THE ROYAL ENGINEERS JOURNAL

Vol LXXXIV DECEMBER 1970 No 4

Published Quarterly by
The Institution of Royal Engineers, Chatham, Kent
Telephone: Medway 42669

All correspondence connected with advertisements should be addressed to the Secretary

THE ROYAL ENGINEERS JOURNAL DECEMBER 1970 VOL LXXXIV No 4

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4,300

Royal Bombay Sappers and Miners

ABOVE is a photograph of the Commemorative Trophy presented to the Royal Bombay Sappers and Miners Officers' Association by the Commandant and officers of the Bombay Engineer Group and Centre at Kirkee marking the 150th Anniversary of the Bombay Sappers on 10 February 1970.

It will be used as a centrepiece at the Annual Dinners of the Royal Bombay Sappers and Miners Officers' Association.

The centrepiece incorporates the present badge of the Indian Engineers. The badge on the plinth is that of the 1946 Bombay Group, Royal Indian Engineers.

Officers who served in the Royal Bombay Sappers and Miners will be interested to know that an Association of retired officers of the Bombay Sappers, similar to the Association in this country, is being formed in India.

Royal Bombay Sappers And Miners

Engineers in General Management
The Army's Experience

MAJOR-GENERAL R. L. CLUTTERBUCK OBE, MA, C Eng, FICE

(Major-General Clutterbuck presented the following paper for discussion at a Meeting of the Engineering Management Group of the Institution of Civil Engineers on 23 November 1970.)

INTRODUCTION

CIVIL engineers are inclined to point out, [1]with some truth, that—

(*a*) Too few engineers reach higher management posts in industry (other than in firms of consultants and engineering contractors) or in government.

(*b*) There is therefore inadequate professional consideration of engineering factors in policy-making and decision-making in industry and in government.

(*c*) The benefits of engineering projects are too often obscured by the clamour of their detractors—conservationists and others —in parliament and other public bodies and in the mass media.

(*d*) Because relatively few reach the most lucrative or influential posts, engineering graduates have an expectation of a lower average income at all stages of their careers than those of graduates in other disciplines—especially of lawyers and accountants.

(*e*) For this and other reasons the profession attracts a lower standard of entrant[2] —both in terms of academic and managerial ability—in competition with other professions.

(*f*) Linked to this has been the overspecialized training of engineers at university —though there are now strong trends towards their wider education—in "why" as well as "how" to engineer.

Engineers must take some blame for these things themselves. Many get more satisfaction from seeing their labours reflected in concrete results on the ground than from winning victories in board-room politics; and because they enjoy solving technical problems more than administrative ones. But unless more engineers are both willing to become administrators, and also able to compete successfully in the open market for higher management, their profession must inevitably accept the shortcomings listed above.

In some countries, despite specialization by the bulk of executives, technically trained men do reach the top—many more than in UK, with its long tradition of non-technical, arts-trained Boards of Directors.

[1] See for example: The Institution of Civil Engineers—*Proceedings*: May 1970 pp 107–10; August 1970 pp 481–4 and pp 489–91.

See also "Cambridge Brains Don't Drain" in *Engineering* 10 October 1969, which gives some interesting (and rather discouraging) statistics of the pay earned by engineers in 1968, as recorded in surveys by the Cambridge University Engineering Department and by the Ministry of Technology. Average earnings were particularly poor in the 40–45 bracket.

	Lower *Quartile*	*Medium*	Upper *Quartile*
Cambridge Graduates (1968)	£2,980	3,550	4,900
Others (Mintech Survey) (1968)	£2,347	2,822	3,644
Royal Engineer Officers (1971)	£4,535	4,615	5,220

While comparisons of figures from different sources and at different dates are dangerous, these leave little doubt that the great majority of engineers are poorly paid.

[2] One particular problem is that so many engineering graduates emerge from the universities. A student can get a place to read engineering with two Grade E A levels—and is then educated free. Because there are too many for the jobs available (especially in the South), the lower grade graduates get little responsibility, and are often employed as little more than technicians. It is in any case cheaper for a firm to recruit a State-educated graduate as a technician than to spend thousands of pounds training one as an apprentice. In the long run, however, the poor prospects of responsibility do deter many good young men from joining the profession.

The Army's "Board of Directors", though it contains no engineering post, has never for the last 25 years been without at least one Royal Engineer (RE) amongst its five military members (The Chief of the General Staff and members for Operations, Personnel, Logistics and Equipment). The RE also have a higher proportion than any other arm in higher management posts as a whole. Because this has been so for more than a generation, the Royal Engineers have consistently attracted the highest average quality of intake for its officers—a matter of chicken and egg.

This happy situation can broadly be ascribed to three things:

(*a*) The large number of relatively small scale operations (the 15,000 men of the RE are at present spread over 19 countries of the world) means that RE officers have much independent responsibility when young.

(*b*) The best officers of all arms spend more time than their civilian counterparts on junior, middle and higher management courses. These not only result in better management but also in engineers getting the chance to compete on equal terms for the top jobs.

(*c*) It is RE policy to "spare" its best officers whenever they are in demand for general staff or management posts—and indeed it consciously pushes them for such posts.

This paper aims to describe how this happens in the army. The question of how far it might be applied to the benefit of the civil engineering profession will be left for the discussion.

ROYAL ENGINEERS IN HIGHER MANAGEMENT

"Higher Management" in the army may be defined as incorporating the ranks of Brigadier and above, which are held by 3 per cent of the army's officers, or by 0·3 per cent of its total labour force. 4·2 per cent of RE officers hold these ranks—a higher proportion than in any other arm—see Annex A. Over half of these 4·2 per cent are in general management (not engineering) posts, open to competition by all arms. For example two (about 15 per cent) of the army's infantry and armoured brigades[1] are commanded by engineers. About 1 per cent of the army's officers—and of RE officers—are Major-Generals[2] or above, but of the 10 RE Generals only 3 are needed to fill engineering posts, the other 7 being in general management.

More significant, and already mentioned, has been their continued selection for at least one of the five places on the Army Board[3]—sometimes two and occasionally three. In other words, though the Royal Engineers only amount to 9 per cent of the army, they have provided on average 25 per cent of the Generals on its "Main Board". Similarly, within the hierarchy of the Ministry of Defence, there is no departmental military chain in which there is not at least one RE officer in the higher echelons. Thus, no major decision is reached, at the top or lower down, without the participation of an officer trained and experienced as an engineer.

MANAGEMENT TRAINING AND EXPERIENCE

The path by which an RE officer reaches the highest management is illustrated by three examples in Annex B of officers who have risen high or who look like doing so. The first is an officer now aged 55 and posted to the Army Board. The second is 47 and commands an infantry and armoured brigade. The third has just been promoted Lieutenant Colonel at 37—the youngest age at which this is possible.[4]

[1] A brigade contains about 5,000 men, including infantry and the crews of tanks, artillery, engineering and electronic equipment. The value of the equipment is usually about £30 million.

[2] A Major-General manages about 15,000 men.

[3] The Army Board manages about 150,000 men and has an annual budget of just under £700 million.

[4] All the officers in the examples shewn attended the Staff College course in general management. A number of RE officers instead take specialist courses—e.g. in civil or electrical and mechanical engineering or in survey. None of these, however, have so far reached the highest ranks—as is often, the fate of the specialist in industry too. During recent years, however, a number of particularly able officers have fitted in *both* a specialist course *and* a staff college course, and there is every sign that some of these will become Generals—but not for 5 or 10 years yet. The effect of the split between technical and general management training, and its effect on selection for promotion was discussed by the Management Group and recorded in *Proceedings* July 1965 pp. 319–321.

The significant points in the pattern which emerges are:

(*a*) Up till the age of 30, the officer is employed almost wholly in command of engineers except for a "junior management" course of about a year, which trains him specifically to manage engineers—i.e. in his own specialist aim of the service. Officers of other arms receive equivalent courses (eg in artillery).

(*b*) At about 30, he attends the Staff College—one year for officers of all arms, specifically aimed at widening their horizons and training them for general management outside their specialist arm of the service—after which he goes to a general staff appointment—not usually concerned directly with engineering. (But see also footnote 2.)

(*c*) Thereafter, he alternates between command of engineers and appointments on the General Staff up till his early 40s.

(*d*) After the age of about 42, if he is going to the very top, he seldom if ever again does an engineering appointment—alternating still between staff and command, but managing all arms rather than engineers alone.

(*e*) Throughout his career, he not only goes on regular management courses (as a young officer in his early 20s, at Staff College at 30 and the Imperial Defence College in his late forties) but he also frequently instructs on these courses. For example, of his 35 years service so far, the Army Board Member in Annex B has spent 3 years on such courses and 5 years instructing on them. (The proportion for officers not likely to reach high rank is far less.)

ARGUMENT AND CONCLUSION

It must inevitably be asked:

(*a*) Can a big organization afford to send so many of its best managers away from "profitable" work so often and for so long, to study and to teach management?

(*b*) Can the Royal Engineers afford to do without the overwhelming majority of its best managers (i.e. 70 per cent of its top 1 per cent, and virtually all the very top ones) by sending them forever to a series of general management posts from their early or mid-forties?

The experience of the army and of the Royal Engineers in particular is that they could not afford to do otherwise, because:

(*a*) The army now works on a tight budget to which it is strictly held. Despite this it must be able to respond to emergencies—its primary task. Northern Ireland was a good example. RE have to do more than most—responding to natural as well as to man-made emergencies. In 1968, the rainstorm in the West Country washed out 41 bridges overnight; 7, on trunk routes, were replaced within 3 days. More recently, a 550 foot road bridge span was built at King's Lynn in 14 days, and eight 800 ton piers erected to shore up the damaged Menai Bridge in 16 days—all with very little time for planning and preparation.

(*b*) In these circumstances, as in the civil engineering profession, good management pays more than it costs. The total of the managers' salaries is minute compared with the margin of gain or loss which lies within their competence. Time and money spent in educating and re-educating them at regular intervals is more than repaid.

(*c*) Provided that management courses are kept up-to-date, the student (or instructor) does not "get out of touch" with his profession. On the contrary, it is difficult for a manager who is involved with the daily problems of running his business to introduce new techniques unless he has a periodic refresher course, away from responsibility.

(*d*) It therefore pays the army handsomely to employ, as it does, more senior managers than are needed to fill its management posts, so that some 15 per cent can be relieved at any one time to attend long courses.[1]

[1] Students on most long army courses are required to undertake to serve at least 5 years after completion of the course.

For the Royal Engineers the "loss" of so many of its best into general management has every advantage in the long run—and, since this has been its policy for generations it is reaping these benefits now—because:

(*a*) Higher policy decisions take proper account of engineering factors, and the interests of the Corps are understood at the top.

(*b*) The higher-than-average promotion opportunities for engineers has, for at least 50 years, attracted so many of the best of the army's intake that its junior and middle management is of the highest quality, and it can well afford to find its senior management from its own "B Stream". This is probably of better quality than any "A Stream" it would have recruited if it had not been able to offer these opportunities.

ANNEX 'A'

ORIGINS OF THE ARMY'S BRIGADIERS AND GENERALS

(*September 1969 figures*)

	Total Regular Officers	Percentage Reaching Rank of		Number of Army Board Members
		Brigadier and above	Maj. General and above	
Army	12,776	3·0	0·9	5
Royal Armoured Corps	1,032	3·3	1·4	1
Infantry	3,516	3·3	1·3	2
Royal Artillery	1,756	3·2	0·8	1
Royal Engineers	1,125	4·2	0·9	1
Royal Signals	967	2·9	0·5	–
REME	690	2·5	0·4	–

* * * * *

ANNEX 'B'

CAREERS OF RE OFFICERS IN GENERAL MANAGEMENT POSTS

AGE	ARMY BOARD MEMBER	BRIGADE COMMANDER	LT COL, AGE 37
20	University	Lt / Capt Comd RE Troop	2 Lt Young Officer Course
	Young Officers Course ‖	University	University
25	Capt Comd RE Troop	Maj Instructor School of Military Engineering	Lt Comd RE Troop
	Maj Comd RE Squadron		Capt Instructor Royal Military Academy
30	Lt Col Comd RE Regiment	Staff College	Staff College
	Maj Staff College ‖	Staff	Maj Staff
	Staff ≡		
	Lt Col Instructor Staff College ⦀	Comd RE Squadron	
		Joint Services Staff College	Comd RE Squadron
35	Maj Staff ≡	Staff	Maj Instructor Junior Command and Staff Course
	2IC Regiment	Lt Col Comd University OTC	Lt Col
	Lt Col Comd RE Regiment		
40	Lt Col / Col Staff ≡	Staff	
	Col Senior Instructor Staff College ⦀	Comd RE Regt	
45	Brig Commander Infantry Brigade ≡	Col Senior Instr, Staff College	
	Imperial Defence College ‖	Brig Commander Infantry/Armoured Brigade	
50	Maj Gen Commander Infantry Division ≡		
	Staff ≡		
55	Lt Gen Staff ≡		
	Gen Army Board ≡		

NOTE In the first column only, the following sidelines are used to indicate

General Management Posts ≡

Student on Management Course ‖

Instructor on Management Course ⦀

The Menai Bridge Project

MAJOR C. W. WOODBURN, RE, MA, AND
CAPTAIN C. P. R. BATES, RE, BSc (Eng)

INTRODUCTION

THE historic Britannia Tubular Railway Bridge across the Menai Straits was seriously damaged by fire in May 1970. British Rail asked for the Army's assistance in constructing Bailey towers to provide additional support for some overloaded bridge members. 8 Field Squadron built eight towers in three weeks to a design prepared by 62 CRE (Construction).

BRIDGE DESIGN

Robert Stephenson was commissioned by the Chester and Holyhead Railway in 1845 to design and build two bridges, one across the Conway Estuary and the other across the Menai Straits, to complete the link to Holyhead. Both were across deep water, with very rapid currents, and thus required longer spans than had been normal for railway bridges up to that time. Stephenson therefore decided that a radically new design was required.

His original idea was to use circular or elliptical wrought iron tubes, through which the trains would pass, the tubes being partially supported by suspension chains. Stephenson then commissioned William Fairbairn to conduct experiments upon these lines. Fairbairn was doubtful that a rigid tube, partially supported by flexible chains, would stand up to the vibrations caused by trains passing through the tube, but nevertheless carried out a large number of experiments with models of circular and elliptical tubes of many different designs. These experiments showed him that the elliptical tubes with reinforced top and bottom sections were markedly stronger. This led Fairbairn to build a rectangular riveted wrought iron tube with a cellular top and bottom flange. This proved to be so successful that Fairbairn became convinced that the supporting chains would be unnecessary. Stephenson was not so readily convinced and later made provision in the bridge design for chains to be fitted if the tubes proved to be insufficiently strong after construction.

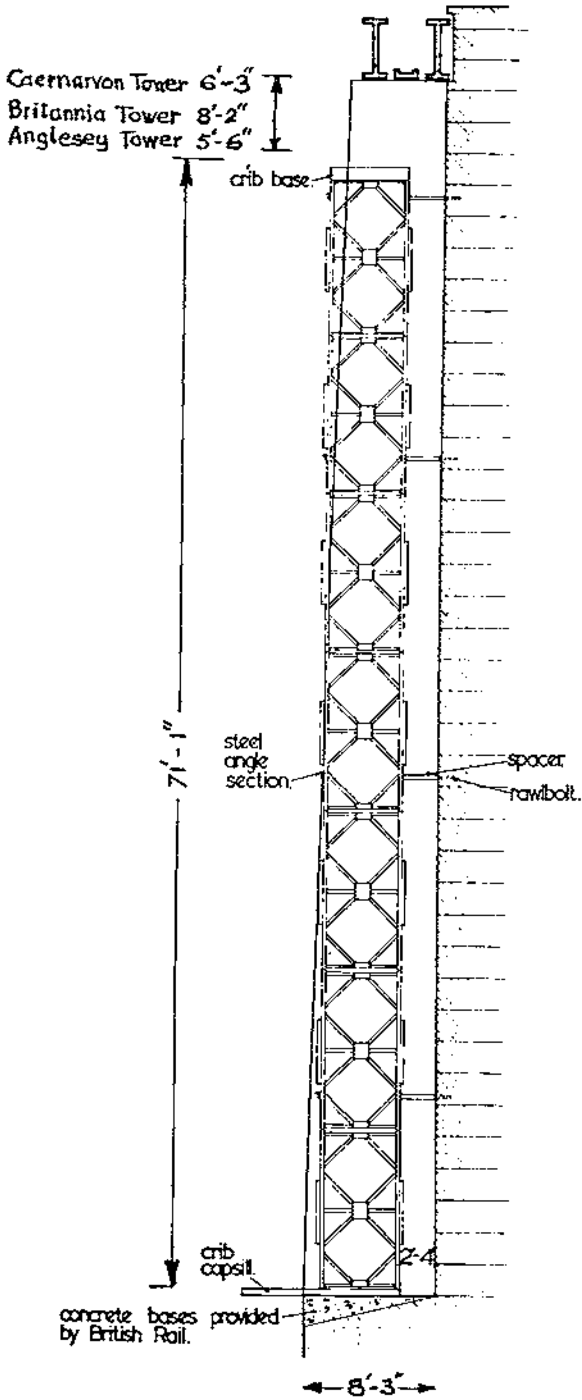
BRIDGE CONSTRUCTION

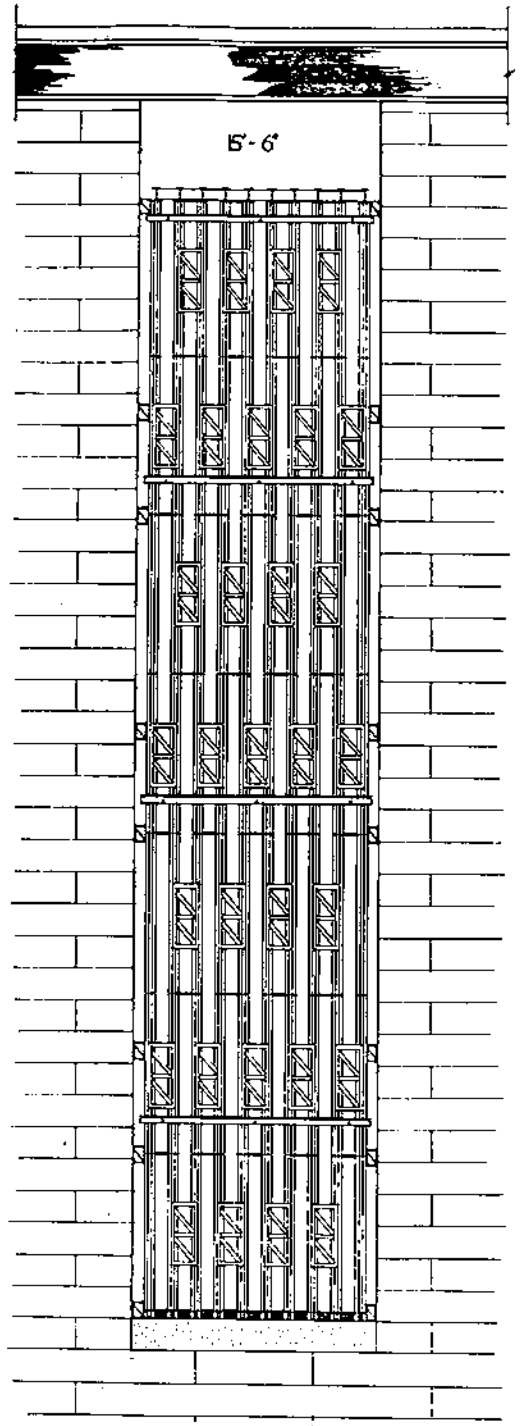
Construction started first on the Conway Bridge which consisted of a single 400-ft span of two parallel tubes. The Britannia Bridge across the Menai Straits was to consist of two main spans of 480 ft with a centre pier resting on the Britannia Rock. Two subsidiary spans of 240 ft were to connect the Caernarvon and Anglesey land piers to the respective portals.

The Admiralty demanded that there should be sufficient clearance under the bridge to allow fully rigged vessels to navigate the Straits. Therefore massive masonry piers had to be constructed to support the spans. These were hollow and built largely of Anglesey limestone.

The subsidiary wrought iron tubes, which consist entirely of plates, angles and T sections, were riveted together in situ on wooden scaffolding. The four main tubes, each weighing 1,600 tons, were constructed on platforms along the shore of the Straits. The platforms were so constructed that pontoons could be floated underneath the tubes to support them and allow them to be floated into position on a high spring tide. The tubes on their pontoons were controlled carefully by cables and capstans until the ends of the tubes were lodged in recesses in the piers. They were subsequently raised about a hundred feet into position using hydraulic pull-lift jacks.

Short lengths of tube were constructed across the pier tops, and the tubes were riveted together to form a continuous bridge from abutment to abutment. The tops of the tubes were then protected from corrosion by a tarred timber roof across both tubes. The bridge was opened in 1850 and has provided the sole rail link to the port of Holyhead and Island of Anglesey ever since.





NOTES.

1. 8 towers total – 4 in Britannia pier
   2 in Caernarvon pier
   2 in Anglesey pier
2. Heavy bracing frames
   a) on outer face
   b) on rear face, on fourth lift only
3. Light bracing frames
   a) on inner face, less fourth lift
   b) on top of each lift (four on top of the seventh lift)
4. Timber wedging shown thus – ⧅ rear chords only in top three lifts.
5. Timber chocks shown thus between capsills ▬
6. Extra channel stiffeners from original design fitted between crib bases.
7. Bracing to back wall of recess provided by British Rail.

BRITANNIA TUBULAR RAILWAY BRIDGE MENAI STRAITS

TEMPORARY BAILEY TOWER DESIGN

Designed by 62 CRE (Construction)

Constructed by 8 Field Squadron RE

The bridge has been maintained carefully since. Fire precautions, until the advent of diesel locomotives, consisted of men walking down a tube from each end, after the passage of a train, to exchange a tally over the centre pier. The timber roof was tarred regularly and the wrought iron painted, even to the extent of sending men crawling down the cells on the top and bottom of the tubes.

FIRE DAMAGE

On the night of 23/24 May 1970 some children, searching for bats on top of the bridge at the Caernarvon portal, were disturbed and dropped a burning newspaper against the timber roof. The roof started to blaze furiously, fanned by strong winds, and the thick coating of tar which had collected on top of the tubes added to the fire's intensity. Access to the site was difficult, and the Fire Services were unable to prevent the timber roof being completely destroyed.

On cooling, large cracks appeared in the tubes at the original construction joints above each pier, and some of the cast iron girders, carrying the spade bolts which partially support the tubes, were also fractured. The bridge was thus effectively split into four simply supported spans. The main spans sagged by up to 2 ft 6 in compared to the normal sag of about 9 in, and this, together with the loss of continuity, tended to impose excess loading on the outer edge of the tube bearings over the piers. These outer edges rest on cast iron beams spanning the construction recesses. British Rail started to stitch the cracks using steel beams during the first few days after the fire, thus stopping any further sagging, but the cast iron beams were grossly overloaded. Thus the bridge was barely able to support its own weight, and needed to be almost entirely rebuilt. In the short term, before reconstruction work could start, the overloaded cast iron beams required additional support, and having considered various alternatives, British Rail asked the Army for assistance.

PROJECT BACKGROUND

An initial reconnaissance was carried out by 62 CRE (Construction) in early June, and 70-ft high Bailey Bridge Towers were designed to fit into each of the eight recesses in the bridge piers underneath the overloaded girders. British Rail accepted the design as providing a suitable platform from which to jack, to relieve the stress in the beams. The project was designated a Military Aid to the Civil Community task under Headquarters Western Command, to be called EXERCISE WELSH ROCKET. 8 Field Squadron was nominated to undertake a detailed reconnaissance, and to prepare outline plans. 17 Port Regiment RCT were instructed to make a Ramp Powered Lighter (RPL) available for the project.

After consultations with 62 CRE and British Rail a reconnaissance party visited the bridge on 25 and 26 June 1970. A site conference was held on 26 June at which the plan was discussed with the British Rail Engineer responsible for the project. He agreed to undertake preparatory work to enable work to start on the project as soon as clearance was given. This preparatory work consisted of alterations to the scaffolding platforms which had already been constructed around the bases of two piers, the preparation of mooring rings for the RPL and the cutting of holes through the tube bases directly in front of each recess, to enable snatch blocks to be fitted for hoisting.

British Rail maintained a Resident Engineer on the site, but all construction work prior to, and during, the project was carried out by Norwest Construction Company. During the project close liaison was maintained with both British Rail and Norwest, with the result that every effort was made to assist us. The preparatory work was completed on time to our satisfaction, and the drilling of holes and fixing of rawlbolts was arranged so that the towers were effectively braced at all stages, with only slight delays in construction.

TOWER DESIGN

The original design prepared by 62 CRE incorporated seven lifts, each of ten Bailey panels placed vertically, resting on crib capsills, and topped by crib bases. The towers were to be braced using heavy bracing frames placed vertically on the front and rear faces, and light bracing frames placed horizontally on the top of each lift except the seventh. The number of heavy bracing frames was to be four in the first lift, with five light bracing frames at the top of that lift. In the second lift the numbers were to be five and four respectively, and so on to the top of the towers, which were to be capped by crib bases braced together in pairs. These towers were to fit into the recesses which measured 15 ft 6 in × 8 ft 3 in at the bottom, decreasing to 15 ft 6 in × 6 ft 0 in at the top. The heights varied between 76 ft 7 in and 79 ft 3 in on the different piers. This precluded the normal Bailey pier design, but the design used followed a wartime design called a "Leaf Pier". The crib capsills were put at the bottom because their length would have caused an obstruction at the top.

The design was later modified when it was discovered that only 300 Heavy Bracing Frames were available, and so they were eventually placed on the front of each tower, and on the fourth lift only, at the back. During construction the design was further modified when it was discovered first, that bracing frames could be fitted between the seventh lift and the crib bases, and then that all ten crib bases could be joined together using extra channel stiffeners, which were provided by Central Engineer Park.

Timber chocks were fitted between the crib capsills to stop lateral movement, and timber wedges were fitted between the panel chords and the recess edges. These wedges were fitted near the panel pin points, in positions where there was horizontal bracing between the outer panels, and near the vertical bracing, in positions where this was between the outer panels. This wedging could not be placed on the front chords above the fourth lift because of the batter of the face of the pier.

The bracing to the rear face of the recess was provided by British Rail. It consists of four rows, each of three rods, bolted into rawlbolts secured in holes drilled seven inches into the masonry. On each rod a spacer bears against the rear faces of two panel chords and, at the front, the rods are bolted through a steel angle section bearing across all ten panel chords. Each rod is capable of withstanding a pull of about 2 tons.

As each of the 480-ft long tubes weigh 1,600 tons the towers might be expected to support 800 tons each, should the full weight fall upon them. Each panel chord and panel pin has a safe working load in compression of 55 tons, giving a theoretical compressive strength for each tower of 1,100 tons. To attain this strength in practice it is important that the towers should be maintained in a truly vertical position. The wedging, chocking and rawlbolting was designed to achieve this. British Rail had prepared designs for load spreading steel beams to fit between the crib bases and the jacks, under the cast iron beams, and they were intending to relieve the stress in the cast iron beams by imparting an upward thrust of 200–250 tons. Should the beams shear during this operation, then something approaching the full weight of 800 tons would have to be supported by the towers.

STORES

All bridging stores were transported from Long Marston in 50 rail wagons. The train was left in sidings at Menai Bridge station, and a shunting engine was supplied to shunt the wagons down to the unloading point just short of the Caernarvon Abutment, as required. The stores were transferred using a bridging crane from the rail wagons to unit 4 ton vehicles, which had been stripped to flat beds. The vehicles then drove down a steep, newly constructed road to the Caernarvon Quay, where the stores were unloaded by another bridging crane to be stockpiled for use on Caernarvon Pier, or transferred to the RPL for use on Britannia Pier.

The track leading to the Caernarvon Abutment passes under a bridge with 11 ft headroom. This meant that the bridging cranes had to be driven to the site along the railway tracks from Menai Bridge Station, with suitable packing being placed across points.

The RPL, which was moored at Port Dinorwic when not in use, proved to be almost the ideal craft for ferrying stores across the Straits and was handled with great skill by its crew. The current in the Straits flows at up to 9 knots at spring tides, with many dangerous eddies. The RPL could berth alongside the Caernarvon Quay for two hours, and alongside the scaffolding platform around the Britannia pier for about four hours at high water. The capacity of the RPL was approximately one complete tower's worth of stores, and it was found that the supply of stores to the Britannia Pier could easily keep pace with construction, and that it was unnecessary to work more than slightly extended working hours to fit in with the tides.

The stores for Britannia Pier were unloaded from the lighter using an electric winch on the scaffolding platform with a cable passing through a snatch block suspended from a steel beam placed across the top of both tubes above the platform edge. Stores were moved around the platform for stockpiling, or transferred to the far side of the pier for the construction of the two towers facing Anglesey, using 8 ft long gravity rollers. Because of its bleak appearance and its isolation the Britannia rock became known as "Alcatraz".

It had originally been intended that stores should be supplied to the Anglesey Pier using the lighter, but it was found to be easier to use the unit 4-ton flatbeds to bring stores by road from the unloading point near the Caernarvon Abutment. The scaffolding platform area was limited by the rock configuration at the base of the pier, and would not have allowed room for stockpiling sufficient stores. The track down to the pier had been improved after the reconnaissance and proved to be quite easily negotiable for 4-ton vehicles with tightly secured loads, except at the track entrance where there is a sharp turn through a narrow gateway. The stores were unloaded by hand onto the Anglesey shore behind the pier, and stockpiled there until required, when they were moved up a train of gravity rollers along a ramp leading to the platform. Mooring trials were carried out and it was found to be quite possible to bring the RPL alongside the platform.

TOWER CONSTRUCTION

One field troop was responsible for the construction of all four towers on Britannia Pier whilst the other troop built two towers each on Caernarvon and Anglesey Piers. The Squadron worked a six-day week, and the first four towers were complete after seven working days. The bases for the remaining towers had already been set out, and with the benefit of experience these towers were constructed in four days. The total number of working days on site was thirteen, as a day was spent before and after tower construction on stores handling and launching and de-launching of tugs.

The concrete bases which had been prepared for the towers were found to be as much as half an inch out of level, and so steel packing had to be cut. Strips of damp-course felt were used for bedding down the capsills.

Ingersoll Rand compressed air winches were used to lift the tower stores into position. The winches were positioned at the bottom of the towers, lashed to two horizontal Bailey panels, with cables passing through snatch blocks which were secured from within the holes cut by British Rail in the base of each tube. On Caernarvon and Anglesey piers there is less clearance between the bottom of the tubes and the tops of the towers than on Britannia Pier, and this together with the obstruction caused by the damaged aluminium painting gantries at these points, made it difficult to swing the panels in the last two lifts of each tower into position. To enable the towers to be completed the snatch blocks had to be repositioned until they were suspended from steel channel sections resting on top of the cast iron beams, between the tube bearings. Once completed the towers could be adjusted to a truly vertical position by slackening and tightening the appropriate rawlbolt bracing bar nuts.

EQUIPMENT

Two Mk 7 Tugs were used as safety boats, and for ferrying personnel and small stores. They were transported to site using RCT 10-ton trucks and were trailer launched at Port Dinorwic. Skilled Craft Operators were necessary to cope with the very difficult currents in the Straits.

Three 3 phase electric winches with a 1-ton working capacity were hired for use on Britannia Pier. They were powered by a $27\frac{1}{2}$ KVA generator sited near the Caernarvon Portal with cables running along the top of the tubes to Britannia Pier, and then down the side of the pier to the scaffolding platform. The degree of control was found to be too imprecise for use in construction and so the electric winches were used solely for unloading the lighter.

All construction hoisting was by Ingersoll Rand compressed air winches, which were drawn from Central Engineer Park. They were originally purchased as accessories for Heavy Girder Bridge Pier construction. The HGB pamphlet states that the winch consumes 150 cfm at 80 psi supplied through 1-in air hoses for hose lengths of 50 ft or less. However the largest service hose size available is $\frac{3}{4}$ in and the inlet thread to the winch is of a completely different size and type to normal hose fittings, necessitating the manufacture of special couplings. Nevertheless it was found that two winches, albeit lifting loads of less than the working capacity of $1\frac{1}{4}$ tons could be operated simultaneously from one 125 cfm compressor using 150 ft of $\frac{3}{4}$-in hose to each winch. The degree of control attainable was excellent, and enabled loads to be inched up or down into position with perfect safety. The air winches on the Caernarvon Quay were operated from a 315 cfm Coventry Climax compressor on the quay. When it had been established that the electric winches were unsatisfactory, air winches were set up on the Britannia platform. They were powered by a light Ingersoll Rand 100 cfm compressor borrowed from the contractors, which had been mounted on a small rail trolley. This was pushed along one of the tubes until it was over Britannia Pier. The hose was then lowered down to the winches through one of the holes cut in the base of the tube.

A Pescara Compressor proved to be too unreliable for use, and later the Coventry Climax compressor clutch failed, and so a 125 cfm Atlas Copco compressor was also borrowed from the contractors to enable the air winches to be used on the Anglesey towers. The Coventry Climax compressor had proved, before it broke down, to be too large and unwieldy to handle easily on a site with such restricted access.

SAFETY

The project was potentially dangerous, and safety was of prime importance. The SSM was appointed to be Project Safety Officer. A set of safety rules were drawn up and rigidly enforced, with the result that the only injuries were a few minor cuts and bruises.

All personnel working below the bridge wore plastic safety helmets, which were bought especially for the project. Safety harnesses with snap links were drawn from the RAF for use by the tower construction parties. They were designed for use by helicopter crewmen, and were both ideal for the job and psychologically invaluable.

PUBLIC RELATIONS

The project attracted a surprising amount of publicity. The Squadron was greeted on arrival at the site on the first day by both BBC TV and ITV cameramen. Reporters and photographers from the national Press were always in evidence and some members of the Squadron are said to have spent more time posing for photographs than working. The Squadron was given a friendly welcome by the local residents, though they were somewhat disillusioned when they realised that, even after the towers were constructed, trains would still be unable to cross the bridge.

MANAGEMENT

Captain Bates, normally a troop commander, was appointed Project Officer with a senior NCO, Staff Sergeant D. Owen RE, as his assistant. Together with the Squadron Commander they carried out the detailed reconnaissance and prepared the plan. During construction the Project Team were responsible for the allocation

Photo 1. Britannia Tubular Bridge from Caernarvon Abutment, showing the sag in the tubes

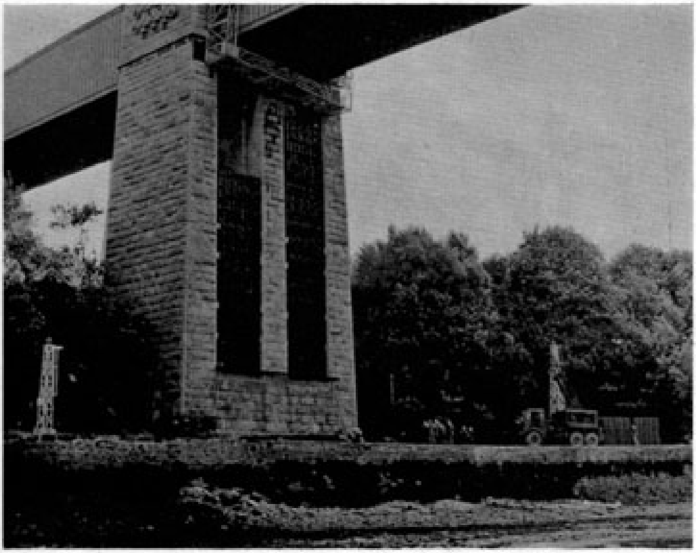


Photo 2. Partially completed Bailey towers—Caernarvon Pier

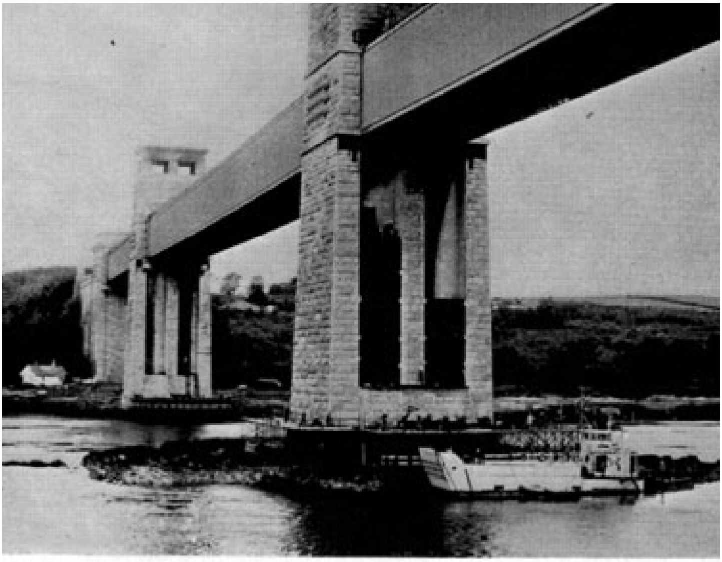


Photo 3. Stores being unloaded from the Ramp Powered Lighter—Britannia Pier

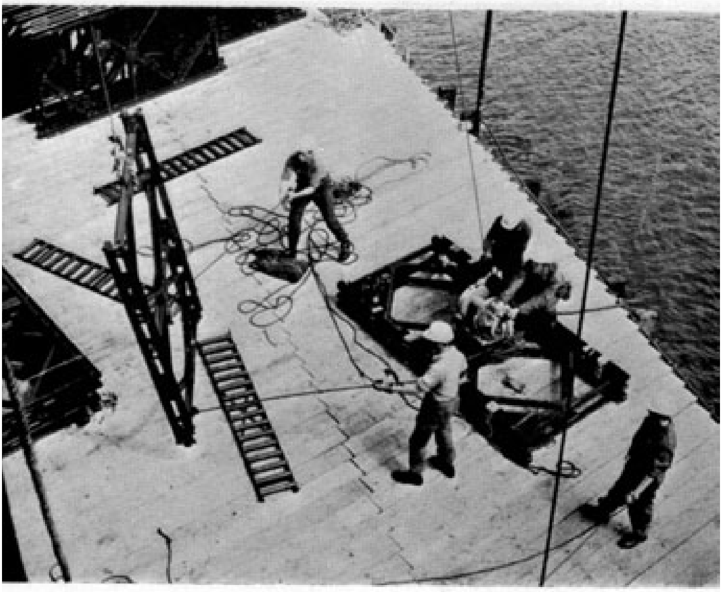


Photo 4. Winching on Anglesey Pier

The Menai Bridge Project 3 & 4

Photo 5. The first panel of the fifth lift being lowered into position—Caernarvon Pier

of stores and plant, quality control of work and liaison with the site contractors and British Rail. Communications were maintained on the site by establishing both radio and field telephone nets. A skywave link was also established to the Squadron's base at Tidworth.

CONCLUSION

The new bridge design has recently been announced. It incorporates steel lattice arches to support the main spans, and props to support the shorter spans. The existing tubes will be removed. In addition, there will be a road bridge above the rail bridge, bearing on the same existing piers. This will relieve the congestion on Telford's suspension bridge. All this is going to take many months. British Rail have given no firm indication of when in the reconstruction the Bailey towers will become redundant and may be removed. It is certain, however, that dismantling will be a totally different problem.

The Squadron received a great deal of help with the project: from the staffs of the Ministry of Defence and British Rail, London Midland Region; from 62 CRE (Construction) who did all the preliminary work and Headquarters Western Command who mounted the operation. Central Engineer Park somehow managed to find all the stores and get them to the site on time and 17 Port Regiment RCT sent the RPL and its excellent crew all the way from Marchwood. The staff of the Trials Establishment Royal Artillery at Ty Croes, Anglesey went to a great deal of trouble to accommodate the Squadron. We are very grateful to them and many others for all their hard work on our behalf.

The project provided an essential step in the reconstruction of the bridge and offered excellent training in bridging, watermanship, communications and management. The opportunity to work on an important engineering project in a civilian environment was an invaluable experience for all ranks.

Flood Relief in Tunisia Exercise Last Fling

CAPTAIN R. H. SMITHERMAN, RE

BACKGROUND

TUNISIA is a country whose agriculture is hampered by drought. Until September 1969 there had been negligible rain for three years; indeed the south and centre regions of the country had had no rain at all for a year.

On the 27th of September 1969 unprecedented rainfall lashed the whole country. Vast areas were flooded, sections of road were uprooted, the remains littered along existing oueds and the railways were brought to a standstill. Emergency supplies were flown in by many Governments, but no sooner had relief and reconstruction work been begun than further intense rainfall destroyed much of it. Overall an estimated 550 people and a million head of cattle died. In addition 300,000 people were made homeless.

The Tunisian Government appealed for assistance from outside. French, Belgian, Spanish and American Engineer units were soon committed and on 10th of October a troop of two Officers and forty-eight men of RE Malta was stood by at forty-eight hours notice to move by HQ British Troops Malta, but political and financial considerations precluded any commitment until January. Because of the imminent disbandment of RE Malta and the fact that no places in the Malta Land Force had at that time been offered to RE LEP it was planned to rotate this troop on a monthly basis.

On 30th of December Major A. Jackson RE, the Officer Commanding the Malta Fortress Squadron was authorized to travel to Tunis to advise the British Ambassador on suitable tasks for the detachment. He was briefed by British Embassy and Tunisian Ministry of Agriculture officials on the following possible tasks:

(*a*) A barrage at El Ksar.
(*b*) A barrage near Gammouda.
(*c*) Well clearance in the Gammouda Area.
(*d*) The repair of existing well pumps and motors now clogged with sand in the Gammouda Area.
(*e*) Similar well clearance and pump repairs at Maknassy.

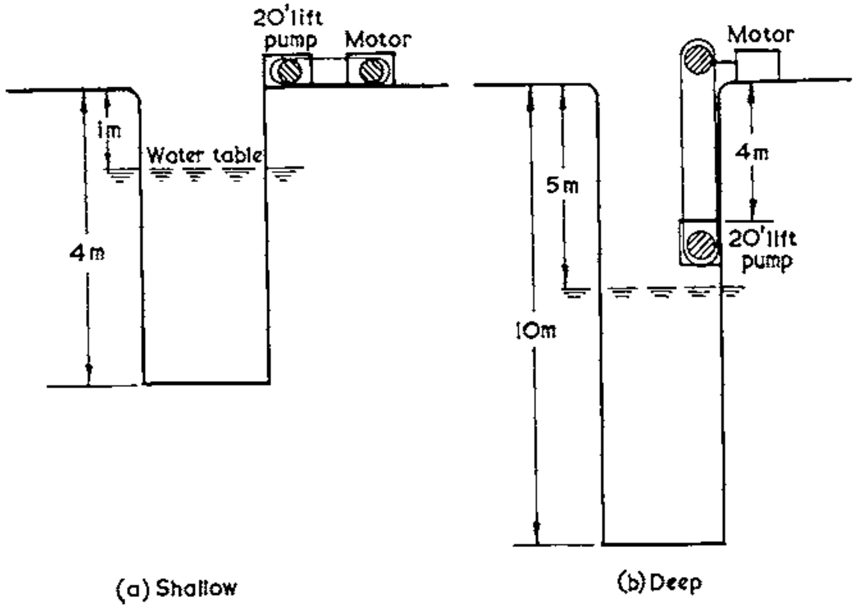
In order to keep the RE Malta detachment concentrated, the Gammouda tasks were recommended and soon accepted in the following order of priority:

First.	Well Clearance.
Second.	The repair of pumping equipment.
Third.	The construction of the barrage.

The local population of Gammouda was so overcome by the magnitude of the damage, that they lacked the willpower to make use of even the limited resources at their disposal. Thus the most important contribution the RE Malta detachment could make was to arouse the local population to help themselves.


MEDITERRANEAN
ALGERIA
Tunis
Sousse
Gammouda
Maknassy
Sfax
Gafsa
El Ksar
Gabes
TUNISIA
0 20 40 60 80 100 miles

Sketch 1



Sketch 2 Typical Tunisian wells (depths are approximate)

WELL CLEARANCE

Sketch 2 shows typical wells as they were found by the RE Malta detachment. The greatest weakness of these wells was the absence of any wall above ground level to prevent sand from drifting into the well. In many instances the well wall had not even been completed to ground level round the whole circumference. As a result when flooded the unsupported earth soon collapsed into the well.

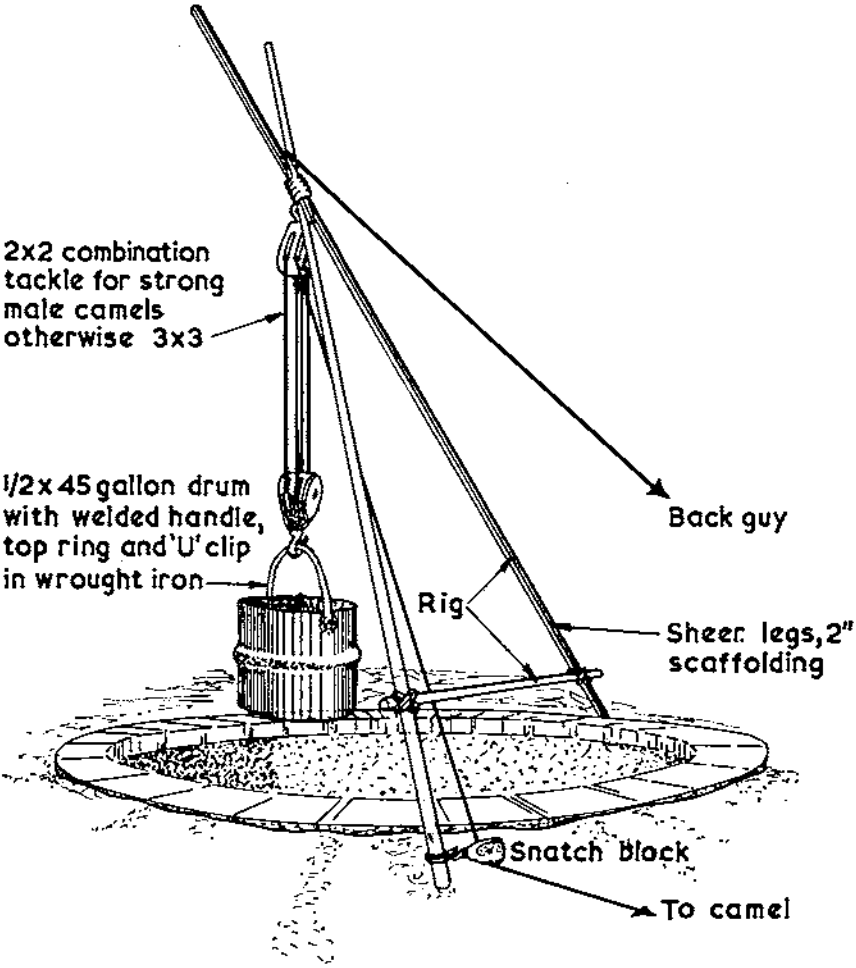
Most of the wells in the flooded area were filled to ground level with sand. Sketch 3 shows the tackle adopted for their clearance. One male camel power was found to require a 2 × 2 combination tackle. Small male camels or female camels required a 3 × 3 tackle. The RE Malta improvised bucket which held 7 cu ft of sludge had to be hand-filled in the well.

It was hoped that the owners of all the wells in the area would join forces to clear each other's wells under the supervision of the Maltese sappers, but this system never worked. In the event a labour force for well clearance had to be provided by the local authorities. The work was carried out under the supervision of WO II C. Galea, RE and S/Sgt F. James. Five wells were undertaken at any one time each having a Maltese L/Cpl or Sapper in charge of a team of between four and five labourers usually assisted by the well owner.

Great difficulty was experienced in keeping the local labour at work down the wells in spite of the fact that they recieved extra money for doing so.

The above method turned out to be very slow and builders hoists were requested and provided at very short notice from UK. These considerably speeded up the woık on the deep wells and enabled labourers to be released for work on additional small wells. A BK 50 and crane each with a grab were also used with great success on some of the deepest wells.

In addition to well clearance many locally owned pumps and motors which had become filled with flood water and sand were repaired. Well clearance was continued



Sketch 3 Original lifting tackle

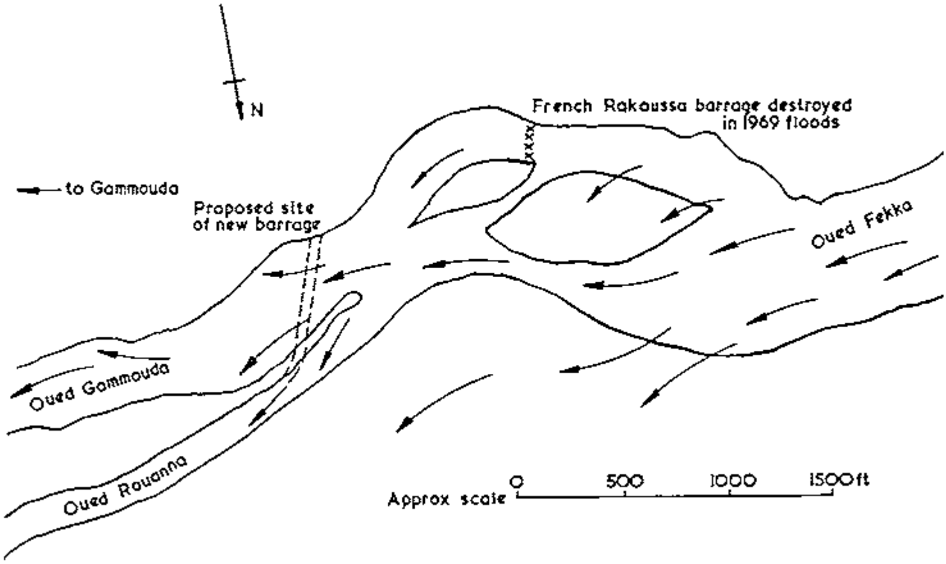
for eight weeks during which period 33 wells were cleared using the manual lifting tackle or the builder's hoists, 9 were cleared with the grabs and 34 pump or motor repair jobs were completed.

THE GAMMOUDA BARRAGE

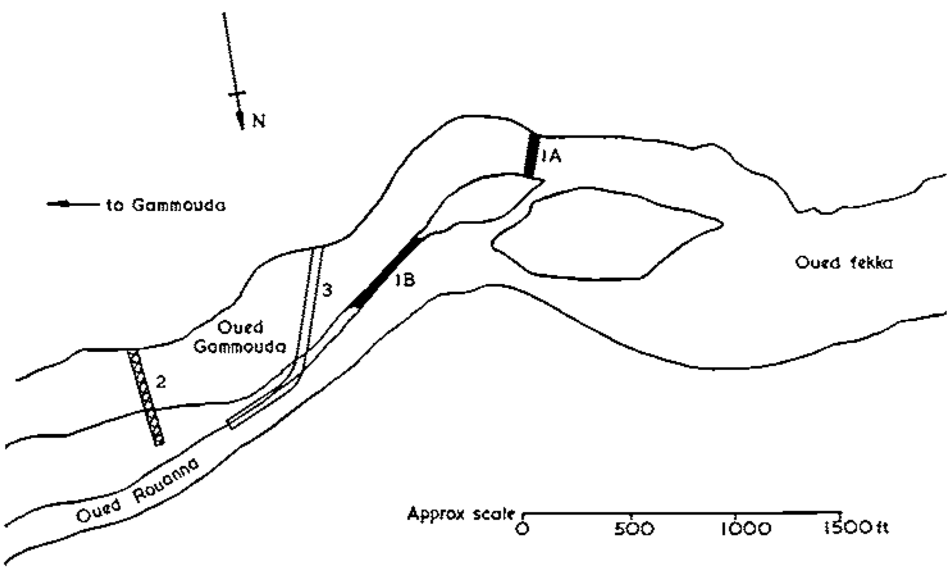
A barrage was necessary to divert the flood waters of the Oued Fekka away from the Oued Gammouda, which ran towards the town, into a oued which avoided it. The Oued Rouanna which had originally been enlarged to feed irrigation canals in the surrounding area developed into a significant water course during the floods. It was the only suitable choice. The area of the junction of three oueds is shown in Sketch 4.

The three ways in which the need could have been met are shown in Sketch 5. They were:

(*a*) To rebuild the old Rakoussa Barrage (1A on sketch) and build a dividing wall between two islands in the Oued (1B on sketch). This method was discarded on the grounds that it would have been impossible to anchor either end of the dividing wall against future flooding.



Sketch 4 The barrage area showing principal flow during 1969 floods



Sketch 5 The barrage area showing the sites considered during recce

(*b*) To build the barrage across the narrowest part of the Oued Gammouda (2 on sketch). This method would have produced the shortest barrage but would have involved considerable earthworks. This was discarded as there was no guarantee that the Tunisians could provide sufficient plant and RE Malta had only two Bray LWT and one Drott.

(*c*) To build the barrage across the junction between the Oued Gammouda and the Oued Rouanna. This involved the minimum earthworks although it required a longer barrage than Method *b*.

THE BARRAGE DESIGN

General. The calculations for the barrage design were based on those to be found in "The Design of Small Dams" by the US Bureau of Reclamation and was carried out in the following stages:

(*a*) Calculate the maximum possible flow in the Oued Rouanna.

(*b*) Compare this with the actual quantity of water to be met under flood conditions to see whether a spillway is required, and if so what flow it must take.

(*c*) Hence find the required length of spillway.

(*d*) Adjust the dam thickness so that it is stable against overturning.

Capacity of the Oued Rouanna

(*a*) From Mannings formula $Q = \frac{1{\cdot}486}{n} a.r.^{\frac{2}{3}S} S^{\frac{1}{2}}$, where

$Q =$ flow in cusecs
$n =$ coefficient of roughness for the Oued
$r =$ hydraulic radius in ft
$a =$ cross sectional area in ft^2
$s =$ slope of the energy gradient

(*b*) The value of n is affected by:

(1) The type of soil.
(2) The degree of meander of the water course.
(3) Obstructions in the oued bed.
(4) Changes in cross section.

(*c*) The value of n used in local Tunisian engineering practice is 0·02. This value was assumed to be correct.

(*d*) Cross sections at two points A and B were taken and the gradient between them found. The data was as follows:

	Point A	Point B
(1) Area in ft^2	1,545·3	1,628·5
(2) Hydraulic Radius in ft	9·552	7·418
(3) Height difference	1·71 ft	
(4) Distance A to B	485 ft	

(*e*) Now K (the coefficient of discharge) $= 1{\cdot}486\, a.r.^{\frac{2}{3}}$ such that $Q = K^S S^{\frac{1}{2}}$. Therefore:

$$\left.\begin{array}{l} K_A = 458{,}400) \\ K_B = 488{,}400) \end{array}\right\} \text{and } K \text{ mean} = 473{,}400.$$

(*f*) From Bernoulli's total head equation $(h_v)_A + Z_A = (h_v)_B + Z_B +$ Losses (h_L) where $h_v =$ velocity head.

$Z =$ position head.

Therefore: $h_L = (Z_A - Z_B) + [(h_V)_A - (h_V)_B]$

$= 1{\cdot}71 +$ velocity head difference.

and $$s = \frac{h_L}{\text{Distance } AB.} = \frac{h_L}{L}$$

(*g*) The true value of Q is found as follows:

(1) Assume a value of Q
(2) Hence calculate V_A and V_B and $(h_v)_A$ and $(h_v)_B$
(3) Hence calculate h_L and s
(4) Put this value of s in the equation $Q = K \text{mean}.\ s^{\frac{1}{2}}$
(5) When this value of Q agrees with the assumed value, Q is found

(*h*) Assume $Q = 35{,}000$ cusecs, then:

Point	$V = \frac{Q}{a}$	$hv = \frac{v^2}{2g}$	$(hv)_A - (hv)_B$	$h_L = (Z_A - Z_B + (hv_A - hv_B))$	$s = \frac{h_L}{L}$	K_{mean}	$Q = Ks^{\frac{1}{2}}$
A	22·69	8·042	0·816	2,536	0·0052	473,000	35,080
B	21·50	7·224					

Therefore $Q = 35{,}000$ cusecs $= 980\ m^3/sec$

Spillway Design

(*a*) L'Etude Hydraulique of the Gammouda Region dated 1963 gives the following likely flows in the Oued el Fekka (no figures for the 1969 floods were available).

(1) 10-year flood 1,600 m^3/sec
(2) 100-year flood 3,200 m^3/sec
(3) 1,000-year flood 4,800 m^3/sec

(*b*) Of these flows, the Oued Rouanna will take 980 m^3/sec and the remainder must flow over the spillway. It was considered that to design on the basis of a 1,000-year flood was impracticable as it would involve designing for a contingency which was unlikely to occur in the foreseeable life of the barrage. Thus a design for a 100-year flood was decided on.

(*c*) 3,200 m^3/sec is equivalent to a flow of 113,000 cusecs. Of this, 35,000 cusecs flow down the Oued Rouanna leaving 78,000 cusecs to flow down the Oued Gammouda over the spillway.

(*d*) The flow over an uncontrolled Ogee crest is given by:

$$Q = C L H_o^{\frac{3}{2}}$$

Where:

(1) C is a variable coefficient of discharge.
(2) L is the effective length of the crest.
(3) H_o is the design head (including the approach velocity head) in feet.

(*e*) The approach velocity is given by $\frac{Q}{a} = \frac{78{,}000}{4{,}800} = 23{\cdot}55$ f.p.s.

Therefore the approach velocity head is given by $\frac{v^2}{2g} = \frac{(23{\cdot}55)^2}{64{\cdot}4} = 7{\cdot}16$ ft

The design height of the spillway = 3 ft. Therefore $H_o = 7{\cdot}16$ ft $+ 3 = 10{\cdot}16$ ft.

The height of the weir below the crest is 6 ft, therefore $\frac{P}{H_o} = \frac{6}{10{\cdot}16} = 0{\cdot}59$

(*f*) The tables in "The Design of Small Dams" by the US Bureau of Reclamation give a value of 3·83 for C with this value of the ratio P/H_o. This value, however, assumes a smooth surface shaped to the ideal Nappe form. To allow for the gabion construction used, a value of $C = 3{\cdot}5$ was assumed. With $Q = 78{,}000$ cusecs and $H_o = 10{\cdot}16$ ft, the equation $Q = C L H_o^{\frac{3}{2}}$ gives a value of the effective length of the spillway of 688·4 ft.

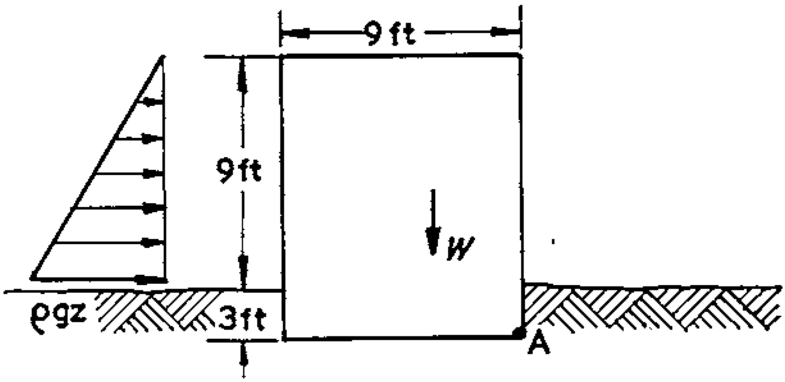
(*g*) But the effective length (L) is related to the true length (L_T) of the spillway by the equation:

$L = L_T - 2\, Ka\, Ho$ where Ka is the abutment coefficient.

In this case $K_a = 0{\cdot}08$ has been used. This value of K_a produces a true length of 690 ft.

Stability of the Barrage

(*a*) The least stable portion of the barrage has the following configuration:



Sketch 6

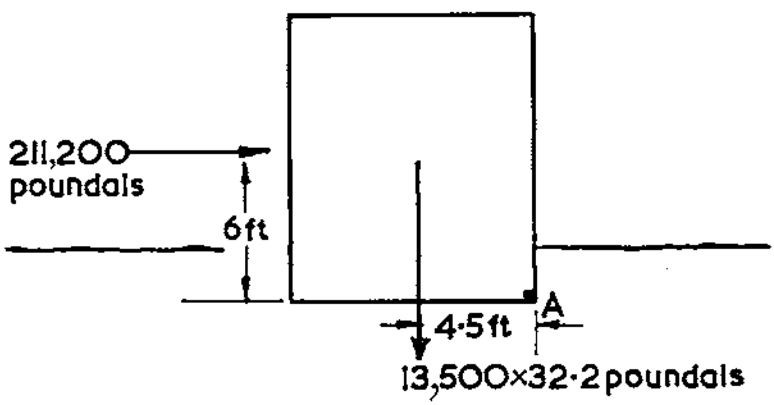
(*b*) The pressure acting on a strip of width dx at a depth of x ft is $dP = \rho gxdx$

Therefore $P = \rho g \int_{x=Ho}^{x=H_o+9} x\,dx$

$$\rho g \left[\frac{x^2}{2}\right]_{Ho}^{Ho+9} = \frac{62{\cdot}5 \times 32{\cdot}2}{2}(16{\cdot}16^2 + 7{\cdot}16^2)$$

$= 62{\cdot}5 \times 16{\cdot}1\,(23{\cdot}32\,(9) = 211{,}200$ ft poundals/unit length.

(*c*) Assuming a barrage density of 125 lb/ft³ then W/unit length is $125 \times 9 \times 12$ lb f $= 13{,}500$ lb f acting through the centroid. Thus we have:



Sketch 7

Overturning moment $= 211{,}200 \times 6 = 1{,}267{,}200$ ft poundals.

Righting moment $= 13{,}500 \times 32{\cdot}3 \times 4{\cdot}5 = 1{,}956{,}150$ ft poundals.

Therefore the barrage is stable.

WORK ON THE BARRAGE

The Quarry

(*a*) The Sapper party consisted of:

1 NCO IC.
1 Spr storeman and compressor operator.
2 Sprs supervising the SL9 teams.
1 Spr Bray LWT operator.

(*b*) Under this party were some eight to twelve Tunisian Labourers who worked the SL9s and prised the cracked rock from the face. The fact that the Tunisian foreman came from a different village to the labourers was the cause of considerable friction between them; a difficulty which had to be dealt with by the local political headquarters.

(*c*) Initially there was no sapper supervision of the SL9 teams but it was soon found that the Tunisian SL9 operators were getting the longer rip rods stuck in the fissured rock, because they tended to let the weight of the SL9 do the work without controlling it sufficiently.

(*d*) During the course of the exercise some 42,000 cubic yards of stone were transported from the quarry to the barrage involving a turn round of some twenty-two miles. In addition to three veteran RE Malta 10-ton tippers, we had only one Tunisian 5-ton tipper for the first two weeks of barrage construction and two Tunisian 10-ton tippers for the last four weeks of construction. The fact that our 10-ton tippers did not have front wheel drive put a tremendous strain on their clutches. Two in fact burnt out. In addition to this much time was spent welding up the sides of these old vehicles broken by the heavy rock tipped on them by the LWT. The two 10-ton tippers provided by the Tunisian authorities were Russian. They gave little trouble apart from a fractured fuel pipe.

The Barrage

(*a*) Gabion construction has been used in the building of small dams in North Africa by both the French and the Italians. A gabion is in essence a wire cage filled with stone.

(*b*) This form of construction has the following advantages:

(1) It is easily taught to unskilled labour.
(2) It requires the minimum of skilled supervision.
(3) It is structurally flexible to cater for an unstable foundation.
(4) Suitable bulk material is likely to be readily available, no crusher is required.

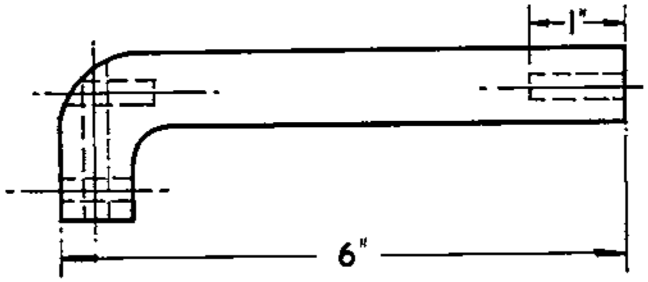
(*c*) It has the following disadvantages militarily:

(1) It is expensive in wire mesh.
(2) It requires a considerable transport tail, for the initial supply of wire.

(*d*) In the case of the Gammouda barrage the gabions were one m^3 in volume and BRC L26 was used because it was the most suitable mesh available. The BRC provided a rigid cage which facilitated accurate positioning. BRC sheets were cut to size, shaped and then placed; the protruding rod ends being bent round adjacent gabions to provide resistance to shear failure. The bending was done with the "Raycut" bending tool. (Sketch 8).

Notes:

1. Tool made from 3/4" ϕ M S bar
2. Holes are 1/16" ϕ larger than ϕ of the BRC bars
3. Tool should be case hardened for longer life
4. The positioning of the holes enables the bending of bars in awkward places to take place



Scale-Half full size
The 'Raycut' bending tool
Sketch 8

The ground plan of the barrage (Sketch 9) shows the dimensions of the barrage and gives details of the various cross sections. The gabions were staggered in elevation to provide increased shear resistance.

(*e*) There was no foundation of any kind on the Rakoussa Barrage and as this may have been one of the reasons it failed, it was determined that the RE Malta barrage would have one gabion below ground level. The foundations were dug by two Tunisian tractors (a D8H and a D6). In many places along the alignment the foundations got down to an intermittent layer of impermeable blue clay but in other places they were still on the sand. The foundations were still settling when the Fortress Sqn portion of the task was finished.

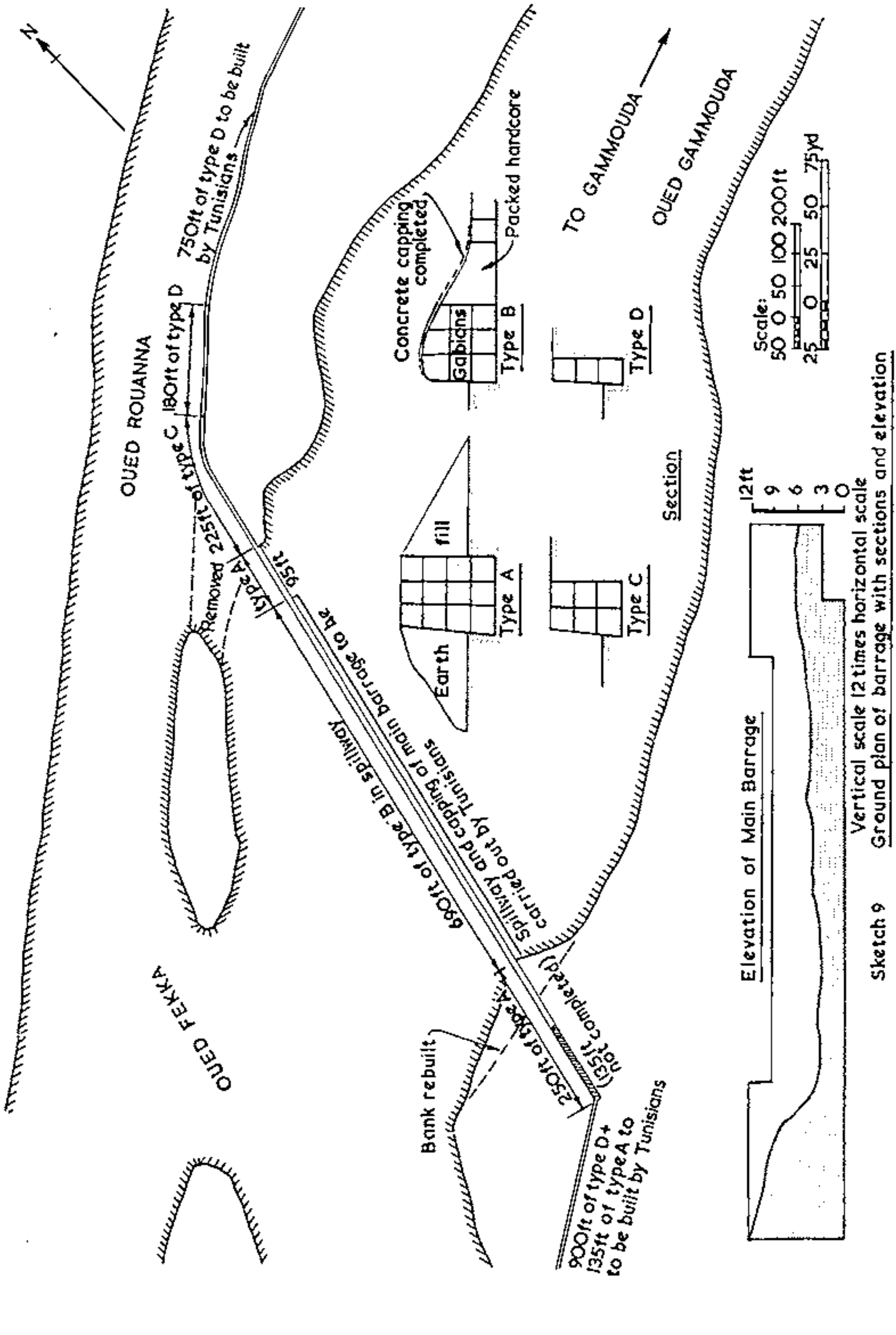
(*f*) In a task of this kind site layout is of primary importance if unnecessary handling of the heavy stone and wire is to be avoided. The schematic layout (Sketch 10) shows how this was organized for maximum efficiency. By staggering work on the various layers, work could be undertaken on all layers at the same time. The Sketch shows a stagger of only eight gabions, but this is to reduce the size of the diagram. In fact the gabions were made in groups of six and thus twelve was the usual stagger. Also worthy of note is, the position of the stone dumped in relation to the position of the gabions being filled, and the position where the wiring party work in relation to the wired gabions. In practice this ideal scheme was not always adhered to, because for example, as the gabions were not all of the same size it was found quicker to have one wiring party producing one type of gabion only.

(*g*) Details of the build up of a cross section are shown at Sketch 11. The gaps show where the constituent parts are joined.

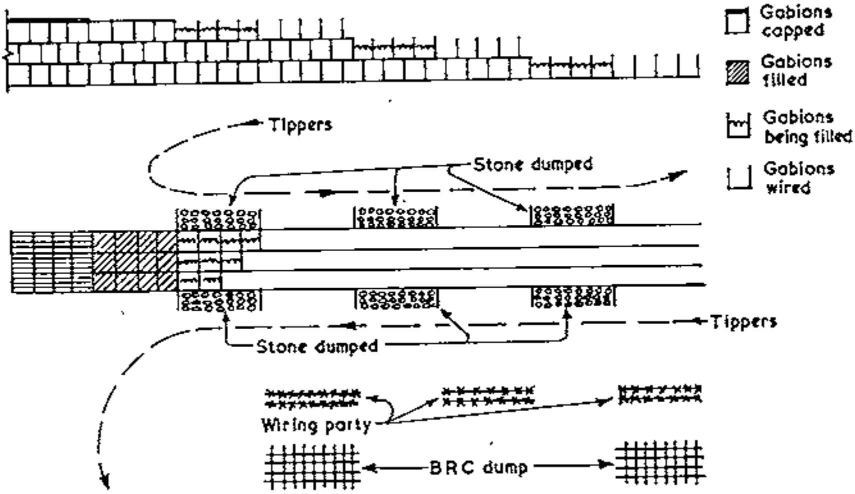
(*h*) The access tracks for the tippers were prepared and maintained by the Tunisian tractors and by a RE Malta grader. Frequent maintenance was essential to reduce clutch wear on our 10-ton tippers, a problem already mentioned.

(*j*) The local labour at the barrage was organized under one "chef" and two "sous-chefs". Overall site supervision was carried out in turn by Sgt Mifsud, RE, Sgt Cutajar, RE and WO II Knight of the Assault Pioneer Platoon of 1st Battalion the Devon and Dorsetshire Regiment. Each party was under non-Tunisian supervision with the wiring party in particular requiring close control. Members of the party were also required to guide the tippers to the correct dumping spots as the locals could not be relied on to do this accurately.

(*k*) Progress on the barrage was not initially as fast as hoped. This was partly due to the delayed arrival of the sea lift and to local labour difficulties. Because the barrage was much larger than originally envisaged, it could not be completed by 1 April when RE Malta became non-operational. Thus a second phase of the exercise was organized with manpower provided by 1 D & D, members of the Royal Malta Artillery (to act as interpreters) and some UK based sappers under the command of

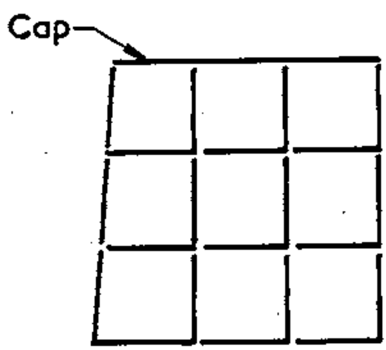


Sketch 9 Ground plan of barrage with sections and elevation



Schematic lay out of site

Sketch 10



Gabion construction

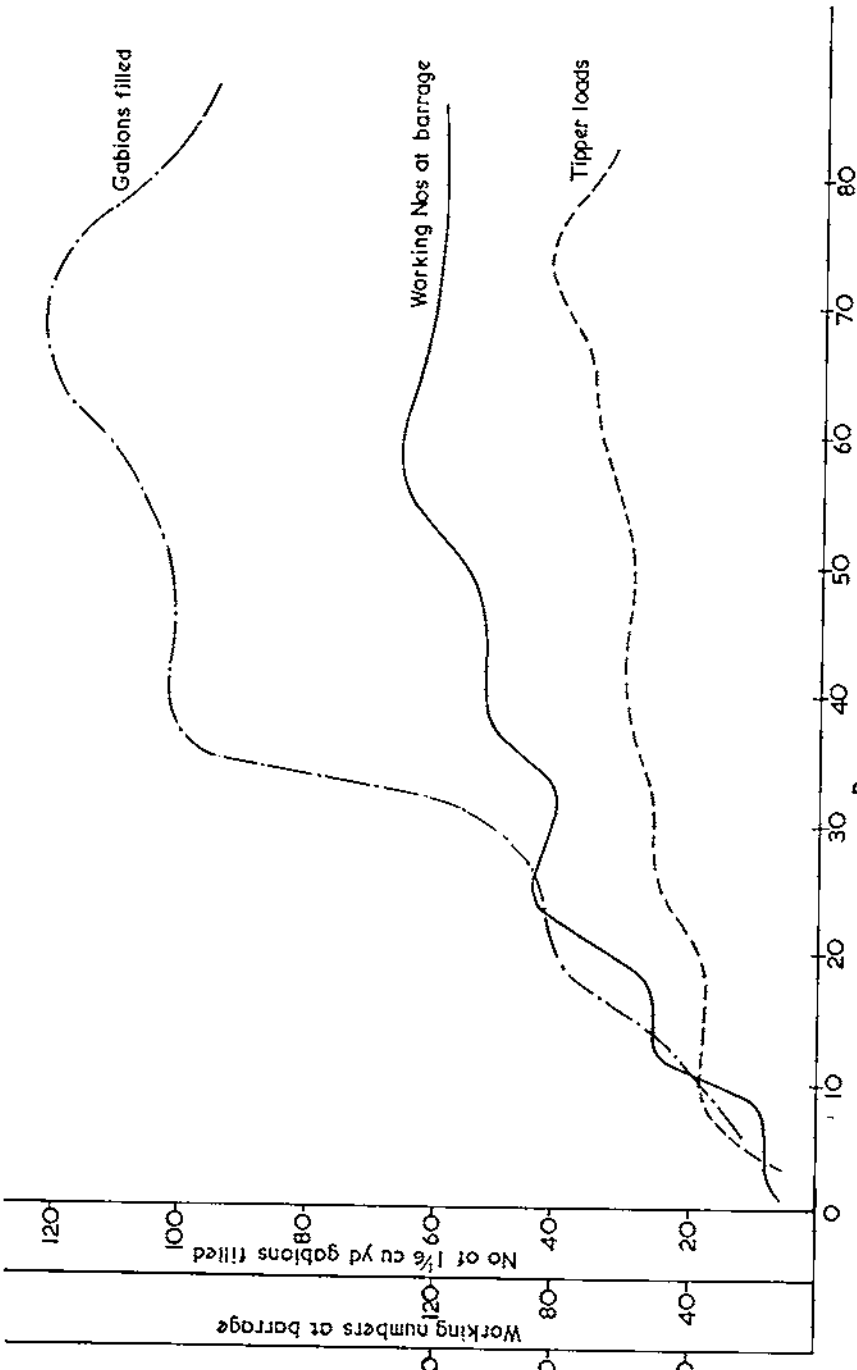
Sketch 11

Major J. Olley, MBE, RE. This party completed the southern half of the spillway, the south wall and put the concrete cap on the spillway by 27 April.

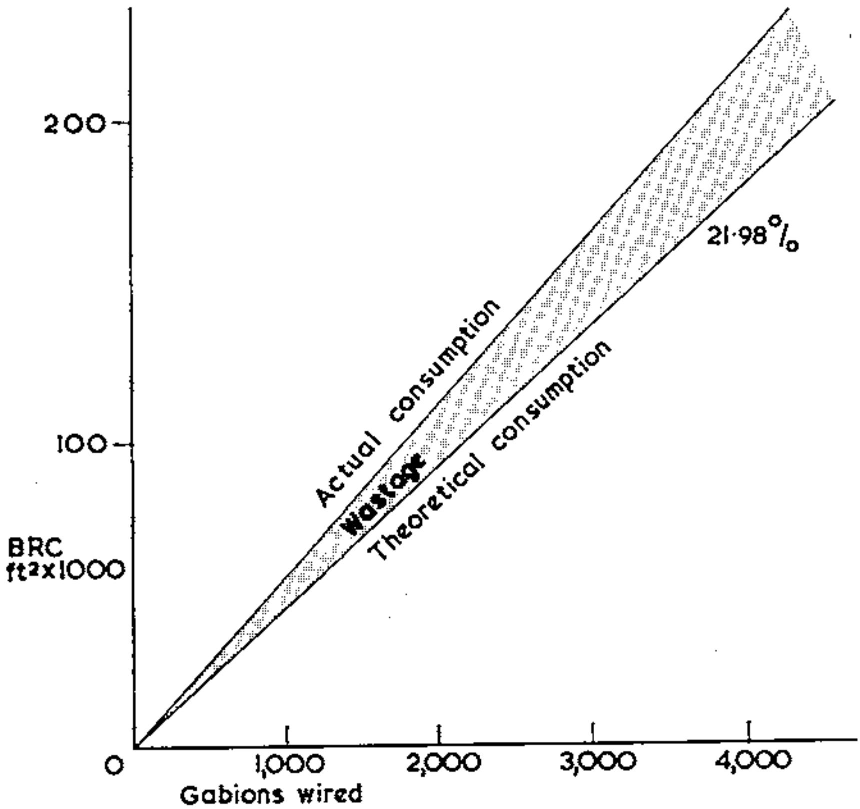
(*l*) The concrete cap was to ensure the minimum turbulence in the water passing over the spillway and thus to ensure maximum flow, and to prevent the fill material from being dragged out by the passing water. It was made to penetrate the gabions to a depth of only four inches so that it was sufficiently flexible to give without breaking up when they moved.

(*m*) The graph Sketch 12 shows gabions filled, working numbers and tipper loads plotted on a time scale. The time lag between an increase in working numbers producing an increase in the number of gabions filled is a measure of the time taken to train the wiring party.

(*n*) The graph Sketch 13 shows theoretical and actual BRC used against wired gabions. The first calculation of actual consumption was done at the 1,500 gabion mark and thereafter it was done weekly allowing for the wire required for capping. The straight line shown above is the best straight line through the points obtained.



Sketch 12 Graph showing the relationship between gabions filled, working numbers and tipper loads



Sketch 13 Graph of BRC used against gabions wired

There was little variation from this straight line and it is therefore assumed to be a reliable estimate of the BRC requirement. The mean surface area of the gabions used in this project was 54 ft^2. Therefore to calculate the wire required to build N gabions each of surface area SA ft^2 the following wire should be used:

BRC required = 1·02 × N × SA ft^2. This equation allows a wastage rate of 22·4 per cent as the constant has been rounded off to three significant figures.

(*o*) One gabion per man per day appears to be a reliable labour constant for $1\frac{1}{8}$ cu yd gabions. Therefore to build gabions of volume *V* cu yd and surface area *SA* ft^2 the labour constant *LC* becomes:

$$LC = \frac{63}{V \times SA} \text{ gabions/man/day}$$

While the last party was at Gammouda a survey and report on the protection of the town from flooding from the south was prepared for the Tunisian Government.

GENERAL COMMENTS ON THE PROJECT

The inadequate design of the wells as found by the RE Malta party was pointed out to the Tunisian authorities. It is to be hoped that they take steps to remedy these obvious faults. It remains to be seen whether the work done by detachments from Malta inspires the local population to help themselves to the maximum extent to make good the flood damage. At best this will take some years.

The barrage is a contingency measure and has a limited life which will depend on how long the BRC lasts and how much the foundations move or settle.

It is not known what effect the barrage will have on the local flow characteristics as there was no time either on the reconnaissance or during the project itself to do any kind of hydraulic study. Even if there had been time there was insufficient topographical or hydraulic data available to do a meaningful study.

If in future the Corps is engaged on work of this kind and if sufficient local data is available, then the Corps should have the ability to carry out such a study. Suggestions for ways and means of producing a simple hydraulic model in the field with the equipment and facilities available to a field squadron might be a useful subject for a future report in this Journal.

Lastly all those who worked on the project found it a very valuable experience in a field not often tackled by the Corps. It is to be hoped that the Tunisian authorities have learnt from it and will apply the procedures and lessons learnt on this project on similar projects elsewhere in the country.

Communication with Construction Sites—Field Experience using Computer Output

CAPTAIN J. C. M. FORREST RE, (T & AVR), TD, BSc, C Eng, MICE, M I Struct E. Senior Engineer and Nottingham Office Manager for Kenchington Little & Partners

INTRODUCTION

Two previous articles in December 1969 and March 1970 of the *RE Journal*, by Major G. K. Booth, RE, have given a broad insight into current methods of computer designed and detailed reinforced concrete structures used by consulting engineering practices in the UK. The author is concerned with one such practice which has developed a philosophy of communication with its construction sites based on the use of a computer to produce designs and details of reinforced concrete work. The system has been developed to meet the lack in the supply of expert detailers available and to provide a better quality of work for the site contract management at a cheaper cost to the practice.

This philosophy is by no means confined to reinforced concrete work and the article will attempt to show how similar systems could be used in the military sphere to give a much speedier design and detailing service to Sapper units engaged on construction work.

The practice of Kenchington Little & Partners is one firm which has now answered firmly "yes" the question "Do we need computers?" The drudgery of calculation and checking involved with manual procedures has for the most part been banished and the final quality of work on site is comparable in quality and refinement with a high standard of traditional work as built from conventional reinforced concrete drawings.

THE PHILOSOPHY AND DEVELOPMENT OF THE SYSTEM

Five years ago a study of the communications with site was started with a view to overcoming the serious shortage of detailers in the construction industry felt particularly acutely by expanding consulting engineering practices. Some of the gaps in detailers were filled by newly qualified graduate engineers as well as young engineers under training. This resort of replacing the expert detailer suffered not only from the lack of detailing experience by the young Engineer but also the task of detailing has a large element of repetitive donkey work and thus appears to be quite unrewarding to junior engineers with their sights set on the status of a Designer.

At this time in 1965 the early computer design programmes for analysing structural forces in frameworks were already becoming well known in the profession. Use of these however would not solve the current problem—it was the production of the drawing not the design that was the real bottleneck. So the first task of the study group was the overhaul of the drawing as a means of communication. It was soon found that, as expected, the drawing was not used to anything like its proper purpose on site. Often it would remain in the care of one man who would not willingly release it for exposure to contact with sun, rain, wind or even fresh air wherein worked the tradesmen with the greatest need for access to it. The practical men overcame their difficulty by making personal notes from the drawing in their notebook or back of fag packet. If jobs could still be built successfully with the drawing so ill used it was possible that building information could be given in a more simple manner for all to use if the detail could be reduced to note form.

This philosophy became the secret of the system. Use computers at their ideal moronic best, gobbling millions of additions and subtractions per second to produce notes and figures for use by the tradesmen and leave the decision taking and control to the Engineer. The development was not without pitfalls though. At first the task of checking output from the computer was a most daunting prospect with reams and reams of figures over hundreds of pages. This was clearly drudgery of a much higher magnitude than before. Surely the computer could check or police its own output. If the beam exceeded its deflection limit could not the computer "cop" book it in conventional form with a penalty in the form of an asterisk beside the result for critical examination by (the magistrate) the Engineer. This was clearly the control needed from the system, i.e. a management by exception technique to check only those "failure to comply" situations, set beforehand by the Engineer.

As interest in the system and its use grew within the Practice a second type of police test was introduced for the Engineer to pit his wits against his moronic but exceedingly fast friend; the concept of the guessed answer. Experience from operation of computers suggests that errors, when they occur, are usually exceedingly gross and generally in powers of 10 from decimal points in the wrong position, etc. The designer was asked to guess at the required answer and the computer would list any divergence exceeding say 20 per cent from this guess for a more critical examination. Yet a third policing task compared the Engineer's judgement of the summary of column loads at foundations and adjacent column loads with the computers answer to avoid errors in reaction transfer and so on.

This game between the Engineer and the computer has helped the Engineer using the system to improve his judgement enormously. Good men usually "beat" the computer and end up with only a handful of output asterisks to check prior to release to the site. The philosophy thus employed to ease the burden of the Practice from the lack of expert detailers developed a most useful system for communication with the site. The necessary programme of instructions to the computer became very complex and the output data of immense use to designer and constructor alike. Such was the usefulness of the system with advantages for the Construction Industry as a whole that the Partnership decided in 1969 to make the system available to all through an existing Company, Associated British Consultants Ltd.

THE CURRENT SYSTEM

The system for the computer design and automatic detailing of reinforced concrete developed from the philosophy of improving communications with site is centred round the programme entitled DIGITAL DETAILING ABC/4. Its language is in fortran IV and it carries out an elastic analysis, optimized design, detailing, scheduling, and measurement of complete reinforced concrete structures comprising slabs, beams and columns, and eliminates the need for reinforcement detailed drawings. Reactions are transferred automatically from slabs to beams and from beams to beams or columns and the loads are summated for each column at foundation level including live load reductions where appropriate. The work on columns is not yet fully operational but rapid progress is being made to complete this work by the end of 1970. The design and details are in accordance with the Current Code of Practice CP114. Dimensions and reinforcement sizes for input and output may be in either metric or imperial units.

A complete service is offered by ABC and no computer equipment is required by the user at all. Processing will be normally carried out on the Atlas 2 computer at the CAD Centre Cambridge to which the Company has a remote terminal link.

The input for this fully automated procedure starts after the concept stage of the design has been completed in the conventional way. The design engineer will have made his assessment of the concrete outline of each member and will have a shrewd idea of the reinforcement required in typical members. A systems engineer from ABC visits the designer at his office and records the following designer's choices on pro-forma:

(1) Permitted stresses to be used for materials
(2) Geometry of concrete and degrees of continuity
(3) Pattern of loading and methods of analysis
(4) Patterns or types of reinforcement detailing.

It is usually sensible at this stage to make the first programme run to obtain budget quantities and to check the design chosen complies with the many codes of practice requirements. The first run will produce a fully indexed set of calculations on which to base modifications, make provisions for holes, and to record accurate loads to foundations. Dimensions which are not finalized at the early stage can be approximate and accurate dimensions can be inserted later before the second and final run which can be fully updated in checking last minute alterations. The system includes sophisticated load transfer facilities thus no item of information is input twice and the consequential answers are transferred from slabs to beams to primary beams and hence to foundations automatically. Automatic implied repeat facilities reduced the form filling procedure to a small operation.

The output description from the programme is preceded by an extensive data check. All the data including alpha numeric characters are checked for accuracy of punching input etc—only when this section has been satisfied can the main programme be run. The output produced by the computer is as follows:

(*a*) A full repetition of all the input data printed under the appropriate headings.

(*b*) A table of "caution" and "error" markers indicating where Code of Practice and similar design or detail requirements have not been met. These are fully indexed and referenced.

(*c*) Tabulated design results for each slab, beam and column element. These show clearly all the relevant information required by the design engineer and Local Authority. The column loads to be carried at foundation level with and without live load reductions are listed separately to enable foundation design to be undertaken manually by the engineer.

(*d*) Schedules for each slab can be divided into two main parts:

(i) A full schedule to BS1478 or BS 4466.
(ii) Complete fixing instruction for every bar, stirrup or link within the member. The sizes and covers to reinforcement are also dimensional on each member.

(*e*) Quantities for shuttering concrete and reinforcement. These are tabulated by member on each schedule and summated for each floor and for the complete run.

(*f*) Cost analysis data is printed out at the end of the run showing, for example, the weight per unit volume and weight per unit area for the various elements.

(*g*) A small booklet showing the typical reinforcement patterns used on the particular contract is issued for use by the site. In practice bar fixers normally discard these booklets after the first few days.

Examples of the system are given in the plates at the conclusion of the article. Plate 1 is a typical input data form completed in metric for 19 beams in level section

C3 of the Eastbourne New Hospital Project. One of the beams is reference 252, the second line entry, and Plate 2 shows the output data for this beam complete with all necessary information to position all the reinforcement and fix it correctly. Plates 3 and 4 show photographs of reinforcement fixed by data supplied by the system on Myers Factory at Huntingdon and J. Sainsbury's shop at Coventry. These two plates illustrate how relatively complex junctions of reinforcement and steps in construction can be accommodated.

THE CONTRACTORS USE OF THE SYSTEM

Inherent in any communications between Designer and Contractor is the establishment and maintenance of trust that the information conveyed to site is not only technically correct but up to date. A change from conventional drawings gave rise to scepticism with the first contractors usage of the system for they feared disorganisation and delay from this new method. However as the output from the computer started to be used on site this sceptical view gave way to an enthusiastic reception for it soon became apparent that the noted and figured sheets gave important advantages over the conventional drawing approach.

1. Each element of the structure, i.e. slab, beam, column had its own details on one sheet of output, cross-referenced to a framing plan, regardless of repetition. Six identical beams have six separate data sheets with the same information for fixing but each with its own reference number.
2. Areas of shuttering, volumes of concrete and weights of reinforcement were summated sheet by sheet and became an invaluable planning aid to contract management who had never had such a facility before.
3. The output data sheets were up to date and could be trusted by the contractor.
4. The steelfixer did not have to spend time studying a variety of drawings to achieve the required reinforcement pattern. The reinforcement was supplied correctly bundled, member by member matching the fixing instructions for each sheet of output. Bonus targets were easily calculated and rate of fixing steel rose as a direct result.

USE OF THE SYSTEM BY THE DESIGN TEAM

(a) *The Engineer*

Many of the benefits to the Engineer have been explained earlier in the article in the section of the development of the system. However, it would be worth noting the chief advantages the system now gives the Engineer in the performance of his duties. These advantages are particularly attractive because the Engineer soon realizes none of the engineering has been denied him by his use of the programme. He still has to make his usual assessment of the structural concept and provide the policing limits.

1. A sophisticated programme ensures that no input data is repeated by the Engineer.
2. All decisions recorded on forms in simple layout. Ready reference is available to the input data.
3. Changes easily made by altering only the input data. Consequential changes in output achieved automatically.
4. Help and advice available from ABC System Engineers both with input and use of output on construction sites.
5. The first of two runs of the programme gets the Architect, Quantity Surveyor and others "off the Engineer's back" at the preliminary design stage. The second run ensures that all ensuing changes in the detail design can be accommodated up to a few days before the appointment of the main contractor.
6. A sharpening of judgement by the Engineer in his contest of wits with the computer.

(b) *The Architect, Quantity Surveyor, Services Engineer*

The other members of the design team are finding the use of the programme by the design engineer of considerable benefit. In particular, the architect is able to proceed with his detailed design of his work because he has at a very early stage in the preliminary design all structural sizes available from the first run of the computer programme. This saving in time means that his own design process can be speeded up considerably. The present aim is for 75 per cent to 85 per cent of the reinforced concrete work in any one scheme to be detailed by this system so that any special details, such as nibs or unusual elements in concrete need not be constrained to conform with the system because these can still be dealt with manually in the conventional manner. Such elements can be hived off from the main programme and can have the time spent on them as necessary by the Architect and other members of the team.

With the first computer run at a very early stage in the design, the engineer using the system can offer the Quantity Surveyor accurate initial data for budget purposes. This man, so often pressed to give an early indication of costs, find the majority of the reinforced concrete information at the preliminary planning stage an immense benefit. The Quantity Surveyor is also able to analyse the problems of the construction at a much earlier stage than hitherto and consequently achieve a much more realistic budget figure.

Perhaps the services consultant and service contractor gain most, for they know the precise geometry of the whole structure early enough to ask for changes to admit uncomfortably large holes or ducts through which to feed M. and E. services. All three parties can ask for modifications prior to the second run and these can be recorded as received and integrated into one comprehensive re-run of the programme.

(c) *The Local Authorities*

All structural works have to satisfy the Building Regulations, the necessary checks being applied by the Engineering staff employed by Local Authorities. These Engineers have welcomed calculations submitted in such an ideal form, properly documented, logical in presentation and up to date covering all design alterations. Approvals are usually quickly forthcoming.

THE NEW PHILOSOPHY AND ARMY COMMUNICATIONS

The future of the system for computer-aided design and detailing in reinforced concrete is capable of extensive development. The new philosophy of communications by numbers and notes superseding drawings is certainly not confined to this sphere although the nature of structural detailing lends itself particularly well to the new method. Similar systems are already in use within the construction professions for producing engineering designs and/or detailed information via computer for road and bridge works, airfields, special structures (i.e., silos, crane gantries) retaining walls and the like.

Clearly this philosophy is readily adaptable now to military construction work. The communication equipment for the task is available subject to any special development necessary to suit the particular needs of the system adopted, i.e. line printers working direct from radio beam rather than telephone line. Basic Sapper tasks of design and construction of roads, airfields and bridges could be speeded up to the extent that work could start hours after a recce had been made rather than the present weeks or at best days.

A bridge project would be a good example of the use of such a military adapted system. The Sapper officer would perform his recce in the normal way and establish his basic design data; gap to be spanned, bank seating dimensions, levels access, load classifications, timings, etc. From his pocketbook he would extract and complete his input data form recording this information and giving the policing instructions to the computer, i.e. whether there were any restrictions to be observed, say, in the number of piers to be provided. The input form would be scanned at Sqn HQ by the computer team and the data put onto punched cards by the unit operators. The cards would then be processed into the transmitting device direct to the Computing centre via telephone link if UK based operation or radio relay and communications satellite

ABC 4 | FORM 5 | BEAMS SHEET 1 | METRIC | SHEET 7 OF 11

	FLOOR REFERENCE	FIRE RESISTANCE HOURS	% REDIST. OF SUPPORT MOMENT	ENTER '1' TO EXCLUDE QUANTITIES	NO. OF BEAMS THIS SHEET	MIN. DIA. OF BEAM STEEL mm.	MAX. DIA. OF BEAM STEEL mm.	OVERWRITE DIA. NOM. STEEL mm.	THIS SHEET NO.
*BEAMS1	C3	1.0	15		19	12	32		7

REF.	MOD.	REPEAT REF.	VAL.	SPAN mm.	DEPTH mm.	BREADTH mm.	T WIDTH M	SLAB DEPTH 1 mm.	SLAB DEPTH 2 mm.	COVERS TOP mm	COVERS BTM. mm.	COVERS SIDE 1 mm	COVERS SIDE 2 mm	L.H. SUPPORT REF.	L.H. CO-ORD BEAM M	L.H. BEARING mm.	DIR.	R.H. SUPPORT REF.	R.H. CO-ORD BEAM M	R.H. BEARING mm.	DIR.	ORDER
96			5	7350	575	225	1425	100	100	64	32	32	32	81	16	225		C25	00	300		A
252			7	6150										C25	00			361	16			B
94			5	7350										81	50			251	33			C
264			7	6150										251	33			361	50			D
21			5	6150	600		625	0		32				C2	00	300		C3	00			E
3			6	6600										C3				C4				F
4														C4				C5				G
5														C5				C6				H
6														C6				C7				I
7														C7				C8				J
8														C8				C9				K
9			7	6150										C9				C10				L
19			5	4950		300	1500	100						C19				C20				M
20			6	3300			1100							C20				C21				N
21							1500							C21				C22				O
22														C22				C23				P
23														C23				C24				Q
24														C24				C25				R
25			7	4950										C25				C26				S
																						T
			0	1300	175	5254	1402	1		96	32	32	32		99	525			99	300		Z

CONTRACT NAME	JOB NO.	CLIENT	ABC ENGINEER	CLIENT'S ENGINEER / TELEPHONE NUMBER	DATE	REVISION
EASTBOURNE HOSPITAL	ABC/41	KENCHINGTON LITTLE & PARTNERS	J.S.	J. R. HEMMINGS / 01-636-9872	17/6/70	DATE

ABC DIGITAL DETAILING SYSTEM BY ASSOCIATED BRITISH CONSULTANTS LTD. LONDON. © APRIL 1970

Plate 1. Working example of input form completed by engineer as basic data for the system

Kenchington Little & Partners 38 Queen Anne Street London WIM OHN
Job No. & Name SEH/3 Eastbourne New Hospital

Date Run 28 7 70

Concrete Covers (mm.) Side 1 32 Top 64 Bottom 32 Side 2 32

Beam Size (mm.) 575 × 225
Bar Pattern 7/ 3.0

Schedule No. 48 Rev.
Floor Level C3
Beam Ref. 252

Bar Mk.	Type Size	No.	Total Lngth.	Shape Code	A	B	C	D	E	Item	Bar Mk.	No. Off	Bar Begins		Crs.		WT.
	mm.		mm.		mm.	mm.	mm.	mm.	mm.					mm.	mm.		KGS.
1	Y16	2	6700	42	750	200	5650	55		(1)	1	2	LT A	375		Bottom Layer	18
2	Y16	1	6700	42	750	200	5650	55		(2)	2	1	LT A	375			9
3	Y32	2	3800	20	3800				100	(21)	3	2	LT	1850	32	Top Layer Left	41
4	Y32	1	3800	20	3800	200	5425	50	500	(22)	4	1	LT	1350	32		20
5	R12	2	150	43	500	200		50	500	(23)	5	2	RT	5300		Top Layer Centre	0
6	Y12	2	1663	51	425				100	(24)	6	2	RT B	4975		Top Layer Right	2

Bar Mk.	Type Size	No.	Total Lngth.	Shape Code	A	B	Item	Bar Mk.	Stirrup Spacing Along Beam (Left to Right) mm.	mm.	mm.	mm.	mm.	Grouping	
7	R8	30	1280	72	480	165	(50)	7	11 at 40	1 at 290	14 at 290	1 at 290	3 at 290	Outer	13
8	R8	20	380	35	180		(59)	8	20 at 300					Top closer	3
															106

Side Shutters approx. 12 300 mm. run by approx. 475 mm. deep = approx. 5.8 sq m
Soffite Shutters approx. 6 150 mm. run by approx. 225 mm. wide = approx. 1.4 sq m
Volume of concrete in stalk of beam = approx. 0.7 cu m

Calculation Sheet No. 5
Dimensions to BS 4466

Digital detailing system by associated British Consultants Ltd. London

Plate 2—copy of computer output detailing beam 252 for use on site.

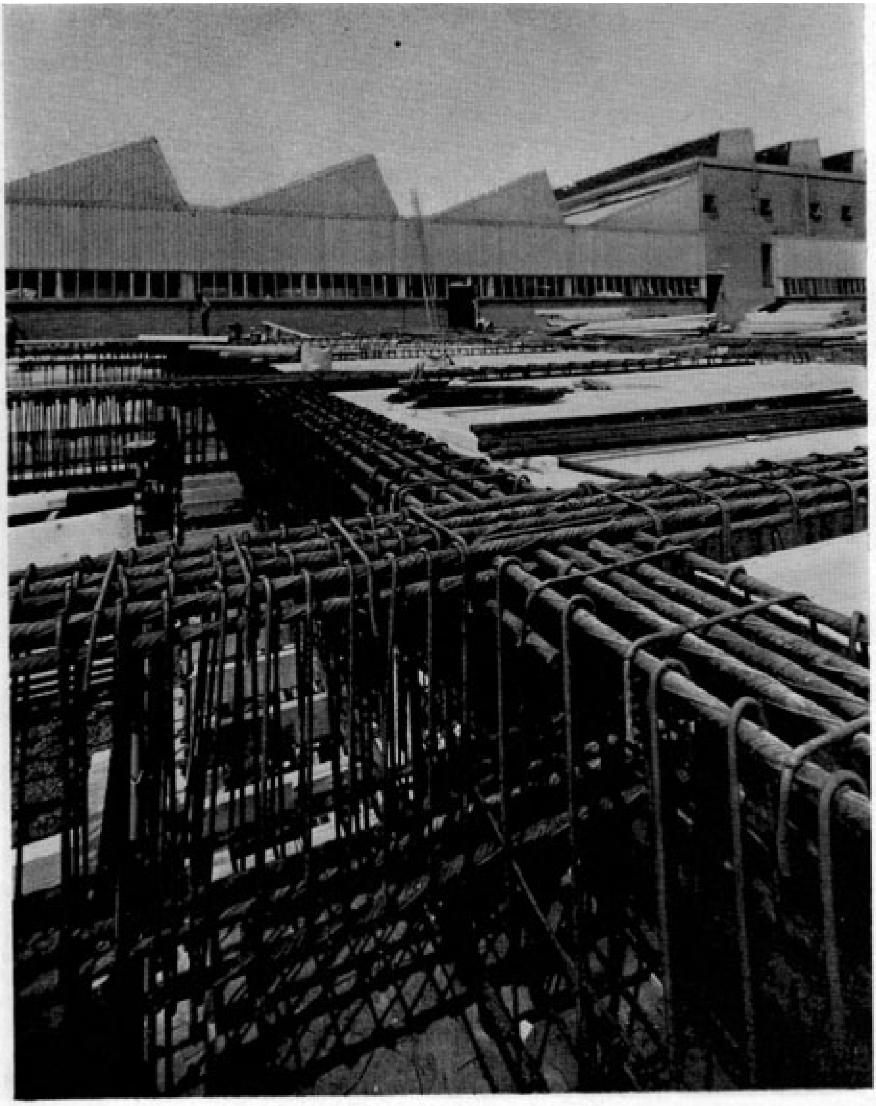


Plate 3. Beam intersections computer detailed for Myers Factory at Huntingdon

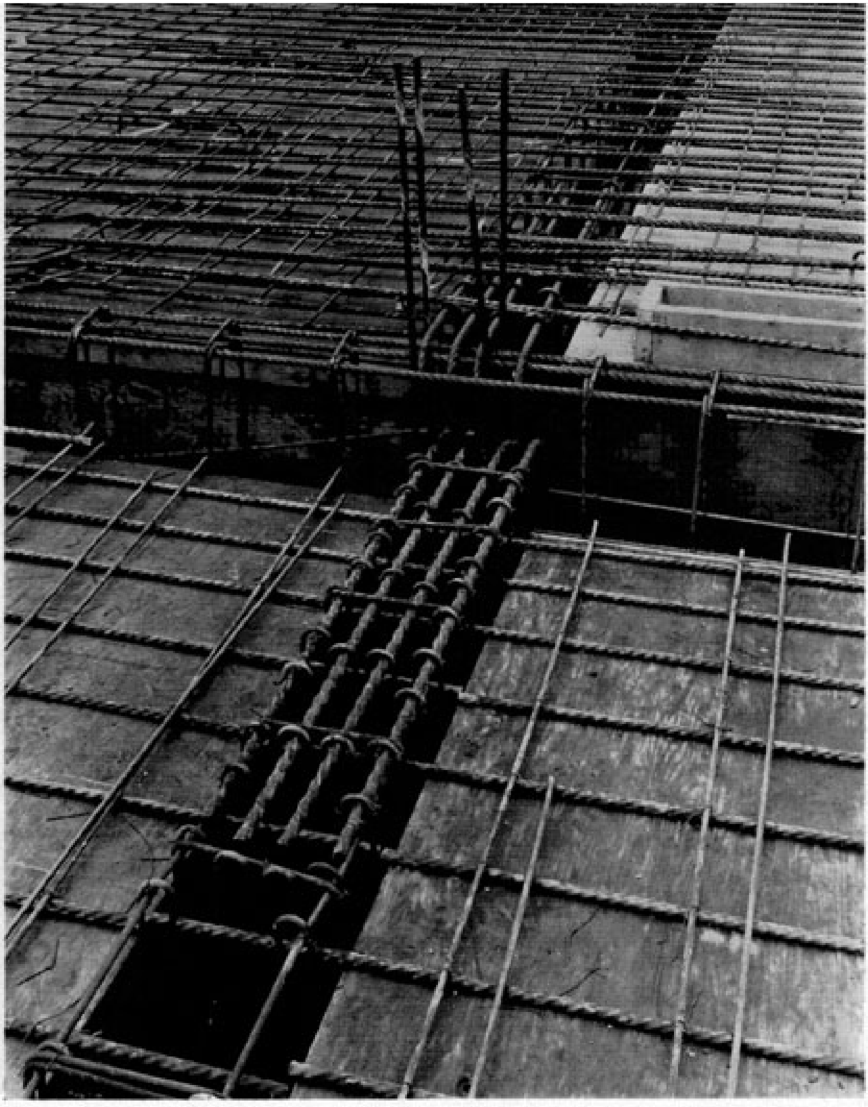


Plate 4. J. Sainsbury Coventry Store computer detailed reinforcement for main floor

if a Far East project say was in hand. The computer would analyse the data, prepare the design of the bridge within the parameters set by the recce officer, list every piece of bridge equipment required, schedule a works construction detailed programme within the scope of the men available, and check and issue orders for he necessary stores from the nearest military depot. This output information could be available back at Sqn HQ within 24 hours of the recce.

Such a rapid return to Sqn HQ of the information required to build the bridge is perfectly feasible with present techniques but could well be improved by military control and communications systems designed to accept this philosophy.

It is interesting to note that on our recent T and AVR camp in July 1970 in Cyprus our unit gave serious consideration to the design and detail for a new section of road using our civilian computer facilities in the UK. Had the necessary computer communications been available the unit could have filled in the input data forms in Dhekelia HQ, radioed this data to the UK, and received back from the processing centre the necessary output data for us to have completed the whole of the design and detail in approximately a day. Instead it took six men working for ten days on the project during the fortnight's training, as the communication facility and military control procedures did not exist. It won't be many more camps surely before this applied philosophy will become a normal feature of the work of a T and AVR Specialist Team RE (Construction). Here civilian experts familiar with the use of all modern aids available via their various offices in the UK, will be able to assist the Regular Army in a variety of ways. In time this facility must surely be available directly to the Sapper officer in the Regular Army. The question is begged and the answer rests with those responsible for the development of the work of the Corps of Royal Engineers.

CONCLUSIONS

This article has endeavoured to describe how an expanding Consulting Engineering Practice has overcome the problem presented by the dwindling supply of expert detailers in the design and detailing of complex reinforced concrete structures. The adoption of a new philosophy of communication with sites using computer output data with notes instead of the conventional detailed reinforced concrete drawing, has enabled the practice to reduce its costs substantially. The contractor is provided with the information, albeit in a novel form, to produce a standard of construction at least as good and often better than by normal traditional drawings. The system used has been employed on 52 jobs (as at September 1970) and is capable of handling 75 per cent to 85 per cent of the work in the large majority of reinforced concrete structures, at its present stage of development.

It is further suggested that this new philosophy can be of immense use to the Regular Army RE units engaged on construction work. The development of the required military control and communications equipment for military systems, similar to the civilian system ABC/4, will give the Sapper officer a planned, designed and detailed construction project available within hours of completion of his recce.

* * * * *

Sappers in the Sahara
An International Study

MAJOR D. N. HALL, RE

ACADEMICS, Sappers, and Sailors were an unusual crew to lead into the Sahara for nearly four months. This strange mixture formed part of an international study in loose association with a Belgian team, which, led by Professor Léonard, studied in SE Libya for four months; and with Professor Monod's Chadian/French team which hopes to visit Northern Chad when civil wars permit.

The British Expedition to the Aïr Mountains, as we called ourselves, was international in itself. Three archaeologists came from Berkeley, University of California, and one geomorphologist from Macquarie University in Australia. They helped to make up a balanced team of some twenty academics and young servicemen.

We left the European winter immediately after Christmas 1969 to make a really detailed study of a piece of desert in the Republic of Niger, hoping that our various projects might one day contribute to a new flowering of the desert. The Expedition had the patronage of the Duke of Edinburgh, and the support of the Royal Geographical Society, the British Association for the Advancement of Science, and a number of other bodies. The Royal Society backed our study of sand dune behaviour with a grant of about £1,700, and the British Academy gave £1,000 to the archaeological project. Other studies were made on landforms, botany, zoology, locust ecology, survey, and there were two medical studies made of the members of the Expedition. Niger is a country which lies astride the southern fringes of the Sahara, sandwiched between Algeria and Nigeria. Our study was originally planned for the lonely part of the Tibesti Mountains in Libya.

The Sahara crossing started from Tunisia at the beginning of January in four dayglow orange Landrovers, two beetle-like crimson dune buggies lent by Volkswagens, and an old Bedford lorry. None of these would have stood much chance of surviving the rigours of the Sahara without the careful preparation by 56(MT) Training Squadron at Crookham. Our stores, also collected there, were piled roof-high in the fifteen-year old Bedford RL acquired for £125 in Malta which was our first base, and where again the Sappers provided invaluable support.

The remarkably efficient "grapevine" of the Sahara saw to it that news of the colourful convoy went ahead, so that our team was expected in the town of Agadez at the bottom end, some 1,800 miles south of our Tunisian start point. It was to be our main base for nearly three months, and it was there that we met the spectacular Tuareg tribe, who, probably of Berber origin, are remarkable in that the men are veiled, and not the women. Dressed in their long shiny indigo-blue robes with only their eyes visible, and carrying formidable swords, it was a relief to many of the team to find these people so friendly and helpful.

With the main base established in rapid time, our problems seemed to begin in real earnest. Although Niger contained every type of desert required, our sites were miles apart, making control and mutual support almost impossible. Most effort went into the Adrar Bous site which was right up off the NE corner of the Aïr. It was a granite massif protruding from a vast plain of sand which stretched unbroken for 230 miles. Here we worked for most of the time on the approaches to, and in amongst the dark forbidding hills. It lay 340 track and desert miles from Agadez, and Geoffory Parkes had the unenviable task of administering the little camp for much of the time, working out petrol, water, and ration requirements, and trying to persuade Ibrahim, our Arab cook, to make something interesting out of the limited food. Ibrahim had been recruited in Agadez for the sum of £12 per month, and it was not until later that we discovered that he had accepted the job with alacrity because he thought Adrar Bous was a thriving village in West Africa with high lights and all the comforts imaginable. However, he took his error remarkably well; and, with a little extra kit and bedding to keep out the desparately cold winds, he entered the spirit from a mock "mess night" under the cold stars, to pushing vehicles through soft sand in burning temperatures.

The greatest problem at Adrar Bous was water, which at first all came from a well 140 miles away. Since the petrol used fetching it had to come the 340 miles from Agadez, a glass of water became quite costly. The discovery of an old filled in well at Adrar Bous raised our hopes, but even though at twenty feet the sand became distinctly damp, bottom was reached without success. Even a further 4 ft auger length produced nothing. But the work of many hot and dusty days in the small dark hole was not wasted, for the different layers of soil in the well revealed a variety of climates in the past for the geomorphologist. Eventually the problem was eased by the discovery of a source about 45 miles away in a steep sided wadi. Instructed by our Tuareg guide, we dug about 4 ft through the granite gravel, and miraculously—and probably to the guide's surprise too—water seeped in. We used 500 gallons of this precious liquid, every drop being scooped up in a saucepan. The quality of the water was good, but none the less it was usually put through a Berkefeld hand filter before drinking. That supply dwindled just as we departed, and as the increasing summer heat made the two gallons per man per day insufficient.

Adrar Bous produced some spectacular finds, most of them archaeological. The skeleton of a Neolithic cow obviously came top, and is said to resemble closely the cows depicted in the remarkable paintings of the Sahara. We found a wealth of evidence that in wetter or slightly cooler times, the depressions round the mountain had been lakes containing crocodiles, cat fish, and turtle. Men of the later Neolithic period had left their burned fish bones and delicate bone harpoons lying untidily about. Other bones, which are now being studied, show that these early people had to contend with large mammals. So richly were the efforts of the hard working archaeologists rewarded that it became a point of contention when they wanted nearly two tons of samples moved back to Britain.

The study of Adrar Bous was assisted by a Sapper-led survey team who made a traverse of the mountain from an astro fixed base line. Their work included some heighting and place naming. As usual, the system used for giving names, was to make them as "local" as possible. Gone are the days of naming places after explorers, and instead we adopted such names as "Valley of the Cow", "Hidden Valley", and "Lookout Hill". All names were translated into Tamashek by a small committee which sat under the direction of the school teacher of Iferouane.

A more spectacular survey was that undertaken in Northern Aïr, when John Rogers, Tony Pigott, and Naval Lieutenant John Trewby were left for ten days with enough food, and water, plus, hopefully, a cross bow for hunting. Their tasks included twenty miles of simple traverse to prepare a map for the scientists coming later. They took the first day off to climb the highest mountain (6,000 ft+). It was remarkable to find a Mediterranean climate on top, with olive trees growing on the upper slopes. A sample of the wood was taken back for dating as it is believed that they could be as much as 3,000 years old. The little party failed to shoot anything worthwhile with the cross-bow, but experienced real adventure training. Unsupported, they coped entirely by themselves, and, of course, thoroughly enjoyed it.

The sand dune study took place 200 miles east of Agadez in the vast Ténéré Desert. The small team working there comprised five members with one Landrover and the dune buggies. The ocean of sands was their own, and they became masters at navigation and interpretation of air photographs. They got the drill of sand sampling down to a fine art, though they were often frustrated by breakdowns. Theirs was a really dry desert which could be unmercifully cruel in sandstorms, when wind and sand raced past, at times dimming the sun so much that sun compasses could not be used. Unlike in the mountains, there was little wild life. Where sand and mountains met a number of herds of the fated addax were sighted, and numbers recorded. The great cow-like beasts with their white coats would lumber up the sides of dunes

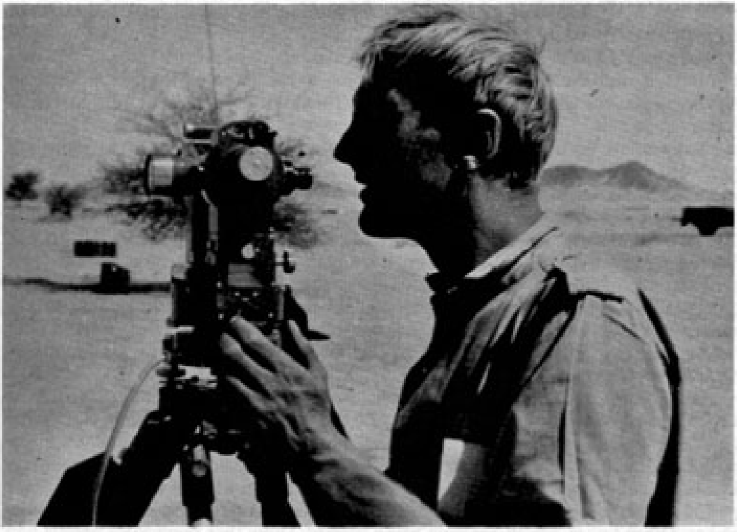
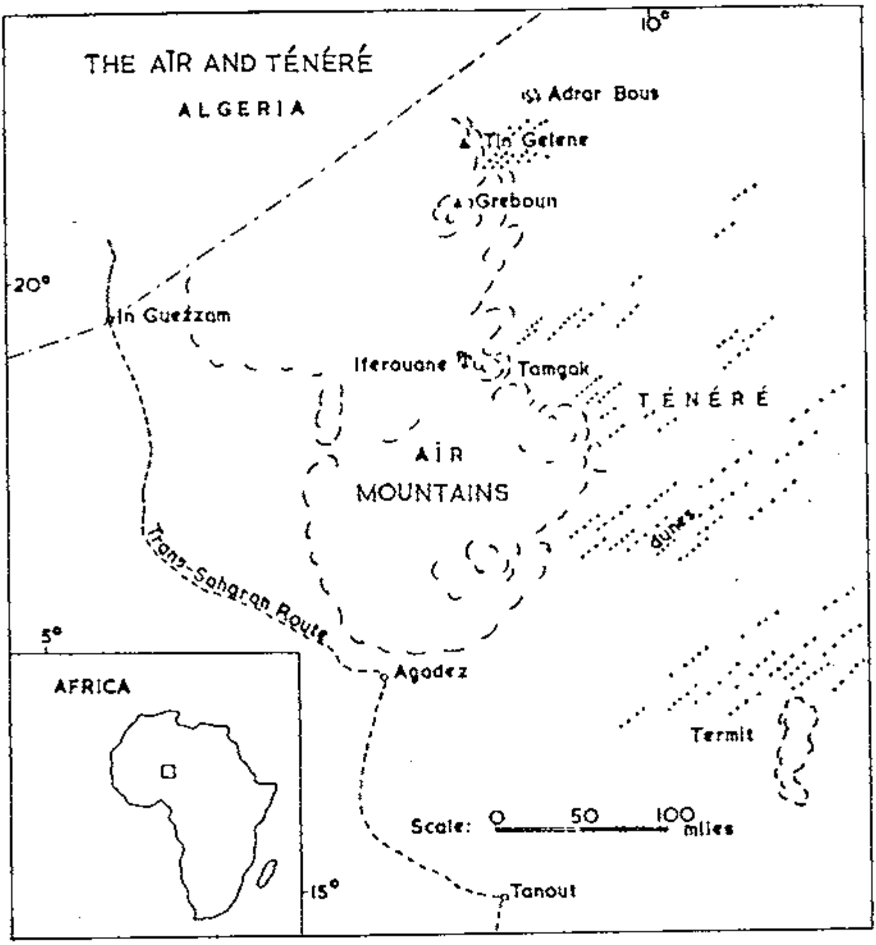


Photo 1. Lieut A. J. Pigott checks his theodolite for the Adrar Bous traverse

Photo 2. Lieut J. W. G. Rogers during a 24-hour set of medical readings being taken by Dr P. Beighton

Sappers in the Sahara 1 & 2



British Expedition to the Aïr mountains

bewildered by the strange coloured vehicles. There were heavily coated mouflon in the mountains, and a great many gazelle. We had our share of snakes and scorpions, but without disasters. One morning a rather alarmed member found that he had been sharing his bed with a huge hairy camel spider, which, when given a fair-sized beetle, showed the power of its jaws by crushing the shell with one bite.

All the time we were there, plants were being collected for Kew, Paris, and Brussels. The small collection of reptiles made, gave the British Museum its first specimens from the Aïr.

Now in England, America, Australia, and France, bones are being dated, grains of sand sieved and analysed, pollen examined, maps drawn, place names put forward, heights noted, "firsts" up spectacular mountains recorded, medical reactions assessed, and the Expedition is being brought slowly to an end. Yet work will continue for many years to come before all results have been fully analysed. A report is being prepared for all those who helped so generously to make the Expedition possible.

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Which Engine for Our Next Main Battle Tank?

MAJOR C. W. BECKETT, RE, BSc, AMBIM

BACKGROUND

Introduction

IN the 1980s armoured regiments can reasonably expect a new Main Battle Tank (MBT) to replace Chieftain. When the latter was accepted for production, the choice of power pack was limited to reciprocating engines running on petrol or diesel but multifuel for preference. When the decision is next made there ought to be four starters.

This article is about the two new contenders; the gas turbine and the Wankel.

The Requirement

Several forms of armoured vehicle will be required in the 1980s, the MBT, SP gun, self propelled anti tank gun (S.P.A.T.G.), specialist Engineer vehicle and a recce vehicle, to mention a few. The weight range could be 25–50 tons, depending on the choice of MBT. Whatever the weight, one thing is certain, namely the power weight ratio of engine power to vehicle weight, will be higher than it is on Chieftain. The increased figure of about 25 bhp per ton is necessary to produce better mobility with higher speeds and acceleration on the battlefield.

To produce power, an engine needs some or all of the following: fuel and air for combustion; a cooling system; an exhaust system and accessories like a starter motor and alternator. These items, considered together with a suitable transmission, cannot each be optimized in isolation. The need is to produce the smallest armoured volume containing them, which meets the requirement agreed by designer and user. A very small light powerful engine with high fuel consumption, like a gas turbine in its simplest form, may easily have a larger armoured volume with its fuel, than a heavier larger diesel engine that uses less fuel, for a given range and requirement of speed and acceleration.

By the 1980s, it seems likely that legislation in the USA, which is aimed at limiting exhaust pollution, will have forced manufacturers to design engines to meet the stricter standards. Extensive motorway systems, with more powerful heavier high-speed trucks will be commonplace, these vehicles being driven by larger engines with considerable military potential. The need for higher military engine power comes at the time of increasing demand in the civilian market for the same thing—increased power weight ratio.

RECIPROCATING ENGINES

There is a wealth of experience available to back any future design of this type of engine. Diesels of 1,200–1,500 bhp are available in the USA and West Germany now. A steady improvement in higher performance for lower weight and bulk can be expected. This can only happen if the problems associated with filters, required for the reduction of exhaust pollution, are overcome to enable these large engines to be used.

The diesel is a strong contender for the next MBT. Whatever happens in the gas turbine and Wankel field, this type of engine will be available and must be kept in reserve as the back-up.

Engines working on the Stirling principle (an external combustion cycle) are unlikely for a tank during this period, although their use is quite probable for auxiliary power, as they are comparatively silent.

The Wankel, in its single rotor petrol form, had a bad start. Prejudice against this type of engine was understandable, but is quite unjustified in the context of the twin rotor versions, as found in the Ro 80 NSU and R100 Mazda cars, the latter being made in Hiroshima. This type of engine could well have a firm hold on the two litre car market by the 1980s and the Mercedes four rotor petrol injection version, giving 350 bhp, should not pass unnoticed. The motor industry must however see a return on capital invested before this will happen. It is unlikely, in spite of the work being done in the USA, where a 1,000 bhp engine has been built and tried as a research project, to be found in a MBT in petrol form. The diesel application is a much more attractive proposition.

Rolls-Royce are working on a diesel Wankel as a Defence project now. An ingenious combination of compressor and engine has produced over 100 bhp and target performances around 700 bhp are being set for multi-rotor versions. The savings in bulk and weight, together with smoother power, make this engine a strong contender as the basis of a range of engines for the whole family of AFVs due in the 1980s. Performance at part load, so important to an AFV, is not as good as the best diesels and exhaust pollution may be slightly higher but in the military context, may not be so important.

The Rolls-Royce project is in its infancy and is full of promise. The sealing problems, the downfall of the first Wankels, seem to have been partly solved, even at the higher diesel pressures.

THE GAS TURBINE

The gas turbine has almost completely replaced the piston engine in the air: but few laymen have considered its automative applications. Yet for reliability, cost, performance, clean exhaust and multi-fuel operation, it has the potential to overtake the internal combustion engine. Performance at part load has been poor and this has been against the turbine.

The blades of the compressor, which provide the large volume of air required by the turbine, are designed aerodynamically to run at high speed. 30,000 rpm is a typical figure. Small speed variations on the simplest compressor-turbine combinations, typical of part load performance, result in turbulence, decreased power and increased fuel consumption. This is unacceptable and can be remedied by the use of heat exchangers.

Heat exchangers, using the hot exhaust gases, heat the air from the compressor before it is burnt with fuel. The static type or recuperator, similar to a vehicle radiator, is simple but not as good as the moving version, the regenerator. The latter is more efficient, simple in theory but difficult to make and gives a considerable improvement on part load fuel economy. It is in this field that most of the current research work is now being done. A typical gas turbine is depicted in Figure 1 in the form of a simplified cross section. The air (black arrows) enters at the eye of the centrifugal compressor, is heated by passage through either of two rotary heat exchangers and then supports the burning of fuel in the combustion chamber. The resulting hot gas drives the compressor turbine, passes through variable incidence guide vanes and drives the power turbine and then exits through the heat exchangers where most of its remaining heat is removed. Mechanical details such as the drive to the heat exchangers or variable guide vanes are shown purely schematically.

The Ford, Crysler, General Motors, Lycoming and Caterpillar companies in the USA and Rolls-Royce and British Leyland, to mention a few, have or soon will have, gas turbines which mounted as a pair or singly, could produce the power needed for a MBT. Further stimulus is provided by the high performance train requirement. British Leyland predict a heavy commercial vehicle market of 100,000 gas turbines a year by 1980.

Unfortunately the environment in which an AFV engine has to work is a very demanding one. Cross-country work produces high dust concentrations, vibration and excessive heat or wet, creating inside the engine compartment an environment which can only be rivalled down a mine! The turbine has still to prove itself under these conditions. Fitting it into an AFV is a bold project with little experience upon which to draw: by contrast reciprocating engines have many years of backing in this use. As a result, costs could be two to three times that of the comparable diesel initially but this figure would fall when costed for an engine from Research and Development through its working life. Work in the USA indicates that progress is being made but a good deal more money and time may be needed. The S tank was criticized for the heat shimmer of its gas turbine; yet another problem to be overcome.

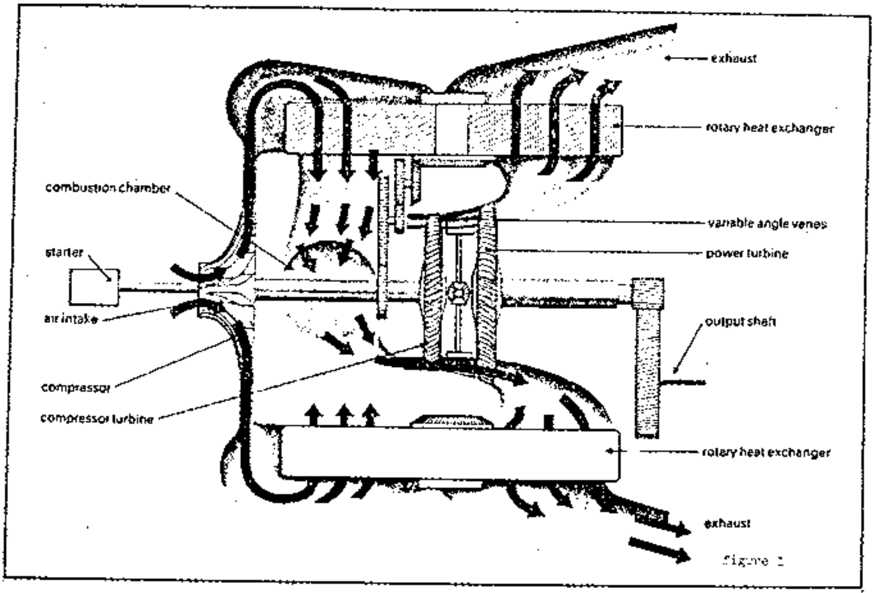

Figure 1. A typical gas turbine

CONCLUSIONS

A diesel of 1,200–1,500 bhp is available now in the USA or West Germany. By the 1980s, one could reasonably expect better performance for less weight and bulk, provided exhaust pollution standards (a major design requirement) can be met.

Wankel diesel, developed by Rolls-Royce as a Defence contract, is in its infancy and promises well for a range of engines to fit a vehicle family.

The commercial interest in gas turbines is growing rapidly, both for highway use and heavy earth movers. Improved technology should overcome the snags of manufacture of the regenerator and make part load economy, the bogey of gas turbines, attainable.

A choice is very difficult to make. A gas turbine would most likely be American: diesel Wankel is British. There is insufficient published information available at present. If one were to choose now, my bet would be the turbine in spite of what looks like higher costs.

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Colorado Rocky Mountain School

LIEUTENANT P. J. WILLIAMS, RE

The following article appeared in Officer 28*—Some Reports of Service Life Autumn 1970—and is reprinted by kind permission of the Central Office of Information.*

Colorado Rocky Mountain Summer Session offers eight weeks of demanding mental and physical activity. It is designed to present the students with a wide range of new experiences—from the Colorado Rocky Mountain School's brochure.

The author of this article learnt of the Colorado Rocky Mountain School and its rigorous training programme while he was at the Royal Military College of Science, Shrivenham. He lost no time in deciding that the school's outdoor activities in particular would match his ideas of adventure training during the eight-week summer vacation. Already an experienced canoeist, he had, for example, represented the Army in long-distance races, taken part in such ventures as canoeing from Dover to Calais, and had been an instructor in the sport. His other interests included kayaking and mountaineering, and he was also well qualified academically. So he applied for a post on the CRMS staff—and got it.

THE Summer School is a particularly American institution. American youngsters may spend up to two months of their summer vacation at such schools, which specialize in outdoor activities or a combination of academic and outdoor activities. CRMS is in the latter category offering a wide variety of academic subjects such as geology, anthropology, French, Spanish, philosophy, music, art and creative writing. Its outdoor programme is designed to develop fitness, stamina, skills and confidence. It includes white-water kayaking, mountaineering and rock climbing, riding and packing. Rules and supervision are at a minimum, and everyone is on christian name terms.

The principal of the school and his wife are English. At my particular sessions there were 14 instructors and 60 students, 30 boys and 30 girls, whose ages ranged from 15 to 18.

For me, anyway, one of the great attractions of the school was that it provided an opportunity to meet people from widely different backgrounds. The staff, a cosmopolitan and talented group, included college lecturers and instructors and school teachers on a working vacation. There was even an 80-year-old ex-Austrian—in his younger days he had served in his country's Imperial Guard—who taught cookery and jewellery making. All the staff had outspoken views on topics such as communism, religion, politics, drugs and the military. The students came from all parts of the United States and they represented the complete American social strata, from youngsters whose parents thought nothing of spending £400 on the course to others whose fees were financed by a scholarship fund. This fund was supported by money-raising schemes, including short periods of work by the students themselves on ranches in the neighbourhood.

Sited in a few hundred acres of its own land on the banks of the Roaring Fork River, the CRMS centres on a converted round barn which houses the main assembly hall, classrooms and library. Clustered around are other quarters largely built by former students, which contain, for example, the art room, music room, various workshops, kayak repair shop, dormitories (two students per room), dining room and kitchens.

The food was excellent, notable particularly for the variety of meats and the quantities of fruit, fresh vegetables and salads.

Adventure training? My time was limited to the summer vacation at Shrivenham so I travelled most of the way to the Colorado Rocky Mountain School by air. For the final 200 miles, though, I resorted to a more down-to-earth means of transport—motor coach. Did I say down to earth? The route across the Rockies climbed to nearly 12,000 feet at its highest point at the Continental Divide. (If two drops of rain landed only a short distance apart on the road there, one could end up in the Pacific and the other in the Atlantic.)

The practical problems of living at high altitude faced me on my second day when the school made its mass assault on Mount Sopris (13,000 feet). All the students and staff, with children and dogs if they had any, were expected to have a go at the summit. I retain only two memories of that particular Sunday. First, the final 1,000 feet along a windswept, boulder-strewn, icy ridge wondering what had happened to my lungs; and next, a 400-foot glissade down one of the snowfields which made for a rapid descent. The day provided me with my first opportunity to use the "buddy-buddy" system of improving blood circulation in cold hands and feet. You and your buddy vigorously rub each other's hands and feet, then try to keep them warm, usually by holding them under the arm pit. This is when you discover who your real buddies are!

Soon the daily routine became familiar: four academic classes each morning, commencing at 8 o'clock, with a mid-morning meeting for the whole school; outdoor activities and work crews in the afternoon; extra-mural activities in the evening. Although primarily employed as a kayaking instructor, I found myself fully occupied for 14 hours a day. There seemed to be a big demand for algebra tuition. I took on the job as the standard was fairly basic. Curiously, most of those interested in algebra were pretty 17-year-old girls.

The daily morning meetings for discussions, films, visiting speakers and craftsmen were a great success. The civil rights movement and the plight of the American Indian provided fruitful topics for films and talks. A concert given by the students showed what a wealth of musical talent we had among us. My contribution to these meetings was a series of illustrated talks on north-east Thailand in general and, in particular, Operation Post Crown. This was a Royal Engineers road construction project in that area, and I had worked on the scheme as a troop commander with a Sapper unit. I also acted as chairman of a school debate on "Communism in South East Asia". It was interesting to hear the points of view from both staff and students.

There was a considerable amount of maintenance work to be done in the grounds, so two afternoons a week were devoted to work crews. There was also haying, gardening and irrigation; and cutting, hauling and skinning spruce logs for the corrals—and then more haying!

At the start of the term, the students were given the choice of two or three evening activities—music, drama, pottery, jewellery, leathercraft, photography or mechanics. The last two were made my responsibility and after some liaison with one of the local ranchers, the mechanics class was presented with an antiquated jeep to strip down. I also found myself acting in the drama group's production of *Under Milk Wood*, having initially been recruited as a Welsh language adviser by the producer.

Kayaking provided the most memorable moments of all. Basic techniques were taught in the school "pond" before the students graduated on to the local rivers, the Roaring Fork and the Crystal. Further graduation came on the Colorado, Arkansas and Green Rivers with their fiercer waters. The chief kayaking instructor and one of the other instructors knew them from previous years, and were well aware of the hazards and pointed them out to everybody else. However, the force of the water in the canyons must be experienced to be believed, and provides a stiff test for even the most expert kayaker. One of the parts we "ran" was, in fact, the course of an international down-river race. What was important to us was that these rivers provided very real adventure training, and were a gruelling challenge, calling for all a student's stamina and skills. Our training, however, was good; we had worked up in graduated stages, and our equipment was also good. Further, all possible safety measures were taken. A thorough reconnaissance of all the large rapids was made before the first instructor ventured through along the best route.

CHANGING HAZARDS

Various factors could increase the hazards, of course. The force of the water can alter the course and the layout of the rapids from year to year. River levels, dependent on snow melt from the Rockies, can differ each year. Some of the canyons are remote and inaccessible, miles from the nearest settlement, and this placed an added responsibility on the instructors to get everybody through safely. Finally, despite their training, some of the students could be unpredictable in their reactions. Capsizes were inevitable at the outset, and on some of the longer stretches of the rapids the instructors were kept fully engaged doing rescue work.

After a capsize, the boat was emptied and, if damaged, a temporary repair was carried out with waterproof tape. Each member of the group had a waterproof container-bag, and failure to fasten this properly resulted in a wet sleeping bag. Some of the young people learnt the hard way. For this we showed little sympathy. We all had the same standard equipment.

The kayaking group—4 instructors and 18 students—spent two afternoons each week on the water, with an overnight trip at week-ends. These week-end ventures, American style, were characterized by log fires, camping out under the stars, with juicy steaks, hamburgers and frankfurters, pancakes and maple syrup. By far the most eventful trip was the one through the Westwater Canyon of the Colorado River. The river here is BIG. Once in the canyon, there is only one feasible landing place where one can camp for the night. Otherwise the customary exit is straight downstream, because the canyon walls rise vertically to 200 feet and more above the racing, muddy waters.

PERSONAL BATTLE

On this particular week-end, following an uneventful drive across the Utah desert, we launched our kayaks after lunch. By late afternoon the party was scattered over a mile of river above a rather frightening feature called Skull Rapids which had a 15-foot drop over its 100 yards. The main chute of water was flanked by large jagged rocks and sheer canyon walls. At the bottom of the chute was a series of stop waves, some five feet high, whose effect was to capsize a kayak, not sideways, but end over end. Just to the right of the waves was a seething whirlpool, 30 yards in diameter.

On this stretch, each person quickly became engaged in his personal battle with the raging river—with varying results.

In short, it was only after they had spent some time rescuing capsized students with their boats and paddles as they were being swept downstream, that the instructors could pause for a moment to take stock of the less urgent situation. This was it: three boats circling aimlessly around the perimeter of the whirlpool; two boats wrapped around some rocks; numerous paddles and safety helmets missing; and some of the students looking a bit battered and bruised. Just upstream of the rapid: a tiny figure, hanging on by his fingernails to a rock in mid-stream.

It was nearly two hours before the marooned student could be brought safely to land, and by that time it was too late to reach the scheduled camping site downstream. So we made a 200-foot climb on soft sandstone, in the dark, to find somewhere suitable nearby. A climb under such conditions broke all the rules—but at least it got us somewhere to sleep. That night's camp was particularly quiet. Everybody was exhausted and drained by the battle with the torrents. Several of the group had lost their food and dry clothing but, with some reorganization, we made ourselves reasonably comfortable.

The following morning there was some more big water to negotiate and, to ensure that the lesson was fully learnt, those with damaged boats swam the rapids and those without paddles used their hands.

There was then only one more big kayaking challenge: the Lodore Canyon of the Green River, which we ran on a four-day trip. Here the group was confronted with Hell's Half Mile, Disaster Falls, the Triplets, Moonshine Rapids and Son-of-a-Bitch

Photo 1. Preparing to enter a canyon

Photo 2. Author leading through rapids

Colorado Rocky Mountain School 1 & 2

Photo 3. CRMS Student in the Westwater Canyon

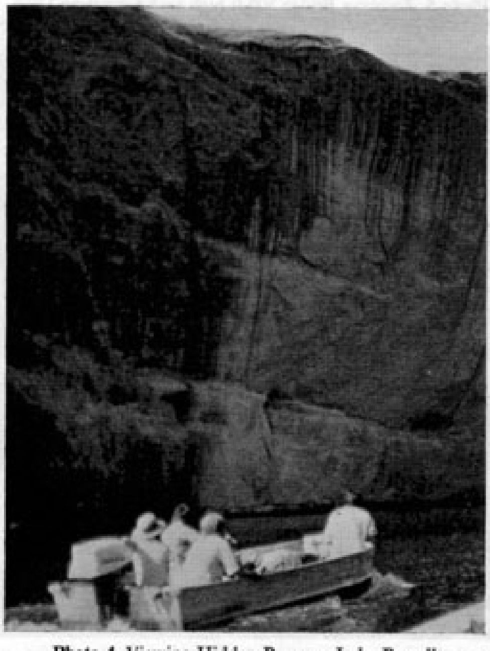


Photo 4. Viewing Hidden Passage, Lake Powell

Colorado Rocky Mountain School 3 & 4

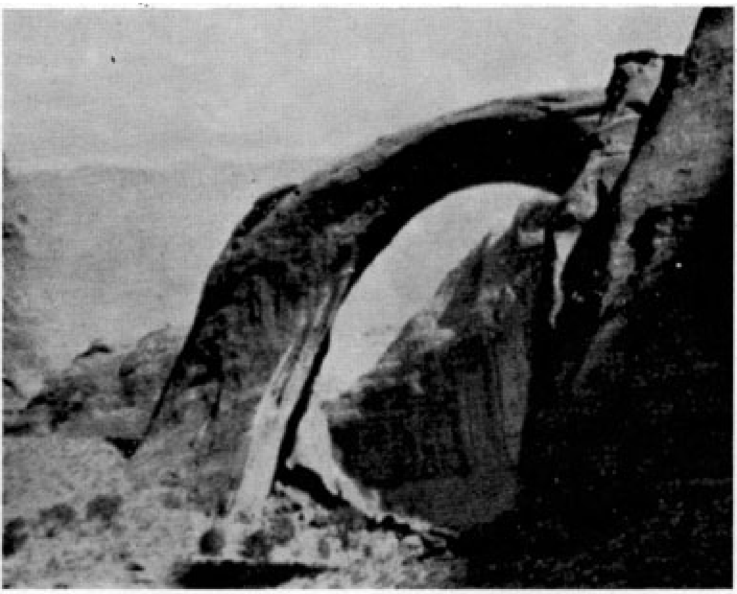


Photo 5. Rainbow Bridge 300-ft high rock formation Utah

Photo 6. Repairing a track in the Navajo Indian Reservation

Colorado Rocky Mountain School 5 & 6

Rapids—all well named! Hell's Half Mile took its toll, including one spectacular end-over-end capsize during which the kayak and its occupant became separated, the former attaining an altitude of some 10 feet, and the latter a similar depth. Less testing experiences included trout fishing, Pueblo Indian wall paintings, corned beef and champagne.

The last major event was a week-long expedition which took my group of three boys and five girls on a 500-mile desert drive in a rather antiquated truck. The object? First, to boat down Lake Powell, this time in tin boats, with outboard motors on this occasion, to Rainbow Bridge to view the magnificent scenery. (During our river trip we managed to perfect an eskimo roll with six people sitting astride an old log.)

The next stage of the trip was a 14-mile hike through canyons and across desert to the centre of the Navajo Indian Reservation in Arizona. This proved a hard experience for some of the group even though we started at four o'clock in the morning to avoid the intense heat of the day. Sapper initiative played a part in the success of the final phase of the journey when a desert track needed to be repaired after a flash flood, and our truck's clutch had to be fixed in impromptu fashion with baling twine (with apologies to REME). However, the truck packed up completely only just before we reached our destination, the Indian trading post.

THE REWARD

Next day there was a 20-mile ride on Navajo Indian ponies to the Anasasi cliff dwelling ruins of Keet Seel. My mounting of an Indian pony was a much-awaited moment. So, suitably dressed in jungle hat, climbing breeches and desert boots, I did not disappoint my student spectators. As it proved, I had the only horse capable of raising a gallop, much to their disgust. But the trip was worth while, if only to see the expert horsemanship of our Navajo guides.

And so, after all the expeditions had ended, after the boys and girls had said their sad good-byes, what had the summer really meant to us? Most schools such as CRMS are based on high ideals. CRMS was certainly able to put those principles into practice. The conditions could be demanding, mentally and physically. The outdoor activities were training with real adventure. The situations were often unpredictable, as were some of the students' reactions. But those two months, with the challenges to be met, the tasks to be overcome, the friendships to be forged, could bring out the best in a person and reveal a wealth of hidden qualities. For me the reward came when I compared the students at the end of the session with those same young persons who had arrived eight weeks previously. Their experiences had not only made them fitter, stronger and more self-reliant but also more aware of their duty as an integral part of a community.

* * * * *

A Hundred Years Ago

"Mata Kacha"

IN the autumn of 1870 the eyes of professional soldiers were directed across the English Channel at the progress of the Franco-Prussian War. On the first of September the French had been disastrously defeated at Sedan and the whole of their forces at that place, together with the Emperor, Napoleon III, made prisoner. Thus, within five weeks of the outbreak of hostilities, one of the French armies was shut up in Metz, the other destroyed, and the Germans were free to march on Paris. By the end of that month the capital was invested and the terrible siege, which was to last 131 days, had begun.

When, therefore, the second number of this *Journal* reached their breakfast tables in October, readers will not have been surprised to find its contents devoted predominantly to assessments of the performance in these operations of the Prussian engineers, and to what, in 1970, would be termed "taking a close look" at the organization and readiness for war of their own Corps.

In "Prussian Field Engineering" we are able, for the first time, to identify (from the initials over which it appears) the name of a contributor. Lieut-Colonel C. C. Chesney, then filling the appointment of Administrative Officer at Aldershot, examines the four branches (as he calls them) of field engineering in the light of the information so far made public. Of siege works he finds little to report which could not have been written when the Archduke Charles was before Strasburg seventy-five years earlier. The question of the "pontoon service"—in the Prussian, as in most other continental armies of the period, kept distinct from field engineering proper —the writer deems to have been decisively settled by the experience of this campaign. The problem, however, not new at the time, remains with us in constantly evolving form a century later, setting increasing axle-loads—then of siege artillery—in conflict with the mobility and construction times of bridging equipments. The Germans had, it appears, adopted a middle course, planning for the rapid conveyance of whatever guns could accompany the "ordinary marches" of an army, and by this provision had been enabled to carry out the bold strategy which hemmed Bazaine's army into Metz by crossing whole Army Corps at any required points on the Moselle, while pontoon bridges over the Meuse, "cast in a single morning's dawn", allowed the Crown Prince to outflank the prepared defences at Sedan. This mobility made practicable the *Blitztaktik* and rendered the siege guns unnecessary, but the difficulties of transporting the latter to the front (notwithstanding the use of railways) proved so great that to have had special pontoon bridges ready for them would have been "to carry superfluous encumbrances into the field".

The war had presented little opportunity to practise the third branch of field engineering, namely the throwing-up of defensive positions, but that one great lesson of the American Civil War had not been lost on the Prussians was demonstrated on 19 August at Gravelotte, where, before the wounded had been cleared from the ground won by such lavish expenditure of life, the engineers were hard at work preparing the ruins to resist any attempt to recover the position. When, a week later, the French tried a sortie in force, the Prussian outposts at once fell back on a line of fieldworks carefully prepared, which they were able to hold with ease.

The author turns lastly to what the Germans then, and up to the reformation of the army of the Third Reich, regarded as a distinctive *Pioneer* role, the definition of which was simply "to clear the Army's way before it". This function was at that time little thought of and hardly practised in the British Service, but the Prussians included a purpose-trained battalion of Pioneers in each Corps, charged broadly, under the Staff of the Advance Guard, with the repair of bridges and railroads, and the passage of swamps and other obstacles, all details of which were "to be left to the intelligence of the officer employed". Tracing the results of this policy, we learn that the 12th

Corps, "when ordered to move from Metz due eastward", made 50 miles as the crow flies in the first four days, marching chiefly on by-roads, effecting a passage of the Meuse, and traversing a district where every stream flows north to south, exactly crossing their line of movement. "Truly", concludes the Colonel, "there are many lessons for us to profit by in the study of the Great War of 1870." One of them might have been that the River Meuse traces its course many many miles to the *West* of Metz. The Prussian *Pionierdienst* comprised also the inverse role in retreat, but they were still advancing into France and not yet withdrawing to the Fatherland!

An unidentifiable contributor follows with a proposition for the "Organization and Equipment of the Royal Engineers", the first of many to enliven the pages of the *Journal* in the years to come. At that period the Corps still comprised a number of foot companies, distributed largely to conform with a peace-time requirement for technical capabilities (Works, Survey, Telegraphs), and the horsed Troops at Aldershot intended to furnish a proportion of them with mobility and field equipment on mobilization. Here the author advances his views on the purpose, chain of command, and optimal size of sapper units—all good, hardy annuals, which bloom today as then. He begins with the postulation that the object of the Corps is a military one; that their services can usefully be employed in times of peace is secondary. The latter should never be allowed to interfere with the former; and the aim of organization must be to render the Engineer Arm most efficient in time of war.

It reads strangely to a twentieth-century sapper officer that in those days service with the companies was "more or less despised", but a generation had not passed since the integration of the Corps with the Royal Sappers and Miners in 1856. This was, moreover, the heyday of special and extra-regimental employment and a period of unprecedented progress in the civil applications of engineering, while the superior qualifications of Royal Engineers opened to them many opportunities in Government postings at home and abroad. A high proportion of sapper officers were thus to be found in technical and other appointments outside the Corps, and often outside the Army. It is, therefore, not difficult to comprehend that "an officer who has for years perhaps led a secluded civilian life, in comparative ease, is suddenly posted to the, *to him*, irksome duty of the command of men"; less so to believe that "instead of doing his best he grumbles and shirks, and is never satisfied till the red coat is again laid aside except as a Holiday attire". This state of affairs the writer hoped to see altered by an increase in the size and composition of the companies, providing them with integral components of transport and equipment in peace-time.

A Unit, he aphorizes, should be complete in itself, capable of expansion or contraction, of being made for a time part of a larger body or of being rapidly detached, without losing its individuality or self-reliance; not too large else it becomes cumbersome; not too small or it becomes insignificant. Now the nominal strength of an RE Company at that time was 100 in peace, though then, as often in the intervening decades, the actual strength might be no more than one officer and fifty NCOs and men. The War Establishment was 120 and the normal allocation would have been one such company to a division in the field. The process of mobilization, argues the revolutionary, would "require a great deal of oil to make it work at all". Let the company exist in peace-time at a strength never below 5 officers and 120 men, he suggests, let each trade be represented and each cart or waggon be provided with half its full complement of horses. The strength for field service should then be 7 officers and 200 NCOs and sappers and the peace-time company would then need only the difference in officers and men from the Reserve and a doubling of the number of horses to make it at short notice fit for war.

Comments the Editor: "It is believed that ere long there will be a discussion of Company organization at one of the RE occasional meetings at the War Office." Today he might not go so far, contenting himself with the familiar observation that the views expressed were those of the author alone. We know only that these ideas bore fruit and formed the basis for Establishment and Mobilization policies ever since.

This number of the *Journal* contains a notice of the formation of "C" (or Telegraph) Troop at Aldershot, initiating a service since hived-off to the Royal Corps of Signals. It rates a mention only in so far as the scale of operations envisaged. The whole Troop composed "a unit of Field Telegraph" and was "the proportion for a Corps d'Armee as laid down", yet the 12 Wire Waggons carried between them no more than 36 miles of cable. The carriages were the first in the Service to be constructed with springs and, for those in the know, "the wheels are the 3° class wheel, with madras nave and a 3" tire".

Of more arresting import to the general reader will have been the precis of a "Retirement Scheme" advanced by the Vivian Committee, which assumed the current standard periods for promotion in the Engineers to have been as follow:

Lt.Col. (with Major's pay)	25 years.
Captain	18 years.
Second Captain	12 years.

The Committee proposed to add one year to the standard times, thereby ensuring that, to become a Field Officer, the Sapper must serve 8·3 years more than an Infantry officer. "There will, therefore", the Committee justly observes, "be no danger of his ever superseding the latter". The proposed pensions payable to a Royal Engineer after twenty years service was £200 per annum, rising to £600 after forty years.

Corps News holds little of interest beyond the fact that, at the RE Regatta, which had taken place above bridge at Rochester in July, the Cutter Race was for the first time rowed by three crews, respectively of Officers, NCOs and Sappers, the latter winning a gruelling contest from the officers by a quarter of a length.

A *Supplement* now accompanied the *Journal* listing the Books and Papers Printed in the Printing School and presenting a choice of reasonably priced bed-time reading ranging from *Instruction for use of Lasso* to *Remarks on Locomotives for ascending steep inclines with sharp curves* and from *Guncotton for Blasting purposes* to *The harmony of Sound and Form*. For the keen company commander not ashamed to wear his red coat other than on holiday, his Roll Call Books would have cost him 9*d* each, and for 8*d* he could have had,"By written demand on the Brigade-Major", one hundred copies of the Report of a Birth.

A page of advertisements by local tradesmen completes this *Supplement*; of the sixteen or so tailors, grocers, watchmakers, milliners, cobblers and all, not one survives today in the Yellow Pages of the Post Office Telephone Directory. The "Little Men" are gone, which is a pity, for Charles Hillier, the Ironmonger, would hire you a bath (or sell it to you, at 5 per cent discount for cash), while Mr Sparkhall, Hairdresser and Purfumer, held Combs, Brushes and Pen Knives in Great Variety. You can, however, from the local branch of a widespread chain of Wine Merchants, still buy your bottle of claret at the same address, not far from the Barrack gates, from which Edward G. Jell was honoured to serve your predecessors a century ago. As they studied the news of the war, in that winter of 1870, the officers of Chatham Garrison might enjoy the "Fancy Breakfast Bread, French and English Rolls every morning at 8 o'clock (Sundays excepted)" offered by W. J. Stigant, Baker, of 44 High Street, Brompton; the starving citizens of Paris would surely have surrendered their City for the smell of them.

* * * * *

Everyone Can Play

THE world at large takes very little notice of the shooting sports and, in fact, they attract practically no spectator interest. But, because spectators evince little enthusiasm for a game or sport does not mean that it cannot be an important and engrossing pastime—for the participants. Chess is hardly the most stimulating watching, but no-one would deny its popularity.

Shooting is similarly popular and has the advantage of being a healthy, outdoor activity. But here's the rub—for anyone to enjoy rifle or pistol shooting they must be capable of a reasonable standard of performance or feel that they can make a steady improvement. Apart from those gifted people who have a natural aptitude, some form of basic instruction is necessary for this activity which requires manual and physical skill.

This is why the National Smallbore Rifle Association operates its National Coaching Scheme which, among other things, holds courses for County Coaches at the National Recreation Centres. Following this examination, qualified County Coaches hold courses for club instructors under the control of their County Association. By this system the governing body is rapidly achieving its objective of having a qualified instructor in every club.

The fact that there are now so many instructors available means that anyone who decides to make Target shooting his—or her—pastime can get the necessary basic instruction which will allow them to enjoy their chosen sport, be it with rifle or pistol.

Over the past two years there has been an interesting development with the army forming Target shooting clubs. Many candidates have been sent to National Coaching Courses and teams are taking part in events organized by the NSRA. In fact, they are now playing the game the civilian way whereas, in the past, the sport was merely thought to have military overtones.

Information about the sport may be obtained from the National Smallbore Rifle Association (R. C. Russell), 113 Southwark Street, London SE1, or the Army Rifle Association (Lieut-Colonel T. W. Whittaker, OBE), C/O Headquarters South East District, Steeles Road, Aldershot, Hants.

Correspondence

Major W. G. Crawford, RE, BSc(Eng)
Civil Engineering School,
Technical Training Group,
Royal School of Military Engineering,
CHATHAM, Kent

10 August 1970

DRAFT CODE OF PRACTICE FOR STRUCTURAL CONCRETE

Sir,—S. R. Arnold's article in the June *Journal* is most timely and should serve as a reminder that all RE officers must learn to work with the new Code of Practice and should therefore find some time to study the draft code. However, some of his remarks may be misunderstood and I will therefore attempt some further explanations.

As far as the Code is concerned "Nominal Mixes" are indeed out, but they have served well in the past and there is a clear case for their retention, particularly for non-structural military work. Nominal Mixes are essential if weigh batching equipment is not available.

Although it is possible to specify a Designed Mix which cannot be achieved on site, the new Code offers a much improved method of site control. We are all aware of the importance of water/cement ratio and, I hope, equally aware that the quantity of water actually added to a batch is determined by the concrete mixer operator. The Code now specifies narrow limits on cement content, limits on water/cement ratio and control by workability (Slump or Compacting Factor tests). Control by workability enables an inspector to reject a batch of concrete before it is poured; surely better than cutting out hardened concrete after 28-day-old cubes have failed to reach specification.

I completely disagree that any conflict will exist when the third cube in forty has failed. The engineer will make up his mind whether it is better to remove substandard concrete or to leave it (and perhaps adopt other remedial measures). The contractor has only to comply with the engineer's instructions. On a civilian contract, it has been suggested elsewhere that substandard work, if structurally or aesthetically acceptable, should be paid at a lower rate (say the rate for mass concrete rather than reinforced concrete). This should satisfy both client and contractor.

Arnold's mention of properly certificated technicians is most appropriate since a recent Clerk of Works Construction course attained well above average City and Guilds results. However, even though the Corps may recognize that the concretor is a tradesman, we nevertheless call him a bricklayer!

Limit State Design is a concept introduced by the Comité European du Béton (CEB). Design against particular limit states embodies Load Factors (to cater for accidental overloads or incorrect estimation of loads) and Materials Factors (to guard against uncertainties in the performance of materials). The old-fashioned Safety Factor has become two Factors of Uncertainty which are included in two separate equations for Loads and Material Strengths.

The load equation reads:

$$\text{Design Load} = \text{Load Factor} \times \text{Characteristic Load}$$

As an example, the Characteristic Load for buildings is obtained from CP 3 Chap V and for a simply supported beam the Limit State of Collapse for dead and imposed load requires load factors of 1·4 and 1·6 respectively.

The material strength equation is:

$$\text{Design Strength} = \frac{\text{Characteristic Strength}}{\text{Materials Factor}}$$

The Characteristic Strength is that below which only 5 per cent of test results fall. Considering the Limit State of Collapse the factors are 1·5 for concrete, but only 1·15 for steel. The latter reflects the greater certainty of knowing how the material will behave when acting as part of a structure.

Having calculated the Design Load and Design Strength, the section can be designed. For the Limit State of Collapse this consists of using "load factor" equations or graphs to select a section with a Moment of Resistance no smaller than the Design Bending Movement. For the Limit State of Deflection, it is normally possible to apply a simple set of "deemed to satisfy" rules. However where it is necessary to calculate deflection different factors are used. If the deflection so found exceeds a proportion of the span, redesign of the section will be necessary.

Although the foregoing may appear to be a great complication of the design process when compared with Elastic or Load Factor design according to CP 114, it is a far more rational approach to a complex problem.

Correctly, Arnold has warned about the necessity for design against deflection now that working stresses are increased. However his "design strength" of 2180 lbf/in^2 is really a working stress and he relates it to *mean* cube strength of 6000 lbf/in^2. The Characteristic Strength will be less than the mean strength by a margin ,which he has taken in this case as 1090 lbf/in^2. The code requires a minimum margin of 1·64 standard deviations or in the absence of previous test data, 15 N/mm^2 (2176 lbf/in^2) for this grade of concrete.

One of the major advantages of the new Code is that the rational Limit State basis of design and the multiplicity of load and materials factors will allow for minor amendments without the need for a major revision. Thus, as new information on loads is discovered and new technology produces better materials, the code can be updated to meet the changed situation.—Yours faithfully, W. G. Crawford.

S. R. Arnold, BSc(Eng), C Eng, MICE, MINUC E
Materials Branch,
The Royal Military College of Science,
Shrivenham,
Swindon, Wilts.
26 August 1970

Sir,—I am grateful to Major Crawford for his additional comments. By allowing me to see them before going to press, he has given me a chance to make one or two more comments of my own.

I regret I see no value in retaining nominal mixes in the code of practice. If the work is non-structural, then the code need not apply and if the work is structural, only weigh batching should be employed.

I can also see that we will never agree on the question of compliance. It is still my firm belief that unless specifications are carefully prepared and sensibly interpreted, there will continue to be disputes over the acceptability of concrete. Although the concept of the "Characteristic Strength" rather than "Minimum Strength" is a step forward, the code has done little to help. It is one thing to say "the engineer will make up his mind . . .", and another to make the contractor agree with him.

Major Crawford's comments on design really emphasize the problem I faced in reviewing the draft code in a limited space without virtually writing a text book in the process. I would like to emphasize, however, that although it all "appears" complicated, once the science is mastered, design becomes not only more rational, but easier than design by the elastic method.

From my Shrivenham ivory tower, I would like to pose a question to the readers of the *Journal*. Bearing in mind that an officer with a degree is only partly trained in Civil Engineering and hence is not fully qualified, how many Squadrons could, at this moment, accept a job of *designing* and constructing a 50-metre span reinforced or prestressed concrete bridge to comply with the latest codes and standards? I sincerely hope, and would expect, that the answer is 100 per cent, but it is a question which maybe Major Crawford is best qualified to answer. For those squadron commanders who would like to improve their potential concreting capacity, I would suggest that a solution would be to run additional one week courses at Shrivenham and Chatham to cover all aspects of the science. In the meantime, may I advertise the excellent 3 to 5 day courses run by the Cement and Concrete Association at Slough. Details of these courses may be obtained through Major Crawford or myself.—Yours faithfully, S. R. Arnold.

Captain C. B. Prescott, BSc, RE,
3 Falterley Road,
Wythenshawe,
Manchester 23.
12 July 1970

RATIONALITY RATING IN MANAGEMENT

Sir,—I read with interest the article by "Fiat Lux" on "Rationality Ratings in Management" in the June 1970 issue of the *Journal*.

The second and third paragraphs of the article may lead one to suspect that all major civilian concerns plumped for either wholly rational or wholly intuitive (wholly irrational?) management during the sixties. One large construction firm agreed (at least in 1967) with "Fiat Lux" in that successful management reflects a blend of the rational and the intuitive. I enclose a chart on Contract Administration based on a lecture given at the Dudley College of Technology in 1967 by an Assistant Director of Wimpeys.

There are some interesting comparisons. "Fiat Lux" gives Delegation of Authority a 10–20 per cent rationality rating (RR) which agrees with Delegation Systems on the chart.

Resources receives a 99 per cent RR in the article but consideration of Plant Management (75 per cent RR) and Materials Control (80–90 per cent) together with the Man Management aspects of Putting People in the Picture (ugh!), Man to Man Discussions (ugh!) and Giving Orders (all at 10–20 per cent RR) perhaps indicates that resources have proved less of a problem for civilians than they have for poor Sappers in the back of beyond.

It would also appear that our military training gives us more a rational outlook on planning. "Fiat Lux" awards 85 per cent RR to Project Planning whereas the civilian Planning aspects all get about 50 per cent RR.

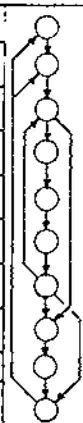
Cost Control Planning at 50 per cent RR agrees with "Fiat Lux's" estimate but surely the other facets of Cost Control (Data Collection and Analysis) are more rational than this? What about a compromise at 65–70 per cent RR?

I cannot argue with Working Drawings and Specifications or Statutory Returns assessments but do endorse the statement about "imaginative entries due to lack of information or intent to deceive".

As a final comment on the excellent article, it never ceases to surprise me that people try to show that a way of life is a pure art or pure science. There cannot be many rich pure scientists and all the world knows that no one is as poor as a pure artist. There are, however, many artists and scientists who make a nice blend of the rational and the intuitive and do very well—particularly if they are in the right place at the right time. Now, is being in the right place at the right time intuitive or rational? AG 7 please note!—Yours faithfully, C. B. Prescott.

Contract Administration:- The Process and the Tools

ARE Agent/RE discussion
BA Bids analysis
CCA *Cost control
Analysis of data
CCD *Cost control, data collection
CCP *Cost control, plan
DS Delegation systems
EW Eyes on the work
FAC Final account inc. claims
FAD Final account documentation
FD Formwork design
FSA *Financial status, actual
FSF *Financial status, final
FSO *Financial status, outlook
GO Giving orders
HM Hunch
HLM High level meetings/letters with engineer and client
IA Interim accounts
IM Introspective meetings
JDS Job data summary (methods, progress, outputs, costs, restraints, mistakes, claims)
JT Judgement
LR Labour returns
MC Material control
MF Market forecasts
MM Man to man discussion in the field
MR Market research
PCA *Progress control, analysis of data
PCD *Progress control, data collection
PER *Programme and estimate review
PG *Planning
PM Plant management
PME Progress meetings external (with client/RE)
PMI Progress meetings, internal
PP Putting people in the picture
QCD Quality control, data collection
QCL Quality control
lab. recommendations
QCR Quality control research
RP *Records from past jobs
RPE *Replanning and reestimating
RR Routine reports to client as requested



The process	The tools
1. Decide policy	HM MF JT BA MR
2. Tender	TPE SI TD RP
3. Go to work	PP DS WL GO PG TW SY FD LR WD CCP TG PM MC TP
4. Routine health check	MM EW PMI PCD QCD CCD FSA
5. Routine health forecast	PER FSO
6. Pinpoint troubles	MM ARE IM WS PCA QCR EW CCA
7. Decide remedies	PP DS ARE RPE QCL GO HLM
8. Keep client happy	ARE PME RR HLM
9. Get paid	TLN FAC IA FAD
10. Apply experience and capital to future jobs	FSF JDS
	0% (Wholly intuitive) ← Approximate rationality rating % → 100% (Wholly rational)

SI Site investigation
ST Safety
TD Tender documents
TG Training
TLN Top level negotiations
TP Time and pay
*TPE Tender planning and estimating
TW Temporary works, design and schemes
WD Working drawings and documents
WL Welfare and labour matters generally
WS Work study

Note: RE stands for Resident Engineer and not Royal Engineers

COMMENT BY "FIAT LUX" ON CAPTAIN PRESCOTT'S LETTER

It is understood that Captain Prescott is with his contractor on a Long Civil Engineering Course, and therefore writes from experience. I was delighted to learn of his basic support for my contention.

Several national contractors understand, and use, the Rationality Rating (RR) concept but the question remains, "Are the Corps aware of RR?"

I must admit that I was agreeably surprised that the RR values in Captain Prescott's letter showed such a degree of similarity as essentially civilian contractors are financially involved, their aim is to make a profit, whilst we in the Corps are not.

I gave Resources a high RR because, rightly or wrongly, we have to work strictly within a relatively rigid system of procurements which our civilian counterparts would not tolerate. If we were allowed more latitude on site, (the "bag of gold" approach), the RR would go down. Freedom of choice will always reduce the RR as more options are open on which personal judgement must be exercised.

I would reiterate that Rationality Ratings are not constants, they will vary from job to job as well as reflecting the personalities involved.—"Fiat Lux".

* * * * *

Brigadier G. MacLeod Ross, MC, M(Eng), FICE,
3 Cobourg Street, Goderich,
Ontario, Canada
12 July 1970

ROYAL ENGINEERS IN THE EIGHTIES

Sir,—I have read Majors Dell and Benham Crosswell on this subject in the June issue of the *Journal*. I note with some disquiet that today (31 years later) we have still not resolved such basic questions as: (*a*) "Engineer" or "Pioneer"? and (*b*) "Military" or "Civil Engineer"? Since the use by the Corps of more sophisticated equipment is envisaged, and rightly so, surely we should include some reference to the Mechanical and Electrical Engineer, or is this understood to be covered by the expression "Civil Engineer"?

As one who obtained a regular commission in the Corps in 1921 at a time when it was the exception to possess an engineering degree, whether civil, mechanical or electrical, I would like to say this. The education of any engineer means Theory plus Practice. The Corps has suffered since 1914 from inability to give its officers sufficient "Practice". Until the Corps can offer an honest to goodness career as a professional engineer, so long will a considerable proportion of its cadre be forever looking over its shoulder (up to age 35) at the glitter of "command"; which means the Staff College, and perhaps the IDC, staff employment and finally selection as a Commander.

Thus the first hurdle to clear is to provide those enticed into the Corps with the two essential elements of an engineering education: Theory and Practice.

Perhaps the record of a 1939 Committee on the Technical Training of Army Officers has been mislaid. Here is what Professor C. E. Inglis, who fathered the Sapper classes at Cambridge University, said in part evidence before that Committee:

". . . The problem was of such vital importance that it was a little disquieting to realize that any problem existed at all. It was unfortunately however a fact that Civil Engineers and Military Engineers in a great many cases were not moving in the same plane. The real reason was that in far too many cases the Military Engineer's, by which he meant the Royal Engineer's, knowledge of engineering was confined to what he had been taught when going through his theoretical course at Chatham and Cambridge but, unlike his civilian contemporaries, far too few of them had any real opportunity of applying those principles. They learnt with great success, a knowledge of theoretical engineering but a paucity of practical engineering experience would sooner or later tend to produce what, for want of a better word, he would describe as an engineering inferiority complex. . . . More and more the young RE tended to look towards the military and administrative side of his career, rather than to the technical side. That was the cause of such estrangement as there might be. . . . He had yet to hear of any Civil Engineer of repute who would not be glad to take into his office officers of the Royal Engineers. Those offers . . . had not been utilized to anything like the extent to which they ought to have been. The reason . . . was because the officers "could not be spared', but he wondered if they were doing work of such paramount importance, that it had to take precedence over the important consideration of gaining practical experience, or was there possibly some truth in the rumour that in far too many cases the RE were being put on jobs which were quite unworthy of their ability and early training? He realized that an RE officer had primarily to be a soldier . . . but was it too much to ask that, of the first ten years after leaving Cambridge, at least 3 or 4 years should be devoted to gaining real practical engineering experience?"

Brigadier Pritchard said: ". . . He could assure Professor Inglis that he could give him a very long list of Royal Engineers, who had had good practical engineering experience."

As some of us saw it, and still see it, the Corps must make up its mind whether it is going to be officered by engineers or staff officers. I might add that the preferment of RE officers who have elected for the Staff, into the highest RE appointments does not do very much "pour encourager les autres".—Yours faithfully, G. MacLeaod Ross.

Captain R. M. Stancombe, RE, BSc (ENG)
23 Amphibious Engineer Squadron
BFDO 31
21 July 1970

Sir,—I feel that I have some qualification to comment on the article "Royal Engineers in the 1980's" in the June 70 edition of the *Journal* if it is only that I have spent the past six years between Strategic Reserve and BAOR units. As a young officer I can view the Corps from the working end and have seen some trends which may be pertinent to its structure in the decade after this. I must say at the outset that I find it difficult to ensure that my views are all relevant to developments in the 1980s and are not concerned with the ensuing ten years. However, I wish to take sides with the author of the article over his views on retraining, which I consider to be the crux of the Corps' development during the period under consideration.

The whole organization and training of the Sappers of the 1980s will depend on the speed and ability of units to retrain. It is surely wrong to suggest that there will be time available for general purpose units to maintain a state of operational training which will enable them to do any task efficiently. From my experience, it takes a squadron several years to reach a peak of efficiency in any particular group of tasks. I do not believe it is feasible to foresee these squadrons being able to reach a level of training which will enable them to perform more than EEC or UN/Commonwealth tasks in any one period for the following two reasons.

Time available. Even with the improved career planning structure there is still going to be a limited time for effective training of a unit as a whole during peacetime. It is fantasy to imagine that even in ten years' time a squadron commander will be able to train his unit to carry out more than an EEC role or a UN/Commonwealth role. At the present time the general standard of unit FFR is low due to lack of time available for intensive training with all members of the unit present. In BAOR only the FTX season of barely two months is used whilst Strategic Reserve units are often worse off due to the dispersion of individuals for a variety of reasons.

Specialization. Whereas it may be possible to attach specialists for projects it is not possible to do so in order to make units in the EEC role operational. There is a strong argument for a basic vein of combat engineering to run through all units, provided it is kept in practice, but it would not seem possible to boost EEC units with these few experts to suddenly convert a general purpose unit. The equipment will be even more sophisticated than that coming into use now and, despite the likely higher intelligence of the soldier, it is the basic skills of the individual operating his own equipment that counts for everything. An amphibious troop, for example, within an engineer squadron will require all its members to train for the entire available training season to become proficient at that one facet of the squadron's role—likewise with the operators of CET and other assault bridging equipment.

I agree that, theoretically, we may seek to train all our units to do anything anywhere but, practically, this would seem impossible to achieve under the present organization and with the manpower likely to be available.—Yours faithfully, R. M. Stanscombe.

SQUARE ONE

The following letter was published in the Journal of the Royal Signals Institution and is republished by kind permission of the Editor of that Journal.

Sir,—Before I leave the Army next month I would like through the courtesy of your pages to table a topic for thought and discussion in the Corps. There will inevitably be those among your readers who at worst will acuse me of heresy or, at best, of a lack of propriety in this our fiftieth year. There will also be those who will take my thesis as just so much hot air being blown off in a fit of pre-release irresponsibility, I would assure all of these that never, in thirty years of service, have I been more sober or serious.

The problem before us is, in a nutshell, the increasing simplicity of military signalling. Setting aside the howls of the operators of Bruin, who are having to cope with a transitory situation, it is a fact that in the next couple of decades, the need for technical skill, for improvisation and for signallers' intuition will become part of our history. Maintenance as we have known it will become a simple logistic problem of the positioning of replacement equipment, operating will become a matter for the user. The bottom, in fact, will have fallen out of the tasks for which we have hitherto recruited and trained a particularly intelligent, important and resourceful type of soldier.

While all this is going on, however, there will be new, complementary problems concerning the refinement and simplification of the communication complex and in the devising of command and control methods compatible with ever-increasing signalling possibilities. These will place unprecedented demands upon our managerial levels, as will the tactical deployment of these highly sophisticated systems.

We shall therefore have a situation in which, while our soldier-structure is atrophying, our officer and warrant officer requirements will demand unprecedented levels of skill and knowledge. This expertise will not only be in the field of communication engineering, To be able effectively to influence, as they must, the whole military scene, they will need to be broadly based soldiers who will carry full credibility in the Army as a whole. By current criteria (and I detect no possibility of a change of heart on the part of the Establishment) this depicts a totally non-viable situation.

Now let us look for a moment at the prospect before the other engineering arms and services. The Royal Engineers face no comparable problem. There will be increased automation of some of their services but the presence of their soldiers on the ground will remain largely unimpaired. They will stay in balance.

REME, on the other hand, will encounter a falling demand for maintenance personnel much as we shall. As maintenance is, however, their *raison d'etre*, we can anticipate that this will give rise to increasing and successful pressure for them to take over every form of equipment maintenance wherever it may exist. So although their soldier strength will fall, it will be most unlikely to do so to the same degree as ours. With no management commitment beyond supervision of their own effort, however, their officer and warrant officer structure can be expected to fall more sharply.

So in the overall field of military engineering we see the communicators and mechanicals getting into a mess while the constructional component remains stable. My proposition is that this is a situation which can only be met by Royal Signals and REME applying for admission—or re-admission—to RE. The result would be a large, economic and thoroughly viable military engineering organization. It would permit the rational training and deployment of soldiers and, so far as officers are concerned, could offer three main specializations while providing the necessary time and strength margin for wide staff and ERE employment.

Moreover in a single stroke internecine conflict would be ended—strife which sometimes puts into the shade many of the armoured and infantry "tribal wars" which we claim to deride.

These are the days of the big battalions. We see them all around us. The need for the economical and effective development of modern equipment and methods is dictating amalgamation in all parts of the community—in industry, in commerce, even in public administration. Can we honestly avoid it in our part of the Army? Our loyalty to our Corps, to Jimmy and to our 50 years of history, is real and intense. I suggest, however, that there is one loyalty greater than all these—our responsibility to the Army for seeing that it has the best possible command, control and communication system. We must get our priorities right.

Some may say why not go the whole hog and have a Royal Army. Why not, indeed: who can tell what might follow were we to set an example.—I am, Sir, Your obedient servant, P. E. Hutchins, Brigadier.

15 June, 1970.
London, SW1.

Brigadier M. E. S. Goodall,
HQ No 1 Conservation Task Force
South East England
17 October 2020

AN EDITORIAL IN 2020

Sir,—I was delighted to read Brigadier Crosthwait's most interesting article comparing our present military engineering organization with that of the Royal Engineers of the seventies. I well recall my great uncle telling me of the many interesting conversations which he had with Brigadier Crosthwait's grandfather on the role and organization of the Corps.

I am, however, disappointed to note that he has made no mention of the great part now played by military engineers in the preservation of our environment. Perhaps the reason for this omission is an indication of how we now take this vital role for granted, and yet 50 years ago little constructive thought had been directed towards this problem. It took the disasters of the late seventies to persuade the world that drastic measures were required if mankind was to have surroundings fit to live in and a worthwhile heritage to pass on to future generations.

It will be remembered that the Royal Engineers were the immediate choice of the Government of the day to form and lead the emergency task forces which were instituted in order to check, control and eventually restore the balance of nature in hard hit areas. The devastation which had been caused by industrial pollution, individual carelessness, increasing nuclear waste and over-farming, is something which present generations are probably not aware of.

It was, however, the engineering and management expertise of the Royal Engineers, so wisely fostered and jealously preserved at a time when normal military tasks were dwindling, which was harnessed to deal with the terrible situation of those years. I would also venture to suggest that it was this that finally tipped the scales in favour of an integrated Engineering Corps in the Armed Forces of the United States of Europe.—Yours faithfully, M. E. S. Goodall.

G. W. Kirkland, MBE (Mil),
C Eng, FICE, FI Struct E,
M Inst HE, FL Arb.

R. Travers Morgan & Partners
Wellington House,
Strand, London, WC2
22 October 1970

Sir,—"Once more unto the breach, dear friends".

I am not a professonal letter writer but something about that which Brigadier Crosthwait writes seems frequently to stimulate an urge to become one. I refer to the Brigadier's "crystal ball" editorial for the year 2020 in the Centenary number of the *Journal*.

In the same issue, the Engineer-in-Chief, in addition to advising us as to the "good state" of the Corps, has emphasized the need of a top level intake of Sapper Officers and has emphasized the need of a top level intake of Sapper Officers and has emphasized the desirability of good quality applicants for Short Service Commissions at salary rates and with futures which sound exciting. The Short Service Commissioned Officer is not likely to have many opportunities of further education and must use his time in obtaining practical experience in the various aspects of Military Engineering (Sapper variety) and learning all he is able of man and task management. For all that, his Sapper experience will not be likely to be of much assistance to him to enable him to proceed to Chartered Status in one of the civilian professional Institutions. Were this new Short Service Commission applicant able to see ahead of him the professional status of Chartered Military Engineer, how much more attractive would such a commission appear.

Reverting to Brigadier Crosthwait's look into the future, I can see no need for the Sapper Institution to wait until a possible merging of the Technical Army Corps is organised and indeed as the oldest of all, both Sappers and our Institution, we could well provide a lead and become the Military equivalent of the CEI, arranging our byelaws after discussions with Ord, Sigs, REME, etc. Institutions so that we might anticipate the future.

Should Brigadier Crosthwait's prophesies not be proven, could not a merged and united Military Technical Institution do more for the Sovereign, the nation and its members than the smaller Regimental bodies now are able?

In my letter published in the June 1969 *Journal*, I indicated that it would take a decade to see the benefits of an improvement in Military Engineer status, and it now looks as though we must spend another decade before any change is effected. Brigadier Crosthwait has the system all working by 2020—we haven't all that much time! Can someone, somehow, start doing something?—Yours faithfully, G. W. Kirkland.

A. M. Hamilton, BE
FICE, FI MECH E, FNZIE,
M CONS E, MFR.SOC, CE
Consulting Engineer.

Oaklea,
Badgers Mount,
Sevenoaks Kent,
8 October, 1970

HAMILTON UNIT CONSTRUCTION BRIDGE

Sir,—Regarding the September 1970 Centenary number of The *Royal Engineer Journal*, which is a very important issue, may I, as a former member of the Corps, and as a name in the above Journal, offer my comments on the article "The Evolution of Equipment for the Royal Engineers 1870–1970" by Brigadier B. G. Rawlins? In several places it is quite inaccurate in regard to Hamilton Unit Construction Bridging in a most harmful way. Railway and heavy bridging, particularly that developed in India by very experienced RE and IE engineers, is not mentioned nor is there even one photograph to represent the resulting SEAC road and rail bridges so vital to that campaign.

Above all I see no mention whatever of the brilliant planning with so limited funds of the Royal Engineer Board under Colonel A. P. Sayer, as its President, and Lieut-Colonel R. S. Rait-Kerr, as its Secretary. Their work extended beyond military bridging and the many other requirements of the Corps to aero-hangar development for the RAF and Fleet Air Arm and to securing the civil adoption of Hamilton UC military bridging by the Ministry of (War) Transport and the Government of India. They recommended the widest available manufacture of the UC aero-hangars and bridges in both countries and their stock-piling or immediate use. Their wisdom was shown in that all three of these structures were then available for the campaign against the Japanese and to keep contact with the Chinese with communications over some thousand miles of mountains, jungles and rivers to contend with.

The article describes a World War II seemingly only as it appeared inside MEXE, formed after the RE Board had been dissolved and replaced by a war-time Ministry of Supply. Then all bridging not of MEXE origin was reported—as stated in Brigadier Rawlins' article—"about Class 30, too weak for tanks, etc". Yet at the same time and for 30 years since. Hamilton UC bridges of the identical type, in use by the Ministry of Transport, have been carrying Class 70 and considerably heavier loading! Secondly the Hamilton bridge production was not stopped, as the article says, in 1940. It was in production throughout the war, is still and is in use throughout the world. Thirdly it is by no means slow to erect, Dutch, French, New Zealand, Indian and UK engineers have all proved that, as did the SEAC bridging. Fourthly it was not only the first bridge with multi-truss construction (which the article says it was) but the first in multi-tier construction (which the article hands to the Bailey bridge). Fifthly its advent, in all four Hamilton types, brought ten times the strength of previous military bridging due to its variable section methods. Sixthly Brigadier Rawlins is breaking the second Award Agreement which the Crown (Ministry of Supply) made with Hamilton & White-Parsons and dated 21st October 1953 on their war bridging. Para 3 says:—

> "The Crown will endeavour to refrain from any action which would or might damage the commercial reputation of the Bridging."

In view of what is obviously false about the strength of Hamilton bridging could this letter be published in the Journal with an apology for any commercial damage due to wrong information.—Yours faithfully, A. M. Hamilton.

NOTE BY EDITOR

There was of course no intention to denigrate the Hamilton Unit Construction Bridge and a most sincere apology is made to Mr Hamilton if, by implication, any wrong information was given about his bridge

As pointed out by Brigadier B. G. Rawlins in his article the equipments described were those available for the range of traditional tasks carried out by the basic sapper tactical unit —the field company/squadron—in the combat zone. Space prevented a description of the development and production of the wide range of engineer equipments and stores, such as railway and other permanent L of C bridges, hutting, hangars, etc, required for construction projects in the communications zone. Which often enough, as at Imphal were combat zones also.

During the Second World War the Callender-Hamilton (Unit Construction) Bridge was held as a Transportation and not a Royal Engineer store. It was mentioned in Brigadier Rawlins' article as an example of the introduction of a new characteristic in bridge design, used later by subsequent bridge designers. It is regretted that the article did not state the full load carrying capacity of the bridge and did not mention that the bridge could be built in multi-tier as well as multi-truss construction and that the article might have given an erroneous impression that the production of the Hamilton Bridge stopped when the Bailey Bridge was introduced into the service.

"The Second World War 1939–45 Army—Transportation", published by the War Office in 1950, clearly sets out how the Hamilton Bridge was manufactured in large quantities throughout the war, two types roadway and railway, and successfully used to ensure the maintenance of large armies in numerous theatres of operations, often over long and difficult lines of communication, and thus materially contributing to ultimate victory.

The equipment is still being used and a Royal Engineer Squadron has just completed the construction of two Callender-Hamilton (Unit Construction) Bridges in the Trucial States.

E-in-C ADDRESS TO THE 1970 ANNUAL GENERAL MEETING OF THE CORPS

It is regretted that an error occurred in the information superimposed on the map in Figure I of the report of the Engineer-in-Chief's address to the 1970 Annual General Meeting of the Corps, published in the September issue of the *RE Journal*.

It would appear from the marked map that Northern Ireland was shown an "Overseas Garrison". This of course is incorrect, and the symbol used on the map in this case should have referred to "RE in support of normal garrisons".—Editor.

Memoirs

LIEUT-GENERAL SIR JOHN WHITELEY, GBE, KCB, MC

May I, as an old friend of General Sir John Whiteley, be allowed to add a little to the obituary notice of him published in the September *Journal*?

Jock Whiteley was commissioned in the Corps in February 1915, and was posted that summer to the 10th Divisional Signals. He survived three years of active service, and when the First World War ended in 1918 he had the opportunity of transferring to the newly formed Royal Corps of Signals. However Jock was sufficiently conservative to prefer to remain a Sapper, and in June, 1920, he arrived at Chatham to join No. 4 Supplementary Course. These Supplementary Courses were instituted for the benefit of those officers whose normal Young Officers' Courses had been curtailed because of war conditions. This was before the days when Cambridge entered the curriculum.

No. 4 Supplementary Course numbered about 30 and it included no fewer than three officers who were destined to make the Army Council: K. N. Crawford, N. C. D. Brownjohn, and Jock Whiteley himself. Even in those early days it was clear that he might go far. He had a good brain and came out near the top of the list in all the multifarious tests we had to pass. Physically active, he played most games more than adequately. He was a good horseman, and when he went to the Staff College later on he became one of the Whips of the Drag Hounds. He was very good-looking; a cartoon of him drawn at that time by another member of No. 4 Supplementary—E. L. M. Burns—portrayed him as a Matinée Idol, standing in the spotlight on a stage and requesting ladies who wanted his photograph to send half a crown!

He was a man of many friends. His particular crony at Chatham was David Morris, also a member of No. 4 Supplementary, who was later crippled by arthritis and died comparatively young. At that time David was still as active as a cat and played stand-off half for the Sapper Rugby team. He and Jock walking side-by-side presented a curious contrast: David short and stocky, Jock tall, slender and elegant.

Part of the Supplementary Courses' training programme was a month's survey tour in South Devon. We packed ourselves into a little hotel at Torcross, overlooking the Slapton Sands where twenty years later American Divisions rehearsed the landings which they made on the Normandy beaches on D-Day. It was a strenuous month—out all day with plane-table and theodolite, taking with us haversack rations which we supplemented by buying mulberries and cream at the little inn at Chillingdon; and long sessions in the Slapton school house working out "computations"—but we did enjoy ourselves. The war was over, it was summer, and we were young.

The years between 1921 and his retirement from the Army in 1956 saw his steady progress up the Army List. During the Second World War he was in the thick of things in Mideast, emerged with credit from the vicissitudes of the Western Desert, and was brought to England by Eisenhower to join the staff at SHAEF. Here he stayed till the war ended, and here he formed the American connexion which took him to high appointments on the far side of the Atlantic.

Not long before his death he was recalling that month at Torcross in 1921, and commented: "What a care-free lot we were." We wouldn't have believed it at the time but how true it was!—A.C.D.

Brigadier G. B. Gifford-Hull, CBE

BRIGADIER G. B. GIFFORD-HULL, CBE

GORDON BURNETT GIFFORD-HULL, who served with distinction in the Royal Engineers during both World Wars, died on 15 September 1969, in his eighty-fourth year.

The following Obituary Notice of him, which was published in the April 1970 Proceedings of the Institution of Civil Engineers, is reprinted by kind permission of the Council of that Institution.

Gordon Burnett Gifford-Hull, who was born on 29 January 1885, died on 15 September 1969.

Educated at Birmingham Technical School, and privately, he received three years' practical training under J. W. Madeley before joining Stockport Corporation in 1906 as Assistant Waterworks Engineer, under T. Molyneux. Two years later he sailed for Mexico to become Resident Engineer at Monterrey Waterworks.

So began a distinguished career, spent mainly as Resident Engineer in foreign parts and concerned chiefly with dams, in which he took an absorbed interest. In the days before air travel, resident engineers in distant lands needed to be capable, self-confident types ready to take the right decisions on their own responsibility. Cut off from their firms at home for long periods (letters took four or five weeks to reach the Far East) they were visited perhaps once a year by one of the partners. Civil engineering contractors were scarcer then than now. All this added to the authority of the man on the spot—and it was as an outstanding Resident Engineer that Gifford-Hull made his name.

While working in Mexico he was caught up in the Mexican revolution and had many a close shave among the rebels before joining Wheatman Pearson & Son in 1909. Engaged first as Resident Engineer at Portezuelo masonry dam, then on surveys and studies for the development of Rio Branco masonry dam, he finally became Sub-Agent on the construction of Conchos Dam, Mexico—'a cyclopean rubble structure' with power house—cost £1½ million.

Brigadier G B Gifford-Hull CBE

In 1913 Gifford-Hull transferred to Messrs J. G. White and Company on sanitation at Guayaquil, Ecuador, where he shortly became Chief Engineer. Two years later, after investigations, he designed for Sir Douglas Fox and Partners alternative schemes for increased water supplies to Lima, Peru (city and suburbs).

From 1915–19 he served with the Royal Engineers in World War I in France, Salonika and Russia, emerging with the rank of Lieut-Colonel. Immediately after the war he volunteered for the Archangel Force under General Ironside. Travelling by sleigh with a machine gunner through woods infested with Bolsheviks, he built block houses over 1,000 miles of communication, teaching himself Russian meanwhile by his own system of learning ten words a day and a verb on Sundays. Russian peasants he found helpful and hospitable. He was presented with the Medal of St Stanislaus.

Returning to Messrs J. G. White in 1920, he superintended construction on the Guayaquil sanitation contract for the next four years, after which he joined Sir Douglas Fox and Partners and was put in charge of hydroelectric projects totalling over £1 million, including arched and masonry dams in Malaya.

A new phase in his career opened in 1927 on his appointment as Chief Resident Engineer to Messrs Binnie, Deacon and Gourley (now Binnie and Partners) on the big Johore water-supply scheme for Singapore. To this firm he was to give many years of outstanding service in the Far East.

At that time the pipeline crossing the Johore Strait was nearing completion—40 miles of 33, 36 and 39 in. steel—and a start had been made on the Gunong Pulai main dam. But both at Pulai and when filling a reservoir at Pontian two years later, work was held up by an extraordinary series of supernatural happenings, of which Gifford-Hull gives chapter and verse in his memoirs. Also at Pulai malaria broke out among the coolies: one of the earth dams there was 3,000 ft long and built on a swamp. Repeatedly it was from men on the spot that he learned to cope with other local difficulties: a Welsh miner solved a collapsed tunnel problem at Pulai without the use of the compressed air methods which were at first thought necessary, and local stoneworkers demonstrated how to break up large boulders without use of tools. A minor problem was a tiger in a tunnel.

The Johore water scheme was highly successful: it has done its job and given no trouble to anyone since it was built over 40 years ago.

In 1932 Gifford-Hull left Singapore for Hong Kong to take up a new appointment with Messrs Binnie & Partners as Chief Resident Engineer on the construction of the Shing Mun dams in the New Territories, so starting an association with the Hong Kong Public Works Department that still flourishes. These three—all needed to impound the 3,000 mg Jubilee Reservoir—consisted of the main dam (known first as Gorge Dam, later as Jubilee Dam), Pineapple Pass Dam and Lower Gap Dam. On this assignment Hull was given complete authority on expenditure and construction of work—a revolutionary decision which worked so well that the whole project was completed 15 months ahead of time and $1½ million were handed back, unspent. "At least in one case"—in Hull's own words—"a Colonial Government waived its rules to meet a special and unusual need."

When in 1939 the Jubilee Reservoir was completed in Hong Kong, he predicted that in 20 years the Colony would need another just as large: later he had the satisfaction of building the magnificent Tai Lam Chung Reservoir there, opened in 1957.

At the outbreak of World War II Gifford-Hull re-joined the Royal Engineers. As CRE he was in charge of Construction Party No. 1 in Turkey, and he went to Iraq as Chief Engineer (Works), Paiforce. With one of his occasional flashes of genius, he designed and built in Iran a unique bridge (named the Hull Bridge), the centre span of which, instead of lifting, submerges into the confluent Tigris and Euphrates to permit ships to pass up and down stream. Later he acted as Liaison Officer on the construction and assembly of the Mulberry project for the invasion of Europe and also on the first assault bridges over the Rhine. He served with the 21st Army Group in Belgium and Germany as Deputy Civil Engineer (Bridging).

After the war he was engaged by the Ministry of Works as Regional Director, London, to build 90,000 prefabricated houses in the London area. But he soon returned to Binnie & Partners, this time as Chief Resident Engineer on the Kalatuwawa water scheme in Ceylon. The dam for the Tai Lam Chung Reservoir in Hong Kong (already mentioned) was the last he completed.[1]

For the last ten years of his life he was actively engaged in Hong Kong as a private consulting engineer. One of his problems was the construction of tanker berthing and oil off-loading facilities in a swift current off Tsing-Yi Island. He had always wanted to die in harness, and at the time of his sudden death in Hong Kong was still practising as a consulting engineer on a construction project at Un Long in the New Territories.

Gifford-Hull was a personality with an original and inquiring mind. He was an incredibly hard-working man, as demanding on those who worked for him as on himself. Strong-willed, with drive and enthusiasm, he was affectionately known as "the Hullmighty" by his juniors. But to those who knew him best he was an idealist of vision and humanity, devoted above all to water engineering. Golf was his game, and even in his eighties he still had a single-figure handicap.

During World War I he received the OBE (Military Division) and he was made a CBE in 1943. He was a life member of the American Institute of Civil Engineers. In 1907 he was awarded the Miller Prize for his paper on "The Water Supply of Large Towns". He also contributed to the Institution of Civil Engineers "A short description of the 'Hull' Bridge across the River Shatt-el-Arab, at Margil (Basra), Iraq", and delivered a paper on concrete dams to the 1951 World Power Conference.

He was on the Roll of the Institution of Civil Engineers for 56 years. Elected to corporate membership in 1913, he was transferred to the senior grade in 1928.

GDR writes:

I first met Brigadier G. B. Gifford-Hull, CBE (Gordon, to his friends), in Persia in 1941–42, when I was in charge of the Persian Railway, carrying "aid" to Russia. Our contacts then, however, were slight. Later, on moving to Baghdad, as DQMG Paiforce (Mov & Tn) I came into frequent touch when he was CRE Basra. Under the Chief Engineer Paiforce Major-General G. B. O. now Sir Brian Taylor, Brigadier Hull had already won for himself an enviable reputation for resourcefulness when there were very few materials available to him.

This can well be illustrated by his ingenuity when asked to build a bridge for me over the Shatt-el-Arab, to enable us to connect up the Persian Railways with the Iraq system. The river was extensively used by steamers running between Basra and Baghdad and no interruption of this traffic could be permitted. The banks of the rivers were composed of sand to an unknown depth, not the best material for the foundations of a railway bridge with heavy top hamper, so Hull decided to lower the deck into the river, instead of trying to raise it into the air, especially as all the steamers using the river, were shallow draft. The lowering apparatus was four winches which he scrounged from somewhere, worked by hand labour. This was a popular job because frequently, on raising the deck again, fish were caught. On one occasion, as well as fish, a surprise cargo of a pair of 50 ton slings came up, which must have dropped off the deck of a steamer when passing over the bridge. The bridge was subsequently named "The Hull Bridge" and I believe still operates.

I next met Gordon Hull and his wife Doff after the war, as their guest at Claygate, Surrey but before he retired from the Corps he had served on the Mulberry Harbours for the invasion of France, and later on the Rhine Bridges (where he severely damaged his back in a fall, but refused to go off duty).

The Hulls were remarkable people, both very talented and musical. They used to play and sing duets on two grand pianos, in their hospitable house, where I was frequently a happy guest. Incidentally, Hull had earlier designed a cheap home bomb

[1]An early ambition of his had been to build 20 dams; in fact he completed 21—in South Africa, Wales, Malaya, Ceylon and Hong Kong.

shelter, of bent tubes, which on occasion proved its worth at a time when the Anderson shelters were the vogue.

Gordon, of course, shed his uniform immediately after the war, and spent most of his time designing and building dams for water supplies in Ceylon and finally in Hong Kong, where he achieved a fine reputation for getting work doen below the estimate (an unusual feat at that time, or any time, for that matter). He died, as he wished, in harness as a Consulting Engineer in September 1969.

Gordon was always in great demand as an entertainer at the piano. He was also a magician with mathematics and the use of numbers, as well as a great linguist. He used to claim he could learn a basic language in seven weeks.

The Hulls were wonderful hosts to their friends, of whom I was privileged to count myself one. They lost their eldest son through drowning during the war, but his widow, one son and two daughters survive him. The Corps can be very proud of the gallant services this brilliant engineer gave to it during the war for which he received the CBE. I am happy too to pay my tribute to a fine gentleman and wonderful friend.

G.D.R.

G.B.O.T. writes:

I first met Gifford-Hull in the winter of 1915–16 in Salonika where he was acting SO RE to Chief Engineer XII Corps and I was commanding 143 Army Troops Coy RE then attached to XII Corps. He designed a very ingenious 60-ft span bridge to take loaded 3-ton lorries made entirely of 2 in. water-piping which my Company erected over one of the many ravines outside Salonika. He used to visit my camp frequently partly to unburden himself over his relations with an extremely "difficult" Chief Engineer and we formed what became a life-long friendship.

Our ways soon parted, but I kept in touch with him and after my return home in 1922 I used to meet him and more than once visited works which he was carrying out near London.

When I was appointed E-in-C Paiforce in 1942 I at once asked for Gifford-Hull as one of my Chief Engineers and on his arrival in Iraq made him CE South Iraq with Headquarters at Basrah.

Amongst the many important works for which he was responsible, apart from the railway bridge over the river at Basrah, I would single out the following:

The expansion of the port of Basrah by building two new deep water berths and the rebuilding and strengthening of two existing berths.

The provision of lighter basins including one at Abadan near the mouth of the river.

The building of a complete new port at Um Qasr on the Iraq-Kuwait borders. Construction here presented many difficulties as land communications were non-existent and the nearest inhabited locality was over 40 miles away. Camps had to be built, rail and road access provided and a water supply laid on by 8-in. pipe-line from Basrah 60 miles away. This new port provided three 500-ft deep water berths. In spite of all difficulties the work was completed in five months.

In addition to all this major construction work and the manifold minor services required in a large military base, Gifford-Hull found time to design a most ingenious form of arched span made of gypsum and sand for the construction of hospital wards in the base at Shaiba.

The more I consider the work done by Gifford-Hull during my tenure of the appointment of E-in-C Paiforce the more amazed I am that any one man could have achieved so much and with so few resources.

There is no doubt in my mind that he was a brilliant engineer with a wonderful capacity for improvization and a genius for organization.

It was an education for one to go down to Basrah on a visit of inspection and go round his various jobs with Gifford-Hull.

The Corps can indeed be proud of his services.

G.B.O.T.

COLONEL A. R. A. IREMONGER

ARTHUR REGINALD ASSHETON IREMONGER, known to his friends as George died on 28 February 1970 in his eighty-sixth year. He was the son of the Vicar of Goodworth-Clatford in Hampshire where the Iremonger family had lived for many generations.

He was commissioned into the Royal Engineers in January 1904 sixth in his Batch having won the Prize for Science at Woolwich. After completing his Young Officer training at Chatham he was posted to the 43rd (Fortress) Company RE stationed at Mauritius. He stayed there for three years and, on returning to the home establishment, he joined the 4th (Fortress) Company RE at Fort Monckton where he carried out the duties of District Officer (Garrison Engineer) at Gosport in addition to his Company duties.

In 1913 he was posted to the 27th (Fortress) Company RE at Bermuda, and shortly after the outbreak of war he returned to the United Kingdom and joined the British Expeditionary Force. He commanded in succession the 102nd, 75th and 81st (Field) Companies. In November 1916 he was posted home, being medically unfit, and became a Company Commander at the Royal Military College, Sandhurst. He returned to the Rhine Army in December 1918, and in April of the following year he was selected to attend the Staff College. On graduating from Camberley he was posted once again to Bermuda and, on completing his tour of duty there, he became Staff Officer to the Chief Engineer Scottish Command. From 1923 to 1933 he held a series of Works Appointments at Exeter, Bulford, Tidworth, Jamaica, Lark Hill and finally CRE Salisbury Plain (West). He was promoted Colonel on 1 September 1933 and placed on the half-pay list. He was later re-employed as Chief Technical Examiner of Works first at Rawalpindi and then at Murree.

He retired on 6 October 1936 and went to live at Berengrove House, Rainham. He was recalled for service after the start of the 1939–45 War and was given command of an Army Technical School housed in huts which now form part of Gordon Barracks, Gillingham. He retired from military service once again when the School was disbanded and the Barracks used for another purpose.

Colonel Iremonger became a well-known Gillingham personality. He was intensely interested in the Boy Scout Movement, the local Scouts used to camp on his land at Berengrove when he first went to live there. He became President of the 20th Medway Group and Medway East District, and he was largely instrumental in the provision of the St George's Scout Hall in Berengrave Lane.

He became Vice-President of the Rainham Cricket Club and his first wife was Chairman of the Ladies' Cricket Club, and also a Vice-President of the Rainham Club—the only woman Vice-President the Club ever had. The cricket field near Berengrove House used to belong to the Colonel, but during the war part of the land had to be sold and the House was used as a Nursing Home, the Colonel and his wife moving to a bungalow which he had built close to it.

On leaving the Army for the second time he worked in the orchards and land surrounding the bungalow. He won many awards for his fruit and vegetable produce at the Rainham Horticultural Society Shows and he eventually became a Vice-President of the Society. He was the Vicar's Warden and a Member of the Parochial Church Council, and for many years he served on the Council of the Friends of Rochester Cathedral.

His wife whom he married in 1910 became a very sick woman and died in 1959. They had two children—James Lascelles, a Major in the Lincolnshire Regiment, and Molly Delicia who has made her home in South Africa. After his wife's death Colonel Iremonger left Rainham. He married again and was by this time going blind. He and his wife lived in a Folkestone Hotel where his wife was fully involved in nursing him as his sight failed and his health deteriorated. For the last few years of his life he was completely blind, but he bore his afflictions with great gallantry.

In spite of his many other activities Colonel Iremonger never lost interest in his

Colonel A. R. A. Iremonger

Corps. He was a great supporter of the Royal Engineers Association and some years ago, when far from well and practically blind, he took a taxi from Folkestone to attend a Veteran's Service at the Garrison Church, Brompton when an RSME Staff Captain looked after him. He had been a contributor to the *RE Journal* and was one of the very few authors who had one of his verses published. His wife used to read the *Journal* from cover to cover to him after he could no longer see, and she also lovingly read to him books from the Corps Library which he continued to borrow up to the time of his death.

Our deepest sympathies are extended to his widow and to his son and daughter.

Colonel A R A Iremonger

Book Reviews

HISTORY OF THE BRITISH ARMY

Edited by BRIGADIER PETER YOUNG and LIEUT-COLONEL J. P. LAWFORD

Published by Arthur Barker Ltd., 5 Winsley Street, London W1

Price (in UK only) 63s net.

Most people who have had the privilege of serving any considerable time in the British Army will remember occasions when they read the news they had themselves helped to make the day before. Seldom will they have been satisfied. Perhaps it seemed inaccurate; perhaps it seemed to put the wrong things in heavy type; perhaps it left out what the reader thought important; or perhaps it seemed downright false. There are many possible explanations of this state of affairs, but the most likely is that no reporter can see everything, no report can include all that is written for lack of space and the best the editor can do is to show good judgement in what he prints and what he omits.

The same applies—much accentuated—to the writing of history. And if you attempt the story of the British Army from A to Z, as the Editors of *History of the British Army* have attempted, you lay yourself open to many attacks from British Army readers. The fact is that you must keep the length to reasonable proportions and you must prevent the story from being far too indigestible. This book suffers neither of these defects. Indeed the Editors have taken the greatest pains to spare the reader indigestion in any form. The print is large; there is a picture on nearly every page; some pages have two pictures and some pictures have two pages. There are plenty of coloured pictures, some of them reproductions of paintings done before it was realized by artists, unaided by the camera, that horses never deploy their legs in the manner portrayed.

Your reviewer is tempted to liken this sort of lay-out to the lineal descendants of the old nursery picture book. If only Nanny can be talked into reading the captions aloud, it may be possible to defer bedtime for ever; it may be possible to hear the happy ending; and it may even be possible to pass through life without the torture of learning to read. Here we have history written in contemporary style—almost Pop History—recalling the habits of mind cultivated by the packaging industry. You must have pretty colours; there must be no suggestion of the slightest effort on the part of the buyer; and no time wasted. There must be instant revelation like an instant beverage. Your reviewer may be eccentric, but he is put off by this format. A book that is 11¼ inches by 9¾ inches, and weighs as much as this one, may look decorative on a casual table in an open-planned sitting-room at an exhibition of modern interior decoration, but it will only fit a conventional bookcase when "on the flat"; and if you try to read it in a chair you need both hands to hold it. Unhappily all this is forced upon the modern writer by the economics of modern publishing. A commendable piece of scholarship must go about in the dress of a strip cartoon.

The credit for founding the Regular British Army is usually attributed to Charles II and dated 1660. Peter Young opens the batting with an informative and lively chapter on *Origins and 1660–97*. The following chapters continue the story; and each covers an appropriate period or part of it. Thus one chapter covers *The War of the Spanish Succession 1702–12*, two cover the wars against France between 1792 and the Battle of Waterloo. It must have been very difficult to parcel out the space available, and your reviewer wholeheartedly approves the balanced way in which it has been done. There must have been a great temptation to give a disproportionate amount of space to the wars of this century, which have provided such a prolific literature, while denying space to former times that we know less about. The work is all the better for this rigorous discipline.

There are some, so to speak, specialist chapters; where your reviewer (perhaps from *ésprit de corps*) gives pride of place to the one contributed by the Secretary of the RE Institution on *The Development of the Royal Engineers*. Other chapters of this nature include one on the *Royal Artillery* and another on *The Technique of Sieges and Fortification*. The period between 1919 and 1939 is dealt with by Liddell Hart, and not unnaturally is largely concerned with the tardy recognition of the scope of armour by the "Top Brass" of the British Army, after having invented most of the techniques themselves. Your reviewer lived through this epoch and can remember, as a junior officer, joining in discussions on the subject. At the time, in India, finance offered two options: to begin at the rear and replace mule trains by motor lorries, or begin at the front and replace horsed cavalry with tanks. While the delights of polo on military chargers must have influenced all but the most clinically cold thinkers, even today, when one knows what happened, one can clearly see that the "Top Brass" did have something comparable to the problem of today with nuclear *versus* conventional forces.

Throughout the book the chapters are good and it is invidious to pick and choose; so perhaps the reader of these notes will be content with some words, quoted in the *Postscript*—and attributed to the founder of the Guides Cavalry, which ring as true today as they did in those far away days when they were uttered; . . . "to be alert and ready; to rise equal to the occasion, be the case small or great; to be not easily taken aback in a sudden emergency; to be a genial comrade . . ." As Peter Young remarks: "not a bad sort of CO to be with under fire".

One last word. The authors have all avoided a common habit of military writers by steering clear of the Principles of War. They may be eternal truths, but they would be out of place in a book like this, which sets out to tell what happened without feeling called upon to criticize the strategy or tactics. The book is like a tapestry; and through it runs a common thread. That thread is the constant nature of the British fighting man. He seems to have changed remarkably little in the last three centuries. We see his endurance; his fortitude when things are going wrong; his humour always; and his kindly tolerance of the shortcomings of his leaders, when he is sure they are trying their best. God bless the British fighting man! A blessing on him, for all that he has done! And may he long remain as we see him in this *History of the British Army*! M.C.A.H.

SINGAPORE—TOO LITTLE AND TOO LATE

IVAN SIMSON formerly Chief Engineer Malaya Command

(Published by Leo Cooper Ltd, 47 Museum Street, London, WC1. Price 50*s* net)

Brigadier Simson was sent out to become Chief Engineer Malaya Command in 1941 with verbal instructions before he left from the Director of Fortifications and Works to "install the most modern types of defences throughout Malaya, including Singapore Island, and to bring all existing defences up to date—specifically against possible beach landings and against tank and air attack". From his previous service he was particularly well equipped to carry out such a mission. Unhappily at that time the post of Engineer-in-Chief at the War Office had not been established and the Sappers had no direct access at high level to the General Staff. The DFW, who was then the senior engineer adviser at the War Office, only had direct access to the Quarter Master General, and "Fortifications" were inclined to be spelt with rather a small "f". Inexplicably no directive was issued on the General Staff net to Malaya Command setting out the tasks Brigadier Simson was to undertake and, in spite of his numerous requests, no such directive was ever issued. It was held locally in high places that the building of defences might produce a Maginot Line complex and be bad for morale, and no effective defences were constructed until the actual Japanese invasion when inevitably too little was done too late.

It is perhaps interesting to conjecture what Brigadier Simson could have achieved had he been given the support and the free hand afforded by Wellington to his Chief Engineer, Fletcher, when he ordered him to build defences to hold the Lisbon peninsula some 130 hundred years earlier. Fletcher was given twelve months to construct his Lines of Torres Vedras. Had he been allowed to proceed at once, Simson would have had less than half that time to build his defences in a much larger area of country. Fletcher's and Simson's problems were similar: to defend a peninsula leading to a Naval Base. The terrain in each case was, however, quite different. Fletcher was able to site his mutually-supporting redoubts in great depth on dominant features of the hilly Lisbon isthmus: Simson would have had to contend with an afforested and jungle country. French troops had invaded Portugal and the outraged Portuguese people raised no objection to Fletcher's scorched earth policy and the ruthless clearance of trees, vineyards and the scarping of hills to give good fields of fire, the demolition of bridges, the blocking of roads and tracks and the damming of streams to produce inundations. The situation in Malaya in June 1941 was completely dissimilar. The country was not then at war with Japan and many influential people lived in a fool's paradise believing that war would never come to them, particularly not by the back door even though, after the fall of France in 1940, the Japanese had moved into French Indo-China. The local Chinese and Malay landowners would not have relished the despoliation of their land by anti-tank ditches, minefields and other land and anti-aircraft defences. The country was producing three vital war materials, namely oil, rubber and tin, and nothing could be done that would interrupt the steady supply of these strategic commodities. The redoubts of Torres Vedras were manned by British and Portuguese Gunners with close support garrisons of Portuguese Militia, thus leaving Wellington's field army available for manoeuvre and counter-attack. In June 1941 there were insufficient troops in Malaya adequately to man any defences which might have been built and at the same time leave an effective striking force in reserve. The Lines of Torres Vedras could not be turned, to the West the Royal Navy dominated the Atlantic coast and to the East naval gunboats patrolled the Tagus unopposed. Supplies could be brought into Lisbon by sea without let or hindrance. In Fletcher's day there was no menace from the air. Faced by Massina's numerically stronger Army, Wellington withdrew his forces into the Lines in October 1810. Following him up Messina was abruptly checked and he saw that an attack against such defences was hopeless. All he could do was to watch and wait. However, whilst Wellington's Army was safe, comfortably accommodated and well-supplied by sea, the French troops had to endure the cold, rain and mud of the winter and try to live off a country, stripped bare of supplies, where foraging parties ran the risk of being cut to pieces by guerrillas if they strayed too far afield. Half-starved and disconsolate their discipline rapidly deteriorated. Massina was thus forced to withdraw and Wellington pursued him and relentlessly drove him out of Portugal with heavy loss.

The strategic consequences of the Lines of Torres Vedras were enormous. They not only decided the issue of the campaign in Portugal but they also proved to be a vital turning point in the Peninsular War.

The story was different in Malaya during the winter of 1941–42. It had all the elements of a Greek Tragedy. The surprise carrier-borne attack on Pearl Harbour on 7 December 1941 gave the Japanese temporary command of the Pacific. That night Singapore was bombed and two Japanese Divisions landed on the North East shore of the Malayan Peninsula and another crossed the border by land from Bankgok. HMS *Prince of Wales* and *Repulse* were sent from Singapore to intercept the invading forces and were sunk by bombs and torpedoes on 10 December. Japanese aircraft rapidly won the war in the air. Japanese infantry and tanks stormed through the Peninsula, driving the British, Australian and Indian troops before them. 18 East Anglian Division, just landed at Singapore, was thrown into the fight. Besieged, with food and ammunition practically finished and with its water supply cut, Singapore was surrendered on 15 February 1941. The short seventy-day campaign was described by Sir Winston Churchill as the worst disaster and largest capitulation in British history.

No official enquiry into the cause of this debacle was ever held.

Brigadier Simson has written his book on his experience as Chief Engineer and Director-General Civil Defence in Malaya from notes made secretly as a prisoner-of-war whilst "his mind was fresh, while facts could be checked with other PW and before ill-treatment and semi-starvation had mentally and physically weakened them all". The story is a sombre one. His book however should be read by all students of war since, as Brigadier Simson so rightly points out: "defeat cries loud for explanation", and not only successes, but failures also, should be studied at our Staff Colleges. As a nation we dislike Learning Lessons.

Many of the vacillations and lapses in co-operation between civil and service departments, so blatant in the story unfolded by Brigadier Simson, were happily not repeated during the post-war confrontations in Malaya. However his book, written without rancour but withholding nothing and setting out the lessons learned in the greatest disaster to British arms that history has to record, is one that should not be discarded nor conveniently forgotten.

J.L.

THERMODYNAMICS PROBLEMS IN SI UNITS

H. J. Smith, MSc(Eng), and J. W. Harris, C Eng

(Deputy Head and Senior Lecturer respectively of the Department of Mechanical and Production Engineering, The Polytechnic, Brighton)

(Published by Macdonald & Co (Publishers) Ltd, 49/50 Poland Street, London W1. Price 30*s* £1·50)

This book is intended to be a revision aid for students reading thermodynamics at Undergraduate and Higher National Diploma and Certificate Course level.

The text consists of ten worked, and twenty unworked questions with answers in each of the eight chapters which individually cover: The Control Volume, The Control Mass, The Second Law, Non-reacting Mixtures, Combustion, Two-phase working Fluids, Gaseous Working Fluids and Heat Transfer. Although the worked examples give the essential steps to problem solutions not all the "arithmetic" is fully presented.

The text is preceded by several pages of symbols, abbreviations and constants and concluded with two appendices (A) Standardised Enthalpies and Absolute Entropies of Gases (B) Bibliography and References.

Would-be readers are invited at the beginning of each chapter to answer, in a few words, about a dozen questions to test their already acquired knowledge of the chapter subject—

with the advice that if the answers are not known the would-be reader ought to do more study before he tackles the twenty unworked examples. Many practising engineers without thermodynamic specialization will find it difficult to find the short answers invited. F.T.S.

ENGINEERING MATERIALS FOR MET Part 2

L. C. MOTT, Farnborough Technical College

(Published by Oxford University Press, Ely House, London, W1. Price £1·25)

Part I of this book, which was reviewed in the *RE Journal*, December 1968, was published to help *Mechanical Engineering Technicians* during their first two years of the *City and Guilds of London Course 293* and students of the *General Engineering Course 287*, it covered methods of manufacture, properties, testing and subsequent processing of the most common mechanical engineering materials in present day use.

This volume, Part 2, has been written specifically within the *City and Guilds of London Syllabus for Mechanical Engineering Technicians in their third and fourth years of Course 293* Whilst the text does not get too involved with the details of metallurgical and chemical theory, it does deal with the basic structures of materials and the chapters cover: Structure of Metals, Examination of Metallic Structures, Phase Diagrams—Molten metals, Structure of Iron and Steel, Heat Treatment of Steels, Properties and Testing of Materials, Properties and Uses of Cast Iron, Production and Properties of Steel, Nickel and its Alloys, Aluminium and its Alloys, Titanium and Titanium Alloys, Plastics, Bearings and Sintered Materials, and other Non-Ferrous Alloys.

The compactness of this soft-covered, 185 paged volume, with its supplementary tables, diagrams, and references to appropriate British Standards for En Steels and many alloys, makes it a useful "in the field" aide memoire for non-specialist engineers as well as an excellent primer for MET students. F.T.S.

Technical Notes

CIVIL ENGINEERING

Civil Engineering and Public Works Review, July 1970

WESTERN AVENUE EXTENSION LANDSCAPING by Mary E. Thaxton MCD, BArch, ARIBA, AMPTI and R. W. Gray ARIBA, AMPTI. The opening of the Western Avenue Extension gives London the longest section of elevated motorway in Europe. How to integrate this structure with its immediate environs has been the subject of much planning effort, and the authors describe the general approach to the problem, drawing attention to the varied Local Borough interests which have influenced the proposals. They outline typical ideas which can be implemented within the existing legislation, and point out the three unusual problems faced by the planners and landscape architects in this particular project: the transition in scale from street to motorway, the link between the motorway-scape and the pedestrian landscape and the maintenance of a planted area below the structure where no rainfall occurs. This interesting article is excellently illustrated by photographs.

GAS PIPELINE CROSSINGS—BRIDGE OR TUNNEL? by Brigadier C. C. Parkman CBE, C Eng, FICE, FIMechE, FIStructE. Although this article refers to gas pipeline crossings, much of the information packed into it is relevant to other waterway crossings for pipelines, services and pedestrians. The specific case studied is a 325 ft span crossing of the Manchester Ship Canal and the tunnel and bridge alternatives were considered and costed in detail. Although the estimate for the tunnel was £135,000, with a possible additional £40,000 if compressed air working was necessary, against £80,000 for a suspension bridge; the former was in fact selected. The requirements of gas boards favour tunnels which eliminate the problems of the appearance of the structure, and do not interfere with waterway traffic during construction. The details of this case are well worth reading.

STRUCTURAL STEELWORK IN DOVER TERMINAL EXTENSION by L. Langford, B Eng, C Eng, FICE, FIStructE and G. E. Dickinson BSc(Eng), C Eng, MICE, MIStructE. Dover's Car ferry terminal extension which was opened in May this year was designed and constructed against time. The work which was on a restricted site had to be completed before the 1970 Summer holiday rush .The use of a structural steel framework with pre-cast concrete decking was therefore dictated by the circumstances and the article deals in some detail with the design of the structural steelwork and the foundations of the various buildings.

ENGINEERING MODELS AND APPARATUS—Exhibits in the annual Conversazione held at the Institution of Civil Engineers on 24 June 1970. A block of 18 pages is devoted to the exhibits in this annual conversazione, with a short section devoted to each. There is much to interest every professional engineer, but perhaps of the 19 exhibits No 17 on Modern control of blasting in Civil Engineering shown by J. H. A. Crockett, BSc, DIC, C Eng, MICE, and D. B. O'Neill, BSc, C Eng, MICE, and No 11 on Ultrasonic testing shown by R. H. Elvery, BSc (Eng), C Eng, FICE are of the most direct interest to serving Royal Engineers. Undoubtedly both topics will be the subject of much research in the next few years. N.H.T.

Civil Engineering and Public Works Review, August 1970

PERFORMANCE OF SPACERS IN REINFORCED CONCRETE. The relative merits of different types of plastic and mortar spacers have recently been examined in tests conducted by the Research Committee for the Cast stone and Cast Concrete Products Industry at Wexham Springs, and the Building Research Station at Garston. This article describes briefly the tests made and the conclusions drawn from them. The scope of the tests covered such aspects as the effect of loading on spacers, the effect of the presence of spacers on the corrosion of steel and reduction of fire resistance produced by the inclusion of spacers. In general, it was found that well designed plastic spacers were as good as, and in many respects superior to, mortar spacers. However, it was found that plastic spacers tended to cause transverse cracking in thin sections more readily than did concrete ring spacers. Also that the loading of plastic spacers should be carefully examined to avoid spacings so close that cracking in line with the steel is induced.

JOINTS AND SEALANTS. A group of six articles under this heading are included in this edition. Two of these are described below.

FLEXIBLE SEALS FOR MOVEMENT JOINTS IN CONCRETE STRUCTURES. A good general description of sealing materials and systems. The advantages and disadvantages of the three categories of seals—gaskets, elastomers and mastics—are discussed briefly. The types of seal suggested for movement joints in various structures are conveniently summarized in table form.

UNREINFORCED CONCRETE CONSTRUCTION ON RAGLAN–USK TRUNK ROAD. The Raglan–Usk section of the Monmouth–Newport trunk road scheme is believed to be the first contract on which the recommendations of the MOT Technical MemorandumH5/69 have been adopted. The pavement is of unreinforced construction with joints at 20 ft intervals. Of particular interest is the jointing system chosen by the contractor.

Crack-inducing timber fillets are first laid on the sub-base at 20-ft intervals and a 7-in course of concrete placed. The dowel bars, which are painted with a bond-breaking compound over half their length, are then positioned at the joints and vibrated into the still plastic concrete by a dowel-bar placer which sets them at a pre-determined depth. A 2-in thick wearing surface of air-entrained concrete is then placed and transverse joints cut. A temporary plastic strip is then placed in the joint. The permanent neoprene compression sealing strip is inserted after the plastic strip is removed from the hardened concrete.

M.J.F.S.

Civil Engineering and Public Works Review, September 1970

PENTROMETER TESTING The article by H. Erwig, Soils Engineer of a firm of Consulting Geotechnical Engineers and Surveyors in Holland, describes both the traditional method of use of the Dutch cone penetrometer and the new electrical resistance method. The latter has been developed by his firm and used successfully for several years.

In the traditional method end bearing and friction are tested by a cone and a friction sleeve respectively. The loads are measured with a hydraulic load cell connected to a Bourdon gauge. In the electrical method, the loads are measured by strain gauge load cells.

The electrical method gives a continuous and detailed record of changes in soil resistance, immediate interpretation is possible and absence of internal friction avoids incorrect results. Additionally it is possible to fit the equipment with a porous ring connected to an electric pressure meter so that pore water pressures can be measured.

Of a completely different order of accuracy (not to say purpose) from the military cone penetrometer, this equipment has a normal maximum penetration of 23–35 m and is mounted inside the body of a truck.

INTERCHANGES IN URBAN AREAS. In this country we are now well used to rural motorways and their intersections. Urban motorways intersection need to be tailored to specific conditions at each site. H. K. Lam, the author, discusses three alternative split level designs based on a flat site so that the intersections will be suitable for a design speed of 50 kph.

W.C.C.

THE MILITARY ENGINEER

JULY–AUGUST 1970

An article on coast protection describes the novel method used to prevent silting up of the channel at Ponce de Leon Inlet. The technique involved the construction of an adjustable weir which allowed the litoral drift to flow into an impounding basin. At intervals the impounded sand was pumped over a second jetty to a beach. Thus the channel was kept clear and a new beach formed which added to the local amenities.

The item on "Designing and Constructing for Safeguard" which deals with the protective works for a complicated installation was disappointing as no details were given, probably for reasons of security, of methods used to counteract nuclear shock.

Two current methods used by American Engineers for getting fuel ashore are described. One is based on a 6-in flexible pipeline floating 5 ft below the surface. This system will pass 380 gpm of diesel or 590 gpm of AVGAS at 15 psi delivery. A 5,000-ft length can be installed by 18 men in 6 hrs. The other system is a 6-in bottom laid one, which is slower to erect but is more robust. 5000 ft of this can be laid by 41 men in 16 hrs, though it is not clear whether the time required for beach preparation and tanker connexions is included.

Notes on the "bombing in", by helicopter, of anchorages for a floating bridge where the bank seats were very soft, is interesting. The problem of getting a culvert through an embankment without digging up the road was solved by pushing through 2 lengths of 12-in steel pipe by means of a dozer. This technique is well worth noting in case a similar problem arises.

P.W.H.

Forthcoming Events

8 December	Varsity Rugby Match	Twickenham
4 March	46 YO Batch Night	RE HQ Mess
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 1970–71

RE RUGBY FOOTBALL CLUB

13 January	RE *v.* RA	Chatham
3 February	RE *v.* LX Club	Cambridge
10 February	RE *v.* REME	Arborfield
13 February	Army *v.* RAF	Twickenham
2 March	RE *v.* RAMC	Chatham
6 March	Army *v.* Navy	Twickenham
31 March	RE *v.* RMA	Chatham
7 April	Inter Corps VII	Deepcut
17 April	Combined Services *v.* French Armed Forces	France

RE HOCKEY CLUB

12 December	RE *v.* Hampstead	Gillingham
19 December	RE *v.* HAC	London
9 January	RE *v.* Met Police	Gillingham
20 January	RE *v.* US Portsmouth	Portsmouth
23 January	RE *v.* Surbiton	Gillingham
30 January	RE *v.* Polytechnic	London
1 February	RE *v.* Cambridge University	Gillingham
3 February	RE *v.* London University	Gillingham
13 February	RE *v.* Blackheath	Gillingham
14 February	RE *v.* Cheam	Gillingham
20 February	RE *v.* Cliftonville	Ramsgate
21 February	RE *v.* Maidenhead	Longmoor
4 March	RE *v.* Royal Artillery	Woolwich
7 March	RE *v.* Villagers	Gillingham
14 March	RE *v.* Chimps	Gillingham
17 March	RE *v.* United Hospitals	Gillingham

RE SQUASH RACKETS

14 January	RE *v.* RAEC	Aldershot
19 January	RE *v.* RMA Sandhurst	Aldershot
27 January	RE *v.* REME	Aldershot
3 February	RE *v.* RCT	Aldershot
22 February	RE *v.* Old Bradfieldians	London
4 March	RE *v.* RA (Bulnois Trophy)	Aldershot

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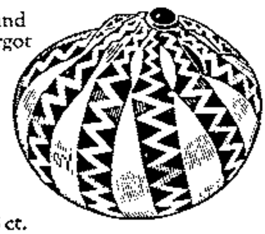

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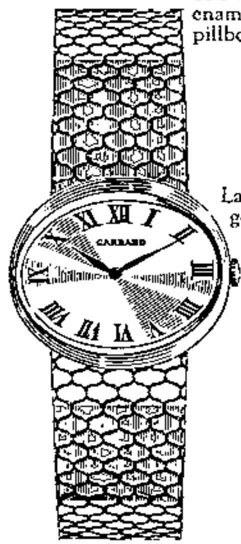

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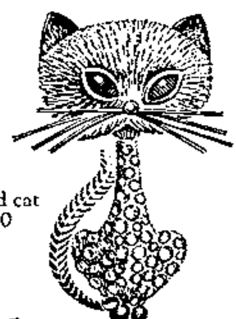

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