ISSN 0035-8878

THE ROYAL ENGINEERS JOURNAL

Volume 94 DECEMBER 1980 No. 4

THE ROYAL ENGINEERS JOURNAL DECEMBER 1980 VOL 94 No 4

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ISSN 0035-8878

THE ROYAL ENGINEERS JOURNAL

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

Printed by W & J Mackay Limited, Lordswood, Chatham, Kent ME5 8TD

Volume 94 DECEMBER 1980 No. 4

Contents

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Could Be!

Lieut Colonel R M Stancombe was "seconded" to John Howard and Company to widen his practical experience on major construction works. He was John Howard's agent on the Pitsea project for the £100,000 contract to construct a new access road.

In the December 1979 issue of *Howard Mail*, the magazine of the Howard Group, the possible effects of such secondments are described. Our thanks are extended to the Howard Group, the Editor of *Howard Mail* and the author for permission to republish the article.

On Parade

FROM TOMMY HOWELL

It was an occasion of great pride to me when, some years ago, I, a humble yeoman, engaged an ex-Paymaster Lieutenant as my cashier. However, I was even more shaken on joining the Pitsea contract to find that my agent was a Colonel on loan from the Army! I cannot help wondering where it will all end if the trend continues. I can picture a typical construction site of the future.

At 0755 hours under the watchful eye of Colonel "Mad Mike" Stancombe, the general foreman strides forth from the time clock on to the heap of mud which, God willing, will eventually become a generating station. He is in full dress uniform; rubber boots stamped "J H & Co", grubby trousers, beer-stained donkey jacket and a concrete encrusted bowler. He comes to a halt in a pool of mud, then turns sharply about. A sheet of mud disappears up his trousers. He looks miserably downwards but, as a general foreman always looks miserable, this passes unnoticed. He calls—"MARKERS!"

A shamble (that being the collective noun) of engineers stumble forward in a version of the palais glide until they are standing before him. He points out the error of their ways in his quaint old-fashioned language. Eventually, with theodolite, staff and arguments about sines, cosines and tangents, they are, more or less, in a sort of line (sufficiently straight to satisfy an engineer's conscience). The timekeeper then blows the hooter. The general foreman screams (that last splash of mud has found its mark),—"ON PARADE". The mincing feet of the carpenters, the steady plod of the bricklayers and the nifty footwork of the excavator drivers are all drowned by the bash, bash, bash of the labourers. At long last all are assembled before the general foreman who removes the mud splashes from his eyebrows and gives his orders for the day—

"*Bricklayers!* Build manholes number one, stop, two, stop, three.
Carpenters! Provide shuttering and—wait for it—stop ends.
Excavator drivers! Excavate.
Fitters! Fit.
Labourers! Head up there on the left you 'orrible little man. You might have broken your ganger's heart but you won't break mine.
Labourers—as detailed by the gangers!
Parade! DISMISS".

The assembled mass of humanity turns right and marches off, saluting their CO with the time-honoured two fingers and vigorously whistling their regimental marching song "Colonel Bogey". The general foreman, looking more miserable than ever, then ambles over to the site office to cadge a cup of tea from the office manager and chat-up the typist. The Colonel, in the meantime, retires to his quarters and awaits "defaulters and deserters". The mind boggles!

Reflections on the Gucha River

CAPTAIN G TAYLOR RE, BA and LIEUTENANT J M GUNNS RE, BSc

The joint Authors of this article were the Project Officers for the bridge and road projects respectively, which comprised EX LARCHPOLE 80. *This was 32 Fd Sqn's four months construction task in Nyanza Province, Kenya, between January and April 1980.*

Captain Taylor (top) was commissioned from RMAS in 1974 and after graduating from Cambridge in 1978 joined the Sqn as a Fd Tp Comd. He had previously served in 30 Fd Sqn.

Lieutenant Gunns (bottom) was commissioned from RMAS in 1978 having completed the six months training for University entrants. He is a graduate of London University and has been commanding his Fd Tp since October 1978.

Introduction

This article describes the work undertaken by 32 Field Squadron during their deployment to Kenya earlier this year, together with some of the planning and preparation that had gone into the project from its inception.

The project held a great challenge for the Squadron. The task site was some 300 miles west of Nairobi, tucked into that corner of Kenya which is bounded by the eastern shore of Lake Victoria and the Tanzanian border. It was in the heart of the country inhabited by the Luo tribe, an area very largely under-developed after years of neglect. A large sugar cane factory had been constructed about two years earlier, 20km away on the eastern side of the River Gucha which itself provided a major barrier for access to proposed cane producing areas. A 100ft span bridge, together with 13km of murram road on the west bank was planned to provide the basis for further development.

Approximately 200 soldiers, both Regular and Territorial Army, took part. They flew from the depths of the British winter to the heat of a dry period in central Africa. They were faced with many days of challenging work which demanded a high degree of skill in both construction and field engineering. There were frustrations and difficulties, there were moments of despondency, but the tour culminated in elation and the satisfaction that they had left behind a worthwhile amenity for the Luo people of Wath Oria.

Reflections on the Gucha River
Captain G Taylor RE BA and
Lieut J M Gunns RE BSc

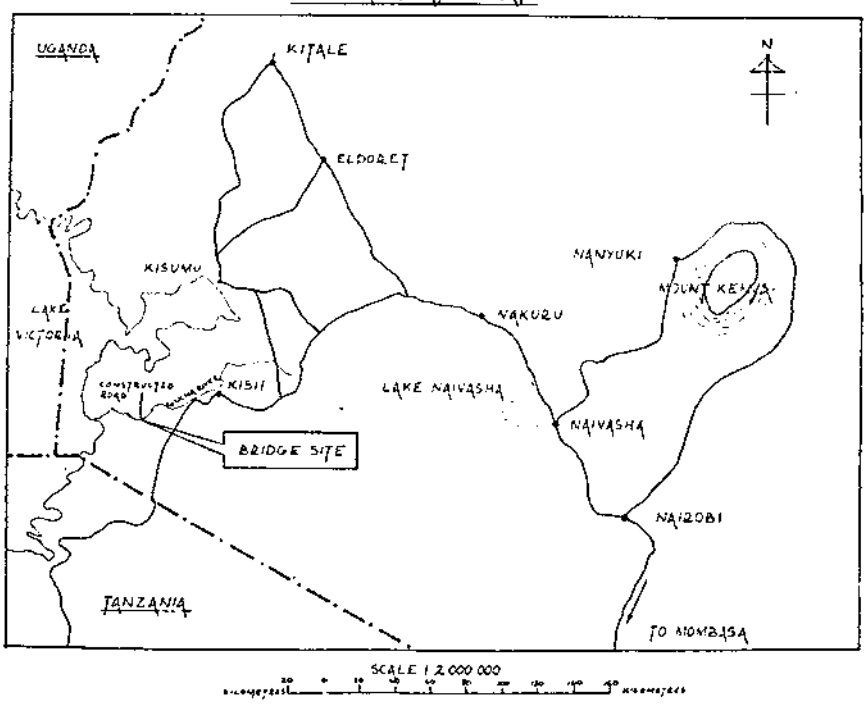
The Bridge

"I would hesitate before crossing a bridge that you had designed" were my tutor's words when I left Cambridge. This summed up my civil engineering ability and as I set out for Kenya as the Project Officer for the Gucha River Bridge, I was a little apprehensive about the task which lay ahead!

The design for the Gucha River Bridge had been left in the competent hands of 62 CRE (Construction), the initial reconnaissance having been carried out by the then Major J L Barker in November 1976. The detailed recce team led by Major A M Kingston carried out a six week reconnaissance in October 1977, and the detailed recce and planning report was produced in April 1978 with Phase 1 of the project to be built in early 1979 by 50 Field Squadron (Construction). The initial phase was to include the reinforced concrete abutments, approach ramps, temporary Bailey Bridge and the western approach road. Phase 2, the replacement of the Bailey with a bridge of steel beams and reinforced concrete composite deck, was to be carried out by 32 Field Squadron in early 1980. At the request of the Kenya Authorities the priorities then changed, and 50 Field Squadron were deployed instead on a construction task for the Kenyan Army at Lanet in 1979, and 32 Field Squadron were tasked with Phase 1 of the Gucha River Project in 1980. Since Phase 2, the permanent bridge deck, would not employ a squadron it was also agreed that this would be done by the Ministry of Works Kenya in due course.

The confirmatory reconnaissance team set out in August 1979 for a ten day visit to Kenya. The technical team consisted of myself as Project Officer, Captain Winship the Garrison Engineer, Captain Reynolds the Professionally Qualified Engineer (PQE) and Officer responsible for any technical variations from the detailed report, together with Staff Sergeant Chatten the Clerk of Works who had been part of the original reconnaissance team. Time spent on site was regrettably short, but all the main points were covered, albeit briefly. The old adage of "Time on reconnaissance is seldom wasted" proved very true, particularly when we found that the time

GENERAL LOCATION MAP



available to the advance party was considerably reduced due to the Zimbabwe-Rhodesia talks in December 1979, and the fact that the RAF transport aircraft could not deploy us. In addition to a general site analysis, all aggregate sources were located, the camp was sited and the gap for the access Bailey Bridge remeasured. The recce gave much insight into the site conditions and showed clearly that because of the remote nature of the site, transportation and provisioning problems were very likely.

The reconnaissance team returned to the United Kingdom to prepare for the Squadron's annual Harrier deployment to BAOR, but detailed project planning was already underway. The immediate problem for the technical team was pre-project training, considered to be a most important step in our preparations. The state of timber in Kenya gave rise for concern over the formwork, so much emphasis in training was placed on the carpenter and joiner team. Initial planning for this training was carried out by myself, but was mainly organized by the Garrison Engineer and the Clerk of Works for the project, Staff Sergeant Gilbertson, whilst the Squadron was away on exercise. A shuttering revision course for the carpenters was organized on our behalf by the Technical Wing at Brompton, and on their return from Chatham they started to construct the formwork for a reinforced concrete abutment at Laver Banks at Ripon. This was designed by the technical team, and dimensions were half the size of the Gucha River abutments, but formwork panels were made identical to the actual project size. The abutment took four weeks to construct, and Squadron personnel were cycled through the training to spread the experience. Other training organized included a visit to a firm involved in a gabion construction task, explosives training with "anfo", plant operator practice, and numerous films and lectures culminating in a Squadron Study Day.

The Squadron advance party was ready to move on 10 December, but the project encountered its first major problem at this early stage as flights were delayed, priority being given to troops waiting to deploy to Rhodesia. As a result, the advance party moved out on 29 December, giving only eleven days preparation before the main body arrived, instead of the three weeks in the original plan. The main body arrived at a virtually completed Gucha Camp on 12 January, and work started immediately after. This was only one week behind the original schedule, but little preparation had been done either on site or by the project team so the task was really two weeks behind schedule from the outset. This was a major concern, with the unpredictable rains apparently only eight weeks away, and the local people advising us that the storms could well be early. The race against time began in earnest.

The site was cleared and set out. A 120ft, class 30, Triple Single Standard Bailey Bridge was constructed 50m downstream from the main bridge site. This enabled all crushing and batching facilities to be set up on the west bank together with the bar bending area. Excavations started using a combination of D6 and Muirhill tractors but each bank posed different problems; the eastern bank was the easier with excavation carried out in soil followed by stratified rock. Spoil was pushed forward into the river but it was not washed away due to the low river level and a protective earth bank was formed. The stratified rock was harder than indicated by the detailed report and the Bristol compressor shattered it at a very slow rate. The decision was taken to use explosives. This was not originally planned, but proved the only way to make steady progress and provided excellent training in the practical use of commercial explosives. Twenty kilograms of gelignite were used in borehole charges, and a firm strata of rock was reached above planned foundation level. On the western side was an outcrop of very hard conglomerate. One rock had to be removed for the front part of the foundation, and the other was left straddled by the return walls. Excavation was carried out either side of this rock using a D6 and a Muirhill, an earth bank again being formed in front of the foundation providing protection from the river should it have suddenly flooded after heavy rains. Pressure charges were used to reduce the rock to foundation level. Every effort was made to exploit each crack and crevice, but a total of 180kg of gelignite and 500 sandbags were used in reducing the

excavation to foundation level. The rock to be straddled by the return walls proved to be more extensive at this level, and hence the rear foundation levels were revised, one at 1m above drawing level, the other at 4m above drawing level. Excavations took seven days longer than we had planned due to the difficult ground conditions and lack of adequate plant, some of which had been urgently required on the road project. The Muirhill was only available 50% of the time and we discovered that a Hy-mac type excavator was really required to tackle the work. There were none available, so we resorted to the hire of additional local labour which proved to be a cheap and satisfactory substitute.

Gabions were also started at the beginning of the project, and 400 boxes and 40 mattresses were laid. The gabion team had been introduced to the problems of construction prior to deployment by making a visit to Seal Sands near Hartlepool where Tarmac were laying mattresses. This combined with the knowledge gained from Maccaferri pamphlets ensured that a high standard was achieved. The importance of having sufficient time for pre-project training was proved. Both banks had gabion protection over a 50m length, and all excavation once more was carried out by hand or by Muirhill, when it was available. One-metre boxes were laid four high, stepped back towards the abutments. The eastern bank had a layer of mattresses laid first at river bed level to reduce undercutting. Another series of mattresses was laid at bank height on both banks, and then each abutment was given the protection of 4m high wing walls. All gabion stone was tediously won on the surface of the western access road and, after hand-loading into tippers using local labour, was delivered direct to site. Mattresses were filled using shutes or wheelbarrows and boxes hand-filled by a local labour chain. This was the first time I had seen gabions used, and apart from their effectiveness against erosion I was impressed by the finish they provided for the completed project.

The first steel-fixing was encountered in the foundations. Despite pre-project training Sappers found steel-fixing a skill difficult to grasp and, initially, long periods were required to achieve the high standard required. The foundation cage was very tight, and the glib comment made by the CLO, "You could keep a parrot in it!" was very true. This problem had been compounded by the shortfall of 16mm steel at this stage of the project due to a country-wide shortage and 20mm steel had to be used instead. Steel delivery remained a problem until the very end of the project, and it

Photo 1. Hand filling of gabion boxes

Reflections on the Gucha River (1)

Photo 2. Using a Tirfor jack to winch gabion mattresses into position on the river bed. All excavation was by hand

Photo 3. Poker vibrators being used on the abutment foundation on the west bank. Note use of gabion boxes as formwork

Reflections on the Gucha River (2 & 3)

certainly provided a major worry for the design team. Several changes had to be made to accommodate the shortages at critical stages of construction and flexibility was the keynote in this aspect of the design.

The batching plant consisted of two 21/14 Benford mixers shipped from the United Kingdom, and they were in turn placed in front of two Lister crushers which gave the aggregate supply. Rock for crushing was won on the surface along the western access road in the same slow manner as the gabion stone. Experiments were carried out with jaw settings and eventually a mixed aggregate of 20 to 40mm practical size was produced. This gave good seven day cube test results, although a higher cement content had to be used than was planned initially. Sand was brought from a source 50km away. It was hand-loaded into tippers using local labour supervised by a colourful Scottish TA NCO who seemed to have a mania for sacking those who did not meet his output requirements!

The Cascade Diagram suggested that the foundations could be placed in three days but, with 160m^3 of concrete to be laid, the project team felt that this time was very short and the foundations in reality took seven days to pour. The eastern side was poured in two stages because of the revised levels of the rear foundations. All concrete was delivered to site by dumper or by Muirhill but due to the difficulty of

Photo 4. Cage reinforcement for the raised wing wall foundation

Reflections on the Gucha River (4)

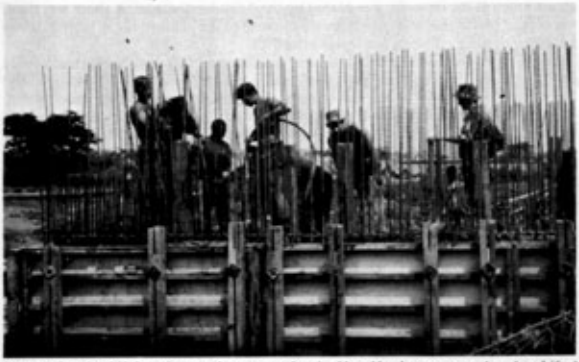


Photo 5. Pouring Lift 3 on the east abutment, galvanised hand buckets were used to place Lifts 1 to 5

Photo 6. Tying-in horizontal reinforcement on west abutment

Reflections on the Gucha River (5 & 6)

access much of the concrete was placed by hand or wheelbarrow. A shute was tried, but proved ineffective and once more we discovered the value of cheap labour. It was not exceptionally efficient, but it was effective.

The project was now eight days behind the Cascade, two days having been made up against the losses. The river level had remained low throughout, and the threatened "light rains" at the end of February thankfully had not yet materialized. Work now began on the main lifts, six of these were 1m high and the final two were 0·7m high. Shutes, wheelbarrows and a local labour chain with buckets were tried as placing systems because no Muirhill was available due to serviceability difficulties. The "bucket" method proved most effective once again, and rates of 1·5 to 3·0m^3 per hour were achieved. After the difficulties encountered with a Muirhill in pre-project training, enquiries had been made about the possibility of purchasing a concrete pump for use on the project. We had used one successfully during our recent Northern Ireland tour, the hire charge for a short period being £750. With careful use of retarder and plasticiser a concrete pump would have been ideal for the project; it would have saved time and labour whilst improving the quality of the work. However, no money could be made available at this late stage for such an item, and the Squadron was advised to try and hire in Kenya. Two "concrete placers" were located, but these had not worked in hot temperatures, both were blocked and were unserviceable. Hoists were also investigated, but they could not be hired and at £5000 they were too expensive to purchase. It would appear reasonable that the Corps should purchase concrete pumps. They would be invaluable in such theatres as Northern Ireland or on any overseas projects where large volumes of concrete are poured.

The formwork was initially constructed using a 4in × 2in timber frame with a plywood face and two 6in × 2in pieces bolted together with a spacer forming the soldiers. The plywood delaminated in a rain shower, so the face had to be changed to blockboard after a lengthy wrangle with the contractors. The panels warped after the first lift, and it rapidly became apparent that a good finish would be difficult to achieve. The decision was then made to use a textured finish on completion of the abutments, as otherwise much time and money would have to be spent on perpetu-

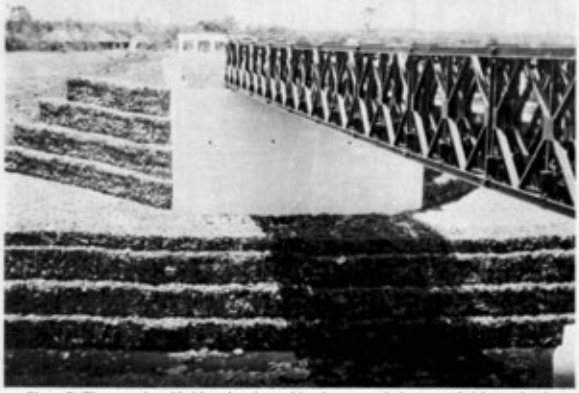


Photo 7. The completed bridge showing gabion layout and abutment finish east bank

Reflections on the Gucha River (7)

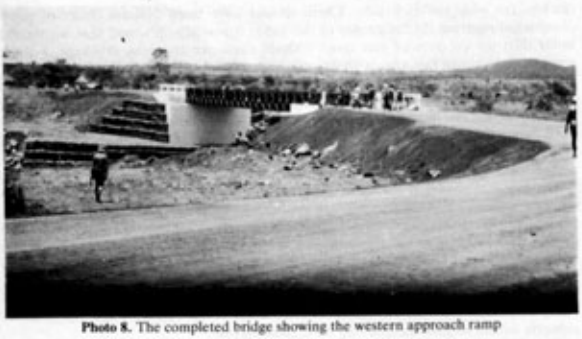


Photo 8. The completed bridge showing the western approach ramp

ally replacing formwork. A further problem we encountered at this stage was the lack of Acrowbolts. We allowed for 180 bolts but each abutment required 172 for each lift. Additionally an Acrowbolt should have been used only two or three times and here we had made a fairly far-reaching error. More bolts were requested immediately from the United Kingdom, but due to the steel strike none could be made available in time. Improvization was called for, and 54 longer bolts were adapted which helped, but five days were probably lost once again. Planning in great detail is imperative when the line of communication is long and tenuous.

With the abutments complete and the approach slab and groundbeam laid, the final task was to strip out the access Bailey Bridge and rebuild it over the abutments. Although the gap was 100ft, the bridge was designed for 110ft Triple Single as the rollers had to be placed behind the baseplates which were set into the abutment walls. The extra panel formed the tail panel which sat on the home bank rocking roller. It was with great relief and considerable pride that I watched the launching nose touch down on the far bank, and the Sappers enthusiastically preparing for the jacking down sequence. It was a magnificent sight.

The major construction on tasks had been completed some ten days later than scheduled in the Cascade plan, but a further week was spent landscaping and finishing. This included making a rendered fillet along the construction lines of the abutments, and all exposed concrete was covered with special paint to give the textured finish previously mentioned.

One project had been completed despite a variety of setbacks: some major, others of a minor and almost trifling nature. Fortunately, difficulties were offset somewhat by our good fortune with the weather despite the wishes of the local witch doctor who apparently willed the death of ten Sappers in revenge for the drought which had ensued and which threatened to ruin the crops.

The Road

The road project involved the construction of 13km of murram road leading from the western side of the bridge to meet a "C" grade road near the village of Ndhiwa. There was already a combination of track and footpath along the planned alignment, but this was in a poor state of repair. In parts it consisted of highly organic soil known as black cotton and other stretches had large rocks protruding. The reconnaissance report called for clearing, widening, ditching, shaping, surfacing and compacting the full length of the road. This would bring the track to a uniform standard equivalent to the Kenyan rural murram road. This design required a 4m wide carriageway with

ditches 1m wide on each side. There should have been 500mm cover of good compacted murram on the crown of the road. It was also planned that we should build thirteen culverts of just over 900mm diameter to assist drainage, a most important factor in this area with its very high annual rainfall.

The road team was split in half under my direction as the Project Officer. The road building team consisted of plant operators and tipper drivers and was responsible for the earthworks and importing of fill. The culvert team was run by a Combat Engineer Staff Sergeant, and consisted of eight combat engineers, four bricklayers, two local stone masons and up to fifteen locally employed labourers. This team was responsible for the excavation, placing and backfilling of all the culverts.

The original plan that I put into practice was a standard system using a D6 with ripper and Muirhill A5000 to work in the borrow pit loading Bedford 4-ton tippers under the supervision of an MT JNCO. Working in front of the road head would be a grader and a D6 with scraper, clearing the existing road to formation level and V-ditching. When the formation was cleared sufficiently far ahead of the road head to allow a full day's worth of fill, the grader and D6 would be employed regrading, watering and rolling fill imported the previous day. After road construction was complete, excavation for the culverts would start. Temporary by-passes around the culverts would be provided during their construction.

As with all sound plans, this one was entirely flexible which was fortunate, as inevitably it changed almost immediately! The plan described, required three D6's, a D8, one scraper, two graders, two towed vibrating rollers, one light-wheeled tractor and a fleet of six Bedford tippers. All this was available from the pool of plant which is held in Kenya for this sort of exercise, but these machines stand idle for much of the year with no permanent maintenance staff and despite the efforts of a combined UKLF FRT to refurbish them, plant serviceability proved a major headache throughout the project, demonstrating the importance of that basic military principle—flexibility. The plant state varied almost hourly, but the D8 which was introduced into service in 1961 showed its age. After working for forty hours it required a further forty hours work on it by the fitters before a two hour finale, during which it made a passable imitation of an oil-filled watering can. Thereafter it gave up altogether. Of the five D6s which reached site, two were equipped with rippers. One of these broke down halfway through the project. The other ripper-attached D6, after working for a long period without a blade and suffering from overheating, finally broke down shortly before the end of the project. The graders were generally reliable as were the vibrating rollers and scrapers apart from the odd tantrum. The water bowsers both refused steadfastly to pump in or out but we were able to resort to "hicycle" pumps to fill, and gravity feed to empty. The light wheeled tractors proved to be the critical pieces of plant, and were gently coaxed along to ensure that bridge and road projects did not suffer. The Bedford tippers certainly did not enjoy hours of trouble-free motoring and it became a popular game to guess the number of tippers on the road at any given time.

The plant which was serviceable had to be used to maximum effect, and had to be shared with the bridge building team. Generally all that we had available for full time road construction was three D6's, a roller, two graders, a couple of scrapers, a light wheeled tractor, one bowser and two or three tippers. It soon became obvious that this was insufficient to carry out the job. The major problem was that the Muirhill and the tippers could not import enough fill, and to complete the road approximately 7000 loads of fill were required. Working for the sixty days available, well over a 100 loads a day would have been needed. Even devoting all five tippers to the road, and assuming that they were all serviceable for the complete period, this would have entailed twenty-three loads per truck per day. Even on a satisfactory working day it was impossible to exceed more than 50 loads in total.

As the project progressed and the road fell further and further behind the Cascade, it became necessary to hire plant and tippers. Initially, a Caterpillar bucket loader was hired from the local sugar factory and a fleet of five tippers from a local

contractor for a period. Using this equipment in addition to our own, we started to catch up and on the best day recorded a total of nine tippers having imported some 220 loads of fill. The hire charge proved prohibitive, however, and the Squadron had to release the hired equipment. Resourcefulness then proved to be of prime importance. We had noticed an American Aid project in progress very close to the Tanzanian border, and with a little gentle persuasion we were able to borrow a Caterpillar 930 loader and five International eleven-ton tippers from them. They were also engaged in building a road for the Ministry of Transport and Communications and without such a loan there is no doubt that we would not have been able to finish our project, to the frustration and disappointment of all. The borrowed machines were better than ours, and in no time total confidence had returned to the team and we began to progress at a rapid rate. It was perhaps another case of "Give us the tools and we will finish the job". The Americans could not have been more cooperative.

Having overcome the major problems caused by plant, other difficulties were encountered. Finding and selecting ideal borrow pits for the murram fill proved troublesome. Two were mentioned in the planning report, one at either end of the road. These were extensively used and produced very good quality material. A number of other borrow pits were investigated along the road alignment and four more were opened. Of these one was very small and produced poor quality fill, while the remaining three were large, but yielded a large quantity of rock in the murram. The advantage of the much shorter haul distance from these pits to the road head outweighed the disadvantage of the rocks mixed with the fill, and a gang of local labourers was hired to remove the unwanted rock after tipping. Normally there was only sufficient plant to operate one road head from one borrow pit, but for a period of about two weeks towards the end of the project two road heads were introduced, operating from different pits. Not least of the advantages of operating two road heads was the competition between teams and the subsequent satisfaction when the two actually met. Fortunately, throughout the project there was very little rain as after only a few minutes it would have proved impossible to traffic the areas of black cotton.

The rains had been expected from mid-February onwards, and so we had a race against time. To lessen the possibility of disaster, it was decided to build on the black cotton areas first whilst the weather was good and then, as the weather deteriorated,

Photo 9. Grading imported fill on the road

Reflections on the Gucha River (9)

Photo 10. Typical culvert, 900mm pipe and random stone walls

we would risk building on sections with better subgrade.

Meanwhile, the culvert team was pushing ahead, and thankfully they were keeping pace with the planned progress on the Cascade Diagram. Inevitably, they too had their frustrations and setbacks, notably with the shortage of plant for excavation. Their local labourers, however, cheerfully dug out all that was necessary, and often entertained the Sappers to a rendering of some colourful songs in Luo. The bricklayers, who overnight had become stone masons, had a particularly worthwhile time. They were required to build the headwalls and retaining walls from the stone won locally. An African mason worked alongside them satisfactorily throughout the project, and on completion of these numerous culverts they were able to admire some very fine work which was carefully finished and pointed. It was an opportunity not often given to a Sapper bricklayer.

Despite the battle to keep sufficient machines taskworthy and keep output high, we managed to complete our project in good time. It was a great sense of achievement to have overcome the apparently never-ending problems both large and small. If nothing else, we had learned the importance of using our initiative and Sapper resourcefulness.

* * * * *

Reflections on the Gucha River (10)

Improvization And All That!

BRIGADIER N B GRANT AVSM

The Author is a regular contributor to military, technical and management journals. He is an active member of many professional bodies in India. Brigadier Grant AVSM, who is a Madras Sapper, has held varied appointments during his career in the Army. To name a few, he was Chief Engineer Nepal Roads Project, Chief Project Manager Central Tractors Organisation, Director R&D (Engineering) Ministry of Defence, Chief Engineer Southern Command. Since retirement he has been General Manager Bharat Aluminium Co Ltd and at present is the Head of Management Services of Wanson (India) Ltd.

THE Author having read *Sappers Fit For War* in the March 1979 *RE Journal* considered that the *Myth of Improvization* topped the list.

INTRODUCTION

The scene is the coordinating conference at a Divisional Headquarters, somewhere in the Eastern Theatre of India.

General Officer Commanding—Well Gentlemen, you now know my plan for the assault crossing. Can I have your bids for any additional resources that you may need.

CO Div Regt Armd Corps—I would like all my tanks to go across during the night, so that they will be in position for exploiting the bridge-head by first light.

GOC—Accepted.

CO Engr Regt—But Sir, I have not . . .

GOC—A little later please. You will all get your turn to speak. Now what does my Assault Commander want?

Comd Inf Bde—I must thank you for giving me the armoured support. You will agree however, that I also must have the entire Div Artillery in direct support during the first phase of the crossing.

GOC—Accepted. What does my Gunner feel about it?

Comd Div Arty—I agree Sir. I would go a step further and would recommend two Regiments from the Corps Arty also to be made available to us for this purpose.

GOC—Accepted. (Turning round to the CO Engr Regt). Cheer up, your turn for bid is soon coming.

CO ASC Bn—I must say that is a lot of guns the C Arty is demanding. Anyway I presume I will get enough transport to cart his ammunition.

GOC—Yes of course.

CO Engr Regt—But Sir, I have not got . . .

GOC—Do not get impatient. You can have your full say in your turn.

. . . And so it went on till the bids of all Commanders were considered and accepted *in toto*.

GOC—(to CO Engr Regt) You have been itching to say something. Now what is it?

CO Engr Regt—Sir, all I was trying to explain is that I have neither the earthmovers

Improvization and all that
Brigadier N B Grant

to complete the approach roads to the river, nor the bridging or rafting equipment to take the vehicles and tanks across.

GOC—Nonsense man—Why don't you improvize? You Engineers are losing the touch of ingenuity and versatility for which your Corps has always been famous. You gave birth to the tanks and the Air Force. Now I want you to do the same thing for your earthmovers and bridges. Don't let these things depress you—improvize—improvize.

Even today, in the age of "Sputniks" and nuclear warfare, when all armies of the world are rushing towards the achievements of technological superiority, there still exists a school of thought in the Indian, and as it appears, even in the British Army, which believes that the Sapper with his skill at improvization, if properly led and trained, can overcome any obstacle, just by his willpower and his natural instinct of inventiveness—any highly complex technical engineering equipment that he may use in the process should be treated only as a bonus. Such officers regard technical expertize as detrimental to the combat effectiveness and readiness of the Armed Forces since, in their view, it breaks tradition and derogates the human element necessary in the military community.

The Misconception of Improvization

Whether it be at training exercises or in actual operations, in the absence of engineering equipment for the job in hand, the Sapper is always expected to improvize. What is not clear is why improvization is expected only of the Sappers and not from any other arm or service. If, say, for any reason a unit loses its clothing, the Ordnance Corps is not asked to improvize this from local material, like the proverbial fig leaf. If a battalion is cut off from its supplies, is the ASC expected to improvize *chow* from the local shrubs found in the locality? We would not dream of asking the Gunner to improvize and use the Roman catapult in case he is hard up for ammunition, nor the Signals to improvize megaphones in case field cables are not available. But, with Sappers it is different. Whether the bridging equipment is available or not, whether earthmoving machinery can be provided or not, or whether or not water supply equipment has reached the site, the Sapper must get the tanks across a water obstacle, build roads and airfields in a matter of hours and supply cool, purified drinking water to the thirsty infanteer in a matter of minutes, by improvizing with whatever is available at hand.

Once upon a time, in the days of sappering and mining, when picks and shovels were the engineer weapons of the day, the Sapper had the reputation of having the most versatile, imaginative and inventive mind in the Army. It had to be that way then, because the Corps of Engineers was the only technical arm in the Army, and all the qualities of a technical man, of which improvization was the most important, were attributable to a Sapper. However the needs of the Army were then simple and, with a little ingenuity, could be met by improvizing with locally available material. The situation has since changed immensely, the new demands of defence in the thermo-nuclear age, have out-dated the simple techniques that served in past wars. This is not to say that the Sapper is no longer versatile and inventive. But the other arms and services have now become so technical in their own field, and have also since taken over so much of the previous Sapper tasks, that any amount of improvization unaided by the proper technical equipment, cannot help the Sapper to perform his role of helping the army to live, work and fight.

The word *improvization* seems to have been misunderstood and, what is more serious, it has been misapplied. When using this term, what perhaps is intended is *substitution*, and not *improvization*. The latter implies producing something from almost nothing, and works on the principle of "no cost, ad hoc" basis. This however applies to all arms and services and not to the Engineers only. When no food is available, the soldier tightens his belt, preserves his strength by cutting out all unimportant activities, has more rest than usual, and carries on as best as he

can—perhaps that is improvization. Similarly if a vehicle gets out of range, and its fuel is finished and none is available for miles, its passengers can always push it to its destination—that again may be classed as improvization. Likewise when taking up a defensive position, when all the available ammunition is exhausted, the soldier can still improvize by gritting his teeth, fixing his bayonet and standing firm, at least mentally. Even in a river crossing operation, if assault boats are not available, one can always improvize by going across in boats made from twigs. However laudable these feats of improvization may be, one certainly cannot take them as factors for planning an operation.

Substitution Versus Improvization

As against this, *substitution* presents quite a different picture. Taking the same examples given above, if say bread is not available, it can be substituted by rice, and any one particular food can be substituted by another possessing similar, if not the exact, qualities of the former, and which will have very little effect on the fighting efficiency of the soldier. Similarly if the infanteer has run out of small arms ammunition, he can still be sustained in his position, if his own fire power can be substituted by artillery and tanks. Lastly, if assault boats are not available, the water obstacle can still be crossed, if we have storm boats or other types of boats as substitutes. However the fact remains that some suitable substitute must always be made available to carry out the task in hand.

Improvization is really the art of survival when the where-withals of war are not available, but without which the soldier must still be able to fight. Substitution on the other hand, entails meeting all, or almost all, the operational requirements originally planned for, but by different means or similar equipment. Whereas one must always be trained and toughened for the former in peace time, in the planning stage it is fantastic to even think of improvization, as it is tantamount to preparing for the battle with one's bare hands, and expect that the training received at the Infantry School and one's own willpower, will see one through the operation, guns or no guns. Though the logic of this is fully realized in respect of the other arms and services, when it comes to planning of engineer tasks, commanders at all levels insist on the Sappers improvizing their requirements if adequate engineer resources are not available. What however is still more pathetic is the fact that the Engineers themselves seem to be accepting this position at face value and appear to be helpless to force the issue in obtaining their due share of resources. What is even more surprising is that, in some Engineer training institutions, regular lectures are given in the "art of improvization".

This does not mean that one must not resort to improvization when necessary. But it is ridiculous to base one's plans on improvization. Operational planning during peace must be based, either on the assumption that all the necessary resources will be made available in one form or the other, or, that the plans will be so tailored as to fit in with the resources available. When however after battle has been joined, either due to enemy action or some other unforseen circumstances, resources asked for do not materialize, then some sort of improvization may be forced on us. This however then comes under the category of "fix bayonets, last man, last round etc", but certainly does not for a factor for resources planning.

Improvization as a Ruse for Shortage of Engineer Equipment

What actually has gone wrong is that the stalwarts of the teeth arms, in their enthusiasm to possess sophisticated guns, tanks and planes, have gone all out to buy these, without the where-withal for transporting them. When questioned the answer is always that as money is limited it has to be spent on essentials such as guns and tanks, and that the transportation of them has to be done by the Engineers as best they can through improvization, an art at which the Sapper is supposed to excel. The result is, that during operational planning or on training exercises, any bid for resources made by the Sappers is frowned upon and they are told to get on with the

job only with their existing resources, failing which to resort to the magic word, "improvize". In the final outcome of the battle when things go wrong, and they will go wrong without adequate engineer backing, the Sapper is invariably blamed for letting the army down.

Conclusion

Improvization as an art of survival, must be practised in peace time, on the same lines as one trains for unarmed combat. Improvization, however, has no place in the planning of operations as a substitute for non-availability of essential resources. Without levels of technical training, and without adequate engineer equipment, it is impossible to conduct modern military operations properly. In this respect a military engineer has become a specialist who has little time left, after attending to the complex systems of contemporary equipment, to carry out other tasks, like improvization.

The time is long past when the Sapper could improvize with his pick and shovel and enable the army to fight. We must now cry a halt to this misconception, and make it clear to all the "Napoleans", that unless adequate and proper engineer backing is available, all the King's horses and all the King's men, will not be able to make their tanks, guns and planes exist, move or fight by means of improvization.

* * * * *

Christmas in the Limassol Area

This charming vignette of life in a Sapper unit nearly 100 years ago was sent to Major General B St G Irwin CB by Miss Anne Cavendish who, for some twenty years, was in charge of the Survey Branch Map Library at Episkopi. She now lives in Cyprus.

Extract from the "Cyprus Herald" *Wednesday 28 December 1881*

"The troops stationed at Limassol kept their Christmas in the good old fashioned way, and their barrack-rooms were gay with Christmas decorations which evinced both taste and care in their preparations. In each, beside the evergreens which, of course, formed the staple of the decorations, many texts of welcome, of good wishes for the officers, and a hundred other pleasant things adorned the walls, while the tables were covered with a profusion of comestibles which bid to keep the large parties assembled fully employed for the greater part of the afternoon. At one o'clock Colonel Dumaresq, CRE, accompanied by his officers and those of the Commissariat and Transport Staff and of the Ordnance Stores Dept with a large bevy of fair dames, arrived to see the decorations and wish a Merry Christmas to the soldiers, their wives and friends, visiting in turns the barrack-rooms occupied by the 31st Coy RE, the Commissariat and of the Ordnance Stores Dept. Colonel Dumaresq and Major Patten* addressed a few words to the party, the latter expressing his regret at leaving the Company at an early date. Serjt Major Drew responded, saying in the course of his remarks, that it would be his last Christmas in the Corps, he having completed his service of twenty one years. The whole company present sang the National Anthem, three hearty cheers were given for Colonel Dumaresq and the officers, and the visitors then moved on to other rooms".

* NB. When Major Patten left he was replaced by Major Chard VC of Rorke's Drift.

The Demolition of Road-Bridges by the Potential Energy Method (DROPEM)

MAJOR P S ADAMS RE, B Sc

The Author was commissioned from RMAS in 1967 and is a graduate of RMCS Shrivenham and The Staff College Camberley. Five years of Regimental duty with UK Regiments took him on tours to N Ireland, Dhofar and Cyprus. More recently he was an Asst Instructor in Bridging at RSME and in his present appointment at HQ BAOR he writes logistic plans for World War III.

Introduction

Colonel Addison's article *Sappers Fit For War* exhorted us to become the masters of "Extraordinary Engineering". In reading his article I was reminded of one particular method of harnessing energy for military engineering which is perhaps not as familiar to combat engineers as it should be. I thought that this example of the use of *DROPEM* might interest readers and also be worth recording for posterity.

The Setting

The setting for this particular Irish anecdote is well known to many; it is the border between Northern Ireland and the Irish Republic and, in particular, the border crossing point M2B near Aughnacloy County Tyrone. It was the Winter of 1975/76 and I was 2IC of 8 Field Squadron, the roulement Field Squadron based at Castle Dillon near Armagh.

The Intelligence Reports were emphatic; M2B lay on a veritable *Ho Chi Minh* trail, with terrorists and munitions flowing unchecked across the border. Recce of the crossing point however made this hard to envisage; apart from finding no terrorists or munitions our assessment was that the route was completely impassable to wheeled traffic. This was due to successful rooting of the approach lane with plant by a previous roulement Squadron. It was our assessment that the route would even be impassable to tracked plant until the Winter rains had moderated into the Summer ones.

However, the Brigade Staff were quite insistent that complete closure of M2B would significantly improve the local security situation and so planning for the task began.

The Problem

The border in the area of M2B followes the course of a large stream which was spanned at the crossing point itself by a fine two-span stone arch bridge. The line of the border passed through the centre of the Southern span and it was clear that the obvious course of action was to demolish the Northern span. However, this idyllic scene of rural Ireland was completed by a neat retirement cottage some forty metres or so from the bridge in the Republic with a contented-looking pensioner tending his garden during the occasional gaps in the rain.

The problem was how to demolish the bridge? Explosives were ruled out due to the proximity of the Irishman; plant had been used previously on the Northern

The Demolition of Road Bridges by the Potential Energy Method (DROPEM) (1)
Major PS Adams RE B Sc

approaches and was considered unsatisfactory even though as a result works parties were unable to gain access other than on foot. So, what was to be done?

The Solution

Inspiration

It was at this stage that I made my sole contribution to solving the problem which was to recommend use of the *DROPEM* technique. (I claim to be the originator of this method if only to trigger off a flood of Correspondence from those who I know have used it before). Our Squadron Commander—Robbie Reive—then took the brave decision to employ this embryo technique whilst Captain Charles Pickles and Staff Sergeant Batty of 2 Troop were told to get on and do it. The rest of us sat back to watch the fun.

The Planning Phase

For the uninitiated *DROPEM* requires a large heavy object to be dropped onto the target from a great height. In this case the object was to be a Universal Concrete Block (UCB)—weighing about 1 ton and found in profusion around Northern Ireland—whilst the means of achieving the height was to be an RAF PUMA Helicopter.

For several days the conversation in the Mess introduced echoes from our academic pasts. Frequent mention was made of "mgh", "$\frac{1}{2}$ mv^2", "Terminal Velocity" and "Stokes Law" plus many other gems hitherto forgotten. However, notwithstanding a good sprinkling of engineering degrees amongst the Officers, no-one could answer the fundamental question:

"From what height should the target be attacked?"

We therefore decided to conduct a joint trial with the RAF. This was duly carried out in a quiet corner of Long Kesh and out of this emerged a *DROPEM* aiming technique which followed the best traditions of Barnes Wallis. The technique required a large mirror to be placed on the target. The mirror was laid on a bed of sand and levelled using a bricklayer's level. The attack helicopter then hovered over the target with its UCB munition slung underneath, whilst the RAF Loadmaster shone a powerful torch below. (Students of Physics will immediately appreciate that when the Loadmaster could see the reflection of his torch then he was vertically above the target and he could accurately release his bomb).

We found that the limiting height for this method was about 100 feet, above which aiming errors became significant. The RAF declared that they were happy to "give it a whirl" on M2B and so detailed planning for the closure went ahead.

The plan for the closure was to be the standard sequence of six phases which had become routine for this sort of task. These were:

Phase 1—(Before dawn)	—Infantry pickets secure the high ground around M2B.
Phase 2—(Dawn + 2 hours ie when shadows had begun to shorten)	—Auster Reconnaissance Aircraft (RIC) overflies the target and its approaches taking vertical air photography.
Phase 3—(About lunchtime)	—Confirmation received from the photographic interpreters of RAF Aldergrove that RIC flight had detected no tell-tale signs of terrorist Improvised Explosive Devices (IEDs).
Phase 4—(Early afternoon)	—Squadron search teams sweep the target and its approaches to confirm that there are no IEDs.
Phase 5—(Late afternoon)	—Demolition carried out.
Phase 6—(Early evening)	—Withdrawal.

As ever we were constrained by the limited number of daylight hours—about nine at that time of year—and by the vagaries of aviation, weather and photography.

However, if necessary, the Infantry could have held the ground overnight and we could have continued the following day.

The Execution Phase

The day of the closure was a typical dark grey Irish day but nevertheless a "goer"! There were however the inevitable delays and it was after 1500 hours before the target was declared clear of IEDs. Daylight was beginning to fade and all commanders were looking agitated. However, the aiming mirror was quickly positioned and the PUMA—piloted by a latter-day Biggles—came forward for the first shot. (It was difficult at this stage to know whether the theme tune of the *Dam Busters* or *Monty Python's Flying Circus* would have been appropriate). The shot was however a miss and the PUMA flew away over the hill to collect another round.

The next three shots were more promising since one missed, one struck the bridge parapet with a glancing blow whilst the third penetrated the soft fill above the centre pier of the bridge like a hammer going into marshmallow. The bridge however stood intact, whilst the Irish pensioner scratched his head in disbelief and Biggles announced that he had to go and refuel. We all cursed silently for not having brought with us the RAF Tactical Supply Wing (TSW) Detachment who operated from our base at Castle Dillon. Their seal drums of aviation fuel and field refuelling equipment could have saved precious minutes. We had overlooked the golden rule of operating with Support Helicopters which is to control them by controlling their fuel. However there was nothing we could do except wait whilst it got darker.

In fairness to the RAF they weren't away for long and soon the PUMA was lining up for another shot. This one was almost a bullseye; it struck the bridge deck at the crown of the arch ring and a good third of the roadwidth plunged into the stream below leaving a gap of about 1·5 metres. The mirror was also shattered but plenty more were held in reserve and a replacement was quickly positioned. The PUMA returned to finish the kill and three shots later the bridge had been completely breached across its entire width.

All that remained was the tidying-up phase. For this the PUMA lifted in a lightweight compressor and using pneumatic tools plus picks and shovels the gap was

Photo 1. Oblique view of Border Crossing M2B taken from the North. (By courtesy of HQRE NI)

The Demolition of Road Bridges by the Potential Energy Method (DROPEM) (1)

rapidly increased to about 3 metres. As ever, the last away were the Infantry and they left a perplexed-looking pensioner studying our efforts. It would have been interesting to have read his thoughts.

Conclusions

The general conclusions which I draw from this particular task are as follows:
—the Engineer role in Northern Ireland is more interesting and more fun than the Infantry one.
—simple solutions to complicated problems are often the best.
—do not expect much to come from theoretical analysis at unit level—empirical methods offer the best approach.
—*DROPEM* is a proven demolition technique which brings out the best in ARMY/RAF cooperation.

Electric Cables for Project and Trade Training Work

E & M CHIPS

"The new Electrical School forms a conspicuous pile of buildings facing the lines, some 200 yards in the rear of the RE Institute. Its extent, design, and equipment furnish a striking testimony to the increasing importance now attached to electricity in the training of the officers' NCOs and men of the Corps".

Written by Col Ward in 1909. Sadly the E&M Wing has moved to a new building where we struggle to maintain the importance of electricity.

We were surprised and delighted with the response we received on the ELCB article and this has prompted a second submission. In this article we attempt to unravel a mystery that has puzzled the best of us for years: If you want to order ordinary electric cables for power and lighting how does one identify the one needed from the Ordnance Catalogue?

We have avoided the problem so far by local purchasing but as cash is short, and bulk buying is considerably cheaper, we can save by obtaining certain items from Ordnance Stores. If you look at Section Y3 there are solid pages of *Cable, Electric* and all you want is a power cable to supply the coffee pot in the Squadron Club. Ahh—on page 38 there is *Cable Power, Electrical*—one only, then your hopes are dashed as you read the detail which says "Used on Battery Pack—Rapier"—could even be something to do with fencing?

So where do we start? The *RE Pocket Book*—nothing of use. *Royal Engineers Metrication Aide Memoire*, page 36 to 39. This is the first clue, but it refers us to the IEE Regulations. So to simplify the subject Table 1 has been produced for cables that

Electric Cables for Project and Trade Training Work
E & M Chips

are installed in buildings and Table 2 for flexible extension cables so often needed for vugraphs etc. These lists are not designed to be complete, if cables are required outside these dimensions an Electrician, Clk of Wks, E&MO or PQE can translate the Ordnance Catalogue lists. A clue for him would be a copy of Defence Standard 61–12 Part 1 and Part 2.

So now you can order your extension cable for the Vugraph. But here is the problem, 13A plugs are too attractive to be listed in the ordinary catalogue so under Section Z32 (not issued of course) is a magic number Z32/5935–99–940–1682 which is the 13A plug electric. This is not the "duraplug" unbreakable one, we haven't found that number yet but a reasonably robust one. Of course by printing this number the plug could become more freely available and open to pilfering but on the other hand it is better than the traditional 3 wires and matchsticks into a 13A ring main socket.

The other component, the rubber unbreakable socket has defeated us. We admit it. It does not even qualify for UKLF Standing Instruction No 24 under Local Purchase so we are back to old faithful COPF. There is of course a surface mounted breakable socket Z32/5935–99–911–4231. Anyway somebody somewhere (RETS) is looking after our interest and trying to unravel Section Y3 so maybe by the time you have forgotten this article it will all be clear in the Ordnance Catalogue!

Table 1. Insulated Domestic Type PVC Grey Cable

NATO Stock No. Y3/6145–99–017	*Plain Copper Conductor*		*PVC Insulation*	*Overall Dimensions of Cable (Upper Limit) mm (Ord Cat)*	*Current Clipped to Surface Amps*	*Remarks*
	Cross Sectional Area mm²	*No. of Wires Forming Conductor*				
2629	1·5	1	One core Red One core Black Earth wire not covered	5·4 × 9·6	15	For Lighting
2630	2·5	1		6·2 × 11·0	21	For 13 Amp sockets
2631	4	6		7·2 × 13·0	27	For Immersion Heater up to 6kW
2632	6	6		8·0 × 15·0	35	For Cookers Single Phase

Notes 1. Usually ordered in 50m drums
2. Normally cable is surface clipped

Table 2. Flexible Extension Cables, Rubber Insulated

NATO Stock No. Y3/6145–99–017	*Tinned Copper Conductor*		*Overall Dimension of Cable mm (Ord Cat)*	*Current Capacity Amps*	*Remarks*
	Cross Sectional Area mm²	*No. of Wires Forming Conductor*			
2677	1·5	30/0·26mm	11	15	For ONE 13 Amp socket outlet only i.e. Vugraph or projector
2678	2·5	50/0·26mm	13	20	For Vugraph *and* projector
2679	4	56/0·31mm	16	25	Not often used

Note: Usually ordered in 50m drums

* * * * *

Construction of Aerial Walkway

OPERATION DRAKE (PAPUA NEW GUINEA)

SERGEANT L E GALLAGHER BEM RE

The Author enlisted into the Corps on 8 February 1961. He has served in Malaya, Borneo, N Ireland, Canada, BAOR, Cyprus, Kenya, Libya, Belize and UK. He has been involved on Operation Drake *and was recently awarded the BEM for his services in Belize. He has spent most of his service since 1965 with 9 Para Sqn RE.*

BACKGROUND

Operation Drake is a two year, round-the-world expedition which involves scientists, servicemen and Young Explorers in challenging and useful scientific and community projects. It is based on the circumnavigation of the world by the 150 ton Brigantine, *Eye of the Wind*, which has been equipped with a scientific laboratory. It is also the home for twenty-four Young Explorers who change over after each of the nine phases of the expedition. The Director of Operations is Lieut Colonel John Blashford-Snell MBE RE.

During the two years, the ship has visited four areas where Operation Drake has carried out projects for up to four months at a time. These were Panama (January to April 1979), Papua New Guinea (October to December 1979), Sulawesi (January to May 1980) and Kenya (July to October 1980). For each project a large team of Directing Staff of military personnel, doctors, scientists, group leaders and administrators is employed. There is always a Royal Engineer element included in each team to carry out construction tasks, to provide potable water, to operate boats, to undertake field surveys and many other minor tasks. Their training and knowledge makes them ideal expedition members and the Operation is a valuable vehicle for them to gain experience in difficult and primitive conditions in parts of the world they would not normally visit.

Several scientific projects have been carried out in all of the four land phases and in three of them—Panama, Papua New Guinea and Sulawesi—the scientists required the use of an aerial walkway so that they could investigate not only ground level activities but also what was happening at the tops of the trees. The forest canopy remains the least known part of tropical jungle and the walkway provided an unique opportunity to study the flora and fauna continuously rather than just observe small parts of it for short periods.

Various walkways were developed and tested before the Operation started and as experience was gained in the field, the materials and designs were changed to simplify construction, improve strength and safety, and reduce maintenance.

I was given the task of constructing three walkways in Papua New Guinea at the

Sergeant LE Gallagher BEM RE
Construction of Aerial Walkway

Operation Drake Scientific Camp near the village of Buso. The report which follows refers to the construction of one of the spans.

AIM

To construct a span of approximately 30m of walkway in the Bulolo Forestry College Reserve, 60km south of Lae, Morobe Province near the small village of Buso. The span was to be constructed to the south of the camp and was to be handed over to the College on our departure, after being used by our scientists.

LIMITATIONS

The span was to be constructed in primary jungle using the tallest and strongest trees. While providing as much botanical variety as possible it would also provide the opportunity to study several different ecological systems. A botanist had to agree the choice of site before construction started.

Minimum damage was to be done to the jungle at, or near, the site.

MATERIALS AVAILABLE

Out of the material available from Operation Drake sources, the following items were selected:—

(a) For main support cables—25mm diam SWR,

(b) The walkway flooring was to be Dexion and was made of a strong, light alloy. It came in 1·8m lengths and was 0·225m wide. In dry conditions it was ideal, provided that the user wore sensible footwear with gripping soles. When wet, it was slippery so construction and use ceased.

(c) Nylon strap suspenders were used to join the Dexion to the main support cables. These suspenders were supplied by Package Control Ltd. They varied in length to make the walkway as horizontal as possible while being supported by the curve of the cables.

(d) Fishplates, made of 50mm wide Dexion strips with 6mm diam holes were used to join the Dexion planks. They were bolted on to both inside and outside of both sides of the plank's cross-section, complete with crushing washers; four fishplates were thus used per plank.

(e) Shackles were used to join the nylon suspenders to the main support cables and to the Dexion, at one end and at the middle of each plank, using eight shackles per Dexion plank.

(f) The safety cable was 3mm diam SWR.

MANPOWER/TIME

Walkway construction was a time consuming rather than a manpower consuming task. Only two men could work on each platform, meaning that a maximum of four men could work in the canopy at the same time. Two men were needed on the ground to haul constructors, material and equipment into the canopy when required.

Any structure that is intended to be permanent, meaning up to ten years in this case, also needs unending minor improvements to its safety and facilities prior to leaving it unattended to survive against the elements.

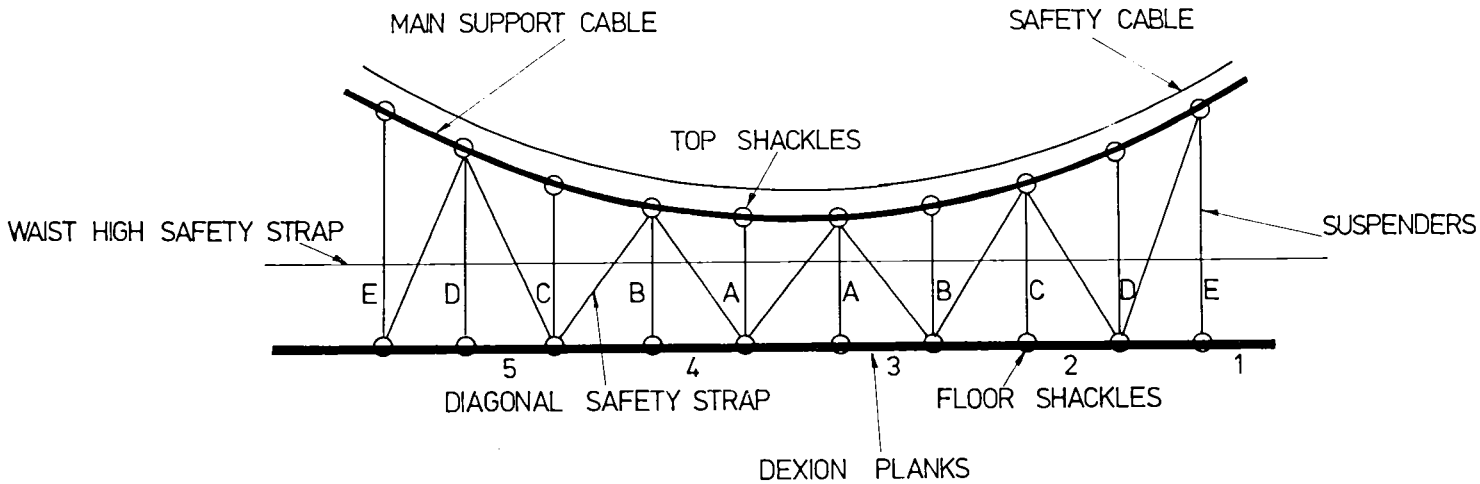
SEQUENCE OF CONSTRUCTION

(a) *Select Emergent Trees.* Called "emergent" because they were tall enough to emerge through the forest canopy. Trees were selected with suitable strength, height and distance apart and were then agreed by the expedition botanist (Dr Willy Wint of Oxford University).

(b) *Gain Access to Platform Level.* One of our climbers, chosen from Sergeant R Aki PNGDF Engr Bn or two locals hired to help with walkway construction, climbed the selected tree to the required height and passed a cord over a fork. (Their ability to climb great heights using vines was truly remarkable). The cord was then used to pull up a climbing rope which was climbed using improvised etriers (three jumars on separate nylon straps with one jumar for each hand and the other attached to the climber's chest). The climber then lashed a block and tackle to the fork.

(c) *Construct Platform.* The design of the platform was determined by the shape of the fork and the direction of the span. Timber spars were cut from outside the area of the site and were nailed to the branches and had supporting spike hooks under them.

SKETCH OF WALKWAY



NB 1. Letters indicate different lengths of suspenders.

NB 2. Numbers indicate distance from end tree in metres.

Figure 1

Lengths of Dexion were then used to make a platform across the spars. The Dexion planks were bolted together and were windlassed to the spars with 14 gauge wire.

(d) *Connect Emergent Trees*. The method was to throw a weight with a line attached as far as possible, climb the next tree or vine and repeat the process until the target tree was reached.

(e) *Install Main Support and Safety Cables*

(1) The cable was pulled from one tree to the other with an endless loop passing round a snatch block.

(2) The main cables were passed round a tirfor block and then secured to both trees.

Z3) The safety cable was positioned and secured around the trees with bulldog grips.

(f) *Construct Walkway Floor*. The construction of the walkway floor proved to be similar to using an adult's version of Meccano.

(1) The span gap distance determined the number of Dexion planks required.

(2) After consultation with the expedition botanist concerning the required height of the walkway, the appropriate batch of nylon suspenders was chosen. The suspenders were provided in twenty lengths, lettered A-T, varying in 50mm increments between 1·19m and 2·2m. Only two suspenders were attached to each side of each plank with one pair having an adjacent letter and therefore length to the next pair.

(3) While still on the ground, the Dexion planks were prepared with four suspenders, eight shackles and fishplates on one end only.

(4) Two lengths of plank were pulled up the tree at a time, using a block and tackle hoist.

(5) At platform level, each plank was connected to the main supporting cable by its four top shackles. The first plank had the highest lettered suspenders for the far end of the span (as did the last plank for the close end of the span), with the lower lettered suspenders used at the centre of each plank. Each plank was then boomed towards the further tree on the main support cables after being bolted to the plank already in position.

(6) When all planks were in position, the ends of the walkway were secured to the trees using the 25mm wide nylon strapping.

(g) *Construct Safety Strap Network*

(1) A safety strap network was constructed, consisting of a length of nylon strapping on each side of the walkway at waist height and connected to each suspender by a half hitch. A further length of nylon strapping was threaded alternatively through top and floor shackles on adjacent suspenders. See Photograph 1 and Figure 1.

(2) The diagonal safety strapping was threaded inside the waist high safety straps and vertical suspenders, to enable scientists to lean back on all the safety strapping and operate their telescopic pruning poles and other instruments.

(h) *Final Check of Walkway*. Before the span was declared ready for use, a final check was made on all main components:

(1) *Tension of Main Support Cables*. Accessibility to plant specimens was a large consideration before any final tensioning adjustment was made. Cables, however, should never be over-tensioned.

(2) *Tension of Safety Cables*. After consultation with our scientists, it was agreed that the safety cable should hang approximately 2·4m above the Dexion. It was tensioned up to this height by hand, rather than by jack, to allow enough sag to:

(a) Arrest a falling walkway user gradually rather than with a jerk.

(b) Provide enough give in the cable to facilitate attachment of a personal safety strap carabiner.

(c) Provide enough give in the cable to allow users to sit down comfortably on the Dexion flooring.

(3) *Tighten Dexion Connection Points*. On this span this check was not necessary

Photo 1. The end of the walkway showing the platform and the diagonally arranged safety strapping. The box suspended to the left of the walkway is an insect trap

because of the crushing washers and fishplates.

(4) *Tighten Cable Securing Points*. This was done for the bulldog grips on the SWR.

(5) *Minimise Bridge Sway*. This was done using lateral guys connected to the mid-point of the span. The guys were connected to the two main support cables.

(6) *Check Main Support Cable Spreaders*. These were used to widen the main cable separation to 0·9m to allow users to move easily along the walkway. The spreader was a 10cm minimum diameter spar lashed between the main cables at both ends of the span. This also became a daily check.

METHODS OF ASCENT AND DESCENT

(a) *Ascent*. There were two methods. On the east tree personnel were pulled up to the walkway level by a double block assembly hoist. On the west tree ascent was by climbing 30cm spikes which were driven 10cm into very hard wood. The spikes provided the favourite method of ascent with the scientists and they are recommended for any such permanent method of ascending a tall tree. Clogs were used to connect climbers to their safety ropes when they climbed the spikes.

(b) *Descent*. Methods of ascent could be used but, additionally, walkway users abseilled on nylon climbing rope using the figure of eight method. This was the most favoured method and its use was much encouraged.

SAFETY

(a) *Daily Safety Checks*. A great deal of emphasis was placed on the daily safety checks, consisting of:

(1) Main and safety cable tension.
(2) Bolts joining Dexion planks for tightness.
(3) Wear and tear on all cordage including climbing ropes.
(4) Security of lashings.
(5) Mousing on blocks.
(6) State of personal safety harnesses.
(7) Firmness of spikes.

Construction of Aerial Walkway (1)

(8) State of all safety straps on walkway.
(9) Firmness of personal safety strap fastening points such as pitons.
(10) State of main support cable separators.

(b) *General Safety Points*. There was always someone responsible for safety when the site was in use. This was a somewhat nerve-racking task but one that had to be done with a high degree of firmness and politeness. Great emphasis was laid on proper abseilling technique; when not to use the walkway because of rain or wind; and keeping the number of people on any span to a maximum of two, although more could work on the platform.

Photo 2. The completed walkway

Construction of Aerial Walkway (2)

Photo 3. A scientist using the walkway

CONCLUSIONS

(a) With a continuous good working relationship between walkway constructors and walkway users, post-construction modifications were kept to a minimum.

(b) With fastening points for the main support cables on the same horizontal plane and with the safety cable fastening point immediately above and between the two main support cable fastening points, it became relatively unimportant for the floor of the walkway to be level.

(c) With all safety precautions firmly observed, there should be no accidents. There were no accidents at our Buso sites.

(d) This particular task gave a high level of personal achievement and depended on the team-work of all the members of the construction team.

AFTERNOTE

The walkway described is now being successfully used by the Bulolo Forestry College and it is hoped that, subject to the non-collapse of the two anchor trees, the walkway will be safe for at least ten years. Since the construction of this walkway two more have been built by Sappers and used in the Sulawesi phase of Operation Drake.

Construction of Aerial Walkway (3)

A Fridge Too Far

CAPTAIN (E&MO) J E WRIGHT RE

The Author was commissioned as an E&MO from the CW(E) roster in 1977. After an unaccompanied tour in Nepal he joined 64 CRE (E&M) in Barton Stacey whence he became involved in various E&M projects and in particular PROJECT SINEW.

Foreword

Funafuti, capital of Tuvalu, was recently host to a nine man RE Management Team working for four months on *Project Sinew*. The main tasks were to instal a new electricity distribution system and erect a seaplane hanger, both sponsored by the Overseas Development Authority of the Foreign and Commonwealth Office, using British funds.

Introduction

Tuvalu (the name of the former Ellice Islands since their separation from the Gilberts on 1 October 1975), comprises nine islands situated in the south-west Pacific around the point where the International Date Line cuts across the Equator. The territory is remote from large centres of civilization, Funafuti the capital island, being some 1000km from Suva (Fiji) and 4000km from Sydney.

The islands are all low lying atolls, nowhere rising more than 4·5m above sea level and composed of coral reefs. On Funafuti, discovered by Captain De Peyster in 1819, the reef encloses a sizable lagoon which ships can enter. This island was the site of Sir Edgeworth David's test (1897) which proved the Darwinian theory of Atoll Formation. During World War II US Forces occupied it and constructed a 2500m runway of compacted coral.

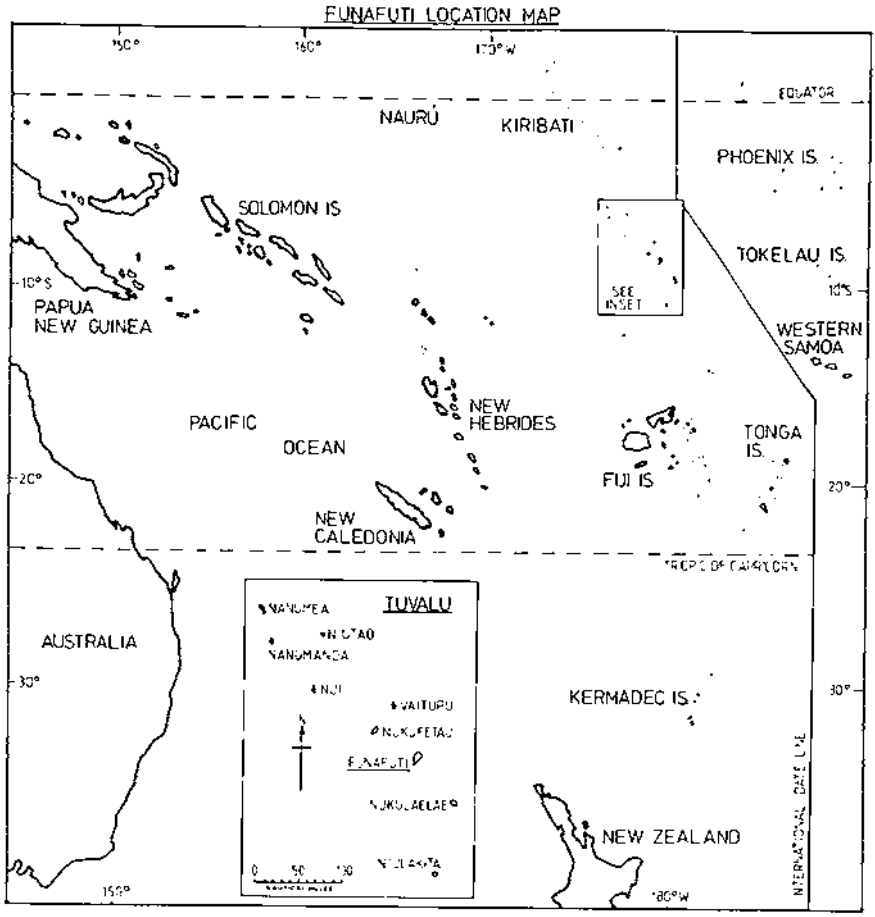
The climate is pleasantly tropical, if monotonous, there being no marked seasons. Rainfall averages 3708mm (146in) annually and the mean temperature is 29°C (86°F). The heat is moderated by trade winds which blow from the east for much of the year. The population of Funafuti is around 2200. The main languages are Tuvaluan and English.

Though Tuvalu is situated to the north of the recognized hurricane belt, the islands have been struck twice in the last 100 years by severe cyclones—in 1894 and, more recently, in 1972 Hurricane "Bebe" devasted the island of Funafuti. It was as a result of Bebe that the Royal Engineers and 64 CRE (E&M) in particular became involved in the area.

Background

In mid 1975, through the offices of the Overseas Development Authority (ODA), 64 CRE was tasked by the MOD(A) to produce an Initial Reconnaissance Report (IRR). The object, to advise on the expansion of the electricity supply system on Funafuti.

A Fridge Too Far
Captain J E Wright RE



The recommendations of the IRR were accepted and, as a result, in June 1976 a team from 64 CRE visited Funafuti, with the object of producing a Detailed Reconnaissance and Planning Report (DRPR) dealing with the design and contract documents necessary for the construction of a new electrical power system for the island.

At the request of ODA the Corps accepted the task, 64 CRE was given the green light in June 1978 and *Project Sinew*, as the task became known, was born.

Nearly two years had elapsed between the production of the DRPR and the tasking of 64 CRE and it was therefore necessary to arrange a Confirmatory Reconnaissance to Funafuti to update the electrical requirements.

The confirmatory reconnaissance was carried out in July 1978 and the report produced in August covering the following works:

(a) Installation of 6000m of High Voltage (HV) underground cable, 11000 volt grade.

(b) Installation of five external sub-stations with their associated switchgear and transformers.

(c) Connection of the old and new Low Voltage (LV) systems using new feeder pillars.

(d) Change the existing 150kVA 3300 volt step-up transformers for one of a similar capacity rated at 11000 volts.

(e) Commissioning the system.

The original Reyrolle switchgear and associated transformers due for replacement

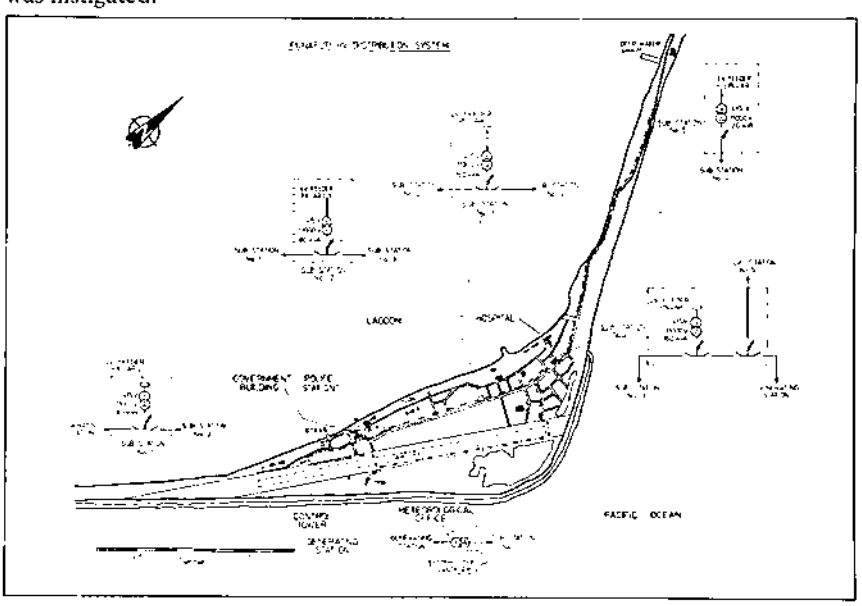
under *Project Sinew*, were a reminder of earlier Corps activity in this area of the Pacific. The equipment had originally been installed by the Sappers on Christmas Island during Operation Grapple in the mid 1950s; during the run-down period the equipment was removed and re-located on Funafuti by the local PWD. Using this equipment the existing electrical distribution system consisted of a 150kVA 400/3300 volts 3-phase step-up transformer, fed from the generating station, which in turn supplied two sub-stations via a 3300 volt underground cable. Each sub-station had its own switchgear controlling step-down transformers 3300/400 volts 3-phase, and between them these sub-stations served the majority of the consumers.

In 1978, at the time of the confirmatory reconnaissance, the step-up transformer was out of commission and the only distribution system was at 400/230 volts 3-phase via temporary cables from the generating station to the sub-stations. The effect was an abysmally low voltage at the furthest consumers, nearly 2km distant and ironically including the hospital with its voltage sensitive X-ray equipment. The measured voltage in this instant was 175 volts at the X-ray outlet against a minimum requirement of 220 volts, a situation which, when the machine was operable, required many seconds of exposure time to obtain a result. More noticeable was the effect on refrigerator motors which due to the distance and resultant low voltage tended to overheat and burn out. The net result was a very unsatisfactory system and a long list of would-be consumers who could not be connected for fear of aggravating the situation.

The Government of Tuvalu was very keen to have the new system in operation by the end of 1978, some four months after the reconnaissance, to coincide with the granting of its Independence (October 1978). However completion by this date was never a practicable proposition and even if it had been, the turbulence of industrial action in the UK during the winter of 1978 with the lorry drivers and engineering workers strikes put paid to any hope of a rapid response.

Stores and Equipment

The method of obtaining stores and equipment, both of RE and RAOC origin was unusual. A new system based on the lessons learnt during the early days of *Project Bonaparte* (another ODA sponsored venture carried out by 64 CRE on St Helena) was instigated.



Basically it required Engineer Resources, which along with MWF forms the Engineer Support Group (ESG), to procure all stores of RE origin, accept these, and with RAOC stores (ordered direct by Ord Branch at HQ UKLF) arrange inspection, packaging and containerising before delivery to the container terminal at Hull. Accounting of the stores was undertaken by a HEO within the Procurement and Accounts (P&A) Wing who took on charge all stores prior to their issue to either the Public Works Department (PWD) Funafuti, or the Project Officer.

The majority of stores items were purchased directly through P&A but the three main items namely, cable, transformers and switchgear required contract action. Co-ordination for the contracts was dealt with by Material Wing of Engineer Resources located at Barton Stacey. The cable contract went extremely well and the cable was available in November 1978. Unfortunately the transformers and the switchgear were delayed because of strike action. The overall result was a completion time of 34 weeks against specified delivery time of 16 weeks, with a corresponding delay to the start of the project until August 1979, exactly one year after the confirmatory reconnaissance.

In spite of the delays encountered, the system of involving Engineer Resources in the initial accounting worked well and the subsequent success of the project reflected the support and effort contributed by this particular organization.

Team Selection and Pre-Project Training

The mounting conference for the project took place at HQ UKLF on 15 September 1978, during which the composition of the Management Team was finalized. The term Management Team was adopted since the team would provide the technical expertise for the project, manual and admin support being provided by the local PWD. The team was to comprise:

(a) OC, E&MO 64 CRE(E&M)
(b) CW(E), WO2 64 CRE(E&M)
(c) 4× Electricians (preferably Class I)
(d) 1× Surveyor Engineering
(e) 1× Storeman/Admin NCO

Selection of the electricians, surveyor and storeman was completed once a trawl had taken place within UKLF units. Names of the selected applicants, subject to interview and confirmation by 64 CRE, was available on 18 January 1979 and consisted of two members each from 22, 36 and 38 Engineer Regiments.

The outstanding technical problem for the project was the lack of experience by the electricians in HV cable jointing and terminating. It is taught at the RSME on the Class I course and then only for copper-cored cable, not for stranded aluminium used on the project, although of course the techniques when using compression methods of jointing are virtually identical. The main-drawback, when any HV project is discussed, is the lack of practice in jointing. It was therefore necessary to put the electricians through an intensive refresher course dealing primarily with HV jointing but in addition covering other aspects of the project such as switchgear/transformer erection and commissioning, earthing requirements and cable handling. This course was organized by the RSME and lasted four weeks, a further weeks training took place at CEP Long Marston when the electricians, plus the storeman and surveyor assisted in the initial work for *Ex Power Pack V*. All training had been completed by early May 1979 and the team, subject to stores delivery, was ready to embark. However as previously described the delay to contract items resulted in the start date slipping to August 1979.

Electrical Installation

The team eventually departed on 9 August 1979, once all stores had been dispatched from the UK. This was to some extent a calculated risk, 80% of the stores were readily available on Funafuti but the switchgear had only recently departed on 31 July. An anticipated delivery time of 6–8 weeks by sea meant that the switchgear

would arrive on site in plenty of time to be incorporated in the sub-stations—according to the patron saint of Cascade Planning and Project Control!

The team's journey by air to Funafuti via Los Angeles and Fiji took five days including a three day stop-over in Fiji whilst awaiting the weekly flight to Funafuti. The team arrived on 15 August and work began the next day.

At this stage it may be of interest to recall the main features of the project which was to lay 6000m of HV cable and connect the existing generating station using this cable to a total of five sub-stations; the system to operate at 11000 volts via a step-up transformer situated adjacent to the generating station. The design of the HV cable route was such, that, although working as a spur or single feeder it could be easily converted to a ring main under Phase 2 of the programme (New Generating Station). The five sub-stations served the inhabited part of the island with no consumer more than 400m distant; sub-stations 1–4 covered the town area whilst the fifth, situated to the north of the island, was positioned to cater for the new deep water wharf under construction and a projected deep freeze plant. Each sub-station comprised a ring main unit (rmu), transformer and an LV feeder pillar, all mounted on separate concrete plinths and enclosed by a safety fence.

During the confirmatory reconnaissance, carried out the previous year, the local PWD agreed to carry out certain preliminary works prior to the teams arrival. This work consisted primarily of preparing trenchwork for the underground cable and concrete bases to accept the sub-station equipment. The initial impression when walking the cable route was one of dismay. Less than half the cable route had been dug and of that which had, only 50% approached the required standard. Another shock was the lack of bedding sand for the cable. The impression of a South Sea Island surrounded by golden beaches is not applicable to Funafuti. Trenches, where dug, included large sections of hard coral, which needed compressed air tools to remove it, and sand when required in any large volume had to be brought overland from the extreme northern part of the island, which meant a 15km round trip, or alternatively brought in by barge from one of the outer islands—two trips a day maximum. It was estimated that 350m^3–400m^3 was used, a considerable amount taking into account the shortage of transport. This problem was to remain with the team throughout the project and although the thought of scouring an island looking for sand sounds amusing it proved to have its frustrating moments. On a lighter note one aspect of the preliminary works undertaken by the PWD was the manufacture of cable protection tiles and markers cast out of concrete. The dimensions as specified were correct but it was thought initially when checking the finished product that some Russians had infiltrated the PWD, all bore the inscription ƎLBAƆ VH. However, all was revealed when it was pointed out, with the help of mirrors, that to end up with the words HV CABLE the cable marker mould had to read the reverse.

The execution of the project was very much labour intensive; or to put it more simply the management team had at it's disposal a pool of specially recruited casual labour and the minimum of plant. The labour was immediately put to use in preparing and improving trenches; initially it was not uncommon to see five or six teams of ten labourers under the guidance of a Sapper or J/NCO breaking out coral. Contact was quickly made with the Australian firm involved with the installation of the deep water wharf and they generously put at the teams disposal jack hammers and bits, parts that were missing from the PWD compressor. This particular phase of the work was not for the faint hearted or indeed the Health and Safety at Work Inspector. The sight of a jack hammer dancing on hard coral around bare feet ensured that the island had more than its share of budding John Travoltas! In deference to safety regulations it should be stated that boots are virtually unknown on the island and shoes, when worn, are normally of the flip-flop variety.

After ten days 2500m of cable had been laid and the first through joint completed—the latter celebrated in local traditional style by the popping of Fiji Bitter cans. The method of cable laying would not be found in the annals of *Military Engineering Vol X*. A system was devised using a gang of ten labourers and a

Photo 1. A budding John Travolta

tractor-drawn trailer. The tractor would travel parallel to the trench whilst the cable, supported by jacks on the trailer, was run off. The disadvantage using this method lay in the fact that the trailer was not wide enough to accept the drum width of well over 1·5m. Consequently the drum had to be mounted at right angles to the trailers wheelbase and ultimately the cable trench. The solution was to provide ample manual support as it left the drum, prescribe an arc to avoid damaging the cable and lay it in the trench. The only instance when this method could not be used was the crossing of the runway where the cable was drawn through a duct. Manpower alone provided the force although a Tirfor jack had been taken along to assist had it been required.

One disadvantage of a low lying atoll surrounded by tidal waters is not only is there

A Fridge Too Far (1)

a high water table but it fluctuates with the tide. This led to some interesting if not unique situatiogs. Two joints were required alongside the runway, a particular stretch that was prone to flooding at high tide. Much studying was done of the moons behaviour and cable laying was planned to suit; laying cable in water filled trenches is not to be encouraged. To eliminate the ingress of moisture jointing was done in purpose-made concrete pits laid at ground level which allowed the cable ends to be brought nearer the surface, above the water table, the pit providing mechanical protection normally given by laying to a depth of 800mm.

A more striking example of tidal influence lay in the recorded values of earth resistance. Six earthing installations were made, each consisting of 2400mm copper rods driven vertically into the ground and bonded together. Individual installations showed differing values for high and low tide, the more noticeable cases occurring at the Generating Station (HV earth) and Sub Station No 5—see Table 1. To the term, Floating Neutral, familiar to electrical engineers can now be added the technical term "Floating Earth"!

TABLE 1 EARTH RESISTANCE VALUES

	Earth Resistance	
Sub-Station	High Tide	Low Tide
1	1·0 ohms	1·3 ohms
2	1·3	1·6
3	1·0	2·3
4	3·5	3·6
5	2·9	4·0
Gen Station	1·6	3·0

The normally prevailing easterly winds in this area of the Pacific are replaced towards the end of the year by westerlies which tend to be more ferocious and rain bearing. These elements combined are not conducive to HV cable jointing where cleanliness and a dry joint are basic requirements. Certainly during the month of October a noticeable increase in rainfall was apparent, which meant that any planned cable jointing, which could take 6–7 hours per joint, could not start until there had been a weather check at the beginning of the day. However the situation when rain arrived

Photo 2. "... and the rains came"

A Fridge Too Far (2)

Photo 3. Distribution Sub Station 1 completed. Note Feeder Pillar raised above ground to overcome condensation problem

unexpectedly, was foreseen during the planning stage of the project and sufficient tarpaulins were taken to ensure that no jointing started without a temporary framework erected around the site with tarpaulins draped ready to pull over. It became a common sight to see a sub-station shrouded in canvas, and not unknown when left overnight, to find next morning that a temporary squatter had moved in, slightly the worse for drinking the local toddy (fermented coconut-tree sap.)

When the main cable runs had been installed and the various transformers positioned, connection of the LV feeder pillars took place. The type chosen was manufactured by GEC-Henley with a concrete root and fibre glass cover, ideal for the salt laden air of Funafuti. It soon became apparent, once the installation of the first feeder pillar had been completed, that there was a problem of condensation. Moisture was being drawn up into the pillar from the surrounding coral (with its high water table) and overnight, when cooling down, considerable condensation was taking place. Hurried signals to the manufacturer requested a remedy (possibly in the form of a small internal heater, a common cure in UK) but only brought the response that this was a familiar occurrence in hot climates and had been previously experienced in the Middle East, and no heaters were available. One wonders why this information was not forthcoming at the time of purchase. The problem was overcome by raising the concrete root and placing it on a concrete plinth, purpose made by the PWD to the teams design. This base permitted air to circulate within the fibre glass cover avoiding the build up of condensation.

The switchgear which had been shipped from UK on 31 July eventually arrived at Funafuti on 15 October, eleven weeks later. The delay in the arrival—it was only expected to take 6–8 weeks—was due to lack of shipping from Fiji. Having been off-loaded from the container ship at the end of August it lay on the quayside awaiting a local ship to take it the relatively short distance to Funafuti. This particular period was to cause much frustration not to mention reshuffling of the cascade diagram. Who said critical activities cannot slip without delaying the overall job!

A Fridge Too Far (3)

Having arrived, the switchgear was connected and the system was ready for commissioning.

No matter how carefully individual items of equipment are checked and tested the period of system commissioning invariably results in a few heart-stopping moments and so the day the complete system was initially energized found some of the team looking to the heavens for guidance, whilst those of a more technical nature were keeping their fingers crossed!

Pre-commission testing had been severely affected by the inability of the HV testing equipment taken on the project to test long lengths of cable (up to 1500m between sub-stations) which naturally included any through joints or terminations carried out on the cable. This inability or restriction was the result of the equipment not having sufficient output to cope with the relatively high charging currents required for long lengths of cable with their high capacitive effect.

It was therefore with the possibility of undetected faults, plus the large in-rush currents that normally occur when cables and transformers are energized, that a method of controlling the system voltage from zero–maximum was devised and with it the ability to restrict the current. The method chosen was to supply the exciter circuit of the test generator (one of the permanently installed generators suitably modified) with an external dc supply capable of infinite adjustment. Using this arrangement it was possible to increase very gradually the generated voltage from 0 to 400 volts with a corresponding build up of voltage on the 11000 volt system via the step-up transformer.

When energized initially the generated voltage did not exceed 50 volts before meters monitoring the main circuit indicated a fault on the yellow phase, an observation that was confirmed by the rupturing of the HBC fuse protecting that phase. Logical deduction narrowed the possibility of the fault to one of two places, either the step-up transformer or a through joint in the cable between the transformer and sub-station No 1. The odds at this stage were on the joint, always susceptible and normally a prime suspect when faults are considered. However rather than break the joint down, the decision to eliminate the transformer as the culprit was taken.

Fingers were uncrossed and put to work on draining down oil and removing the top cover of the transformer tank. The inspired guess of checking the transformer first had its reward when on careful examination of the windings, the fault was found to be on the copper tail connecting the yellow phase LV winding to its bushing on the side of the transformer tank. This connection was touching the metal yoke or frame providing a short circuit path to earth, a fault easily rectified by re-routing the copper tail. A further search of the windings revealed, what could have been in the future, a major fault on the HV winding in the shape of a loose metal nut which had become lodged in the HV coils. This had obviously been left during the manufacture and led to doubts regarding the quality of inspection by the firm and MOD Inspectorate.

The fault having been cleared the system was re-energized and the voltage increased to its normal working values. No further faults were found and the transfer of consumers gradually took place from the old to the new system, a task which was completed within two weeks.

The effects were soon plain to see, the hospital was able to use its X-ray equipment to its full capabilities; switching on the local radio transmitter no longer dimmed the lights in the surrounding houses; and last but by no means least, refrigerators became practical once more which as far as the local hotel was concerned—not to mention the team—the dream of instant cold beer became a reality.

Erection of Seaplane Hanger

This particular task, not normally associated with the world of E&M engineering, came by way of ODA who sponsored the electrical installation work. It was during one of the meetings held at ODA offices in London, dealing with the electrical work that the team was requested to undertake the additional task of erecting a seaplane hanger. This had, as far as the Government of Tuvalu was concerned, become an

Photo 4. Fixing Cladding

urgent requirement to fulfil a basic condition under which New Zealand was to present an amphibious aeroplane to Tuvalu, a simple case of no hanger—no plane. The machine was to be used to inaugurate a much needed inter-island service for the group, a service carried out rather spasmodically at times by ship.

The building measuring 18·2 × 21·3 × 8·3m high was a portal steel frame with aluminium alloy cladding, designed to withstand a basic wind speed of 45m/s (101mph). The four interleaved access doors were steel framed, sliding on bottom rollers, each door measuring 5 × 18m. Roof lights and side windows completed the basic structure.

The concrete base for the hanger had been laid and the majority of steelwork delivered to site but there work had ceased due to a lack of an experienced erection supervisor. It was under these circumstances that the team added to its original number 1× WO1 CW(M), normally a member of 64 CRE, and in fact due to visit Tuvalu to undertake the DRPR for Phase 2 during the latter stages of Project Sinew. His visit was brought forward and extended by some six weeks to enable him to take on the extra work. His experience of steelwork, it must be said, was rumoured to be limited to Bailey Bridging in the dim and distant past. Luck, as they say, favours the brave, checking with the manufacturer of the hanger it was found that the firm concerned, Condor Ltd, had their main office at Winchester and their workshop at Southampton, both within easy reach of Barton Stacey. Visits to the firm were arranged during which the design staff were most helpful in explaining erection techniques and arranging for site visits where buildings, of a similar nature to the hanger, were under construction.

In the meantime the main party had moved out to Funafuti and along the way had made contact in Fiji with firms supplying scaffolding, ladders and hand tools which would be required during the building stages. Various arrangements were made to have the equipment delivered to Funafuti subject to confirmation by the CW(M) who was following in early September, three weeks after the main party. The delivery

A Fridge Too Far (4)

of scaffolding was subject to delay due to the Pacific Games taking place in Fiji which required all available steelwork for temporary stands.

Initial work on site required the identification of building components, organization of labour and plant and the checking of the concrete foundations and stanchion bases. The latter with the help of the team's surveyor confirmed the suspicions voiced by the ODA in London, that the base as laid did not meet the overall tolerance for the stanchion footings of 10mm, the deviations being as much as 60mm. However much cutting by compressor and acetylene equipment resulted in an acceptable figure of 6mm being reached. Further checks as the building progressed revealed that the base level had in fact been laid to the finished floor level, instead of the base datum level. Fixing the lower side cladding and more seriously the main sliding doors could not take place without major alterations. The alternatives were to reduce the complete base by approximately 100mm or, as was decided, cut out the base around the sides to accept the lower cladding panels and in the case of the doors, reduce their height by 75mm using an acetylene torch. This sounded drastic at the time but was the practical solution to an inherited problem; however, before this step was taken the operators of the seaplane firm were contacted, who confirmed that the reduction in height of the doors would not affect the entry and exit of the plane.

Work on the hanger was carried out by a team of five locally recruited casual labourers and a local PWD carpenter, supervised of course by the Clerk of Works. The team was assisted in the erection by the one and only crane on the island (6 ton Iron Fairy) when it was not being used in its priority 1 role of off-loading ships at the wharf or assisting the main team in lifting transformers and switchgear. The local populace made natural steel erectors with a good head for heights from long experience of climbing palm trees, not so much for removing coconuts but for fixing Toddy bottles. (This pastime involves the positioning of bottles in trees, beneath suitable cut notches in the trunk or branches, for collection of the resultant extruded juices from which toddy is made. New arrivals on the island can be forgiven for thinking, when looking at the trees, that coco-cola and not coconuts grow on them!)

The enthusiasm and natural ability of the islanders compensated for the building aides which when ordered in Fiji with promise of delivery in days actually took weeks

Photo 5. Hanging Modified Doors using 6 Ton Iron Fairy Crane

A Fridge Too Far (5)

to find their way to the island. The scaffolding and ladders arrived during the projects last week and came in useful for placing the roof cladding in situ, virtually the final job before completion.

When departing from Funafuti probably the last building seen, is the aircraft hanger alongside the main runway. It is perhaps a fitting reminder of the unhurried pace and tranquil atmosphere of these Pacific islands that a set of stamps had been issued by the local Philatalic Bureau commemorating the inauguration of the inter-island service in May 1978—two years before the plane was received!

Social And Sporting Activities

The social life as expected on a small Pacific island had its limitations but the activities that did take place reflected the living environment and local life. Where else would you be able to partake in beach picnics using coconut husks to barbecue freshly caught reef fish or spend hours during darkness looking for lobsters with the aid of lanterns (most unsuccessful in spite of a local guide assuring the team that the moon and tide were right for the sexual orgies that drive the lobster into shallow water).

Relaxation was mainly confined to the water sports, snorkeling being the most popular. The many reefs around Funafuti provided ample opportunities to study the large number of brilliantly coloured fish. At times the appearance of the odd sting-ray or two guaranteed what could be described as moving moments. Sea fishing had its share of enthusiasts as did canoeing, the latter using local craft complete with outrigger and a built-in characteristic that ensured you went anywhere you wanted—so long as it was in a circle. Away from the water, project members were in demand to help form a football team to test the local national side who were due to play in the Pacific Games held in Fiji. The only area on which team sports can be played is the airstrip, it is not unusual to be buzzed by an unscheduled plane wishing to land and the use of portable goal posts ensures that this operation is quickly, if not grudgingly, carried out.

The final week, after the successful conclusion to the electrical distribution scheme and the seaplane hanger erection, was a succession of parties culminating in the invitation for the team to attend a farewell cocktail party at the house of the Prime Minister of Tuvalu the Rt Hon Toalipi Lauti. Each member of the team was personally thanked by the Prime Minister and given presentation packs of Tuvaluan stamps signed by him, a rare collectors item.

Summary

The two widely differing tasks undertaken during Project Sinew were successfully completed on time and within the financial budget, factors which are guaranteed to keep the majority of Staff Officers happy and inquests to a minimum. For the team members it provided satisfaction in knowing that worthwhile jobs had been concluded in an area devoid of military engineering tasks for a considerable time, possibly since the closedown of Christmas Island. It is a sad reflection on E&M work within the Corps that it was in this part of the world, around twenty years earlier, that the last major project involving HV electrical distribution was concluded.

* * * * *

End of an Era

BRIGADIER D J LONDON OBE, FBIM, FAAI

The Author was commissioned from Sandhurst in March 1946 into the Gloucestershire Regt having previously served two years in the ranks and also having held a Lord Lieutenant's Commission in the Army Cadet Corps for two years prior to that. He transferred to the RE Postal Section in 1950, having previously served in Palestine, Cyprus, Greece and Austria, and since then has seen service in BAOR, East Africa, Aden, Cyprus with both British and UN Forces, SHAPE and also in the UK with 3 Div and MOD. He assumed the appointment of Director of Postal & Courier Services in August 1980 having been Deputy Director for three years before then.

On Her Majesty's Service

READERS will have no doubt noted the announcement in the National Press on Friday 4 July quoting Mr Channon, Minister of State at the Civil Service Department, to the effect that "Official Paid" post is to end. The official press release stated:—

"As part of Sir Derek Rayner's campaign against Whitehall waste, the envelopes used by Government departments will be replaced by stamps, franking machines and printed postage impressions. The aim is to cut the Government's £100 million a year postage bill.

A Civil Service Department spokesman said the standard pre-paid official envelope costs 11·538 pence and some 504,923,000 of them were sent out every year."

It is interesting to note that the cost of operating the MOD Official Mail Service is set at £7·097 million in 1980 estimates.

Appreciating the acute disappointment which all public-spirited Officers will experience at not receiving their at least twice yearly "OHMS—Official Paid" letters from the Department of Inland Revenue, the first with their Tax Return form and the second and subsequent ones with reminders and demands etc, this brief article endeavours to set out in general terms what the Forces Postal Service has in mind to fill the yawning gap left by the withdrawal of the much loved and much abused "Official Paid" facility.

Obviously, the Ministry of Defence is every bit as concerned with the phasing out of the "Official Paid" facility as other Government departments. In fact, the Forces

End of an Era
Brigadier D J London FRIM FAAI

Postal Service had as long ago as early 1978 been considering this very aspect of postal business in conjunction with MOD Common Services Division, and had commenced a preliminary study of the matter in August 1979 (Joint DCI 5–80).

The results of this preliminary study attracted a certain amount of attention and earned the following mention by the Minister in the Debate on Defence Estimates, as reported in *Hansard* 1188 of 29 April 80:—

"In a major executive Department like the Ministry of Defence there is a constant process of review aimed at improving efficiency and cutting out waste, which rarely hits the headlines. I should like to mention such a project, a review of postal and mail services. A small team of experts has been systematically going round establishments identifying means of meeting their postal requirements in the most economical way. In the last six months they have clocked up economies worth perhaps £400,000 a year. This is only a start."

The Minister was correct when he said "This is only a start" for since the completion of the initial study there has been:—

(a) A declaration by the Post Office to the effect that the "Official Paid" service is to cease on 1 April 1982, and,

(b) The setting up of the formal MOD Working Party (PAO 17/80) and census (Joint DCI 14/80) to study and recommend the methods which should be adopted to replace "Official Paid".

The Working Party has as its wider aim the coordination of all available MOD services to produce an integrated Official Defence Mail Service (ODMS) network covering the United Kingdom and linking with existing official mail services to overseas commands and stations. Its terms of reference conclude:— "that within the MOD there exist facilities which could be utilized to provide an integrated Official Defence Mail Service to the advantage of both service and civilian units and establishments at considerable reduction in operating costs." The Working Party is to report with recommendations in January 1981.

Ideally, the new system will produce no additional bill for manpower or transport but will aim at a redistribution of existing resources to accomplish the objectives—after all, the MOD will surely not be increasing its output of official correspondence—by the establishment of central mail collecting points within main areas of MOD population and interest in the UK. A simple analogy is the existing method for the distribution of mail throughout the BAOR accomplished by linking a series of distribution points (FPO's) within a system of connecting trunk road services.

Obviously within the UK no MOD system can achieve the door-to-door delivery standards provided by the Post Office and there will remain a need for official correspondence addressed to destinations not served by ODMS to be carried and delivered by the Post Office. How this is to be paid for is currently subject to negotiations with the Post Office but it seems apparent that a combination of methods involving postage stamp accounts, meter franking, business reply licences and in some cases, involving bulk posters, negotiated contracts will be needed. Accounting systems to accommodate all methods will of necessity have to be devised as will training programmes for those involved in the application of new systems.

Planning is now going ahead to effect the introduction of a pilot ODMS service throughout the South West of England which will involve HQ's, units and installations of all three services and the PE. Experience gained from this exercise will point the way ahead for the complete revision of the "Official Paid" service which will certainly follow.

Several things are certain—with the goodwill, cooperation and support of the staff and members of each Service, considerable savings in the cost of official mail can be achieved, standards of official mail transmission improved and the dependence on agencies outside the MOD considerably reduced.

It is coincidental that the year 1982 will see the centenary of the formation of the "Army Postal Corps" and fitting that such a major change in official postal services will mark the anniversary within the Ministry of Defence.

A Pull-out Test for the Quality Control of Sprayed Concrete

CAPTAIN A H DOUGLAS RE B Sc

The Author was commissionged into the Corps from Sandhurst in March 1973. After his YO Course and a short period as a project officer with 36 Engr Regt, he was posted to BAOR and served for a year as a Tp Comd in 35 Engr Regt at Hameln. Three years at RMCS Shrivenham led to his graduation and his current tour as a Tp Comd in 37 Fd Sqn 4 Armd Div Engr Regt.

INTRODUCTION

The Dinorwic Pumped Storage Scheme is under construction at present for the CEGB (Central Electricity Generating Board) in North Wales. Extensive use has been made of sprayed concrete, in the underground caverns and tunnels in particular. No method had been found of satisfactorily and economically determining in situ strength of the relatively thin sprayed concrete layers (typically 20–50mm thick) and this subject seemed, therefore, to be an interesting topic for my final year project at RMCS Shrivenham.

The paper which follows describes sprayed concrete and the test which was developed for determining its strength. Most of the practical work was carried out on site in the laboratory of James Williamson and Partners, Consulting Engineers to the CEGB. Additional tests and the written work were completed at Shrivenham during the academic year 1977/78.

SPRAYED CONCRETE

Sprayed concrete is a mixture of cement, sand, coarse aggregate and water delivered by compressed air through a nozzle at a high velocity. It has been under development since the early 1920's (the original gun was invented by Karl E. Ackley in 1908). There is often a confusion over terminology and many proprietary names such as *guncrete* or *flungcrete* are used. Guniting is the term used for spraying mortar (aggregate size less than 10mm); sprayed concrete, therefore, is defined as having an aggregate size greater than 10mm.

THE SPRAYING PROCESS

There are two different methods of spraying concrete. The first has been practised longer and is called the "dry mix process". Here the water is added to the mix at the nozzle in the form of a fine spray and hydration therefore occurs in the surface. This method requires a well graded aggregate, a skilled operator—as he controls the water flow rate, and careful control of the moisture in the aggregate before it is sprayed (this should be between 2–5%).

The "wet mix process" is a more recent innovation popular in America. In this process, water is added to the cement before the concrete is conveyed to the nozzle. Initially, it was found that powder accelerators could not be used. It does, however, have several advantages over the dry mix. There is less rebound, probably because

A Pull-out Test for the Quality Control of Sprayed Concrete
Captain A H Douglas RE Sc

Photo 1. Tester 4 with studs and sprayed concrete mould

hydration has taken place earlier; the dust problem is reduced; and the quality of the work no longer depends on the nozzle man.

Admixtures are often used with sprayed concrete. They are mainly in powder or liquid form and are normally used to reduce the setting time. Reinforcement can be used in the form of bars, mesh or fibres. The gun can either be held by hand or by a remote controlled robot.

USES OF SPRAYED CONCRETE

Sprayed concrete is particularly useful where strong, thin overlays are required. Tunnels can be lined using this process in conjunction with rockbolts producing a quick and relatively inexpensive lining compared with conventional concrete or steel arch ribs. Quick local repairs can also be carried out as spraying concrete eliminates the need for shuttering. Railway tunnels can be strengthened and embankments lined giving structural support combined with an increased fire and frost resistance. Applications of the sprayed concrete process range from negative buoyancy for pipelines to skate-board tracks.

TEST METHODS

Testing concrete can be carried out either in a laboratory or on site. Laboratory tests tend to be more accurate but take longer and are more expensive than in situ methods which give results which generally have a wider scatter. Sprayed concrete presents several problems when one is faced with determining its characteristics. Standard tests can be carried out on individual ingredients, but due to the inherent variations in the spraying process, accurate laboratory testing does not necessarily correlate with the finished in situ concrete. Each layer has an effective maximum thickness of about 50mm—after which spalling occurs. This makes the cutting of cores or cubes difficult to achieve as a core used to determine compressive strength should be about 100mm deep.

Because the process is very quick an equally fast method of maintaining quality

A Pull-out Test for the Quality Control of Sprayed Concrete (1)

control is required. Spraying moulds and cutting cores from these moulds was the method used initially, but this took too long and was not necessarily representative. The following method was developed from a paper by Stig Sallstrom of the Swedish State Power Board who used a shot bolt test to produce a correlation between pull-out force and depth of penetration with compressive strength. Various other subsidiary experiments were also carried out to substantiate this main theme of an indirect non-destructive test.

TEST DEVELOPED

A progression of thoughts and experiments advanced through the following stages to the final method statement being produced. First of all the cartridge and stud used in the *Hilti* bolt gun had to be determined. Then the test was developed. Six studs were fired into the test area. These were then pulled out using a "Hilti Tester No 4". An average of the six results was obtained and recorded along with the compressive strength taken from a core in that area. Test areas included sprayed panel moulds and in situ areas both in the underground caverns or tunnels and above ground. The sprayed concrete areas were up to three years old. Investigations were made into the relationship between pull-out force and age by making up twenty-four cubes of a mix similar to sprayed concrete. Eight of these cubes were tested after being cured for 7, 14, 28 days. Four were crushed to test compressive strength, and the other four had studs fired into them. A statistical and theoretical analysis of the results was then carried out.

RESULTS

A graph of pull-out force against compressive strength was drawn up and a computer analysis then followed. Various factors such as age, strength, orientation and density were considered. Eventually a linear regression was found up to 25Nmm^{-2} between compressive strength and pull-out force. The theoretical analysis did not give a good correlation with the results obtained in practice. The pull-out force should be proportional to the Young's Modulus and Poissons Ratio of con-

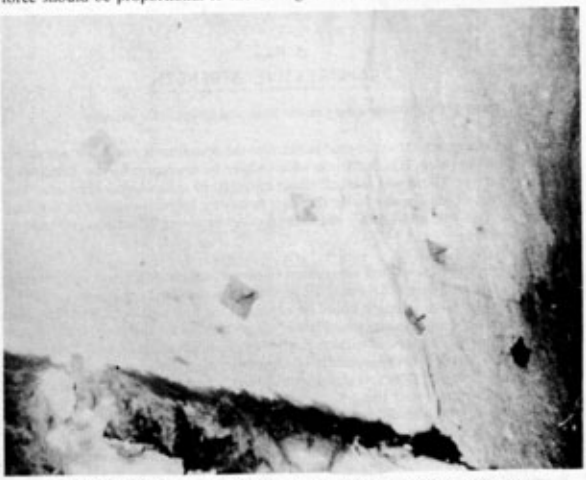


Photo 2. Wall of underground cavern showing sprayed concrete and rockbolts

A Pull-out Test for the Quality Control of Sprayed Concrete (2)

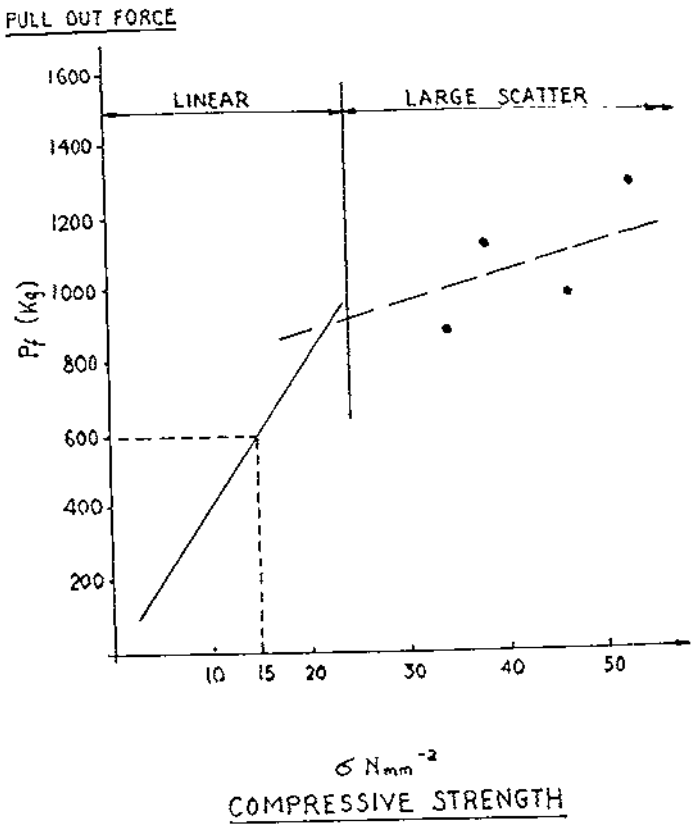


Photo 3. Graph comparing pull-out force and compressive strength

crete. It would appear that as the stud penetrates the concrete, it exerts a stress which in turn holds it in place. It is this stress which has to be overcome by the Tester as it pulls the stud out. There was a much closer correlation with weaker concrete. The reason for this would appear to be that it is behaving more elastically as the stud squeezes the concrete apart rather than impose the shattering effect it has on harder, stronger concrete.

CONCLUSIONS

The pull-out test gave a good correlation between pull-out force and compressive strength for concrete up to 25Nmm^{-2}. Beyond this the standard error increased but a minimum compressive strength could be obtained for any pull-out force. The test proved quick and simple to carry out. It was also relatively inexpensive. It should be useful therefore as a method of quality control to pin-point areas of weakness which require more detailed investigation. At Dinorwic, the specification for sprayed concrete was 15Nmm^{-2}. The test should prove satisfactory in determining whether a sprayed area complied with this.

The theoretical analysis did not concur with practical considerations owing to the inhomogeneous nature of sprayed concrete and the ballistic effect of firing the stud.

The "Tester 4" could be modified with a more accurate dial and an easier winding handle.

Further work would prove useful in the following areas. First of all other ranges of

studs and cartridges could be tried to discover if a better correlation exists. Further analysis of the stud penetration might yield more information on the theoretical considerations associated with pull-out force. Other parameters such as moisture content, shear strength or tensile strength could be considered. Further tests should be carried out to substantiate this project's findings. Overall, however, the author had the satisfaction of being able to study a subject in depth, develop a test and find that it produced reasonable results.

Hydro Seeding

CAPTAIN G J F PRICE RE, B Sc

The Author read Applied Physics at Lanchester Polytechnic and since joining the Army has served with The Queen's Gurkha Engineers who undertake projects on behalf of Hong Kong Government in support of Anti Illegal Immigrant Operations on the frontier with China. He is currently with 3 Trg Regt RE.

A RECENT project I undertook in Hong Kong introduced me to new techniques of site stabilization and rehabilitation.

67 Gurkha Field Squadron have recently completed construction of a frontier base at Yung Shu Au in the New Territories of Hong Kong. The site of the camp lies within an area now designated as a country park. One of the conditions under which land was approved for Army use was given in the following text:

"All cutting and/or filling slopes within or adjoining the lot shall be turfed, stone pitched and/or landscaped to the satisfaction of the Secretary for the New Territories. For the purpose of carrying out such works, chunam or other plastering works shall not be used, except with the prior written approval of the said Secretary and under such terms and conditions including the colouring of such chunam or other plastering works as may be imposed by the said Secretary".

The project required the opening of a borrow area from which fill was used to reclaim part of the village fishpond. The local geology is shown on the 1:50000 Geological Map of Hong Kong as being part of the Repulse Bay Formation, in which two similar components RBs and RBp are present. The rock types encountered in the borrow area showed the following general characteristics:

RBs—predominantly sedimentary rocks and water laid volcaniclastic rocks.

RBp—dominantly pyroclastic rocks and some lavas.

The type of weathering typical of this type of rock produced sand, gravel and boulder-sized fragments in a soil matrix. In lay terms, the apparently solid red granite-coloured rock found beneath the surface quickly weathers to an unstable "soil" in which the fines are soon washed away by heavy tropical rainfall. Typically, cut slopes in the Colony suffer from internal erosion once the drainage pattern is

Captain G J F Price RE Sc

Photo 1. The type of soil on which the hydro-spraying was attempted. Note the coarseness of the material

disturbed and they often fail. The classic solution in Hong Kong has often been the use of "Chunam", a costly and unsightly plastering of the slope to protect it. Chunam is often used in conjunction with costly drainage.

There was no critical requirement to stabilize the slopes of the borrow area, but the requirement to restore the site to an aesthetically pleasing level was still challenging.

A recently introduced technique, of Japanese origin, involves the "planting" of

Photo 2. The growth one week after seeding

Hydro Seeding 1 & 2

Photo 3. The borrow area cut slope two weeks after seeding. Note the temporary boards erected to prevent wash-down of fine material

Photo 4. The lush, thick growth that formed on good top soil three weeks after seeding. Even black and white the almost surreal difference in colour is just noticeable

Hydro Seeding 3 & 4

grass seeds in a base which is enriched with fertilizer and nutrient. The method of application varies but it is possible to spray the seed and its base in a fine spray of water giving the name "Hydro seeding".

Grass seeds are mixed with a chemical soil stabilizer, a soil solidifying agent, mulching fibre, fertilizer and fresh water. Bitumen and asphalt emulsions were used in the past, but recently various plastic and resin emulsions have been developed.

The fertilizer is typically made up of a high nitrogen slow release component, CDU (Crotonylidene Dieuea) and an organic "instant" nutrient for accelerated grass growth. The soil conditioner, basically an adhesive, is composed of SiO_2. $A1_2O_3$, $CaCO_3$, and adhesive. The seeds and chemicals are sown on "Mulch", a soft straw fibrous material soaked in "Royal Jelly", another nutrient which also prevents water evaporation and protects the seeds from the sun.

These materials are sprayed on to the slopes in a jet of water. To assist the operator in obtaining uniform cover a green dye is added which persists on the soil for two or three days.

The technique will produce grass cover on fine material (topsoil) of a depth of 10cm. Under the conditions we encountered, a depth of about 2cm produced luxuriant growth, whilst that sprayed on soil surfaces at random produced about 50% cover.

Another related technique uses a non-woven cotton lint material as a net. When the seed has been sown the net is pegged down and watered. As water is sprinkled on the net it sticks to the surface and seeds germinate and penetrate through the net. The advantage of this technique is that limited stabilization is achieved even before germination of the seed.

Both of these techniques are now widely used. The cost at less than HK$10 per square metre, (about £1 per m^2), is significantly less than that of turf and "green cover" and limited stabilization is quickly achieved.

TICRE hold copies of the technical literature I received on this subject.

The Fortification of the State

THE BALANCE BETWEEN POSITIONAL DEFENCE AND MOBILE DEFENCE

GENERALMAJOR BIERMANN
(Edited and translated by Lieut Colonel R D Garnett MBE)

Extracts from a Paper written by Generalmajor Biermann, at the time Colonel in the Directorate of Fortifications in the Wehrmacht, and presented by him on 27 June 1941.

General Biermann was not only one of the chief architects of the Westewall (Siegfried Line) but also carried out detailed investigations into the design and effectiveness of fortifications erected in Belgium, Czechoslovakia, France, Greece, The Netherlands, Poland and Russia, and subsequently overrun by German forces. The following is based on the final part of his paper where he considers how Germany, located in the middle of Europe, can best secure her territorial sovereignty in the future. With only a little adaptation for the passage of thirty-nine years, his proposed concept of defence has a remarkably modern ring.

Fortifications as much as cannons are weapons in the hands of a commander who understands them.—Napoleon.

To the old duel between *Wall* and *Gun*, a third party has appeared—the *Motor*, whether on land or in the air.

The biggest danger is attack by the air forces. They spring over all ground defences on the borders and can appear suddenly and everywhere, whether with air-landed troops or with bombing attacks.

Of considerable interest in this respect is the system of territorial defence of the Tutonic Order in Prussia during the 14th Century. Everywhere in their territory were

the restless and hostile population of the Pruzzen. The problem was to secure the complete territory, not just the borders. In consequence one finds castles separated from each other by a day's march, that is 20 to 25km. They are always on tactically important points; for instance on trade routes, on commanding heights, on navigable rivers and in defiles. They could communicate with each other by visual signals and, if necessary, hurry to provide mutual assistance. After a day's ride a travelling Knight could always find a safe rest. In total there were 100 castles.

This type of area defence is important today since airlanded forces can cross the mightiest border wall and land at important traffic points, near administrative centres or industrial areas and create total chaos just as once the Pruzzen did. What counter measures are possible? Probably one has to take similar measures as the Tutonic Knights so that even in peace there are permanently manned air defence centres in the form of armoured and mobile forces in addition to alert anti-aircraft weapons and fighters.

The barracks must be carefully selected and suitably constructed. The troops allocated must always be available and, in the event of mobilization, remain in place. Naturally a balance between the importance of, and threat to, particular objects and areas is essential following a careful analysis of the question.

Turning to the problems of permanent preparations against the ground threat, one has, as a first priority, to deal with mechanized forces. Armoured forces, in surprise attacks, will breakthrough every weak point of a fortified front, fan out from the breakthrough, thrust deep into the rear areas, break all important communications, destroy military and economic installations, paralyze the administration and spread panic amongst the population. What can be done against this? Create powerful obstacle areas in depth, of uniform strength and using the natural advantages of the terrain, such as rivers, lakes and mountain ridges. Consciously to leave weak areas is unacceptable. A chain is only as strong as the weakest link; a bridge will only carry the load of the weakest span. Anti-tank obstacles should be covered by anti-tank fire from the flanks from bomb proof positions. The fire positions covering the obstacles must not be visible from the front otherwise they will inevitably be destroyed in advance. Thick concrete roofs which project obviously above ground level should be avoided and replaced by armoured plate. Armoured turrets stuck on top of a work are impossible. Anti-personnel obstacles should be constructed against the assault troops supporting the armoured breakthrough. The anti-tank obstacles should not restrict the movement of our own forces and carefully concealed gaps, covered by mines should be left in them. Within the depth of the position one will frequently employ mines rather than mechanical obstacles and these must be so constructed that they can be made safe to allow for our own movement and then rearmed once it is over. In addition to flanking fire positions, many observation posts are required, which serve at the same time as command posts. As a rule these will be under armour. Completely secure information and command channels are a prerequisite for the control of the battle. Distributed throughout the area are bombproof shelters for assault troops who will intercept tanks and accompanying infantry that break through. In addition anti-aircraft defences should also be protected and carefully camouflaged against both ground and air observation. All these installations should be tasked, constructed, equipped and manned so that at any time and under any conditions they will not be surprised by an attack from mechanized forces; and this applies to an attack from the rear as well. Behind the obstacle area, armoured formations should be located to attack and eliminate any enemy formation which breaks through.

It is clear that the air forces and the tank can conquer but not hold what they have conquered for any length of time. To hold the ground is the task, and will always be the task of the good old footslogger, the Infantry. He must, however, cross the obstacle zone in order to reach his objective and that he can only do with the force of battle. It will come, therefore, to a forceful, heavy attack through the obstacle areas. But the obstacle areas described up to now are not constructed with this in mind. For

this task it must in all circumstances be reinforced with mobile forces and weapon systems. Into the positional defence system slides a mobile armoured fortress. How far it moves into the obstacle zone depends on where the main battle is to be fought. The remaining portion of the positional defence system then acts as covering works.

This armoured fortress consists of armoured vehicles for all arms, for infantry, for flamethrowers, for anti-tank weapons, for anti-aircraft weapons, for close support and long range artillery. What is important, however such a force might be made up, is that their mission must be carried out without any loss of time. Further armoured formations are held behind the fortified areas as a reserve.

Everything that has been developed here are thoughts as to how the future defence of the country might appear. They are not official doctrine. The Fortress Engineer has a first duty to create a clear concept in this very important area. Nevertheless a final decision on the fateful question of the future defence of our land can only be achieved by the understanding and cooperation of all parts of the armed forces, the cleverest heads in all arms and the thorough study of war experience.

The art of fortification is not based on rules and fixed forms but only upon healthy commonsense and experience.—Vauban.

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REVISED PRICE LIST FOR HISTORY OF CORPS

BECAUSE of reprinting the prices of Individual Volumes and Sets of *The History of the Corps of Royal Engineers* have been revised. The policy of the Institution is still to recover costs only from Members.

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The Bombay Sappers and Miners at Maiwand, 27 July 1880

LIEUT COLONEL C A SWETENHAM MC

Clement Swetenham was commissioned in Li C P Jones Batch (14 YO) in 1925, the first to go to Cambridge as a batch. Until 1934 he served in Fd Coys and as a GE in between riding and skiing! In 1934 his India service began. He was a member of the Quetta rebuilding team before moving to the Royal Bombay S& M. He returned to UK in 1943 and managed to join in the conflict in Europe. After a final tour in Malaya he retired from the Active List in 1952. He spent some 18 months organizing a Public School in the Punjab, a year stressing the undercarriage of a supermarine fighter, was a site foreman on building sites and then to the Sperry Gyroscope Co working on the Control System of the Sea Slug for the Royal Navy. He has had an interesting and varied life, possibly typical in its diversity of those led by many Officers of his generation.

This short article is based on the account in *The Indian Sappers and Miners* by the late Lieut Colonel E W C Sandes and extracts from RE Journals of the time. By coincidence the 1980 RE Memorial Service at Rochester Cathedral took place exactly one hundred years to the day after the disastrous, yet inspiring confrontation.

In 1878 and 1879 the Russians intensified their intrigues to instal a puppet government in Kabul which would have turned Afghanistan into a Russian satellite. After months of diplomatic representations, which were either ignored or met with evasive replies, the then Viceroy of India ordered the Indian Army to advance into Afghanistan and to reassert the influence of the Government of India. The invasion was two-pronged. The Bombay Army crossed the Khojak Pass from Quetta and the Bengal Army used the road over the Khyber.

The Bombay Army occupied Kandahar and in June 1880 the Afghan leader Sirdar Ayub Khan with 20,000 men advanced towards Kandahar from Herat. On 4 July a Brigade Group was sent towards the Helmond River to co-operate with a friendly Afghan faction, but these Afghans departed before the Brigade Group arrived.

On 27 July 1880 the Brigade Group of three Infantry Battalions, two Cavalry Regiments, a Horse Artillery Battery and a half Company of 2nd Company Bombay Sappers and Miners, attacked Ayub Khan's 20,000 men at Maiwand. Being greatly outnumbered and outflanked they soon had to retreat.

The Ghazis swept away HM's 66th Regiment (later the 2nd Battalion Royal Berkshire Regiment) who left some 10 Officers and 230 Other Ranks dead on the field, the 1st Bombay Grenadiers lost 10 Officers and 320 Other Ranks killed and 30th Bombay Infantry (Jacob's Rifles) lost 6 Officers and 210 Other Ranks killed. On the left the half Company of the Bombay Sappers and Miners, commanded by Lieutenant T R Henn RE, stood fast until all other members of their Brigade had retreated. They were the last to leave the field.

These Bombay Sappers and Miners had protected E Battery Royal Horse Artillery, enabling them to continue firing until all the infantry had retreated. The Battery

The Bombay Sappers And Miners at Malwand
27 July 1880
Lieut Colonel CA Swetenham MC

then limbered up and saved four of their six 9-pounder MLR guns. How fierce the fighting around the Sappers was at this juncture may be judged by the fact that Sergeant Patrick Mullane RHA was awarded the VC for delaying his gun's withdrawal for about a minute so as to lift a wounded Gunner onto the limber. The Gunner losses were 2 Officers and 18 ORs killed and, in addition, many of their horses were killed and wounded. Not till the Battery had followed the Infantry and Cavalry did Lieutenant Henn and his half Company withdraw in an orderly and steady sequence of fire and movement against the thousands of Ghazis. They followed the line taken by the 66th Foot. Some twenty Sappers got separated during this operation.

A party of forty-six men of the 66th Regiment rallied in a small enclosed garden at a place called Khig where they were joined by Henn with fourteen Sappers and by some twenty-three Bombay Grenadiers. The Sappers took up position along a small irrigation channel in the garden. This small group of eighty-five continued to exchange fire with the enemy until only Lieutenant Henn and eleven soldiers of the 66th were left. Henn then led this party in a final charge on the masses of Ghazis. All twelve were killed.

Later when the Army re-occupied the site of the last stand they found the corpses of all forty-six men of the 66th Regiment, twenty-three men of the Bombay Grenadiers and Lieutenant Henn with his fourteen men of 2nd Company Bombay Sappers and Miners. Leonidas and his 300 Spartans would have been grateful for such men as allies in 424 BC.

The group of about twenty Sappers who had become separated from Henn and his party joined the exhausted survivors of the Brigade and with them arrived back at Kandahar at noon on 28 July. In true Sapper tradition before entering the City they fell in under the Senior Sapper present and marched in as a formed body. They were joined in Kandahar by Subedar (later OBI Bahadur) Hassam Khan who had been wounded and had made the journey on a camel and by Sapper (later Havildar MSM) Karamat Khan and five other wounded Sappers who had been carried all the way on E Battery Horse Artillery limbers.

The Members of 2nd Company Bombay Sappers and Miners who fell at Maiwand were:

Lieutenant Thomas Rice Henn RE
Sergeant Heaphy RE
1st Corporal Ashman RE
Havildar Muhamad Khan
Naik Siuram Wanjari
Bugler Shaikh Abdulla

Sapper Biru Nikam
Shaikh Pir Bakhar
Govindrao More
Chocnak
Ramji Talekar
Siurattan Singh
Sapper Jangu Narsu
Rama Powar
Ambuji
Balnak Yesnak
Poshuti Piraji
Ithu Damu

To complete the story 2nd Company Bombay Sappers and Miners was part of the Garrison during the seige of Kandahar, 28 July–31 August, and took part in the Sortie of Deh-Khoja on 16 August where six Sappers were killed and one Indian Officer and six men were wounded. For their courage in this action Lance Naik Shaikh Abdulla, Sapper Saiyid Mohammed and Sapper Abdulla Khan were awarded the IOM 3rd Class and Lieutenant Turner Jones RE (then Commanding 2nd Company) was recommended for the Victoria Cross for his gallant conduct.

* * * * *

Freedom of Nienburg—7 June 1980

LIEUTENANT J E MARSHALL WRAC

After working as a civilian for the British Forces in Cyprus, the Author was Commissioned from the WRAC College Camberley in April 1978. Her first tour was as 2IC 18 RSME Squadron at Chattenden and from there she was posted to Nienburg in West Germany as the first A/Adjt of 1 Armd Div Engr Regt. She is currently serving at the WRAC Centre Guildford.

The Council of the town of Nienburg on the Weser passed a resolution on 26 February 1980 to grant the Corps of Royal Engineers the Freedom of the Town. This confers the right to march through the town on ceremonial occasions with bayonets fixed, drums beating and music playing in accordance with tradition. The conferment of this honour is to serve as a mark of the good cooperation existing between 1st Armoured Division Engineer Regiment and the town of Nienburg.

THUS reads the scroll, and so it was that on 7 June 1980 under the command of the Commanding Officer, Lieut Colonel J A J P Barr, 1st Armoured Division Engineer Regiment assembled on parade to accept this great honour on behalf of the Corps.

Historically, formed bodies of troops were not allowed to march through a town or city without the permission of the Council. Freedom of the town or borough might be granted to locally based troops but only after sufficient time had elapsed for mutual confidence and friendship to be established and for the citizens to be satisfied that the troops would protect their interests. In granting the Freedom of the Town to the Corps, the community of Nienburg confirmed its confidence and acceptance of the Regiment in its midst.

The Engineer connections with Nienburg go back thirty years to Holzminden where, in 1949, 21 Field Engineer Regiment was formed. The Regiment started to move to Nienburg in December 1950 and became a Divisional Engineer Regiment in support of 7 Armoured Division. The disbandment of 7 Armoured Division, and the reorganization of the Engineers in 1 (British) Corps in 1958 saw the demise of 21 Field Engineer Regiment as a named Regiment and 1st Division Engineers was founded based on the Field Squadrons of the old Regiment. In April 1969 a further reorganization of the Engineers in British Army of the Rhine took place and 21 Engineer Regiment was reformed with 1 Field Squadron and 4 Field Squadron under command. The reformed Regiment supported 11 Armoured Brigade as part of the 1st Division until March 1978. On 1 April 1978, as a result of the latest Defence Review, 21 Engineer Regiment and part of 32 Engineer Regiment joined to form 1st Armoured Division Engineer Regiment. The new Regiment took under command two additional Squadrons, 7 Field Squadron, which moved from Hohne, and 45 Field Support Squadron, which has been resident at Nienburg throughout, but not under Regimental command.

Nienburg too has an interesting history, and this picturesque North German town will be familiar to many who served with the Regiment. It is a provincial town on the

Freedom of Neinburg 7 June 1980
Lieutenant J E Marshall WRAC

Photo 1. The Bürgermeister Herr Radtke hands over the Freedom Scroll to the Chief Royal Engineer Lieut General Sir David J Willison KCB OBE MC

Weser, and lies between Hannover, the capital of Lower Saxony, and the Hanseatic port of Bremen. The town is almost a thousand years old, but as a settlement, however, it is very much older with some local discoveries dating from the Stone Age. Nienburg has always had a close association with the military, and has at some time been a garrison for Infantry, Cavalry, Dragoons and Artillery. Historically the town has been a stronghold of great significance for Nienburg has one of the Weser's most important crossing-points.

There are links too with the English Crown, George I was the first Hannoverian prince to ascend the English throne. He succeeded to the Electorship of Hannover in 1698 and in 1714 he was crowned King of England. Great Britain and the Electorship of Hannover shared a common ruler. British and Hannoverian soldiers often fought side by side; against the French in 1803, during the Seven Year's War, and in 1775 an Infantry Battalion of the Nienburg Garrison was despatched to reinforce the

Freedom of Neinburg 7 June 1980 (1)

British Garrison at Gibraltar. They returned in 1784 to a tumultuous reception, and to this day a painting depicting a scene from the last violent battle at Gibraltar still hangs in the Rathaus at Nienburg. The Union Jack Flag features prominently flying from the Men-of-War in Gibraltar Bay, and kilted Highlanders help fill the large canvas.

The construction of the Hannover-Bremen railway line in 1847 and the onset of the machine age heralded a new era for the town. The country market town, whose inhabitants had lived mainly by growing agricultural produce and by making soap, vinegar, dextrin and mustard, expanded industrially. Today its products, which include bottles, chemicals, vehicle parts and adhesives are highly rated, and its pearl-catalysts are exported to oil refineries all over the world. As well as its industry, Nienburg is a popular shopping-centre with buildings old and new standing in happy coexistence along the banks of the river Weser.

It was in a park in the midst of this lovely town that the Freedom Parade took place. The Regiment was inspected and addressed by the Chief Royal Engineer, Lieut General Sir David J Willison KCB OBE MC, and the Bürgermeister, Herr Radtke. Gifts were exchanged; for the Regiment, the Freedom Scroll, received on behalf of the Corps; for the Stadt, a limited edition Corps plate to be followed by a painting of the Parade by the artist Ken Howard. (This was handed over to the Bürgermeister by Lieut Colonel Barr at a ceremony on 13 July 1980.)

In his speech to the Regiment and the assembled spectators the Bürgermeister said that "The town's association with the Corps of Royal Engineers has been determined not only by the requirement for military cooperation between the United Kingdom and the Federal Republic of Germany, within the framework of the North Atlantic Alliance, but in a very personal way by the thirty year presence of a British Engineer unit in Nienburg and its integration into the corporate life of the town. The soldiers of the Engineer Regiment have often given us their willing support and thereby earned our thanks."

The Chief Royal Engineer replied, thanking the Bürgermeister and town for the great honour bestowed upon the Corps. "I suggest that the ceremony here today is a

Photo 2. The Chief Royal Engineer and the Bürgermeister inspect the Parade

Freedom of Neinburg 7 June 1980 2

shining example of the present state of relations between our two countries. We live in times when it is important that this lasting development should be widely and publicly recoghized."

The Commanding Officer then requested permission from the Bürgermeister for the Regiment to march through the streets of the town with bayonets fixed, drums beating, band playing and full ceremonial. "The town is open to you" was the Bürgermeister's reply. Led by the Bürgermeister and Frau Radtke and the Chief Royal Engineer and Lady Willison in an open landau, and to the accompaniment of the Band of the Corps of Royal Engineers (Chatham), the Regiment marched through the town and past the sixteenth century Rathaus where the salute was taken by the Bürgermeister and Chief Royal Engineer. There followed a reception in the Rathaus given by the Bürgermeister, and then receptions and luncheon in both the Officers' and Sergeants' Messes for several hundred guests.

It was a most memorable day, and a great honour for the Regiment and the Corps.

Osborne

BRIGADIER C R TEMPLER DSO

ALTHOUGH "Sister Agnes", King Edward VII Hospital for Officers in London, is widely known, his Convalescent Home for Officers at East Cowes, Isle of Wight receives less publicity than it deserves.

Queen Victoria built Osborne House in 1854, retired there in 1861 on the death of Prince Albert. Thereafter she stayed at Osborne House on many occasions and herself died there in 1901. King Edward presented this magnificent mansion to the Nation expressing a wish that the Household Wing should be converted into a Convalescent Home for Officers which was effected in 1904.

Here serving Officers receive *free* medical treatment and accommodation when on sick leave following an operation or other illness. Their wives can accompany them on a small payment. Retired Officers both ex Regular and Territorial, their wives and, more recently, Civil Servants may stay there for a reasonable fee. There is a resident House Governor, Surgeon Captain R S McDonald MRCS LRCP RN (Retd), and a full Nursing Staff.

Osborne
Brigadier C R Templer DSO

Osborne is renowned for treatment of afflictions of the joints, its hot bath, heated to 98°F with a hydro-therapist in attendance, has a wonderful effect on easing stiff and creaking limbs. An expert physiotherapist and exercise in the gymnasium too help recovery.

The kindly attention of the Nursing and other staff to one's needs is beyond praise, the messing is first class with a good selection of wines at very reasonable prices available. The rooms and corridors, designed and built in another age under the supervision of Prince Albert are superb. The smoking room was Queen Victoria's Privy Council Room, the Dining Room that of her Household Staff, while the Library, TV and Billiard room would put the Ritz in the shade.

But what makes Osborne so special is its atmosphere, that of a cheerful first class Officers Mess with a continuous round of treatments followed with billiards and other indoor competitions. There one is always cheered by finding someone much worse off physically than oneself and so can thank ones lucky star. Once mobile there is an occupational therapy room where one can use a wood lathe, learn to paint, make baskets and acquire other skills. Nearby is a Golf Club for pre-lunch drinks and a good 9-hole course. Yacht Clubs in Cowes also make residents Honorary Members.

To get a brochure and application form to attend, write to:

The House Governor
Osborne House
East Cowes
Isle of Wight PO32 6JY
Tel: Cowes 292511

For Serving Officers with sick leave wanting to recuperate *free* with expert medical attention and in congenial company, and also for Retired Officers, I can thoroughly recommend a visit for a week or more to Osborne.

Correspondence

Brigadier J R E Hamilton-Baillie MC, MA, C Eng, MICE
Rectory House
Stanford-in-the-Vale
Faringdon Oxfordshire

26 Field Company and the Maginot Line

Sir,—From December 1939 to May 1940 a small British force from the BEF was stationed with the French forces facing the Germans in front of the Maginot Line. This was said to be to give combat experience to the British troops but was really more for political reasons. The first formation to go was 3rd Brigade from 1st Division, whose supporting Field Company was 26, in which I commanded a section as a 2nd Lieutenant. The Company was the first unit to arrive and was billeted in Veckring Barracks, the peacetime accommodation for the Hackenberg Fort, the largest single work of the Maginot Line. The Officers of the Company were taken on a tour of the Fort and entertained to a good French dinner in its Officers Mess. After a month 3rd Brigade was relieved by another, but in March, 26 Field Company was moved to 51st Highland Division, and in April 1940 returned to the Maginot Line with 154 Brigade whom we supported in that Division. Soon afterwards the force was expanded to the whole of the Division, but in May after the German attack it was withdrawn, eventually to join the remnant of the BEF in the Somme. 26 were thus the first and last British unit in this sector and the only unit to serve there twice.

These reminiscences of forty years ago have been brought back vividly to my mind by an enjoyable if surprising event. After many vicissitudes the Hackenberg Fort has been taken over as a tourist attraction by a local civilian society "Armifort". They

decided to install a Memorial at the entrance, recording the presence of the British troops in that sector in 1939–40. I was the only British Officer they could find who had been among those troops, perhaps they had heard of me through the British Society "The Fortress Study Group".

As a result I found myself with General Vaillont, President of the Maginot Troop's Old Comrades Association and Lieut General Le Mattre, Commander of the Military District, unveiling the plaque, after which the British Defence Attaché laid a wreath. Once again I toured the Fort, and was entertained to more splendid French meals in their Officers Mess in Thionville. All the British visitors were made very welcome and it was an altogether delightful occasion, if gastronomically exhausting.

The state of preservation of the Fort is quite remarkable. All the guns are in place in working order, the disappearing turrets rise and fall, the lifts work and more than 1km of electric 60cm railway runs. A 330kVA generator, one of four standby sets started at the touch of a button. Considering that the equipment is almost fifty years old, in the poor environment of an underground fort, its condition is a tribute to the French Engineers who designed and built it, and to the loving care of the preservation society who look after it.

I strongly recommend a visit by any Sappers who find themselves in the area of Thionville and Metz. Any past or present members of 26 would certainly get an especially cordial welcome.—Yours sincerely, J R E Hamilton-Baillie.

Major A A Wilson RE
c/o BDILS (W)
British Embassy
Washington
BFPO 2

Tanks Through Trees

Sir,—In my article in the June 1980 Journal, the term "Sm" (mean tree interdistance) refers to the mean distance between a tree and its nearest neighbour in a 2-dimensional random distribution. This is a very different concept from "the average distance between each tree". The poisson distribution is used and the formula for Sm is derived by taking the first moment of the poisson probability density function. The detailed mathematics are fairly involved and I have sent them separately to Lieut Colonel Rolt. (Letter in September 1980 Journal). If anyone else wants to see them, I will be delighted to make further copies.

The result can be easily checked by drawing circles of diameter $\frac{1}{2}\sqrt{\frac{A}{N}}$ around each "tree" in Figure 5. It will be found that half the circles touch at least one other, the required condition for "mean tree interdistance". If circles of diameter $\sqrt{\frac{A}{N}}$ are drawn nearly all circles interlock with at least one other, showing that Sm is not as large as was suspected.

However, Colonel Rolt's intuition is in a way correct. The study found the NO-GO situation occurred when Sm was approximately half the width of the tank. Therefore:

Tank Width $= 2 \times Sm = \sqrt{\frac{A}{N}}$ which was Colonel Rolt's conclusion.

Eureka! Intuition triumphs over qualitative analysis yet again. It is the sort of infuriating thing that my wife does. To be honest, we had the same suspicion whilst working on the project and were delighted when we were able to show logically that our subjective judgement was correct.

I think it fair to say that "intuitive" obstacle planning has not produced such satisfying results. Has anyone yet used our quantitative method to check existing plans? I would be delighted to know.—Yours sincerely, Alasdair Wilson.

Colonel W M R Addison B Sc
Army Apprentices College
Chepstow Gwent NP6 7YG

Pioniering

Sir,—Roger Garnett is absolutely right—you don't need military engineers if you're fighting in your own country, with the total resources of the civilian infrastructure, industry and manpower under your command; if your constitution forbids your armed forces to operate outside their own country, so they can be equipped and trained for but one role; if that country is so richly endowed with roads, railways, coldstores, reservoirs, oil farms, generators and installations of every conceivable kind that the chances of battles being lost because of the lack of them are remote; if it were certain that the war once lost could never be refought, because the base for doing so would have disappeared and your forces and military engineers with it; if your country understands and likes engineering, instead of being proudly ignorant of it; if there is a national system producing large numbers of well-educated, broadly-based engineers and apprentices who can turn their hands to anything.

Of course you don't need military engineers if the entire infrastructure of the country in which you are fighting is already operated by professional civilian engineers far more competently than imported military engineers could ever do it—and if patriotism isn't enough to keep the civilians at their posts, a simple decree can convert them all into soldiers for the duration, without having to put them on the square or the range, or even into a uniform.

But you can't have a *levée en masse* in a country which is not your own—and our own is the least likely one in which we will have to fight. (Though perhaps that isn't as certain as it was; how many airborne divisions does the USSR have? Eight, I think, plus two and a half thousand transport aircraft; five naval infantry brigades with eighty-five amphibious ships?).

Who is going to restore the shattered infrastructure of post-strike Europe? The Germans for Germany surely, but what resources will they be willing or able to provide to look after the British Army on the Rhine when they have their own armed forces several times our size, and their own civilian population, to look after?

In any case, could it not be argued that an attack through central Europe is the least likely of all for the Soviet Union to make. It is the thing to which our imaginations are geared of course, and indeed the *only* thing to which some soldiers' imaginations are geared. If the Russians have learnt anything from their three revolutions, two world wars and one civil war within living memory, it is firstly the value of surprise, and secondly the need to avoid immensely costly battles of attrition between massed armed forces, and instead take the indirect approach. Why we are obsessed by the central front when the Russians are on the Red Sea in the Horn of Africa, and very nearly on the Gulf after their successful expedition into Afghanistan, I have no idea. We are still throwing the *Financial Times* out of the window to keep the elephants down in North Germany, while they're busy trampling down the vineyards in South Yemen.*

I wish I was as confident as Roger when he says "the tactical commander we are talking about lives in all probability in Germany. That is where the rest of the field army is going. Our commitment to the flanks of NATO are minimal. . . . The rest of our nineteenth century empire, with its jungle, swamp, desert and bad water to be pumped to hilltops has gone." The empire may have gone but the competition for allies, resources and markets that led us into the wild places of the earth is now, if anything, greater than it was. We withdrew from the Gulf a few years ago to save a few millions; what would we pay to be back there now? Is it utterly inconceivable that the British Army will find itself not on the Rhine but the Rajang, the Ross or the Red Sea?

Now to move from a dozer to a demolition slab is easy, and from being a steel

erector to building a MGB. It takes a matter of weeks to train a combat engineer, a matter of years to train a tradesman. Even so civilian engineers are not military engineers: they are specialists in fine engineering whereas we are generalists in coarse engineering. Who is going to have the knowledge of what engineering support a fighting army needs, and the imagination, flair and drive swiftly to restore shattered plans and shattered installations? An everyday civilian engineer—your local PSA DWO for example? Where are the tradesmen who will work all hours in all weathers on any job coming from? Can you see your friendly neighbourhood electrician happily lying on his back in the mud with a spanner, helping a fitter get some damaged equipment working?

Military engineering *is* different from civilian engineering, and it encompasses far more than what is now, quite wrongly, called combat engineering. We may not be very good at it, but the answer is not therefore to abandon it entirely, as Roger advocates; we don't stop shooting because we are not very good at that either.

Soldiers of all people must never close their options—for sure as hell the enemy will go for the others, because that's his job; and if he doesn't Macpherson will.

North Germany is a tiny part of the world, and "combat engineering" is a tiny part of military engineering.—Yours sincerely, Mike Addison

* *Editor's Note:*—The allusion is to the Surrey commuter who threw each page of his paper out of the train when he finished with it—"to keep down the elephants". When his neighbour remonstrated with him he replied "well it works, doesn't it"!

Major J A Jennings-Bramly RE, MA, MICE
and Lieut Colonel B R Rawlings RE, FICE, FI Plant E
Civil Engineering Wing
Royal School of Military Engineering
Chatham Kent ME4 4UG

Sappers Fit For War

Sir,—It is to be hoped that you will allow space to answer charges seemingly implied but not stated by Lieut Colonel Garnett in his thought provoking letter from the German equivalent of the RSME.

The implication is that artisan training is not necessary in the Royal Engineers. He may be correct in his belief that aspects of certain trades are more important than others to the Priority One Role as he understands it; which those might be could be argued long and hard.

It is only after discussion with Lieut Colonel Bannwart (the FRG LO at the RSME) that we dare comment upon the Bundeswehr. As a Conscript Army the Bundeswehr have totally different training requirements and problems but they do believe in the value of artisan skills within their Pionier Battalions. The German educational system and craft apprenticeship scheme also differ greatly from ours: they are able to recruit qualified apprentices in appropriate trades directly into their Army. The period that these recruits spend in uniform is naturally devoted to Combat Engineer training. In the event of "call-up" the soldier may be expected to possess competent skills in combat engineering and an artisan trade. The regular Sapper element of their Army does receive adequate training to supervise their Sappers in construction works, where necessary "PQE" Officers being involved. One should not forget the words "fur Bautechnick" in the name of their school. One could argue that the Bundeswehr commitment to construction engineering in war is greater than our commitment in this direction within BAOR, even allowing for our Engineer Works Organization. The VBK must of course be included in this comparison.

We like to think that the Royal Engineers are pioneers in the very best sense but

there are other ways in which the word is used. No doubt the German Sappers had similar feelings when choosing to call themselves "Pioniers".

However, the point of this letter is to suggest very strongly that, while we are probably right in gearing the establishment of BAOR Sapper units to combat engineering, the members of those units must be able to improvize. Many useful improvizations will be possible with minimal equipment and few materials given a breadth of engineer understanding, and familiarity with what looks adequate for its purpose. This is not learnt without taking a wide interest in engineering methods ranging from boy scout style "works" to the use of fairly advanced and modern methods and materials. The regular Sapper Officer who limits himself and his men to practicing the skills necessary to operate modern "meccano" style equipments may get good chits on exercise, but is surely not the Officer of most worth in a tight situation requiring an "engineers answer". That is what we are paid to give.—Yours sincerely, J A Jennings-Bramly and B R Rawlings.

Major G Young MBE
6 Dane Court Gardens
St Peters
Broadstairs Kent

Darland Boys

Sir,—I recently attended a Corps Guest Night at the Headquarters Mess and during the course of the evening realized that probably the last two "Darland Boys", namely Gordon Ramsey and Alfred Wilkinson were about to leave the service.

As the years go by now would seem to be a good time to find out how many of us are left. There were only about 600 of us so a reunion of some sort may be appropriate. It would not be possible to hold it in the old Barracks as these are being demolished. Incidentally the Barracks are probably better known to Corps members as Gordon Barracks, Gillingham. If any of your readers are "ex-Darland" would they contact me at the above address and additionally of course if the whereabouts of any more are known to your readers they too may like to get in touch.—Yours sincerely, George Young.

C S Smeeton Esq
Glan Aber
Newbridge Road
Ambergate Derbyshire

Searchlight Electric Tramcars 1915–17

Sir,—I have for several years been seeking information on the period in the Great War between 1915 and 1917 when, with the Zeppelins preparing their offensive, the War Office set about establishing a ring of searchlight units around London, which involved the requisition of various kinds of mobile and fixed platforms for lights and equipment with which to operate them.

One very little-known aspect of this operation was the requisition of a number of London electric tramcars, on which lights were mounted with generating and messing equipment in the lower saloons. Some well-documented examples were the two Ilford trams and two belonging to Croydon Corporation. Ten trams altogether were requisitioned.

There were, however, a number of "Company" owned trams which were taken over for these duties: research at the Imperial War Museum and the Public Record Office indicates that some of these were stationed at Canons Park and Southbury

Road, Ponders End in Middlesex, and at Barnet just inside Hertfordshire. The Barnet example is particularly interesting as this light at one time held in its beam the Zeppelin which was shot down by Lieut Tempest in 1916 and its crew are buried in Potters Bar Churchyard.

Unfortunately no record can be traced of these "Company" trams: In *A History of the War in the Air* published in the 1930s they are briefly mentioned with the Ilford and Croydon cars as "six cars belonging to the Metropolitan Electric Tramways". The MET had at the time, some 312 trams, all of which as far as can be ascertained were in service during the period concerned. This by logical deduction points to the possibility that the "MET" cars concerned, although stationed in the MET area, were a number of cars of a similar type, belonging to the associated London United Tramways, some fifty of which were at the time stored out of service because they were surplus to LUT requirements. Neither the MET nor LUT records mention any of their cars being requisitioned, but as Companies operated in a different manner to Local Authorities this is not at all unlikely.

I am completing a detailed history of the tramways in the Northern half of London and wonder if any of your readers who served in the Tyne or London Electricals and had anything to do with searchlight trams in Barnet, Finchley, Hendon, or nearby places would be good enough to communicate with me on the subject?

My book is to be published by the Light Rail Transit Association and is one in a series of histories of tramways in the Greater London area.—Yours truly, C S Smeeton.

* * * * *

Memoirs

MAJOR GENERAL SIR A DOUGLAS CAMPBELL KBE, CB, DSO, MC COMMANDER LEGION OF MERIT (USA)

Born 20 June 1899, died 3 April 1980, aged 80

ALEXANDER DOUGLAS (PAT) CAMPBELL was a good Ulsterman—red haired, fierce, urgent and not to be lightly crossed but at heart kindly, human and full of sympathy for those in trouble. Educated at Cheltenham College, "The Shop" and Queen's College Cambridge he was in time to see action in World War I and to win the Military Cross as a Sapper Subaltern on the Western Front at Cambrai. Normal Sapper postings followed; a tour with the Royal Bombay Sappers and Miners in Kirkee and Quetta, a Supplementary Course at Chatham, an Instructorship in the Construction School there and then, in the 1930's a tour on the E-in-C's Staff at the War Office—all good preparation for what awaited him in the Sapper world in World War II.

In 1940 he was in Western Europe on the Staff of the E-in-C, BEF, and won a Mention. After a spell of bomb disposal in the blitz he went to North Africa and won distinction there—and a DSO—as Chief Engineer of IX Corps. 1944 saw him back in the West as Chief Engineer I Corps for the invasion of Normandy and this led to the appointment of Chief Engineer Second Army. As such Pat achieved his greatest success in the preparation and development of the Engineer plan for the assault crossing of the Rhine by XXX Corps and the follow-up by the remainder of Second Army. He was meticulous to a degree and this was a task which suited him to perfection; the great success of the operation owed much to him. Pat always had to see for himself so he was to be found well forward, often in situations of considerable danger. His courage was high.

The end of hostilities in Germany saw Pat switched to the Far East where he joined Fourteenth Army as Chief Engineer to take part in the Engineer planning for *Operation Zipper*, the sea-borne assault on the Japanese in Malaya—which thankfully, because of the Jap surrender, did not take place as a shooting operation. Next came a couple of pleasant years as Chief Engineer MELF before being appointed Engineer-in-Chief at the War Office. He held that great office with success and satisfaction from 1948 to 1952.

A Sapper by taste, and employed as such all his time, he was now recognized by the soldiers in high places as something more. In 1952 he was appointed Vice-Adjutant General at the War Office and this led on to Command of Aldershot District which he held from 1954 to 1957 and which, together with what had gone before, won him a well deserved KBE.

Campbell retired in 1957 and was immediately given the pleasant appointment of Lieut-Governor of the Royal Hospital, Chelsea which he both loved and graced. Normally he would have retired from that in 1961 but to ease the entry of General Sir Frank Simpson on the latter's assumption of the Governorship, he stayed on an extra year despite thereby losing the chance of various lucrative and attractive jobs in Industry. That showed the unselfishness of the man. Pat retired altogether in 1962

Major General Sir A Douglas Campbell
KBE CB DSO MC Commander Legion of Merit USA

but continued his active interest in Service Charities, in Education and in the Church—all causes helpful to the Army.

That is a mere catalogue of the highlights of his career but there is more to be said. Pat was quick to anger but equally quick to forgive. He could frighten those on his staff—and would too!—if they failed to stand up to him. He never suffered fools gladly.

He was a real family man and the key to the happiness of the family was Patience whom he married in 1933 and who followed the drum faithfully and successfully throughout Pat's career.

It was a shattering blow when, in April 1945 and starting to plan for the post-war task in Germany, he suddenly heard of the death in action of his Sapper son Roy, who was already making an impact with the Guards Armoured Divisional Engineers. However, he had the strength of character to put this disaster behind him and to carry on.

Pat was human, kindly and understanding though some failed to perceive these qualities unless and until they got to know him well. He showed them in a variety of ways—by coming back to London from a visit to the battle area in Korea and being at pains to contact and reassure a wife anxious about her husband so far away and in danger, by his thoughtfulness for those under his command, by his appreciation of the bodily and spiritual needs of the high spirited and adventurous young. When E-in-C early in 1950 he was approached—not too hopefully—by a member of his staff with a request for open-ended leave (on full pay, of course!) to grasp the opportunity, in company with his wife, of sailing the Atlantic in a suitable yacht, all found—a sporting venture of some considerable risk in those early days on the Northern Ocean. After assuring himself of the soundness of the project the E-in-C's reaction was immediate, enlightened and very human—"Excellent training, have a good time, wish I were in your shoes".

Campbell was a convinced Churchman and a real Christian. Throughout his service and after retirement he interested himself in Church Affairs, in Service Charities and in Education. Particularly he took a great interest in and played a continuing part in the Army Benevolent Fund, the ATS Benevolent Fund, the Sandes Soldiers' Homes, The Cheltonian Society, the Royal School for Daughters of Officers of the Army, The Gordon Boys School, Newells and Desmoor School. He was a member of the Officers' Christian Union and of the Soldiers and Airmen Scripture Readers Association. He was constant in the service of others.

Pat was a Colonel Commandant RE from 1958 to 1964 (Representative in 1960) and was President of the Institution of Royal Engineers 1957–61. He was Honorary Colonel of Queen's University Belfast OTC from 1959 to 1964, a notable compliment.

Altogether he was a proper man—able, powerful in character, efficient, conscientious and successful but full of kindliness, thoughtfulness and humanity. His widow, two sons and a daughter survive him.

CPJ

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MAJOR C C PARSONS RE, B Sc

Born 30 July 1939, died 6 March 1980, aged 40

CHRISTOPHER CLERE PARSONS was born in 1939 into an Army family, a family which had been in the service of the Crown for several generations. It was natural that after his schooldays at Bradfield he should go to Sandhurst and be commissioned into the Royal Engineers in July 1959. He served in various Regimental and Staff appointments in many parts of the world; UK, BAOR, Malaya, Cyprus, Dhofar, Borneo, Malta and Kenya. He went back to Sandhurst, his last appointment, as a Chief Instructor with a broad spectrum of experience behind him and more widely travelled than most.

Christopher led a particularly full life. For years he had derived much pleasure from and demonstrated considerable skill as a sailor, mountaineer and skier. He was a knowledgeable lover of good music, a versatile pianist and additionally was endowed with a particularly fine singing voice. His good humour, sense of fun and of the ridiculous shone through all these activities. It is no wonder that he was at his best with the young for whom he was responsible.

As Chief Instructor of Victory College it wasn't long before he was stamping his unmistakeable mark on the training. He was the key figure in introducing the concept of sending newly joined graduate Officers into the wilderness of Otterburn during the first week at Sandhurst in order to focus training from the start on leadership and self sufficiency. His influence for good extended far beyond the confines of his office. He was a man of deep faith who had come to faith in Christ slowly, after considerable thought and with much humility. Through the Officers Christian Union he had a profound influence on a great number of people struggling to find a purpose in life in what many would see as a godless age. Never a stern moralizing Victorian, the twinkle in his eye revealed that although he regarded life as a serious business, it was by no means as unremittingly serious as all that. The Christian life was integrated within him and reflected in all he did. He set a wonderful example but did not thrust his beliefs upon those with other convictions.

Christopher loved mountains and enjoyed nothing better than transmitting this passion to others. His stamina on the hills was prodigious and most of his companions had to settle for a pace somewhere between the gentle hike they had been anticipating and the uninhibited mountain goat they found themselves emulating. In this, as in so many things, Christopher led from the front.

Why was he skiing alone when he died? The challenge of extreme conditions, often faced by mountaineers, exercises not only skill and physical strength but virtues of moral and physical courage. The sport is stretching and upbuilding. Solo mountaineering takes these qualities a stage further, the risks are greater and the calculations must be finer.

To Christopher the Army wasn't just a job, it was a vocation. If he held some of his views passionately it was because he cared deeply and because he found shallowness and mercenary attitudes abhorrent. In all respects he was an interesting, colourful, talented and effective Sapper Officer.

His death, doing what he loved the best, is a great sadness. One cannot imagine him ever becoming an old man—perhaps he has achieved the eternal youth that eludes most of us. Our heartfelt sympathy goes out to Philippa and the children. For all who knew him, life will be the poorer without him.

RMB, DMRB, WICD, SRG, RM

Major C C Parsons RE B Sc

Book Reviews

LOUIS BRENNAN—INVENTOR EXTRAORDINAIRE

NORMAN TOMLINSON

(Published by John Hallewell Publications, Chatham. Price £7·95)

MOST Sappers know of the Brennan Torpedo (the only surviving example is in the RE Museum), some know of his Gyroscopic Monorail, a few know of his Helicopter, his Gyrocar and his Typewriter and virtually none know of his other inventions.

Brennan lived in Gillingham, Kent from 1883–1912 and spent the first four of these years working on his torpedo in Brompton Barracks. In 1896 he was elected an Honorary Member of the Institution of Royal Engineers (RE Institute as it was then). It is therefore appropriate that the author of this book is Divisional Librarian of Gillingham and that it is published locally.

The book (105 pps) is about Brennan himself and deals in the main with his four major projects, the Dirigible Torpedo, the Monorail, the Helicopter and the Gyrocar. His other inventions are not neglected and a list of his Patent Specifications is in one of the Appendices.

Louis Brennan CB was a mechanical genius, a character and unlucky! He was so far ahead of his time that he met opposition from many sources, not least the entrenched interests of industrialists; for example British railway companies resisted his Monorail and the Gyrocar was resisted by automobile manufacturers on purely selfish commercial grounds. He was unlucky with his Helicopter as prevarication by the authorities held back acceptance and the autogyro overtook his development. It is of interest that nearly every invention has been, or is now being, taken up by industry and "modernized".

Your reviewer unreservedly recommends this book to Members.

EEP

SANDHURST

THE ROYAL MILITARY ACADEMY

ALAN SHEPPERD

(Published by Country Life Books. Price £10·00)

COLONEL Alan Shepperd tells the story of Sandhurst, of its antecedents and of its evolution over a period of some two hundred and fifty years to become the sole Officer-Cadet training establishment for the British Army. His account reaches back to the origins of the Royal Military Academy at Woolwich. Indeed "The Shop", as Woolwich was known, was created early in the 18th century "for educating youth and improving the officers of the Artillery and Engineers in their respective duties" and therefore features prominently in the narrative, making it of particular interest for Sappers to read.

Colonel Shepperd himself was for twenty-nine years Senior Librarian at Sandhurst, becoming Librarian Emeritus after retiring in 1976. He is therefore uniquely qualified to write this book. He has produced an invaluable record which is very readable and provides a happy balance between fact and narrative.

Sandhurst is, of course, full of traditions, and it is fascinating to be able to trace their origins and discover, for example, how the Champion Company came to be known as the Sovereign's Company. The continuing interest and impact on Woolwich and Sandhurst of successive monarchs is also well portrayed. All this and more is done with the help of contemporary accounts and illustrations and photographs which give a picture of the two establishments not only on Royal occasions, but also for everyday life.

There are many instances in the past of men of vision and dedication, such as Le Marchant, laying the foundations of what we now know as Sandhurst against the opposition of the Treasury and contemporary military conservatism. Subsequent expansions and reorganizations reveal a rough pattern of growth in periods leading up to war. Inevitably prompt commissioning of Cadets followed at the beginning of

hostilities, together with a reduction in course lengths to multiply the throughput, until the latter stages of conflict when courses increased in length again. Expansion was usually sustained in the immediate post-war periods until the external threat diminished and Treasury pressure caused pruning once more. Thus Woolwich and Sandhurst seemed to be always in a state of flux.

Colonel Shepperd's book is therefore a valuable fund of information for those with an interest in history, or a particular desire to know the origin of Sandhurst's traditions, or curiousity about past patterns if involved in ever-present debate on the Sandhurst course. It is an achievement to have catered for so many varied interests as well as providing an accurate record of events and personalities in such a readable book.

ACDL

BOOK NEWS FROM INSTITUTION OF CIVIL ENGINEERS

All books in this section are published by Thomas Telford Ltd and are obtainable from the Marketing and Sales Dept, Thomas Telford Ltd, 1–7 Great George Street, London SW1P 3AA

THOMAS TELFORD: ENGINEER

Price UK and Eire £9·00; overseas by air £11·00

PROCEEDINGS of the seminar held at the Coalport China Works Museum, Ironbridge, April 1979, under the auspices of the Ironbridge Gorge Museum Trust and Telford Development Corporation.

The aim of the seminar was to provide an up-to-date summary of current research by leading experts on Telford, keeping a balance between the technical and historical. Papers covered "the bridge that never was"—the 600ft cast iron arch proposed for London Bridge, Telford's early years in Shropshire, the Shropshire canal, Holyhead Road, the evolution of the Menai Bridge design, plus many other highlights of imaginative appreciations and projects. Telford was one of the greatest British Engineers and this well presented and illustrated book is worth reading.

THE ENGINEERS COMPUTER HANDBOOK

Price UK and Eire £11·00; overseas by air £14·00

THE application of computers to engineering problems can result in greater efficiency, improved standards of design and project evaluation, and improved management planning. The attainments of such benefits is expanding continuously. Techniques, once the preserve of a few, may now be encountered by any engineer.

The object of this excellent book is to provide an insight into the ways in which a computer can contribute. It sets down what are seen as basic principles which are supported by references to sources of deeper and more specific information and a glossary of terms to combat the inevitable problems of computer jargon.

This book is worthy of a place on the shelf of all who are computer minded.

THE PERFORMANCE OF ROLLED ASPHALT ROAD SURFACES

Price UK and Eire £13·00; overseas by air £17·00

OVERSEAS CONTRACTS: CONCEPTION TO COMPLETION

Price UK and Eire £8·00; overseas by air £10·00

AIRPORTS FOR THE COMMUNITY (6TH WORLD AIRPORTS CONFERENCE)

Price UK and Eire £14·00; overseas by air £16·50

NUMERICAL METHODS IN OFFSHORE PILING

Price UK and Eire £18·00; overseas by air £21·00

THESE four books record the proceedings of four conferences held in London in 1979. They contain the latest thoughts on their subjects and are a must for the specialists in those fields but are only of general interest to the more broadly based Military Engineer.

A HISTORY OF RE CRICKET 1862–1924

THERE can be little doubt that the deeds of our forerunners are well worthy of study and this book recalls happy memories and should enlist the interest of present day cricketers if not all Sappers.

The 100-page book not only gives match results, individual records, averages and notable performances, but also gives the History of the Cricket Club, the story of the Ground and of the Pavilion, and some wonderful pen pictures of distinguished players. The pen pictures include Corporal Bayfield (the first Other Rank to play for the Corps against the Gunners), A E J Collins (628 not out at Clifton, still the highest ever "recorded" innings), J Fellowes (who made 22 runs off four balls with W G Grace bowling), W C Hedley (probably the best all-round cricketer the Corps has ever had and son-in-law of J Fellowes) and H W Renny-Tailyour (who represented Scotland at both Association and Rugby Football and played in the FA Cup Winning Side).

The book can be obtained from the Secretary, Institution of Royal Engineers. Price £1·00. Postage and packing 50p extra.

PORTRAITS AND SILVER OF RE HQ MESS

Published by Institution of Royal Engineers. Price £1·50

This beautifully illustrated book contains the photographs and descriptive details of fifteen Mess portraits and forty-one pieces of Mess silver. It is a fascinating reference book on the familiar items we have seen and on which our knowledge (for most of us to say the least), is sketchy. Which portrait was the first to be acquired by the Mess? Which piece of silver is the most valuable? Who was Ko? Who was the first engineer officer to command a British army in the field? The answers to these questions and many others are yours for the asking price plus 50p postage and packing.

OUR HERITAGE

RE LIBRARY AND MUSEUM—CHATHAM

MOST Members know about the RE Library and the RE Museum. There may be some Members however who do not realize that both depend to a large extent upon Members and the families of late Members for the majority of acquisitions, which are loaned, given or bequeathed.

There is recent evidence that other Museums and Libraries are approaching Members and even the families of late Members, in an effort to acquire exhibits. This is understandable, as their problems are not unlike ours; and the choice of where an item goes must always lie with the donor.

We are not averse to outside Museums or Libraries coveting the appropriate possessions of our Members. We do make a simple plea however; remember the Corps before parting with any items to other Museums or Libraries.

"Charity begins at home".

ARTICLES AND CORRESPONDENCE FOR THE JOURNAL

YOUR Journal depends for its existence on articles and correspondence submitted for publication on historical, professional, technical and, indeed, on any subject of interest to Military Engineers.

ARTICLES

Articles may be of any length, but preferably not more than 6000 words. They should be typed in duplicate on one side of the paper only, double spaced with a one-inch margin. A third copy should be retained by the author for checking with the proofs.

Articles should be accompanied by a photograph of the author, suitable for reduction to two inches width, and a pen picture of his career to introduce the author to our readers.

Photographs to illustrate an article should be black and white prints on glossy paper. The size of the photograph does not matter as the size can be adjusted. Line drawings, maps etc must be in black ink and all lines, lettering etc must be bold and clear to allow for reduction in size when reproduced. Scales must be drawn and not worded.

The copyright of all articles published in the *RE Journal* is assigned to the Council of the Institution of Royal Engineers.

Payments for articles is at a rate decided by the Publications and Library Committee. An additional award of £20 is made at the discretion of the Committee for articles of particular merit published in each issue of the *RE Journal.*

Three further awards are made each year:—

The Best Article of the Year Prize (£50) open to all authors;

The Montgomerie Prize (a book to value of £25) for the best article on a professional subject by a Serving Regular RE Officer not above rank of Lieut Colonel;

The Arthur ffolliott Garrett Prize (to purchase or help purchase a piece of silver, value £20) for the best article on the technical aspects of logistic engineering or survey by a Serving Regular RE Officer not above rank of Lieut Colonel.

Articles may be submitted at any time but the following dates are *normally* the latest for inclusion in the issues shewn:

MARCH ISSUE	1 DECEMBER	SEPTEMBER ISSUE	1 JUNE
JUNE ISSUE	1 MARCH	DECEMBER ISSUE	1 SEPTEMBER

For articles requiring clearance attention is drawn to Military Security Instructions Part 1 Army Code No 60723 Appendix B to Chapter 5.

CORRESPONDENCE

Correspondence is the life blood of the *RE Journal.* Correspondence on published articles is particularly interesting as it provokes further thought and widens the discussions on controversial topics. It is important however that the initial reactions to articles published should be in the NEXT Journal to maintain the interest in the subject. For this reason the submission date for correspondence *referring to articles* is five weeks later than that for articles. On average this will give correspondents about one month to react.

The submission dates for Correspondence on published articles are therefore:

MARCH ISSUE	7 JANUARY	SEPTEMBER ISSUE	7 JULY
JUNE ISSUE	7 APRIL	DECEMBER ISSUE	7 OCTOBER