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The Bukit Mendi Project

LIEUT-COLONEL N. R. STURT, RE, MA, CENG, MICE

INTRODUCTION

ON 29 January 1970, the Mentri Besar of Pahang cut the ribbon across the centre of a three-span concrete bridge across the Sungei Triang in the south of his state. Simultaneously, a brass plaque was revealed; this announced that Gazelle Bridge had been constructed by 54 (FARELF) Support Squadron, RE, with design and control by 63 CRE (Construction) and support tasks by 17 Division Engineers.

After examining the bridge, the visitors drove the five miles to Bukit Mendi Village along the road formation constructed over the previous year. On his arrival there, the Mentri Besar inspected an excellent Quarter Guard from 54 (FARELF) Support Squadron, made a speech in English and Malay and presented a pewter cigarette box which was accepted on our behalf by the Chief of Staff, HQ FARELF. After further speeches and presentations, the Mentri Besar unveiled a plaque on the Community Centre which stated that the building was "Constructed as a gift to the people of Bukit Mendi Village by British and Australian Army Engineers".

The ceremony was concluded by refreshments in the Community Centre while the Pipes and Drums of the Gurkha Engineers performed with their usual impassive excellence. The visitors finally dispersed, mutual congratulations were exchanged, and the Bukit Mendi Project was over; except of course for the usual well-known sequel to the Lord Mayor's Show.

MOUNTING THE PROJECT

It all started in 1967, when the search for a training project to take the place of OP POST CROWN began. In October the C-in-C's approval was obtained for a Troop from the FARELF Orbat to be employed on a construction task in Malaya, and a proposal was with MOD by the end of the year. In March 1968 MOD gave their consent and laid down the principles on which the Malaysians should be charged for Extra Costs.

After various interchanges between HQ FARELF and the British High Commission in Kuala Lumpur, the CRE Construction eventually obtained his charter to negotiate directly with the Federal Land Development Authority (FLDA) in June. The general pattern of the project was decided at a site meeting the following month and estimating, drafting a Memorandum of Understanding and planning got under way. Meanwhile the Chief Engineer laid down that troops would rotate through the project, for two or three months each, and that the CRE Construction would remain in command of all aspects of the project. The draft Memorandum was sent to FLDA on 22 September and planning continued on the assumption that all would be well.

A verbal assurance was given by the Adviser on Development to the Malaysian Government, on 1 November, that the scheme would get approval, so the advance party was launched to site on 15 November to start camp construction and preliminary works. However, it was a relief to all when the Memorandum was indeed signed by the Chairman of the FLDA and our Defence Adviser in Kuala Lumpur on 9 December 1968. The advance party was formed mostly from 54 (FARELF) Support Squadron RE, and their task was to erect a camp and deploy plant to site. The first element of this task was mainly achieved by constructing some of the wooden houses which would be occupied by settlers after our departure; these houses were each able to accommodate six soldiers comfortably. Moving the plant to site was a considerable undertaking, as the distance of 210 miles from the park in Singapore included long stretches of rough laterite or pot-holed road and a final six miles of unfinished road under construction by the PWD.

THE ROAD

The Bukit Mendi Project formally started on 1 January 1969, when work began on the construction of four and a half miles of Primary Access Road.

This road was to serve two purposes. In the first place it joins the two halves of the giant oil-palm estate complex, so that they can be operated economically and as a single unit, whereas previously they were sixty-five miles apart by road. Secondly, it forms a part of the road link between two north-south roads which previously were linked at Temerloh, some thirty miles to the north, and at Ayer Hitam a similar distance to the south. The road formation, between ditches, was constructed 38 ft wide, of which the central 20 ft is to be surfaced by the PWD (JKR); the Sapper contribution could not include surfacing, as there was no suitable material near Bukit Mendi and no good enough route to site, at that time, for large-scale importation. However, the compacted formation is in full and successful use as a dirt road, and the "black top" is due to be laid shortly.

The road passes over eleven culverts, all of concrete pipe construction, and two bridges. The line of the road was carefully surveyed and aligned to give a design which was economic in both earthworks and culverts, and the design and quality control of the work by 63 CRE (Construction), and the subordinate 522 Specialist Team RE, was very valuable training for these units. Total earthwork quantities were as follows:

Clearance	345,000 sq yds
Total Cut	106,300 cu yds
Cut to Waste	2,800 cu yds
Total Fill	101,700 cu yds
Borrowed Fill	8,000 cu yds
Length of Drains	10,200 yds
Graded Area	144,000 sq yds

There were, of course, various difficulties to be overcome. A notable one was the rather restricted road reserve allowed; although we were able to choose our route, only two chains (132 ft) of unplanted area was left between the palms. This meant that at points of deep cut or fill, or where there was side hill cut across a steep slope, the road-works filled the whole reserve. More serious, however, was the fact that we had to specify the alignment, and the resultant area to be cleared, in the very early days of the project so that the planting programme could proceed. In effect, on difficult stretches the edges of the roadworks had to be set out on the ground before survey or design were complete. It speaks well for the efforts of the Engineer Surveyors in particular that very seldom was there any need to ask the FLDA staff to move additional plants.

As the finished road formation reached further forward, so also the length in use as a road by us, by FLDA and other civilian traffic, increased. Being unsurfaced, and in many places formed from soil which had few of the characteristics that the reference books recommend for a road sub grade (let alone surface), erosion and shallow rutting occurred, which produced a constant maintenance requirement.

The earthmovement output was not high by normal standards, although the FLDA and PWD admitted to being impressed favourably by the standards achieved. The plant was old and liable to much too frequent breakdown, and the operators (the normal field and support squadron personnel) were found to be greatly in need of the practice they got on this project. It was particularly noticeable how many scraper ropes would break for the first week or two after each change of Troop, and what a small proportion of operators can control a grader efficiently in some of the more tricky operations such as bank battering. All the plant operators improved, but only about 25 per cent could be said to be really proficient at scraper work, and only 15 per cent on graders, at the end of their time, out of all the operators employed.

The lesson that the formation must be kept self-draining at all stages, and

especially at the end of work daily, was once more learnt the hard way by those who neglected it and who inevitably were unlucky with the rain. It is to be hoped also that the advantages of grading, and final rolling with the smooth-drum road roller; immediately after the earthworks are now appreciated by all concerned; only thus can rain be made to drain away without percolating into the soil and undoing much of the good produced by careful compaction.

The earthworks for the road were carried out almost entirely by two 12 yd scrapers, towed by D8H tractors. A third D8H did virtually all the forward clearance, which involved grubbing out tree stumps and then pushing them and the previously felled and burnt tree trunks to the outside of the two-chain reserve. Topsoil was cleared at the same time, but this was very thin and presented no problem. More important were a few areas, mostly in gullies, where silt concentrations were unacceptable and had to be removed; in one particularly bad area some 2,700 cu yds of silt were discarded. In general the principle was adopted that the available soil had to be used, and cut and fill were balanced; however, in three areas where reasonably good soil was available, borrow pits were used in order to make good discarded material, or to reduce haul distances as in the case of the approach causeway to the Sungei Triang bridge.

The other plant employed was the usual range of tracked and wheeled tractors, graders, rollers, dumpers, and so on. The Drott 4-in-1 bucket on the International light tracked tractor was of considerable use in loading and carrying, especially when a wheeled tractor would have bogged down, although for straight dozing it was of course inferior to a Caterpillar D4C or D4D. The International tractor also scored when used on finished surfaces, as it tore them up much less than tractors fitted with grousers.

The 19RB came into its own on a number of occasions, notably as a dragline for clearing out silt from gulleys in which dozers would have bogged down, as a crane and as a pile-driver. In the latter role it has the advantages of comparative mobility and a useful outreach, but severe limitations in lifting capacity and rigidity. This point is covered at greater length below. Few operators had any experience of the 19RB as a dragline, and none had used it as a pile driver previously; to remedy the former lack, a fish-breeding pond was dug by dragline, and the latter was alleviated by the driving of thirty-five concrete piles, and even more timber piles, during the project.

The compaction of the earthworks, as usual, proved difficult. The factors causing this were many, and included the excessive moisture content of the soil as a result of frequent rain, the unreliability of a towed vibrating roller, the periodic lack of suitable tractors to tow the wobbly-wheeled rollers, and a general tendency to force on with the earthworks even when a roller was not available. Sand-displacement tests to check compaction, and occasional stopping of earthmovement until it was adequate, helped matters, but the author doubts whether specified compaction was really achieved throughout. The standard Plant NCO's reply of "No, the roller is not available at the moment; but don't worry, sir, I'm compacting with a loaded scraper every few cycles" was too often heard. As compaction of earthworks is seldom indulged in by the Malaysians, and smooth-drum rollers are the only ones normally seen on a PWD road project, we certainly produced a very adequate answer by local standards. One further point on compaction; the 30 cwt towed vibroller plays havoc with the towing eyes of anything less than a size II tractor, and even that is frequently damaged unless its winch or CCU is removed. This seems to be because of the angle of the tow bar and the resultant tilting of the roller mechanism so that it vibrates onto the towing eye as well as the ground.

A Forward Repair Team from the Engineer "C" Vehicle Workshop REME was on site throughout, and proved a real boon. In particular, their Stores Section RAOC was seldom idle and provided the necessary spares to keep most of the old plant working much of the time. Unserviceability of tracked tractors, for example, was 18 per cent, although standing and servicing time were equally unproductive and must

be added in, to give an actual working figure of only 36 per cent of the available time. These figures could have been considerably, but artificially, improved by backloading all dead plant more quickly instead of keeping it on site while spares were awaited.

THE BRIDGES

The road crosses a small stream, the Sungei Sakai, and a swift-flowing river, the Sungei Triang (or Teriang). At the former the catchment area required a water-area of about 120 sq ft using Talbot's formula and assuming up to 4 in of rain in an hour on rolling ground. This could have been provided by four 6 ft pipes (112 sq ft). Alternatively, we could have put in three 3 ft pipes, as the FLDA had done some way lower down on the same stream, giving about one-sixth of the theoretical required opening. Why this discrepancy? The reason is that FLDA, who construct hundreds of culverts throughout Malaysia every year, know by experience that the theoretical requirement is grossly extravagant in capital cost, and they prefer to replace a few washed-out culverts after occasional freak storms than to make all culverts large enough to withstand them. However, in the case of the Sungei Sakai it was decided to construct a 30 ft span bridge partly to play safe but mostly for training purposes; after all, the FLDA were providing the materials! At this stage no decision had been made about constructing the larger bridge across the Sungei Triang, but when in late 1968 it was decided to build the second bridge, the first (and much simpler one) was kept in the programme as a rehearsal for the other.

Both bridges were designed around the concept of prestressed pretensioned beams being placed side-by-side across the whole road width, the spaces between them filled with lean mix concrete, and the whole topped with a reinforced in-situ deck slab. The abutments (and piers) were all designed to be supported on precast concrete piles capped monolithically with reinforced concrete capsill beams. This, however, was about the limit of their similarity; whereas one bridge spanned a stream which would never in any conditions fill more than a third of its available waterway, the other bridge is designed to be over-topped by occasional floods. So one has square sides and parapet walls, the other has pointed cutwaters on its sides and no parapets or railings. In the smaller bridge, beams could be lifted into place by a single 19RB standing on one bank, whereas the larger one required beams to be lifted in by two cranes positioned exactly in accordance with a complicated plan.

In the event, the Sungei Triang bridge was a fairly difficult task for any one other than a contractor experienced in such work. It became clear that it could not be built as one of the tasks to be completed by the field troops which rotated one at a time through the project. An *ad hoc* Troop was therefore formed by 54 (FARELF) Support Squadron, mainly from its Workshop Troop, to provide the necessary continuation and level of trades skill. This Troop was deployed from June 1969 to January 1970, although there was some change-over of individuals during this time.

The rotating field troops, which between them built the Sungei Sakai bridge and nearly all of the eleven culverts for the road, also made most of the piles for the larger bridge. As these were 35 ft long, and each was heavily reinforced with eight main bars, 157 stirrups, two sorts of spacer forks and helices, their construction was a slow and difficult business. The degree of steel-fixing skill available in field units was clearly too low, although great improvements in both skill and techniques were achieved during the project. The other parts of the main bridge task "sub-contracted" to other units were the construction (and later removal) of a 120 ft TS EWBB alongside the site of the permanent bridge, and the construction of temporary platforms over the river, within the limits of the permanent bridge, to support 19RBs during piling, positioning of beams, and other craneage work such as skipping concrete. These temporary works were carried out by 67 Gurkha Independent Field Squadron and 11 Independent Field Squadron respectively. Hence the 'support tasks' referred to on the brass plaque.

The Sungei Triang bridge has three 40 ft spans, and is designed to MOT HA loading. The most interesting aspects of the construction of this bridge were the

piling, the shuttering and steel fixing for the pier capsills, the beam launching, and the complicated procedure required to allow casting of the pointed cutwaters. These phases are therefore described in some detail here.

The 30 ft bridge over the Sungei Sakai had served one of its purposes as a rehearsal by allowing us to confirm that the pile penetrations to be expected could be assessed from use of the Mackintosh Probe. This useful contraption is a simple penetrometer which is hammered into the ground using much the same principle as with the standard camouflet equipment. A weight is raised and dropped, and the penetration for a set number of blows from this weight is recorded. Excluding freak readings, results were reflected remarkably closely during piling. As a second precaution, a single test pile 30 ft long was driven on the centre line of the bridge into the river bed. This also confirmed the likely penetration results assessed from the probing. All the piles were then cast 35 ft long, which was 5 ft longer than the expected requirement, and in fact at least 5 ft of each pile had later to be cut off and discarded; this safety margin was a necessary precaution, as time did not allow for casting extensions on piles, but it was the cause of great difficulties with pile handling. The weight of a 12 in × 12 in RC pile 35 ft long was 2½ tons, and the 19RB could not support this in addition to the pile cap and 25 cwt hammer. Also, the 35 ft pile was too long for the leaders. The answer was to pitch piles into the water (or a trench for the abutments), then secure them into the leaders and rest the pile toe on the bottom. The pile then penetrated a few feet under its own weight, making room for the cap and hammer to be lifted into the leaders in their turn. Driving was slow, as repeated efforts were made to straighten piles beginning to leave the vertical. The pile leaders had little restraining effect on the pile as they and the 19RB swayed with every blow of the hammer. Eventually all the piles reached their design set of ¼ in averaged over ten blows, except for one pile whose head began to shatter and one which started to go out of line; these two marginally missed their full set. The accuracy of driving was quite good, considering the difficulties, and all piles were well within the capsill widths as designed. On the best day, a long one, two piles were pitched and fully driven, but in general a rate of one pile a day only was achieved.

After clamping catwalks to the piles, they were cut off and their reinforcement exposed for tying into the capsill reinforcement in the normal way. Further clamps were bolted to the piles to carry the soffit shutters for the capsills; because of small inaccuracies resulting from pile driving these soffits had to be tailored individually, but they rested on the bottom members of twenty-eight prefabricated rectangular frames made from 4 in by 2 in timber. These frames supported the side sheeting of the shutters, and were re-used with that sheeting on each successive capsill. In the design these frames were made unnecessarily elaborate, and although they worked well they were time-consuming in fabrication. Difficulty was experienced in fitting the main steel inside the shutters with proper cover due to the concentration of steel at the points of the capsills and the lack of any tolerance between the bending schedule and the shutter design. These problems were solved by resorting to a little extra site bending. After casting the capsills, raised cutwater ends were cast on to them (using modified frames to support the shutters) to provide lateral location and support for the spans.

The beam launching, all carried out by cranes, had to be done according to an exact plan, as no available crane could lift the 3·6 ton beams at the necessary outreach to launch them from the banks or from the Bailey bridge. We had to avoid overloading one girder of the EWBB, as would occur in craning from it at a large outreach; the bridge was only about Class 24 in any case. The drill adopted was to walk a beam out, by crane, onto the EWBB, and place it on top of the downstream panels; a spreader beam was necessary during lifting by a single crane to avoid overstressing the prestressed beams. Two cranes, one on each temporary platform, then laid the beam on the centre span, and the cycle was repeated fourteen times until this span was complete. The side spans were launched in two parts; after removal of the downstream halves of the temporary platform, downstream beams were laid by one

crane standing on the remaining portions of the platforms and one on the bank. The upstream beams were then laid, after removal of the rest of the platforms, by one crane on the EWBB (not at mid-span) and one on each bank. Inaccuracies in the exact straightness and dimensions of the beams, which were bought by the PWD from Hume Industries, caused some problems, and finally contributed to slight uneveness in the finished bridge.

The shuttering of the span cutwaters required a system of cantilevers and struts, and an exact order of work. This can best be explained diagrammatically, and is shown at Plate 12. The method illustrated worked well, except for difficulty in lining up the cutwater edge mainly because no direct line of sight was possible. Pouring of the pier capsill cutwater upstands at the same time as the span cutwaters might have been a better solution, but otherwise it is difficult to see how the problem could have been solved without completely recasting the design of the bridge.

The construction of this bridge was due to start (apart from pile precasting) in May 1969, which would just have allowed completion by the scheduled end of the project in late December. So, at least, the critical path plan showed. The start of the work was in fact delayed some weeks, until June, and completion was duly achieved in January 70. Although the Bridge Troop did not always choose to follow the precise order of work considered best during planning, the critical path method undoubtedly gave a more accurate assessment of what to expect and what resources to deploy than any other known planning system could have done. The method used was exactly as described in RE Training Notes No. 2, and the only difficulty encountered was in deciding how long each activity would take with troops inexperienced in this type of work. The odd howler on the swings was balanced by a few extra revs on the roundabouts.

BUILDING CONSTRUCTION

In Bukit Mendi village forty-six timber settlers' houses were constructed, as well as a Community Centre. The advance party, while setting up the camp, had built a number of the houses, and these were used to live in for the rest of the time. The number of houses rose rather erratically during the project, and about half of them were in fact built by three mixed Carpenter training courses from 70 Support Training Squadron in Kluang. This gave the trainees an excellent chance to do some practical work in the field, and a similar use of all trades courses, for two or three weeks late in their programme, is strongly recommended.

One problem was the inability of FLDA to get their contractor to supply component parts for the houses as required. This resulted in a dozen or more houses standing partly built for some months, and they had warped badly enough to make completion by the next course both difficult and slow.

The settlers' houses, partly prefabricated, were simple but effective, and pleasant to live in—especially when fitted up with field lighting and plumbing. Many a visitor commented that they could do with one of the houses as a holiday chalet, and did we have one spare?

The Community Centre was a timber structure, 60 ft by 29 ft, with corrugated asbestos cement roof and concrete floor. It is designed so that all internal and external walls can be removed, or moved as panels, after undoing a few bolts, if a change in the lay-out is required. Site work for the Centre was started in October 1969, and, finished in the following January. Design, to a general layout specified by the FLDA was by 63 CRE (Construction). Construction was principally carried out by 2 Troop of 11 Independent Field Squadron, with metal-work prefabricated by the Engineer Workshop of FARELF Engineer Park. This Workshop was also the source of many special parts and equipments used throughout the project.

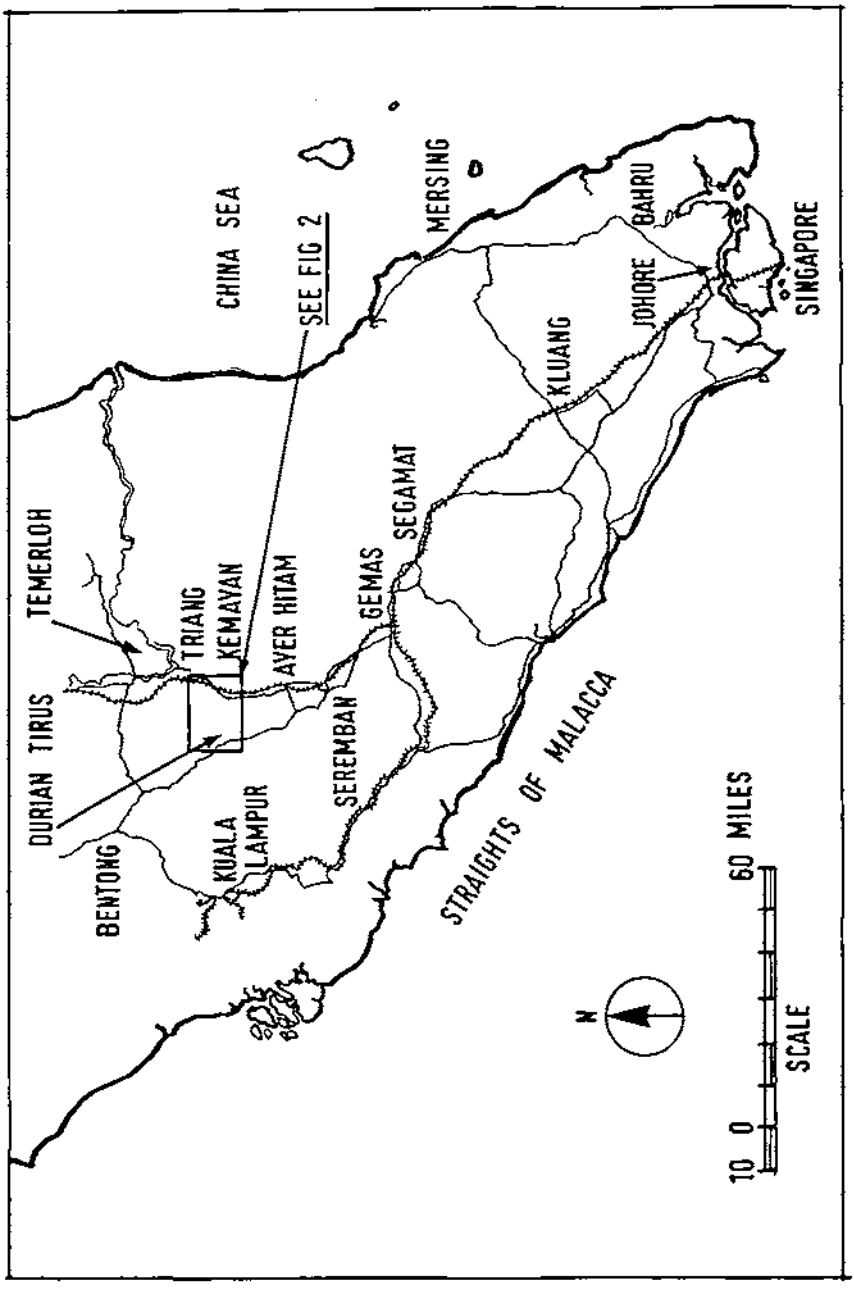

Plate 1. Map of South Malaya showing location of the project

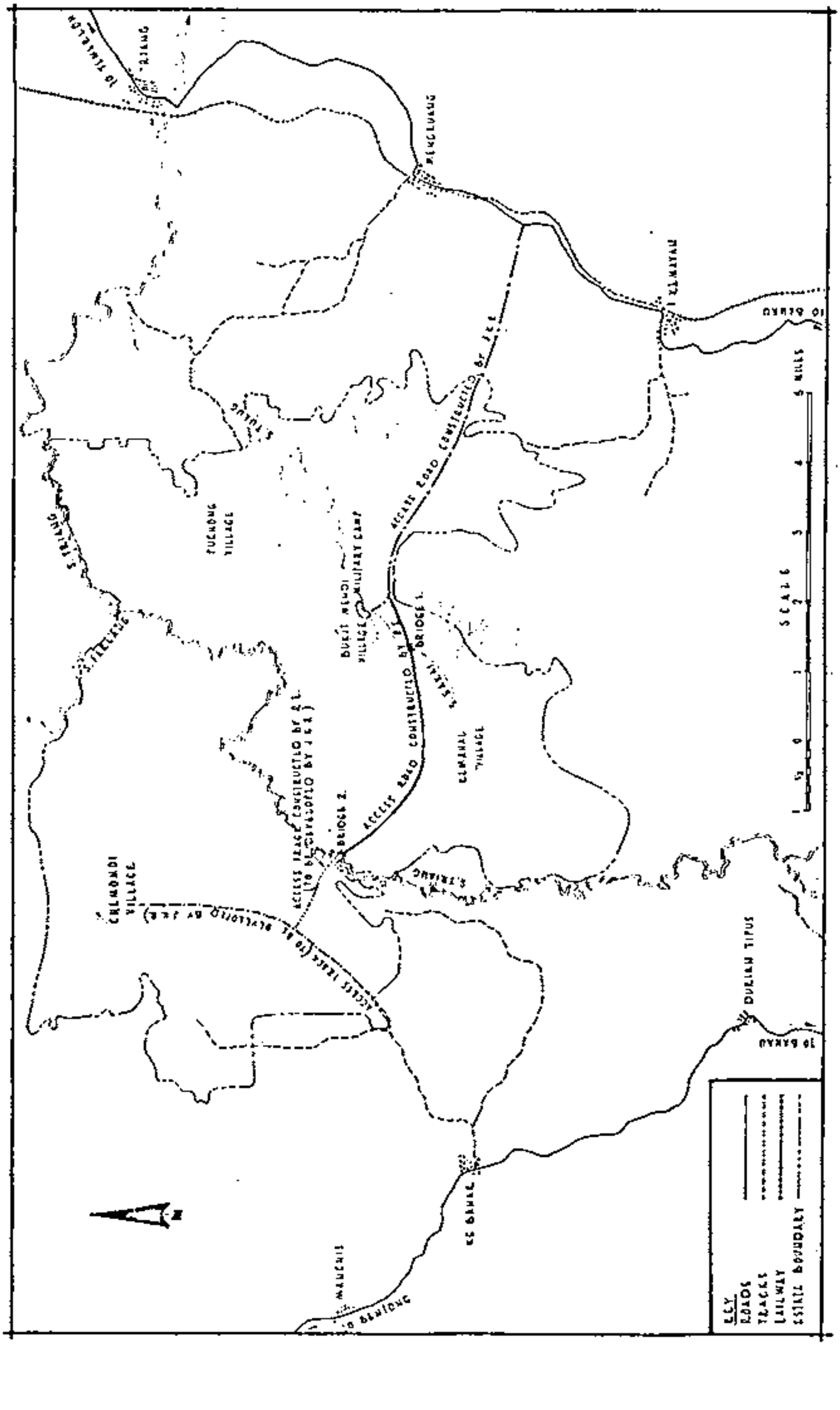

Plate 2. Map of the project area

Plate 3. Bukit Mendi Village under construction. The completed houses are occupied by the construction force

Plate 4. The Pipes and Drums of The Gurkha Engineers play during the opening ceremony. The Community Centre and one of the settlers' houses can be seen

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Plate 5. Earthworks in progress on the road. Banks of cuttings over ten feet in height were benched

Plate 6. Bridge 1. The last prestressed concrete beam is placed during a visit by the Deput Prime Minister of Malaysia

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Plate 7. Bridge 2. A temporary access bridge and piling platforms can be seen. The wet piers have been piled and capsills are being constructed

Plate 8. Bridge 2. Reinforcement mesh being laid for the deck slab

Plate 9. Bridge 2. Shuttering being fixed for the pointed cutwater

Plate 10. Bridge 2. Expansion joints are sealed on the completed bridge

The Bukit Mendi Project 9 &10

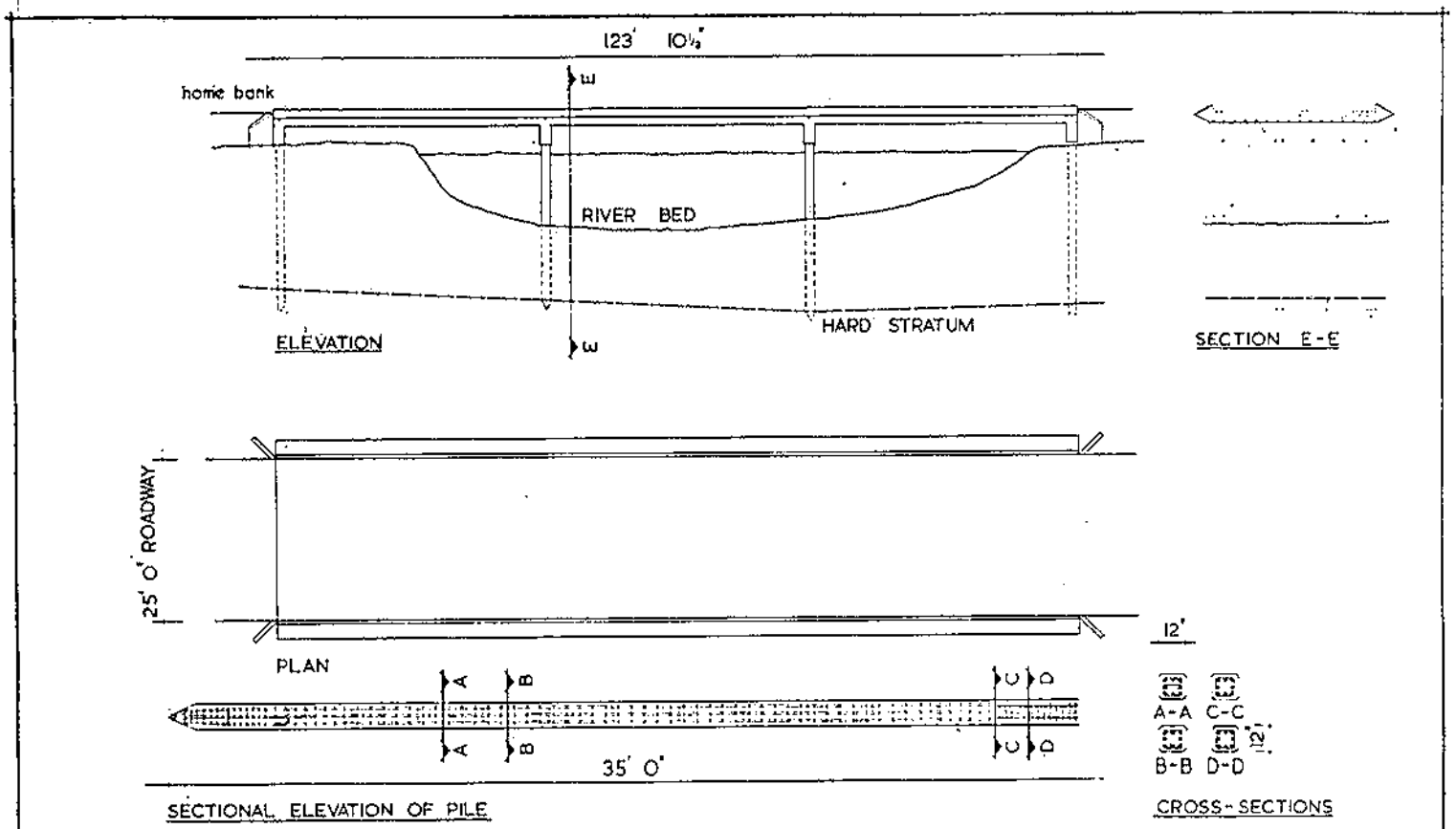

Plate 11. Bridge 2. General arrangement

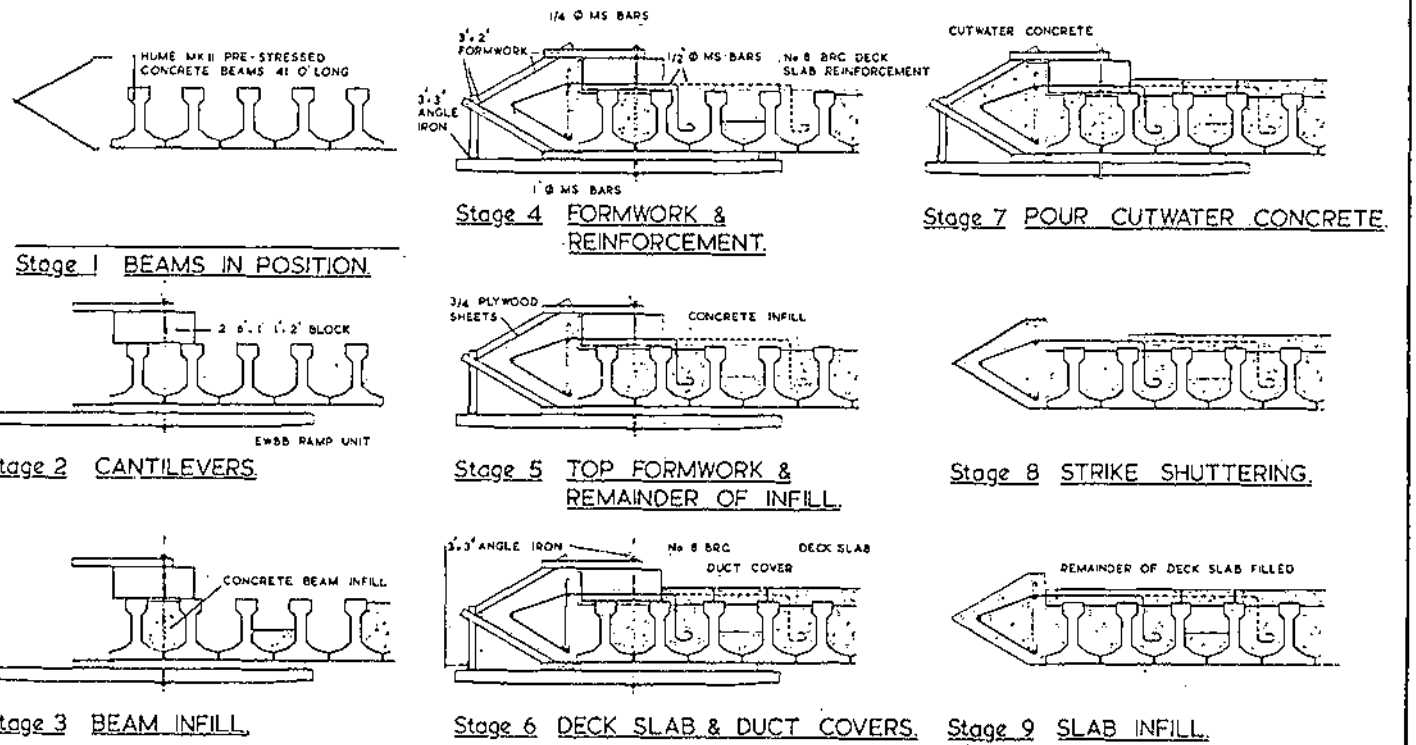

Plate 12. Bridge 2. System of span construction

CONCLUSIONS AND LESSONS

The project was carried out for two reasons; as a source of varied training, and as a civil-aid construction task. On both scores it was a tremendous success. Of course neither the standard nor organization of the work were perfect, but a great number of all ranks learnt much, gained both experience and confidence, and can look back on a useful project of lasting value to the Malaysians. The direct financial saving to the Malaysians was over M$300,000, but there were also considerable indirect savings through the accelerated development of the area.

There are a number of further conclusions worth stating here; they are by no means the sum total of those reached. Firstly, a troop cannot be economically deployed distant from its parent squadron for a considerable period of time; the operative word is "economically", as administrative overheads are too high, and the appropriate plant force is hardly viable unless every machine works with scarcely a breakdown. Nor is the one officer able to give adequate attention to both site supervision and administration.

Secondly, there is a danger of young officers abdicating entirely the control of plant to the Military Plant Foreman; to some extent this is inevitable as the more experienced practical man knows so much more about the use, maintenance and problems of plant. But mostly it is surely a lack of adequate training of young officers in this most essential, even fundamental, set of engineers' tools; too much reliance on the MPF means that the young officer never really learns the hard way either. However, with the advent of the MPF one has seen plant generally used much more efficiently in recent years.

Thirdly, piling is insufficiently practised on continuation training, and probably on courses also. Coupling this with the difficulties experienced in preparing the reinforcement cages for the concrete piles, one is led to the conclusion that pile casting and driving should be covered at Chatham (by the respective schools) more fully than they have been.

Fourthly, cost-consciousness is rare in field units.

Fifthly, the loss of all unit plant fitters into "C" Vehicle Workshops REME, although allowing the excellent institution of Forward Repair Teams to flourish, does leave no suitable tradesmen for overseeing the maintenance, inspection and fault diagnosis of plant in the unit.

Sixthly, as is now officially recognized and promulgated by HQ Engineer-in-Chief, the negotiations for and mounting of a civil-aid task of squadron size (as this one practically was) take over a year to complete.

Finally, it was shown that field units can carry out reasonably complicated engineering tasks if adequately supported and supervised by a specialist (MES) unit. As a corollary, the specialist unit was shown to be capable of providing the necessary negotiating, design, planning, accounting and supervisory services for a project of this scope.

The Bukit Mendi Project was full of interest, both technical and organizational (any reader wishing to study some aspect of it more fully is referred to the Project Report, held, *inter alia*, by RSME and the Corps Library). Let us hope that the Far East, perhaps the best training area for engineer construction we have ever had, is not entirely lost to the Corps, and that any opportunities to carry out further projects of this sort are seized and exploited.

* * * * *

Underwater Demolition of Coral Obstacles

CAPTAIN J. W. R. MIZEN, RE

INTRODUCTION

General

THE Turks and Caicos Islands are a group of islands at the extreme southern end of the Bahamas chain; they form a Crown Colony which is governed by a native Parliament and a British Administrator. The Administrator asked for the help of the British Army to undertake various development tasks to demonstrate to the islanders that the British Government wanted to play an active part in the development of the Islands. To a certain extent the exercise was mounted to avoid an Anguilla-type situation. 15 Field Support Squadron of 38 Engineer Regiment was assigned to the project. A reconnaissance showed that three main tasks existed within the scope of the squadron:

(*a*) Construction of a road and a water tank on South Caicos.
(*b*) The need for engineering apprenticeship courses on Grand Turk.
(*c*) Improvement of the access to the islands from the sea.

This article describes how the latter task was tackled.

Geophysical Data (*see plate 1*)

The Caicos Islands are fringed on the northern side by a reef one mile offshore and by a bank to the south side which extends up to fifty miles southwards. Five miles from the southern shore the water depth seldom exceeds one fathom. Traffic between the islands is by aircraft or shallow draft speed boat. There are few good roads on the islands; consequently much of the movement between the islands is

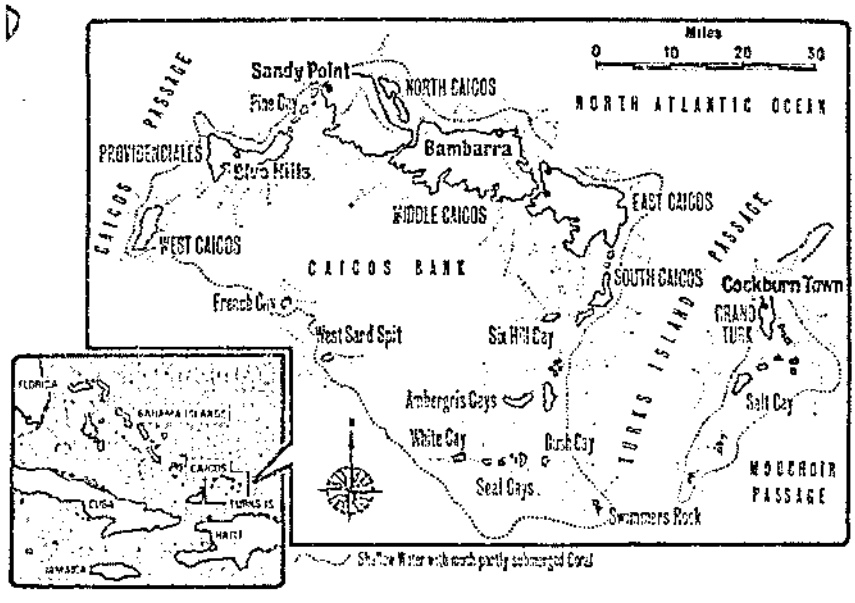

Plate 1. Map of Turks and Caicos Islands

done by boat. The islands enjoy the dubious advantage of being ideal tourist attractions having incomparable beaches and unspoilt marine life. A vast amount of money will pour into the islands in the next decade to build up a tourist industry. The task of the diving party on Exercise Cossack was to open up channels so that the islanders, tourists and developers could move more safely in these treacherous waters.

The Plan

The initial reconnaissance had suggested that the various cuts could be marked by using the Government fisheries vessel travelling round the North side of the islands, visiting each cut in turn.

The confirmatory recce showed this was practicable during the summer, but no boats ever went north of the reef in the period January–March, the time when the task was scheduled. A revised plan had, therefore, to be formulated and approved by the Administrator; the factors were:

(*a*) Resupply difficulties.
(*b*) Stores available.
(*c*) Location of fresh water.
(*d*) Location of POL.
(*e*) The weather.
(*f*) Local interests.

It is worth mentioning in passing that the tasks have to be impartially allocated; the island government could not be seen to be favouring one locality because indirectly they might be saving a developer a considerable sum of money, a fact soon noted by his rivals. It was, therefore, essential to get a top level decision on the priority of tasks.

The following plan was decided upon.

The party should mark a channel from Fort George Cut to Sandy Point; it would then move to Providenciales and mark Sellars Cut to 3rd Turtle Inn. By this time it was hoped that the weather would have improved sufficiently to enable the party to mark the remaining cuts using the Government fisheries vessel.

SANDY POINT CHANNEL

The Task

A Canadian developer had just bought a large tract of land around Sandy Point in North Caicos.

Stores could arrive on the island either by air (landing strip at Bottle Creek 3,000 ft) or by sea. The task of the diving party was to enable shallow draft vessels to follow a safe channel from the sea (Fort George Cut) to a harbour (Sandy Point) on North Caicos. Fort George Cut was opposite Pine Cay (see plate I).

Method of Tackling Task

The most important factor of any channel is the depth, so it is essential to get an overall idea of what the limiting depth of the channel will be. For this we were fortunate enough to have a local seaman who knew the area like the back of his hand. This Godfearing mariner showed us the channel the native fishermen used and we were able to mark the turning points with temporary buoys and concrete sinkers, thus we could then see what maximum depth would be practical for the whole channel, and it gave us some useful reference points. Construction of our buoys then commenced. We used 10 in diameter orange fishermans' floats which were attached to concrete sinkers by means of 1 in polypropylene cordage. One problem to overcome was the chafing of the polypropylene at the attachment to the sinker due to the continuous movement of the buoy. The solution was to attach the polypropylene rope to metal ties which were put in the mould before the concrete was poured. The concrete covered these ties completely so that they would not corrode, nor could the polypropylene chafe. Several different lengths of buoyline were used; it was essential

to have a little slack to take the rise in tide into account, but a great deal of slack would allow the buoy too much freedom of movement. Buoys were tied on with a split clove hitch and the end respliced into the buoyline. One hundred and thirty of these buoys were made for the channel.

While these buoys were being made the remainder of the party were finding the optimum route to take. The RAF had kindly offered to send a diving team of three to provide protection underwater against shark and barracuda, and also to provide a photographic record of what was accomplished. They had underwater guns and cine cameras which Army divers have to do without. The RAF Team had an electronic depth gauge attached to their Avon inflatable dinghy which could draw a cross section of the sea bed over which the boat passed and this was to be our method of finding the route for the channel. Unfortunately, like many pieces of sophisticated equipment we were to use, a fault developed and all depth measurement had to be done using a boathook.

The best method of finding the channel was to use a process of elimination and mark on a master chart the places which the channel could *not* go. Aerial photographs proved invaluable at this stage. Tentatively a number of buoys were laid along our chosen alignment. It is important to get the buoys down early since they act as reference points, which is absolutely vital on a featureless sea, and they can easily be moved later on. The approximate alignment of the channel from cut to harbour was dependent on the following factors:

(*a*) Maximum overall depth.
(*b*) Maximum width.
(*c*) Straightness.
(*d*) Shelter from heavy seas.
(*e*) Nature of sea bed (sand preferred to rock).
(*f*) Number of coral heads requiring blasting.

It is a great boost to morale to see a line of buoys stretching into the distance even when there is a lot more work to do. It is important to keep the channel as straight as possible to make it easy to follow, and bends should be gradual where practicable.

Coral heads were the next obstacle. These are solid formations of living coral sometimes spherical and up to 6 ft in diameter, slablike rising up to the surface of the water. They are honeycombed with holes which provide protection for a wealth of exquisitely coloured fish and succulent lobster. Experiments were carried out to find the best way of removing this coral and, after a number of trials, the following method was used. Ten-pound charges of PE4 were made up on the surface complete with primer and detonating cord. A reconnaissance of the coral head would show how much explosive was needed. For a quick calculation 1 lb of PE was found to clear 1 yd^2 of coral from the seabed at depths up to 10 ft. The diver doing the recce would decide on the number of charges needed.

On the dive proper three boats were needed. One assault boat contained divers and the detonators; another assault boat carried the explosive and spare diving sets; the third boat was the RAF inflatable.

Two sapper divers, accompanied by two RAF divers as shark guards, would go down and lay the demolition. The coral had natural holes in which to place the explosive. These holes usually contained crayfish which the RAF promptly collected for our dinner. Moray eels had the unfortunate habit of also living in these holes; it was a nighmare that an eel might latch on to a diver's hand, and as it would never let go the supervisor would be faced with an awful dilemma. One sapper diver would press the charges as far into the centre of the coral head as he could while the other carried the bag containing the remainder of the charges; the ever-present RAF would act as our eyes. It is not pleasant to dive and see a shoal of 5 ft barracuda and to have to turn your back on them. The RAF divers filmed and hunted for fish as well as keeping a look-out. When all the charges were laid a spare end of detonating cord was passed down from the explosives boat to the sapper divers who connected up the

ringmain and switch. A generous foot was allowed at all junctions, and detonating cord clips were used. Lengths of detonating cord were not allowed to cross except at junctions. This prevented blinds.

The spare end of the detonating cord was returned to the explosive boat when the ring main was complete, an initiation set of primers, safety fuse and percussion igniter was then transferred to the RAF boat together with the ends of the ring main. The two assault boats, complete with red flags, would then move away and maintain guard. The RAF boat was anchored by a length of polypropylene line to the sea bed and the initiation set was attached to the detonating cord. When everything was ready and the detonator was firmly fixed to the primer, the polypropylene line anchoring the boat was released and held by one man. The pin was pulled and a check was made that the safety fuse had ignited, only then was the safety fuse put in the water and the polypropylene line released. These elaborate details were included because at first mistakes were made with the initiation. Among these were: blinds due to wet safety fuse, the anchor of an assault boat fouling on top of 150 lb of PE when the pin had been pulled and the motor of an assault boat failing as the pin was pulled. Blinds on the surface are dangerous enough, underwater you haven't a chance if the demolition goes off.

The aim was to blow the coral outside the channel and the height of the water spout was an indication of how far the debris would be blown. A waterspout of 200 ft was normal, the haul of fish on the surface was never very large but provided enough to supplement our rations. The demolition area was then checked. All the authorities on shark say that they will converge on any demolition because of their acute "hearing" on their lateral line and their inquisitive nature. Not once, however, did we see shark after demolitions although they were about.

The other point of interest is the behaviour of barracuda. We had been told that they were harmless unless provoked. Usually when we were diving they would remain motionless about 20 ft away just watching and occasionally snapping their jaws. One day, however, one of the divers, Sgt Geoff Barry, came up at the end of a dive, took off his set and reported that there were a number of barracuda around. As he put his weight belt on board it slipped and dropped to the bottom. Like any good diver he cursed heartily and dived without weights to recover it. It is no easy thing to reach the bottom without weights and it involves a lot of splashing. This acted as a trigger to the barracuda and they started to "buzz" him. We now know it is possible not only to walk, but run on water.

A beacon was erected on the reef denoting the start of the channel. It was 20 ft high, painted red and white and had a triangular top mark. The base was cemented in a hole blown out of the coral and the pole was guyed with polypropylene line to pickets driven into natural holes in the coral.

There remained only one further task and that was to ensure that the channel was used correctly. Accordingly a report was put in the local newspaper and the locals of Sandy Point were given rides up and down to show them how much safer this channel was compared to the one they had been using. On one bright Saturday in February the first native craft used the channel and afterwards the skipper pronounced laconically, "Man, that's some channel!"

LONG BAR TASK—PROVIDENCIALES

The Camp was moved from Pine Cay, which had been a real Robinson Crusoe existence to the 3rd Turtle Hotel at Blue Hills, Providenciales. This was a luxury hotel for millionaires and provided a welcome change. Our task was similar in that we had to mark a channel from Sellars Cut to the 3rd Turtle Inn Harbour. The main difference was that there were few coral heads but a finger of coral, called Long Bar, which stretched from the shore to within 20 yards of the reef. All boats, especially sailing boats, had a perilous passage getting from the Cut to the Hotel. The main task was to blow a channel through Long Bar, so that boats could get direct to the Hotel from the Cut. A reconnaissance showed that Long Bar was made up of dead

Plate 2. CD11 with Macaroni tin for air gap. A diver holds the charge down while another brings sand bags to fix the charge

coral and the water depth generally was 4 ft. The requirement was a channel 10 ft wide and 8 ft deep. Since explosive was critically short the cut had to be at the point where the minimum amount of coral had to be removed. Several sections were taken and the amount of coral to be removed calculated. It was possible therefore, to arrive at the mathematical optimum section. This section was 180 ft long. At this section a centre line was laid and anchored at both ends. Experiments were again carried out to find out how best the coral could be removed. These included using surface laid charges of different sizes, home made CD11, CD11 with an airgap and CD11 with no stand off. The best method was to use a CD11 with a macaroni tin to provide an air gap. This produced a crater 2 ft deep and into this crater a 40 lb charge was placed and as much fill as possible put on top of the charge. The resultant crater was 8 ft deep and 12 ft to 14 ft in diameter. A trial demolition using surface laid charges was also fired. The spacing was 12 ft between centres and 40 lb charges. The result was a line of unconnected craters 4 ft deep and 8ft in diameter. A shortage of suitable tins to provide the correct airgap meant that the CD11 had to be used with no airgap and with legs bent back. This produced a crater 1 ft 6 in deep.

With this information the final plan for the demolition was made; it was appreciated that all the coral had to be blown out of the channel by the demolition. We tried one day's work with pick and shovel underwater and got nowhere. This in turn meant that the whole ditch had to be blasted in one demolition, or the debris from future explosions would fall in the completed part of the channel. The following plan was therefore adopted. Craters would be made by CD11 for 40 lb charges which would be buried as much as possible. A 20 lb box of PE can be conveniently filled with 40 lb of PE, which makes handling underwater much easier. The spacing between charges would be 7ft 6 ins. It was thought that this would ensure that the craters connected up. Although it is normal to put safety fuse and detonator straight into the CD11, it is not good diving practice to be in the water when a demolition might possibly go off, accordingly a length of detonating cord was doubled and put

Plate 3. Digging in charges from holes loosened by CD11 action; 40 lb PE4 is about to be buried

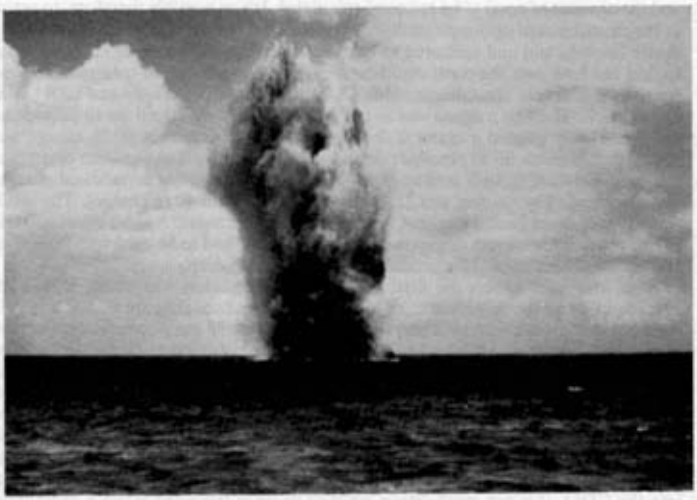

Plate 4. 1000 lb PE4 go up on Long Bar. Base length of explosion is 200 ft

Plate 6. The obstacle to vessels, Long Bar, is clearly seen at the bottom left. The task required a channel 200 ft long through this coral and onwards to Sellars Cut (top right)

Plate 5. Sergeant Barry of the RAF Diving Team with one of his enemies, the barracuda

Underwater Demolition Of Coral Obstacles 4 & 5

into the top of the CD11, leaving the required 12 in spare end, the top was packed with PE4 and the cap, with a hole punched in it, was replaced on the CD11.

The location for each charge was measured off and marked with a punctured beer can. Divers then laid a CD11 at each beer can and the whole ring main of nineteen CD11 was connected up and fired. The effect of the CD11 was to loosen and shatter the coral.

Now had arrived the big day when we staked the remainder of our explosive on these calculations. After a careful briefing a team of divers dug each 40 lb charge into the coral as far as possible and backfilled with anything they could find, a further team of divers followed up connecting the charges to a ring main. All we had learnt on the initial task was put into practice here since we were now very much in the public eye. Boats were sent to keep people out of the water up to one mile away, because it was not known what the effect of 1000 lb of PE being detonated underwater would be. Two separate initiation points with ten-minute safety fuses were ignited and we retired a discreet distance. The effect was formidable. The waterspout must have reached 800 ft and was very beautiful to watch. The Hotel a mile away received two shockwaves, one through the ground, the other through the air, which did little damage. An inspection of the demolition site revealed a continuous trench 5 ft deep with all the craters connected up. There remained a certain amount of clearing up both ends and for this we used surface charges on the coral and a "dummy" demolition in the trench of 15 lb. The idea of this dummy was to keep debris from falling into the trench.

At a memorable party on our camp site that night, to which at least five millionaires came, we handed over the channel to the islanders and developers. The conclusions arrived at after this task, which was our last since both time and the weather were against us, was firstly our real appreciation of the role of the RAF divers. They dived continually with us and kept us well fed. These tasks were good training value to army shallow water divers and showed that "tough" training is essential. Finally it is hoped that these tasks, which would have been extremely costly on the civilian market, proved a useful demonstration of how the British Army, and the Royal Engineers in particular, can benefit developing communities.

* * * * *

The Civil Works Programme of the U.S. Army Corps of Engineers

COLONEL D. L. G. BEGBIE, OBE, MC, BSc, CEng, MICE

"The one great central problem is the use of the earth for the good of man."
Gifford Pinchot

"Conservation means development as much as it does protection."
Theodore Roosevelt

INTRODUCTION

THE scale and nature of the Civil Works Programme of the US Army Corps of Engineers may be little known in the United Kingdom. It may also not be widely known that for the past few years a small number of Royal Engineer officers have been learning practical civil engineering as they work within the American Programme. This article is intended to serve as an introduction to a fascinating and enviable occupation enjoyed by our counterparts in the USA.

After the War of Independence, the US Army Corps of Engineers was virtually the only agency for engineering in the new nation. Though it can trace its history back to the mid-eighteenth century, the present Corps of Engineers dates from 1802. For many years the Academy at West Point was the only engineering school in the USA and it continued under engineer management until 1866. The Army Engineers led the way exploring the West, in surveying for roads, canals and railroads, in making the big rivers of the Middle West safe for navigation, in developing harbours on the Great Lakes, and in boundary surveys. Highlights of later activities were the construction of the Panama Canal and the St Lawrence Seaway.

The first formal recognition of the Civil Works programme of the Corps of Engineers came in 1824 with the Rivers and Harbors Act. Water has continued to be the centre-point of the programme ever since. Overall control of the programme is exercised by Congress. Surveys and project works are considered by the Public Works Committees, and funding is provided by the Appropriations Committee. Thus, unlike its other military branches, in this one of its major responsibilities, the Corps of Engineers is engaged on work which is not under the jurisdiction of the Armed Services Committee.

THE MAIN TASKS OF THE PROGRAMME

General

The main task is to carry out nation-wide comprehensive water resources planning, construction, and operations in co-operation with all the other Federal, State, local government and private interests concerned. In the West, the Bureau of Reclamation of the Department of the Interior also carries out a major water resources construction programme. At a cost of $21,500 million, 4,000 projects have been completed by the Corps and are now being used and maintained; 270 more are currently under construction. The annual budget is about $1,300 million and accounts for two-thirds of the Federal effort in water and related land resources development. The major areas of work are reviewed briefly.

Flood Control

Flood control measures taken by the Corps of Engineers have saved much damage and loss of life. The Corps is spending $400 million a year on this work and has already spent $5,000 million. The property damage believed to have been saved in consequence is calculated at three times this amount. The measures include dams, levees, floodways, and by-pass channels. By the regional control of the dams, flood waters can be impounded so as to prevent over-topping of the river banks and levees downstream. Information is being made available to local authorities so that they may regulate the use of flood-vulnerable areas as a supplement to structural flood control measures.

Plate 1. *Kansas City*. This photograph illustrates the partial success of the earlier Kansas City flood control project. In the extreme top left is a corner of the airfield which remained dry

Civil Works programme of the US Army Corps of Engineers 1

Navigation

Improving and maintaining the navigation capabilities of the Atlantic Intra-Coastal and Gulf Waterways and of the major rivers is a historic task of the Corps. One-sixth of the nation's freight is carried on the inland waterways, which are over 20,000 miles in length. The task involves the construction of locks (now normally 110 ft by 1,200 ft), the maintenance of water channels by dredging, snagging of debris, bank protection, buoying, and the control of civic, commercial or private development. The system is being steadily improved. For example, the original fifty dams and locks of the busy Ohio completed in 1929 are being replaced by nineteen modern structures. The Ohio already carries 100 million tons of freight a year. To illustrate the magnitude of the country and the potential of the major rivers to serve the interior, the Missouri alone is 2,315 miles in length and, joining the Mississippi at St Louis, the combined river is 3,484 miles long and the world's third largest river.

Power

Hydro-electric power generation is a feature of many of the Corps of Engineers' dams. Forty-nine generating plants provided 10 million kW which is one-fifth of the nation's total hydro-electric capacity. This power can be obtained without the pollution of the air caused by coal or oil-burning power stations, and without the cooling water and possible radio-active waste problems of nuclear plants. When the next twenty-two projects are complete, the capacity of the seventy-one plants will be nearly 22 million kilowatts. The use of pumped storage to generate power is receiving increasing attention. By this means water is pumped from a low pool to a high reservoir at periods of low power demand.

Water Supply

Water supply as much as flood control is becoming a major factor in any dam and reservoir project. So far, the Corps has completed 300 manmade lakes. Water is required for municipal, industrial and agricultural purposes. The need for water storage space in 1980 is predicted as being double what it was in 1960.

Recreation and Amenities

The lakes or reservoir-type water impoundments built by the Corps offer 4 million acres of water and 30,000 miles of shoreline for recreation; 400 parks have been established along these shores; 250 million people visited the lakes in 1969 and 700 million are expected to do so in the year 2000. Each dam and lake project is designed with recreation and the public interest in mind by the construction of look-outs camping and picnic areas, marinas, and by landscaping. In addition, the Corps has built 250 small boat harbours on the shores of the Great Lakes and in coastal areas. In the past the Corps included in its achievements the George Washington Memorial Parkway from Washington, DC, to Mount Vernon, Virginia, and in Washington the preservation of Rock Creek Park, the construction of the Tidal Basin, the building of the Capitol Dome, the completion of the Washington Monument, the building of the Lincoln Memorial, the Pentagon, and many others.The Corps have recently designed a means to preserve the American Falls at Niagara.

Relocation

As part of the penalty for taking over the land required for water storage, the people who live in the areas to be inundated have to be compensated or re-housed, road access has to be re-located to a standard which is as good or better than it was before, cemeteries have to be moved, wells sealed off, and generally the whole area completely cleared of buildings and vegetation. To achieve this with a minimum of friction entails the most scrupulous attention to public relations by giving early warning of intentions and convincing explanations of the long-term benefits to the region.

Fish and Wild Life

The conservation of fish and wild life is nowadays a part of all of these schemes. These endeavours now add up to 150 fish and wild life management areas with a combined area of 1¼ million acres. The dams are provided with fish ladders or lifts,

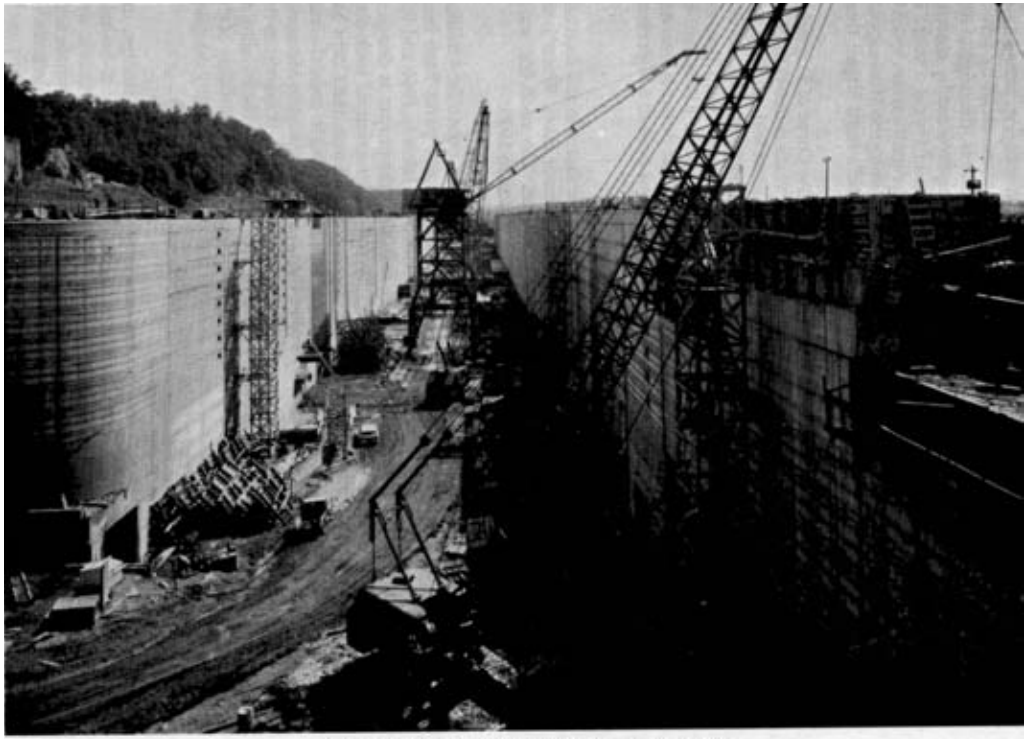

Plate 2. *Cannelton, Indiana.* Construction of lock

Civil Works programme of the US Army Corps of Engineers 2

the lakes are stocked, the rivers are kept running clear, fish hatcheries are stocked and provided with water at regulated temperatures, and areas are set aside as game refuges.

Pollution Control

Since the Corps controls the permits for the discharge of effluents to harbours and rivers, it is in a strong position to prevent pollution. Unhappily, the criteria until recently have only related to possible effects on navigation, and there is a tremendous problem to regulate water treatment abuses that have built up over the years. The Corps is co-operating in developing regional schemes to combat the menace of water pollution. Where appropriate, new dams include storage capacity for the quality control of streams and rivers by regulating the flow, thus preventing stagnation and diluting acids.

Coastal Engineering

Coastal engineering tasks include the major work of maintaining and developing the nation's ports and harbours, dredging the harbours, and preventing the erosion of beaches. Ninety per cent of the nation's coastline is in private ownership; the Corps is becoming involved in planning the conservation of the remaining unspoilt and underdeveloped stretches. A very major task is to protect coastal areas from hurricane floods and tidal surges.

Special Studies

A series of far-reaching and very important studies is taking place. In co-operation with other agencies, and under the guidance of the Water Resources Council, the Corps is preparing an inventory of the country's water resources and the framework of a development programme to meet all future water-related requirements. A special study is being made of the depressed Appalachian region stretching along the mountainous spine of the Atlantic States from Alabama to Pennsylvania with a view to designing a plan to use the water resources to induce healthy economic development. Another study is directed towards meeting the long-range water supply needs of the growing and vast urban concentrations in the North-Eastern States.

Disaster Relief

At the request of the Office of Emergency Preparedness, under the President, the Corps provides engineering assistance to localities affected by major natural disasters, such as hurricanes, tornadoes, and earthquakes. The Corps also supplements local resources in flood fighting and rescue operations. The Corps has the largest engineering force in the world, thoroughly experienced in all types of heavy construction, and already organized, geographically dispersed, and immediately available to respond to natural or war emergencies. As part of the Army, this force has immediate access to available resources of military forces, equipment, and supplies. Since 1963, the Army Engineers have been called upon for assistance in more than 100 disasters, over ninety of which have been caused by floods or hurricanes. Of the others, the Alaskan earthquake of March 1964 was the most serious.

THE ORGANIZATION

The Corps of Engineers has four directorates: Military Construction, Civil Works, Military Engineering and Real Estate. In addition, the Chief of Engineers has under his command the US Army Topographic Command. Military construction parallels our old Works Services, but includes much of the construction for the US Air Force. A very major task at the present time is the construction work for the Safeguard anti-ballistic missile system. Both the Military Construction and Civil Works Directorates turn to the Real Estate Directorate for assistance in land acquisition and related matters.

There are thirteen Engineer Divisions world-wide, of which ten are in the continental United States. Under the divisions are over forty districts. The military construction programme has recently been reorganized so that its control is concentrated in relatively few of the districts, leaving the others with the sole task of civil works. The divisions are commanded by generals and the districts by colonels.

Plate 3. *Cannelton River, Ohio, Kentucky Bank.* Dam construction inside cofferdam.

Plate 4. *Stockton, Missouri.* Dam under construction. Spillway on left

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The staff of the Office of the Chief of Engineers in Washington, DC, is relatively small, that of the divisions larger, and that of the districts considerably larger. The responsibility for preparing designs, drawing up contracts and supervising the work generally lies with the districts. Unlike military construction where standard designs are often usable, in civil works each project is different.

A typical district office has over 1,000 people. It has, amongst others, legal, real estate, engineering, construction and operations divisions. The engineering division develops the designs; construction oversees the work in progress; and operations runs the facility once it is completed. The office is usually located in a fine modern Federal building and is provided with excellent appurtenances including a computer, desk calculators, reproduction machines, etc. The predominant civilian element is entirely loyal to the Corps of Engineers and most of them devote their whole working life to the district. There are, in fact, very few military people to be found in any district. The Corps of Engineers are good employers and are rewarded by their civilians with devoted service, continuity, and an invaluable reservoir of accrued knowledge and experience.

The Civil Works areas of responsibility are defined by the water-sheds of the major rivers, which means that one district can have responsibilities in quite a number of States. The military construction responsibilities, however, conform with Army boundaries, which in themselves conform with State boundaries. As water is the dominant factor in the Civil Works programme, the difference is logical.

THE ADVISORY AGENCIES

The great responsibilities of the Corps of Engineers, if they are to be effectively carried out, require the backing of reliable and forward-thinking expert advisers and agencies. Many of the advisers are to be found within the Office of the Chief of Engineers and in the divisions and districts. This section, however, describes briefly some of the laboratories supporting the Corps. There are a surprising number.

The largest is the US Army Engineer Waterways Experiment Station (WES) at Vicksburg, Mississippi. It originated from the need to evaluate the problems of flood control from models. Now largely historic, the huge outdoor model of the Mississippi river basin is open to the public. Indoors there is a large model of New York Harbour. Today WES provides expert advice on hydraulics, terrain analysis, protective shelters, expedient surfacing of roads and airfields, flexible pavements, concrete, dust control, etc.

At Hanover, New Hampshire, is the US Army Cold Regions Research and Engineering Laboratory (CRREL). This laboratory provides advice on engineering in cold regions and has a test unit in Alaska. It has probably the largest library of works on cold region engineering in the world.

In Washington, DC, is the US Army Coastal Engineering Research Center. This centre has test tanks to help establish the best means of preventing coast erosion and constructing surge barriers. It also studies the problems of dredging the Intra-Coastal Waterway and harbours generally. Though nowadays it has useful and friendly links with the Hydraulic Research Station at Wallingford, England, at one time it was concerned with strengthening the sea coast defences against the British.

Established only in 1969, at Champaign, Illinois, is the US Army Construction Engineering Research Laboratory (CERL). This laboratory has been set up in association with the Engineering Department of the University of Illinois, and it is hoped that in time it will become the foremost centre of its kind in the United States. It is pioneering the whole life or systems engineering approach to construction. It is being equipped with a test bed for determining the best structures to resist earthquake shock, and with many supporting laboratories and workshops.

Then there are the Nuclear Cratering Group at Livermore, California, which studies the peaceful use of nuclear energy for construction; the Engineer Reactor Group at Fort Belvoir, Virginia, which developed a shipborne nuclear power station and trains all services in the operation of military nuclear power plants; the US Army

Engineer Institute for Water Resources at Alexandria, Virginia, for long-range environmental, ecological, and biological studies; and one or two others specializing in such subjects as rock mechanics, hydrology, paint, etc.

All of these are directly under the Corps of Engineers. Finally, there is the more complex relationship with the Mobility Equipment Research and Development Center (MERDC), broadly comparable to the Military Engineering Experimental Establishment (MEXE) before it became part of the larger organization of the Military Vehicles and Engineering Establishment (MVEE). Some aspects of the work of MERDC are relevant to the civil works programme, an example being materials research. The co-ordination of the work of the engineering laboratories is the responsibility of the Chief Scientific Advisor to the Chief of Engineers.

PARTICIPATION BY THE CORPS OF ROYAL ENGINEERS

Over the last few years, and by a friendly agreement made between a former Chief of Engineers and a former Engineer-in-Chief, we have been attaching a few student officers from the Long Civil Engineering Courses at the RSME for two years to the Civil Works Programme. This agreement is entirely in our favour and we are deeply indebted to the US Army Corps of Engineers for affording us this great opportunity. These officers start with one year in a district office becoming familiar with the organization, and preparing an original design for a structure to be built in the programme, followed by a second year spent in the field in a resident engineer's office on a major project. Since the physical work on all projects in the programme is invariably placed out to contract under the supervision of the Corps, our officers find themselves employed in this phase primarily as inspectors. The two phases of the attachment are designed in part to enable each officer to qualify for Membership of the Institution of Civil Engineers. But more importantly, the officers become familiar with the management of large projects, engineer design, the supervision of contracts, construction techniques, and the aids to design and quantity estimation afforded by computer programming. Perhaps above all, they become completely immersed in a professional world of great achievement, wide experience and splendid company. The photographs give some indication of the size of the projects in which they are involved.

Captain D. H. Philpott was the pioneer officer of the present scheme. In 1967 he began in the Louisville District office where he gained experience in flood protective works, dam foundations, designed a complicated prestressed concrete girder to support the trunnion bearings for the tainter gates of a large dam, and wrote useful papers on subjects such as slip-form paving, dust control, and the design of cellular cofferdams. For his second year, he worked with the resident engineer on the Cannelton locks and dam on the Ohio River. He was involved in the measures necessary to save the cofferdam in flood conditions.

In 1968, Captain M. F. J. Stephens began in the Kansas District. His first year in the office was spent on road relocation schemes, including the design, aided by computer programming, of a large reinforced concrete bridge, and a study of river bank protection. His second year was spent with the resident engineer on the Stockton dam project in Missouri, where he worked on the dam and on the road relocation projects, including a number of reinforced concrete bridges.

Now their successors, Major J. N. Leivers and Captain C. P. Allain, are in the same Districts. The first is working on the Cave Run dam in Kentucky and the second will go out on the Harry S. Truman dam project in Missouri this year. It has recently been agreed that an officer from the Long Electrical and Mechanical Course should do a parallel attachment. He will go to Oregon where he will work on the expansion of the Dallas hydro-electric power plant on the Columbia River from a capacity of one million kW to 1·8 million.

The pattern for all five of these officers accurately illustrates the central place of water in the Civil Works Programme. It is an inspiring and tremendous enterprise in a vast country the size of a continent.

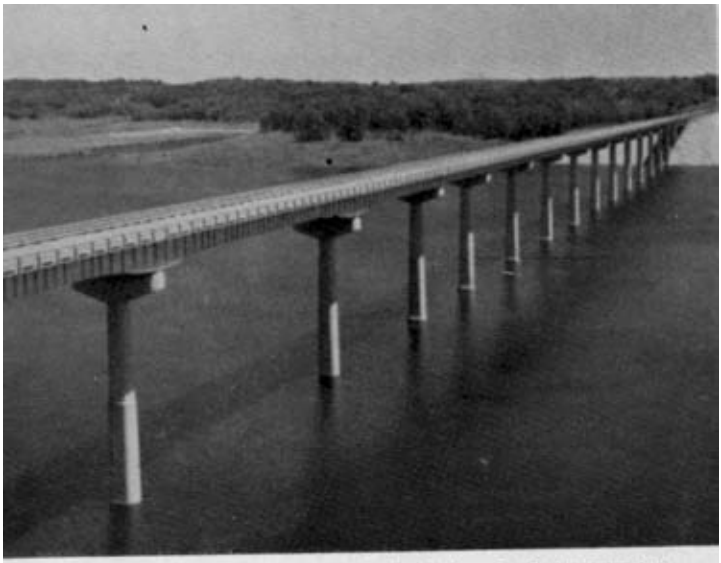

Plate 5. *Stockton, Missouri.* A large relocation bridge of typical construction.

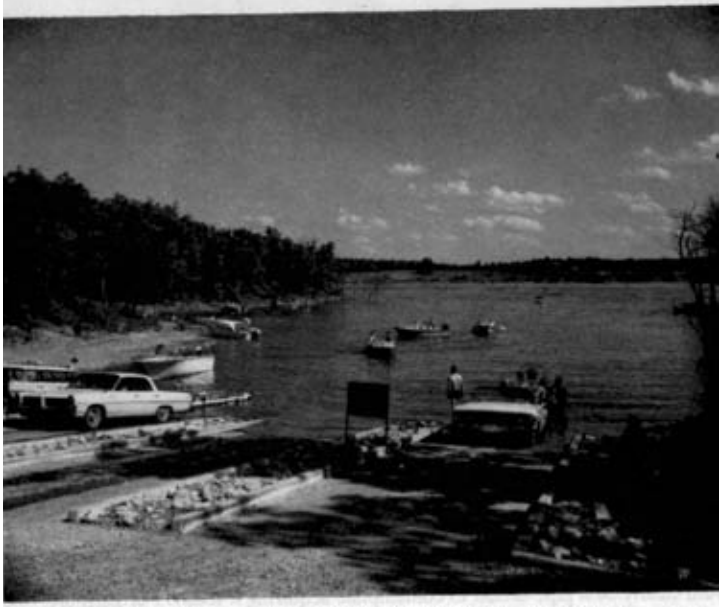

Plate 6. *Missouri.* Boat ramps at a Corps of Engineers reservoir

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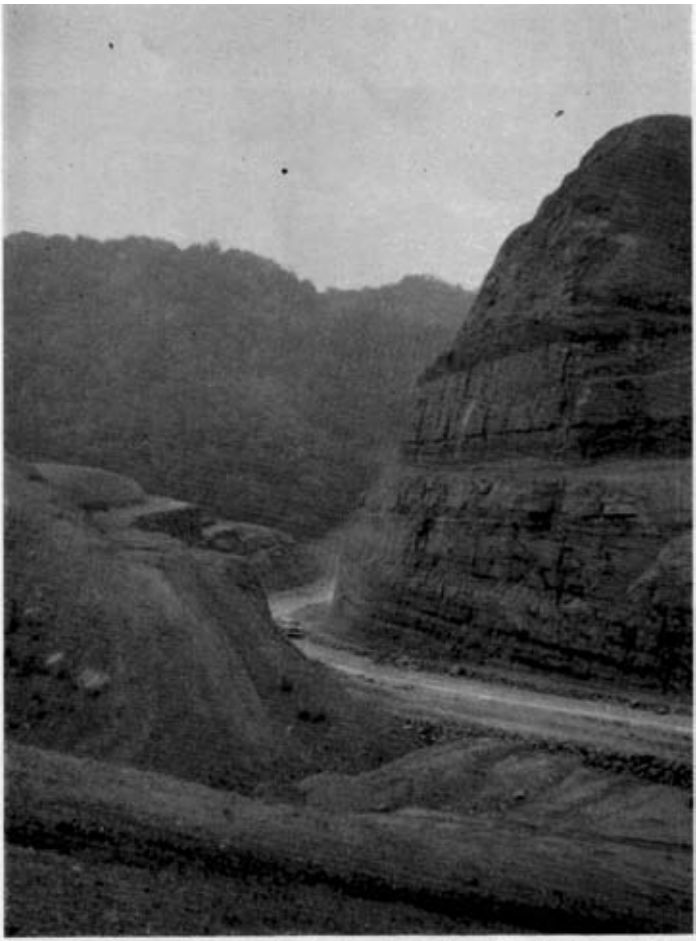

Plate 7. *Cave Run, Kentucky.* Road re-location. Cutting through rock with pre-split faces

It is easy enough to wish that in the United Kingdom the Royal Engineers had inherited from history some of the challenging tasks comprising the Civil Works Programme of the US Army Corps of Engineers. One could wish for similar satisfaction in helping to meet the needs of our Nation too in developing its water resources, in flood control and for consumption, power, transportation, recreation, and for the quality control of rivers and streams. We would similarly amass experience in engineering management and techniques. Yet, not having inherited this function, it would clearly be a pipe-dream to contemplate acquiring it today. Furthermore, one might ask whether it would not divert attention from our primary role, which is to

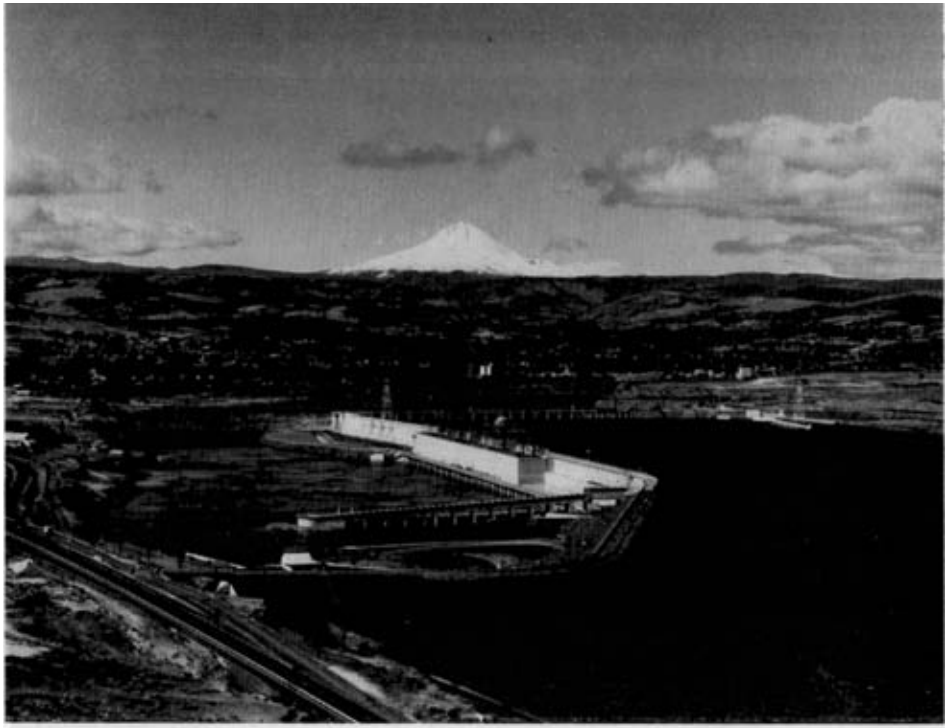

Plate 8. *The Dalles Oregon.* The Dalles Dam on the Columbia River with Mount Hood (11,235 ft) in the background. The navigation lock with a lift of 87·5 ft is on the right, the powerhouse parallels the river at the center

Civil Works programme of the US Army Corps of Engineers 8

Plate 9. *The Dalles, Oregon.* Powerhouse at the Dalles Dam on the Columbia River currently extends 1,462 ft and houses fourteen main turbine-generator units. When the installation of eight new units is completed (at the far end of the powerhouse) the total length of the powerhouse will be 2,150 ft. Width of the powerhouse is 75 ft and its total height from 15 below sea-level to 217 ft above sea-level is 232 ft. The Dalles Dam was constructed and is operated and maintained by the Portland, Oregon, U.S. Army Engineer District

Civil Works programme of the US Army Corps of Engineers 9

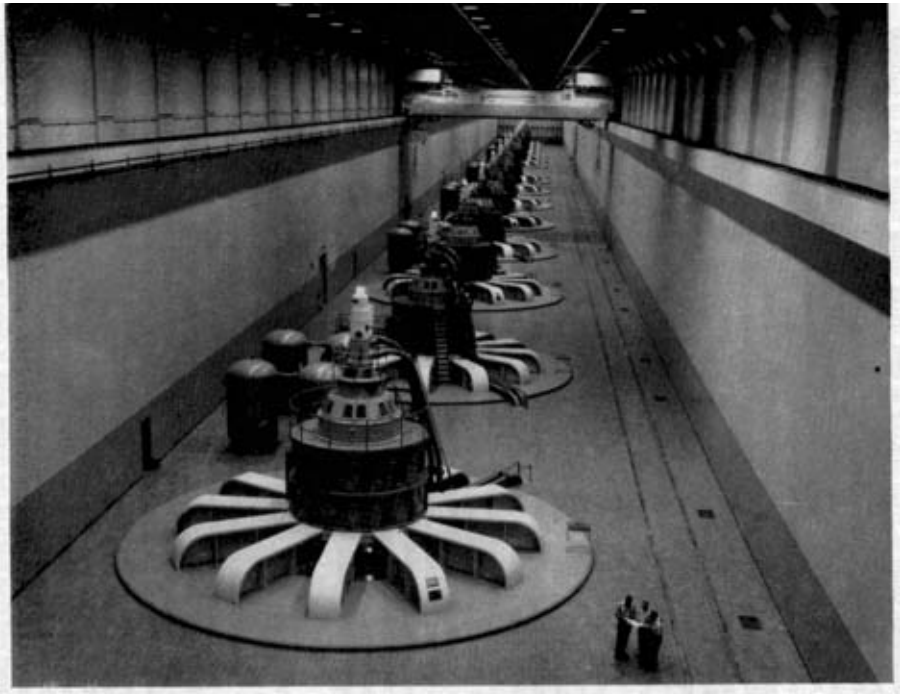

Plate 10. *The Dalles, Oregon.* Interior photograph of the powerhouse at the Dalles Dam. When installation of eight new units is completed the powerhouse will extend from its present 1,462 ft length to 2,150 ft. The generators shown have nameplate ratings of 78,000 kilowatts each. The room housing the generators is 75 ft wide and 73 ft high

support the Army in war. It is not, for example, essential that senior Sapper officers generally should know the intricacies of financial and contract procedures or land acquisition; or more than desirable that they should have extensive experience in public relations in the context of such a web of almost exclusively civil interests. On the other hand, it would be of great value for more Sapper officers to obtain professional experience in engineer design, quantity calculations, costing, project management and quality control; it would be of the greatest benefit if our units or groups of tradesmen could be given practice in their trades whilst doing work of national importance.

By comparison with the USA, the land area of the United Kingdom is minute, densely populated, and heavily developed.

Are there then any aspects of this great American Civil Works Programme which, even though on a much more modest scale, could be applicable to the Corps of Royal Engineers? There could be at least three. First, the peacetime geographical coverage of the home country by an experienced military engineer organization is of tremendous importance because of its ability to help deal with disasters, with major damage, and with the unexpected in peace and war. Without wishing to detract from the fine Sapper response to calls for flood disaster relief over the years, one wonders how well the United Kingdom in general is prepared for these contigencies today. Second, there must be a number of tasks, possibly in remote areas, where military engineer units could do useful work in peace in the home country as well as overseas. Reclaiming land from industrial misuse or from the sea, and the prevention of coastal erosion would appear to be possibilities. Third, with more leisure, more money and easier access to the sea and country, there will be a rapidly increasing popular demand for outdoor recreation. The efforts being made to meet this demand in the United States appear to have no parallel in scale in the United Kingdom. Here, it would really seem that the Corps of Royal Engineers could help in the national parks and other areas by building hostels, rest areas, camp sites, picnic areas, trails, swimming beaches and pools, marinas, small boat harbours, and scenic look-outs. These tasks would exercise many skills and provide good management experience; they would give satisfaction to both Sappers and the public; and they would be less likely to be in conflict with employers or trades unions. It would be a fine theme in keeping with the times: helping to improve the environment and the quality of life for the people of the United Kingdom.

THE BURDEN OF RESPONSIBILITY

Within fifty years, the population of the United States will double itself to reach 400 million. Seventy-two per cent of the present population live concentrated into 2–3 per cent of the nation's land area. The use of water doubles every ten years and the population grows at the rate of one city of a quarter of a million per month. With these stark facts in mind, and with so many enduring achievements to its credit, it is paradoxical to find that the US Army Corps of Engineers is often the target of criticism and seldom acclaimed as a benefactor in providing for the future of the nation, except immediately in the aftermath of some national disaster. How does this situation come about?

There are those who do not understand why military engineers should be the principal Federal agency for construction and question why they should be involved in the programme at all. In fact, as has been seen, the Corps of Engineers are the managers of the programme; almost all of the construction work is carried out by contract and even much of the design work is done by architect/engineers. It cannot be argued that the Corps is depriving anyone of work of that it is using troop labour. It can only fairly be asked whether a similar number of managers out of uniform, say from the Department of the Interior, could do the job equally well or better. The Corps, however, stands by its record of good management, high integrity, economic effort and unbroken success. For the sake of a whim or a principle, it would be a dangerous or even foolhardy decision to demolish such a successful organization,

well proven to be able to meet national emergencies. Furthermore, if the Corps lost this testing ground for large-scale construction management, it would be at a grave disadvantage when it came to face incomparably greater tasks in war. However, there is an important proviso which is that the Civil Works function must never become so predominant that the primary role and justification for a Corps of Engineers, as a force of military engineers to support the Army in war, should be allowed to take second place.

But there are others, often only very partially informed, who criticize the detail rather than the principle. They ask why large areas need to be inundated to provide water when water could be desalinated from the sea. They ask why hydro-electric power schemes are necessary in an age of nuclear reactors. They do not see why dams and levees need to be built for flood control since they argue that all that is necessary is to ensure that people do not live in the flood plains, or perhaps to ensure that ground cover vegetation is properly planned. They do not like to see rivers straightened out for navigation purposes. They fear the effects on the ecology of a major work such as the Cross-Florida Barge Canal now being built. They criticize the manner in which the dredgers dispose of the silt from the harbours and navigation channels.

Then there are some who criticize the Corps for lack of imagination in its designs. They ask, for example, why nearly all the dams are built of the impervious core gravity earth dam type of construction. Where mass concrete gravity dams have been built, they wonder whether aesthetically more pleasing results could not have been achieved by using slender reinforced concrete arch dams.

Yet another criticism is that the Corps has been misled by aspiring Congressmen and others into obtaining approval for projects which gave the promoters local kudos but which were not strictly necessary. The truth is, in fact, the opposite; the Corps, as a Federal Agency, is impartial and unlikely to be susceptible to State and regional pressures.

There is never a single project that does not have some element of controversy connected with it. To all these multitudinous criticisms, the Corps responds with carefully reasoned written answers, briefings and press conferences explaining in detail why projects are being undertaken, the basis for the selected design, and the long term benefits to the local community and the nation. Some District Engineers spend more than half their time on public relations. In effect, the Corps is deeply involved in the prevailing national concern over the environment, over the pollution of the land, sea and air, and the need for the conservation of the natural beauty of the land. If it was ever true that these aspects were neglected in the urge to progress rapidly in the development of the nation's natural resources, then this is most certainly not the case today. One important change is that the criterion of efficiency or least cost is no longer over-riding in the Corps' analyses; contracts now take the need to preserve the environment into account as fully as possible.

CONCLUSION

The professional integrity and effectiveness of the US Army Corps of Engineers are not held in doubt. The Corps' success in the Civil Works Programme is there for all to see and is so impressive that it is almost inconceivable that it should ever cease to have this function. The Corps is likely to continue as the major Federal construction development agency for the management of natural resources. It will become more and more concerned with the long-range problems of meeting the needs of the expanding population, with environmental problems, with fostering the dispersion of the population away from the over-crowded cities to comparatively empty areas with great potential such as the Arkansas and Missouri River Basins, with assisting in raising the standard of living in the depressed regions such as Appalachia, with developing Alaska, with balancing the needs of the cities and of the rural areas, and with whichever other tasks are put to them by the President and Congress.

"The Corps of Engineers is essentially a development agency seeking to promote the total general welfare and enhance the quality of living of all our people."[1f] "The Corps' sole purpose is to serve the public welfare and carry out the public's wishes."[3] At the same time, the civil works programme allows the Corps "to keep together an organization with tremendous potential for construction leadership available in time of emergencies",[1e] and a continuous means of training officers for large-scale engineer management in peace and war.

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[1f] This refers to [1f] in the Bibliography

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A Hundred Years Ago

MATA KACHA

Two numbers of the *Journal* were brought out in the first quarter of 1871; the new venture was gaining momentum and its appearance was henceforth to be a monthly event. Interest still focused on the war now drawing to its close in France and on the lessons to be learned from it—most pertinently, perhaps, that the Corps should be augmented with a view to being more frequently employed in conjunction with the other branches of the service, and so being better prepared to act with an army in the field. At the time the sapper strength was so restricted as to be scarcely sufficient for the Colonial garrisons, the fixed fortifications, and barrack construction and maintenance.

Our revolutionary (noticed in the previous review) continues his argument on this very theme, observing that ever since the Crimean War the RE companies had been chiefly engaged in the construction of large defence works to guard the dockyards and arsenals, in repairs and petty constructions at military stations, on the Ordnance Survey, at the SME and, latterly, on the telegraph network under the Post Office. He now proposes that a sufficient number of his "field" companies be created to enable at least one to be immediately available for service with each army division. Of these, one should be maintained permanently on a war footing and furnish a model for all others. It might (he suggests) be attached to the Brigade of Guards and assume the status and style of "Sappers of the Guard", similar to those to be found in the armies of major sovereign continental Powers. A romantic might be excused for thinking that he had something there.

With the exception of those specially assigned to the Survey and Telegraphs, all RE units should be employed in peace on works, at which they could readily be relieved by civil labour in the event of mobilization. "Who can deny" (he challenges) "the economy of using at all times a machine kept up for one time only, for war", notwithstanding that, as a general rule, military labour could not compete with civil on a cost-for-cost basis? "Not so" (footnotes the Editor), "with proper and careful supervision military labour *must* be cheaper than civil." Unmoved, the writer continues to expound that, since the programme of major new construction must fluctuate and be unpredictable, the normal occupation of the companies must be found in the routine construction and repairs to War Department property in and around their respective stations. "Not so" (booms the Editor 'de profundis'), "repairs are the *worst* work at which to employ sappers, both for discipline and other reasons." Perchance the proposer pictured his "Sappers of the Guard" peacefully and in model fashion attending to the "petty" maintenance of the Royal Palaces, where their duties would surely have embraced that of operating the Royal Laundry Establishment at Richmond, which (if we credit the *Richmond and Twickenham Times* of 24 April 1970) had been staffed by Royal Engineers since its inception in 1849. This installation, a brain-child (inevitably) of the Prince Consort, processed annually some 700,000 pieces of linen alone from Windsor, Buckingham Palace, Osborne (in the Isle of Wight) and other Royal Households. Powered by a steam engine, the machinery included a giant mangle, said to have cost all of £60 and described as "the most perfect machine ever made"; while collections and deliveries were effected daily by special trains running from Richmond station.

From its very beginning, "the works" had dictated the structure, distribution and occupations of the Corps; and its resultant predominantly static role was reflected a hundred years ago in the title of Inspector-General of Fortifications, its executive head. In these pages of the *Journal* we are witnessing the first whispers of a wind of change, which would not blow itself out until, in 1963, the last peace-time responsibilities of the RE Works Services were swept into the arms of the Ministry of Public

Building and Works. Meanwhile, the first four field companies came into being in 1877, when "B" Troop of the Train was broken up to provide them with the necessary mobility. The earlier obsession, however, pervaded all the multifarious diversifications of the Corps' activities which realized themselves in the ensuing decades. An unending tale of miscreant sappers in the widest variety of roles have answered to charges framed identically under Section 40 of the Army Act in that they were (for example) idling, or improperly dressed, on, or without leave absent from, or quit "the works"; while a ceaseless succession of Serjeant-Majors have, irrespective of the setting, dismissed prisoner and escort with the timeless formula "Break-off and join the works". Does this endearing tradition persist in the nineteen-seventies?

The proposal before us lifts a corner of the curtain on a scene of domestic friction over Working Pay, the fair and proper allocation of which seems at that date to have presented something of a problem. "The case frequently occurs of a weakly mechanic working side by side with a lusty ex-navvy and receiving more than twice the pay for half the work." The pay of the sapper should be slightly increased throughout and every NCO and man required to work at any but a skilled mechanical task without extra remuneration. There would then be no cause for complaint when all were not "on the works". When employed at his trade the skilled mechanic would be paid at the appropriate rate, but at military engineering, and in war, no one should receive extra pay. "These are but ideas" concludes the seer; what confusion in the pay office!

While the Royal *dhobi* puffed its daily way in and out of Richmond, thoughts were being turned to the utilization of railways in war, which (allows a condescending contributor) may be regarded simply as an additional means of transport. Now, General Hamley, in the first edition of his famous *Operations of War* in 1866, had already taken note of the tactical role played by the railroads in the Franco-Italian War of 1859, and to a greater extent in the American Civil War (1861–1865), but it required the large-scale strategical involvement of the Prussian State Railway system in the war of 1870–1871 to attract serious attention to this subject at home. An article here recognizes the impossibility in an England of private enterprise of legislating such an organization into existence, but pleads for careful study of the problems in peace, and for the creation of a nucleus of specialist railway troops as part of the Engineer Corps. Eleven more years would elapse before the 8th Company RE was converted to this function for service with the expeditionary force dispatched to Egypt under Sir Garnet Wolseley in 1882. This was to be followed three years later by the 10th Company, sent out for work on the contemplated Suakin–Berber line. As in the case of the field companies, these things take time.

Another author examines the potential of road-steamers and railways for military purposes, deducing that a small 6-horse power engine, competent to pull 15·8 tons up a slope of 1 in 11 can be made to draw 16·75 tons up the same slope and work at all times with far less jar and noise by the expenditure of £195 on tyres. Drawing on the experience of the war in France, he predicts the employment of these machines to bring the heaviest natures of artillery into the field, travelling at 5 or 6 miles per hour on fair roads. Sadly he confesses that such optimism may be open to ridicule, "but stranger sights than guns of position horsed by engines may yet be seen in war". Sappers of a later generation of Road Construction Companies, who steamed their rollers away to safety before the advancing Germans at Amiens in March, 1918, may well acclaim their prophet in these words.

Turning to railways, he gives us his opinion that the line laid down during the late war in Abyssinia was "more or less a failure . . . chargeable to the nature of the equipment, which we think may be stated to have been the most unsuited to the purpose required that could possibly have been furnished". He thereupon advocates the development of a narrow-gauge equipment specially for field use, drawing attention to a variation of the monorail system advanced by a certain Mr Fell. The accompanying line drawing supplies us with the first example of an illustration to be found in the pages of the REJ. The principal advantages offered by this proposition were the

great latitude permissible in tracing an alignment, and the reduction of earth-work in the formation, both to be achieved by adjusting the length of the supporting columns to match the undulations of the ground. Who this Mr Fell was we have been unable to ascertain; his ideas are described as "perfectly undeveloped", but we cannot believe that they went long untried, for this was above all an era of experiment.

Before the advent of centralized Ministry Experimental Establishments, the Corps stood foremost among the Country's scientific nurseries; and diverse indeed were the subjects of trial and enquiry simultaneously in hand. Here is notice of the introduction of a new pattern 5-inch theodolite, "on Everest's principle, with improvements due to Lieutenant Grover RE". Everest made his name in the earlier part of the century on the Survey of India and left it on the highest mountain in the world. Grover appears in the List as "specially employed at South Kensington". On another page a nameless investigator records the outcome of his macabre inquiries into the wounds produced respectively by the French Chassepot and the Prussian Needle-gun bullets. His "Medical friend in Metz" enjoys the same notorious obscurity as the "Military Spokesman in Cairo" of World War II. At Chatham we find the ingenious Lieutenant Abney, subsequently Director of Science at the South Kensington Museum, pursuing his experiments in the fields of chemistry and photography. This was the future inventor of the clinometer and level which bear his name, as well as of a photo-lithographic process to be adopted at all stations observing the Transit of Venus in 1874. In this issue of the *Journal* he presents us with a complex mathematical formula with which to calculate the effect of guncotton charges fired under water at varying depths. From an instantaneous photograph of the column of water raised at its greatest height he contrived to obtain a "tolerably accurate" estimate of the explosive force generated. No doubt Abney made use of the new Dynamo-electric Mine Exploder, weighing no less than 28 lb, which, we are told, had been adopted in place of the old and unreliable frixtional machine with its associated condenser arrangement of Leyden jars.

Diving from the steam-launch *Ware* off Cardiff, Lieutenant Moore with a party of two NCOs and two sappers had just completed the systematic demolition of the submerged wreck of the iron steamship *Golden Fleece*. Whether or not they tried out the Abney formula we cannot know; they effectively disposed of 4,800 lb of guncotton and 12,000 lb of powder and took nearly a year to assure a clear navigable depth at low water of 18 ft, at a cost to the Trinity Board of rather less than £2,000. Lieutenant Nugent and his friend Captain Hatchell, of the 43rd Light Infantry, were less fortunate in their dealings with the sea, both being drowned in Cork Harbour while pulling ashore from their yacht one dark and stormy night. "It is believed", reads the report, "they stood up in the punt to change places and capsized her by doing so." This, as others have learnt to their cost, is an experiment which frequently fails disastrously.

All in all this excursion into the past reveals a diversity of occupation and of interest which the Lansdowne Committee of 1870 on the employment of RE officers found right and proper, recommending that the establishment of the Corps should be so cast as to provide, over and above the requirements of the companies, a substantial number of officers to be available for extra-regimental duties. Although, under the current Regulations, sapper officers were eligible for appointment to the General and Administrative Staff of the Army without holding a Staff College certificate, there persisted at that date a prejudice against Engineer officers filling such posts. It seems paradoxical that, whereas the instructors in military subjects at the Staff College were almost exclusively drawn from the Corps, no RE officer appears to have been through the course prior to 1874. In the Roster we search in vain for a single G or AQ staff posting, but a Return here published lists some 200 RE officers who had held, or were holding, special appointments outside their Corps, ranging from Serjeant-at-Arms in the House of Commons to the organization of Special Constables, and from Governors of Royal Princes to a humble Instructor in Drawing at Woolwich.

"On the works" a generation of scientifically gifted extroverts were busy harnessing steam and electricity, and the expanding technology of their age, to the Service of the Crown. That the men were no less versatile than their officers is evident from the appointment, dated 3 January 1871, of Quartermaster-Serjeant F. D. Hamilton, Royal Engineers, to be Apothecary to the Forces, vice E. Rickards, deceased.

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Society in India Long Ago

LIEUT-COLONEL E. W. C. SANDES, DSO, OBE, MC

"A SOLDIER should be as attached to, and careful of, his musket as his mistress", wrote the Directors of the East India Company in 1770, choosing a metaphor which they knew would appeal to their men.

Female companionship was sadly lacking, though not so scarce as a century earlier when the Directors had decided to send out some of the "civillest" Englishwomen they could procure in a praiseworthy effort to found a colony in Bombay. "And for such single women or maides as shall now come unto you", they wrote, "we order that if they desire it or do not otherwise dispose of themselves by marriage to Englishmen, that then for one year after their arrival they shall have victuals at our charge, with one suit of wearing apparel, during which time they are to be employed in our service as you shall think fit: and we do not consent that the said English women or maides be permitted to marry any other people but those of our Nation or such others as are Protestants."

Twenty young women "of sober and civil lives" eventually reached Bombay; but within a few months they were reported "to have grown scandalous to our nation, religion and government", and the authorities were ordered "to give them fair warning that they do apply themselves to a more sober and Christian conversation: otherwise, the sentence is this, that they be confined totally of their liberty and fed with bread and water till they are embarked on board ship for England". This threat seems to have been quite effective, for most of the maidens married soon afterwards. The Directors, however, were not content to rest on their laurels. In 1678 they gave free passage to Madras to three single women who said on arrival that they had not the least idea why they had been sent out, but that, having arrived, they expected the Company to maintain them. The Council had to admit liability and agreed to give them free board and lodging, and to pay them each ten shillings a month, until they could find husbands, which they lost no time in doing.

The Company's hold on India was then so precarious that its servants were advised to be most humble in their dealings with the powerful native potentates around them, and particularly in the matter of correspondence. The opening paragraph of a letter from the Governor of Bombay to the Emperor Aurangzeb shows the result. "The petition of the least of your servants, Sir John Child, like a grain of sand and with the greatest regard for your Majesty's Person, Amber-like Influence, Lord of Beneficence and Liberality, Solomon-like Throne, Epitome of Priesthood, Heavenly Judgement, Potentate of the World, Centre of Security, Emperor of the Earth and of the Age, Object of all sub-lunary things, the Divine Shadow of the Holy Prophet Mahomet, whose person and kingdom the Divine Powers long prosper that his righteousness and justice may spread over the whole world and everlastingly continue for the benefit of its inhabitants, *Representeth*, after due recommendation of servitude and vassalage, with humility and lowness of mind, kissing the floor of all servile offices with lips of respect and obsequiousness, and with a head bowed down to your Fame and Greatness, etc, etc." It is surprising that any Englishman could be induced to grovel to such an extent, although it may have been the fashion of the country.

In spite of their miserably low scales of pay, the Company's employees wasted much money on drink. "We are sorry to hear", wrote the Directors in 1711, "that of late there has not been a Sufficient Decorum kept among our people and particularly among the young Writers and Factors, and that there have been Files of Musqueteers sent for to keep the peace at dinner time." A few years later a certain Ensign Clarke was accused of "incorrigible sottishness" in being "so much disguised by liquor that he was incapable of doing his duty". Many tried to drown their sorrows in *arrack*, a liquor distilled from molasses. Some even experimented with *arrack*

flavoured with different meats. They could choose between "spirit of deer", "spirit of mutton" and "spirit of goat". These disgusting concoctions derived their distinctive tastes from lumps of raw flesh thrown into the vats in which the *arrack* was being distilled. "It is a wonder to us", wrote the Directors, "that any of you live six months to an end, or that there are not more quarrellings and duellings among you if half the liquors charged by the steward are really guzzled down. It is positively affirmed that you have good water, and it is further said that a little tea boiled in the water doth admirably correct it, and that water so drank would contribute to the health of those who used it." Duelling was common. In 1721 a naval squadron under a very choleric Commodore sailed into Bombay harbour. "Bombay Island was now thronged with the Navy officers", remarks a contemporary writer. "These looked as much superior to us as the greatness of their ambition could possibly lead them. There were daily duels fought by one or other of them, and challenges perpetually sent round the island by the gentlemen of the Navy". From every point of view, the expectation of life was short, and most of those who failed to amass a fortune in a few years left their bones in the country.

Senior officials lived in great state. "Female choristers seem to make up the equipage of any great man when he goes abroad", writes Thomas Salmond in 1724. "Every man of figure in the country has a number of these singing women running before him, and the Governor of Fort St George is sometimes attended by fifty of them as well as by the Country Musick when he goes out, though some of our late Governors, out of their excessive modesty, have thought fit to dispense with this piece of grandeur. The Governor has as much respect paid to him at his going abroad as a sovereign Prince. The guards are drawn out, the drums beat as he passes by. Fifty or sixty armed blacks run before him, and some of the likeliest young fellows he can pick of the European soldiers, armed with blunderbusses, run by the side of the palanquin he is carried in. A numerous train of servants also, and the Country Musick, attend him, and with their harsh untuneable trumpets give notice of his march. This Musick is a privilege bought by the Company at a very great charge and is therefore kept up, it being looked upon here as one of the greatest Marks of Grandeur that can be; but it is far from agreable to any of the Europeans."

In the middle of the eighteenth century, Clive reigned supreme in Calcutta, maintaining his prestige by lavish expenditure combined with a judicious display of strength. The unfortunate Directors had to foot any bill he saw fit to submit, and in this connection some of the items appearing in an account for 50,000 rupees spent on entertaining the Nawab of Bengal are worthy of record:

	Arcot Rupees
To 9 large Looking Glasses	517
To Nabob's diet..	657
To 101 Gold Mohurs gave to Nabob	1515
Waxwork:-	
To 12 standing Venuses to pull off behind	840
To 6 kissing figures	72
To 8 ladies under glasses	160
To 2 ladies richly dressed in silver, playing two tunes ..	2080
To purchasing a coffre (slave) boy	500
To 70 maunds (2 tons) wax candles sent to Nabob ..	3430
To presents to people who brought presents	310

Among the Englishwomen venturing on the six-months' voyage round the Cape was a certain Mrs Jemima Kindersley, who gives her impressions of Madras while on her way to join her husband in Bengal. "It is without exception the prettiest place I ever saw. The town is laid out in streets and squares: the houses are neat and pretty, many of them large: in all the good houses the apartments are upstairs and all on one floor: the rooms are large and very lofty: most of the houses are built with a *verander*.

But what gives the greatest elegance to them is a material peculiar to the place: it is a cement or plaster made of shells of a very large species of oyster: these shells, when burnt, powdered and mixed with water, form the strongest cement imaginable. If the cement is to be used as a plaster, they mix it with whites of eggs, milk and some other ingredients, and when dry it is as hard, and nearly as beautiful, as marble. The mode of living is so extraordinary that I can scarcely believe myself among English people. I shall only say they are expensive in horses, carriages, palanqueens and number of servants: are fond of entertainments, dress and pleasure: sociable with each other: and hospitable and civil to strangers."

In Bombay also life was gay and indolent, if often brief. "The hours of business", writes James Douglas, "were from sunrise to 1 p.m. when its cares and troubles were laid aside and our breeched and wigged citizens, and our patched dames and demoiselles, spent their time, like little children, in eating, drinking and sleeping. The hour of universal satisfaction was 1 p.m. when dinner was served. After this came the *hookah*, the gurgling sound of which had a wonderfully soothing effect and sent the guests to sleep. They rose like giants refreshed and sallied out to walk, ride or drive on such oxen-drawn vehicles as were available near Bombay Green. Fortified with the fresh sea-breeze along the Back Bay sands, or a lounge at Mendham's Point, our diners returned at eight o'clock to attack the ghost of the midday feast, and if they could not eat, they could drink the strong wines of Portugal, the consumption of which contributed to swell the mortuary returns. To hunt the tiger from his lair in Salsette: to course the hare on Malaber Hill: to play cards and drink sack or *arrack* punch in a bungalow on the Thana Creek until all was blue: to sit and moon over some speculation to Bantam or Amboyna: to weary your life out for an hour under a hair-dresser so that you may appear the cynosure of neighbouring eyes in curl and bagwig at Parel or the Royal Bastion at the witching hour of sundown: or peradventure on a Sunday at Church, as you sat with your feet on the old cow-dung floor gazing listlessly on, but not through, the oyster window-panes, to hear from the pulpit the sentence which debars you from Communion: to drive from the Breach to the ballroom in a bullock garry and return with lighted flambeaux: and if you survived the ten or twenty years' conflict, to see *Hic Jacet* written over almost every friend you knew or cared about: such were some of the environments of the Bombay merchant."

Captain Innes Munro, a newcomer to India, gives a rather prejudiced description of Madras society as he found it in 1780. "An entertainment by the Governor, or any other gentleman of consequence, is really a curious spectacle. It is the custom for each guest to go thither attended by all his retinue of servants who wait upon him at table in great pomp, the head *dubash* (steward) taking post directly behind his master that he may convey his orders to the rest who are all arranged in rear as far back as the diningroom walls. This ridiculous fashion, together with the steam of the meat, renders the room intolerably suffocating and disagreable during dinner. A foreigner at first feels quite in pain when he is obliged to ask for anything at table, for the sign is no sooner made than twenty servants get into rapid motion, all darting at one object. Every liquor that is brought to a great man's table, even the water, is cooled with saltpetre, for the art of wine-cooling is a distinct profession in itself. When the cloth is removed, all the servants, except the *hookerbedar*, retire and make way for the sea breeze to circulate, which is very refreshing to the company whilst they drink their wine and smoke their *hookers*. This instrument is trimmed and set in order by the *hookerbedar* who has no other profession and who sits on his hams at a distance in rear of his master adjusting the *chillum*, as they call the different ingredients, whilst he conveys the coral pipe to his mouth which at every whiff sounds like boiling water. When a young lady arrives at Madras she must, in a few days afterwards, sit up to receive company, attended by some beau as master of ceremonies; which perhaps continues for a week or until she has seen all the fair sex and gentlemen of the settlement. This is a favourable opportunity for the display of folly and extravagance, the ladies vying with each other who shall put their husbands or parents to the most

expense. They are seldom seen before, and never visit until the candles are lighted up in the evening; and then four or five are quite sufficient at one time to fill up all the couches and chairs in any house, being obliged, from the extravagant width of their bell-hoops, to sit three or four yards asunder."

Mrs Eliza Fay, on the other hand, was pleased with what she saw when passing through Madras. "The ladies are very fashionable, I do assure you," she writes, "and I found several novelties in dress since I quitted England which a good deal surprised me as I had no idea that fashions travelled so fast. It is customary to take the air in carriages every evening for excursions in the country; but in town they have Palanquins, carried by four bearers, which I prefer. These are often beautifully ornamented and appear in character with the languid air of those who use them, which, though very different from any thing I have been accustomed to admire in a woman, yet is not unpleasing in a country the charms of which are heightened by exhibiting a view of society entirely new to me."

In Calcutta, Mrs Fay and her husband soon fell into the ways of the country. They dined always at two o'clock, the table being spread usually with a large tureen of soup, a roast fowl, some curry and rice, several tarts, cheese, butter and bread and a bottle of Maderia. Prices were remarkably low. A sheep cost two rupees. For one rupee you could buy either a lamb, six fowls, twelve pigeons, twelve pounds of bread or two pounds of butter. Hot curries, grills and stews were popular and a good deal of wine was drunk during dinner; but afterwards, when the cloth had been removed, very little was consumed except at bachelors' parties. From 4 p.m. to 5 p.m. the streets were almost empty of Europeans as most of the men, and all the women, were asleep. Then followed the evening airing on horseback or in carriages on the dusty *maidan* and several cups of tea after return home. Cards or music filled the gap until supper was served at ten o'clock. The most popular game among the men was Five Card Loo played for high stakes. The women preferred Whist. Formal visits were paid in the evening. They were generally very brief because each lady probably had a dozen or so to make. Men also called occasionally to pay their respects, and if asked to put their hats down, were considered as invited to supper. Many a hat could be seen dangling for half an hour in the owner's hand before all hope was abandoned and a dignified exit made.

Mrs Sophia Goldborne, another graphic correspondent, adds to the picture of Calcutta society. "I have been to church, my dear girl, in my new palanquin", she writes in 1789. "There, all ladies are approached, by sanction of ancient custom, by all gentlemen indiscriminately, known or unknown, with offers of their hand to conduct them to their seat. Accordingly, those gentlemen who wish to change their condition (which, between ourselves are chiefly old fellows, for the young ones either choose country-born ladies for wealth or enrich themselves in order to be united later to their favourite dulcineas in their native land), those gentlemen, I say, on hearing of a ship's arrival make a point of repairing to this holy dome and eagerly tender their services to the fair strangers; who, if this stolen view happens to captivate, often without undergoing the ceremony of formal introduction, receive matrimonial overtures and become brides in the utmost possible splendour, have their rank instantaneously established and are visited and paid every honour to which the consequence of their husbands entitles them. Thus you are liable to be plundered of your consent any evening of your life, and so, being married in haste, left to repent at leisure."

The kit recommended for a voyage to India was formidable indeed. "The young adventurer", writes Innes Munro, "should carry with him as much light cloth and other furnishings as will be sufficient for three or four coats, a few fashionable waistcoats, three hats (two black and one white), four pairs of boots, twelve or eighteen pairs of neat shoes, a few pairs of silk stockings, a neat saddle and bridle with a strong bit, and spare girths and straps. A fowling piece and a few books should be added. For the requisite conveniences on board ship, however, he should in the first place complete his stock to one dozen ruffled shirts for particular occasions, and

three dozen plain ones. He should likewise have a few black stocks or neckcloths, two pairs of dark fustian trousers, and six neat white ones to button at the ankles, with his former stock of breeches and stockings; a boat-cloak, a ship-cot with three pairs of sheets, six pillow-cases and bedding; two dozen hand towels, an huswife, a few quires of brown paper, some tea, sago and sugar ready pounded; a cheese, a few pounds of salt butter and some biscuits; with a tin kettle and tea equipage for six persons; also two large and four small japanned mugs, a good stout case of spirituous liquors, particularly gin; six dozen Bristol water, some bottles of souring and shrub, and three dozen of wine; and these, I think, will be quite sufficient for any private gentleman's stock for an East Indian voyage."

Innes Munro describes also the equipment taken on field service. "In India the preparations for war carry nothing hostile in their appearance, ease and comfort being more studied upon these occasions than dispatch. It would be absurd for a Captain to think of taking the field without being attended by a *dubash*, cook and boy; and as in these times bullocks are not to be had, he must assemble fifteen or twenty coolies to carry his baggage, who, with an horse-keeper and grass-cutter, and sometimes a dulcinea and her servants, complete his train, having occasionally the assistance of a barber, washerman and ironer in common with other officers of the regiment. It might be thought improper, on such occasions as that of taking the field, to allow a Captain a palanquin, although I have known many of them permitted to enjoy this luxury at very important seasons, which of course must add nine bearers to his suite. His tent is furnished with a large bed, mattress, pillows, etc, a few camp stools and chairs, a folding table, a pair of shades for his candles, and six or seven trunks with table equipage; his stock of linens (at least twenty-four suits); some dozens of wine, brandy and gin; tea, biscuit and sugar; an hamper of live poultry, and his milch goat."

And this was written only two centuries ago! How different are the conditions today. Modern India, with its railway and canal system, its air services, its well-trained army and its parliamentary Government, bears little resemblance to the land where John Company's servants spent the best years of their lives in artificial grandeur. Yet few of those who have known the country in more recent times will regret their service in India. Memories of harships and disappointments become dulled with the passage of years and only the pleasures remain.

Note by Editor

Lieut-Colonel E. W. C. Sandes is the last surviving Institution Gold Medallist. The Medal is awarded from time to time by the Council of the Institution of Royal Engineers at their discretion as a rare mark of honour for some major work connected with the advancement of historical, scientific or technical knowledge related to the Corps of Royal Engineers. Three Gold Medals were awarded at the 1964 Annual General Meeting of the Corps, the awards being made to commemorate the Queen's bestowal of the Royal title on the School of Military Engineering on 24 July 1962. The Gold Medals were awarded to:—

Major-General C. H. Foulkes, CB, CMG, DSO, for his work connected with Chemical Warfare.

Brigadier M. Hotine, CMG, CBE, for his contribution towards the advancement of the theory and practice of air survey, particularly for military purposes, and the development of geodetic science and practical geodesy.

Lieut-Colonel E. W. C. Sandes, DSO, OBE, MC, for his contribution to the advancement of historical knowledge especially of the work of the British, Indian and Pakistan Military Engineers. Among the books written by Lieut-Colonel Sandes are:—

The Military Engineer in India, Volume I, published in 1932, which dealt with the achievements of the military engineers in war and in military works from 1640 to 1932.

The Military Engineer in India, Volume II, published in 1935, which recorded the outstanding services of military engineers whilst employed as civil engineers, surveyors, scientists and administrators under the Government of India over the same span of history.

The Royal Engineers in Egypt and the Sudan, published in 1937, which described the services rendered by the Corps of Royal Engineers, both collectively and individually in those two countries between 1800 and 1936.

The Indian Sappers and Miners, started in 1938 but, due to Lieut-Colonel Sandes's war work, not published until 1948, which described the achievements in peace and war of the Madras, Bengal and Bombay Sapper and Miner Corps from 1759 until the prelude to the Second World War.

The Indian Engineers 1939–1947, published in 1956, which described the wartime exploits of the Sappers and Miners and the Indian Engineers in the Middle East, North Africa, Italy, Burma, Malaya and the East Indies, and their activities postwar up to the time of the partition of India.

Lieut-Colonel Sandes is also the author of *In Kut and Captivity* published in 1919—he was himself made a prisoner of war at the surrender of Kut Al Amara, in September 1916, *Tales of Turkey*, published in 1924 and *From Pyramid to Pagoda*, published in 1956, being a history of the West Yorkshire Regiment in the Second World War.

* * * * *

What About the Unions Then?

MAJOR F. G. E. GRAINGER, RE

I AM proud to have served Queen and Country all my working life. I am happy with my lot (I have a few groans) in the Army and am not motivated as some civilians appear to be in bettering their lot by industrial action. There must be something in this striking business for just compare the last Government's reactions to strikers and the resignation of a Sea Lord over the proposed axeing of aircraft carriers. Resign is all that a Serviceman can do. There is no stronger action that our masters in the services can take, but it did not appear to impress the Government, whereas the number of times the last Prime Minister personally intervened in industrial disputes to meet strikers demands are too numerous to relate. Perhaps Union is mightier than Sword. The other day Mr Cousins (Junior) from the Transport and General Workers Union suggested that he should represent soldiers. Before we throw the idea out as too ridiculous for words I feel we ought to know something more about trade unions and hence my title; what about the unions, then?

TRADE UNIONS

The Sidney and Beatrice Webb definition is, "a continuous association of wage earners for the purpose of maintaining or improving of their working lives". The present image of trade unions is hardly this, for publicity has focused our attention on to pay demands and strikes. During its evolution, the trade-union movement, has see-sawed in its legal standing. Today unions enjoy legal recognition by an Act of Parliament introduced by the Labour Government in 1946. During the fight for recognition, the unions enlisted the support of Members of Parliament, and this has led to their affiliation to the Labour Party. Today union members are levied a "voluntary" subscription which is used specifically for political purposes. With legal recognition the unions gained immunity from action in tort. This gives them the right to call strikes without fear of legal action being taken against them.

The Unions are concerned principally with working conditions, hours of work, recreation and remuneration for their members. Many workmen will claim that union membership improves all facets of their working lives. However, it can be statistically proved that increases in wages are short term, in that they are soon cancelled by rising costs and the loss of purchasing power of money. As far as working conditions are concerned improvements mark the successes of the trade unions.

There are some 160 unions in the United Kingdom representing about nine million men and women. The size of unions vary from a dozen (13 Jewish bakers) up to 200,000 members. Representation is through local committees, groups, areas up to the national level. Trade unions go about their work by negotiating with employers and their ultimate arguing point is strike action.

SERVICE MEMBERS OF BRITISH TRADE UNIONS

Servicemen with certain trade qualifications can join an appropriate union. The Ministry of Defence has agreements with several unions in the recognition of military trades which are duplicated in civilian industry, e.g. the plumbing trade union recognizes military plumbers. The membership afforded by these special agreements is limited to personnel about to leave the services. These members cannot take an active part in union matters beyond paying their annual subscription. Bandsmen are permitted to join the Musicians Union as you will know many of these gentlemen develop the talents during "off-duty" hours for financial reward. In both cases mentioned the membership of a trade union only permits servicemen to be represented in activities outside the services. Under current regulations servicemen are not permitted to join a trade union to represent their interests in the services.

TRADE UNIONS IN FOREIGN SERVICES

Several countries have organizations similar to trade unions within their Armed Forces. Recently at Staff College I had the opportunity to discuss trade unions with officers from foreign countries. It must be remembered that our servicemen are all volunteers, and most other countries have some form of conscription.

In Sweden the working population has organizations to represent their interests and they operate in a manner similar to our trade unions. There are four basic organizations representing workers, white collar workers, the professions and officer status employees of the State. NCOs can join the white collar workers group and specialist officers, such as engineers and doctors, can join the professions body. Soldiers do not have a specific union but retain their civilian connections whilst completing their conscripted service. All members of the services can have union membership, with the exception of commanding officers who have to relinquish their membership during command.

The four Swedish unions negotiate with the Employers Associations on all matters concerning pay, welfare, and working conditions. Servicemen are represented to an independent body appointed by the Government. Agreements are made for two to three years, and whilst negotiations are continuous. The Swedish system of permitting their servicemen to have representation is apparently generally accepted and successful. For servicemen, as a body, representation is divided and may be accordingly weakened.

Danish officers are represented by the Foreningen af Danske Linie Officerer. This organization was formed by regular officers and is accepted by the Danish Government. It is not a trade union, but has considerable power and represents its members to the Government in the discussions of officers' employment, remuneration, and compensation. NCOs, soldiers and reserve personnel have similar organizations.

West Germany has an active and successful organization working for servicemen. The Bundeswehrverband (BwV) was formed by fifty-five men in 1956, today it represents 88 per cent of West German servicemen, ranking from private to a four star general. The BwV enjoys recognition by the West German Government. This organization claims to represent servicemen, their families and dependants in all their economic and social interests with the Ministry of Defence and the general public. Members are represented by groups and committees, headed by a national committee.

Some successes claimed by the BwV are: Regular engagements increased from twelve to fifteen years—newly weds entitled to separation allowance—increases in annual leave—interest free loans for house purchase, etc. etc. The BwV are presently negotiating: a summer uniform—university places for ex-servicemen—improvement in messes—increases in the pay of NCOs. Another aspect of the BwV is to represent their members in civil actions. They claim to have taken up 1,413 cases in court, won 463 and still have 306 awaiting decision.

Members of the German Services believe that the BwV represents them as individuals and its negotiated successes have benefited everyone. Some officers are prejudiced against unions but believe the BwV assists them in maintaining the morale of a conscripted force. The number of officers taking an active part in the organization is considered to be small due to the extra work involved, not the principle of being a trade union.

Of the three countries considered, all appear to benefit from the representation of their servicemen. Such organizations help the services to maintain morale, especially with conscripted personnel. They provide the machinery for dealing with complaints and help officers and NCOs in their duties. These organizations are not trade unions in the accepted sense of the term, for they have no right to call strikes nor have any political bias. The Swedish system negotiates pay and allowances with a board independent of the Government, whilst in Germany and Denmark negotiations are with their Governments. It has been proved that servicemen can be represented by

organizations which do not have the power to call strikes. Such organizations appear to gain improvements for their members. It must be remembered that these arrangements have not been tested in times of war.

THE CIVIL SERVICE AND POLICE

The British Civil Service is represented by their union at the Whitley Council. (The Retired Officers' Association is not a registered union.) Government industrial establishments and nationalized industries have civil unions and appoint joint bodies to take the parts of manager and employee. All other UK based civil servants are represented through the Whitley Council. The section concerned with civilians employed by the Services is the Ministry of Defence Whitley Council. This Council is the platform for negotiations in all matters which affect conditions of service. Certain members of the Council represent the employer, the unions, and treasury representation is available on request.

The Ministry of Defence employs a large number of civilians who play a vital role. A strike by these men would not paralyse the Ministry but it would drastically reduce its efficiency, especially the Departments in London. The Civil Service organization demonstrates the fact that the Ministry of Defence can and does, depend upon employees who are represented by unions and have the right to strike. It should be noted that in the General Strike of 1926 the Civil Service did not withdraw its labour.

The Police Forces of this country have an organization called the Police Federation to represent the interests of policemen and policewomen. The Police Act of 1919 expressly forbids policemen to be members of trade unions and disciplinary action can be taken against offenders. The Police Act, however, permitted policemen to join the Federation which is not considered a trade union. Policemen do not have the right to strike, and the Federation does not have the legal protection that unions enjoy. In all other respects the Federation works as a trade union.

A TRADE UNION FOR THE SERVICEMEN OF THE 70S

I have briefly described the activities of trade unions, how similar organizations work in foreign Services, how unions work in the Civil Service and how the Police Federation works for our Police Force. Two fundamental features of British trade unions are clearly incompatible with the Army namely the right to strike and political affiliation. However, trade union type organizations without these rights appear to be workable for foreign Services and are acceptable for our Police and Civil Service. One could argue that Civil Servants and the Police are poorly served considering wages, terms of service and working conditions and that representation has done little for them. Even if a trade union could be made acceptable to the Army and the Government, what could it achieve? Officers are responsible for administration, man management and morale and are constantly concerned with conditions of work. Perhaps a union could serve a useful purpose in the unlikely event of the Defence of Staff being overruled by the Government or if an unfair incomes policy was forced on the Services (not the Geddes Axe, I trust). Some form of representation might bring pressure to bear on the Government. It might work but it would assume the failure of the Chiefs of the Defence Departments, so as a soldier I could not accept a trade union, could you?

THE MESSAGE

In my studies I have learnt something about trade unions. I hope I have passed something on to you. Trade unions are working successfully in the services of some foreign countries so they could possibly be with us in the future. If you believe the saying "With the Americans to-day, with the British tomorrow", relax, for the Americans haven't got them and I do not expect (or want) to see a trade union in our Army in my time.

Corps Paintings

THE Corps has two paintings by Terence Cuneo: "The Royal Engineers opening the way through the minefields at the Battle of El Alamein on the night of 23/24 October 1942" and "The bridging of the Rapido, Amazon Crossing, on the night of 12/13 May 1944".

These two paintings will be reproduced in colour if there is sufficient demand for them to a size 12 in by 17 in on a mount 15 in by 25 in. The estimated cost of each is £1.75. Would-be purchasers of one or both of these coloured reproductions are invited to notify the Secretary, RE Corps Committee, HQ E-in-C, Kitchener Barracks, Chatham, Kent, of their requirements.

Plate 1. Mine Clearance at El Alamein

Platé 2. Bridging the Rapido

Corps Painting's 1 & 2

Correspondence

Major-General W. F. Hasted, CB, CIE, CBE, DSO, MC,
Oaksmere,
Brome,
Eye, Suffolk.
28 December 1970

FIELD-MARSHAL VISCOUNT SLIM, KG, GCB, GCMG, GCVO, GBE, DSO, MC

Sir,—I do not know if there is a precedent for the publication in the *RE Journal* of a memoir to an officer who is not a Sapper nor a Member of the Institution.

I feel, however, very strongly that the Corps should do honour to the passing of that great warrior Field-Marshal Viscount Slim, who was such a friend to and did so much for the Corps, by publishing a Memoir in its *Journal*. I suggest the following:

"With the passing of Field-Marshal Viscount Slim, the Corps mourns not only a very great Commander but a special friend. As his Chief Engineer in 14th Army and E-in-C in SEAC Land Forces I would like to add a tribute on behalf of all ranks of the RE and RIE of 14th Army.

"Only those of us who have served and lived with commanders in war realize the very great and continuous strain imposed on them, and the difficulties of getting across vital engineer facts and limitations at the height of the battle. These stresses and strains were accentuated in Burma where the situation was touch and go for months on end, the difficulties of terrain appalling and engineer resources woefully short.

"'Uncle Bill', as he was affectionately called, was exceptional in his understanding and sympathy with engineer problems. Over three years I saw him almost daily, and regularly had to discuss unpalatable engineer situations. Always a patient listener, scrupulously fair in judgement, invariably constructively helpful and never once, whatever the intensity of the situation, other than courteous.

"Moreover, and this of paramount importance to the engineer, he always kept us informed well in advance of his future intentions and discussed the engineer problems involved.

"Once a decision was taken he placed implicit trust in his subordinates to carry it out, thus giving full rein to initiative. And conversely the greatness of his character and indomitable presence inspired in every rank of 14th Army an absolute trust and confidence which enabled them to execute whatever task befell. In this he had many attributes in common with the great Duke of Wellington. 14th Army undoubtedly owed its ability to live up to its motto 'The difficult we do at once: the impossible takes a little longer' entirely to this mutual trust and confidence inspired by its peerless commander.

"We all mourn a very perfect gentleman and a wonderful friend."—Yours faithfully,
W. F. Hasted.

Brigadier Sir Mark Henniker, Bt, CBE, DSO, MC, DL,
Pistyll, Began Road,
St Mellons, Cardiff.
28 December 1970

SINGAPORE—TOO LITTLE AND TOO LATE

Sir,—Reading the review of Brigadier Simson's book on the fall of Singapore in 1942 prompts the following disconnected reflections:

1. Returning from the East in a troopship in 1935 the OC Troops required every subaltern, of whom I was one, to give a short lecture on a military subject of his own choice. My subject was "The Yellow Peril in the Far East". The ship's library held a book, whose title I have unhappily forgotten, that fairly accurately forecast what actually happened in 1941. I "potted" this into a twenty-five-minute talk and sat down sweating but triumphant. A tiresomely well-informed major, however, got up and asked a question in a stern, deflating tone.

"Does the speaker realize," he asked, "that if the Japanese declared war on Britain, the Americans would join us at once? And does he realize that the British and American navies together exceed the Japanese navy by at least ten to three? And does he realise that the

American steel production alone exceeds the Japanese production by nineteen to one? And in view of the inevitable nature of the war that would follow, does the speaker really think the Japanese would be such fools as to start a war they hadn't a chance of winning?"

The logical answer was clearly "No". But logic plays only a minor part in the greatest events. There is another power at work. It is reflected in the Latin tag that, translated, means (roughly): "The gods first make mad those whom they would destroy." In all military appreciations there should be a paragraph headed "Gods", though a *small g* would suffice.

2. In 1935, a vexed question was whether to build airfields on the Malayan peninsula. On the one hand the airfields would have made air cover over the battlefield easier. On the other, if there were to be no British aircraft to use them, the airfields merely would serve as stepping stones for the enemy. They would be difficult to defend and not easy to destroy when evacuated. Anyone who advocated the no-airfield-policy left himself open to every kind of reproach. He was not airminded; he had not advanced *in thought* since the Somme; he was a defeatist, and so on. Yet as thing turned out, he would perhaps have been right; for there were (more or less) no aeroplanes to use them. This argument might have come in the Gods paragraph.

3. The lessons of Torres Vedras are well worth thought. Suppose a belt a mile wide had been laid bare, what would have happened? If all the tree trunks had been burnt or otherwise removed, and if sufficient weed-killer had been used, it is possible that a fairly effective swathe might have resulted. But without actually testing the proposition, you might end up with a belt of "secondary jungle" that would defeat the vision of a giraffe. And it would only take about forty-eight hours to be much too high to fire through. Its nature, if left, would be a very dense wall of undergrowth a mile wide, through which movement would be slow but still possible. Without air superiority the defender would have many of the problems of the tunnellers in World War I. A superior infantry would be as essential as in the campaign that actually happened. Nothing in war is a certainty, except that the Gods have many surprises. The Gods paragraph is needed always to examine them.

4. In the afterlight another defence plan suggests itself. Supposing we had taken advantage of the Chinese—particularly the Communist Chinese—and their dislike of the Japanese. Supposing we had organized guerrilla bands, led by British personnel, to harass the invaders' L. of C.? How would this have worked out? Anyone who advocated it in high places in 1940 would almost certainly have been sacked as politically unreliable. It was probably a non-starter till it was too late to make it effective. By then it really was a very difficult proposition. But when we consider what the Bandits did in the Emergency against us in the 1950s, we can get some idea of the possibilities. The Bandits were never very numerous; they were unbelievably hidebound; yet at least twenty battalions were needed to suppress them—and even that might not have worked but for the political climate that supervened.

Such a policy would have needed very good nerves on the part of the Top Brass. Innumerable difficulties would have had to be surmounted. The greatest faith would been called for. The writers of the Gods paragraph would have had a field day. But the paragraph should have been written.

If any theme runs through these notes it is this: Let us consider how the Gods try to make us mad, and by resisting them, let us avoid destruction. But you must have a Gods paragraph, or you never even consider the matter.—Yours faithfully, Mark Henniker.

* * * * *

BRIGADIER GODFREY-FAUSSETT, a previous Chief Engineer 8th Army and 15 Army Group and Commandant the School of Military Engineering died at his home the Old Rectory, Badlesmere, Faversham, Kent, on 17 December 1970, aged 74 years.

Brigadier Godfrey-Faussett CB DSO OBE MC

Born on 28 November 1896, Bryan Trevor Godfrey-Faussett was the son of Richard Fermor Godfrey-Faussett. He started his Service life as a young cadet at the Royal Naval College, Osborne. He had, however, to leave Osborne for medical reasons and he completed his education at Wellington College and the Royal Military Academy, Woolwich. He was commissioned into the Royal Engineers in July 1915, aged 18 years.

After a short wartime YO Course at Chatham and further instruction at the RE Signal Service Training Centre, he served for the remainder of the war with 33rd (Signal) Company, RE, in France and Flanders. He was mentioned in despatches and awarded the Military Cross, the citation, published in the *London Gazette* of 26 July 1917, read: "2nd Lieut Bryan Trevor Godfrey-Faussett, RE for conspicuous gallantry and devotion to duty. He personally reconnoitred all possible routes for cables and saw them laid. The result was that communications were kept up throughout the day. His work was carried out at great personal risk under heavy fire."

After the war he attended a Supplementary Course which consisted of a period at Chatham and a year as an Undergraduate at Jesus College, Cambridge. The next twelve years were spent mostly on survey duties which consisted of work at home with the Ordnance Survey, and overseas in Constantinople in 1923, Nigeria 1927–30, and on the British Somaliland/Ethiopian Boundary Commission 1932–4.

Early in 1935, now a substantive major, he was given command of the 7th (Field) Company, RE, then stationed at Colchester. Although his previous experience had been limited almost exclusively to signalling and survey, he very quickly attuned himself to the work carried out by field companies, their techniques, trade skills and equipments. Indeed, so completely did he master the art of field engineering during his two and a half years in command of the 7th Company that, in 1938, he was posted to the School of Military Engineering at Chatham to become Chief Instructor of the Field Works and Bridging School and made a brevet lieutenant-colonel.

Shortly after the outbreak of war he was appointed CRE 44 (Home Counties) Division which eventually became part of III Corps of the British Expeditionary Force in France. The units of 44 Divisional Engineers comprised the 11th (Field) Company—a regular unit—and the territorial 208th and 210th (Field) and the 227th (Field Park) Companies. 44 Division was commanded by Major-General, later Lieut-General, E. A. Osborne, CB, DSO, late RE and Royal Signals. The division moved forward with the rest of the BEF to the River Dyle in 1940 and its Sappers were heavily engaged on a number of major demolitions during the withdrawal to the river Lys, the preparation of defensive positions in the Dunkirk perimeter and in assisting the evacuation of some 337,000 troops from the beaches. For his outstanding work during these operations Lieut-Colonel Godfrey-Faussett was awarded the OBE. Posted to the Middle East, he became Chief Engineer X Corps in 1941 and in the following year he was engaged on the major demolition of the port and large administrative area that had been built up at Mersa Matruh during the general withdrawal to the Alam Halfa–El Alamein position.

The Allied landings at Salerno, south of Naples, in September 1943 were carried out by the Fifth Army comprising the VI American and X British Corps. Brigadier Godfrey-Faussett had at that time under him the RE units of the 7th Armoured Division—the 46th (West Riding) and 56th (London) Infantry Divisions, and his own Corps Troops Engineers. His Sappers were very heavily committed in the beachhead and in the subsequent break-out and advance on Naples. The following year he became Chief Engineer Eighth Army and in 1945 Chief Engineer 15th Army Group. In recognition of gallant and distinguished services in Italy he was awarded the DSO in 1944 and the CB in 1945.

He returned home after the war and was Commandant of the School of Military Engineering from 3 October 1945 until his retirement on 15 September 1948. During the time he was Commandant the SME was at Ripon, and there were many discussions on whether it should return to its traditional home at Chatham or be rebuilt on a new site where better and more extensive training facilities could be found. The

traditionalists won the day and the School officially returned to Chatham on 1 October 1945, Brigadier (later Major-General) B. C. Davey then being Commandant. For the last two year's of his service he was an ADC to HM King George VI.

After retirement he busied himself at his Kentish home and cultivated strawberries with great expertise. He kept, however, in close touch with the Corps, and he was one of the eight past Commandants present at the visit of HRH The Duke of Edinburgh to Chatham on 20 July 1962 to mark the 150th Anniversary of the SME and the gracious award by HM The Queen of a Royal title to the School.

In 1925 he married Katherine Monica, daughter of Mr and Mrs Patterson of Harviestoun House, Gorebridge, Midlothian. They had a son and a daughter. His widow and children survive him and our deepest sympathies are extended to them.

T.H.F.F. writes:

Though I never had the privilege of serving under "GF" in wartime, I came to know him well as his Brigade Major at Ripon in 1946 to 1948.

I will not deny that it was with some consternation that I exchanged the euphoria of victory in Burma and the joys of command there for a staff appointment, entailing loss of rank, to a Commandant with so severe and exacting a reputation. It did not take long, however, to discover that behind his austere expression and curt speech on duty, and his insistence on the highest possible standards in everything, lay a very warm heart and an impish sense of humour. I also came in time to realize that it was one of the luckiest days of my life when AG7 telephoned to cut my leave and send me off to Ripon.

"But, sir!" protested the DAA and QMG: "the SME *must* have leave that day. It's a Bank Holiday!" "We're not a bank," said GF, and that was that. And if, when visiting training, he should remark that this was a subject he knew nothing about, it was excellent policy to assume that he knew far more about it than anyone present.

This was, of course, a time for embodying into our doctrines the lessons of the recent war. However, another of GF's principal objects as Commandant was to restore the Corps's traditional standards of efficiency and civilized behaviour, which had inevitably been affected by enormous expansion and hasty training and, though his measures may have been irksome at times to some, he had the unanimous support of all ranks and his firm policy greatly alleviated the task of his successors. In fact, few Royal Engineers at any period can have had more influence than GF on the Corps, since most of the World War II Supplementary Batches passed through his hands, as well as the normal officers' and other ranks' courses.

It is obvious from the Memoir that GF stood far above the normal run of very able RE officers. How else could he have advanced so rapidly, after twelve years' specialist duties in Surrey, to become Chief Engineer Eighth Army and of 15th Army Group? And the question must then be asked why a man of such exceptional ability and strength of character did not go even further in the Service. Of course, he was not staff qualified, but the answer probably lies in his refusal ever to compromise with people on policies which he believed to be mistaken, or to give the least countenance to anything he did not approve of. There were people—outside the SME—to whom he refused to speak except through an intermediary. He had so great an intensity of feeling for the efficiency of the Corps that I have seen this austere figure with the tears of mortification pouring down his face when his earnest advice had been rejected. Thank heaven for such constant pilgrims!

It was with great sorrow that his many friends heard of his death, and it is with warm affection and profound admiration that we remember him. All our sympathy in their loss goes to his son and daughter and to his widow, Judy.

BRIGADIER ERNEST BADER, OBE, MIMechE, MIEE

ERNEST BADER, always known to his friends as "Jock", died after a long illness at the age of 71 on 20 October 1970. He was born in Norfolk, the eldest son of Ernest James and Margaret Julia Bader, on 11 October 1899. A year later the family returned to South Africa and took up farming in the Orange Free State. Jock went to St Andrew's College, Grahamstown, and matriculated with first-class honours. After a year at Rhodes University he took the Army Entrance Examination in 1918 and passed into the Shop. Passing out second of his batch, he was commissioned in the Corps in January 1919. If it had not been for a curious system of marking then in vogue he would probably have passed out top.

At that time the SME was not fully reorganized after the Armistice and courses for young officers had not been revived. So Jock and the rest of No 1 JO were posted to field companies in the Rhine Army for a year before going to Chatham. Jock went to 219 Fd Coy in the Lancashire Division stationed in and around Bonn. It was a pleasant time for all concerned, with plenty of sports and games, free transport, theatres and opera, and extra pay—intended to make up to those whose mobilization had been delayed. Jock made good use of his opportunities, riding a great deal and winning the Rhine Army Show Jumping Championship.

At the end of his JO Course in 1922 Bader was selected from several applicants to go on a long E & M Course. Completing this in 1924 he was posted to Egypt and served as E & M Officer to the Chief Engineer British Troops in Egypt until 1929. Little new construction was in hand at the time, but he was responsible for electricity and water supplies and cold storage plants as well as a couple of armoured trains. He established first-class relations with civilian engineers in the country, both through his character and his technical ability, from which his successors in office much benefited. His hobby was desert navigation and travel, and he went on many expeditions to Siwa and elsewhere in the Western Desert with R. A. Bagnold, a Sapper who had transferred to the Signals. They tried out methods of getting the vehicles of the day across soft sand, in particular the so-called Sand Sea, and developed the sun compass for desert navigation. Bader was a principal member of Bagnold's team and his mechanical knowledge was of great value in the experiments which paved the way for the Long Range Desert Groups and other desert travellers of World War II. Bagnold's books describing their work are still well worth reading.

It was in Cairo that Jock met his future wife, Juliet Wise, and they were married in August 1929 after his return home.

After a few months with a field company at Catterick, Jock took the Advanced MT Course at Woolwich and thereafter concentrated on the engineering problems of military transport. From 1929 he worked at the Mechanical Warfare Experimental Establishment at Farnborough until appointed a member of the Mechanization Board in 1934. His contemporary W. M. Blagden (later Brigadier) was following the same path, and both of them made a significant Corps contribution to the development of vehicles and armour. In due course Jock was elected a Member of the two Institutions of Mechanical and Electrical Engineers.

In 1936 Jock was sent to Hong Kong for the usual five year posting, but in the spring of 1939 a drive began to mechanize the Indian Army and he, with other specialists, was sent to India for the purpose. In those days the Army in India had little mechanical transport and less than 100 armoured vehicles and tanks. The UK could not supply the many thousands that were called for and the MGO was given the task of organizing the development of sufficient manufacturing facilities to meet all requirements. Jock as an ADOS at GHQ was responsible for the engineering side of the job, which required close liaison with Ordnance factories and workshops and civilian firms, such as Ford and General Motors, which were supplying almost the whole of India's needs.

Early in 1941 it became evident that the task of arranging the supply of raw

Brigadier Ernest Bader OBE MIMechE MIEE

materials and of developing and fabricating all the various types of vehicles, both armoured and soft, was too big for a branch of GHQ and it was transferred to the recently set up Supply Department of Government. This Department opened a special Directorate of Vehicle Supply, responsible for all army requirements, and the Ordnance factories were transferred to the new Directorate. Bader went as Director of Vehicle Supply and from then onwards became the link between the Army, the civilian manufacturers and the Ordnance factories on all matters connected with the supply of military vehicles.

When the new system began the output of vehicles in India was in the region of 2000 a year from all sources. By the time that Bader had completed the reorganization production reached 48,000 a year. When it is remembered that this increase was achieved in some two years the magnitude of the task, and the effort and ingenuity required to fulfil it, can be appreciated and it is no exaggeration to say that at all times Bader was the prime mover. As can be imagined the difficulties, on the one hand of keeping pace with the constantly changing requirements of the Army, and on the other of adjusting these and production methods to cope with them required constant vigilance, drive and tact. During all this time Jock was supremely imperturbable and resourceful in dealing with the many crises. There were certainly very few people who could have done the job as well as he. For his work in India he was awarded the OBE. He finally handed over the Directorate as a going concern in 1942 and went to Burma as Chief Staff Officer to General Wood, Administrator General of Eastern Frontier Communications.

In 1943 Bader returned to England, refusing a responsible post in the USA in order to serve nearer the scene of action. After various short postings he joined the Control Commission for Germany, first in the Planning and Operations Branch and later as Deputy to Sir Percy Mills, Chief Economic Adviser. He was promoted colonel in 1944 and shortly afterwards to brigadier. It was while serving in Germany that the illness developed which troubled him for the rest of his life. He was invalided out of the Army in 1947 and returned to South Africa, eventually settling in Durban, where he died. Fortunately he was well enough to lead an active life for many years. He worked for a firm in Johannesburg importing farm machinery and roadmaking plant, and later was concerned with the construction of prefabricated houses for the Bantu.

Jock soon took an interest in politics and was a prominent member of the United Party, being elected to the Natal legislature in 1950 and bringing a sympathetic, but realistic, attitude to the problems of his country. Later on he and Juliet devoted much of their time to the cinephotography of wild animals and birds. They were very successful in their hobby, and won a number of awards in international competitions, including a sound track with some films. Jock was an active member of his Church Council and was also much occupied with the Durban Branch of the Sapper Association, and St Andrew's Old Boys Club.

Jock was an all-rounder and a most cheerful companion. He would join in any activity that was going and contribute to its success. At Chatham or Hong Kong he was equally at home sailing or playing tennis or cricket—he was a good slow left-arm bowler and played for the Corps on a number of occasions. If his health had not failed his ability, coupled with his capacity for making friends, would have taken him to important positions, probably in the civilian rather than the military world. He leaves a widow who looked after him without a thought for herself throughout his long illness, two married daughters and six grandchildren in whom he took great delight.

I am indebted to Colonel P. Nelson for the information regarding Bader's work in India.

K.H.T.

ESMOND HUMPHREY MILLER CLIFFORD, who died on 2 September 1970, was born on 6 March 1895, son of Miller Hancorne Clifford and Louisa Mann (née Peterson). He was educated at Clifton College and the RMA Woolwich and commissioned into the Royal Engineers in August 1914. During the First World War he served in France and Belgium 1915–17, and in Italy 1917–19. He was wounded, awarded the Military Cross and twice Mentioned in Despatches. After completing a Supplementary Course at Chatham in 1919 he was posted as Second-in-Command of

Colonel E H M Clifford CBE MC FRGS

101 Field Company RE, and in 1920 he was posted to 19 Survey Company RE, where he became Acting Adjutant of the Ordnance Survey Battalion.

He married Louise Marie Gilberte Phillips in 1921. Their only son, an airgunner RAFVR during the Second World War, was wounded in North Africa and died after the war as a result of his wounds.

Clifford remained Adjutant of the Ordnance Survey Battalion until 1925, when he was appointed Officer Commanding 13 Survey Company RE. From 1925 to 1928 he was Assistant British Commissioner on the Anglo-Italian Jubaland Boundary Commission, for which work he was awarded the OBE. During the years 1928–31 he served as a Major in MI4 at the War Office. In 1931 he returned to North East Africa as Senior British Commissioner of the British Somaliland–Ethiopia Boundary Commission. A colleague at that time has written:

"In conjunction with the RAF in Aden, he was a pioneer in the use of aerial photography as an adjunct to the ground survey during this Commission.

"His Boundary Commission work was carried out over very difficult terrain and in primitive working conditions, but in spite of these adverse factors he never allowed his high standard of accurate survey work to slacken. He spoke and wrote perfect French, the master language in which both of the Boundary Commissions were carried out.

"During the study on the ground of the trans-frontier grazing rights of the nomadic British and Ethiopian Somalis the Commission were confronted at Walwal by armed Italian native levies. Clifford's calm and sound advice were instrumental in getting the Ethiopian Section to agree to withdraw along with the British Section from the immediate area. Later when the Italians attacked the Ethiopian escort with armoured cars and light aircraft, he ordered all the transport resources and medical facilities of the British Section to evacuate the Ethiopian wounded and stragglers across the waterless region to the nearest waterhole, where an emergency hospital was set up. Clifford's work brought him true and lasting friendship among the British, Italian, French and Ethiopian colleagues with whom he worked."

This Boundary Commission completed its work in 1936 and Clifford was awarded the CBE. In 1937 he was promoted lieut-colonel and was appointed CRE Welsh Area of Western Command. In 1940 he was promoted colonel and appointed Chief Engineer China. After the fall of Hong Kong in 1941 he remained a prisoner of war in Japanese hands until 1945. He was interned in camps in Kowloon, Formosa, Shen Shim Tung on the edge of the Gobi Desert, and finally Mukden, where he was liberated by the Russians.

After the war he was appointed Chief Engineer Salisbury Plain District in 1946 until his retirement in 1948.

From 1950 to 1957 he was the British Commissioner of the Kenya-Ethiopia Boundary Commission. One of his colleagues of that time has written:

"The post of Commissioner on a Commission of this sort was one which required peculiar qualities. He needed to have a knowledge of the local peoples and an understanding of, and sympathy for, their way of life and their needs; above all he needed great patience and tolerance and these qualities Humphrey Clifford possessed in abundance. He had a deep knowledge, acquired over many years, of the history of the area and an understanding of the very complicated and changing tribal relationships and loyalties. This knowledge, combined with his inexhaustible patience, earned him the respect of his own staff and that of his Ethiopian counterpart as well as that of the local chiefs and headmen with whom he had to deal. He genuinely loved the country and its people and continued to take an interest in developments there right up to his death. He had among the Africans and the European administrators of an earlier era a wide circle of friends with whom he kept in touch and by whom he will be missed."

In his retirement he lived near Chichester in Sussex and enjoyed the recreations of golf and shooting. He leaves a widow and many friends.

J.F.C.

Book Reviews

GREAT SIEGES

VEZIO MELEGARI

(Published by Wm Collins & Sons Ltd, 144 Cathedral Street, Glasgow 4. Price £1.25)

This book is the product of the International Library a unique development in book publishing whereby five leading publishers in five major countries, Great Britain, France, Italy, USA and West Germany, have collaborated to produce a series of books for young people. Each book carries the seal of approval of an international editorial board. Vezio Melegari, the author of this book, is not only an acknowledged military historian but also a well-known writer of childrens' books and a script-writer for Italian television childrens' programmes. The name of the excellent English translator is not given.

The first chapter of the book outlines the development of fortifications, engines of war to overcome them and siege techniques from prehistoric times to the present day. The remaining nine chapters describe famous sieges of history which were decisive events in the wars of which they were part. They range from the mythological Siege of Troy to the sieges of Leningrad and Stalingrad.

Although the book was written primarily for young people and the plenteous coloured illustrations were no doubt selected to fire their imagination, grown-up Sapper readers will find the book quite enthralling and most instructive. Indeed, once the eye starts to scan the pages and study the fascinating details of the pictures it becomes difficult to close the book.

J.H.S.L.

SUCCESSFUL PROJECT MANAGEMENT

W. J. TAYLOR and T. F. WATLING

(Published by Business Books Limited, London. Price £4.75)

The authors are Senior Project Managers in the Designated Systems Organization of International Computers Limited, but both have a wide experience on the ground. As Tom Watling was a Sapper officer for some years he may be known to many of you.

The advertising blurb on the dust jacket claims "That this book gives a complete picture of project management . . .". This is an extravagant claim for a book of some 250 pages. It is, however, a good book for those who wish to improve their management techniques and who have knowledge of management. The book is difficult to understand in places, yet in others it is crystal clear. It is suspected that the authors in their efforts to cover as wide a variety of projects as possible for an equally wide range of potential managers, have been unable to aim the book at any particular group of likely readers.

Part IV of the book, dealing with finance and costings, is of particular value to serving officers considering their second career.

At £4.75 this book will have limited appeal, but should be read by those who wish to make a career of management.

E.E.P.

STANDARD METHOD OF DETAILING REINFORCED CONCRETE

(Published by the Concrete Society in conjunction with the Institution of Structural Engineers. Price £1)

There are many ways of detailing reinforced concrete and the very variety tends to cause errors of estimating, ordering, and construction. Within the Corps, Draughtsmen (Architectural, Civil and Structural or Design) have tended to use different methods from professionally qualified engineers. This incongruous situation is now remedied by the Standard Method.

In 1968 a joint committee of the Concrete Society and the Institution of Structural Engineers produced a report on the subject. The present document results from comments received and metrication.

The method is very clearly set out in ten pages of type and fifteen pages of diagrams and examples of drawing practice. Although it is perhaps unwise to single out particular items for comment the following are particularly helpful; bar marking system, standard abbreviations, thickness of lines, dimensioning and tolerances. The use of standard bar shapes in

accordance with BS 4466: 1970 is shown in the example of a Bar Schedule. This alone is a major advance and makes easier any use of computers.

The Standard Method is already being taught to Long Civil Engineering Course and Design Draughtsmen courses at RSME and is strongly recommended for use in the whole Corps. W.G.C.

TELECOMMUNICATIONS (SI UNIT EDITION)

W. FRASER, MSc(Eng), FIEE, Senior Lecturer Dept. of Electronic and Electrical Engineering University of London, King's College

(Published by Macdonald & Co (Publishers) Ltd. 49–50 Poland Street, London W1. Price £4.2)

This book was first published in 1957 to meet the needs of engineering students reading for the University of London Engineering Degree, and to be of use for HNC students and those preparing for the examinations in Radio and Line Communication of the Institution of Electrical Engineers and the higher grades of examination in Telecommunication principles held by the City and Guilds of London Institute.

For the Second Edition of 1967 some chapters were rewritten or enlarged and new material added, and in this revise SI units are used throughout.

The text, comprising some 800 pages, covers: Network heorems, Circuit theory, Transmission lines, Attenuators and filters, Thermionic valves, Semi-conductor devices, Low-frequency amplifiers and the distortion and feedback in them, High-frequency amplifiers, Oscillator circuits, Modulation, Demodulation and detector circuits, Noise, The transmission of information, Microphones and sound reproducers, Telephony and Telegraphy, High-frequency transmission lines and wave guides, Ultra-high frequency devices, Radio wave propagation and aerials, Radio transmission systems. All chapters include derivations of formulae, explanatory diagrams and student exercises at each chapter end (with answers).

The text is supplemented by eight appendices dealing with: Parameters of the Four-terminal network, The Hybrid-II Circuit, Mathematical formulae, SI Units table, Fourier analysis, The relation in automatic telephony between the grade of service, the traffic and the number of trunks, Maxwell's equations in rectangular co-ordinates, The propagation of a plane wave.

The book, which is well produced and stiff covered, is a bargain at £4.20 for those intending to specialize in this engineering field.

F.T.S.

ATLAS OF PHOTOGRAMMETRIC INSTRUMENTS

V. J. CIMERAN (University of Skopje) and Z. TOMASEGOVIC (University of Zagreb)

(Published by Elsevier Publishing Co. Price £11·75)

This book is described as an "Atlas", and it is something between a formal treatise, such as the American "Manual of Photogrammetry", and the catalogue of a very large survey exhibition.

It describes in English about 500 different instruments, giving a description of what they do and how they are used, but without going into the theory on which they depend. In this, it is not a manual of photogrammetry. Almost all descriptions include a photograph of the instrument (normally recognized as those used by the manufacturers for their brochures, which is acknowledged at the end of the book). Information is not given in any standard format, which would indeed be difficult with such a variety of equipment. However, it might be convenient if sizes and weights were always given. Technical performances are often given, but the Atlas is in no sense a "Which?" comparative assessment of accuracies, output, value, etc. Prices are not included, for obvious reasons!

The object of the Atlas, is quoted in the preface and is, "to answer the following questions . . . what is produced, which company manufactures the product and where is that company operating?" The end of the preface goes on, "We are of the opinion that geodesists, foresters, architects, mining and civil engineers, geologists and agronomists will accept the Atlas-type of the book with interest. We also hope that this work will serve as a manual for students of photogrammetry."

These quotations justly indicate the object of the book, and it should certainly be useful to the type of people listed, including the student, but, as already mentioned, it is hardly a manual of photogrammetry.

It is obviously difficult to produce such a book fast enough to make it really up to date. The authors have therefore included an addendum which describes eighteen recent instruments, though some of these were seen about two years ago. Perhaps any future edition of this work could be in loose-leaf form. The book is well produced on good quality coated paper, with good illustrations, and the occasional slightly inferior photograph is clearly not the fault of the printer.

E.W.D.

NOTES FOR DRAUGHTSMEN

NEIL ORTON, AMIED

Head of Engineering Drawing and Design, Mombasa Technical Institute

(Published by Macdonald & Co Ltd, 49/50 Poland Street, London, W1. Price £1·25)

The author states in his foreword that it was not his intention to write a text book on engineering drawing in the accepted sense of the word, but rather a supplement to those currently available to suit the practical needs of young students on Technicians Courses. To this end he has confined the mechanics of drawing—principles of orthogonal projections, relatives axes, auxilary projections, figures and letters, types of lines used in drawings—to one section of seventeen pages. The remainder of the 122-page booklet covers dimensioning, draughting, assemblies and system, limits and fits, fastenings, transmission threads, bearings and lubrication in ninety pages, descriptions of materials in nine pages and a glossary, linear measure conversions, British Standard references and a bibliography in six pages.

In each section the standard drawing examples illustrate the design text provided—which is purely basic.

It is pleasing to see that the assembly drawings in section 5 are laid out in a practical drawing office manner including the vital revision (or modifications) record in the left-hand bottom corner.

Provided that it is used in conjunction with classroom instruction this booklet would be most useful to students.

F.T.S.

Technical Notes

THE MILITARY ENGINEER SEPTEMBER-OCTOBER 1970

A description of the "Sturgis" in the Panama Canal Zone explains how and why the American Engineers are running the first floating nuclear power plant. Sturgis is a converted Liberty ship which is moored close to the outlet of the Gatun Power Station at the Northern end of the canal. Extra power is necessary because there is a conflicting requirement for the waters from Gatun lake which are needed for running both the Gatun power station and for topping up the Gatun locks; at certain periods of the year there is not sufficient water for both purposes. After a year of operation Sturgis had worked at an average power level of 8·5 megawatts for 92 per cent of the time and had been available for power production for 95 per cent of the time.

Potential military and civilian applications of lunar vehicle technology are discussed. The conical elastic wheels could well prove useful as a puncture proof type, a complete vehicle might be used to recce highly nuclear contaminated areas, are two possible applications.

Practical Civil Engineering ideas described were the driving of piles through holes blown in the deck of a bridge to be replaced on a very constricted site. This enabled the old bridge to be used as a safe and ready made working platform. Subsequently the bridge was destroyed by ear-muff charges leaving the pier intact. The problem of placing 70 ft depth of fill on an Armco type culvert was overcome by the imperfect fill technique. In this method fill is placed and compacted normally up to 1 ft above the culvert; 6 ft depth of compressible material (grass, leaves, twigs etc) is then placed over the culvert with compacted earth on either side. The fill is then completed normally. This system allows pressure from the load above the culvert to be dissipated to the material on either side.

Other articles describe waste water renovation and details of emergency bridge repair/rebuild techniques which are of interest.

P.W.H.

CIVIL ENGINEERING

Notes from Civil Engineering and Public Works Review, November 1970

ROTTERDAM ROAD JUNCTION. The establishment of Europoort has necessitated the building of a very complex "concrete spaghetti" road junction to relieve the city centre of Rotterdam. In complexity it appears to rival Gravelly Hill Interchange at Birmingham. A special feature is the use of moulded rubber sheeting on the face of the formwork to provide suitable relief and cachet.

CHESTERTON BRIDGE, CAMBRIDGE. Although the need for two bridges were recognized in 1889, only the Victoria Bridge was built. July 1971 will see the fulfilment of a 92-year-old planner's dream. The bridge is a three-span continuous structure, built as two separate monolithic three-cell prestressed concrete box beams. Construction will be *in situ* except where the depth of temporary work is restricted by the navigational channel requirements. Longitudinal movement is restricted on the North Pier. At all other supports either ptfe or roller bearings are used. The bridge is founded on 48 in and 36 in bored piles which were tested by Maintained Load and Constant Rate of Penetration methods. On the complete project 34000 ft of piling was installed in three months.

ANALYSIS OF NON-UNIFORM BEAMS. Macaulays' technique for the integration of the moment-curvature relationship for beams is very well known. It is not generally appreciated that it can be extented to deal with non-uniform beams. This short article by Professor A. Coull of the University of Strtahclyde uses an example to demonstrate the method.

M6 MOTORWAY. The completion of thirty-six miles of motorway over the notorious Shap Fell and the opening of this stretch on 23 October 1970 are reason enough to highlight some of the special techniques used. Mr J. F. Lindsay of Scott Wilson Kirkpatrick and Partners does this and also describes the particular topographical, meteorological and natural beauty characteristics of the area which make the project so interesting.

Vertical and horizontal separation of carriageways have been used to reduce earthwork quantities and lessen the likelihood of snowdrifts. On some sections it was found necessary to use fill material which was too wet but otherwise suitable. It was laid in 8 ft 6 in layers separated by 12 or 18 inch layers of granular material which permitted rapid draining and thus limited total settlement to 2 in.

The major rock cuts in the Lune gorge were cut to a slope of 3 in 1 using presplitting techniques, however the distorted folded and friable nature of the rock over considerable lengths required the use of rock bolts. These bolts $\frac{3}{4}$ in diameter and 8–30 ft in length were anchored with synthetic resin, tensioned to a load of 5 tons and then grouted with cement or bitumastic material.

SLOPE STABILITY ANALYSIS BY DESK TOP COMPUTER. Now that 62 CRE and 39 Engr Regt (Airfields) have Hewlett-Packard 9100A desk top computers this article on the calculation of the factor of safety for an earth slope or embankment will be of especial interest to practising engineers in the Corps. The desk top computer permits analysis of at least ten slip planes in an hour but in this time cannot approach the accuracy obtainable with a digital computer.

MELBOURNE BRIDGE COLLAPSE. There has been so much uninformed guessing about recent bridge failures that it is refreshing to read an objective unemotional article describing the design and construction of the West Gate Bridge which collapsed on 15 October 1970. In view of the public disquiet, it should be the duty of all engineers to inform themselves as to the site conditions and the method of construction. Until the Royal Commission has published it's findings it is useless and irresponsible to speculate on the cause of failure or to make comparisons with similar structures at Milford Haven, Erskine, Wye, Tinsley and Avonmouth. W.G.C.

Notes from Civil Engineering and Public Works Review, December 1970

THE USE OF CRANES FOR HIGH STRUCTURES. In this article W. K. Taylor, DSc, CEng, MIMechE, of Coles Cranes Ltd, discusses the development and use of the high-lift, high-capacity mobile cranes which are now available. In an age when labour costs are soaring it becomes more and more necessary to prefabricate large sections of structures on the ground and hoist them into position with a minimum of falsework. The article is lavishly illustrated to show such equipment as a 30 ton hydraboom with 92 ft jib and 23 ft fly lifting 4 tons, a strut jib crane with 170 ft jib and 30 ft fly, and two 105 ton capacity cranes placing the final

35 ton section of a 162 ft concrete telecommunications mast. The most surprising feature of these equipments is that they are all mobile. The ultimate in crane design (so far) not a Coles product, is the crawler mounted Manitowoc which has a total boom length of 410 ft.

VEHICLE CRASH BARRIERS. The patented Fitch inertial barrier is a clump of plastic barrels partly filled with sand. On impact by a high-speed car the barrels shatter but bring the vehicle to an abrupt but safe stop.

A MULTI-STOREY PRECAST LIGHTWEIGHT CONCRETE BUILDING. Russian engineers have devised an intriguing system of multi-storey building construction for use in seismic areas where lightweight concrete is beneficial. The system uses rectangular frames of concrete assembled three-dimensionally so that the sides of the frames form parts of beams and columns when the *in situ* concrete is placed. W.G.C.

Forthcoming Events

13 March	RE Point to Point	Charing
13 March	RE Hunt Ball	RE HQ Mess
25 March	REYC Dinner	RE HQ Mess
25 April	RE Memorial Service	Rochester Cathedral
23 June	Corps Meeting and Dinner	London
24 June	Colonels Commandant RE Garden Party	Hurlingham
2 July	RE Summer Ball	RE HQ Mess
31 July	RESME Open Day	Chatham
23–26 September	RESA Regatta	River Medway

SPORTS AND GAMES FIXTURES 1971

RE CRICKET CLUB

26 May	RMCS	Shrivenham
16 June	RMAS	Chatham
25 June	RCT	Aldershot
9 July	RAC	Bovington
11 July	Free Foresters	Chatham
13 July	Infantry	Chatham
14–15 July	Royal Signals	Chatham
16 July	Beckenham	Beckenham

RE GOLFING SOCIETY

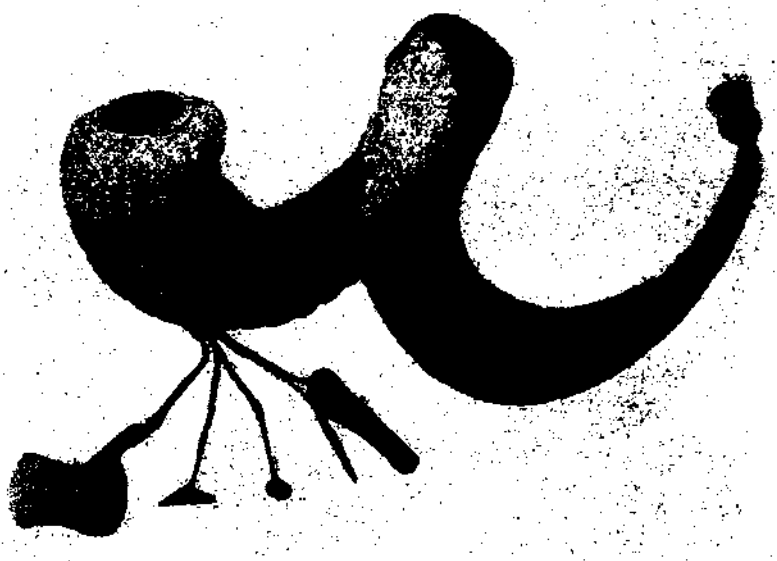
1 April	RAPC GS	Liphook
14–15 April	Spring Meeting	Woking
21 April	Serving *v.* Retired	Hankley Common
28 April	Guards Division GS	West Hill
10–14 May	AGS Spring Meeting	Sandwich & Deal
12 May	RNGS	North Hants

RE HOCKEY CLUB

27 March	T & AVR	Longmore
12 April	Worthing Festival	Worthing
17 April	Southgate	Gillingham
24 April	Spencer	Gillingham

RE RUGBY CLUB

31 March	RMA	Chatham
7 April	Inter Corps VII	Deepcut
17 April	Combined Services *v.* French Armed Forces	France



This snuff box was presented to the Mess in 1844 by George Sim, Bengal Engineers. It is one of the many historical pieces of the RE HQ Mess collection. Photographs and descriptive details, written by the Late Colonel J. M. Lambert, of fifteen Mess portraits and forty one pieces of Mess silver are included in a beautifully illustrated booklet entitled

THE PORTRAITS AND SILVER OF THE RE HQ MESS

The book is obtainable from the Secretary, Institution of Royal Engineers, Chatham, Kent. Price £1·50 post free in the United Kingdom.