THE ROYAL ENGINEERS JOURNAL

Vol LXXXII JUNE 1968 No 2

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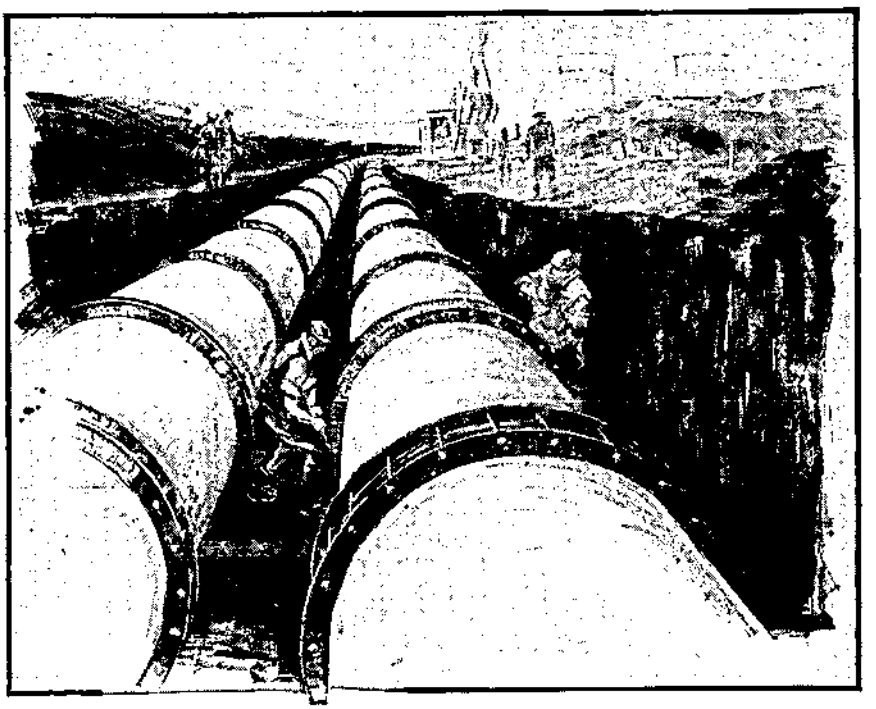

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THE ROYAL VISIT TO THE RSME
28 MARCH 1968
Her Majesty and HRH Prince Philip welcomed by the Chief Royal Engineer

The Royal Visit To The RSME, 28 March 1968

Visit of HM the Queen and HRH the Duke of Edinburgh to the Royal School of Military Engineering, Chatham, on 28 March 1968

ON a day of glorious springtime sunshine Her Majesty the Queen, in her capacity as Colonel-in-Chief of the Corps of Royal Engineers, accompanied by His Royal Highness the Duke of Edinburgh, graciously visited the Royal School of Military Engineering on the occasion of the completion of the School's Modernization Project.

The Countess of Leicester, Lieut-Colonel the Right Hon Sir Michael Adeane, Air Vice-Marshal Alan Boxer and Major Charles Howard were in attendance on Her Majesty and His Royal Highness.

On arrival at Gillingham railway station the Queen was received by the Lord-Lieutenant of the County of Kent, the Lord Cornwallis, KBE, MC, and the Mayor and Town Clerk of the Borough of Gillingham—Councillor F. W. Harris and Mr Glyn Jones. The Royal Party was not asked to ascend the steep, gloomy stairs by which ordinary folk leave the station, but was escorted to a flower-decked exit into Railway Street, where Penelope Johnson, the 14-year-old daughter of Major H. Johnson, presented the Queen with a bouquet. The route from the station to the Pasley Road entrance to the RSME was lined by a vast crowd which included thousands of joyful, excited children waving Union Jacks and red, white and blue streamers.

The Royal car, with its escorts and motor-cycle outriders, turned into Pasley Road at precisely 1115 hours. The Royal Standard was broken at Brompton Flag Station at Pasley House, the Corps Flag fluttered proudly over the Crimean Arch and the Flag of the Depot Regiment, RE, flew on Brompton Parade Ground. Her Majesty and His Royal Highness were greeted by the Chief Royal Engineer, General Sir Charles Jones, GCB, CBE, MC, and the Commandant RSME, Brigadier W. M. Inglis. Her Majesty then inspected a Guard of Honour, commanded by Major A. R. Russell, RE, comprising 2nd Lieutenant C. A. Lowe, RE, and ninety-six rank and file found by 12 RSME Regiment and drawn from the Plant, Roads and Airfields School. Among the reception party were General Sir Charles Richardson, GCB, CBE, DSO, Master General of the Ordnance and ADC General to the Queen, the Representative Colonel Commandant Major-General Sir Gerald Duke, KBE, CB, DSO, the Engineer-in-Chief Major-General J. H. S. Bowring, OBE, MC, the Royal Engineer ADCs to the Queen, Brigadiers K. H. Stevens, MBE, and R. H. Walker, and the Queen's Gurkha Orderly Officer Captain (QGO) Sherbahadur Limbu, the recipient of the 1966 Durand Medal.

After inspecting the Guard of Honour, the Royal Party moved into the resplendently redecorated Institution Building, where the wives of certain senior officers of the Corps were presented to the Queen in the foyer.

The Royal Party then entered the Library to meet representatives of Corps organizations and activities. Major-General T. H. F. Foulkes, CB, OBE, Colonel Commandant RE, President of the Institution of Royal Engineers, of which Her Majesty is Patron, Major-General Ll. Wansborough Jones, CB, CVO, CBE, Chairman of the Royal Engineers Association, of which Her Majesty is also Patron, Major-General G. N. Tuck, CB, CBE, Colonel Commandant RE, Chairman of the Royal Engineers Benevolent Fund, Major-General I. H. F. Boyd, CB, CBE, Colonel Commandant RE, Chairman of the Royal Engineers Officers' Widows Society, Major J. H. Grubb, Treasurer RE Corps Funds, Captain J. C. Baggett, Secretary of the

Corps Committee, and Mr A. W. Pullen the Editor of *The Sapper* were presented to the Queen by the Chief Royal Engineer.

Brigadier Inglis then briefly described to the Queen the role of the RSME, which is not only the Headquarters of Her Majesty's Royal Engineers but also the main training centre where all RE officers are instructed in advanced military engineering and most Sappers in their trade. Over 200 different courses are run each year for nearly 3,000 students, of which about 400 are officers. The Commandant reminded Her Majesty that, when she attended the Centenary Celebrations at Chatham in 1956, she saw a demonstration of combat engineering and other Sapper activities at Gordon Barracks, Gillingham, a wartime hutted camp with a very restricted training area that offered no possibility for expansion. However, the subsequent closure of the Royal Naval Ammunition Depot near Upnor, on the other side of the River Medway, provided an opportunity to embark upon a huge £7½ million building programme on both sides of the river. Planning started in 1958, and in July 1962 His Royal Highness the Duke of Edinburgh laid the foundation stone of the new Chattenden Barracks just north of Upnor Castle, and the Combat Engineer Group moved there from Gordon Barracks four years later in September 1966. As well as being close to the traditional bridging hard at Upnor, the new site includes an excellent and extensive training area of several hundred acres. Also located there now in new barracks are the Joint Services Bomb Disposal School and the Bomb Disposal Unit RE, both previously housed in hutted accommodation at Horsham. On the Chatham side of the river the project comprised the modernization of Brompton Barracks, built in 1804 to house Artillery units for the defence of the Royal Dockyard, and the building of new and extensive workshops for the Technical Training Group. Work started towards the end of 1964 and, except for a few married quarters, the project is now completed.

The Commandant then presented the chief persons responsible for the Brompton project, namely, Sir Donald Gibson, Kt, CBE, Controller-General Ministry of Public Building and Works, W. S. Atkins, Esq, CBE, Chairman W. S. Atkins & Partners, Consulting Architects and Engineers, the Viscount Marchwood, MBE, a Director of George Wimpey & Co, the Main Contractors, Major J. B. Hackford, RE, the RSME Project Liason Officer, and Brigadier H. L. Lendrum, CBE (a retired Sapper officer), Superintending Officer of W. S. Atkins & Partners, who, by means of models and photographs, outlined the Brompton Barracks project to Her Majesty.

From the Library the Royal Party drove to the Headquarters of the Technical Training Group, where they were met by Colonel R. G. Bishop, Colonel (Engineering) HQ RSME, and Lieut-Colonel I. J. P. Ransley, Chief Instructor of the Electrical and Mechanical School. Also present were Lieut-Colonel J. C. Court, and Warrant Officer Class I A. R. Warr, who preceded the Royal Party during their tour of the workshops, which included a visit to the Electrical Wing, the Bricklayers' Shop, the Engine Test Shop, the Machine Shop, the Sheet Metal Workers' Shop, the Welders' Shop, the Plumbers' Shop and the Carpenters' Shop. The Queen and the Duke of Edinburgh spoke to Instructors and soldiers under training and the Queen showed great interest in the panel depicting how the grille, representing the Crown of Thorns designed by Sir Basil Spence for the Gethsemane Chapel of Coventry Cathedral, was fabricated in the Workshops in 1961. Mr K. F. Tinklin, Superintending Instructor of the Welders' Shop, who had supervised the fabrication of the grille, was able to give Her Majesty a first-hand account of details of the work.

From the Workshops the Royal Party drove to the Depot Regiment Junior Ranks Club, known as the Jacknife Club, where they were met by Lieut-Colonel P. Norbury, Officer Commanding the Depot Regiment, RE. From a window, close to the entrance to the Club, Brigadier Inglis was able to show the Queen the north section of the Brompton Barracks, rebuilding project and the view across the Medway to Upnor Castle, the bridging hard and Gundulph's Pool. Over 300 persons were assembled in the Club, decorated with hydrangeas and spring flowers, comprising a selection of all ranks and civilians, and their wives, of the Headquarters RSME,

the Technical Training Group, the Combat Engineer Group, the Depot Regiment RE, 12 RSME Regiment and the Bomb Disposal Unit RE, representatives of local Branches of the Royal Engineers Association and three Sapper In-Pensioners of the Royal Hospital, Chelsea: Sergeants Banning and Keily and RSM H. Taylor. Also present were Major D. O. Cooksey, Corps of Engineers US Army, Captain J. C. Beacham, RCE, and Captain J. M. Sanderson, RAE, attached officers to the RSME, and their wives. The Queen and the Duke spoke to many of those present and, as Her Majesty was about to leave the Club, 86-year-old In-Pensioner RSM Taylor presented her with an exquisite little posy on behalf of her Royal Engineers—a delightful and touching gesture by the oldest Sapper on parade to his Queen and Colonel-in-Chief.

From the Jacknife Club the Royal Party walked to the parade ground to see a display of Corps activities which had been stage-managed by Lieut-Colonel P. H. Budden. The display consisted of two mobile and seven static examples of Corps activities which demonstrated the wide and diverse means by which the Royal Engineers have always attempted to maintain the classical concept of "mens sana in corpore sano".

The two mobile displays comprised respectively a combined show by the RE Draghounds and the RE Saddle Club, and a parade of the RE Beagles.

Dominating the static displays was the 7-ton Bermudan sloop *Annasona*, through no fault of navigation, high and dry on the NE corner of the parade ground, glistening above and below the load waterline in a radiant coat of new paint, burnished topsides and dressed overall for the Royal occasion. A Bosun dinghy and a Flying Dutchman, equally immaculate, completed the RE Yacht Club and RE Sailing Association displays. The RE Mountaineering and Exploration Club exhibited photographs and equipments used on expeditions to Nepal in 1967 and to Norway and Ethiopia this year. The Junior Leaders' Regiment displayed two canoes and a board depicting the Regiment's canoeing activities and its remarkable achievements. The RE Flying Club had a display board showing details and photographs of recent European flights, the RE Skydivers exhibited free-fall parachuting equipment and the RE Diving Club their undersea "bubble". There was also a stand showing the work of Major (now Lieut-Colonel) W. D. Rushworth and his small party, who last year erected boundary posts to demarcate exactly the disputed frontier between Chile and Argentine in a mountainous and almost inaccessible sector of their common boundary, both governments having submitted a case for arbitration to Her Majesty Queen Elizabeth II and accepted her gracious Award.

A note on the hunting-horn greeted Her Majesty as she arrived on the parade ground from the Jacknife Club and ten couple of the more steady draghounds trotted by with the Joint Masters Brigadier J. H. S. Lacey and Major C. T. P. Holland. Following them came Lieut-Colonel J. A. Coombs, the Field Master, and the "field" mounted on RE Saddle Club horses and privately owned ponies, several children, ardent followers of the Drag in holiday-time, having managed to get off school for the great day. Bill Porter, the kennelman, and John Holland each held two couple of unentered puppies, bred in the kennels and walked by the Hollands, which demonstrated how the pack is, in one way, kept up to strength.

Major-General J. H. S. Bowring, the Engineer-in-Chief, conducted Her Majesty around the static displays in which both the Queen and Prince Philip took the greatest interest. They spoke to the "crew" of *Annasona*, Lieut-Colonel J. B. S. Hamilton, Secretary of the REYC, Major J. H. Edwards, Captain A. Robson, WOI A. J. Esslemont and Corporal W. Nunn, who sailed across the Atlantic in 1967, to the dinghy "helmsmen" Major R. C. Gilliat, Secretary of the RESA, Corporal M. G. Lee and Lance-Corporal M. Moncur, who won the National Moths Championship in 1966 and was second in last year's International Championship, and to the mountaineers and explorers Major G. R. Owens, the Secretary of that Club, Captain J. N. Blashford-Snell, Lieutenant I. Whittington and Corporal Brady. They had a special word for the Junior Leaders' canoe experts, 2nd Lieutenant W. F. Hollister,

and Junior Corporal Green, Lance-Corporal Kearns and Sappers Hewson and Parry. And then to quite a different element, the Queen and the Duke spoke to Major I. G. Graham, Secretary of the RE Flying Club, and Lieutenant S. Lane-Jones and to two RE Skydivers, 2nd Lieutenant A. W. Walker and WOII P. W. Turner, who is a Skydiving National coach. From the sky-divers to the skin-divers, where the Queen and the Duke spoke to Captain D. F. Jones and Lieutenant J. S. Ashcroft, and Sergeant Stoddard and Corporal Jenkins explained to Her Majesty details of last year's trials off Malta with their undersea "bubble". Finally Her Majesty spoke to Lieut-Colonel Rushworth, Staff-Sergeant M. G. Browning and Sergeant W. G. Anderson, who had taken part in the Argentine-Chile Frontier Demarcation Mission.

A second note on a hunting-horn was then heard and the merry beaglers were paraded past Her Majesty at a sharp walk. With the thirteen couple of hounds were the Joint Masters, Colonel R. G. Bishop and Mr D. T. Bertram, six past and present whips, the Secretary, Captain John Robertson, and John Lambert, the kennel huntsman. With the pack, led on couples, were eight unentered puppies.

When the beagles disappeared from view the Royal Party entered the RE Museum, where the Queen was met by the President of the Institution of Royal Engineers, Major-General T. H. F. Foulkes, who introduced Her Majesty to Lieut-Colonel H. S. Francis, the Curator, and Major F. D. Jennings, the retiring Publications' Clerk of the Institution. Major Jennings was born in Bermuda in 1899, the son of a Royal Engineer Company Sergeant Major. He enlisted as a Boy Soldier at the age of 17 during the First World War on Boxing Day 1916. He rose to the rank of Warrant Officer Class I in the Corps and served in Shanghai, Singapore, Palestine and Egypt. He was commissioned in 1940 and served during the Second World War in Engineer Staff appointments and in Bomb Disposal. He retired in 1948. He was employed in a retired capacity at Chatham for five years and for the last fifteen by the Institution. He now goes into well-earned retirement after over half a century's continuous devoted service to the Corps. It was a great day for him and a wonderful culmination to his outstanding career. Brigadier Inglis, the Commandant RSME, introduced Major and Quartermaster J. H. Meyers, who is in charge of the RSME Stores, whose father, grandfather and great-grandfather had served in the Corps before him since 1827—surely a family record difficult to emulate. Major Meyer's father had the great pleasure of watching his son's presentation from the gallery of the Museum. A special exhibition had been arranged for the Royal visit around which Lieut-Colonel Francis conducted Her Majesty. It consisted of a display of items connected with previous Royal visits to Chatham, the development of military engineering equipment, the early history of Royal Engineer-pioneered military flying, this being the Jubilee Year of the Royal Air Force, the history of the Royal School of Military Engineering, the regalia of Royal Engineer Field Marshals and other distinguished officers and our unique medal collection which includes numerous Victoria Crosses and a case containing both the obverse and reverse side of every campaign medal issued since 1793 up to the conclusion of World War II, each medal having been awarded to a Royal Engineer, the recipients ranging from General Officer to Sapper, or Private of the Royal Sappers & Miners, or Royal Military Artificers, surely a wonderful example of our proud motto of "*Ubique*" to denote the Battle Honours of the Corps which has never been absent from any campaign of sufficient importance to be honoured by the award of a special medal.

The visit to the Museum over, the Royal Party walked to the Headquarters Mess. At the door stood the top-hatted, frock-coated George Le Dane, who has been with the Mess from the days of its wartime exile in Ripon from 1940–1948, to whom the Queen spoke before entering the Mess. It is difficult to describe adequately what the Headquarters Mess looks like after its modernization face-lift. It is, however, magnificent—truly magnificent. Two hundred sat down to lunch with Her Majesty and HRH the Duke of Edinburgh, amongst whom, in addition to those who had been connected with the previous events of the morning, were Their Worships the Mayors of the three Medway Towns and Lieut-Colonel E. T. L. Baker, OBE, TD,

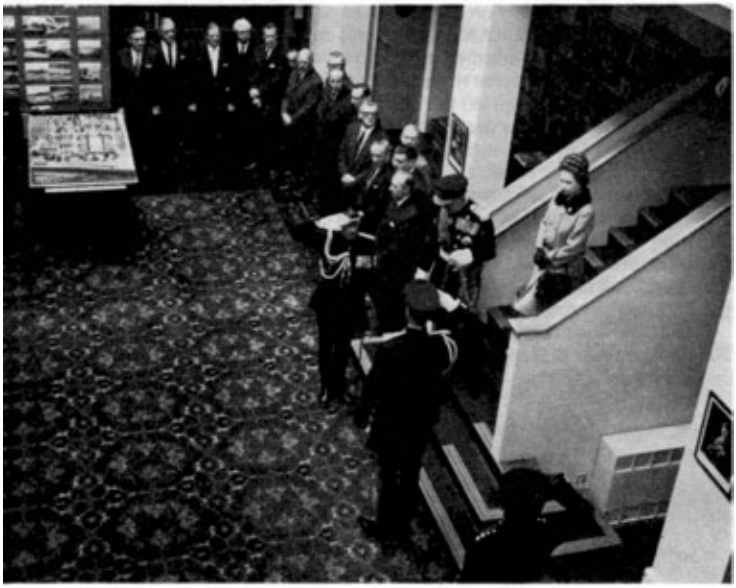
Chairman of the Strood Rural District Council, shortly to "adopt" the Royal Engineers at Chattenden, Mr F. A. A. Burden, the MP for Gillingham, the Lord Bishop of Rochester the Right Reverend R. D. Say, and the Dean of Rochester Cathedral (lately Bishop of Maidstone and Bishop to the Forces), the Right Reverend S. W. Betts, CBE, who preached so splendidly at our recent Memorial Service in the Cathedral, the Chief Constable of Kent R. D. Lemon, CBE, Vice-Admiral W. J. Parker, CB, OBE, DSC, Flag Officer Medway, the Army Commander Lieut-General Sir David Peel-Yates, KCB, CVO, DSO, OBE, Colonels Commandant Royal Engineers General the Lord Robertson of Oakridge, GCB, KCMG, DSO, DL, Honorary Colonel of the Engineer and Railway Staff Corps, Major-General J. C. Walkey, CB, CBE, Lieut-General Sir William Stratton, KCB, CVO, CBE, DSO, Major-General Sir Henry Sugden, KBE, CB, DSO, Lieut-General Sir John Cowley, KBE, CB, Major-General J. R. C. Hamilton, CB, CBE, DSO, Major-General R. W. Urquhart, CB, DSO, Her Majesty's Deputy Lieutenant for Gloucestershire, who died so tragically a few days afterwards, and Major-General J. K. Shepheard, CB, DSO, OBE and Major-Generals W. G. F. Jackson, OBE, MC, I. H. Lyall-Grant, MC, C. W. Woods, MBE, MC and J. C. Woollett, CBE, MC, Brigadier R. L. Clutterbuck, OBE, the Engineer-in-Chief designate, and three senior T & AVR officers Colonels K. G. Miller, MC, TD, J. L. Osborne, MBE, TD, and W. C. S. Harrison, CBE, ERD, and a selection of officers of all ranks from staff appointments, formations and units at home and in Germany. On being requested to do so by the Chief Royal Engineer, the Bishop of Rochester said Grace and, when lunch was over, the Chief Royal Engineer rose to propose the Royal Toast: "Mr Vice, the Queen our Colonel-in-Chief" to which 2nd Lieutenant S. R. Adams responded with great dignity and self-assurance, well becoming a newly-joined Young Officer of the Corps. After the Royal Toast the Pipe Major of the Gurkha Engineers, of which Major-General J. H. S. Bowring the Engineer-in-Chief is Colonel, played the March of the Queen's Own Highlanders in honour of HRH the Duke of Edinburgh, who is their Colonel-in-Chief. Throughout the lunch the Aldershot Band played a selection of music, the Chatham Band being away on an overseas engagement, and their Director of Music, Captain E. G. Horabin, LRAM, ARCM, was congratulated by the Queen. The Band had also been on duty with the Guard of Honour when Her Majesty arrived.

All good things must come to an end, and when luncheon was over and the Queen and the Duke of Edinburgh left the Mess they were bid good-bye by the Chief Royal Engineer. As the Royal car drove slowly in the brilliant afternoon sunshine through a route lined by beautifully turned-out NCOs and Sappers across Brompton Parade Ground, along Pasley Road, and thence to Gillingham Station, a great cheer broke out from the Sapper officers and soldiers, and their families, who had gathered to give their Colonel-in-Chief a right royal send off. Even the host of golden daffodils, fluttering and dancing in the breeze in the Brompton Barrack's flower beds, whom the Adjutant of the Depot Regiment had threatened with Court Martial proceedings if they were not in flower by 28 March 1968, seemed to trumpet their joyful and loyal greetings to their gracious Queen.

The Royal Visit was over. It had been a memorable day and, in the words of our National Anthem, a Happy and Glorious one.

God save the Queen.

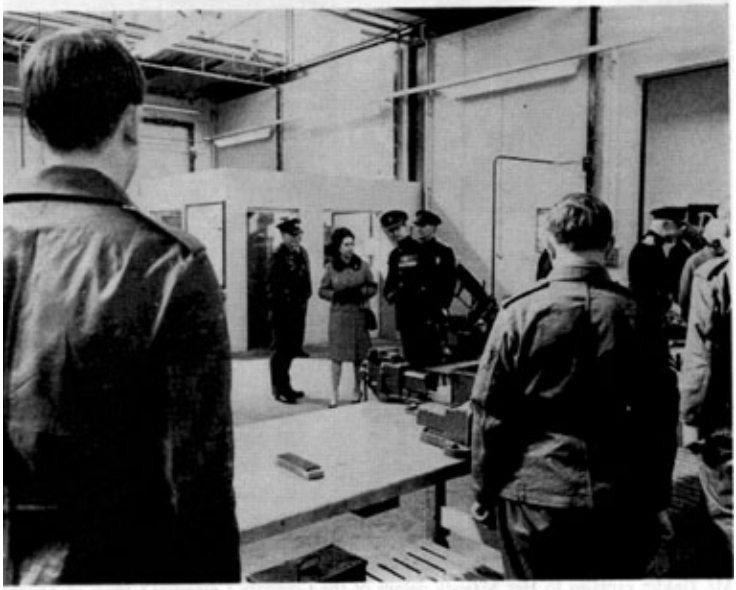
Her Majesty inspects the Guard of Honour,



and enters the Corps Library

Visit of HM the Queen And HRH The Duke Of Edinburgh 1 & 2

Colonel Bishop conducts Her Majesty



around the workshops of the

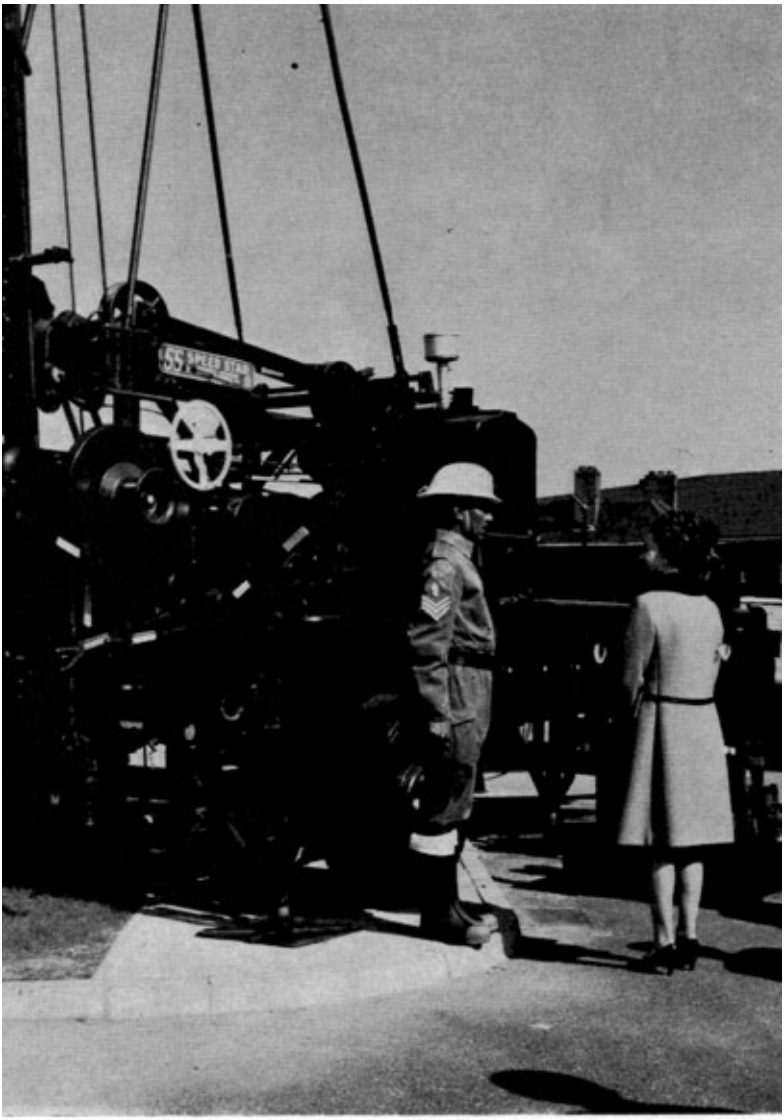
Visit of HM the Queen And HRH The Duke Of Edinburgh 3 & 4

Technical Training Group

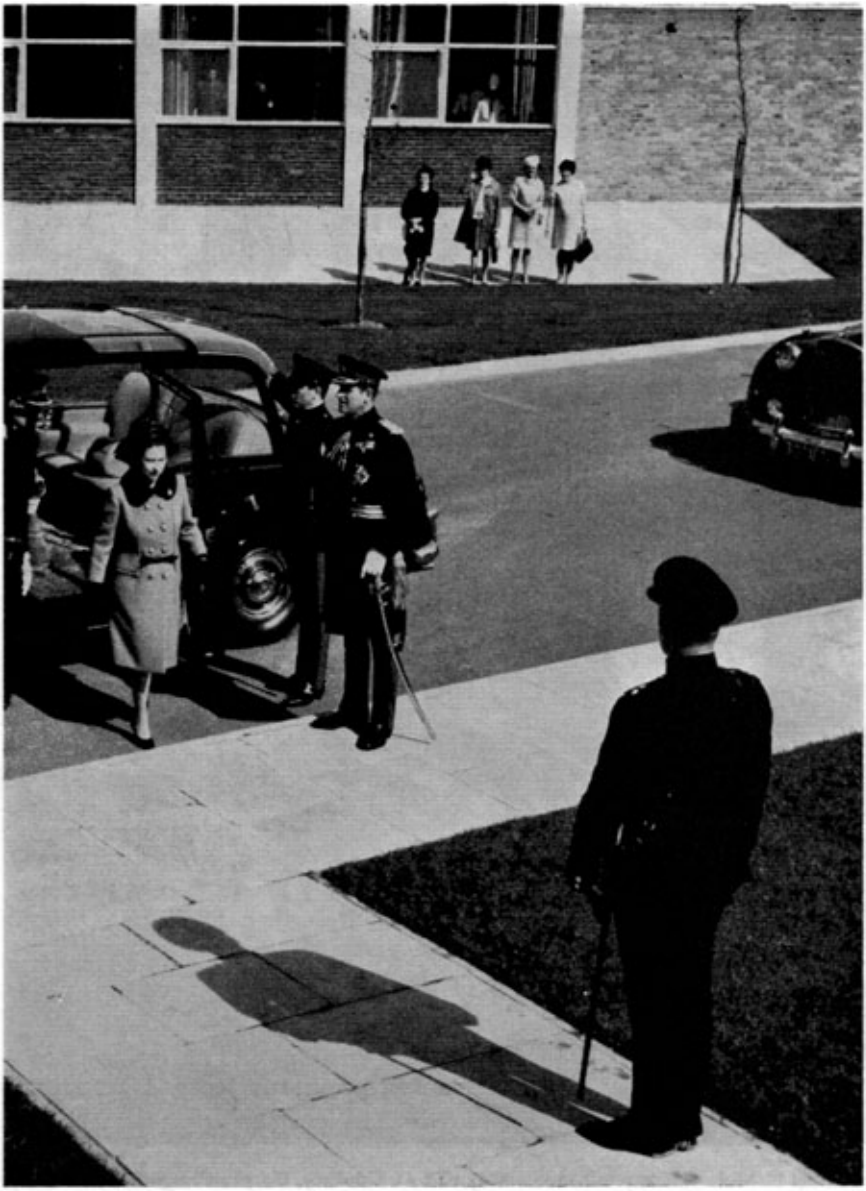
Mr Tinklin explains to Her Majesty details of the Coventry Cathedral Crown of Thorns Grille for the Chapel of Gethsemane

Visit of HM the Queen And HRH The Duke Of Edinburgh 5 & 6

Her Majesty talks to Corporal P. Vant



and to Sgt H. P. Green



Lieut-Colonel P. Norbury, OC Depot Regiment RE, welcomes Her Majesty into the Jacknife Club

Visit of HM the Queen And HRH The Duke Of Edinburgh 9

Colonel E. McL. Mackay introduces Major D. O. Cooksey, Corps of Engineers US Army and Mrs Cooksey

Lieut-Colonel P. H. Budden introduces W.O.1 and Mrs Wilson

Her Majesty speaks with L/Cpl and Mrs Wilson

In-Pensioner RSM H. Taylor presents a posy to the Queen on behalf of the Corps

The Engineer-in-Chief points out certain Corps sporting activities to Her Majesty

RE Draghounds

L/Cpl G. Graves of the RE Saddle Club

The "crew" of *Annasona*. The Queen is speaking to Corporal H. Nunn who crossed the Atlantic in 1967

The Queen speaking to Junior Corporal Green of the Junior Leaders Regiment, RE

The Queen meets the Skydivers

and the Skindivers

The Queen meets S/Sgt Browning of the Argentine/Chile Boundary Survey Mission

The RE Beagles

Major-General T. H. F. Foulkes introduces the Curator of the RE Museum

Following the visit the Right Honorable Sir Michael Adeane, Private Secretary to Her Majesty the Queen, wrote thus to the Chief Royal Engineer:

Dear General,

When The Queen and the Duke of Edinburgh returned to Buckingham Palace this afternoon they told me to lose no time in sending their warm thanks to you and to all the officers of the Royal Engineers for your hospitality and for the excellent luncheon which you gave for them in your Mess at the Royal School of Military Engineering. I need not tell you that they both greatly enjoyed it.

As your Colonel-in-Chief, The Queen was particularly glad to have the opportunity of seeing something of the Corps and of its many activities which was offered by the opening of the rebuilt Brompton Barracks. You showed Her Majesty and Prince Philip a great many things which were of absorbing interest and they both were glad to be able to meet and talk to Royal Engineers of all ranks.

Her Majesty desires me to send her sincere congratulations to you and to the Corps on the unfailingly high standards which you maintain and which were so well exemplified in today's programme.

To end up with, may I thank you and all our hosts for your kindness and hospitality to the four Members of the Royal Household who were in attendance.

Yours sincerely,
Michael Adeane

To which General Jones replied:

Thank you so much for your letter of 28th March.

It gave me and all in the Royal Engineers the greatest satisfaction to know that Her Majesty The Queen and His Royal Highness the Duke of Edinburgh enjoyed their visit to the Royal School of Military Engineering on Thursday last. Their presence in the home of the Corps was a delight to us all, has uplifted our spirits now and will prove an inspiration in the future.

I wish to present our humble duty and thank Her Majesty and His Royal Highness for the honour they have done the Corps and the pleasure they have given to so many.

Sir Michael Adeane also wrote the following letter to the Engineer-in-Chief:

I have of course written to the Chief Royal Engineer to send him The Queen's thanks for luncheon yesterday and to tell him how much Her Majesty and the Duke of Edinburgh enjoyed their visit to Brompton Barracks. If I may, however, I should like to thank you for all your help in making the arrangements for what, from The Queen's and Prince Philip's point of view, was an outstandingly interesting and pleasant day; I don't remember many visits that involved so little unnecessary fuss and bother, but this I am sure is characteristic of the Sappers.

May I also take this opportunity of thanking you and your brother officers for all your kindness and hospitality to the Members of the Household and for all the trouble you took to make it as interesting for us as it was for your principal guests.

Some Comments on Pavement Design

MAJOR G. K. BOOTH, RE, BSc(ENG), AMICE

AN increasing number of Royal Engineer projects today are including more sophisticated pavements. Not everyone is required to design pavements, but they should understand the factors involved and current developments.

INTRODUCTION

Roads and airfields are the same basic engineering problem: the natural soil will not take the wheel loads or repetition of loads required. The general solution to this problem is to improve the soil by compaction and drainage and then to protect the improved soil against the effects of traffic and weather. If the subgrade is not strong enough it will be necessary to construct a pavement to reduce the subgrade stress due to the wheel load to an acceptable value. The pavement should then also protect the subgrade. There are, of course, changes of emphasis in the engineering problems of roads and airfields due to the difference in dimensions, location, loads and safety requirements.

Soil Mechanics for Road Engineers (*Military Engineering*, Vol V, Pt II) lists four methods of pavement design.

1. Empirical methods using soil classification tests for comparison with past experience of the thickness of construction required.
2. As 1 above, but using a special soil strength test instead of soil classification.
3. Methods using a simplified theory of stress distribution and soil strength supported by the justification of experience.
4. Wholly theoretical methods using a true analysis of stress distribution and soil strength.

Due to the non-uniformity of materials and the irregular mode of behaviour, soils and flexible pavements have defied theoretical analysis and there is no true theoretical flexible pavement design. Rigid pavement design, however, is soundly based on Westergaard's theory and only some of the comments that follow apply to rigid pavements.

In World War II the Americans selected the Californian Bearing Ratio method of flexible pavement design for roads and airfields (Method 2) and it was given accelerated development. Many pavement design methods that appear to be different today come from this original development, but have been modified to suit local conditions. As pavements, however, have a long life, the development and adjustment of design is generally a slow process.

These comments consider the following aspects of road and airfield pavement design:—

1. The load to be carried.
2. Pavement life.
3. The subgrade strength.
4. Pavement materials.
5. Evaluation of pavements.

There are other factors to be considered in pavement design such as resources available, cost and maintenance, but they are not covered. Rigid pavements are not covered in any detail.

LOAD

Empirical road pavement design methods do not all directly consider how the laden weight of a vehicle is distributed to the axles or the effect of dual wheels or

impact. The current Royal Engineer design curves (RESPB 5A) use the maximum single-wheel load in the vehicle load class being considered. The parameter for the United States Engineers road design is an 18,000 lb single axle with dual wheels: Shell use a 22,000 lb axle load, which represents the normal legal limit, and the Ministry of Transport design is related to commercial vehicles with an unladen weight exceeding 30 cwt. The Ministry of Transport parameter covers the significant loads generally and the design curves have been adjusted by experience to cover the whole range and effect of loading. Investigations are being made into the specific effects of different load categories. The Shell and United States Engineers system reduce the total traffic to an equivalent number of standard axle loads.

The loading on an airfield pavement must be considered in more detail. There is no impact factor on landing, as there is still lift from the wings. The maximum load occurs when the aircraft is standing or taxi-ing slowly. The load on one main undercarriage assembly is considered and the load carried by the tail or nose wheel, which can be up to 10 per cent of the all-up weight, is ignored. There are two main differences compared with roads. One must consider the effects of tyre pressure and multi-wheel undercarriages, that is the aircraft flotation. Aircraft tyre pressures are generally higher than those on the road as, unless directed otherwise, a designer tends to allow minimum space for the undercarriage. At the upper end of the scale there is the Phantom operating with a tyre pressure of 400 psi and at the other end tactical transport aircraft with tyre pressures of approximately 80 psi. In order to provide an acceptable pavement loading, designers of heavy aircraft have to use multi-wheel undercarriages. This started with the prototype Flying Fortress, whose single-wheel undercarriage caused pavement failures. It is necessary to consider the load distribution effect of the multi-wheel undercarriage assembly to produce the design parameter of equivalent single-wheel load (ESWL). For a given multi-wheel assembly the ESWL varies with the modulus of relative stiffness for a rigid pavement or the depth of construction of a flexible pavement. In the Load Classification Number system (LCN) the ESWL and tyre pressure can be expressed as a single number. It should be noted, however, that for a given LCN it may be necessary to examine different combinations of ESWL and tyre pressure: higher tyre pressure will be critical up to a certain depth of pavement and then heavier ESWL will become critical.

COMPARATIVE PAVEMENT LOADS

	All-up weight lb	*Tyre pressure* psi	*Approximate equivalent single-wheel load* lb
Aircraft			
VC 10	310,000	117	58,000
C 130	155,000	87	36,000
Phantom	54,000	400	25,000
Road Vehicles			
20-ton "six wheeler"	45,000	85	7,000
truck cargo 3-ton 4 × 4	18,000	70	5,000

Some pavement design curves consider the load alone, but most allow for the number of loadings or pavement life.

LIFE

Pavement life is generally expressed as a number of load repetitions. The present military road design curves do not consider life directly, but allow a reduction of pavement thickness to 65 per cent in the combat zone and an increase in thickness of

20 per cent for repetitive loading. The Shell and United States Engineers design curves consider the total number of axle loads on the road during its life. The Ministry of Transport design curves consider the number of heavy vehicles per day in twenty years' time. This requires a traffic survey and an expression to calculate the growth of traffic. It is possible to predict traffic growth in this country, but not in rapidly developing areas overseas. The problem there is partly overcome by staged pavement construction. The road base is surface dressed and when the traffic increases beyond a certain point the pavement is strengthened with a black top surfacing.

On a road vehicles travel in well-defined tracks. This is also the case for airfield taxiways. The most severe loading on an airfield comes from repetitive, slow moving, positively steered aircraft. This is not the case for a runway which is wide enough to allow for the variation in landing and take off largely due to beam wind components. A landing or take off is termed a movement. The life of an airfield pavement is expressed as a number of coverages: a coverage is when each usable part of the pavement has been loaded once. The number of movements to a coverage depends on landing habits, the usable width of the pavement and the undercarriage configuration. The LCN system takes a general ratio of three movements to a coverage. The design curves normally consider three movements to the coverage and also channelized traffic with one movement to a coverage. Other expressions are used for airfield life. Sorties and cycle generally mean one landing and take off, but it is necessary to study the layout of runways, taxiways and aprons to see exactly what is involved. An American design system considers a circuit of runway and parallel taxiway. A cycle gives one movement on the taxiway and two on the runway. The pavement design is based on a detailed study of the movement to coverage ratio for the channelized taxiway traffic. The resulting design thickness is used for the taxiway and the runway, but the middle third of the runway length is reduced in thickness by 20 per cent. Most other systems design each particular pavement.

There is a further aspect of airfield life. The LCN system considers a permanent pavement with a life of ten years or 30,000 movements. This is virtually an unlimited life providing the pavement is not grossly overloaded and is properly maintained. The system, however, does allow a limited amount of overloading. An aircraft with LCN 1·1–1·25 times that of the pavement may make 3,000 movements (it is 1·1 because the system is only considered accurate to within 10 per cent) and an aircraft with LCN 1·25–1·5 times that of the pavement may make 300 movements. This overloading would increase the maintenance effort required to retain a permanent facility. Conversely it is possible to reduce LCNs in order to design to the exact military short-term airfield life required.

SUBGRADE STRENGTH

The subgrade strength is the most difficult design factor to establish. The problems are to allow for the variability of the subgrade and to establish the in-service or equilibrium moisture content. Many designs use the Californian Bearing Ratio (CBR) as the measure of subgrade strength and it is a well-known test. A criticism of the CBR system was that soaked specimens were used in the test. This was not a valid criticism, as design must be based initially on a standard laboratory procedure and some design curves have been adjusted by experience to make allowance for the in-service condition compared with the soaked laboratory specimen. The Road Research Laboratory design curves in Road Note 29 are, however, based on the CBR at the in-service moisture content. Although the CBR test is well established, there is a tendency to replace the actual test with classification of the soil. In military practice CBR is sometimes estimated from a scaled soil classification chart. In the latest edition of Road Note 29 a table gives estimated CBR values for British soils compacted at their natural moisture content categorized by their plasticity index and well or poorly drained. Some American pavement design systems are based on a detailed soil classification taking into account the fines content, liquid limit and

plasticity index which are expressed as a group index. The estimated subgrade strength is quite reliable when it is based on experience in developed areas. In undeveloped areas it is necessary to relate soil properties affecting water movement, the rainfall cycle and the level of the water table to establish the in-service moisture content. Research may make this easier in future.

There are other tests to establish subgrade strength. A plate-bearing test is used to establish the modulus of subgrade reaction for rigid airfield pavement design. *In situ* tests, however, have the disadvantage of only measuring the momentary strength. This means that although simple field tests, like the cone penetrometer or torsion vane, are attractive, they cannot be used alone as a basis for economic pavement design.

In cold countries the depth of construction required to protect the subgrade from frost may well be the critical factor and not the strength of the subgrade.

EVALUATION OF NATURAL SURFACES

In military operations the engineer will make best use of the natural surface before he starts pavement construction. For airstrips it is necessary to consider the soil strength in depth and the resistance due to wheel sinkage and drag in ruts. To measure the subgrade strength MEXE have developed the Soil Assessment Cone Penetrometer shown in Photo 1. With this simple instrument CBR can be read directly up to a depth of 24 in. As the instrument relies on a cone, it is limited to fine grain soils and covers a CBR range of 0–15 per cent. Correlation with standard CBR tests is excellent. A critical layer is defined for various soil-strength conditions and the design curves, giving number of aircraft movements allowed, used with the instrument allow for loss of strength due to remoulding of the soil. The effect of, or need for, maintenance is rather indeterminate, but it will generally produce a smoother surface with little effect on strength. CBR is a convenient parameter, but sinkage and drag are not allowed for directly and are the subject of further research.

A larger cone is similarly used to establish the Cone Index, which can be used to estimate trafficability, the permissible number of passes, for wheeled and tracked vehicles. Remoulding can be allowed for, but there is no reliable method of assessing slipperiness, which is an important factor.

PAVEMENT MATERIALS

Design factors and pavement design curves give the thickness of pavement required. An overestimate of subgrade strength, or an underestimate of load, will result in a pavement thickness that is not sufficient to reduce the load to an acceptable subgrade stress. This will lead to compaction and consolidation of the subgrade, followed by pavement failure. The quality of pavement materials is as important as the thickness of the pavement. Poor materials will deform under load and lead to failure. The high-pressure tyres of aircraft produce high stresses on surfacing materials which must be of the best-quality concrete or asphaltic concrete.

Specifications for flexible pavement materials indicate an increasing strength from subgrade to surface. The simplest specification is the CBR of the compacted materials in various layers. This type of specification has been developed to cover the gradations, liquid limit and plasticity index of materials. The CBR design basically determines the depth of crushed stone to protect the subgrade, or lower layer of a pavement, by distributing the applied load to give an acceptable stress. The CBR design system is criticized because it does not allow for increased strength or load-spreading properties of materials bound with bitumen or cement. Full-scale pavement trials on the A1 at Alconbury Hill by the Road Research Laboratory showed that CBR design thicknesses were too conservative for bound materials. Road Note 29 now allows a reduction of thickness for better load-spreading materials. As an example for base construction, 8 in of waterbound macadam, cement-stabilized material or lean concrete is specified. However, 6 in of bitumen macadam, or 5 in of hot rolled

asphalt, are acceptable alternatives. It is still necessary, nevertheless, to maintain the over-all pavement thickness by increasing the depth of sub-base. Unfortunately, although they have been quoted in the past, there are no simple factors for converting thickness of unbound material to a thickness of bound materials, as there are too many variables. The Shell 1963 Design Charts for flexible pavements allow selection of a whole range of thickness combinations of asphaltic and granular construction. As an example, to meet one requirement, 9 in of completely asphaltic construction can be used or 4½ in of asphalt on top of a 10-in granular base or any of a series of combinations between these two limits. These charts are for roads only, but Shell are prepared to design specific airfield pavements.

Design curves for rigid pavements usually refer to a type of construction and then specify the concrete quality by compressive or flexural strength.

It is, of course, essential that related design curves and specifications are used.

EVALUATION OF PAVEMENTS

There are a number of methods of evaluating existing pavements, many of which require tests on the pavement materials and an investigation into the life and loading history. The best method used for airfield pavements is the LCN plate-bearing test using an 18-in diameter steel plate with 40, 70 or 100 ton testing rig. This is an irrefutable direct evaluation on which the LCN system is based and requires no knowledge of pavement materials or history. The Road Research laboratory is developing the use of a deflection beam (Benkelman's beam) to estimate the strength and future performance of roads. The beam measures the transient deformation of the road surface between the twin wheels of a loaded truck due to the passage of the wheels. This is shown in Photo 2.

OTHER PAVEMENT FUNCTIONS

This paper has considered providing a pavement that will support the load required for the required life. The pavement has three other functions which should not be overlooked.

The pavement must be waterproof to maintain the pavement materials and subgrade at their design strength. Accordingly a dense surface or an impermeable skin, as given by surface dressing, is required. Surface density partly depends on compaction, and it is worth noting that traffic on a road will assist compaction, whereas this is not so for an airfield.

On a road it is important to provide a skid-proof surface that allows good braking under all conditions. The traffic kneading of a flexible road pavement produces a uniformly polished, close-textured surface free from cracks, and friction for braking must be especially built in. An airfield pavement is not kneaded by traffic to the same extent and braking efficiency improves with weathering of the surface, which is the main life factor. Against this the surface will crack and must be resealed regularly.

The third pavement function is riding quality. Due to aircraft electronic equipment, harmful longitudinal rocking and undercarriage fatigue it is necessary to have a higher standard of surface finish on an airfield than on a motorway. The specification calls for no gap greater than ¼ in between the surface and a 10 ft straight edge.

FINAL POINTS

1. One must ensure that the measurement of subgrade strength, the design curves, materials specification and that for construction are all related and meet the requirement being considered.

2. A design system with the maximum experience and development is generally best, and one should always use the local one. The present military road design curves have not had this experience or development, but are sufficient for short-term unsophisticated pavements.

3. In developed areas soil strength is tending to be related to soil classification rather than actual strength tests. In undeveloped areas it is still necessary to establish the equilibrium moisture content and the soil strength at that moisture content.

4. More use of simple soil-strength tests like the direct reading cone penetrometer and torsion vane is desirable, but to start with they will only be used to increase testing coverage.

5. The LCN System for airfields is an excellent one and the only system to cover aircraft flotation, pavement design and pavement evaluation. Perhaps the deflection beam could be used similarly for roads.

6. Pavement design is important, efficiency and economy must be balanced, but it is only part of the engineer task. Other equally important aspects are identification of local materials, alignment, drainage and, of course, management on site including quality control of the mass production.

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Photo 1. Direct Reading Cone Penetrometer (MEXE Photograph)

Some Comments On Payment Design 1

Photo 2. Deflection Beam (RRL Photograph)

Some Comments On Payment Design 2

Attachment of the RE Air Troop FARELF to POST CROWN Force Thailand

CAPTAIN D. E. DURHAM, RE

INTRODUCTION

THE RE Air Troop FARELF was detailed in February 1967 to move to Thailand and support the Royal Engineer force there. The following short report is about this deployment, some of the problems that arose and the uses and some other possible tasks to which an air troop could be put when supporting an engineering project.

GENERAL REPORT

As members of the RE Air Troop FARELF waited around in the hot sun on a Saturday afternoon in March 1967 at Seletar Airfield, Singapore, permission finally arrived, after being accepted by the DA Bangkok, for us to move to Operation Post Crown at Leong Nok Tha Airfield, Thailand. All the kit was loaded and lashed down and the Troop flew off in three Beverley aircraft. The first two arrived on Sunday after a night stop in Bangkok and the third arrived on Monday afternoon, having broken down *en route*. The next few days were somewhat hectic, particularly since the accommodation and works areas, agreed upon during an initial reconnaissance, had to be altered, as they were required by the Thailand Security Forces. However, an area in the camp was found, trees were felled, an Aldershot shelter erected, PSP laid, fuel acquired from the depot seventy miles away, visits made to the USAF Control and Radar sites in whose area we were to work for security briefings, and last, but not least, the aircraft were assembled. So it was with great delight that we were fully operational six days after our departure from Singapore and in time for the Chief Engineer's visit.

The Operational Orders, direct from the Foreign Office, were quite clear about our role whilst in Thailand. We were to support Post Crown Force and those people who were directly involved. We were not to carry any other person except in the casualty evacuation role and then only if the aircraft happened to be on detail in the area. Our Operational area was one of about fifty miles in diameter with one border along the River Mekong. Lastly the orders stated that there was to be no publicity, but that has now been relaxed.

For the information of those who have not been to Leong Nok Tha, the airfield is about sixty miles from Ubon, our nearest town and USAF base and where the RAF maintenance aircraft landed, 350 miles from Bangkok and 1,200 miles from Singapore. It is believed, therefore, that we were the furthest any small air troop has operated from any aircraft workshop and stores for a prolonged time. This distance was seemingly increased by there only being one resupply aircraft a week, and the mail from Singapore being unreliable. The major problems of aircraft servicing were obtaining the spare parts in time and moving the aircraft back to Malaysia for second line servicing. This latter task generally involved flying to Bangkok, with special permission, boat to Singapore and lorry to Malaysia.

The tasks of supporting Post Crown Force increased as time progressed. The Troop supported four squadrons during its detachment, and for each there was the initial task of trying to make all the members "air-minded" and not to look upon the helicopter as a "glorified taxi".

The major task was the lifting of surveyors and soil mechanics from the road-head to their area of survey or setting out, a saving of up to four hours in movement and the elimination of the need for security guards overnight. Another task was the rapid

deployment of urgently required stores for broken-down plant at the road-head, a great time-saver as the road progressed; this task was given the name "Operation Superspeed" by the OC Post Crown Force. Apart from the tasks of flying visitors, who averaged about one every three days, normal administrative flying, training and Casevac details were flown, all of which helped the Force to realize how invaluable a helicopter can be in support of this type of project in this type of terrain.

The following tasks were also undertaken which are more specific to this type of project and may be worthy of further investigation.

1. *In the setting-out role*

The helicopter was positioned over a chainage point, bearings were taken by the surveyors to enable accurate alignment. The pilot also guided troops on the ground either by radio or hand signals in the positioning of survey pegs. This was found to be very useful in hilly wooded terrain.

2. *Photography*

Cinematograph and Polaroid films were taken from the air to brief future units, plant operators and surveyors. This method also enabled one to show the "builders" the progress and perfection of their work.

3. *Location of new material*

The major problem on this project was the location of good sources of laterite used for the road surface. As it is slightly magnetic, methods using compasses and other instruments that react to magnetism were tried to little avail. It was, therefore, decided to try to locate this material, and gravel if possible, by using low-level photography, but little success was achieved. With the rapidly growing interest by geologists, soil mechanics and hence engineers in physiographic maps that are mainly derived from aerial photographs, the low-level idea may be practicable. The main disadvantage of using high-level aerial photographs is the skill required by the interpreter, and low-level photographs may reduce the skill required.

CONCLUSION

The Air Troop proved its worth at Post Crown as time progressed. There did, however, at first seem to be a disinclination on the part of most Sappers to think about anything other than the project, and initially little or no effort was made by passengers in our aircraft to practise map-reading, recognize features or judge distances. This was particularly noticeable amongst the younger officers who will soon be sitting practical promotion examinations that will contain an element of flying. This was later remedied, but junior officers should try to benefit from every chance they get.

The time at Post Crown has enabled the newly formed Troop to settle down as a team. All have worked well under the difficult conditions of climate and terrain. For the pilots the conditions were very different from Malaysia, being almost featureless and colourless. However, the opportunities of meeting very many RAAF, USAF and Thailand people and hearing about their problems and tasks were most worth while and the Air Troop will never forget the help and kindness they gave so willingly.

The Working Relationship between Field Squadrons and Specialist Teams Royal Engineers

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AIM

THE aim of this paper is to discuss the division of responsibility between a field squadron and a specialist team RE and to suggest a formula to resolve some of the problems. The views expressed are the authors' personal opinions, based on experience commanding 32 Field Squadron and 516 STRE (Bulk Petroleum), and are not necessarily a reflection of official policy.

INTRODUCTION

There are several types of STRE, each designed to deal with a special engineer task that Field Squadrons either cannot plan or execute on their own. Each type differs considerably in role, organization and characteristics from the others—a fact often overlooked when considering their employment.

The main problem involved in the working relationship between Field Squadron and STRE is organizational, and arises from the fact that, where two units commanded by officers of equal rank are both responsible for a project, it is likely that there will be a clash of judgement/personality leading to a possible disruption of work.

The division of responsibility laid down and the organization of the work force must minimize the chances of such a clash. The Chain of Command must help, not hinder.

CONSULTANT-CONTRACTOR ANALOGY

The popular concept of the working relationship between the STRE and Field Squadron is similar to that which "normally" exists between Engineer Consultants and Contractors. If this is said quickly enough it sounds like a neat arrangement. But does it bear examination?

In order to study this it is necessary to consider their duties in closer detail and to compare them with the characteristics of the Field Squadron and STRE and also with the situations where they are likely to find themselves working together.

CONSULTANT

In normal practice a Consultant's duties include advising the client in deciding *what* is to be done; drawing up specifications and inviting tenders; reviewing the returned tenders and awarding the contract; carrying out quality control on site, on all aspects of the specification; giving decisions on contractors' "deviations"; and finally measuring up the work and arranging payment.

Often enough the Consultant will do more, or less, than this and cases are known where the Resident Engineer has taken over entirely from the Site Agent. However, in normal practice the duties are as suggested.

CONTRACTOR

By contrast, a Contractors' duties include planning *how* the work is to be done, and putting a price on it; tendering for the contract; and on being awarded the contract, ordering the stores and getting on with the work.

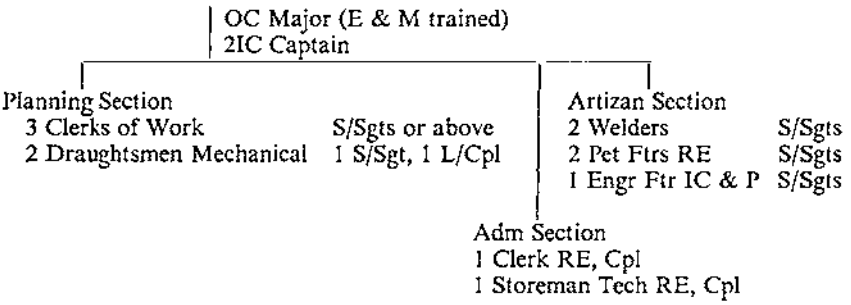
Implied in this are a number of limitations to his conditions of work. In the first place he is expected to have experience of the type of work involved. Next, by the very act of tendering he affirms his confidence that his organization can carry out the work successfully and that his confidence is based on detailed planning, done before committing himself. Finally, all the materials and methods he uses are subject to the Consultant's inspection and approval.

FIELD SQUADRON

It is hardly necessary to say that the main unit of military engineering labour is the Field Squadron. Its role is primarily to improve the mobility of our own forces and to hinder the movement of the enemy; and secondarily, to help our forces to fight and live. Its characteristics are that it is self-administrating, mobile with good radio communications, commanded by a promotion-hungry major, and its labour, plant and equipment are balanced to give a highly flexible capacity for a wide variety of engineer tasks. This capacity is increased by additions to the establishment, as in the Airfd Squadron, help from the Support Squadron RE with extra plant, stores and workshop facilities, and by deployment with STRE on specialist engineer tasks.

SPECIALIST TEAM RE (BULK PETROLEUM)

The role of this STRE is to plan and supervise the construction, modification or repair of bulk fuel installations needed for military operations. It is organized to carry out this role as follows.



Its characteristics are that it is not self-administering and therefore needs a "Mother" unit, it has no organic labour except five highly skilled artisans to do the more difficult tasks, supplemented if necessary by tradesmen from a labour force found from elsewhere. Its supervisory capacity is limited by its small strength (fourteen all ranks). It is also commanded by a promotion-hungry major.

PROJECTS

In any project involving the STRE and Field Squadron, the Engineer Staff would normally call in the STRE at an early stage to advise on the concept. In fact, al engineer projects have to go through a number of distinct stages:

Planning	concept and "Approval in Principle"
	recce and detailed planning
	final plan approved in detail
Deployment	stores, plant, equipment and labour
	collected and deployed to site
Construction	site preparations including access,
	survey, security, communications, amenities,
	stores and workshops
	main works
	embellishments
	commissioning and "handover"

Aftermath	site clearance
	close accounts
	redeploy labour, eqpt and plant
	present formal technical report
	investiture/impeachment

The boundaries between each phase will undoubtedly become vague, especially during the initial build-up and the final thinning-out. Of the four phases the deployment phase is often the longest. This is accounted for by "delivery times" of six months or more when buying equipment or stores on the civil market and by "shipping time" —for example a cargo vessel is eight weeks or more at sea *en route* to Singapore from UK via the Cape.

The full installation of the Interim Limited War POL Set calls for an Engineer Regiment plus STRE (Bulk Petroleum) in the construction phase. In this situation the STRE would clearly work under command of the CO of the Engineer Regiment. The CO would allocate tasks and would supervise them with the STRE's advice. Members of the STRE would be attached to working parties for technical control at the lower level. There seems to be no organizational problem in this arrangement, and the CO is there to eliminate them if they occur.

On the other hand, if the project calls for the employment of an STRE and a field troop, then the field troop would work under command of the STRE and the two establishments would integrate or merge for the project. Again, there seems to be no problem.

The Final Limited War POL Set calls for one field squadron plus STRE (Bulk Petroleum). The project is extremely important and the successful completion by the due date could well be critical.

What organization or division of responsibilities would best assist the operation? If the Consultant-Contractor relationship were prescribed, the STRE would provide the specification and would then inspect the results produced by the field squadron, rejecting any sub-standard work. Clearly the field squadron command would be fully responsible for success or failure.

However, the situation is not unknown where the field squadron is nominated for a task late in the deployment phase. It might well be that the Squadron Command knows very little about the special engineering techniques appropriate to the project, or the field squadron may have had no recent experience or training in the skills involved. The Squadron Commander may not even have time to recce the task himself before the field squadron starts work. Certainly he only comes into the plan after the stores and equipment, etc, have been ordered (by the STRE!), and his room for manoeuvre is limited to that extent.

The Squadron Commander is forced, therefore, to accept a detailed plan prepared by the STRE. Certainly a field squadron taking over a project half-way through the construction phase would have to accept the existing plan as it stood. But he may feel that the plan is bad and have good reasons to back his opinion.

He would have to know his subject well and have had time to study the plan before coming to this conclusion. Or he may feel that his squadron is incapable of carrying out the plan because of lack of skill, manpower, equipment, etc.

He can only represent these points to Higher Authority knowing full well that any fundamental change in the plan would affect the finishing date which might be critical. This sort of representation is an unpopular and dangerous pastime for an ambitious officer. In the circumstances it would be unjust to hold him fully responsible for the success of the plan.

EXERCISES

The current arrangment for dividing responsibility employed in three recent exercises is that the STRE plans the project and "advises" the field squadron which is responsible for the construction phase up to commissioning. On each of these exercises the way the "advice" was given differed.

Exercise STRIP-PILLOW was held in Scotland in the spring of 1966 with 36 Engineer Regiment landing over the beach from HMS *Fearless* to construct a landing strip and installations to pump fuel from an ocean tanker through pipelines to the airfield. This was the most difficult and the most realistic of these exercises for a number of reasons—stores delivered by sea, difficult tide conditions, little experience with the equipment under these conditions, etc.

The STRE was planning, or amending plans, right up to the last moment and many of the problems which arose had to be resolved on the spot. The field squadron responsible for execution had carried out preliminary training, but the problems were such that when it came to the "crunch" the members of the STRE were taking the detailed decisions and the field squadron personnel were, in effect, carrying out STRE orders. This was a good working arrangement. However, if their combined efforts had not been successful, and blame had to be apportioned, the Squadron Commander would have been held responsible.

Exercise PIPE-USER was held at the School of Petroleum RAOC Westmoors in July 1967 to confirm construction and operating techniques for the Interim Limited War POL Set. The STRE produced a complete plan for the construction of the installation which was approved by succeeding Engineer HQ's and was finally passed to the field squadron nominated to do the work. Because of other commitments the STRE was able to provide only one "adviser". The field squadron deployed straight on to the task with only minimal preliminary training and "bashed-on" with the job, faster than advised by the STRE. In other words, the the working relationship was almost non-existent.

Later the field squadron came under criticism for poor workmanship, and this created counter-criticism and bad feeling all round, although most of the complaints were due to faulty equipment. From the subsequent enquiries it was obvious that the field squadron had failed to appreciate the finer details of the engineer plan and had carried on in blissful self-confidence.

Exercise PIPE-MAJOR was held in Singapore in October 1967 as a follow-up to Exercise PIPE-USER. In this case the field squadron (airfields) was detailed for the task of construction early and they were fully represented during the recce. They were able to prepare themselves, the stores and the site before the exercise proper began. The STRE attached "advisers" to the working parties, but it seems that the field squadron (airfields) were able to retain technical control, which might be due to the fact that they had an E & MO, Clerk of Works (Mechanical) and four Petroleum Fitters RE and were therefore better established to deal with mechanical engineering tasks than fields squadrons. Anyway, the working relations were excellent and the exercise was predictably highly successful.

Experience on these exercises confirmed the opinion that the trouble with giving "advice" is that it can be rejected, or the receiver may not know how to apply it, or may not even understand it. Certainly, there often isn't time in operations *where things are going wrong* for the adviser to take the man-in-charge aside and convince him of the error of his ways and teach him better.

What is needed is for the "people who know" to be positioned at the points of difficulty to control the work so that errors are avoided, and to give quick decisions to the working party whenever a change of plan is necessary. In other words, the only really successful arrangement is for the two units, field squadron and STRE, to integrate for the project. After all, the field squadron cannot always "go it alone"; certainly the STRE cannot. Both OC's need the other, and both their reputations depend upon success.

CONCLUSION

A suitable formula reflecting this relationship could be:

"STRE to be responsible to the CRE/CE for the engineer work, field squadron to be in *direct* support of the STRE."

This would not prevent the field squadron commander from assuming disciplinary powers of a detachment commander in an isolated station nor stop him from being

station commander, if he is the senior officer present; nor stop his field squadron from carrying out other tasks not connected with the STRE.

This formula would give full weight to the principle that the man who makes the plan should also make it work.

The appropriate analogy from civil practice would be with the CRE as main Consultant, STRE as Sub-Consultant and Main Contractor and the field squadron as Sub-Contractor for labour and plant.

SUMMARY

It is a fact of life that officers of equal rank responsible for parts of a single project are liable to quarrel. The "Chain of Command" must cater for this possibility, and one way of doing it is to apply the prime engineering principle "that the man who makes the detailed plan should be responsible for its success".

When a field squadron is deployed with an STRE responsible for the work, it is proposed that the field squadron should be "in direct support" rather than "under command".

Corps Nominated Advisers

"RECEDOS"

PREFACE

IF the ideas expressed in the following article were put into practice, the inside front cover of the November 1970 issue of the *Royal Engineers List* might have, in place of the list of Names and Addresses of Secretaries of Corps Funds, etc., which would go on the inside back cover, a list which looked somewhat like this:

NAMES AND ADDRESSES OF CORPS NOMINATED ADVISERS

Water Supply in Mountainous Country	Major A. B. See, RE, 36 Engr Regt, Invicta Park, Maidstone, Kent.
Desalinization of Water	Major D. E. Eff, RE, RMCS, Shrivenham, Wilts.
Mobile Nuclear Power Plants	Lieut-Colonel G. H. Eye, MBE, RE, AWRE, Aldermaston, Berks.
Fuel Cells as a Source of Power	Lieut-Colonel J. K. Ell, RE, HQ 1 (Br) Corps, BFPO 39.
Tunnelling Techniques	Captain M. N. Owe, RE, 4 Div Engrs, BFPO 16.
Use of Solar Heat	Major P. Q. Arr, RE, M of D (ASD 7), Old War Office Bldg., Whitehall, SW1.
Carbon Fibre Developments	Colonel S. Vee, OBE, MEXE, Christchurch, Hants.
Sea Walls	Major U. Exe, MBE, RE, Engr Support Group, Woolwich.
Soil Mechanics and Dynamics as applied to Earthmoving	Major W. Why, RE, MEXE, Christchurch, Hants.
Road Construction over Peat Bogs	Captain Y. Zed, RE, 39 Engr Regt (Airfields), Waterbeach, Cambs.

INTRODUCTION

There must be a number of officers in the Corps who have, as one of their hobbies, the deep study of one small facet of engineering. Equally there must be a number of others who would derive a great deal of pleasure from studying in depth some particular subject if only they knew that their studies would have some recognition and application.

The Corps already has its specialists in many subjects such as airfield construction, petroleum engineering or well drilling. These are found at the RSME, in specialist teams, or in the specialist pool of the T & AVR. Many of these officers are also members of professional institutions, but what happens to them when they leave their specialist jobs? What use do we make of their knowledge and experience?

The Corps has many responsibilities and we cannot all be experts at all the tasks we are likely to be given. The Corps must nevertheless keep abreast of, and make use of, new ideas and techniques if every task undertaken is to be done as well and efficiently as possible, and it needs some formal impetus to encourage the development of new ideas. It needs expertise and there is untapped potential amongst individual officers.

This article is intended to suggest a way of providing the impetus and of tapping this potential to the mutual advantage of the Corps and of the officer.

THE PROPOSAL

The idea, in essence, is that any officer may put his name forward to be nominated as Corps Adviser on any subject on which he is particularly keen and in which he had already become knowledgeable. Once nominated, he would be helped and encouraged by the Corps in his further studies of the subject, and, in return, he would be used by the Corps as a consultant whenever his advice might be useful.

It should be made clear immediately that there is no intention of usurping in any way the functions and responsibilities of the specialists in the RSME, in the specialist teams, or in the T & AVR. For official advice on projects, or indeed for many other purposes, these experts are available to give well-qualified advice on a wide range of subjects. Nevertheless, even the specialist has limited experience, and for the unusual task, or the task which has to be done in particularly awkward circumstances, even he would appreciate advice at times. Why not draw up a list of officers who have made themselves particularly knowledgeable in special fields? The RSME does have such lists already, but who else knows about them? Any commander faced with an unusual or difficult task should be able to obtain the advice of an expert direct should he so wish.

IMPLEMENTATION

How should such a list be publicized? A ready-made publication already exists in the form of the *Royal Engineers List*. At the head of this article is an extract showing how the inside front cover of the *RE List* for November 1970 might look if the idea were adopted. The *Supplement to the RE Journal* could be used for publishing monthly amendments, as it already does, in the case of professional qualifications.

What would be the incentive for an officer to become a Corps adviser? Financially and materially he would gain little. He should be able to claim travelling expenses to meetings of appropriate learned societies and institutions, and he might be granted a sum of money, which could be nominal but desirably about £20 per year, for books, magazines, journals and subscriptions. The real advantage to the officer would be the personal satisfaction he would derive from being recognized as a Corps Adviser. It would be an added interest in life and the officer would know that not only was he able to make a real contribution to the Corps, but also that he was improving his own employability when he eventually retired.

There is no suggestion that officers should be directed to become advisers, but simply that a scheme should be devised to make the best use of individual officers' hobbies, talents and enthusiasms. So often individuals are hesitant in becoming too specialized in their profession. Equally the Corps does not want too many specialist appointments. This proposal overcomes these difficulties, since an officer can be a specialist without being limited in his employability—he can become, in fact, a "spare-time specialist", if he wants to. He continues to keep up the subject as a hobby, becomes a nominated adviser and thus remains an invaluable member of the Corps in his subject no matter where he is subsequently posted.

Obviously the standards expected of a Corps adviser would be high. There should be a Corps Committee of distinguished officers whose task it would be to approve the nomination of Corps Advisers. To become a Corps Adviser should be at least as difficult as, if not more difficult than, to become a member of one of the professional institutions. The committee would need a staff to do the routine administration, and this could be undertaken as a sideline by HQ Engineer-in-Chief or the RSME.

The scheme must, like justice, not only be good, but must be seen to be good. Advisers, besides giving advice as and when it is needed, would be expected to stimulate thought and action by writing articles in the *RE Journal* and, possibly, by presenting papers and giving lectures to meetings of the Institution of Royal Engineers or other learned societies. In this way the Institution would come alive to many more officers in the Corps, and the Corps might once again take the lead in the development of new ideas.

CONCLUSION

The Corps of Engineers is a professional body, but it is not as professional as it might be. It needs to keep up with new ideas and techniques. One way of doing so would be to encourage its officers, some of whom already have considerable specialist knowledge, to study particular aspects of engineering in greater depth, so that they could be used as Corps advisers on that subject. A list of such advisers should be published in the *RE List*, and their advice should be available to all who might need it. Corps Advisers would stimulate thought and action within the Corps by means of articles in the *RE Journal* and lectures and papers to professional institutions.

FOOTNOTE

It is hoped that this short article will stimulate and provoke discussion. If you think that this is a good idea, why not write to the Editor? If sufficient officers are in favour in principle it may be possible to get the scheme started.

It would be of great value to know how many officers would personally be prepared to become a Corps Nominated Adviser. If you are interested, write 'In Confidence' to RECDS, HQ E-in-C, c/o HQ RSME, Chatham, stating the subject in which you are particularly interested. If there were initially just ten officers who would be prepared to become an adviser, then the scheme would be worth developing.

The BM's Nightmare (or, "Why can't a YO be like Us?")

EX-BM

(With apologies to Lerner and Loewe and "My Fair Lady")

This playlet was produced for and enacted at the November 1967 Annual Conference of the Chief Engineer FARELF, as a lead-in to discussion on Young Officer Training.

Any resemblance between the characters portrayed and real life is entirely intentional.

CAST

The cast of four consists of a Brigade Major RSME, a CRE/CO from BAOR, a CRE/CO from FARELF and a CRE/CO from the Strategic Reserve.

SCENARIO

When the curtain rises all four players are on stage. The three CsRE/COs, appropriately dressed and each with an appropriate backdrop immediately behind him and a field telephone or radio in front of him, are sitting in line across the front of the stage, facing the audience. At the back of the stage, and 6 ft above the CsRE/COs, the BM is sitting at his desk, facing one of the wings. He is framed by clouds, and sits against a backdrop depicting the RSME Headquarters, which is clearly visible through a gap in the cloudbank. The BM and his backdrop are fully lit, the remaining figures are in semi-darkness. The BM is partially enveloped in a swirling white mist (achieved by a hidden QMSI skilfully dropping lumps of dry ice into a kettle of boiling water—without, if possible, scalding the BM's legs.)

THE PLAY BEGINS

Music . . . "Somewhere over the Rainbow" . . .
Curtain rises.

RSME backdrop is fully lit, the rest in darkness. Mist rises through the clouds and around the BM's head and shoulders.

After about 30 seconds' music, which then slowly fades, BM dials his telephone. Telephone bell rings three times off-stage. Front lights come on slowly showing three CsRE/COs sitting in front of their backdrops each with a field telephone or radio. After the third telephone ring, they pick up their receivers and reply in sequence:

BAOR: CRE!
FAREAST: CO!
STRAT RES: CRE!
BAOR: CO!
FAREAST: CRE!
STRAT RES: CO!
BM (*using echo box*): Good morning, sir. This is the BM, RSME.
CsRE/COs (*all together*): Good morning.
BM: Sir, my Commandant has been instructed to undertake a review of our system for Young Officer Training, and has ordered me to seek the opinions of Commanding Officers and CsRE. Have you, sir, any strong views on YO training?
CsRE/COs (*all together*): Yes, I certainly *have*!
BM: Good! Now may I take it for a start that you approve basically of our present system?

BAOR, FAREAST, STRAT RES (*all together*):
- Certainly *not*!
- Good heavens, *no*!
- You must be joking!

BM: Oh! In that case, sir, perhaps you would like to indicate what you think is wrong with it?
BAOR: Well, there's precious little right with it!
FAREAST: You teach them all the wrong stuff!
STRAT RES: You don't teach them the right stuff!
BAOR: You waste too much time on unnecessary detail.
FAREAST: You broad-brush too much and don't get into enough detail.
STRAT RES: You go into far too much detail on the wrong subjects.
BAOR: You don't spend enough time on important subjects like bridging and all-arms tactics.
FAREAST: You don't spend enough time on important subjects like roads and airfields.
STRAT RES: You don't spend enough time on important subjects like camp structures and improvization.
BAOR: The whole system is slanted far too much towards cold-war training for the Far East!
FAREAST: The whole system is geared to that ridiculous mechanical ballet in BAOR!
STRAT RES: The whole system is based on outdated types of warfare.
BAOR: The course isn't long enough!
FAREAST: The course is too long!
STRAT RES: The course is too short!
BAOR: Now take equipment bridging! This is really vital stuff in this modern age and yet you . . .
FAREAST: . . . waste an appalling amount of time on it at the expense of something useful like suspension bridges and trestle bridges which . . .
STRAT RES: . . . very rarely come our way, whereas the old Bailey bridging is something you find everywhere.

BAOR: Then look at all that soil analysis business! All that technical rubbish about Casagrande and LCN and CBR is . . .

FAREAST: . . . absolutely essential to any young Sapper officer worth his salt because he will very . . .

STRAT RES: . . . rarely be in any one place long enough to make use of it. The whole accent ought to be much more on air-portability and lightweight equipment and plant, which is . . .

FAREAST: . . . no good at all on any construction project of a reasonable size, and after all it is the larger construction projects which are the . . .

BAOR: . . . bane of our existence, and stop us getting on with something useful like all-arms battle group training. There is no doubt whatever . . .

STRAT RES: . . . that the whole system . . .

FAREAST: . . . needs radically revising.

BAOR: What we *want* . . .

STRAT RES: What we *want* . . .

FAREAST: What we *want* . . .

(*Now simultaneously, getting louder and louder and louder, until the* BM *shouts* "Stop, Stop, STOP!")

BAOR: . . . is a far greater accent on modern all-arms warfare, with particular emphasis on all the NBC aspects. The average YO who arrives here doesn't know a roentgen from a rowlock. You people just don't seem to realize how really advanced and technical we are in Germany now. The place really hums the whole year round, and if a chap doesn't know his stuff and isn't really up to date and with it in every sense of the word he just can't stand the pace . . .

FAREAST: . . . is a realistic approach to the whole thing instead of the present policy, if any, which seems to be hinged entirely to a lot of high-faluting nonsense geared to Rhine Army myths and fantasies. All the real sharp-end soldiering at the moment is happening in the Middle East and the Far East and the sooner you people in the Training Organization realize that, the better. This theatre really kicks the whole time and a chap has simply got to know his stuff before he gets here. If he doesn't he just won't last six months . . .

STRAT RES: . . . is a completely different concept to the whole problem of training for modern warfare. The chaps in Germany all want one thing and the chaps in the Far East all want another, and none of them really know what the hell they're talking about. The keyword to everything now is strategic mobility, and until you people at Chatham really hoist that in and get the right message we shall never get our young officers properly trained. I simply cannot understand why it all seems to be so difficult, when really it's just a matter of logic and common sense . . .

BM (*aghast with horror, at a suitable moment as the* CsRE/COs *jointly approach a crescendo*) . . . Stop! Stop! STOP!

CsRE/COs *become silent abruptly, but still hold telephone/radio receivers to their faces.*

Music starts. First few bars of "Why can't a woman be like a man", *as* BM *mops his brow and replaces his receiver.*

Music fades.

Damn! Damn! Damn! Damn!
What in all this heaven can have prompted these tirades
After all our training triumphs of the past?
What can so possess them, what does so obsess them?
They simply do not realize what they ask.

Commanders are irrational, that's all there is to that,
Their heads are full of grandiose ideas;
They really are exasperating, irritating, vacillating, aggravating, agitating, maddening and infuriating peers!

CsRE/COs (*together; starting very softly*)
Why can't a YO—be properly trained?
A smart young chap with the proper idea
Of what *really* matters, of what we want *here*.
When he leaves Chatham he should have it off pat—
Why *can't* a YO—be like *that*?

BAOR:
Why do they waste all his valuable time on stuff that he never will need,
Then send him to me with a BLR brain and a negative power to lead?
I want a man who's up to date in everything that's vital,
A man who knows his tactics and his nuclear survival,
His thinking must be armoured, whether half or fully tracked,
His mind must be amphibious, his knowledge soundly backed;
APCs and ADMs—these are the genuine stuff,
Not LCN and CBR and all that stupid duff!
I want a man who really knows that mechanized sappering's bliss.
Now why can't a YO—be like *this*?

FAREAST:
Why do they waste all his precious time on things he will never use,
Then send him to me with the state of his mind like a powerhouse without a fuse?
I want a man conversant with the things that really matter,
The cone penetrometer, the cut and fill, the batter.
Horizontal projects are the only things that count,
With progress charts and plant returns that mount and mount and mount . . .
Fifteen miles of feeder road, or twenty-five or more,
'N' replacement school-houses and 'x' deep-wells to bore.
This is the stuff a young man should have under his hat,
Now why can't a YO—be like *that*?

STRAT RES:
Why do they waste all his priceless time on knowledge he'll never require,
Then send him to me like a broken reed with his belly lacking fire?
I want a man who really knows what soldiering's about,
A man whose thinking's flexible—now here, now there, now out!
A man who's at home in the desert, a man who can live in the snow,
The sort of chap who's already gone before you can tell him to go.
He's got to know something of everything, but not too terribly much,
A little bit here and a little bit there—*not* the whole bloody book at a touch!
Selective training, that's what I want—but they always miss the bus.
Why can't they make—a YO—like *us*?

BAOR:
A YO should know how to tactically plan—to advance, to withdraw, to pursue,
How to lay fifty thousand odd mines in a night and be gone before daylight breaks through;
How to keep up to date with his EDP role and to not mix up this year with last year;
And this above all—he *must* be adept at adopting a nuclear posture.

FAREAST:
A YO should know how to measure precisely the soil moisture content and type,
How to use Casagrande at the flick of a hand, or lay line for a POL pipe;
What to do with an MO who's hostile and rude and declares as his firm diagnosis
That all of your carefully purified water is full of that Leptospirosis.

STRAT RES:
A YO should know how to improvise fast when there's nothing to improvise with,
How to knock up a structure that really will last and won't wither away like a myth;
A coconut shy for the Tidworth Tattoo, a bridge for the Mayor of Southend,
A quick trip to Libya, an airstrip or two—then back for the Ripon Week-end.
BAOR:
His hasty demolitions should be slick, precise and thorough,
And all his Heavy Ferries built in less than half an hour.
Thermal shielding, minefield breaching, Gillois rafts by night,
These are what we thrive on—dammit, there's no other way to fight!
FAR EAST:
Panji pits and booby traps he's got to clear with skill,
Not by deploying eight yards abreast—and doing some FEMW drill!
Tunnel systems, jungle forts beneath the giant trees—
We go down ropes from helicopters—not from APCs!
STRAT RES:
A jeep-track in the Isle of Skye, a landing ground on Mull,
A Bailey gallop from Trent to Wye, demolish a stack in Hull;
Transportable—airportable—to any foreign station—
But back again, of course, in time for the RE Demonstration.
FAR EAST:
A YO should know his Theory of Struts and Maximum Bending Stresses,
How to knock up a company base or two—latrines, cookhouses, messes . . .
STRAT RES:
. . . How to build an instant airstrip at an out-of-way location . . .
BAOR: . . . And use his personal instrument to check his radiation.
BAOR: A YO should know how to throw a bridge across the River Weser,
And pass a tank for the Armoured boys or a field gun for the Arty . . .
FAR EAST:
. . . How to build a jungle suspension bridge, or a trestle bridge, or raise a . . .
STRAT RES:
. . . Neat little scaffolding footbridge for the Commandants' Garden Party.
ALL CsRE/COs (*together; starting softly and getting steadily louder*)
Why can't a YO be properly trained?
Why can't they teach him what he really ought to know?
Why do they fill him up with fundamental rubbish
And then post him to me without a string to his bow?
Why, why, why in Heaven's name can't they see
That any self-respecting YO should be like me.

(*Getting still louder*)

BAOR (*rising to his feet*): Why can't a YO . . .
FAREAST (*rising to his feet*): Why can't a YO . . .
STRAT RES (*rising to his feet*): Why can't a YO . . .

(*All drawing their pistols, and now very loud*)

BE—LIKE—ME!

All turn and point their pistols at BM. *Loud bang and instant smoke* (*if* QMSI *is on form*), BM *screams and slumps below cloudbank, lights go out and curtain drops.*

"Wither" the Corps?

CAPTAIN C. G. B. BRODLEY, MBE, RE

By 1971 we shall be firmly established in Sennelager, Salisbury and Sennybridge. The Army as a whole will be committed to NATO and a seven-day holding action on the frontiers of Western Germany. This is the import of the latest Defence Review—and what will the Sappers do then?

Ten years ago Brigadier J. B. Brown's article "Whither The Corps" (*RE Journal* of December 1958) sparked a controversy that ran to twelve months' correspondence and divided the Corps into Civil (Long Courses, Specialists, etc.) and Military Engineers. The Brigadier's article contained the warning that Specialist Corps that relinquished their specialist roles were vulnerable. Since then we have lost Works Services, Transportation and Movements.

Today the argument should be restated: are we to be Military Engineers or Assault Pioneers? The answer will depend entirely on our role and commitments during the next ten years. At present our prime "specialist" functions are roads and airfields. Those of a secondary nature are demolitions, mine warfare, equipment bridging, water supply and field defences. By secondary nature I mean functions that could readily be learnt by infantry units given a little training. The educational gap between Engineer Troop and Infantry Platoon is not as wide as many of us would believe, and we would be unwise to stake our future on the margin.

The foreseeable trouble with roads and airfields is that there will be nowhere for us to build them. There will be no more "Crown" airfield; no more Christmas Islands (or Aldabras) and, after the recent deliberations, no more Borneos. Operations outside NW Europe will be restricted to company-sized airlifts similar to the 138 men lifted to Mauritius in January. Perhaps to Fiji and possibly to some African states. The opportunities to fulfil our "specialist" role will become less and less and, in all conscience, they have already been few enough.

It is difficult to conceive that roads and airfields will ever enter any future conflict in NW Europe; particularly a short-lived conventional one. The development of amphibious vehicles and VTOL aircraft are surely undertaken to reduce our dependence on permanent installations in the forward areas.

As the end of the present, planned run-down approaches is not the Corps going to look particularly vulnerable? To date cuts in the Royal Engineers have been slight, but as the logistical tail diminishes are we not going to look increasingly ripe? Can we really justify plumbers and pipefitters, painters and decorators, joiners and carpenters more than a decade after losing Works Services?

A number of RE officers think so. In his article "The Unconventional Sapper" (*RE Journal* of December 1963) Lieut-Colonel I. T. C. Wilson, MBE, MC, put forward ideas for the use of trained military engineers in the development of areas sensitive to Communist pressures. In his article he quotes Brigadier R. L. Clutterbuck, OBE, as saying, "The two most valuable men in contacting local tribes are the medic and the engineer . . ."[1] and in his conclusion Colonel Wilson said: ". . . the Corps of Royal Engineers should once again lead the trend of development in the Army by establishing a unit or units specially trained to take an active part in the Cold War. . . ." The Americans are already doing so. Since 1961 American Military Engineers have been engaged in civic action programmes in countries as diverse as Guatemala, Thailand, Mali, Ecuador, Bolivia, Peru and, of course, Vietnam. American civic action is naturally concentrated in areas of prime American interest. There was a time when much of the globe was considered to be within the British sphere of interest. Are we no longer interested?

[1] To an audience at Fort Bragg, US, 1963. See also "The Engineer as a Weapon in the Cold War", by Colonel R. L. Clutterbuck, OBE, *The Military Engineer*, November–December 1963.

This is not crying over spilt milk. Because we can no longer afford to maintain bases abroad, it does not follow that we cannot afford to assist in overseas development. Indeed, with defence expenditure abroad at a minimum, tentative promises of increased economic aid have already been made. There can be no doubt that the provision of equipment and technical expertise has far greater effect than cash grants-in-aid. Small teams of Sappers, moved to disaster areas abroad at short notice, have already demonstrated what can be achieved in terms of emergency relief and, as a by-product, goodwill.[a] The effect of putting such action on a firmer more permanent footing would be of enormous benefit both to the country and the Corps. I do not believe, as Colonel Wilson does, that the units need of necessity, be specially trained. A full equipped, properly trained and well supported Field Squadron can turn its hand to most things. What would be necessary would be the selection of capable and enterprising officers and men. There are two Engineer Regiments in UK; one of them would be a good jumping-off place. The ability, the techniques, the men and materials all exist *now*; only the opportunity is lacking. Unless the Corps actively seeks, fights for, grabs and makes the most of a peacetime role of this nature, we are doomed to perpetual pioneering. We will no longer attract the calibre of man to which we are accustomed. Many of those that we already have will vote with their feet and depart.

In truth, we should be honest and change our name to something more apt. The most appropriate has been appropriated.

Note by Editor

E-in-C welcomes this letter, as a natural expression of what many officers must be feeling. Most of Captain Brodley's arguments are developed in the paper entitled "The Future Role and Organisation of the Royal Engineers", circulated to Chief Engineers and other senior officers under reference BR/A/442/ASD7 of 16 January 1967. In addition E-in-C has recently circulated his views on "Corps Objectives" to lieut-colonels in command and to senior officers of the Corps, of which all officers should be made aware.

As these documents are classified, they cannot be discussed specifically in these columns; but E-in-C hopes that any further correspondence on the subject will take account of their contents.

[a] Captain Brodley commanded an RE detachment, sent from BAOR to the earthquake-damaged town of Skopje in Yugoslavia in 1963, to erect Nissen hutting—see September 1964 issue of the *RE Journal*. EDITOR

Guwwaat as Sultan

CAPTAIN B. A. F. RANDEL, RE
Recently a Staff Captain in Muscat

THE Secondment Manual states: "Service with SAF offers a hard, active and interesting life with high pay, in a little known part of the world." How accurate but how inadequate a picture this paints of what must surely be one of the most interesting and rewarding soldiering jobs in the world today. Unfortunately few people get the opportunity to serve in this unique force, but having been one of those lucky few I feel I should pass on something of the atmosphere of the country and the job that is being done there.

The country itself is a far cry from most peoples' idea of a corner of Arabia. True there are vast areas of sand and gravel plain, but these are not the flat featureless tracts conjured up in people's minds by the image of the wandering bedu on his camel. The sands of the Empty Quarter and the Wahiba Sands have a fascination of their own which has been dwelt on at length by such writers as Philby and Thesiger; even having read the books of these Arabists one's first sight of unbounded miles of sand-dunes can only fail to fascinate the most unimaginative and unfeeling person. Some people adore the desert; others hate it, but few are unmoved by it. The physical backbone of the country is the Hajar range of mountains running basically from the north-west to south-east in the northern part of Oman. This range varies in height from 2,000 ft to 10,000 ft and is intersected by precipitous but fertile wadis down which flow surging torrents after the rains. There is a further range of hills in the Dhofar province in the south; but whereas the Hajar range strikes the newcomer immediately by its sheer size and grandeur these seem far less imposing; although on closer acquaintance they become just as awe-inspiring and inhospitable if treated flippantly.

To seaward of the Hajar range is the Batinah plain. This fertile strip between five and thirty miles wide is best known for being the breeding-ground of the famous Omani white camel which has been sought after for centuries by princes and commoners alike as the thoroughbred of the camel kingdom. The Batinah coast also contains many famous old towns such as Sohar, the legendary home of Sinbad the Sailor, and the remains of an unknown civilization many years before the Arab conquests.

The majority of the country's population live on the Batinah and in the area of the inland towns of Nizwa, Ibri and Buraimi, from whence there are routes to the coast through the Hajar range. The twin cities of Muscat and Muttrah are strategically placed at the entrance to the Gulf of Oman and at the head of the main route into the interior. The people are largely of pure Arab stock, but on the Batinah and at certain centres inland there is a large Baluchi population who stem from the days when Gwaduri Baluchistan was a part of the Sultanate. There is also a minority Indian trading population in Muscat and Muttrah and the wild men of the Qara tribe, whose antecedants are unknown, inhabit the hills in Dhofar.

The Sultan's Armed Forces in their present form were born out of the Muscat Infantry and the Batinah Force after the Jebel War in 1958. Until that time there had been small military forces in the country but no overall command structure, really adequate communications nor logistic support for modern warfare. The Muscat Armed Forces, as they were then known, fought gallantly against a group of insurgent rebel tribesmen during the Jebel War, but were not able finally to subdue the uprising without assistance from both the Trucial Oman Scouts and the British Army. The Sultan has had treaty relationships with Britain ever since the beginning of the nineteenth century and after the Jebel War he asked for British assistance to

reorganize his Armed Forces. This assistance was provided in the form of some thirty-five officers, seconded to SAF for periods of eighteen months or more at a time. The Forces were then organized as a Brigade Group and are still so today. There are currently three infantry battalions and a frontier force of a weak battalion strength with supporting artillery, an integral air force and a coastal patrol vessel. These are supported by a small ordnance depot, medical services, workshops and a second-line MT company. Communications are nearly all by key and it never ceases to amaze some people how Arab boys of 16 or 17 can send morse so fast that British signallers, both Army and Royal Navy, often have to ask them to slow down. All basic training is done at a training centre where there are always ten squads of thirty-five recruits doing their basic six months' course.

Apart from the officers seconded from the British Army, there is an equal number of British officers employed directly by the Sultan. Most of these have had a wealth of experience either in the British Army or the Colonial Police. They tend to stay in SAF for rather longer than the seconded officers. They provide the essential continuity and are invaluable in holding in check some of the more impetuous seconded officers. Both these facets are absolutely vital in a force of this nature, because not only is much passed on purely by word of mouth but the Arab soldier is very sensitive to change and looks upon his officer very much as a father figure. If one can gain the confidence of these soldiers, they are loyal, courageous and endearing, but their very volatile nature often needs controlling and this is far easier done by someone whom they know well and understand.

The majority of the Force today is deployed in company posts near the main centres of population. From these modern camps the companies patrol their area gathering intelligence about any subversive elements who may have returned to the country after receiving basic military training in other Middle East countries. In addition to this intelligence-collecting role the companies keep the Sultan's peace by showing a military presence and assisting the local population by providing a postal service and a certain amount of transport and medical help.

In addition to the companies deployed in these peacetime locations in the north of the country, there is part of the Force involved in a small anti-rebel war in Dhofar. The dissidents are Egyptian or Iraqi-inspired and are trying to put the country into such a state of unrest that the Sultan is deposed and a so-called democratic régime set up. They have no real base in the country, but are supplied at intervals with arms and ammunition from outside. Whilst terrorizing the local population in the hills and mingling with them, they lay ambushes for military and oil-company convoys and occasionally make armed forays nearer the towns. There was one unsuccessful attempt on the Sultan's life eighteen months go. Military operations in Dhofar take much the same form as anti-guerrilla warfare in any part of the world and are largely a matter of incessant patrolling and following up any intelligence leads. Operations are complicated by the fact that there are no good maps of the area and the fact that none of the soldiers come from local tribes. This lack of topographical information gives a distinct initial advantage to the rebels, but as time goes on and SAF have acquired more knowledge, a number of distinct successes has been achieved. The most notable of these has been the killing of one of the rebel leaders and the capture of a large quantity of arms and ammunition as they were being brought in from the desert. The very fact that SAF have an air potential is of tremendous psychological value and the enemy are very loath to prolong any engagement long enough for the strike aircraft to reach the scene of the action. It may take a long time before the rebel groups are eventually cleared out of Dhofar, but with modern communications, weapons and determined leadership SAF have very much the upper hand and operations there offer ample scope for the young British officer to exercise his initiative and tactical knowledge.

Life in Muscat and Oman for the British officer is immensely varied and provides a new challenge every day. When he is not commanding a patrol in Oman or Dhofar he may be faced with the day-to-day administrative problems of running a com-

pany 200 miles away from his Battalion HQ. These problems, that are unlikely to be met with in the British Army, vary from explaining to a soldier that a fall of snow 7,000 ft up in the Jebel is not some retribution from Allah for looking adulterously at another man's wife to loading donkeys on to a dhow via an open boat. One of the recurring problems is keeping the Force supplied with all items from a new three-tonner to a pair of hose tops. All supplies are bought direct from UK or Pakistan on a very limited budget and, quite apart from the normal length of time it takes for anything to reach Muscat from UK, such outside events as the British seaman's strike last year and the closure of the Suez Canal make it very difficult for the Q Staff to explain to a battalion commander why the new mortars he has been waiting for longingly for nine months are still further delayed. Despite this type of incident, however, and the very diverse sources of procurement, the force is well equipped with modern equipment, vehicles and weapons. There is a very efficient EME organization to keep the mechanical equipment in good order and efficient medical and veterinary services to look after the welfare of the soldiers and donkeys.

Donkeys are used extensively for transporting wireless sets, food, water and personal kit on patrols in areas that are inaccessible to wheeled transport. These donkeys are not the normal rather scrawny ill-kept creatures seen in the suqs of Aden and Bahrein, but a larger, tougher breed bred high on the Jebel which make light work of carrying a 100 lb load up and down precipitous paths for days on end. Contrary to some people's idea of an Arab army, there are no picturesque camel-borne companies charging across the desert with swords drawn and abbas flying. The camel has been entirely superseded by the Land-Rover as an efficient means of military transport. This much to the relief of most people who have not been brought up to ride one of these flea-ridden, bad-tempered creatures. A camel in the hands of bedu is a beautiful, useful and majestic animal. However, in the hands of an Arab from the mountains, or a British officer, it is only an uncomfortable and very slow means of transport.

Although there are no night-spots or other sophisticated centres of entertainment for the European in Muscat, there is plenty to exercise both mind and body during periods of relaxation. Facilities exist for the energetic to play tennis or water-ski off the most beautiful beaches and, for the not so energetic, to brew their own potions from the local dates or grapes or even cultivate very colourful gardens in the winter. There is very good shooting, for sand-grouse, partridge or duck; and two expeditions have so far been organized to capture specimens of the rare Arabian Oryx in order to keep this fast-disappearing breed of animal alive in captivity.

I hope that what I have written has given some insight into the life led in Muscat and Oman, which is such a little-known country to most Europeans. It is now a fast-developing country, but I personally hope that even with the benefits that oil production is bound to bring not all the character of a country which has been said to be "a country living in the twelfth century rushing headlong into the fourteenth" is lost amongst the so-called benefits of modern civilization.

Torpedoman George Hill, New Zealand Cross

LIEUT-COLONEL K. C. FENTON, RNZE
Corresponding Member of Council, Institution of Royal Engineers

THE Regular component of the Corps of Royal New Zealand Engineers traces its ancestry from the New Zealand Permanent Militia formed under the Defence Act 1886. At that time the New Zealand Armed Constabulary, formed to maintain law and order during the Maori Wars, became the NZ Permanent Militia and the NZ Police Force. By April 1887, the establishment of the Militia totalled 350 all ranks—50 Field Artillery, 120 Garrison Artillery, 50 Torpedo Corps, 20 Engineers and 110 Rifles. Early in 1888 the Field Artillery and Engineers were absorbed into the Garrison Artillery and Torpedo Corps respectively, and on 19 June 1896 the Torpedo Corps was renamed No 2 Service Company, being the Submarine Mining branch of the NZ Permanent Militia. This company on 15 October 1902 was granted the dignity and name of Royal New Zealand Engineers, which with Royal Assent was changed to the Corps of Royal New Zealand Engineers on 3 September 1903.

The original Roll (1887) of the NZ Permanent Militia shows the name of No 92 Torpedoman George Hill, New Zealand Cross, as a member of the Torpedo Corps. A New Zealand soldier of some note, he is remembered in New Zealand for his gallant conduct at the relief of Jerusalem Pa at Mohaka on 10 April 1869 and for the service he gave to the Torpedo Corps and to its successor, No 2 Service Company. The Torpedo Corps to which he belonged was in effect initiated by Colonel (later Major General) P. H. Scratchley, CMG, RE, who on 1 March 1880 submitted for consideration of the Governor and Commander-in-Chief of New Zealand a report on its defences. He recommended that "submarine mines be placed in channels by which the enemy must pass in order to enter ports" and that torpedo boats be obtained for attacking the enemy's vessels. He went on to say in his report that "no doubt the attack upon an enemy's vessel with torpedo boats will be a service of great danger, but I am quite satisfied that there will be no difficulty in obtaining volunteers for this purpose". That such men as George Hill were prepared to undertake this work indeed confirmed Colonel Scratchley's prediction.

Before describing the work and equipment of the Torpedo Corps in the 1880s to give the setting to George Hill's life with the Sappers, it is important that his distinguished Infantry service prior to 1886 be recorded. His career before 1886 was both varied and colourful.

George Hill was born at Dawlish, Devonshire, and in 1851, at the age of 14, joined HMS *Britannia*. He served on HMS *Leopard*, a paddle-wheel frigate, at the bombardment of Sebastopol during the Crimean War, and later saw active service on land as a member of a Naval detachment from HMS *Leopard*. At the outbreak of the Indian Mutiny he was serving on HMS *Shannon* and, as a member of a Naval detachment sent ashore, was attached to Captain Peel's Naval Brigade, which took a battery of 32-pounders to the relief of Lucknow. He was slightly wounded at Lucknow, was later wounded at Cawnpore and fought at Delhi. In 1862 he left HMS *Hannibal* at Palermo, and served in Italy in Garibaldi's Army of Liberation being wounded before he rejoined his ship. His absence from HMS *Hannibal* was fortunately overlooked. Coming to New Zealand in the troopship *Empress* in 1864, he jumped overboard and swam ashore while the ship was anchored in Waitemata (Auckland) harbour.

He joined Major Von Tempsky's Forest Rangers and served in Taranaki, and on the East Coast against the Hau Hau in No 1 Company, Military Settlers, and No. 1 Division of the Armed Constabulary. He fought in fifteen engagements against the Maoris, winning his New Zealand Cross as a Constable. He was promoted to Sergeant after his inspiring leadership at the siege of Hiraharama (Jerusalem) Pa on 10–12 April 1869. However, shortly afterwards he reverted to the ranks at his own request; being unable to read or write, he felt unfitted to hold the rank of Sergeant.

At the siege of Hiraharama Pa near Mohaka, he led a party of friendly Maoris past the rifle pits of the Maori Hau Hau leader, Te Kooti, and after gaining admission to the pa, fortified it and successfully defended it against Te Kooti's attacks.

Te Kooti had attacked the smaller pa of Te Huke (which was situated nearer the mouth of the Mohaka River) and secured it before mounting his main attack on Hiraharama. Among the few that escaped from Te Huke to Hiraharama was a Maori girl, Harata Hinerata, who, after fighting with great courage at Te Huke, joined George Hill in the defence of Hiraharama. They later married and together shared forty years of married life.

When Hill and his small party of Maoris arrived at Hiraharama there were only ten able-bodied men in the pa. He took charge of one of the angles towards which the Maoris had started to sap, there being a heavy fire from Te Kooti and his three hundred or so supporters. As the enemy was thought likely to revert to his favourite practice of pulling down parts of the palisade by means of a rope and crossbar, Hill got the defenders to pass bullock chains round the fort angles, making them fast to the stout corner posts and thus strengthening the palisade. The small defending garrison of less than forty were kept on the alert, and after a night of continual firing saw the Hau Hau give up the siege and withdraw. Hill so inspired the defenders by his exertions that the repulse of Te Kooti was attributed to him.

For his gallantry at Mohaka, George Hill was awarded the New Zealand Cross,[1] joining the select band of twenty-three officers and men of the Colonial Forces given that decoration, which was recommended by Colonel (later Major-General) Whitmore to be awarded to those who "in the presence of the enemy performed some outstanding act of bravery during the Second New Zealand War".

To return to the Torpedo Corps, this Corps was raised prior to the formation of the NZ Permanent Militia in 1886, and although torpedo boats did not arrive in New Zealand until 1884 and 1885, the Corps was active from 1880 onwards following Colonel Scratchley's report on the Defence of New Zealand. The Corps was assisted in its training by the loan of Instructors from the Submarine Mining Branch of the Corps of Royal Engineers. They were trained in the techniques of running torpedo boats and laying electrically fired submarine mines. The four third-class torpedo boats ordered by the NZ Government from John I. Thornycroft, of Chiswick, England, were built in 1883 and launched late that year. The first two, numbered 168 and 169 by Thornycroft, arrived in New Zealand on 9 May 1884 as deck

[1] Following the representations of Colonel (later Major-General) G. S. Whitmore, KCMG, to Governor Bowen, the Governor agreed to the issue of an Order in Council instituting the New Zealand Cross as a decorative distinction for members of the Militia, Volunteers and Armed Constabulary who distinguished themselves by conspicuous bravery in action. However, when a copy of the Order in Council was submitted to the Secretary of State, Earl Granville, he officially reproved the Governor for instituting this decoration resembling the Victoria Cross without Royal approval. Earl Granvile, however, stated that "under the very exceptional circumstance of the Colony, the Queen was graciously pleased to ratify the Colonial Order instituting the decoration and to permit the decoration to be awarded as if it had been instituted by Her Majesty's direct authority". The New Zealand Cross ranked in New Zealand next to the Victoria Cross, and is one of the rarest decorations in the world, only twenty-three having been awarded. The ribbon, 1½ in wide, is deep crimson and identical with that of the Victoria Cross. A full account of the circumstances surrounding the conception of the NZ Cross, its design and award, is contained in *An Encyclopaedia of New Zealand*, published by the NZ Government Printer, 1966.

cargo, while numbers 170 and 171 arrived on 25 August 1884. The boats were distributed and named as follows:

No	*Location*	*Name of Boat*
168	Lyttleton Harbour	*Defender*
169	Port Chalmers	*Taiaroa*
170	Auckland	*Waitemata*
171	Wellington	*Poneke*

The Maori names given to three of the boats were appropriate to their location.

The boats, which were built at a cost of over £4,000 each, and classified as third-class boats (being less than 50 tons), had the following characteristics:

Hull dimensions
Length, 63 ft
Breadth, 7 ft 6 in
Depth, 4 ft
Draught 3 ft 6 in

Displacement
12 tons

Engine
Compound reciprocating steam engine
High-pressure cylinder, 8.25 in bore
Low pressure cylinder, 13.5 in bore
Stroke 8 in
Steam pressure, 130 psi
Indicated horsepower, 170 at 630 rpm
Single screw, 2 ft 10 in diameter

Speed
17 knots (maximum trial speed according to Jane's *All the World's Fighting Ships* 1899)

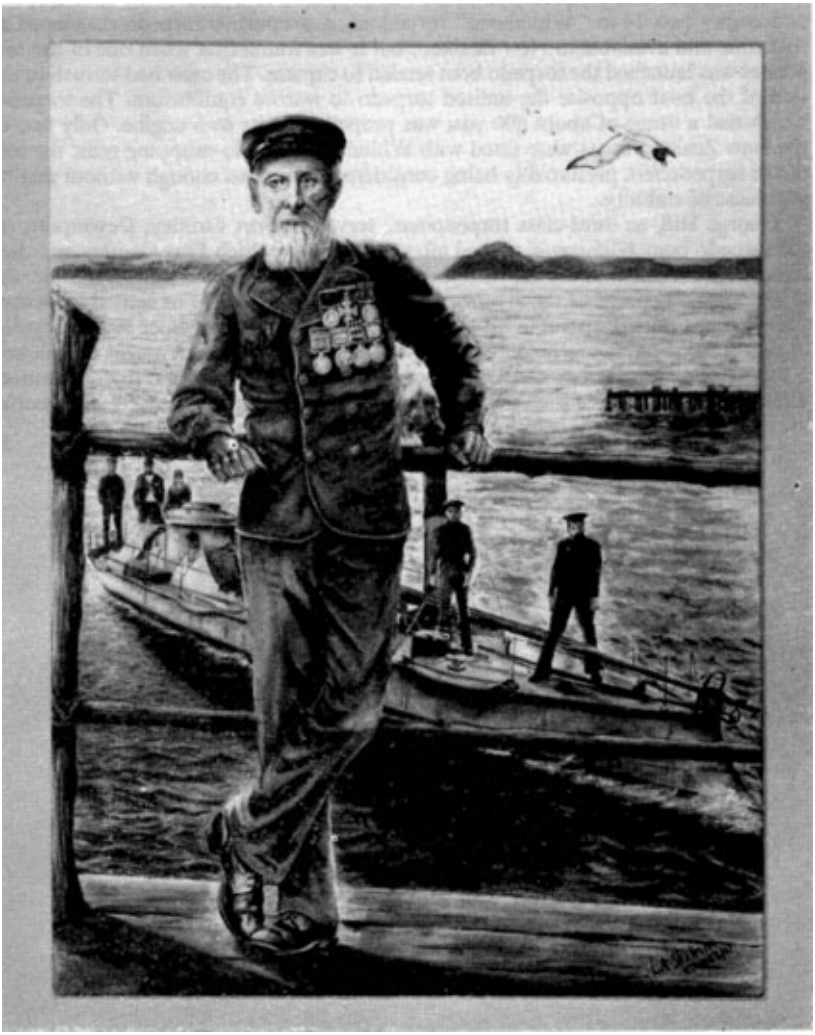
Coal stowage
3 tons

The hull plating was of galvanized steel $\frac{3}{32}$ in thickness, and the engine of advanced design. At the stern of the vessel was a small cabin for the commanding officer, and forward of this an oval conning tower and also a compartment for the steersman quartermaster. The top of the conning tower was fitted for mounting a 1-in Nordenfeldt gun. Forward of the steersman's compartment was an engine-room, where steam was generated in a locomotive-type boiler. The stokehold was kept reasonably cool, forced air draught for the furnace being provided by a large fan. The forward portion of the deck was "turtle-backed" for strength and protection. Slightly ahead of the midship section were two funnels mounted alongside each other. The photograph of the painting of Hill and the torpedo boat *Waitemata* illustrates the boat's proportions.[2]

[2] The painting showing Torpedoman George Hill with a torpedo boat in the background was executed by WO I L. A. Skelton, RNZE, in November 1967 after studying photographs of Torpedoman Hill and the *Waitemata* torpedo boat. The medals won by Hill are:

Left breast: New Zealand Cross, Baltic Medal, Crimea Medal wth clasp "Sebastopol", Turkish Crimea medal, Indian Mutiny Medal with clasps for "Lucknow" and "Relief of Lucknow", New Zealand (Maori War) Medal, New Zealand Long and Efficient Service Medal (sixteen years).

Right breast: Royal Humane Society's large bronze medal (awarded while serving on HMS *Hannibal*, 17 February 1860), Royal Humane Society of Australasia's bronze medal, 28 February 1896.



Torpedoman George Hill, New Zealand Cross

The torpedo boat was equipped with a spar 34 ft in length mounted above the forward deck in a near horizontal position. It carried an explosive charge of 35 lb of guncotton in a canister 2 ft by 1 ft at its outer end, which could be advanced many feet ahead of the boat's bow and depressed to immerse the charge in the water.

It was intended that the torpedo boat would steam close to the hull of an enemy vessel, and detonate the charge against the enemy hull below the waterline by contact or electric current from the torpedo boat. The explosive charge, although called a torpedo, was really a placed mine. It was proposed to abandon the spar torpedo and empty two 14-in "Whitehead" torpedoes, a propulsive torpedo developed at that time and available in New Zealand, but it was found that when one of the torpedoes was launched the torpedo boat tended to capsize. The crew had to rush to the side of the boat opposite the unfired torpedo to restore equilibrium. The torpedo, which had a range of about 400 yds, was propelled by its own engine. Only two of the New Zealand boats were fitted with Whitehead torpedo-dropping gear, the role of the torpedoman presumably being considered hazardous enough without adding problems of stability.

George Hill, as third-class torpedoman, served at Fort Cautley, Devonport, on the torpedo boat *Waitemata*, named after the harbour which Fort Cautley guarded. Records are limited on his life with the Torpedo Corps, but it is known that he was at one stage in charge of the *Waitemata* and that on retirement he settled at Devonport. He was not successful in his application to proceed to the Boer War, but prior to retirement from Government Service was in charge of a Government launch and a scow. When he was too old for service at sea, he held a position in Government Stores at Auckland. He died on 15 February 1930 aged 93 years, after an eventful life of Military and Government Service.

Correspondence

Brigadier C. T. Edwards, CBE,
Lists House,
Husthwaite, York.

28 February 1968

ARMOURED CRUSADER
by Major K. J. Macksey, MC, RTR

Sir,—Many thanks for your letter MR/A of 19 December last, and for sending me the copy of Kenneth Macksey's biography of the Hobo. It is an interesting book, but I think rather a biased one. It does, however, give a very full account of the Hobo, and throws light on the mismanagement of the development of our Armour between the wars (though it does not mention the fact that, at one time, the Director of Mechanization was a Horse Gunner who could not drive a car). Macksey is evidently a fervent admirer of the Hobo, which leads him at times to distort facts and arguments in favour of his subject. He is also led to cast aspersions on the motives of some of the greatest and least self-seeking figures of the war when he thinks that they are doing the Hobo wrong—eg Wavell, Brookie and Bob Haining.

It is difficult to arrive at a fair evaluation of such a complex character as the Hobo, but I would say that Jumbo Wilson's letter on page 170 is a very fair one. Copper Finlayson's Report on page 162 is, in my view, largely correct, though he is quite adrift in saying "Personality average" and "methods of managing officers and men do not get the best results". His RTC chaps would do anything for him. Jumbo's letter refers to the Hobo as commanding a division of all arms. When he came to command the 11th Armoured in March 1941 I would say, from a humble standpoint (I was his CRE for the first fifteen months), that the same criticisms applied equally. He tended to devote all his time and interest to his armoured units, and largely neglected the need to bring on the other arms and units as an integrated part of his division. He very much gave the impression that the armour were the boys, and the rest were the common herd. Morale undoubtedly suffered as a result and it was not a happy division. In his training, too, he was all for the Armour fighting the battle on their own, neglecting the need for close co-operation of all arms.

When the Hobo was developing the Armoured Brigade in 1934, however, he was dealing almost entirely with armour both as regards organization and tactics. As a result his job was rather simpler, and this, I think, was partly the reason why he made such a success of it. There is no doubt that, when he was developing and training the Armoured Brigade, he was quite magnificent. He worked his chaps very hard, and they responded 100 per cent, being most interested in all new ideas, and sweating till all hours to keep their old Vickers tanks on the road. Yours faithfully, C. T. Edwards.

Brigadier E. E. Read, CBE, MC, C St J,
Red Bines,
Beavers Hill, Farnham.

7 January 1968

THE FRENCH ENGINEER SCHOOL

Sir,—As one of the first British officers, in 1924, at the École Militaire du Génie at Versailles, I read with interest Major Shave's article on the new School at Angers, that appeared in the June 1967 issue of the *RE Journal*. I then bore the somewhat imposing title of "Professeur d'Anglais".

Our facilities for over 200 *officiers élèves*, and *élèves officiers*, were most exiguous, and it was a full-time job for one French staff officer to draw up weekly an immense chart showing the timings and the classrooms for each lecture. No branch had its own rooms, and there was no continuity, so an immense carting around of books for staff and students was necessary. It was not always easy to put across one's subject at 7.30 am on a Monday morning or at 6 pm on a Friday. Education physique was not very popular, and there were no games.

The bridging with 1896 equipment and the field-work grounds were not lavish, and we had to go to Strasbourg-on-the-Rhine for real work.

It was a very happy time, but, as Major Shave indicates, we suffered from the lack of any Mess life and chances to meet socially. The Salle d'Honneur was a most impersonal place, only entered for a presentation on the day I left. Our greatest meeting-place was the wonderful riding school in Louis XIV great stables. These were spokes of a great wheel, 120 horses to each spoke. Four rides could be worked simultaneously in the big school. Our equestrian manners were most exactly regulated. When hacking in the Great Park, you could not pass a senior officer without saluting and asking permission to pass. Hunting with the stag hounds of the Duchesse d'Uzès at Rambouillet it was necessary to take off your uniform cap and bow deeply, at whatever speed, if passed by the Duchesse either at the Meet or when hounds were running.

At that time, as Engineers, we had no colours. However our "nephew" establishment of St Cyr was just down the road. I enclose a photo of British Colours being presented to St Cyr, for which I was guard of honour, as I had enlisted for a few days in 1914 in the Breton Regiment. The colour-bearer is Salisbury-Jones, later Major-General and Marshal of the Diplomatic Corps, who had been a cadet at St Cyr. This was taken at the start; we remained with swords at the carry for 1½ hours during the ceremony, including a gallop past of St Cyriens in a snowstorm. It was a job to hold the ceremonial Coupe de Champagne afterwards! Yours faithfully, E. E. Read.

Major K. Donaldson, RE,
The Civil Engineering School,
Technical Training Group,
RSME.

19 April 1968

SAPPERS IN THE BORNEO CAMPAIGN

Sir,—Though I enjoyed reading Major Napier's article in the March *Journal* and found it to be a well-balanced account, I feel I ought to point out one error at the bottom of Table 3. As far as I am aware, Major D. E. Townsend-Rose was not with the Brunei Works Section; it was his brother Major J. D. Townsend-Rose, MC. In fact, I formed the Brunei Works Section, as recounted in my article which appeared in the September edition of the 1964 *Journal*, and was its first OC. Yours faithfully, K. Donaldson.

Maj K Donaldson RE

Memoirs

MAJOR R. D. McLEOD, MC

It is just thirty years since Don McLeod arrived in Chatham with four other Canadians to join Donald Ross's 38 YO Batch in 1937 after graduating from the Royal Military College at Kingston. His death in a tragic accident in Toronto on 20 June 1967 came as a great shock to all his many friends in the Corps, not only for its suddenness but more especially because he was always so full of life, making friends wherever he went and appearing as young and as carefree as the day he arrived at the SME.

Don was born in St John, New Brunswick, in 1915 and was educated at St John High School. He entered Kingston in 1935. He always stood high in his class and was one of the most popular members of it. He had a nice sense of humour and was ever prepared to lend a helping hand to anyone who needed it. He was a keen rifle shot and became a member of the 1934 Canadian Bisley Team, representing Canada in the Kolopore Cup, tying for first place in the *Daily Mail* match and finishing thirty-first in the King's Hundred. Later that year he won the Gooding Gold Medal in Ottawa for the highest aggregate for those under 21. His other sports were sailing and skiing, which gradually took over from shooting as he grew older. Just before his death he was organizing the International Dragon Class races at Toronto during Canada's Centenary celebrations.

When war broke out in 1939 he joined John Forbes's 55 Field Company, spending the dreary first winter of the war waiting to demolish the oil installations in the Low Countries if the Germans launched a winter offensive in the west. In the spring the company was switched to the Norwegian Expeditionary Force, and Don and his field section went off in support of Carton de Wiart's force which landed at Namsos. For his work in covering the withdrawal of this force and particularly for his spirited action against the Germans at Verdal Bridge he was awarded his very well-deserved immediate Military Cross.

On return from Norway he stayed with his company, working on beach defences in Suffolk. In 1941 he was posted to the SME, where, after a spell as GSO III, he became the youngest Brigade Major to hold the post. After a short spell with 553 Field Company of 43 Division, he went to Washington as a member of the British Army Staff, returning in time to take part in the invasion of Normandy and the advance to the Rhine. He missed the last winter of the war in north-west Europe, as he gained a nomination to the Staff College, where he arrived for the first six months' course which started in January 1945.

The war ended in Europe while he was still at Camberley, and so, at the end of the course, he volunteered for the Far East, arriving just in time to take part in the reoccupation of Malaya and Singapore.

After the war he served on in the Far East with the 14th Army, Malaya Command, and FARELF. The problems of educating his children, however, made him feel that he must return to Canada. He retired in 1949, subsequently becoming the Manager of the Toronto Medical Arts Building, from which he extended his responsibilities to the management and reorganization of other major offices.

He leaves his wife Helen and three daughters, Priscilla, Ellen and Valerie; and is greatly missed by his many friends on both sides of the Atlantic.

W.G.F.J.

LIEUT-COLONEL (QM) L. J. FIELD, MBE, RE

LEONARD JAMES FIELD was born on 22 September 1915. He joined the Army at the early age of 14 and served continuously until his sudden and unexpectedly early death on 20 October 1967 at the age of 52.

Len started his military career as a Boy Apprentice in M Company of the Depot Battalion RE at Kitchener Barracks in June 1930 and remained in Chatham until 1937, changing to man's service and moving to the Training Battalion in 1933. After completing his training he remained with the Battalion as an NCO. While in Chatham Len developed his natural ability as an all round sportsman. He was soon recognized as a good soccer player, but it was not until an injury caused him to be moved from centre-forward to goal that his real talent was discovered; and he played in goal for the remainder of his time with the Training Battalion, including the well-remembered Army Cup Final of 1937 when the Training Battalion RE narrowly lost to the Training Centre RASC.

At the outbreak of war in 1939 Len was a Corporal serving with the 41st Fortress Company in Singapore. He was soon promoted and reached the rank of Warrant Officer II before going to India to attend the OCTU at the Royal Bombay Sapper and Miner Headquarters in Kirkee, where he passed out top of his Officer Cadet course. His first commissioned appointment was as Second-in-Command of 59 QVO Madras Sapper and Miner Field Company, serving with this unit in Burma and later becoming its Officer Commanding.

After a brief return to the UK in 1946 Len returned to India to the Madras Sappers and Miners, and he was appointed Commanding Officer of the Training Battalion. The understanding and consideration which he displayed with regard to the troops under his command, coupled with his enthusiasm and technical competence, made him a popular, successful and much loved commander of Madras Sapper troops.

It was during his service in India that Len met and married his wife, Paddy, who was serving there as a Sister of the Queen Alexandra's Imperial Military Nursing Service.

In 1948 Len left India for the last time and on his return to the UK he was appointed Second-in-Command of 4 Training Regiment, Royal Engineers, at Gibraltar Barracks in Aldershot. In 1950 he started a tour with the RE Records Office in Brighton where he remained until 1956 when he was given a regular QM commission, and was immediately promoted to Major (QM). His desire to be of assistance and his ability to anticipate requirements, together with his abundant good humour and cheerfulness, fitted him well for his new role. His service as a Quartermaster included tours with the Territorial Army and with The Depot Regiment, Royal Engineers, and at the end of 1963 he was posted on an unaccompanied tour as Quartermaster of CRE (Works) Crown, the Sapper unit building an airfield in Thailand. After this he was the Quartermaster of the Engineer Base Group in Singapore, where he was rejoined by his family to complete a full overseas tour. He returned to the UK in 1966 and was promoted Lieut-Colonel (QM). He then took up the appointment of Quartermaster 12 RSME Regiment in the new barracks at Chattenden and was serving there when he died.

Throughout his service Len Field remained a keen and active games player. He became an enthusiastic golfer and a very good badminton player, and kept himself physically fit and in good health until his tragic death as the result of a heart attack. This came as a complete surprise to everyone who knew him, and it is typical of Len that he had shielded his family from his own newly-found suspicions that he was not as fit as he seemed.

Len had the great ability to see the best in everyone and in any situation. This, no doubt, led to his unfailing good humour and cheerfulness and it was these qualities which enabled him to contribute so much to the Service he loved and

endeared him to all those with whom he came in contact. His untimely death is a real loss to all who knew him and our sympathy goes out to Paddy, their daughter Dierdre and their two sons, John, who is at Sandhurst and hopes to follow his father into the Corps, and Michael, who is waiting to go to University.

Lieut.-Colonel (QM) L. J. Field, MBE, RE

ALEXANDER McDONALD, ESO, CBE, BSc, MICE

The following obituary notice is reproduced from The Times *by permission:*

"Mr Alexander McDonald, CBE, Secretary of the Institution of Civil Engineers from 1954 to 1967, died in Westminster Hospital, London, on 27 March 1968. He was 64.

"McDonald, who graduated in 1923 at the University of Edinburgh, had two years' engineering training in Britain before joining the engineering staff of the Public Works Department in Nigeria. Appointed Senior Executive Engineer in 1937, he later became Inspector-General of Works. Of his thirty years' service in Africa twenty-eight were spent in Nigeria. During his secretaryship the Institution's roll grew from just under 20,000 to over 36,000. He made numerous visits overseas with the Presidents, including two world tours. The Conferences on Civil Engineering Problems Overseas owed much to his original suggestion that 'the activities of colonial engineers should receive more prominence in the affairs of the Institution'. He suggested, and took a leading part in the establishment of, the Civil Engineering Scholarship Trust and the Civil Engineering Trust and the Civil Engineering Research Association—two advances of the greatest importance to the profession. To him, also, some of the credit was due for the formation of the Council of Engineering Institutions.

"It was his foresight, backed by enthusiasm and wise guidance, which made possible the present British Nuclear Energy Society."

He was well known to many Sapper officers who valued his friendship and his sound advice. He did much to foster a close link between the Institution of Civil Engineers and our Institution of which he was an Honorary Member.

He was created a CBE in 1965. He is survived by his widow.

Book Reviews

SURVEYOR'S GUIDE TO ELECTROMAGNETIC DISTANCE MEASUREMENT

Edited by J. J. SAASTAMOINEN

(Published by University of Toronto Press. Price $9.00)

This is an excellent little book for use by a surveyor who proposes to use a Geodimeter (modulated light instrument) or a Tellurometer (microwave). The foreword clearly states that these are the only two types of electromagnetic distance-measuring devices used in Canada, and therefore only these two are described. Of course, the reader who masters these two instruments would be able to use his knowledge in order to understand most of the many other types. However, this is mentioned here because it is only fair to a possible buyer of the book to warn him that a more appropriate title would be "Instruction Manual for the Geodimeter and Tellurometer".

The book is divided into five parts, each with different authors, and with considerable differences in theoretical level. Sometimes it is difficult to see the author's object: for example, the introductory theoretical section begins with a description of Ohm's Law, and only ten pages later it discusses mixing amplitude and frequency modulations, with the equations of the various sidebands. It is hard to believe that any reader who needs to be told about Ohm's Law, or how a triode amplifier works, could understand the rest of the section. It is obviously impossible to teach rather elaborate electronics, *ab initio*, in forty-five pages. However, the reader with some previous electronic experience, will find it extremely useful, and a revision of fundamentals may not be wasteful.

The next two sections are entirely practical, giving descriptions and instructions for the use of the Geodimeter (Models 2, 3, 4A, 4B and 6) and the Tellurometer (MRA 1, 2, 3, 4

and 101). Here the "Instruction Manual" aspect is dominant. Detailed suggestions are even given for lists of stores carried either in trucks or in helicopters, and also arguments as to which member of the party should take which instrumental reading. Fault-finding procedure is thoroughly covered.

The fourth section, which is on High Precision Techniques, is an extremely useful theoretical and practical description of the various corrections; such as reductions to sea-level, path curvature corrections, meteorological effects, reflections, etc. The Editor of this book is indeed a recognized authority on these subjects, and is the author of various original papers on curvature corrections. Even so, the degree of technical detail has not been allowed to get out of hand, and the section can be understood by a surveyor who is not also a physicist and a meteorologist. Probably in order to avoid confusing the reader, the very newest techniques of simultaneous measurement by multiple wavelengths have been entirely omitted. Laser modifications to the Geodimeter are not mentioned.

The final section, which is on Battery Power Supplies, has obviously been written by a battery specialist, and it is by no means confined to batteries used with distance-measuring equipment. This can be an advantage, because the information is of general value to any user of batteries. On the other hand, it has the disadvantage that the discussion of nickel-cadmium batteries does not concentrate on the particular battery which is fitted to the MRA3 Tellurometer, and which can be troublesome to charge. Indeed, the only nickel-cadmium battery listed in the book is a heavy one (45 lb) which differs seriously from the corresponding lead-acid battery in only two major aspects—it has five times the expected life, but it costs nearly twenty times as much! (It is, however, easier to store.) Despite this criticism of the book, the description of the method of operation, charging, and maintenance, of nickel-cadmium batteries is extremely useful. Formerly the only easily available source of information on these batteries was the various manufacturers' "Sales Talk" brochures. This book fills a real need, with its very complete description of the qualities of nickel-cadmium batteries.

Some mistakes appear to be inevitable, and this book is not free of them, though there is little that might actually confuse a reader. Some of the drawings were not too carefully checked by the authors, and the sketch on page 22 showing the operation of the triode amplifier is seriously misleading where it shows the signal on the anode in phase with that on the grid. It is surprising to be told on page 24 that "holes" in a semi-conductor crystal are sometimes called "positrons".

This book can be strongly recommended to the surveyor who wants instructions for using the Geodimeter or the Tellurometer. In addition, anyone who wants to understand nickel-cadmium batteries should get hold of it.

E.W.D.

BASIC INSTRUMENTATION FOR ENGINEERS AND PHYSICISTS

A. M. P. Brookes, MA, AMIMechE

Fellow of St John's College and Lecturer in Engineering at the University of Cambridge

(Published by Pergamon Press Ltd: Headington Hill Hall, Oxford. Price 30*s*)

In this book of 190 pages the author successfully presents a brief summary of the theory and practice of scientific and industrial measurement in respect of: the fundamental units of length, mass and time, the non-fundamental parameters of temperature, electric charge, pressure, strain, velocity, acceleration, thin films, levels, angles, density and displacement.

He also covers the use of transducers, the laser, and the instrumentation systems required to measure values relative to specific projects. For the latter his text briefly covers the measurement problem and its solution, electrical connections, transforms, the problem of long connections, the cathode follower and the emitter follower, the production of a square wave, differentiating and integrating circuits, the production of recurrent pulses, the use of a twin-T network, and details of simple control systems for temperature and position. Additionally he includes appendices on the colour coding of the electronic components and the development of Moire Fringes.

The text does not include many detailed descriptions of particular instruments, but those which are given illustrate the theory of certain measurement methods.

The photographs and diagrams chosen to supplement the text are well chosen and excellently reproduced.

An excellent primer for the executive-type layman who wishes to learn the principles without a lot of detail.

F.T.S.

RESERVOIRS AND TANKS

G. P. MANNING, MEng, MConsE, MICE

(Published by Concrete Publications Ltd, 60 Buckingham Gate, London, SW1. Price 36*s*)

This book is a worthy successor to the original work on the same subject by the late W. S. Gray, BA, MAI (Dublin), AMICE. It has been completely rewritten, extended and brought up to date by the present author. Although most of this book is devoted to unlined tanks to contain water, a very useful chapter is included which gives design and construction details on tanks to contain hot, very cold, corrosive or highly penetrating liquids which require special treatment and in most cases special linings.

Those Sapper officers who have been involved in building swimming pools on a "no cost basis" in all parts of the world will know only too well of the problems of building a really watertight tank. This book provides the complete answer to the design of not only this Military Engineering structure but to a wide range of tanks, reservoirs and retaining walls in reinforced concrete.

The use of prestressed concrete has obvious advantages in building circular tanks in that the applied prestress obviates the problem of leaks through cracks in the concrete. The prestress is usually most effectively applied by a continuous wrapping of prestressing wire round the circumference of the tank, as this avoids excessive friction losses. The evaluation of design loads for circular prestressed tanks are included in Chapter 28.

This excellent book is well written and comprehendable to Military and Civil Engineers and is very well illustrated with clear drawings and up-to-date photographs.

R.C.G.

THE INELASTIC SPACE FRAME

PROFESSOR A. L. L. BAKER, DSc(Eng), MICE, MIStructE, HonACGI

(Published by Concrete Publications Ltd, 60 Buckingham Gate, London, SW1. Price 15*s*)

This booklet, which is written by the Professor of Concrete Structures and Technology of the University of London, includes a number of articles on this subject which were previously published in *Concrete and Constructional Engineering*, together with an additional section on recent research. With the present trend towards more accurate design methods in reinforced concrete and the search for a more fundamental approach, such as Limit State Design, it is becoming increasingly evident that the design of reinforced concrete structures, both in regard to serviceability and safety, must take into account inelastic effects. Research has shown that the phenomena of cracking, creep and shrinkage influenced by time, stress, temperature and humidity may in some circumstances be more important factors than the state of stress due to load. In addition, articles in this booklet show that deformations due to shear and tension, and their influence on the stress in continuous three-dimensional frames, may often be very significant. The author deals with this complex subject in a very logical way and the text is well illustrated with clear drawings and graphs. He shows clearly that there are still serious gaps in present-day knowledge and the methods used to analyse and design space frames.

R.C.G.

AN ELEMENTARY GUIDE TO RELIABILITY

G. W. A. DUMMER, MBE, CEng, FIEE, MIEEE, MIERE
R. C. WINTON, BScEng, ACGI, CEng, FIEE

(Published by Pergamon Press Ltd, Headington Hill Hall, Oxford. Price 7*s* 6*d*)

Hitherto, most of the literature published on reliability has dealt specifically with the design and construction of electronic apparatus, and in particular the miniaturized versions.

In this book, however, the authors have endeavoured to cover the principles of the subject which also apply to the associated fields of electrical and mechanical engineering.

The aim of the authors is to present in simple, and largely non-technical language, the various factors which make an equipment or machine reliable, and thereby provide an easy introduction to the subject for laymen and inexperienced engineers.

The text, supported by a few cartoons, diagrams, tables and photographs, covers the importance of reliability, the definitions applicable to its study, simple statistics, the calculation of reliability, the effects of operating conditions and environments, installation, operation, failures, maintenance and cost.

An excellent primer which achieves the purpose of the authors.

F.T.S.

MECHANICAL TREATMENT OF METALS

R. N. PARKINS, BSc, PhD, FIM
(Reader in Metallurgy, University of Newcastle upon Tyne)

(Published by George Allen & Unwin Ltd, London. Price 55*s*)

This book is *Volume 5 of the six Modern Metallurgical Texts*, published by the *Institution of Metallurgists*, and its content, which largely deals with the mechanics of metalworking and plant utilization, supplements the text of the other five volumes whose subject-matters are: Mechanical Properties of Metals, Physical Chemistry for Metallurgists, the Metallurgy of Welding, Brazing and Soldering, Basic Electrotechnology, and the Physical Metallurgy of Engineering Materials.

The text of this volume is mainly descriptive in style, the mathematics of calculations being mostly confined to the chapter dealing with the *Mechanics of Working Processes*. In consequence the volume is of interest to intelligent operatives as well as embyro metallurgists taking a first course in the mechanical working of metals and undergraduates on courses of metallurgy.

The five chapters of this 342-page volume cover:

The Resistance of Metals to Deformation: Which deals with stress and strain, stress systems and plane strains, factors influencing the flow stress of metals and alloys, idealized yield stress, ductility and the working range, and choice of working temperature.

Flow of Metals in Working Processes: Covering work and pressure for homogeneous deformation, the study of metal flow, inhomogeneous deformation—friction and lubrication, flow in technological processes.

The Mechanics of Working Processes: Explaining forging, rolling, extrusion, rod and wire drawing and deep drawing.

Technological Aspects of Metal Working: Heat and temperature for operations, equipment and its manipulation, automatic control, and dimensional tolerances for wrought products.

The Effects of Working on the Structure and Properties of Metals: Covering structural changes, mechanical property changes, residual stresses and surface finish.

The text is supported by many photographic reproductions, drawings and diagrams.

F.T.S.

FRICTION AND WEAR IN MACHINERY VOLUME 19, 1965

Edited by PROFESSOR M. M. KHRUSHCHOV
and translated from the Russian

(Published by the American Society of Mechanical Engineers and distributed outside of the USA by Pergamon Press Ltd, Headington Hill Hall, Oxford. Price 84*s*)

This paper-backed volume is one of a series, of which Volumes 11, 12, 14, 15 and 16 have already been reviewed in *RE Journals* of 1963, 1965 and 1966. Translation and publication in English was undertaken by the ASME with the aid of a grant from the US National Science Foundation.

The volume contains twelve study papers in the fields of wear, friction and lubrication in machine building and mechanical engineering as compiled by leading Russian scientists and engineers. Specifically they cover the following subjects:

The effect of heat treatment and work hardening on the resistance to abrasive wear of some alloy steels.

The effect of composition, structure, and changes in surface layers of steel on its resistance to abrasive wear by iron ores and agglomerates.

Investigations on the wear of steel during rubbing against a loose powder abrasive.

The abrasive properties of small mineral particles.

Oxidation processes during the friction and wear of metals.

Continuous X-ray analysis of friction processes.

The problem of reducing thermal stresses in metal-plastics friction pairs.

External friction of polymers at transition from the highly elastic to the vitreous state.

Anti-wear properties of steel in contact with polymer powders.

Evaluation of anti-friction properties of solid lubricants in different gaseous media at temperatures up to 600°C.

Rolling friction and wear.

The content includes some Russian bibliographical abbrevations of Soviet Institutions and periodicals in transliteration and translation, and the transliteration of cyrillic characters.

In general, the text of the papers is only suitable for metallurgists and chemical engineers specializing in tribology (lubrication).

F.T.S.

OPTIMIZATION IN CONTROL THEORY AND PRACTICE

I. GUMOWSKI
Fellow of Clare Hall 1965–6, University of Cambridge
and
C. MIRA
Electrical Engineering Research Laboratory, University of Toulouse

(Published by the Syndics of Cambridge University Press, Bentley House, PO Box 92, 200 Euston Road, London, NW1. Price 65*s*)

The authors state, quite rightly, that to get the best results from any practical engineering project or system a close collaboration is needed between the two groups of specialists, the "technologists" (physicists, chemists, and practising engineers) and "theoreticians" (applied mathematicians), and the text of their book, which is written mainly from a theoretical point of view, aims to make a study of the problems which are likely to stimulate such collaboration and exchange of ideas.

The illustrative examples used are chosen from the field of control engineering and the authors suppose that the reader is acquainted with elementary control theory and practice and that he or she has some knowledge of non-linear mechanics.

The text covers:

The gap between control theory and control practice—specifying the conditions which render a theoretical optimization problem meaningful to a designer.

Fundamental properties of elementary extremal problems—dealing with the basic properties of functions.

Equivalent formulation of extremal problems—showing that optimization problems lead naturally to a boundary-value problem.

The relationship between the calculus of variations, dynamic programming and the maximum principle—that all currently available optimization methods are merely particular cases of this.

Approximate solution of optimization problems—which discusses approximate methods of calculating extremal solutions.

The text is advanced throughout and naturally only suitable for designers and mathematicians.

F.T.S.

REVIEW OF THE MILITARY ENGINEER

JANUARY–FEBRUARY 1968

The Inland Road—Thailand. This article by Lieut-Colonel A. C. Lehman will be of particular interest to Crown and Post crown officers since it describes the construction of a 125 km all weather road in Thailand. It is interesting to note that construction was commenced at both ends of the road and that suitable laterite pits were recce'd and found. The dust problem created by the use of 150–200 dump trucks in itself caused trouble—solved by the use of ten 1,000 gal and four 5,000 gal water bowsers filled by a POL pipe line pump!

Military Engineer Field Notes

(*a*) These notes describe the combat use of the AVLB. The AVLB was found to be well suited to combat in a developed area where strong abutments are likely to be found, though in other areas improvization for abutment strengthening proved satisfactory. Experience is summed up by the statement that in spite of air transportable and lightweight bridging, tanks still require a heavy class mobile bridge.

(*b*) Another note describes the success of a TD 340 bulldozer delivered to inaccessible sites in Vietnam by lowering it from a CH-5X flying crane when it was initially used to clear helipads for these flying cranes to bring in the much heavier D6B dozer.

(*c*) Another note describes the use of a $\frac{1}{4}$-in. spray applied coating of Polyurethane foam to the interior of three buildings at Eielson Air Base as an insulating device for prefabricated metal buildings. Although expensive in application it does stay in place, provides a very good insulation and has a reasonably good appearance.

Bamboo Reinforcement for Concrete. This article discusses the feasibility of the use of bamboo in reinforcing material for precast units—not a novel practice or idea to many senior Sappers. Amongst its conclusions is the statement that "to maximize the load carrying capacity of a bamboo reinforced concrete beam as much bamboo as can reasonably be placed should be used".

Test Methods for In-Situ Soils. This describes the use of a new instrument developed by the Iowa State University, to measure the cohesion and internal friction of a soil by testing the wall of a newly bored hole.

POL Facilities in Vietnam. This general article shows the vast requirement for POL engineering in a major base area.

Steel Cutting by High Explosive Charges. A most useful and detailed article comparing the US Army formulas for such techniques with those developed by ERJL and a Stanford Research Institute.