the sixties was interesting to note.

Greetings from old friends were not confined to pensioner VCOs, and it was with much pleasure that I met Brigadier Pillai, who had won his MC when he escaped from the Japanese in Singapore, Major Ranade who had been one of my cadets in the OCTU, and Brigadier Rao, now a Chief Engineer, who had been one of my subalterns in North Burma.

After two hours of this "get-together", the whole party moved to a barrack room in the lines where a "barra khana" was already in progress. The officers helped themselves from a table on the "buffet" principle. I was indeed grateful for advice from my old friends regarding the dynamite properties of some of the curries. My arrival had not passed unnoticed by some of the pensioner other ranks who had already started their meal, and until their final departure I was "waylaid" on many an occasion with greetings and enquiries regarding British officers with whom they had served.

The hockey match between the officers and the VCOs (now JCOs) is still an annual feature and this year it had been included in the anniversary celebrations. Despite much "touch-line coaching", the match, which took place in the afternoon, ended in a draw.

The old quarry, which had been the source of so much building material in the past, has been converted into a cinema and theatre and was the venue for the next item of that day. With only a slow and elementary return of the language the drama and humour of a variety performance would have been lost on me, so a visit to Poona was substituted. Fortunately my driver was an expert and, despite the erratic courses of motor-trishaws, hundreds of cyclists, bullock carts, taxis and lorries with blaring hooters, I was able to visit old haunts without incident. The busy and bustling crowds in Main Street and East Street gave the lie to the prevalent idea that all of India is starving. Chairs were being placed on the lawn of the (Old) Club of Western India as in days gone by. This Club, now a Southern Command Mess and Station Institute for Officers, has a compulsory membership from all officers in the garrison.

The first event on 22 February was a visit to the National Defence Academy where lads of 15 to 17 years are trained before entry to the Colleges of the three Services, eg the Indian Military Academy for the Army. The fine buildings and the pleasant vistas made a striking contrast with the rather grim surroundings of the "Shop".

Our return from the NDA was followed by a "Mess Lunch", a buffet meal attended by about two hundred officers and which lasted for nearly four hours. As on previous occasions, the Group brass band in full dress was in attendance. Towards the end of this entertainment a space was cleared and Brigadier Pillai, as the senior Bombay Sapper present, paid a glowing tribute to the British officers who had served in the Bombay Sappers. He referred to the Annual Dinner in London, when the British Officers' Association exchanged greetings with the Group, and

referred in glowing terms to the recent presentation of silver to mark the occasion of the 150th anniversary. He then presented me, as the representative of the Association, with a piece of silver, comprising the badge of the Indian Engineers mounted on a plinth bearing an appropriate inscription. He also handed me a box containing commemorative badges for members of the Association. He hoped that the silver piece would be placed on the table at Annual Dinners. He also gave me a personal gift from all officers of the Group. It was both an honour and a privilege to be able to return the greetings and congratulations of the Association personally, and I hope that the subsequent applause was a measure of the adequacy of my reply.

A hard-working photographer had been in attendance at most of the previous events, and on the morning of 23 February there were set pieces, formal photographs taken of pensioners and others. Having been stationed at Dighi during the war, a visit was not without interest, and again the many flower beds made a striking contrast with my memories of brown, rocky ground on which wartime buildings had been erected. Even grapes were growing outside the office of the Chief Instructor of Fieldworks, which is located on the river bank. Here above the "Arsenal bund" was a fine stretch of water for sailing and I was told that Group boats had won the National championship. Two fine model rooms were shown to me with pride.

The Sergeants' Mess is now the Mess of the JCOs and at 12.30 pm a large crowd of serving personnel and pensioners gathered there for lunch. Once again the "handshakes" and the photographs were an energetic feature. A group of Mahrattas performed the well-known "Lezim" dance, followed by a group of Sikhs who performed a Punjabi dance. The crowning point of this function occurred when Colonel Sridharam, Commandant of the Madras Sappers, presented to the Bombay Group a piece of silver to commemorate the occasion.

As on previous occasions, lunch was no short affair, and many were the small groups of pensioners from various companies in which I had served who were determined to be photographed. Alas, however, the photographer had decided to take a well-deserved rest!

The main event of the festivities was, of course, the Tattoo, which took place that evening on a newly constructed Sports Stadium, stated to be able to hold 9,000 spectators. This ambitious and picturesque event opened with a fine gymnastic display and we were told that one of the participants had represented India in the National Team. After the lights had been dimmed three groups of Mahrattas, each one hundred strong, entered the arena to perform the "Lezim" dance (the "lezim" is a short length of bamboo, about 2 ft long, with a loose chain attached to the two ends). Clad in white with orange sashes and paggarees and expertly handling their lezim to the fast rhythm of the drums and with faultless footwork, the dancers' display was a fascinating sight. We were told that the dance emanated from Persia and had been devised to strengthen the wrists of archers. Mahrattas again followed this item by a performance on the "Malkham". Prodigious athletic feats were executed singly and in groups on these vertical poles, of which there were four. Between items the Pipe Band, reinforced by bands from other units, played some well-remembered airs.

The two performances by Mahrattas were followed by a folk dance or "Bhangra" from the Punjab. Three groups entered the arena, similar in size to those of the Lezim. India has always been a land of colour and the bright colours of the paggarees and lunghies (a sarong-like garment) were no exception. The unrestrained but rhythmic movements of this dance made a striking contrast with the more formal movements of the Lezim.

Once more the arena was "blacked out" and eight hundred performers, each carrying two flaming torches, entered and performed movements that can best be described by comparing them with club-swinging and marching to the accompaniment of the brass bands. The uniformity of the movements and of the drill were a credit to all concerned.

The background of the arena resembled the walls of the fortress of Ghazni and

its famous gate. The gate was now to be blown. Captain Peake, clearly identifiable in his white service topee, laid the charge and the gate was shattered with a loud explosion. The most solemn item of the Tattoo then occurred when the Massed Bands played "Abide With Me", followed by the National Anthem. As we left the arena the commemorative nature of the celebrations was stressed: on either side of the "Exit" were posts carrying the badges of the Royal Bombay Sappers and Miners and of the Pioneer Regiments which had amalgamated with the Bombay Sappers in earlier days.

No celebration of this nature is complete without a ceremonial parade. On the following morning detachments from twelve units of the Group formed a parade of nine hundred strong and carried out a ceremonial drill and march-past before the Colonel Commandant, Major-General Harkirit Singh, watched by Lieut-General P. S. Bhagat, VC, himself a Bombay Sapper, Major-General Lumba, the Engineer-in-Chief, and many officers and wives from the Garrison.

Of course, in addition to these formal events there were numerous other parties of a more intimate nature. All were determined to make this a great occasion. To me it was of the greatest interest to be able to talk to the "New India" in a setting of the India to which I had been so accustomed. It would be ungracious to finish without referring to the very great hospitality and consideration that was shown to me by all. Many were the questions about "our time in India" and so often was I asked if I was being "looked after all right". I was visiting a family—not as a visitor, but as an old member of the family.

To have been invited to these celebrations to mark the 150th anniversary of the Group, and to be the sole representative of the British officers, was a great honour and privilege and I shall always treasure the memories of this great occasion.

Royal Engineers in the 1980s

MAJOR P. L. DELL, RE, MA, MICE, MIE(Aust), AMBIM

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THE role of the Defence Forces, in support of which the Corps of Royal Engineers derives its own role, will change over a period of fifteen years to meet the political requirements. The weakness of any attempt to project this role into the future is that one or more of the basic assumptions may be proved wrong. It is therefore necessary to state clearly what these assumptions are, so that the basis of any ensuing argument is defined. The fairest analogy is the design of the foundations of a building, which, however scientifically exact, often depends on an element of judgement and estimation. The assumptions upon which this projection are made are three in number, namely: that the United Kingdom (UK) is a full member of the European Economic Community (EEC) or its successor; that the UK continues to support the United Nations (UN) in all facets of its work; that the Commonwealth still has political and economic significance, although the terms of the resultant co-operation will be more precisely defined than at present.

The traditional role of the Corps to ensure the mobility of our own forces whilst denying that mobility to the enemy remains, but it requires analysis to determine what is required for each of the three assumptions. The needs of each are certainly different and less open to compromise than in the past.

The UK membership of the EEC in the fullest political sense will probably include membership of the successor to the North Atlantic Tready Organization (NATO). The tension between the EEC and the Warsaw Pact countries will have again decreased, but Germany is likely to remain divided. The threat of an attack, although diminished, will remain. Such an attack could develop either from a Communist

show of external strength to satisfy internal unrest, or by an uprising within a satellite Communist country, particularly East Germany, which certain EEC members would feel obliged to support. The purpose of the EEC Defence Forces would therefore be to deter and if necessary repel the former, whilst preventing the latter by internal political discipline. An attack for either reason would involve the full range of nuclear, biological and chemical (NBC) weapons. The chemical and biological weapons are likely to be much more widely available. The control of the production of these weapons is not easy, since many agricultural fertilizer or pharmaceutical factories can be converted quickly to the production of toxic substances. In contrast the control of the nuclear weapons is relatively simple, since complex industrial organizations are required for their manufacture. The emphasis on military operations in these circumstances must be on speed and protection, enabling a powerful blow to be delivered the moment the opportunity affords. The Corps supporting the ground and air forces requires custom-designed equipment to provide protection to the crew and meet quickly the tactical need for a bridge, rapid demolition or VTOL pad. These elaborate pieces of engineer equipment need to be lightly armoured against small arms fire and radiation, but very mobile and quick to operate in their design role. They should be based on a minimum number of chassis, perhaps that of the 1980s tank or missile carrier and the derivative of the combat engineer tractor (CET).

The military support of UN operations requires very different skills to enable the Corps to fulfil its traditional role. Since the UK is anti-Communist its acceptable military contribution may well take the form of the logistic support of neutral countries' fighting arms. The operations may be in the less well-developed countries, where the provision of mobility means power supply, water, VTOL and STOL strips in addition to pure physical mobility on the ground. The skills required will be those of the professional engineer and craftsman using largely existing resources. The Corps elements of this force must be air transportable and capable of accepting full responsibility for all engineer support immediately on arrival.

The military aspects of Commonwealth co-operation are twofold. Firstly the provision of defence through a formal treaty against an external threat, secondly the provision, at the request of the host government, of military assistance to control an internal security (IS) threat. Both these needs can be met by a combination of the forces, including the support provided by the Corps, outlined as necessary for EEC or UN operations. It does not give rise to equipment or training additional to that needed by the Corps, in fulfilling its role in the other settings.

To meet the three aspects of the Corps' traditional role which have been outlined the organization needs to be changed. To meet the demands on the professional engineer and tradesman posed by UN/Commonwealth operations it is clear that the Corps must justify by training and equipment its claim to the title engineer as opposed to pioneer: the training in particular will enhance its ability to make thorough use of the specialized equipment provided for EEC operations. The EEC role requires a military engineer, rather than professional civil engineer, but the demands of this dual profession are constantly increasing in complexity and are already in excess of the capacity of the average man. It is a delusion to believe that the same person will perform both efficiently: he may perform adequately, but the speed and finality of NBC warfare in particular always demands the best.

The one factor remaining common to all three aspects of the role in the 1980s is the increasing use of equipment. It may be custom designed for EEC, power hand tools for all theatres or the development of nuclear explosives for construction. The basic trade of the Corps, so long the jack of all trades field or combat engineer, must by the 1980s be a derivative of the present equipment or plant operator mechanic (EOM/POM). His skill as an adaptable operator must predominate over the traditional all-purpose tradesman, so that he can operate the 1980 equivalent of armoured, amphibious and combat engineer equipments. It is this type of engineer who is particularly required for the EEC role.

The basic unit of the Corps should remain the Squadron, but its organization will differ for the EEC or UN/Commonwealth role. In the EEC theatre the recently approved two squadron two regiment Royal Engineer support for a division could still form the basis of the organization. The Support Squadron within the division would comprise lightly armoured plant and holdings of additional power hand tools. The specialist armoured and amphibious units would disappear, their equipment being used by the predominantly EOM manned Squadrons. Their manpower likewise would be absorbed by these Squadrons to bring them up to 300. The term field should be dropped from the title, all Squadrons except Support Squadrons being simply a numbered Engineer Squadron. Every vehicle in these squadrons should be fitted with a radio, and the crew and vehicle considered as a whole, like the current armoured fighting vehicle. The capability of this unit to operate during NBC warfare in the 1980s depends on the equipment: to divorce man from equipment annuls this capability.

In the UN/Commonwealth role the Squadron organization will be smaller, probably between 150–200. The EOM will still be needed for his ability to handle power hand tools and civilian plant. The number of officers and Senior NCOs should be the same, or more, than the EEC Squadron to provide it with the ability for management of civil engineering projects. The professional skills of both the officers and men will need to cover all aspects of concrete construction, water and power supply: they will have to be up to date and currently practising these skills. The equivalent of present-day specialist teams could still be added to these, or EEC, Squadrons for specific tasks, but similarly these teams must be in practice with their special skills. All the equipment of these Squadrons must be air-portable, considerable reliance being placed on good engineer intelligence to enable them to requisition local resources.

The divergent nature of the EEC and UN/Commonwealth roles each demand a high standard in very different fields. At the individual level the potential ability to be successful at both will only be held by very few; the period of adaption on change from one to another would be at least twelve months for an officer or senior NCO, which would hardly contribute to unit efficiency. To a limited degree this is true now: by the 1980s it will be an inescapable fact. Therefore the officer or soldier in the Corps must become an expert in either the EEC or UN role, which implies longer tours and retraining on change of role.

Having outlined the Corps' role and the organization derived to meet this, the next stage is to determine the type of unit and individual training required. In the EEC role the current pattern of NATO training will suffice, but with even more emphasis placed on speed of response and operations in full NBC warfare at night. In the UN role the need is for unit training in peacetime to give good practice in civil engineering. The two main fields are projects in sparsely populated countries and international disaster relief. There are large areas in Northern Canada, Australia, Norway and Greenland where civil engineering projects of value to the host country could be completed, although these could not be executed by the country concerned because of the scarcity of skilled manpower. A further possible area in this field by the 1980s might be some of the civil engineering work connected with an EEC space project. The second field, international disaster relief, is one which offers tremendous scope. The September 1968 earthquake disaster in Iran is an ideal example of a natural catastrophe where teams of professional engineers could have given tremendous assistance. The arrival of two engineer regiments, perhaps under UN auspices, to restore power and communications would have been of much more use to Iran than the £10,000, tents, blankets and two planes the UK provided. The wider benefit of international goodwill arising from the UK's help in this way could have made a lasting contribution to stability in the Middle East. This contention is supported by the favourable international reaction to Corps assistance at the Skopje earthquake and Belize hurricane disasters.

The requirement for individual training to enable units to perform adequately

at these tasks has a similar emphasis on the need for professional training and practice. In the EEC role the emphasis must be on maintaining a very high level all the time. The present pattern of training can meet this, but it requires sharpening to reduce response times to provide both faster deployment and shorter periods for the execution of tasks. In the UN role the officer or soldier must be trained and in practice at his professional skills. It is not in the nation's interest to have a trained man whose skill is not extended to the full: this should be the underlying principle behind obtaining more opportunities for providing civil engineering work for members of the Corps. The professional engineer, officer or soldier, should spend a minimum of six years consecutively on training and using his skill. The current practice of attachments to civil firms, the Ministries of Building and Public Works or Overseas Development should be extended even to allowing a man a career as part soldier, part civil servant, part civilian, but always civil engineer. A development on these lines would widen the field of training and experience: its historical roots are the careers followed by the former members of the Corps in India, whilst it is also in accord with the ideas of the Fulton report for the future of the Civil Service.

The recruiting emphasis must be changed to meet the need for longer tours in both the EEC and UN role. Thus a man will have the opportunity to become really proficient in one role. The claim that he can learn and practise a skill must be seen to be met. He will not become fully competent in both roles until he has completed some ten years' service and even then will be more proficient in the role he last filled. After ten years he is well equipped for a continued military or civilian engineering career. Encouragement must also be given, as is already done in REME, to recruit direct the senior NCO. There should be an opportunity for men who do not quite meet the requirements laid down for an officer to undergo training as senior NCO entrants. It is wasteful to make a skilled craftsman serve an extended apprenticeship before making full use of his management and professional skills.

The present emphasis on the career structure is designed to give all officers the chance of promotion to senior Army command and staff appointments and soldiers the opportunity to become RSM of a unit. Few have this ability and little early encouragement is given to those who have talent in narrower, but necessary, fields. The Corps role is to provide support to the Army. To do this well will mean that the technical demands will grow, and there will be less time for officers to prepare themselves for senior command and staff appointments. The role of the Corps must come first, and although it will be in the interest of the Army for those Royal Engineer Officers who merit it to be chosen for such appointments, there must be fewer officers who have their eye on the later goal. To have a dual aim, except for the few, could be dangerous, and if the Corps' ability to carry out its role were to suffer, this would be disastrous. The career structure must determine how many predominantly EEC or UN men are required, subdivide these to more specific professional categories and train the requisite number after early selection to meet these. The pay scale must be directly comparable to civilian scales. The rank for each appointment should be determined by his overall management responsibility, not as at present on the outdated criterion of how many men he commands.

The role, organization, training, recruitment and career structure which are suggested differ markedly from what we know today. Each is more precisely defined than in the past, the whole being less adaptable, but each seeking to produce a higher standard. A summary of each aspect illustrates this.

The first two roles, in support of EEC or UN, are combined in the third in support of the Commonwealth. However, the first two demand respectively a well-trained military engineer or a similarly trained civil engineer. None of the roles allows any time for updating of training. A unit must fulfil its EEC or UN role immediately, and therefore cannot be switched without extensive retraining between the two.

The organization to meet these roles is also different. At squadron level the EEC unit is larger (approx 300), extensively equipped with tailor-made equipment; its basic man-power requirements are for equipment operators. In the UN role it is

smaller (approx 150), lightly equipped with a basic man-power requirement for professional engineers and craftsmen as well as equipment operators.

The training for the EEC role emphasizes the military skills, and requires the equipment operator to be considered as one with his equipment. The UN role accentuates the need for continual practice in his professional skills and the engineers' ability to exploit local resources.

The recruitment for both roles must attract the man by the high standards required and the opportunity to enter directly at a level appropriate to his ability.

The career structure should no longer encourage all to race for the top Army jobs, but rather for each to utilize his more particular ability earlier. The pay structure must equate to civilian rates and be directly comparable to them.

A Matter of Prestige

LIEUT-COLONEL R. S. HAWKINS, RE (Retd), MA, MIMechE

ON the western shore of the Red Sea, 1,200 miles south of Suez, is the small trading port of Massawah. A further thirty miles south is Annesley Bay; a large-scale atlas might show the River Haddas and the unimportant town of Zula on the west. A century ago Zula was a miserable mud village on the river, but for a fantastic year in its history it gave its name to the base for an unbelievably modern military expedition. From time immemorial the Haddas had carved its way through barren country, and discharged its seasonal waters over a gently sloping beach into the Bay. The mean tide rose and fell 2½ ft, leaving 200 yds of filthy mud between high and low water marks on the dismal deserted shore; in the civilized world, nothing much else was known.

In July 1867, Her Majesty's Government enquired of the Government of Bombay how soon, if an invasion of Abyssinia were determined upon, a fully equipped and provisioned force could start from India. This request came as no surprise, because previous diplomatic negotiations were well known. The slightly mad and intransigent King Theodore, a Coptic Christian, held under duress a number of European prisoners, in the vicinity of Gondar and Magdala. The British Consul, Mr Cameron, had been held since January 1864; the others were HM Envoy Mr Rassam, his assistant Dr Blanc, four German missionaries, six "scripture-readers" and an assortment of wives, women and hangers-on. They were held as hostages at the whim of Theodore, sometimes free and well treated, sometimes incarcerated and even tortured!

It was clear that, with British prestige at stake, a military force from India would inevitably be committed to effect the prisoners' release. The C-in-C of the Bombay Army was the Engineer Officer, Sir Robert Napier, and he planned a force to consist basically of fourteen battalions of Infantry, four regiments of Cavalry, seven batteries of Artillery and seven companies of Sappers and Miners. The main body of this force was required to traverse 400 miles of mountainous, rocky, trackless and unmapped country to Magdala.

Even before any practical landing place on the shore of Africa had been reconnoitred, and before any plans whatsoever for an Army base could be formulated, Sir Robert Napier, in August 1867, was instructed to launch and command an expedition from India. The chaos and bungling of the landing in the Crimea in 1854 had not been forgotten; Sir Robert had two great assets, his own personal brilliance, and the almost abject co-operation of HM Government in meeting his military demands in abundance. One result of this was the construction of the port and military base at Zula; another was the formation of the unique 10th Company, Royal Engineers.

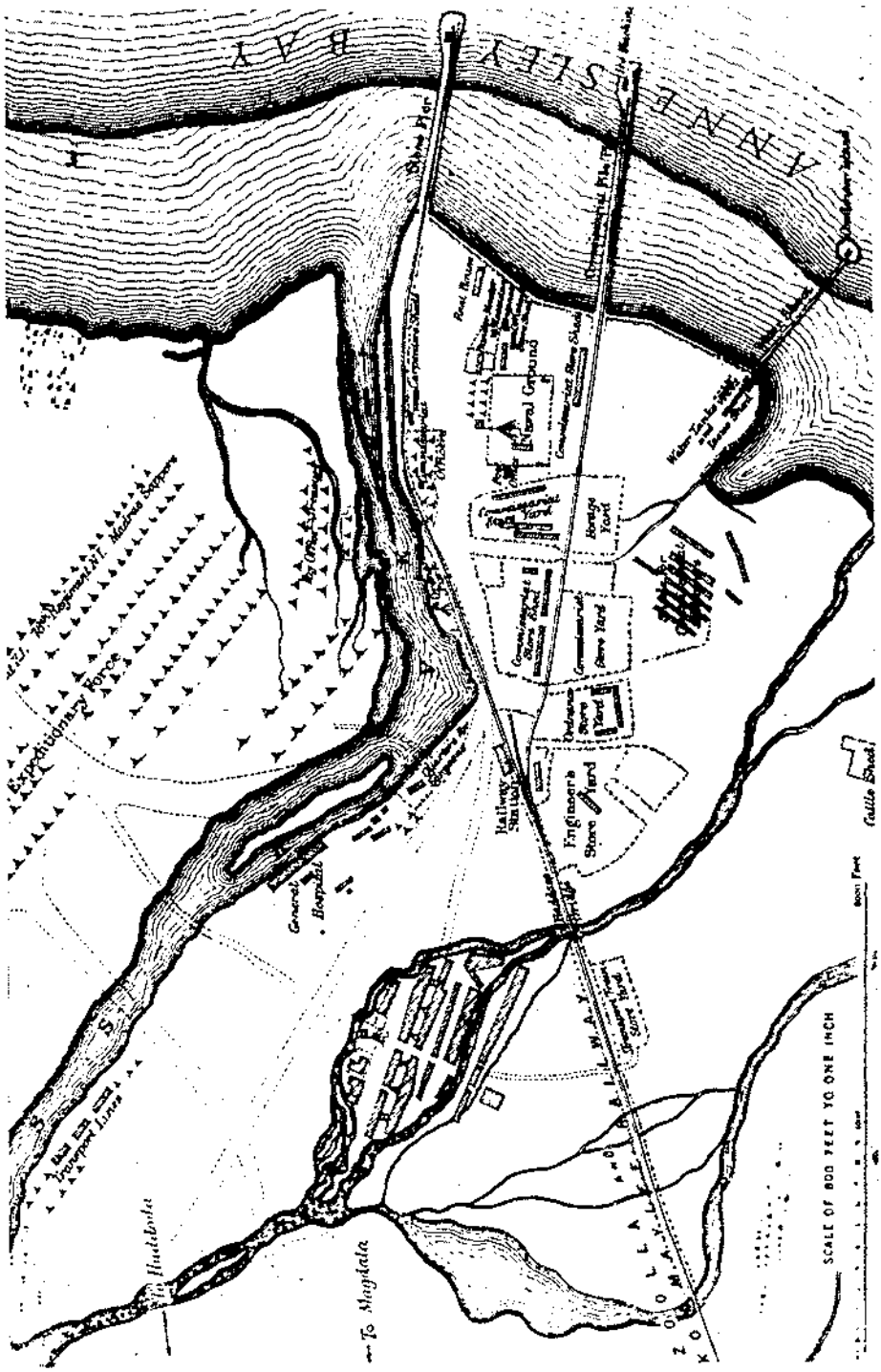


Photo 1. Plan of Zula Base (1868).

The Political Agent at Aden, William Merewether, Esq, had some knowledge of the Red Sea coast; he was therefore placed at the disposal of Napier, and given the temporary rank of colonel. The coastline adjacent to Abyssinia was in Egyptian territory, and this Moslem country had no objection to the landing here of a British force, directed against the despised Copts. The intensely hot and arid coastal plain varied in width from fifteen to fifty miles; at the inland edge the ground rose abruptly to 1,000 ft, and further inland, through progressively forbidding country, to peaks 10,000 ft above sea-level. The requirements of a landing place and base were:

A roadstead for ships of at least 2,000 tons.
Shore landing facilities.
A healthy site for a base camp and vast quantities commissariat stores.
A good route to the high ground, connecting with a feasible route to the interior.

Napier's plan was to disembark his force progressively through the landing place, and pass them rapidly across the low-lying base area, to the cooler high ground, where water was plentiful.

The reconnaissance party under Colonel Merewether set out from Bombay on the hired steamers *Euphrates* and *Coromandel*, and reached Massawah on 1 October. This party included Lieut-Colonel H. St C. Wilkins, Captain W. W. Goodfellow and Lieutenant K. A. Jopp, all RE employed in the Bombay Army. There were eight other military officers, a Marine company, a squadron of Cavalry, 150 pack mules and the inevitable retinue of followers and lascars. The party quickly discarded Massawah as a landing place, owing to the dismal shortage of fresh water, and proceeded thirty miles south to Malkatto, the outfall of the Haddas River into Annesley Bay. Merewether's reports were transmitted to Napier at Bombay in a number of despatches up to 23 November; during this time much country within thirty miles radius of Malkatto had been reconnoitred.

There was a suitable anchorage for ships 1,000 ft off shore in Annesley Bay; piers of this length would have to be constructed with stone brought by native craft from the opposite shore. There was adequate perennial water supply and grazing fifteen miles to the west, but a camp site at Zula could only be supplied with water from the Haddas, during the monsoon season, May to October.

During the whole of this reconnaissance period ships were sailing from India, Aden and England, with men and stores. Three-quarters of the hired transport flotilla from Bombay were sailing ships; in the course of time over 270 ships of all sorts discharged their cargoes at Zula. On 21 October an advanced Brigade, including the 3rd and 4th Companies, Bombay Sappers and Miners, arrived from India. The Sappers started work improvising a pier from brushwood fascines and stone. They also did much initial work on road-making and the erection of temporary accommodation.

At the request of the Bombay Government, much equipment, unavailable or unsuitable in India, was sent from England. Major-General J. L. A. Simmons, Director of the Royal Engineers Establishment[1] (REE) at Chatham, took vigorous action to procure special engineer equipment and personnel, to meet the abnormal requirements of the Abyssinian campaign. It fell to Major-General Simmons and Sir Robert Napier to adopt for the first time the skills of photography, telegraphy, signalling and railway construction, for use by RE personnel in direct support of military operations.

Simmons wrote: "The best maps of any country are generally very insufficient for military purposes, furnish but little information for selecting routes, and are very deficient in the details required for manoeuvring troops. On active operations, this information must be obtained through the exertions of the Staff, who should be continually occupied in preparing and correcting maps. The information thus obtained forms the basis upon which the movements of an army are determined,

[1] The REE became the School of Military Engineering on 17 August 1869 and the Royal School of Military Engineering on 20 July 1962.

and it becomes essential that the sketches of the routes to be traversed, should be available for distribution with his orders, with the least possible delay. The readiest and most accurate mode of copying these sketches and maps, is by photography."

Two sets of photographic equipment were therefore procured, with much care and forethought, by the REE. The most important single item was, of course, the camera itself; this was an "11 × 9 inch sliding and folding camera, brass bound, with a 12 × 10 inch Dallmeyer's triplet lens, rack and pinion adjustment and Waterhouse diaphragms". The teak transit box, 2 ft 6 in × 11 in × 1 ft 6 in, contained the camera, tripod stand and assorted gadgets, the whole package weighing 100 lb. A set of equipment consisted of the camera, a Ross No. 3A portrait lens, a dark tent, quantities of chemicals, printing frames, a portable still and miscellaneous apparatus, the whole made up into eighteen packages, totalling 1,300 lb or seven mule-loads. A set had sufficient material for taking sixteen dozen negatives, 9 in × 11 in or 8½ in × 6½ in, and a capability of "striking off" 1,700 prints. Linen was also supplied for mounting separate prints in the form of a whole map.

It was quite clear that a field telegraph system was essential for the Abyssinian campaign; the entire equipment was provided from England, at a time when a British Army Signal Service did not exist at all. Captain R. H. Stotherd, RE, of the REE, examined the technical requirements most carefully, with a knowledge of the Prussian Army equipment used in Bohemia in 1866. This was the most recent use of army telegraphs in the field, but the system was devised for use in Europe on good roads with a permanent system partly in being. In the appalling terrain of Abyssinia it was far too heavy and quite unsuitable for transport by pack animals.

The Bombay Army further requested from England a detachment of signallers, to establish rapid visual communication between ship and shore, and between units on the line of march. Two systems were then being practised at the REE; one was a light fitted with apparatus for flash signalling at night, and the other was the signalling flag. One form of light was a bull's-eye lantern, with a hand-operated shutter. Another was the "Chatham light", operated by three sappers, and fuelled by a devilish concoction of resin, lycopodium and powdered magnesium; this "Chatham powder" was squirted through a spirit flame by an air jet from hand bellows, operated to produce long and short flashes. A signalling flag was 4 ft 6 in square in any pattern of black and white best suited to local visibility.

The telegraph equipment was procured very rapidly from commercial sources, with little or no experience of its qualities for field use. A very important early decision concerned the nature of the line itself. Two types were envisaged, an ordinary overhead line on the main route, and a so-called "flying-line", laid on the actual line of march for temporary use. The latter was to be laid along the ground, and hence a rubber insulated cable was required. The normal material for overhead wire at that time was iron; a textbook of 1867 stated: "The superior conducting power and durability of copper recommends it, but the danger to which such a line is constantly exposed of being cut, and the wire stolen, is an argument against it. Were it not for this, a copper line would be much cheaper in the end than an iron one. To give the same resistance for the same length, iron must have a section at least seven times as great as would be required for copper. This increases of course the weight of iron line, which therefore requires stronger posts and insulators in order to allow each wire to be strained tightly between supports."

Stotherd decided rightly that weight saving was of paramount importance, and chose copper for the overhead line, but the textbook warning turned out in practice to be not unfounded. The line stores ordered and shipped to Annesley Bay consisted basically of:

50 miles of "Hooper's Core", of three strands of copper wire covered with gutta-percha.

350 miles of No 16 SWG copper wire on 175 drums.

70 miles of galvanized iron wire, 16 BWG.

The ancillary equipment included iron standards, porcelain insulators, earth plates and a very useful range of hand tools for line erection, including, for example, fifty pairs of stout leather hedger's gloves. About 5,000 bamboo telegraph poles, 18 ft long, were also sent from India, but these arrived too late to be of value; in any case their carriage along the line of march was prohibitive, and very few were used.

The operating equipment was procured by the REE from the commercial stock of Messrs Siemens Bros, and included:

12 portable recording field instruments.
8 relay instruments.
1,000 "discs" of Morse paper.
Batteries of Marie Davy's elements.
Spare elements and chemicals for recharging.

A field instrument could be operated to send or receive, in Morse code, by the established system of the tapping key. At the receiver, a message was recorded by an inking device on Morse paper, a ½-in strip automatically unwound from a coiled "disc"; this was then decoded by the operator and printed out as a verbal message by hand. Over long transmission distances (greater than about 100 miles) a relay instrument and battery, in circuit with the receiver, was used to improve signal strength and clarity.

A battery was formed from twelve or twenty-four Marie Davy's elements, in series in a teak box. An element or cell was an advance on the old zinc-copper Daniell cell, and consisted of a rubber-covered carbon pot, containing proto-sulphate of mercury in paste form. Held centrally by wooden plugs was a ceramic porous pot, surrounding a hollow zinc element which contained water. Recharging was by topping up with water, replacing an eroded zinc element, or, when these measures failed, by hopefully renewing the sulphate of mercury. There was at the time no quick method of checking the EMF of a battery; an expert in "galvanic electricity", by means of cunning circuitry, a galvanometer and known resistances, could, however, calculate the EMF in relation to that of a standard Daniell cell. Volts, amps and ohms were then unheard of!

Water supply for the force was foreseen as most difficult in the coastal plain and base area, during the season November to April, when all rivers would be dry. This was the period during which the force would be landed and the base at Zula constructed. Here the bulk of water was to be supplied by condensers on ship or shore, under naval direction, for which enormous tonnages of coal would be required. Major-General Simmons, in September 1867, wisely recommended the provision of adequate supply equipment for use by the Army on land, and on the line of march. He was aware of the recently introduced American Tube Well of Mr J. L. Norton, and directed tests to be carried out by the REE. Three wells were therefore driven, two at Chatham and one at Wouldham; the results were so satisfactory that Mr Norton's agent in England was instructed to procure 100 tube-well equipments for shipment to Abyssinia.

For lifting water from a depth of 25 ft or so in an open well, Bastier's Patent Chain Pump was selected. This consisted of a long vertical pipe, 2½ in or 6 in bore, terminating in a bell-mouth submerged in the water. An endless chain, passing over a pulley at the top, descended to below water-level and then up through the pipe. The chain was fitted at regular intervals with discs of rubber of bore diameter. On the small-bore pump the pulley was rotated through crank handles by two men, who could thus deliver about 30 gallons a minute. For the 6-in pump, power was supplied from a capstan, designed to be turned by a camel or two bullocks. For raising water from a depth of 30 ft, double-action force pumps were purchased. The water-supply equipment sent from England on the advice of the REE consisted of:

100 Norton tube wells and accessories.
12 Bastier chain pumps.

4 Owen & Clinton double-action pumps.
10 force pumps on wheelbarrow frames.
30 portable hand pumps.
19 miles of 4-in iron water pipe.

An adequate supply of 3-in and 2-in piping, water hose, miscellaneous pipe fittings and plumber's tools in abundance were also sent.

By the end of September a number of NCOs and Sappers were being instructed at the REE in the use of quite novel equipment, most of which had never been used in military service. Lieutenant St John, RE, exercised his party in electric telegraphy by the Morse alphabet, line erection and operation. Another party acquired skill in well-boring, the use of pumping equipment and the construction of pipelines and water points. Sergeant Harrold initiated his team of six into the art of photography, under the direction of Major-General Simmons, an ardent amateur photographer. Lieutenant Morgan, RE, and ten sappers were trained in light and flag signalling, as laid down in the official *Army and Navy Signal Book*. This was based on a code using the figures 0, 1, 2, 3 . . . 9 transmitted by a "dash-dot" system, similar to Morse; they were signalled by long and short light exposures, or by a single flag waved left and right, simulating the motion of a single-needle telegraph instrument. The code had four-figure groups for commonly used words, three-figure spelling groups for letters singly or in combination, and two-figure groups with operational and special meanings; for example 7659 was "sausage", and 86 was "Commanding officers of battalions to attend the Brigadier". All these men, with the addition of further artisans and miners, were amalgamated into a single unit at Chatham, the 10th Company, Royal Engineers, as follows:

O.C.	Major G. D. Pritchard, RE.
H.Q.	Colour-Sergeant G. Prosser. 5 sappers.
Telegraph Section	Lieutenant O. B. C. St John, RE. Lieutenant A. R. Puzey, RE. 25 NCOs and sappers.
Signallers	Lieutenant J. L. Morgan, RE. 10 NCOs and sappers.
Well-borers	Lieutenant A. Le Messurier, RE. 35 NCOs and sappers.
Photographers	Sergeant J. Harrold, RE. 6 corporals and sappers.

On 4 November 1867 the screw steamer *Mendoza* sailed from London with HQ and the majority of the 10th Company RE, all its specialist equipment and a tonnage of commissariat, ordnance and engineer stores. The ship arrived at Alexandria eighteen days later, whence all cargo and passengers were ferried across the Isthmus to Suez by rail; Oliver St John, the Company Stores Officer, had the most hectic days of his life! The 10th arrived by ship in Annesley Bay on 12 December, and remained shipbound for several days owing to the congestion there and lack of tents.

It was clear to Napier that for rapid movement of commissariat stores from the shore to base dumps a short tramway would be required; this idea was soon extended, as a result of Merewether's reconnaissance, to the concept of a steam railway running twelve to fifteen miles inland, over the hot coastal plain to Kumayli and beyond. By mid-November the Chief Engineer, Bombay, was arranging for the shipment to Annesley Bay of twenty miles of track complete with sleepers, twenty sets of points, four steam locomotives, seventy trucks and a number of iron plate girders. To this was added a useful range of traffic equipment such as semaphores, guard's bells, signal flags and watches. The track and rolling stock was of the

contractor's type of 5 ft 6 in gauge; all of it was commandeered from various sources at Madras, Bombay and the harbour works in progress at Kurrachee. A complete steam-powered workshop was also sent, consisting of machine tools, a forge, a brass furnace, a stock of assorted railway spares and bar iron, complete with all requisite tradesmen's tools.

Other railway stores from India comprised the entire requirement for coal, and all timber for the bridges, railway stations, and piers; in fact, the entire stock of timber for all structural work at Zula was imported, local resources being non-existent. An unnamed but inspired genius, probably Harry Wilkins, had early on commandeered some 18-in iron plate girders, 25 ft and 12 ft long, which he had spotted at Aden, for barrack-floor construction—"in anticipation that they would prove useful on the railway" observed Lieutenant Thomas Willans, RE. He was profoundly right, for the "barrack" girders had become useful railway bridges, long before any iron girders had arrived from India.

The Field Engineer in charge of railway construction and operation was Captain C. J. Darrah, RE, assisted as time went on by Lieutenants Perceval Pennefather, Thomas Willans and Andrew Baird, RE. As the bulk of the labour, such as the Army Works Corps and operating staff was civilian, and the coal was supplied under civil contract, Pennefather in fact spent most of his time keeping complicated accounts! From January 1868 onwards, railhead gradually crept westward, further from the piers, but the general problem of construction was bedevilled by water shortage and the very mixed assortment of imported rails.

The first six miles of track were laid fairly straight over level country, crossing innumerable watercourses; further west the topography was of a more hilly nature, and the surveyed line took a winding course to maintain a limiting gradient of 1 in 60. The track was laid without ballast on the levelled formation, but "head of iron" was always at the mercy of the track stores being unloaded at Zula. All shipping was in charge of the Commissariat Department; rails arrived with the wrong spikes or chairs, augers were the wrong size or fishplates were missing. There were five different patterns of rail, many of them still curved or cut up into odd lengths, as taken up in India from their original employment.

Charles Darrah was hard pressed to ensure water supply for both the labour force and the steam engines of the construction trains. He was dependent on a precarious supply from any wells, often brackish or salt, that he could find in the vicinity of railhead. A locomotive was quite useless without water, but used 1,000 gallons a day, strongly objecting to even slightly salt water. Darrah therefore had recourse to a naval condenser on the pier, and even water pumped from water-boats. So a locomotive short of water near railhead had to steam light several miles back to the landing place; on occasions the fire had to be drawn to prevent damage. This complicated manoeuvring had to be carried out concurrently with the shuttle service of the construction trains. Fortunately, at about six miles from the pier an adequate supply was found for men and machines.

The locomotives were four tank engines, which had seen much hard service in the hands of Indian works contractors. The trucks were springless trolleys, with plain cast-iron bearings, very ill suited to the dry sandy environment. The wear and tear on rolling stock was severe, and maintenance on locomotives had of necessity to be carried out at night, their condition deteriorating alarmingly.

By 19 February the first six miles of track were laid, and opened for traffic; all Commissariat stores, about 350 tons a day, were then brought up by rail from Zula, the baggage animals being removed to Kumayli, where plentiful water was available. Four to seven supply trains were run a day, in addition to the construction trains with material for extending the line. The civilian operating staff consisted of 200 Indians and Eurasians, many of whom were appropriately skilled tradesmen. Traffic Manager Andrew Baird was fully extended in controlling these operations, while Thomas Willans was heavily involved in maintaining the rather antiquated rolling stock. The iron road reached Kumayli by the end of March; the length of

main line was eleven miles, a further 2,000 yds of track and points being used in sidings and passing loops. Seven iron-girder bridges and treble that number of culverts and short spans carried the line over numerous watercourses. The longest bridge was over the River Haddas; it consisted of three spans of the 25-ft "barrack" girders, centrally and end supported on timber trestles. Photo 3 shows the 50-ft triple span over the Kumayli torrent, built with proper iron railway girders. All bridging was done when the watercourses were dry, the groundsill of an intermediate trestle being embedded to a depth of 5 ft in the river bottom to prevent scour. By mid-May the monsoon rains had filled the larger rivers to a depth of about 7 ft, the water-level being only a few inches clear of the girders.

The development of the landing place and base at Zula proceeded concurrently with railway construction and the influx of masses of men, animals and stores. All Engineer work there was directed by the CRE, Lieut-Colonel H. St C. Wilkins, RE, and his staff of Field Engineers. By Indian Army procedure most RE officers were Field or Assistant Field Engineers, a Sapper and Miner Company generally having only one RE officer regimentally employed.

The important early requirement was the construction of the piers (Photo 2) and this was completed by two companies of Bombay S and M between October and January 1968. Brushwood fascines were used at first, and then enormous quantities of stone had to be brought by native craft from the opposite shore of the bay, four miles away. As more and more troops and animals were landed, further S and M companies were employed on timber accommodation and road construction. At the end of January the advance of the main force to the interior had started. Two companies of Madras Sappers remained in the base area for the whole campaign, for general engineer work there.

Wilkins's main source of labour was the Army Works Corps, recruited in Bombay in November 1867. By mid-February all had been landed at Zula, and were deployed on works. They numbered just over 1,000 all told, and consisted of a motley collection of Hindus, Mussulmen, Maharattas, Chinese and Eurasians, with every possible hue of skin and colour of turban. This Corps provided all the unskilled labour for the base and earthworks of the railway; platelaying was done by the 23rd Punjab Pioneers and the 3rd Bombay Grenadiers.

The magnitude of operations is well illustrated by some details of the "Stone Pier" (Photo 1). It was 950 ft long, and at first formed as a stone causeway carrying a single line of tramway. Later it was widened by imported teak piles and timber decking to a general width of 27 ft, broadening to 92 ft at the pierhead, where the deck was 12 ft 8 in above sea bottom. It allowed for the berthing of ships of 6 ft draught, even at low tide, and carried a single rail track with a siding at the pierhead. For its construction 14,000 tons of stone were ferried across Annesley Bay. The commissariat "Pile Pier" was 1,200 ft long, and largely constructed of teak piles from India. During the period November 1867 to April 1868 structural work, apart from the railway, consisted of the piers, considerable sea wall, hutted accommodation for 4,000 men, a hospital and a graveyard complete with 100 teak crosses.

The Sapper telegraphists and signallers worked as a single team under Lieutenant St John, assisted by Lieutenant Morgan. The Chatham lights were never used; they were far too cumbersome for transport on the march to Magdala. At the head of Napier's column on the arduous line of march the flag signallers proved invaluable. The General Staff accepted with much gratification and surprise that a verbal message could be signalled two or three miles in a matter of minutes, whereas, if delivered by hand, the time would have been a matter of hours in that appalling country.

The field telegraph, 197 miles of overhead line, was erected under the direction of Lieutenant O. St John from Zula to Antalo, which was reached on 2 April 1868. It was 200 miles short of Magdala, then within eight days' march of advanced H.Q.; the telegraph line was not therefore extended further. The rate of progress was much slower than that of Napier's HQ on the line of march, owing to the great toil of bringing up line stores on pack animals.

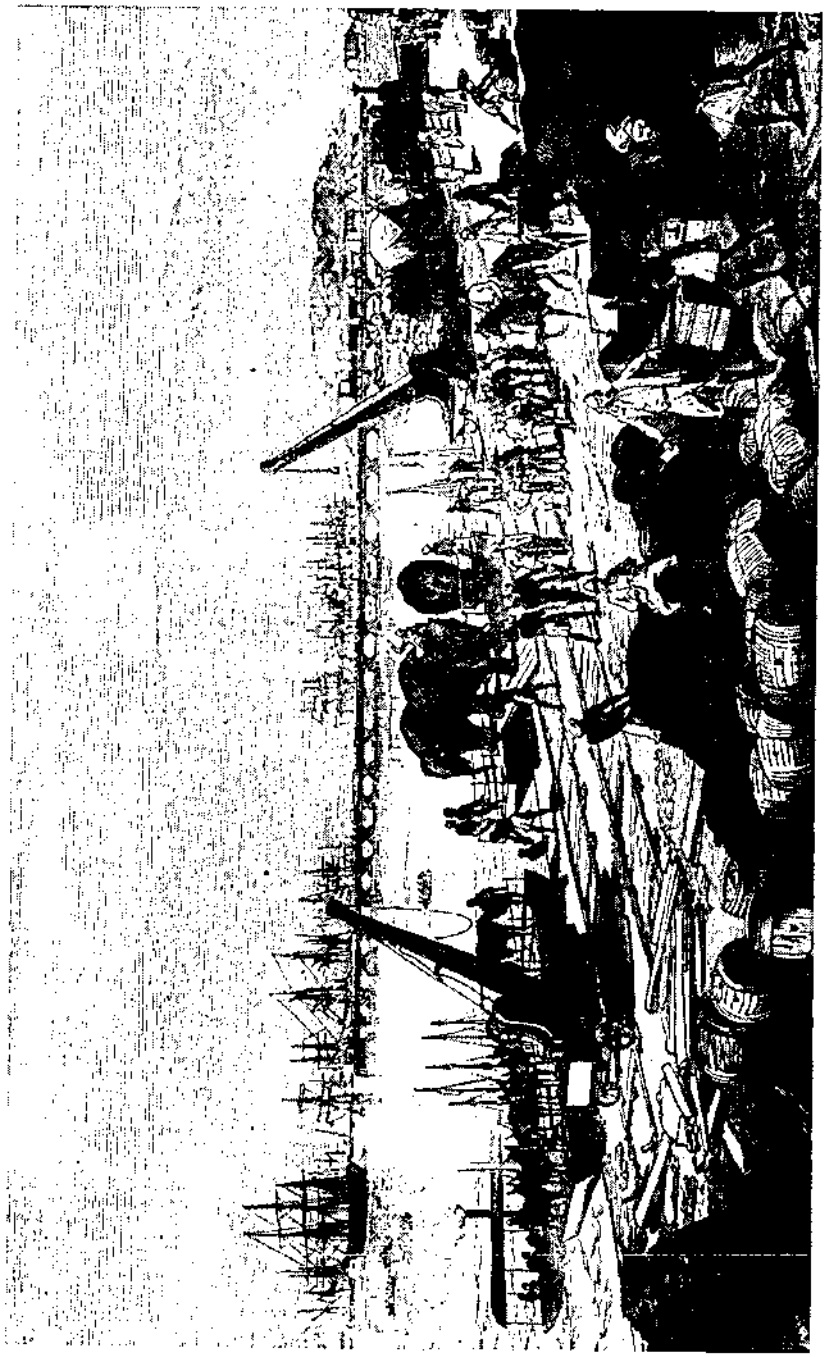


Photo 2. The Port of Zula (1868), built under the direction of Lieut-Colonel H. St. C. Wilkins, RE.

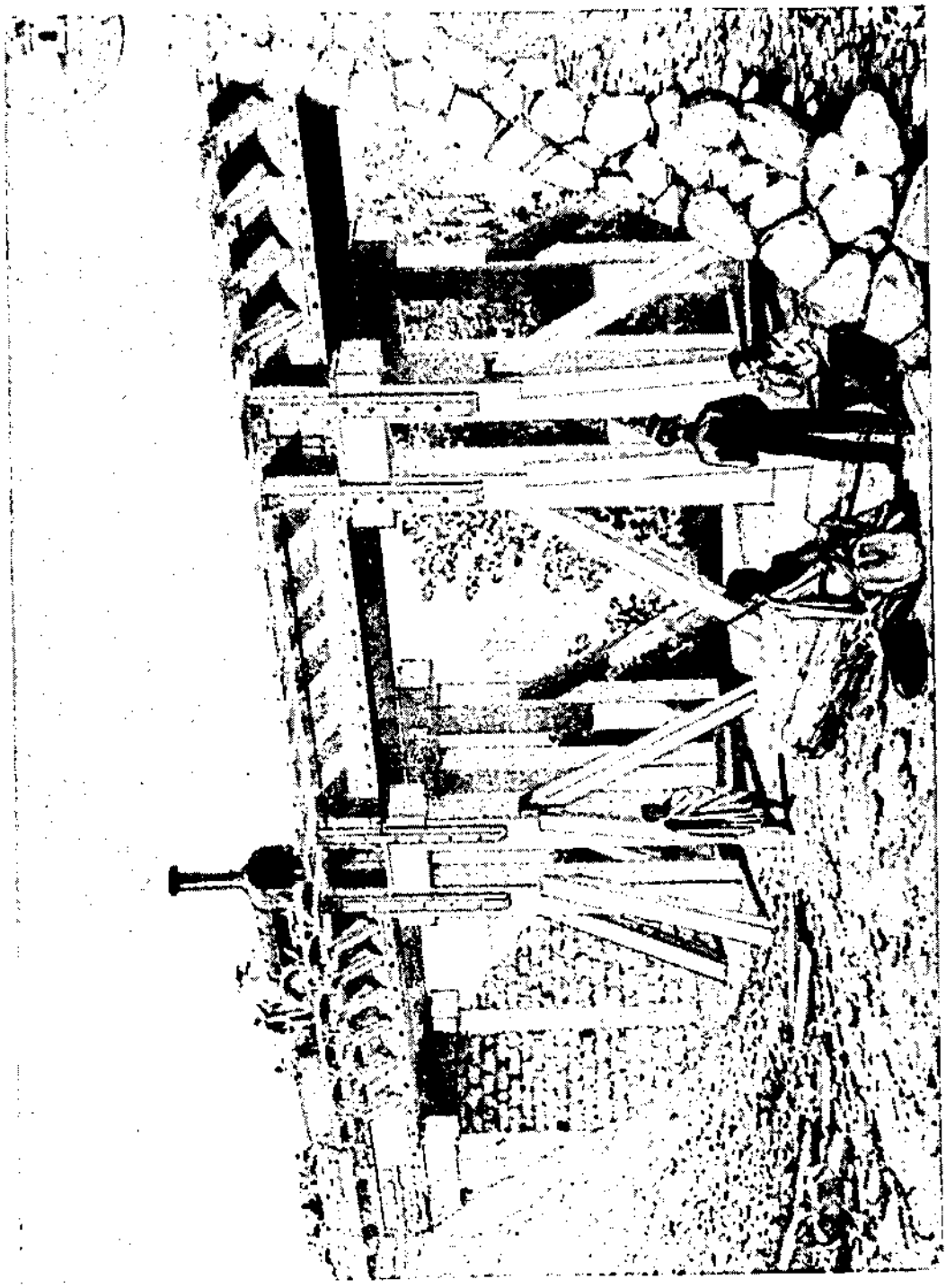


Photo 4. Water point with Owen & Clinton pumps near Kumayli, by Lieutenant A. Le Messurier and the well-borers of 10th Company, R.E.

A further difficulty in line erection was the lack of overhead supports; the wire was fixed to any elevated rock, bush or stunted tree on the route. Great use was made of insulators spiked direct to rocks, or affixed by improvised means to a crevice. For the last fifty miles, where the country was predominantly flat and barren, it was necessary to bring up 700 bamboo poles by native porters from Zula. Much energy was expended in keeping the line in working order. It was prone to disruption by passing traffic and transport animals, due to the lack of high or strong enough supports; thousands of yards of the copper wire were pilfered by Abyssinians. Further, the wire stretched considerably, after being strained between supports, so that it hung in loose festoons, all the more liable to damage and theft. In spite of interruptions, the telegraph handled an ever-growing number of messages, which averaged 100 a day in the month of May 1868. A line was also erected along the railway to Kumayli, for exclusive use on railway operation; this line of iron wire used magnetic single-needle instruments.

Augustus Le Messurier and his well-boring section were responsible for the construction of water points for the whole force. At the start of operations water for the base at Zula was supplied by naval condensers on ship or shore. The sappers, aided by pioneer labour, laid pipelines leading to inshore water points; here much construction was required for the thousands of animals, which accounted for about 80 per cent of the total consumption! The thirsty quadrupeds had a nasty habit of stampeding the drinking troughs, and a vital feature of RE construction consisted of stout timber crush barriers.

In the vicinity of Kumayli, ten miles inland, a major water point was established (Photo 4); here a perennial supply was available from existing deep wells, and from tube wells sunk in the dry river bed. The installed equipment consisted of three Owen & Clinton pumps, six Norton tube wells, five portable and one Bastier 2½-in chain pump. Le Messurier carefully noted that on 19 January 1868 he supplied water to 2,380 camels, 2,646 mules, 879 ponies, 400 bullocks and 20 elephants, as well as numerous troops and followers in transit. The average daily requirement for an animal was 4 gallons, but a camel which had not been watered for several days consumed 6 gallons at a single go.

For continuous supply at an important water point, the Bastier pumps were invaluable; for pack transport on the mountainous track to Magdala, the Norton tubes were found to be the only practicable equipment, in the absence of open shallow wells or streams.

Sergeant Harrold and his photographers accompanied Napier all the way to Magdala. They recorded a fine selection of views and incidents, working mostly in the evening and early morning, when the light was considered suitable. No photo could be taken unless the dark tent was first erected close by; here, each glass negative, first coated with iodized collodion, was sensitized in a bath of silver nitrate. The plate was then exposed wet in the camera for several seconds, and rapidly carried back to the tent for development, before the collodion emulsion dried. If all went well, the result was a negative from which many prints could be taken.

For photo-copying plans, there was a folding table, 7 ft 6 in long, with a headboard at one end to which the original plan was affixed. Brass rails ran the length of the table, on which the camera could slide to a position to suit the scale reduction required. The men sat up all night sensitizing paper for prints, this being greatly preferable to day-time work in a hot and stuffy dark tent. In all, 15,200 prints were supplied, many copies of plans and sketch maps being mounted on linen for staff use.

The 10th Company signallers had their moment of glory on 13 April, at the final assault on the walls of Magdala. The outer wall was of random masonry about 12 ft in height and thickness. The only gate was heavily blocked with stone, and approached by an extremely precipitous path. Major Pritchard's original plan, of blowing it open with gunpowder, was discarded as unlikely to succeed and too dangerous to the assault parties; he and some sappers therefore tried to force an entrance with crowbars, in the face of musket fire from the garrison through loopholes in the wall.

However, the Sappers, with their breech-loading Snider rifles, fired point-blank through the same loopholes, to the great dismay of the defenders.

Meanwhile two men of the 33rd (Duke of Wellington's) Regiment managed to clamber over the wall 70 yds to the right; they then hauled their comrades and the Regimental Colours up over the wall by hand. At the same time, men of the Madras Sappers and Miners brought up some ladders, found at the foot of the path, to Lieutenant Le Messurier at the gate; by these, red-coated sappers scaled the wall close to the gate. With the wall pierced in two places, the defence panicked and all resistance ceased! Major Pritchard and two of his sappers were wounded; the 33rd had five wounded, and two of their men were awarded VCs.

King Theodore, deserted by his warriors, shot himself with a revolver presented to him by Queen Victoria. The European prisoners were freed, and, with Napier's mission at Magdala completed, the fantastic military procession turned about and ponderously retraced its steps to the starting point. Every scrap of military and engineer material was progressively taken up, reloaded on to pack transport, and returned to the Zula base, hundreds of miles away. The telegraph stations were dismantled and packed into their transit boxes; miles and miles of wire were rewound on to drums. Norton tubes were prised out of the ground, and all other pumping equipment sent on its homeward journey.

In the Takazze Valley, six days' march from Magdala, Jeffery Morgan, who had accompanied Napier all the way with his signallers, collapsed and died from fever. Sergeant Harrold recorded views of his funeral procession and grave, surrounded by his sappers; the rough-hewn headstone was nicely engraved with the words J. L. Morgan—Lt. R.E.—26.4.68.

At Zula base, vast numbers of men and animals and an enormous tonnage of stores were loaded on to ships, and sent on their way back to Aden, Bombay and Madras. By June little was left except the "Zula and Kumayli" Railway, manfully puffing and jogging the remnants of Napier's force on its last few miles. Then the railway trucks, the locomotives, the water tanks, and presumably the guard's watches, flags and bells, too, were hoisted on to ships to return to their homeland. But something remained! When it was all over Zula was left proudly in possession of twelve miles of rusting rail track, and a curious collection of assorted junk, which had once been rail trolleys.

One body of men sailed not eastwards but northward to Suez. Unique among the rest of the force, they wore scarlet tunics with white cross-belts and pill-box hats. They had to travel further than the others, and one of their number stayed behind, resting for eternity in the Takazze Valley. Lieutenants St John and Le Messurier returned to India, so only Major Gordon Pritchard and Arthur Puzey accompanied their sappers on the homeward journey.

The men took with them their personal baggage, all the photographic equipment and the Chatham lights; the Norton tubes, Bastier chain pumps, telegraph equipment and wire were sent to Bombay. They crossed the isthmus of Suez by rail to Alexandria, and there boarded the screw troopship, *Simoon*, which anchored off Spithead on 7 July 1868, after an eighteen-day voyage. The following day, they travelled on the Brighton and South Eastern Railway to Victoria, and then marched through the dusty London streets to London Bridge Station. The North Kent Railway bore them on their last journey to Strood, and an unbelievably happy welcome from the military and civil population. The *Chatham News* reported: "The Company, nearly as strong as when it left Chatham, returned to our Garrison, bronzed by African suns, with uniforms travel stained and work-stained—no longer the spruce 10th of November last, but bearing the honourable marks of that Abyssinian expedition and war, in which they had borne so notable a part."

Awaiting their arrival on Strood station platform were Major-General Simmons, HRH Prince Arthur, recently commissioned in the RE, and many staff officers of the REE. Outside the station was a great assembly of the local inhabitants, the RE band, the bugle band of the Royal Marines, and the drums and fifes of the 3rd Depot

Battalion RE. The streets of Strood and Rochester were ablaze with welcoming flags and streamers. Led by Major-General Simmons and his mounted staff, the 10th Company marched proudly through the decorated streets, to the band music of "See the Conquering Hero Comes" and "Home Sweet Home". To those men "home" meant Brompton Barracks, and the village of Brompton was wildly gay in all directions with a splendid display of flags and decorations; across the High Street was a streamer emblazoned with the words "Welcome Defenders of England's Honour".

On the square of Brompton Barracks were drawn up on parade all available officers and men of the RE; as the 10th passed through the Crimean Memorial Arch, led by the General, the troops presented arms in a General Salute. General Simmons then addressed the parade in eulogistic terms of the great and successful exploits of their returning comrades; he concluded this oration with an invitation to the 10th Company to a grand banquet, to be given by the Corps that evening.

At the appointed time the General and entire staff of the REE, accompanied by Prince Arthur, assembled in the Military Gymnasium, Brompton Barracks. For this great occasion, Sergeant-Major Kennedy, RE, doyen of the Sergeants' Mess, had composed a stirring poem of twenty-eight lines in ryhming couplets. On the entry of the 10th Company, Major R. Harrison, RE, the Brigade Major, declaimed this masterpiece, with the opening lines:

> Hail to our comrades of the Royal Engineers!
> Hail to the brave! why should we not receive them with three cheers?

Then followed laudatory passages on the imperishable glory of the Army, the Engineers in particular, Napier himself and the magnificent exploits in Abyssinia. Great acclamation greeted the final words:

> Comrades! that name adds to the fame and glory of our Corps;
> And may that fame in warlike page grow brighter more and more.
> Then Hurrah for brave Sir Robert! his like we've rarely seen.
> Hurrah too for our Royal Prince! Our Country! And our Queen!

The assembled company then sat down, and set about the serious business of the evening. Proceedings opened with a choice of oxtail, mock turtle or clear soup, followed by the alternatives of salmon, turbot, brill and mackerel. Then came in abundance a selection of pigeon pie, rump steak, forequarters of lamb, veal and ham pie, with more to come in the form of raspberry and cherry tarts, jellies and plum pudding. As an essential concomitant to this feast, there was a more than adequate supply of sherry, marsala, claret, champagne, port and punch.

At this stage Major-General Simmons withdrew with his staff, after a short farewell speech pleading a time-honoured previous engagement. Sergeant-Major Buttle, RE, then assumed the duties of Master of Ceremonies, and there followed toasts to the Queen, the Prince and Princess of Wales, Prince Arthur, General Sir Robert Napier, the Officers of the Corps, and finally the 10th Company RE, by which time, according to the *Chatham News*, there was, not surprisingly, "much conviviality". But the evening was only just starting! The banquet tables were cleared aside, and the doors of the Gymnasium flung open to admit Sappers of all ranks, with their wives and sweethearts. The stage was set for a Grand Concert, at which the RE Band vied with brilliant performances of songs, recitations, glees and choruses by members of the Sergeants' Mess. Then there was dancing and much more conviviality, until that day of days drew to its close, in the small hours of a warm summer night, long long ago.

For the next few days there was dreary business at the Quartermaster's Stores, returning equipment and replacing rather tattered clothing. The men were given two months' leave, and returned to continue their service under rather less glamorous conditions. The 10th Company RE continued in existence for many more years, but it retained for ever the distinction of those novel technical services, rendered on active operations, the like of which had never existed before.

Correspondence

Colonel L. J. Cardew-Wood, BSc, FCGI, FICE, FIMechE, AFRAES
Tile House,
Hampden Close,
Stoke Poges, Bucks.
8 February 1970

THE DECEMBER 1969 JOURNAL

Sir,—May I congratulate all contributors to the December edition of our *Journal*. For me, the articles have been not only intensely interesting but many of them evocative. Will you allow a few comments?

Malta I know well and deeply appreciate the "Panoramic considerations" and "Aesthetics" which form such a vital part of the planning of the new road. Would that others, in Malta and in the UK, had the same high principles.

The soil of Malta is very fertile and can support several crops a year if irrigation is available. What an excellent economic contribution it would be if small reservoirs could be cheaply incorporated with road construction. The depth to area design should be as high as possible to avoid evaporation losses.

When Malta was a naval base the contribution in pounds sterling *per capita* to Malta from the UK was very high. A pity that prescience did not impel us then, while the going was good, to encourage or finance more water impoundment.

During the last war, as Director of Special Operations Development in India, I maintained close contact with the late Sir Shantilal Bhatnugger, FRS, then Director of Scientific and Industrial Research in India. He remarked to me that in the long term his country would have been better served by the practical Germanic outlook rather than the sentimental approach of the British, who had saved the lives of millions through ante- and post-natal care and the wide distribution of Government dispensaries (which coped adequately with normal destructive diseases such as malaria and dysentry) and had only thereafter started to build dams on a sufficient scale in the wellnigh impossible task of providing food for the increased and increasing population. The Germans, Sir Shantilal said, would have built the dams first and saved lives afterwards.

Bridge demolition at Litchfield, in an area I know well through fishing and shooting, details a beautifully tidy job in which I should have delighted to participate, though tidiness did not enter into the demolitions I helped to plan, and provide tailor-made charges for, raids during the last war. Their basis was minimum weight for the job combined with maximum simplicity, for a trained Sapper was not always available for their use. Perhaps the maximum effect for minimum weight was the 2 oz of PX per inch bands of hollow charges which enabled parachutists to cut the pinstocks above the Norwegian heavy-water plant. The effect of a vast volume of water released under a high static head accounted for the power station as well as the pinstocks.

Anglers moved for bomb reminds me of a much less dramatic but very amusing test in the early forties. We had been asked to design and provide some delayed-action mines which would move with the tide in median water-level in an endeavour to deal with some important lock gates in enemy-occupied territory. We needed a lake for a trial explosion. This was lent by the civil authorities, but safety precautions were up to us. I had the area well combed by NCOs with loud-speakers, but, on taking a last personal look round, I found a couple, well camouflaged under a groundsheet. Their preoccupation had precluded them from noting or hearing any other activity in their vicinity and discreet coughs brought no recognition. Time was getting short. I delivered a sharp slap on the highest point beneath the camouflage and remarked: "My apologies for interrupting you, but in exactly two minutes there is going to be an almighty explosion in the lake. Get out of here quick! Don't be embarrassed—I'm off!"

As an angler, my heart bled for the men who fished that lake, for our chaps went back to camp with sackloads of fish killed by the explosion. I was assured that many of them provided a welcome change of diet.

Disaster aid in the UK. This excellent analysis reminds me of the lighter side of the *Torrey Canyon* oil pollution. I cannot give too much detail, but naval friends have told me of their senior officers' openly expressed opinion of ill-formed and uncoordinated non-service officials who wasted their time, and I would particularly liked to have listened-in to the signals between Navy and Air Force while the *Torrey Canyon* was being bombed.

If you see fit to print some of these rambling reminiscences, may I suggest that a little of this type of correspondence may lead to new "pen-friends" (I made one through my article on the Sappers Club in South Africa) and may be of particular interest to retired Sappers, especially to those whose contacts are tenuous in that they have not had the privilege of a Regular Army Commission. Yours faithfully, L. J. Cardew-Wood.

Note: This letter was received too late for publication in the March *Journal*. Editor.

Brigadier L. O. Clark, OBE
18 Redhills
Budleigh Salterton
Devon

16 March 70

THE ARDENNES IN MY HAIR

Dear Sir,—I have just read John S. D. Eisenhower's enthralling book, *The Bitter Woods.*

This has driven me into reminiscence, probably unwisely.

In 1915 at school I was told that the German attack through the Ardennes in 1914 was a complete surprise to the French, who thought the country too rugged to support any major attack; but that it had been foreseen by certain British generals, who before 1914 had spent their leave cycling in the Ardennes, studying the ground over which they knew the Germans would come.

At the Armistice in 1918 the 55th Field Company, in which I was then serving, found itself in Maubeuge. After a decent interval, we marched to Cologne in the wake of the defeated Germans, by way of the Ardennes. We crossed the Meuse by a bridge between Givet and Dinant, and billeted one night in the grounds of a country house in Marche. Two days out, among the hills, I was given a week's leave. I rode my pony, with a driver on another horse to take back my pony, to the railway at Ciney. I was lucky; I got a lift on the footplate of a light engine going to railhead at Charleroi, and so home. The roads and bridges in the Ardennes seemed to me then to be magnificent. Perhaps I was jaundiced by months of repairing French roads and bridges. However, my Company Commander, a tough Colonial character, swore that the Germans had built all those beautiful east-west roads before 1914 a' purpose.

During the Staff College course of 1933–4, we had a "European War Exercise", in which students took German and Allied sides, to study how the Germans would attack the next time. Both sides came up with the same solution. They said the main German thrust, probably by ten armoured divisions, would come through the Ardennes. In 1940 the Germans did just that, in slightly greater strength. This apparently completely surprised the French, as they had no reserves ready to meet it.

In 1944 the Allies attacked north to Arnhem, leaving a vast extended right flank, in places very tenuously held. In December 1944, to the complete surprise of Allied Intelligence, the Germans counter-attacked the most vulnerable point on this flank, through the Ardennes, of all unlikely places. XXX Corps was hastily rushed down towards Dinant, to act as a backstop.

We prepared the Meuse bridges from Givet to Huy for demolition, including the one I had crossed in 1918. We had little to do, owing to the magnificent fighting of the Americans. The German spearhead of 2nd Panzer Division was destroyed by the US 2nd Division on Christmas Day about Ciney and Celles, within earshot of the Meuse bridges.

A few days later we moved across the Meuse, passed through Ciney, and billeted in that same country house in Marche. The countryside was deep in snow, but the follow-up was comparatively easy over that excellent road-system.

When the next attack on western Europe occurs, perhaps we should keep one eye firmly on the Ardennes. I feel sure I shall be there in spirit, though almost certainly not in the flesh.

Yours faithfully, L. O. Clark

Brigadier G. Streeten, CBE, MC, FICE,
The Grange,
Ash, Martock, Somerset.

28 March 1970

A TROPHY OF THE CONQUEST

Sir,—I was much interested in the article "A Trophy of the Conquest" in the March 1970 number of the *RE Journal*.

During the 1939–45 War I was in those parts. I found that a well near Quseir, on the track from that place to Qift on the Nile, was still known locally as the "Inglesi" well, doubtless after the expedition from India in 1801. Yours faithfully, G. Streeten.

Major J. A. Benham Crosswell, RE
GSO (W), HQ E-in-C Branch, Chatham.

30 April 1970

ROYAL ENGINEERS IN THE EIGHTIES

Sir,—Major Peter Dell in his article "Royal Engineers in the 1980s" has roamed far and wide under that title to cover such perennial controversies as the conflicting roles of engineers between the worldwide commitment and that of Europe; the (apparent) differing capabilities of civil engineers and military engineers; the end of specialized units; the professional training of Royal Engineer officers, and the manpower strength of field squadrons. He has even suggested that the Corps should once more be divided, as it was between Field and Works! Thus everyone has been given some thing to think about. May I take the opportunity to deal with at least some of the fundamental topics, and thus leave room for others to take issue at a later date.

I take as the first point the organization of engineers for their role in 1980. The basic assumptions I believe are correct, except that NATO will continue in some form or other. The European role is likely to continue dominant, but there will remain a continuing commitment worldwide on a smaller scale. Successive White Papers have provided the structure which must be built upon and, notwithstanding future elections, I cannot foresee the constraints of finance and recruiting being much altered. Principally this means that no unit will survive scrutiny unless it is justified by a role in Europe. The BAOR order of battle is already pitifully small and there are also certain L of C commitments which can no longer be swept under the carpet. In short, one can only start dividing forces between roles when they are large enough to do so. If all the forces cannot even carry out one role, then it is perhaps unwise to so organize them that they cannot readily be diverted from one to the other! The basic requirement is a general purpose squadron which can go anywhere and do anything subject to appropriate small increments of specialists for particular tasks.

The second point is the equipment for these general-purpose squadrons. Those in BAOR will be equipped solely for the role in Europe. The problem of duality lies with those in the Strategic Reserve, whose primary role will be the rapid reinforcement of NATO, but whose organic equipment must ensure the capacity to undertake operations outside Europe. It is true that there will be an increase in mechanization and that these equipments will be purpose-built for a war in Europe. The section vehicle will be an engineer derivative of the future Mechanized Infantry Combat Vehicle (MICV), which will afford protection and permit the use of power-hand tools. The troop will have as its plant the Combat Engineer Tractor (CET) and its successor. Between these two basic equipments must be shared the capabilities for performing rapid demolitions, mine-clearance and bridging, ideally without the need for troops to dismount. With field sections given this degree of protection, and with a position bridge-laying capability for the successor to the CET, the specialization of Armoured Engineers would indeed seem superfluous! But are we ever sure that the surrender of these squadrons would release manpower for use elsewhere? It is likely that establishments will be revised and the manpower total cut accordingly. Of course, each vehicle and crew will operate as an entity, complete with commander, radio and protection armament, but is it really necessary to call them "Equipment Operator Mechanic"? The extension of this designation to tank crews of the Royal Armoured Corps is clearly absurd!

The third point is the manpower requirement. In general mechanization should reduce

the manpower required for any task. If the tendency continues towards more battlefield tasks being undertaken by armoured plant equipments, then it is difficult to concede that more manpower is needed in the squadrons in BAOR. In fact, similar to the Infantry in the back of the MICV, one must begin to question what the engineer section will be engaged upon whilst under the protection of its armoured vehicle. In the case of the Strategic Reserve Squadrons, there will continue to be a problem, since the same degree of mechanization is not compatible with air-mobility. It may therefore be the case that they will require more manpower than the BAOR squadrons.

Next consider the training and structure of the Corps. The battle in Europe will not be one that can be taken on without prior training, and it will be perplexing if the amount of time and effort which Strategic Reserve units can afford, to keep in touch with BAOR problems and tactics, continues to be so scant. It may well be true that BAOR will not need "civil" engineers, even for RAF support and L of C tasks. Military engineers usually have more civil engineering capability than is at first apparent, and thus the invidious distinction between military engineer and professionally qualified engineer (PQE) should be finally buried. The obtaining of a civilian professional qualification must be regarded only as a step towards making the military engineer more proficient in his general responsibilities. However, it should be inconceivable that the technical demands will grow to the point suggested where there will be less time for Royal Engineer officers to prepare themselves for senior command and staff appointments.

Finally, the issue of recruiting. Is it not pure delusion to suggest recruiting could have any success if linked mainly with longer tours in BAOR and only a limited (civilian) trade training? Surely it will still be the chance of trade and travel which will bring recuits in. One might well find a flood of recruits for the Strategic Reserve, and none for BAOR!

To conclude, there will continue to be this controversy as to whether one role or the other should be accentuated; whether to organize separately for the BAOR and Strategic Reserve roles, or to ensure that military engineering implies a sound knowledge of civil engineering techniques. In view of the small size of the Army and the Corps of Royal Engineers within it, it is desirable that the present organization should continue so that flexibility is retained. In essence, this means that any unit must continue to expect to be asked to undertake any task, and it is absolutely vital that those who manage the Corps in the future ensure that the right expertise exists in the right quantities at the right time.—Yours faithfully, J. A. Benham Crosswell.

Memoirs

LIEUTENANT-GENERAL R. K. KOCHHAR, MBE

BORN 1913. One time GC at the "Shop", Undergraduate at Peterhouse, Half-blue at squash, QVO Madras Sapper and Miner, and one of the first Indian subalterns to command a Field Section in 15 Field Company.

He was the first Indian Commandant of the Madras Sappers in 1948 and finished a distinguished career, before retirement, as Quartermaster-General at Army Headquarters.

He died on 20 August 1969.

A TRIBUTE

I was sorry to learn of the early death of Kochh, as we called him; he was such a fit young subaltern when I was his Commanding Officer and, having come through the war, I imagined he would live to a ripe old age, especially as his father seemed such a fit man, too, when we were all together in Singapore in 1940.

I was very proud of our 15 Field Company and was quietly confident on marching out of Meeanee Lines in July 1939 for embarkation to almost certain war that, come what may, we would do well. And my confidence lay in the trust I had in chaps like Kochh, Bewoor, Partap Narayan, WO1 Appiah Dass, and some 380 others in the Company.

Distinctions are invidious, but I had a great opinion of Kochh as an officer, a real liking for his quick understanding and cheerful personality, and an admiration for his skill at games; he could knock my head off at tennis and squash, but he did it so nicely!

So happy was I with them all in Malaya that I had to be ordered to accept a War Time Course at the Staff College, Quetta, and was somewhat jealous of handing over a darned fine unit to Bob Muir, my No. 2, before it could be tested in battle. The reputation that the unit gained subsequently in the operations was thoroughly deserved; Ian Stuart of Argylls fame told me, later, that no finer show was put up so consistently than by 15 Field Company; and, knowing him well as I did, that is praise indeed.

I feel sure that Bob Muir, who then commanded, would agree with me that solid foundations of loyalty, hard work and efficiency in this newly reorganized Company with its different Command structure were firmly laid by Kochh and chaps like him. His example of untiring energy, his friendliness and manliness, and his insistence on high standards especially when working for others certainly helped the unit earn its splendid reputation when the test came.

Never shall I forget that morning in 1945, the second morning of Operation "Zipper", when, as a CRE back in Malaya, I made my way to Port Dickson on hearing there were some Madras Sappers in the prisoner of war camp there in the Police Lines. Twenty to thirty chaps tumbled out of a barrack block and I can hear the shout now "Godwin Sahib agya". Later, they insisted on marching past me, and their bearing and fortitude after years of beastly ordeal was the most inspiring example of morale I have ever seen; and if Kochh had been one of them, I know he would have led them, a man who so typified to me the Madras Sapper spirit. That spirit is one of the best things I found in life, where personal character and ability meant so much more than origin, race or creed; it's a pity there isn't more of it in the world of today.

Lieutenant-General R K Kochhar MBE

My last glimpse of him was in New Delhi in 1950, when I was Colonel GS to CIGS General Slim, who was lecturing to the GHQ Staff on our way back from Australia. We were milling around meeting many old friends outside the Lecture Hall in the long corridor when, out of the throng, wove Brigadier Kochh with a wide grin of welcome. Seeing his rank, I threw him a salute to his great confusion, but to my great pleasure. A moment or two later, when he happened to turn his back on me, I seized an unobserved moment to kick him gently on the backside. With an even wider grin, he whipped round and said: "Thank God you did that, Jimmy; I feel so much better." And that was the man Kochh; a man above all else; and such a likeable one, too. No wonder our task of indianization went so smoothly.

J.F.G.

MAJOR-GENERAL W. L. D. VEITCH, CB, CBE

WILLIAM LIONEL DOUGLAS VEITCH, who died in Edinburgh on 13 December 1969, aged 68, was born at Belhaven, East Lothian, on 21 November 1901, the son of the Rev William Veitch, MA, TD, the minister of the parish. Educated at Edinburgh Academy and the Royal Military Academy, Woolwich, he was commissioned into the Royal Engineers on 13 July 1921.

After his course at Chatham with No 5 JO (Tuck's) Batch he was posted, in 1924, to India, where he spent the whole of the rest of his service.

On arrival in India, Bill Veitch joined the KGO Bengal Sappers and Miners at their Headquarters at Roorkee, and for the next five years he carried out various regimental duties, including service with No 7 Bridging Train and as Assistant Superintendent of Instruction at Roorkee; with the Defence Light Section at Calcutta; and as Company Officer of No 5 Field Company at Rawalpindi.

In 1930 he was posted to the Military Engineering Service as Garrison Engineer of the Wana Road Project at Tanai in Waziristan, where he gained the Indian NW Frontier medal and clasp and a mention in despatches.

Returning to regimental duty with the Sappers and Miners in 1932, Veitch was employed in turn as Company Commander of No 41 Div HQ Company, as Assistant Superintendent of Park and finally as Company Commander of No 5 Field Company, then at Roorkee. In 1937 No 5 Field Company was ordered to Waziristan and took part in the frontier operations of that year. After a short period at Dosalli Camp employed on water supply and local road construction the Company moved to Coronation Camp, where the next five months were spent on the construction of the road from Dosalli to Ghariom and on to Shawali, and on providing semi-permanent water supply to various posts. Finally, the Company moved to Bhittani Camp, where it was employed on further road construction work. In all this work Veitch's previous experience with the MES on frontier roads stood him in good stead, and his work was rewarded with a mention in despatches and, later, with the award of the OBE.

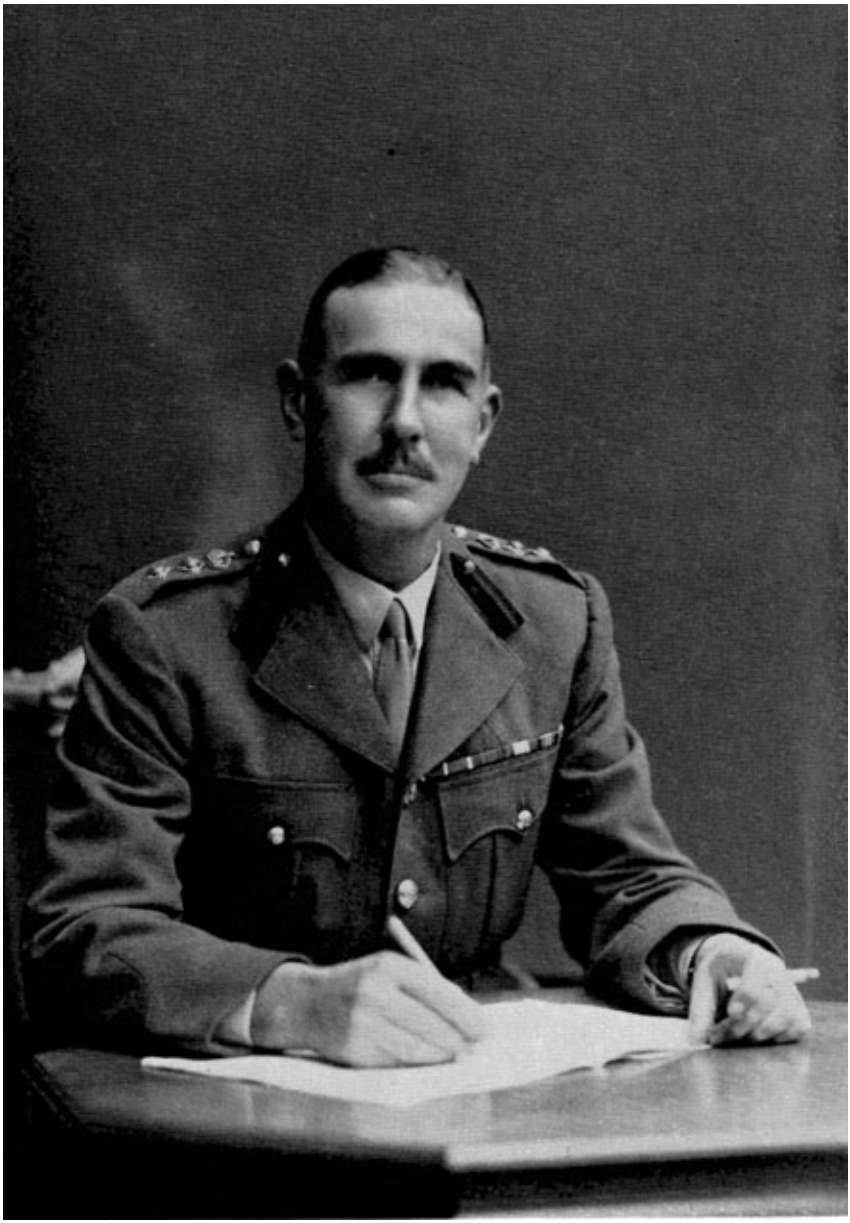
Returning to Roorkee in 1938, he was appointed Officer in charge of Workshops, an appointment he was holding on the outbreak of the 1939–45 War. Soon after the war started, Veitch was given command of the Training Battalion at Roorkee, and in 1941 he was posted as CRE of the 19th Indian Division then in training in Southern India.

In 1942 he was appointed Commandant of No 1 Engineer Group, Royal Indian Engineers, at Lahore, which was responsible for raising certain specialist engineer units for employment as Corps, Army and GHQ Troops, in particular Artisan Works Companies, Electrical and Mechanical Companies and Machinery Equipment Companies. This was an important task for which his marked organizing ability eminently suited him.

From 1944 to 1946 Veitch was Commandant of the Bengal Sappers and Miners, and he later became Deputy Chief Engineer, Northern Army, India, which appointment he was holding on the Declaration of Independence in 1947. After Independence he became Deputy Engineer-in-Chief of the Pakistan Army and in 1950 was appointed their Engineer-in-Chief with the rank of Major-General. This appointment he held till forced to retire by ill health in 1953.

Bill Veitch was an officer of strong character and sturdy independence, who won a reputation as a very fine administrator, an excellent trainer and an indefatigable worker. He had a strong sense of justice and a hatred of what he considered unfairness; he had a high sense of duty and set very high standards, detesting slackness and inefficiency.

Devoted to his troops, he took endless trouble over their training and welfare. He earned among them the name of the "Wakil Sahib", as they could always go to him for advice and help over their domestic and village problems. He was, perhaps,



Major-General W L D Veitch CB CBE

especially in sympathy with the Punjabi Mahommedans, and in particular with those from the Hazara District among whom he had many friends.

He was never a keen games player, partially due to a knee injury in his school-days, but had many outdoor interests. He was a whipper in to the RE Beagles during his Chatham Course and played station polo regularly; but his main hobbies were fishing and big-game shooting. Many of us will remember the shoots he organized in the forest blocks near Roorkee.

He was a loyal friend, a generous host, and an inspiration to the young.

After his retirement in 1953 Veitch underwent a serious operation and suffered a permanent disability which he most gallantly fought till the end. He settled first at Forres and later, in the Borders at St Boswells. During this period he paid frequent visits to Pakistan, where he pursued his fishing and took a very keen interest in sport, particularly athletics, boxing and swimming. There he attended nearly every meeting at which Sapper representatives took part, giving great pleasure and encouragement to the Pakistan Sappers. Returning to Scotland in the summer months, he made regular fishing trips with Dick Connor, who unfortunately only survived him by a few months, to the Western Isles and Sutherland, where he was a most popular visitor.

Bill Veitch was honoured with the CB and the CBE. He took great pride in having been accepted as a member of the Frontier Force Club; but what he always considered the crowning honour of his career was his appointment as the first Colonel Commandant of the Pakistan Engineers. His portrait hangs in their Mess at Risalpur—a memorial of his devoted service to the country and the people he loved so well.

J.R.C. K.G.M. R.K.M.

COLONEL J. R. CONNOR, CBE

JOHN RICHARD (DICK) CONNOR was born on 8 October 1908, the son of the late Colonel John Colpoys Connor, CMG, RAMC, and of Mrs Evelyn Connor, who now lives in Windsor.

He was educated at Harrow School (1922–7), the RMA Woolwich (1927–8) and Emmanuel College, Cambridge (1929–31).

He was commissioned into the Corps of Royal Engineers on 30 August 1928, a member of 20 YO Batch, and his first posting, in 1931, was to India, where he joined the KGV's Own Bengal Sappers and Miners, at Roorkee.

He continued to serve with that Corps until 1942, mostly in Roorkee, but with interludes on active service on the North-West Frontier in the Loe Agra operations of 1935 and in the Waziristan operations of 1936–7. His long service in Roorkee, which he loved dearly, gave him the opportunities, which he took so enthusiastically, to become an expert big and small game shot and fisherman. Jungle shikar in the forest blocks of the United Provinces or duck shooting on the jheels with Dick will raise nostalgic memories for many Roorkee Sappers. He was always a delightful companion and ready to introduce newcomers to the arts of these sports at which he was himself so competent.

In 1942 he attended the 6th War Course at the Quetta Staff College and, after a short spell as SORE II G(Trg) North-Western Army, India, he was appointed CRE 15 Indian Corps Troops Engineers and saw active service in the Arakan, where he was mentioned in despatches and was awarded the Burma Star and the OBE (1945).

Later in 1945 he returned to Roorkee to become Assistant Commandant (Training), and in 1947 he became the last Commandant of the Bengal Group of the Royal Indian Engineers before "Partition".

When Connor first joined the Bengal Sappers and Miners in 1931 their role was primarily for employment in mountain frontier warfare and they were equipped for the most part with hand tools and horse and pack-mule transport. There was even an elephant on their establishment, possibly the last elephant of the Indian Army. During his long service with that Corps a great transformation took place, and Connor personally played a very considerable part in the conversion of the Corps to a role in keeping with employment in a World War completely equipped with modern mechanized transport, power tools and highly technical engineer equipments and, when hostilities broke out, the enormous expansion of that magnificent Corps which served with such distinction in the Middle East and in Burma.

He understood, appreciated and admired the Punjabi Musselmen, Hindus, Sikhs and Pathans, who formed the Bengal Sappers and Miners and they loved and greatly respected him.

When independence came to India in 1947 he was selected to take those Bengal Sappers who were destined for Pakistan from Roorkee to Sialkot, where he set up the new Training Centre of the Royal Pakistan Engineers and became their first Commandant.

He remained in that appointment, with short periods with the E-in-C Pakistan and as Director, Pakistan Engineers, until 1958, when he retired. He was created CBE in 1954.

He was passionately interested in athletics, particularly swimming and boxing, and in Pakistan he took a great personal interest in the training of individuals and teams for local and international athletic competitions. He supervised the training of the Pakistan teams for the 1956 Olympics in Australia and he trained and led the Pakistan team in the Empire and Commonwealth Games at Cardiff Arms Park in 1958.

On retirement, he settled in Melrose, where he spent much of his time adding to his already considerable reputation as a fisherman and taking a heavy toll of the salmon in the Tweed and other Scottish rivers.

Colonel J R Connor CBE

He died at Melrose on 4 March 1970 and he will be sadly missed by his many friends in this country and also by many in India and Pakistan, where he gave such devoted service for twenty-seven years.

Our deepest sympathies are extended to his mother and his sister, Hazel Fisher.

J.K.S.

Book Review

SURVEYORS OF WORKS, ROYAL ENGINEERS

Their History and Development

BRIGADIER C. F. ATKINSON, FRICS

(Printed by Carey and Claridge Ltd, London)

It is not unnatural for a person, when commissioning a job where labour and materials have to be paid for, to ask before the work starts what the ultimate cost of the project will be. The early kings of this realm were no exception and the military engineer has been employed on work of this nature since Norman times; one of his several titles has been that of Surveyor of the King's Works. That he was required to make surveys, or estimates, is borne out by the many original papers that are still available for perusal, one of which, for work carried out during the threat of the Spanish Armada, is quoted by Brigadier Atkinson in his excellent book in which he, with justifiable pride, traces the history and development of the Surveyor of Works from earliest Norman times, through their many civil and military activities and titles, until the retirement of the last Quantity Surveyor RE.

Brigadier Atkinson was himself the last Chief Quantity Surveyor and retired in 1959 after a lifetime in the Corps, during which he rose from the rank of sapper to that of Brigadier. Although there was a further brief period when Quantity Surveyors were held on the Engineer Specialist Services Establishment, in 1966 the military Quantity Surveyor took his final bow.

The book is extremely well written and, although much of it is factual, it makes fascinating reading. There will be many members and ex-members of the Corps, especially those with little Works experience, who will learn much from this book about a branch of the Sappers that has for too long hidden its light under a bushel. The Corps can well be proud of the part the Surveyors of Works have played in the many great engineering projects carried out in all parts of the world, and we have reason to be grateful to the author for the immense care and trouble he has taken to compile this interesting record.

The book can be obtained from the Hon Secretary, RE Surveyors of Works Club, 86 Old Brompton Road, South Kensington, price 24*s* 6*d*. H.J.

Note by Editor: This issue of the *Journal* contains an article by Major (QS) (retired) W. A. Chapman, FRICS, on the training which has been going on at the RSME since 1966, in Surveyor of Works duties.

Technical Notes

CIVIL ENGINEERING

MARCH 1970

A STAGE APPROACH TO GROUND INVESTIGATION, by F. H. Hughes, BSc, MICE, MNZIE, FGS. The article is written round the story of the investigation for the alumina conveyor at Holyhead, where three quite different types of structure, a high-level bridge, a tunnel and a tube, were all open to consideration. The feasibility study and costing of the three options had to proceed in parallel until the most economic and practical type of structure became apparent.

The six stages of investigation put forward for problems of this type eliminate unnecessary and costly investigation and lead to the minimum delay. Each stage is completed before the next is started.

Stage 1 is the detailed collection and information under five headings or "5 Gs". Geographical report, Geological report, Groundwater information, Geometry of possible structures and Growth rate of possible structures.

Stage 2 is the desk study report which deals with the Geometry and Growth rate aspects in more detail.

Stage 3 includes the Geophysical, Hydrographic and other surveys.

Stage 4 is the basic borehole drilling programme, including both shell and auger boring of soils and diamond coring of rock to confirm the geophysical survey and prove soundness or otherwise. By the end of this stage the most attractive option should be evident.

Stage 5 is the continuation of the borehole programme based on the requirements for the chosen type of structure.

Stage 6 is the final report.

Following this sequence a comprehensive ground investigation can be achieved, and all the information collected is relevant to the final design.

The methods of drilling adopted in stages 4 and 5 of the Holyhead project will be of interest to Sappers. Drilling in a tidal and navigable waterway always demands careful planning and ingenuity. It is also worth noting that three specialist subcontractors were employed by the Site Investigation firm.

N.H.T.

Forthcoming Events

24 June	Corps Meeting and Dinner	London
25 June	Colonel's Commandant RE "At Home"	Hurlingham
3 July	RE Summer Ball	RE HQ Mess
22—23 July	RE Musical Extravaganza	Aldershot
23—26 July	Medway Regatta	River Medway
25—26 July	Aldershot REA Weekend	Aldershot
1 August	RSME Open Day	Brompton
17—20 September	REYC/RESA Regatta	River Medway
18 September	RESA AGM	Brompton
19—20 September	REA Weekend	Brompton and Chattenden

Sports and Games Fixtures 1970

RE Tennis Club

1 July	RE *v.* REME	Chatham
22 July	RE *v.* RCT	Chatham
24 July	RE *v.* RA	Chatham

RE Cricket Club

12 July	RE *v.* Free Foresters	Chatham
13 July	RE *v.* RCT	Chatham
14 July	RE *v.* Infantry	Chatham
15—16 July	RE *v.* R Sigs	Chatham
18 July	RE *v.* RM	Chatham
24—25 July	RE *v.* RA	Chatham
8—9 August	RE *v.* Band of Brothers	Chatham
12—13 August	RE *v.* Oxford Harlequins	Chatham