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Editorial

It all depends on which way you look at it!

One reads that in 25 per cent of all road accidents one or other of the parties involved has been drinking—in other words—in 75 per cent of all road accidents the parties involved were sober!

There are many references to the generation gap, the substance of which is that the old do not understand the young—it could equally be argued that the young do not understand the old!

This all started when a relatively senior officer said that the generation gap was beginning to close. He based this observation on the premise that the main cause of the gap was the conviction held by the old that the young were irresponsible, lived from day to day and had little if any concern for the future. It had nothing to do with length of hair or height of platform heels on shoes for men. He had been responsible for a YO Course the previous week and had found that the YOs were very conscious of their future and were concerned about it.

YOs thinking of the future! Is this something new!!

Not so many years ago the long term future planning of the YO was directed towards next month's Mess Bill or next weekend. The next 24 hours were always the most important consideration.

Do the younger Members of the Institution think about the future or only about their future? Indeed is it a good thing that they should do either? The two futures are, of necessity, inter-dependent but which is the dog and which the tail?

In this issue of the *Journal* several contributors pose questions relating to the future. We fail as Military Engineers if we do not join them and consider the probabilities and possibilities of things to come. Engineers, regardless of professional discipline, have been described as men of insatiable natural curiosity, indeed the family of a well known sapper used to dine out on stories of his stopping the family car to walk back and look into any excavation he had spotted.

The future of undersea engineering is assured. Already the bulk of this country's gas comes from the North Sea and oil should begin to flow in about two years time. The several £m loss suffered by a leading oil company on one proving well is not going to reduce the necessity for the exploitation of the natural resources of the sea bed. The profitable installations, which may well combine undersea and surface construction, are vulnerable to attack by man. It is logical to suppose that counter-measures will be required and developed. This is the classic military situation in which the Military Engineer cannot avoid being involved. Natural resistance to new ideas must never be part of the engineers' make-up.

Major-General Sir Eustace Tickell, who died in December, was a man of unusual intellectual powers who welcomed new ideas and was always concerned with the future. His intellectual confidence allied to great determination and moral courage are referred to in the tribute paid to him in this issue.

Evolution—Some Reflections on Corps History

MAJOR-GENERAL T H F FOULKES CB OBE MA CEng FICE
COLONEL COMMANDANT (RETIRED)

This article follows the lines of a lecture given by the Author at the RSME on 16 January 1973.

To have known the Corps for sixty years, to remember it on parade in scarlet, and to have been responsible for its efficiency and well-being for three years may give one some small claim to generalize, but not to hold forth upon its immediate problems. Those are the business of the Engineer-in-Chief, and the best that anyone else can do is to support him.

In 1913, at the age of five, the writer was taken, as a treat, by launch from Chatham to Sheerness with an RE cricket team. Only one member of that eleven survived the year 1914. Since then, greater changes have taken place than any previous generation of ours has known. The map of the world, flattered by Mercator's Projection and then half-red, has changed out of all recognition, and with it the detailed responsibilities of the Corps. But, in the course of history, Britain's relative power and influence in the world have seen many dramatic ups and downs. Even the Super-Power of sixteenth century, Spain, collapsed in a couple of generations. It is seldom given to anyone to see the shape of coming events; and nothing today is too surprising to be possible next week.

To be interested in history, and particularly in the history of the Corps of Royal Engineers, needs no apology. It is not a matter of hankering after the past. Ours is, above all, a tradition of originality and innovation, as well as of service. The future grows out of the past; history does repeat itself; and there is much to learn from the problems of our predecessors and how they met them.

It is hoped that the reflections which follow may not only stimulate some interest in the achivements and standards of our predecessors but also cast a little light on the basic nature of the Corps, on its significant contribution to the vitality and effectiveness of the Army as a whole, and on its own long-term needs.

One cannot here go far into fascinating details of the past; but military engineering has amounted to a significant part of the sum total of all human endeavour. Consider all those great and mysterious pre-historic earthworks, and all the world's fortresses, castles and fortified towns and cities, beginning perhaps with Jericho, about 6,000 BC. Consider the Great Wall of China, 1,600 miles long, the Acropolis of Athens, Hadrian's comparatively little barrier, the Inca fortifications, the Torres Vedras, the Hindenburg and the Maginot Lines. Think, too, of the immense efforts made to reduce them: Troy by all the Greeks; Syracuse by the Athenians; Jerusalem by Titus; Constantinople, Rhodes and Malta by the Turks; Gibraltar by the Spaniards; and other sieges by the thousand. Then remember the strategic roads, from Ermine Street to the Grand Trunk Road of India, and the Burma–China road. There were 50,000 miles of Imperial Roman road, and a man could go from Carlisle to Rome without having to ford a stream. And so, to military bridges. Xerxes put a pair of boat bridges across the mile-wide Hellespont in 480 BC, not very different in design from Wellington's bridge over the R. Adour, near Bayonne, nearly 2,300 years later. Julius Caesar built a timber trestle bridge across the Rhine in AD 55, about 1,500 feet long and 40 feet wide; and it took him only ten days, including felling the timber. Trajan's timber-truss bridge on masonry piers, built over the Danube at the Iron Gate in AD 104, ranked almost as the Eighth Wonder of the World. The military machine of the Emperor Charlemagne, about AD 800, included ox-drawn bridging trains, and even floatable wagons, waterproofed and protected with hides—ancestors of the amphibious APC. Thousands of permanent bridges, the world over, have been built for strategic necessity, from fortified bridges sited to keep the Viking ships out of Northern France, to the bridge over the River Kwai. For maintenance of sea-power, ports and harbours have been constructed on the grand scale from the times of the Pharaohs and Alexander the Great; Piraeus, Tyre and Sidon, Salamis in Cyprus, Carthage and Ostia, to mention a few of the older ones. Railways are now so commonplace that it is easy to overlook the German strategic railways of the nineteenth century and their decisive influence on victory. How many thousand airfields were built in Hitler's war?

All the great commanders have, by sheer force of necessity, had to be masters of military engineering. That is to say, they have had to understand its potentialities and limitations, and ensure they had the right people and the right resources to get the optimum results. Xerxes must well have understood, when he made his plans, that the bridging of the Hellespont was feasible; and he beheaded the two senior engineers who bungled the beginning of the work, and got better ones. Caesar suggested that he was not fit to command Romans if he could not build a *fixed* bridge across the Rhine. It is supposed that he employed the great architect, Vitruvius; but why should he have been the only Roman who could do it?

It is facile to say, as some do, that every soldier in the armies of the ancients was more or less an engineer. With his very limited education and knowledge he can seldom have been more than an excellent pioneer, expert only in the manual tasks he knew. But, from the very earliest times, there must have been people on the scene who could think things out, supported of course by experienced overseers, craftsmen, pioneers and unskilled labour—especially slaves—to provide the power. Kings and captains needed to know if the undertaking was fesasible and what it entailed; which meant calculation, measurement and knowledge of materials, as well as experience and clear thinking, exactly as it does today. No doubt, most of this science was passed on by word of mouth; and in times of defeat or inactivity the precious knowledge could all too easily be lost. It makes little difference if the engineer wore skins, wode, a toga, a cassock, chain-mail or a red coat. He had to be able to "make a project", or those great things would never have been done at all, let alone done so well. In military operations he would fare better if he had some taste and instinct for soldiering; and if he was himself soldier enough to hold the respect of other soldiers, he could win their essential confidence and co-operation. Such people are our professional ancestors, and we, as Sappers, are the heirs and successors to a very large, ancient, and quite distinct profession; a profession which has two aspects, the calculating and the soldiering. The New and Complete Dictionary of Arts and Sciences, published in 1763, says, under the heading, "Engineer": ". . . besides being ingenious they should be brave in proportion".

One of the important and ancient parts of the duties of the military engineer was, of course, the throwing of heavy projectiles by means of stored mechanical energy in mangons, ballistas and other engines of war. Titus used many of them at Jerusalem in AD 70. The Danes had no less than a thousand when they besieged Paris in AD 886. In 1218, that illustrious soldier, Simon de Montfort Père, was hit on the head by a rock from a mangon sited on the walls of Toulouse, and so "died ingloriously". Long after mechanical energy was replaced by the chemical energy in gunpowder that branch of military engineering, as the reader will be aware, was entrusted to a separate establishment. Major-General Whitworth Porter, author of the first two volumes of our History, published in 1889, records that the Artillery and Engineers were separated by Royal Warrant on 26 May 1716, and observes that "the Artillery rapidly reached a sturdy manhood".

The Institution of Civil Engineers was formed in 1818, largely, as the Institution itself explains, "to distinguish engineering work performed for the public good from that of a purely military nature", and "Engineer" continued for some time to mean "Military Engineer", though few who assume that designation today can be aware that they are associating themselves with mangons, trebuchets and petards.

In this country the science of military engineering evolved rather slowly. The Normans, like the Danes and Franks before them, were effective and adaptable military engineers, but they had to rely for their "paper work" on the only educated section of the public, the—happily belligerent—clergy: Bishop Gundulph for one, with his great White Tower to overawe Saxon London, and Rochester Castle, the key to south-east England. It was much the same with the Plantagenets. We find King Edward I entering Scotland in 1300, with Brother Robert as an active chief engineer, supported by Brother Thomas and other sturdy brethren in the work of siege-craft and the repair of castles. Good monks. By then the science of military architecture in western Europe had greatly advanced as a result of the Crusaders' experience of Byzantine and Saracen fortresses in Syria, such as Antioch. It has been claimed that the reputation of Coeur-de-Lion as a great military engineer could stand firm on his design of one fortress alone, Chateau Gaillard, in northern France. As for clerical belligerence: observe the Abbot of St Germain aiming his ballista from the walls of Paris in AD 886 so cunningly as to skewer several (heathen) Danes on one javelin. Behold the Bishop of Beauvais in 1214 at the battle of Bouvines, clubbing down from his charger no less a warrior than William Longsword, Earl of Salisbury. And cheer for the Bishop of Durham, at the height of the battle of Crécy, galloping at the head of thirty knights to the succour of the Black Prince!

After the Renaissance, our military engineering capacity moved by fits and starts according to the emergencies which arose and the abilities of our commanders; and, though certain interesting, and even brilliant, engineers appear on the stage, we came to depend so much on our "wooden walls" that we lagged behind the continental powers, engaged as they were in major wars. Even so, some of our best engineers were foreigners. Our many raids and overseas expeditions were necessarily light in engineer effort. Things engineering were bound to be well done by so professional a soldier as William of Orange and the specialists he brought with him from Holland; but we soon find Marlborough complaining so bitterly about his engineers in his later operations that it seems strange that even he could not secure a more efficient service.

The Spaniards, at the height of their power, had been pre-eminent in every department of warfare; and, much as Queen Elizabeth, in 1588, might "breathe foul scorn that Parma or Spain should dare invade the borders of my realm", that same Duke of Parma was easily the first captain of his age and well known as a master of military engineering, schooled as he had been among the swamps, waterways and fortifications of the Netherlands. Had the Armada enabled him to move an army across the Channel, his first major objective would have been Rochester, after which it is hard to see what English force could have stopped him and his veterans, armed with the formidable arquebus.

It is hardly surprising, against this background, that the man selected to carry out the technical side of the Gunpowder Plot in 1605 should have been a good soldier and expert sapper, who had distinguished himself in the service of the Spaniards in the Low Countries, a Yorkshireman known to his Spanish friends as as Guido, and to us as Guy.

On the decline of Spain, supremacy in military engineering passed to the France of Louis XIV, where the name of Vauban is best known; and in Napoleon's time the military engineers of the Revolution were still leading the world, Carnot being, probably, the most brilliant of all. His services to the Revolutionary armies earned him the name of "The organizer of victory"; and it was at Napoleon's own request that he wrote his celebrated treatise on Fortification.

In spite of our successes in the Seven Years' War, Annus Mirabilis and all, Wellington had a very inadequate engineer arm fifty years later in the Peninsula. His gallant and able Royal Engineer officers were far too few and not well enough trained, and their difficulties made the scale of casualties among them tragic; all of which must have been very galling to the "Sepoy General" who knew what it was to be well served in his wars in India by excellent Engineer officers and numerous companies of combatant Indian Pioneers. In the Peninsula, on the contrary, though there were a very few, but gallant, Royal Military Artificers, most Engineer work had to be done by infantry working parties or civilian labour. A young infantry officer, describing the defence work at Corunna and the British soldier's historic aversion to digging, says, "the men's shovels moved no faster than the hands of a clock"; that is, until they heard the sound of the French guns.

Though such deficiencies could not be remedied overnight, units of the Royal Sappers and Miners were already taking an important part in the war by 1813, and were active again in Holland and Belgium in 1814 and 1815; the great leap forward being due, as every recruit knows, to Sir Charles Pasley, our first Director at Chatham, who had been complaining that the only way an RE officer could study his profession was by use of the enemy's text books, and had long demanded better training and efficiency. But the reform could hardly have been made without the insistence of the Duke of Wellington, who, as a great commander, fully understood the necessity for efficient military engineering, was himself an authority on the subject and had the power to get something done.

Though Pasley, during his thirty years at Chatham, included Architecture in the syllabus, and the fine buildings of his pupils are still to be seen around the old Empire, it would be a mistake to suppose that he emphasized only the technical side of our profession. In fact, "he constantly impressed on the young officers who were under his charge that the only way to attain success in their profession was to be ever foremost in hazarding life and limb in the performance of their duty", as he himself had been, until disabled by wounds.

So, at last, the country was producing, as a matter of deliberate policy, the complete military engineer, whom the writer has previously attempted to define as: "Not a mere pioneer, nor a poor imitation of an infantryman and apology for some civilian specialist, but a member of a distinct and time-honoured profession. A good soldier, able and ready to make sound military appreciations, earning the respect of the best soldiers, as a military engineer; and, at the same time, a versatile engineer, recognized by the best engineers, again, as a military engineer."

To manufacture this article it has been necessary, since really efficient engineer training began in 1812, to attract to the Corps young men possessing both the character to become good leaders and the mental equipment to work things out; and the following statistics of what might be called the "spin-off" from the military engineering component of the Army suggest that we have had some success in attracting the right people. An estimate made some years ago showed that, in addition to our five Field-Marshals, the Corps had produced no less than sixty full generals and another sixty lieut-generals in addition to a large number of eminent engineers and scientists, much more difficult to classify, but including nearly twenty Fellows of the Royal Society. Major-Generals have been like the sands of the sea. Fifty or sixty Sappers have been governors of overseas territories, two of whom will be mentioned later; while forty-four VC's give some hint of proximity to the forefront of the battle. Since the war, there has been only one year when either one, two, or even three Members of the Army Board or Council have not been Sappers, taking their part in guiding the destinies of the Army. On the outbreak of war in 1939, the Corps had less than 1,200 regular serving officers, of whom 565 were of field rank or above, and those 565 produced eighty general officers during the period of the war, or nearly one in every seven. However, an eminent infantry soldier once observed that even more significant than these figures was the fact that, during the war, scattered about in *key* staff appointments at lower levels, one was only too likely to find a Sapper, "The sort of chap", he said, "who can see right into a problem and out the other side"; not that we have any monopoly in this, however.

The figures are impressive, all the same, especially when one remembers that the usual gateway to higher promotion has always been the command of an infantry brigade or brigade group, and it has seldom been made easy for Sappers to get through that needle's eye, or even stand near enough to be seriously considered. Even the entry of Sappers to the Staff College was, over long periods, severely restricted So, taking one thing with another, the contribution the Corps has made—quite apart from its basic role of engineer support—to the thinking, efficiency and control of the Army has been very real; and in this age of continuing technical advance its value would seem unlikely to diminish. But never let it be forgotten that the standards of the Corps itself have always depended on the high quality of the ordinary run of officers and other ranks, less often mentioned by name, doing their own jobs well; of whom we can justly feel even more proud.

The best way to start dipping into Corps history is to read some of the vivid biographical sketches at the ends of Volumes I, II, and III, beginning perhaps with Brigadier-General Holcroft Blood, son of the notorious Colonel Thomas Blood who tried to steal the Crown Jewels from the Tower of London. General Sir Bindon Blood, the first Chief Royal Engineer, belonged to the same—Irish—family. Holcroft

Blood was a capable, French-trained, engineer, whose portrait shows a most determined visage. His command included the Artillery at the battles of Blenheim and Ramilles, and Marlborough probably missed him sadly when he died, at Brussels, in 1707.

Then there are our five Field-Marshals. First, Sir John Burgoyne, who was commissioned in the Royal Engineers in 1798 and retired a mere *seventy* years later from his post as Inspector-General of Fortifications, having served with distinction in the Mediterranean, the Peninsula and North America, and with full vigour, too, in the Crimea in his mid-seventies. His statue stands near the Duke of York's Column and bears the inscription, from "Coriolanus":—

> "How youngly he began to serve his Country:
> How long continued!"

Field-Marshal Lord Napier of Magdala was one of Pasley's students at Chatham. After fine civil engineering work in the Indian Irrigation Department, he was drawn into the Sikh Wars, several North-West Frontier campaigns, and the Indian Mutiny and connected operations, in which he distinguished himself as a military engineer and as a commander of all arms. In 1866 he became Commander-in-Chief of the Bombay Army, from which position he mounted the Abyssinian expedition of 1868. As our historian says: "It was essentially an engineer campaign, and well it was, for its success that it was commanded by a man who was not only a consummate leader but also a highly trained scientific soldier." In his portrait in the RE HQ Mess he looks benevolent and rather slack. Kind and considerate he certainly was but otherwise the picture is misleading.

Field-Marshal Sir Lintorn Simmons had mighty whiskers and an amazing life. Another of Pasley's students, he spent six years on defence works in Canada, but then switched to railway duties at home, becoming Secretary of the Railway Department under the Board of Trade. Suddenly, by the prettiest of timing, he established himself as Commissioner with the Turkish Army and served as such in many operations against the Russians, including some campaigning in the Crimea. In due course, he became Inspector-General of Fortifications, and, finally, Governor of Malta, but continued to be employed on occasion by the Foreign Office on delicate diplomatic missions. He lived latterly at Hawley House, near Camberley, his funeral service being held at Hawley Church in 1903 by order of His Majesty, King Edward VII.

Our strangest Field-Marshal was Lord Nicholson of Roundhay. His obituary in the *Journal* in 1918 said: "He never commanded even a small unit in peace or war, yet he rose to be a Field-Marshal; he never graduated at the Staff College, yet he rose to be Chief of the Imperial General Staff." He did, nevertheless, see a great deal of active service both as a military engineer and as a staff officer in Afghanistan, Egypt, Burma and South Africa, and was Military Attaché to the Japanese Army during the Russo-Japanese war of 1904. After declining a command in the Mediterranean, he became Quartermaster-General, and thence CIGS. The obituary goes on to explain that he had, among his great qualities, "in a most remarkable degree the gift of clear perception of the ultimate aim". In other words, he could see through a brick wall.

As for Lord Kitchener: he eventually became so great a world figure that it is too easily forgotten that it was his brilliant work on topographical survey in Palestine, as a very young officer, which first brought him to public notice. That he remained at heart a military engineer is shown by his exploitation of railways in the Sudan, on the North-West Frontier of India and in South Africa; and he continued, at the height of his power, to look after the interests of his own Corps.

Among the most intriguing of Corps characters is Lieut-General Sir William Denison. As a captain, in 1846, he was appointed Governor of Van Dieman's Land, and subsequently of New South Wales. From there he went as Governor to Madras, with a brief spell acting as Governor-General of India. On his return to England in 1866, he was appointed CRE Portsmouth, a post which he accepted with great pleasure because he had always regarded himself primarily as a military engineer. In the end, this posting was changed—believe it or not—to Chairman of the Royal Commission for the prevention of the pollution of rivers. Porter observes that "The strangeness of this incident was only to be rivalled by the appointment of the man who had commanded the Ever Victorious Army in China to the far lower position of CRE Gravesend", meaning, of course, Gordon.

It is comforting to know that a Royal Engineer, Arthur Dobbs, was Governor of North Carolina for twelve years, from 1753. There is an old story about the two taciturn Governors of North and South Carolina dining together; and one can only hope it was Arthur who eventually broke the silence with: "It's a long time between drinks."

Who would not warm to Major-General Anthony Emmett?, CRE, St Helena, throughout Napoleon's residence, he had seen amazing service in the Peninsula; and Porter tells us that though he had displayed the most conspicuous gallantry on many occasions, he had so modest and unassuming a bearing that "few who knew him in later life would have guessed what a warrior he had been in his youth". Not the first, nor the last, of his kind.

Our History says much about the tribulations, as well as the triumphs, of Works Services. Lieut-Colonel Andrew Fraser RE, was cashiered in 1792 for "constructing works without proper authority", though no one denied those works were operationally necessary. *The Gentleman's Magazine* at that time wrote: "Too delicate to implicate others in the censure; too high-spirited to bear the appearance of disgrace, he went abroad and died." Poor Fraser. And, while on Works Services, we may notice that the Corps *resumed* full responsibility for it in 1822 and 1917; but then there were not all those married quarters.

We are told that the Great Exhibition of 1851 was intimately linked with the emergence of the Corps from "the depression into which it had fallen in the long peace following the Napoleonic War". The Corps came readily to the rescue of the Prince Consort, President of the Society of Arts, to ensure the success of his ambitious enterprise. Lieut-Colonel W Reid, CRE Woolwich, became Chairman of the Executive Committee and a number of officers and other ranks of the Corps took part. The Prince remained grateful and helpful to the Corps, employing Royal Engineers, such as Lieutenant J Cowell, RE and Major H Elphinstone VC RE, as Governors to Royal Princes, and giving officers and other ranks various other appointments in the royal household. Sapper Livingston, for instance, became Inventory Clerk, and Sergeant-Major Wilson was placed over the royal laundry. The Prince continued to be very well served by the many Sappers to whom he gave opportunities in the scientific world, including the brilliantly inventive Captain Francis Fowke.

Such recognition of the value of the Corps, coupled with British military resurgence after the Franco-Prussian War of 1870, led to a position of pre-eminence in a relatively amateur Army; and, by the end of the Boer War, the Corps had reached a peak of expansion. Up to 1897 we were allotted, as by right, ten general officers' appointments excluding officers promoted for distinguished service in the field. In 1902, the Corps was controlled by General Sir Richard Harrison, as "Inspector-General of Fortifications and Inspector of RE Units". General Harrison was a Member of the Army Board and Adviser to both the Secretary of State and the Commander-in-Chief, as well as being an ex-officio Member of the Defence Committee. A couple of years later, by the time the Esher Committee had done its work, there was no Corps appointment left above the rank of colonel—though things did improve later under Lord Haldane.

It would require separate articles to touch even lightly on the stupendous work of the Corps in either World War, or its achievements in Asia or Africa; but it is worth observing, as an indication of how the minds of commanders and staff then worked, that in August, 1914, GHQ in France was supported only by an "Artillery Adviser" and an "Engineer Adviser", each of whom was generously provided with two riding horses and one clerk with a pedal-cycle for mobility. The two Advisers were required to share one motor car, and on the way to France, Lindsay, the Gunner, remarked to Fowke: "I don't suppose you will have much to do in this war."

It is pleasant to see a flight of little aeroplanes in Mesopotamia in 1915 under Major P W L Broke-Smith RE. Forty-seven years later, at a reception for the so-called Jubilee of Military Aviation, in 1962, the writer had the pleasure of introducing the same Brigadier/Group Captain Broke-Smith to Lord Carrington and mentioning that he was qualified in powered aircraft, and airships, and balloons *and* man-lifting kites. (He held the world record of 3,000 feet.) As we withdrew, Broke-Smith said: "You know, you shouldn't have called me the senior pilot present, because there's a chap here in the Air Battalion, RE, who's senior to me"; he may perhaps have been H R P Reynolds.

On the subject of Mechanization, we find our Historian writing in 1951: "Soldiers had to wait for the low-pressure tyre and metallurgical advances that made possible the multi-wheel drive before their ability to leave the roads could justify the scrapping of horse transport"; and it was the long story of ever-decreasing ground pressure linked to ever-increasing cross-country mobility that, in 1960, convinced this writer, at least, that hovercraft had come to stay.

Through much of our nine volumes there is a rather plaintive note. We find Porter saying that, in everything except actual fighting, the British Army in the Crimea was a lamentable failure, owing to "disorganization and incompleteness". He continues: "As it was in the Peninsula, so it was in the Crimea, and in no branch of the service was the evil more fatally apparent than in the Engineers." Then we read that in 1914 we were suffering from the paralyzing effect of lack of preparation by our country for war; that all the lessons of siege warfare from past campaigns had been lost; and that brigade commanders did not understand the employment of engineers in operations. Nor was our state of preparedness, apparently, any better in 1939, when there had been little operational planning and, from the engineer point of view, there was in the War Office at that time no organization for such planning. To quote again: "The planning of bases was greatly prejudiced by the decision not to include in the reconnaissance party sent to France before the declaration of war any representative of the RE Works Services."

For that protracted malaise there have been two main causes, the obvious one being our national aversion to war. Whether our leaders, ever dependent on voters who do not want to know anything about defence till on, or over, the brink of ruin, could or would change that attitude is doubtful. But the other cause is more tractable: namely, the former lack of professionalism in the Army as a whole. One of the marvels of Wellington's victories was that he won them with subordinate commanders who were, in the main, no more than gallant and enthusiastic amateurs; while in the Crimea, our commanders had less experience and there was—unfortunately—no Duke of Wellington. But the Army today is probably far more professional than it has ever been before, far more capable of understanding the whole of its conventional functions, including military engineering, and better equipped to instruct such politicians and statesmen as wish to learn.

So we arrive at the modern military engineer. By very definition he has been professional throughout the ages, and has taken on anything technical or out of the ordinary which has come the Army's way. He has usually shunned specialization, except on the part of a limited number of individuals and has, in the course of time shuffled off large and specialized functions, such as artillery, submarine mining, searchlights, military flying, signals, road mechanical transport, mechanical repair and maintenance, barrack construction and, latterly, railway and water transportation and movement control. But all the rest is his, especially anything unforseen or untried, which will inevitably arise.

One of the perennial concerns of the Corps, expounded by Burgoyne who, in turn, quoted the Duke of Wellington, has been to find suitable technical employment in peace, which it needs not only to prepare it for its likely tasks in war but also to attract to it the sort of officer who has served it so well in the past and whom the Corps and Army will always need. At some periods, the balance has been wrongly struck. Sometimes we have had so much civil employment that officers have become somewhat unmilitary and estranged from the Army as a whole. A quarter of the Corps was at one time employed on submarine mining, and the proportion engaged later in Coast Defence and Searchlights was too large to be healthy. Before the formation of REME we had too much to do in the way of mechanical repair and maintenance; and in the fifties our Works commitment at home and overseas was disproportionate to our small share of the Army's manpower.

This wide-ranging dissertation has attempted to show that the military engineer is fundamentally the same professional as he has always been, under whatever guise or Warrant; that he has an individual as well as a corporate value to the Army; that reading our history can be useful as well as entertaining; that no commander is likely to deserve great distinction unless he includes military engineering in his armoury; and that modern military professionalism promises well for the effective handling of the Corps.

No mention has been made of the changing nature of armed conflict; but the world, as ever, remains near the boil; and until Morality puts an end to violence or Science renders soldiers, sailors and airmen obsolete, there will be work for military engineers, of the same fundamental character as ever, only intensified and with tremendous emphasis on the unforseen. It would be very rash to say to any young Royal Engineer: "I don't suppose *you* will have much to do."

There is no doubt that practical military engineering, with the disciplines and responsibilities it entails, does much to develop a man's latent abilities; while the special traditions, standards and attitudes of the Corps, amounting to a certain mystique, soon stamp themselves on everyone who serves in it. So it is as well for all of us, whether we stand on the rank of Sapper or follow the path of young Lieutenant Kitchener, to give some thought, occasionally, to what the Corps has done for us and what we may, in return, be able to do for it.

* * * * *

Survey Instruction—140 Years on

LIEUT-COLONEL T A LINLEY RE

THE Survey School was founded in 1833. To celebrate the one hundred and fortieth anniversary of this event a Guest Night was held at the School of Military Survey, Hermitage, on 11 January 1973 to which all surviving Chief Instructors were invited. The following were able to attend: Brigadier L J Harris CBE, Brigadier A Walmesley White CBE, Colonel W A Seymour, Colonel C R Bourne, Colonel R C Gardiner-Hill OBE, Lieut-Colonel A J D Halliday MC, Lieut-Colonel P J Carmody, Lieut-Colonel J S Coulson, Lieut-Colonel N J D Prescott MBE. Brigadier J Kelsey CBE, the Director of Military Survey, was also present as well as many other ex-members of the School staff. The following notes give a brief historical outline.

To begin before the beginning, in 1824 Parliament sanctioned the trigonometrical survey of Ireland by the Ordnance Survey. The Duke of Wellington, then the Master General of the Ordnance, obtained a Royal Warrant for the formation of the first military survey unit so that it could assist in this survey. The unit formed was the 13th (Survey) Company, which is still in being as 13 Field Survey Squadron RE, and the men of the unit were all Royal Sappers and Miners. Survey training started immediately at the RE Establishment, Chatham, under the direction of the Commandant, Lieut-Colonel C Pasley RE. The survey was successful, and subsequently more survey companies were formed and trained at Chatham for employment in Ireland.

Lieut-General Sir William Denison Kt KCB who as Lieutenant W J Denison RE formed the Survey School in 1833.

Lieut General Sir William Denison

At this time, cadets from the Royal Military Academy, Woolwich, who were intended for the Royal Engineers, were sent to the Ordnance Survey to learn surveying in the field. However, it was later decided that survey instruction should be transferred to the RE Establishment, Chatham. With the training of officers and men concentrated at one place a Survey School was justified, and indeed formed.

Lieutenant W J Denison RE (later Lieut-General Sir William Denison Kt, KCB) was appointed to start the Survey School, as the first Superintendent of Survey, in 1833. He was throughly prepared for the appointment by the Astronomer Royal, and among other achievements in 1834 he constructed, at Chatham, an astronomical observatory with the movable roof mounted on six nine-pounder cannon balls. He formed and ran the Survey School very successfully and he was succeeded as Superintendent of Survey in 1835 by Lieutenant (later General) E Frome RE who, whilst holding the appointment, wrote a standard work on trigonometrical survey and was appointed a Fellow of the Royal Astronomical Society. In 1839 he departed to become Surveyor General of South Australia, taking with him a detachment of men drawn from the survey companies employed by the Ordnance Survey in Ireland.

In 1855 Captain (later Major-General) H Y D Scott RE was appointed Superintendent of Survey, and he did much to reorganize the officer instruction, especially in the branch of military sketching. He gradually enlarged the officer course syllabus to include such subjects as map production, and the period of survey instruction increased from six weeks in 1855 to six months in 1868. He left Chatham in 1864 on secondment for employment in the design and construction of the Royal Albert Hall.

The appointment of Superintendent of Survey was changed to Instructor in Surveying in 1860, and in 1869 the RE Establishment was renamed the School of Military Engineering. It then consisted of four schools, of which Survey was one, and it is worthwhile recording that of 570 days spent by the young officers in training at Chatham, no less than 230 days were devoted to surveying.

In 1902, Major C F Close CMG RE (later Colonel Sir Charles F Arden-Close KBE CB CMG) was appointed Instructor in Surveying and produced his well known "Textbook of Topographical Surveying". The appointment of Instructor in Surveying was changed in 1909 to Chief Instructor in Surveying during the tenure of Major (later Brigadier-General) E P Brooker RE.

After the 1914–18 War, the survey units were disbanded and the regular personnel were absorbed into a Survey Battalion, stationed with the Ordnance Survey at Southampton. The Survey School at Chatham was reorganized in 1919, under the Chief Instructor Major (later Colonel) L F N I King OBE RE. In 1922, Junior Officer training in survey lasted 12 weeks, and it is interesting to note that students were already doing detail survey from air photographs. By 1935, under Major (later Major-General) G Cheetham DSO MC RE, as Chief Instructor, the Junior Officer survey training was 8 weeks but an Advanced Survey Course for RE officers, lasting 24 weeks, had been introduced.

At the beginning of the 1939–45 War a Survey Training Centre RE was quickly established at Fort Southwick, near Fareham. Survey training took place in the Technical Training Company, which consisted of three Wings—Field Survey, Air Survey and Map Production. OC Technical Training Company was Major A C James RE, an old Colonial Surveyor, who was one of "Calder's Cavalry". The Survey Training Centre RE moved to Ruabon in North Wales, and then in December 1945 to Longleat Park near Warminster.

In 1946, Technical Training Company became Instructional Wing, and the appointment of OC Technical Training Company was changed to Chief Instructor. Lieut-Colonel L J Harris OBE RE (later Brigadier L J Harris CBE) then started his reorganization of the survey training on to the lines that are used to this day. In particular the professional Long Survey Courses, now known as Army Survey Courses, were started in 1948. In 1949 the Survey Training Centre RE became the School of Military Survey, and moved to its present location at Hermitage, where it is flourishing and looking forward with confidence to the next 140 years.

SUPERINTENDENTS OF SURVEY

Lieut W J DENISON RE	1833–1835
Lieut E FROME RE	1835–1839
Capt H D HARNESS RE	1839–1844
Capt J G McKERLIE RE	1845–1855
Capt H Y D SCOTT RE	1855–1860

INSTRUCTORS IN SURVEYING

Capt H Y D SCOTT RE	1860–1864
Lieut-Col A A C FISHER RE	1864–1869
Maj F E PRATT RE	1869–1875
Lieut-Col C N MARTIN RE	1875–1879
Maj M LAMBERT RE	1879–1880
Lieut-Col Sir CHARLES WARREN CMG RE	1880–1884
Capt J du T BOGLE RE	1884–1889
Maj A O GREEN RE	1889–1893
Maj C W SHERRARD RE	1893–1895
Maj A C MacDONNELL RE	1895–1902
Maj C F CLOSE CMG RE	1902–1905
Maj E P BROOKER RE	1905–1908

CHIEF INSTRUCTORS IN SURVEYING

Maj E P BROOKER RE	1909
Maj G F A WHITLOCK RE	1909–1913
Maj W J JOHNSTON RE	1913–1915
Col S C N GRANT CB CMG	1915–1919
Maj L F N I KING OBE RE	1919–1923
Maj D CREE MC RE	1924–1927
Maj P K BOULNOIS OBE MC RE	1927–1931
Maj G CHEETHAM DSO MC RE	1931–1935
Maj F K STRANACK MC RE	1935
Maj R E FRYER RE	1935–1938
Maj A W HEAP RE	1938–1940

OC TECHNICAL TRAINING COMPANY

Maj A C JAMES RE	1940–1946

CHIEF INSTRUCTORS

Lieut-Col L J HARRIS OBE RE	1946–1949
Lieut-Col A H DOWSON OBE RE	1949–1951
Lieut-Col W A SEYMOUR RE	1952–1954
Lieut-Col A WALMESLEY WHITE RE	1954–1956
Lieut-Col M H COBB RE	1956
Lieut-Col A J D HALLIDAY MC RE	1957–1959
Lieut-Col C R BOURNE RE	1959–1962
Lieut-Col P J CARMODY RE	1962
Lieut-Col P C SHERWOOD RE	1962–1966
Lieut-Col R C GARDINER-HILL OBE RE	1966–1967
Lieut-Col J S COULSON RE	1967–1969
Lieut-Col N J D PRESCOTT MBE RE	1969–1970
Lieut-Col T A LINLEY RE	1970–1973

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An Introduction to High-Power Laser Technology

CAPTAIN J W R MIZEN RE

INTRODUCTION

EVER since the early Iron Age, when man sallied forth with his new weapon and shattered the bronze swords of his adversaries, there has been a struggle to gain technical superiority in arms. The participation in this so-called arms race is one measure of the international stature of a country; to opt out is to become a second-class nation. Potentially the most important discovery in the weapons field since gunpowder is the laser; this article sets out to show how the high-power laser works and some of the jobs it may be expected to perform.

BACKGROUND

In 1950 the Bell Telephone Laboratory started research into using a light source to carry communication. The principle is that the amount of information which can be superimposed on a carrier wave depends on the frequency of the carrier. Light in the visible portion of the electromagnetic spectrum has a frequency 100,000 times that of the 6 centimeter signals currently used in microwave systems; so theoretically light can carry 100,000 times as much information as a microwave. The trouble with a conventional light source is that it emits over a wide number of frequencies and there is too much "noise" for transmission. In contrast, radio waves from an electronic oscillator are confined to a narrow frequency band and can be used as carrier waves. The Bell Telephone Laboratory research eventually led to the discovery of the laser which is an acronym for light amplification by stimulated emission of radiation. Figure 1 shows a comparison of the spectra of conventional fluorescent light and laser light; the extremely narrow frequency band characterizes laser light.

It was not until 1960 that such light was actually observed; it was discovered by T H Maiman of the Hughes Aircraft Company using the apparatus shown in Figure 2. A cylindrical ruby crystal was formed with both ends ground optically flat; one end was silvered and the other partially silvered. A high intensity flash lamp enveloped the crystal, which was cooled by a circulating liquid. What Maiman discovered before anyone else was that up to a certain critical flash intensity all that happened was that the ruby emitted a burst of its characteristic red fluorescence spread over the usual decay period; but above a critical level of flash intensity, laser action took over and an intense red beam lasting for about half a thousandth of a second flashed out from the partially silvered end of the rod. The essential characteristics of this light showed that it was monochromatic (one frequency), coherent (all waves in phase), powerful and almost parallel.

In order to understand why laser action takes place it is necessary to examine the energy level states of the atoms in the laser medium. Figure 3 shows the beginning of laser action with the normal or unexcited state of affairs (Fig 3/1), in which the vast majority of atoms are in the lower energy state. The medium is then subjected to some external excitation (Fig 3/2) which "pumps" a sizeable percentage of atoms to an upper energy state; this situation is known as population inversion. An atom falling spontaneously from the upper level to the lower level can emit a photon of light that is capable of stimulating other atoms to emit photons with the same frequency and phase. Since a stimulating photon can just as easily be absorbed by an atom in going from the lower level to the upper level (shown at the right in Fig 3/3), it is important that population inversion be maintained so as to make absorption less likely to occur than stimulation; as long as this condition is satisfied the output will continue to be amplified.

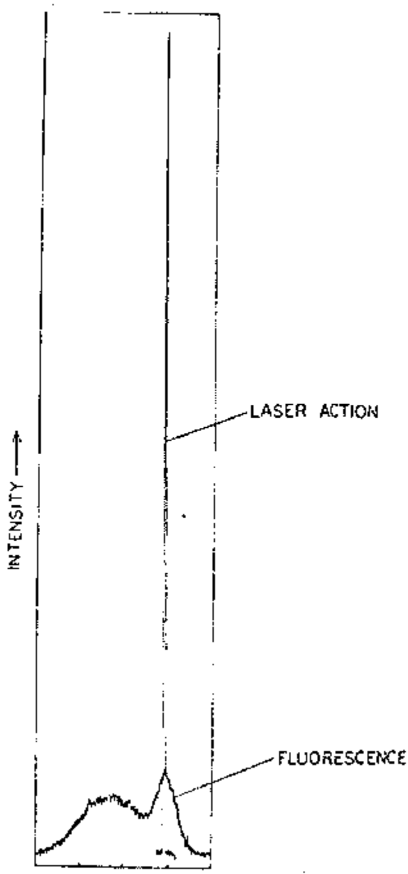

Figure 1. Comparison between conventional light and laser light.

Population inversion is maintained in the laser medium by enclosing it in an optical cavity as shown in Figure 4; the laser employs a shutter to delay laser action until a large population of atoms has been raised to the excited state. Before pumping starts the atoms are in the ground state (open circles). The pumping light (broken arrows) is then turned on and raises the atoms to the excited state (black dots). If an emitted photon (black arrow) strikes another excited atom, it stimulates further emission. This stimulation is limited until the shutter is opened (Figure 4); then photons travelling precisely parallel to the major axis of the laser are reflected back and forth between the two mirrored surfaces, stimulating a cascade of photons. The cascade culminates in a coherent beam of light which flashes through the partially silvered mirror with an intensity of millions of watts; the use of this shutter was the first method by which high-powered lasers were generated.

CARBON DIOXIDE LASERS

In the search for a laser medium which would produce the maximum power, it was assumed that the most powerful lasers that would ever be built would be solid-state lasers for the simple reason that the "lasing" particles are much more concentrated than they are in a gas. However it was found that solid state lasers have their drawbacks; at high powers they only operated in the pulsed mode and were unable to produce a continuous beam. The situation changed entirely with the advent of molecular gas lasers; the outstanding example of this class of lasers is the carbon dioxide laser which could produce a continuous laser beam with an output power of several kilowatts, compared to the milliwatt output of solid state lasers at that time. The carbon dioxide laser produces high output power in the infra-red region of the electromagnetic spectrum with a wavelength between 9·4 and 10·6 microns. The main attraction is that a low loss optical window exists between 8 and 14 microns for transmission through the earth's atmosphere, so the laser can be used for communications both on earth and in space. The obvious military implications of such a system ensured that adequate development funds were available.

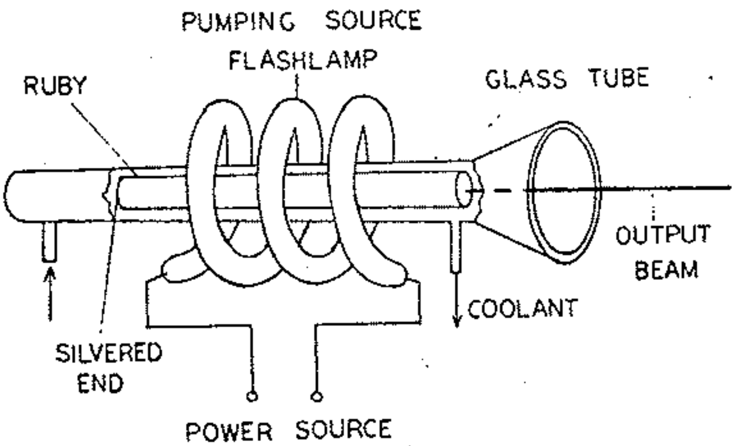

Figure 2. Maiman's apparatus which produced the first laser light.

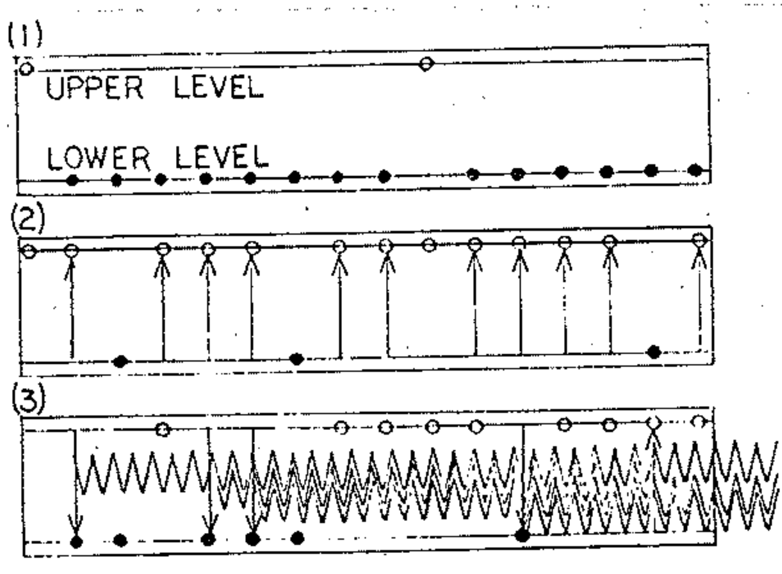

Figure 3. Simplified laser action.

In the original research for a laser capable of producing an infra-red beam, atomic gases (neon, etc.) were used because they were known to fluoresce. They proved unsatisfactory because the energy levels between which infra-red transitions can occur are situated close to the atomic ionization limit—far above the ground state of the atom as shown in Figure 5. As a result, the atom has to be excited to a very high energy level in order to produce laser action, which in turn results in the emission of a photon with a comparatively small amount of energy. The use of atomic gases resulted in a low quantum efficiency.

The situation is entirely different when one is dealing with molecules. The associated energy states for a molecule are the vibration energy levels and it was found that these levels were very close to the ground state of the molecule; thus the laser photon energy is a sizeable fraction of the total energy needed to excite the molecules from the ground to the upper energy state. The result is a very high quantum efficiency compared to that of an atomic gas infra-red laser. It was also

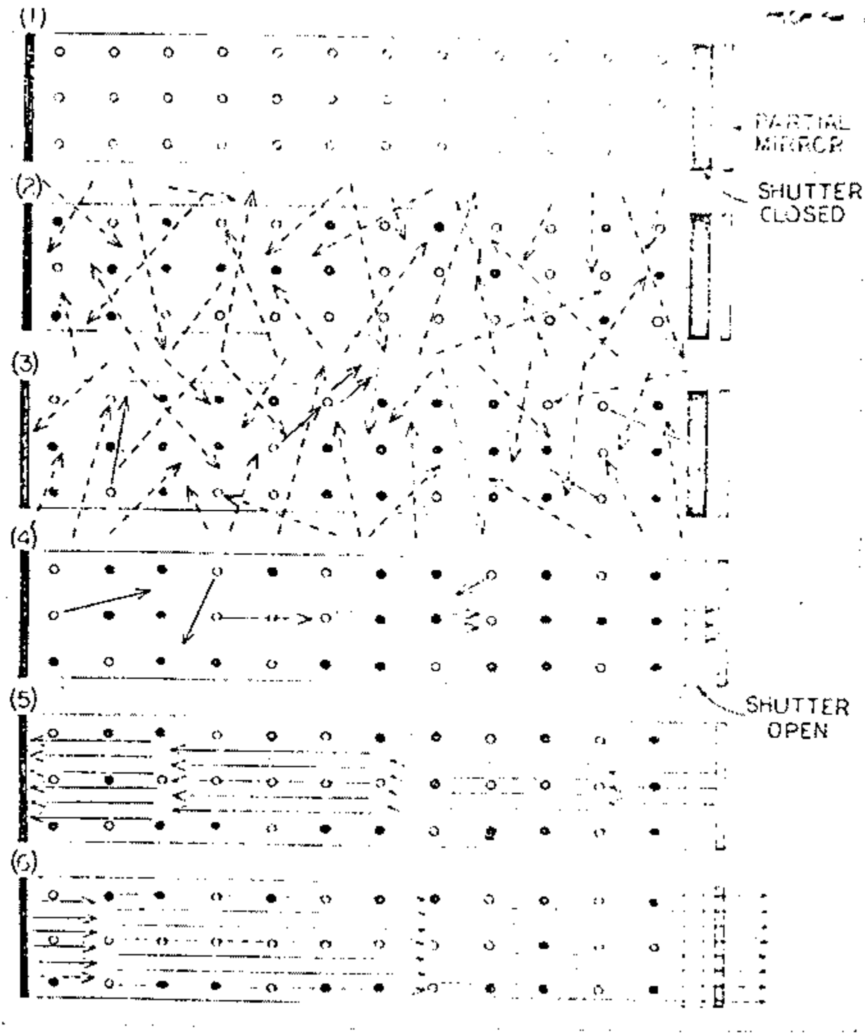

Figure 4. Photon cascade produced by delaying laser action.

found that the lifetime at various vibration energy levels for laser action was long, so energy could be stored in the laser medium for about a millisecond by blocking the path of the beam within the optical cavity, thereby preventing laser oscillation. If the block is suddenly removed, then the output from the laser occurs in the form of a sharp pulse whose peak power is usually 1,000 times larger than the average continuous wave power obtainable from the laser. This mode of operation is called Q-switching or Q-modulation and is most easily accomplished by replacing one of the laser cavity windows with a rotating mirror. With such a scheme a carbon dioxide laser capable of producing approximately 50 watts continuous wave power, will produce nearly 50 kilowatts of pulsed power in bursts approximately 150 nanoseconds (10^{-9}) long and at a rate of 400 bursts per second.

FUSION BY LASER

The rapid evolution of high-powered Q-switched lasers has made available a source of light which, when focused, is capable of heating a small amount of matter to extremely high temperatures, in some cases to more than 50 million degrees Celsius,

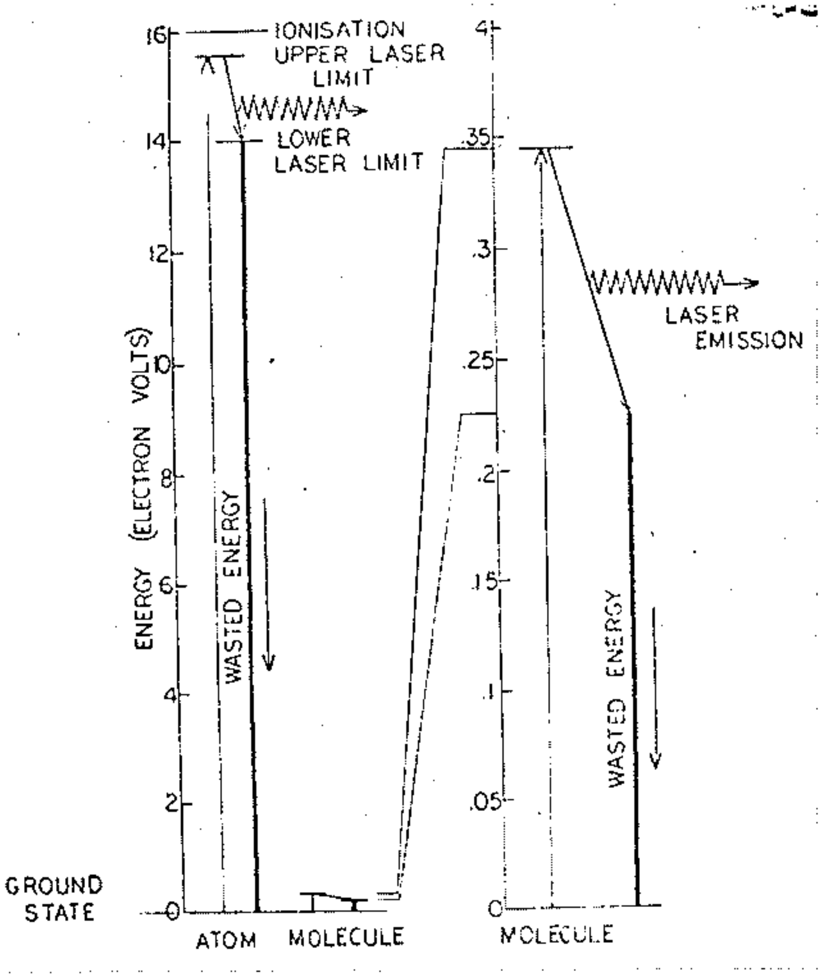

Figure 5. The energy level diagram shows that carbon dioxide is a more efficient laser medium than an atomic gas.

a temperature which can sustain thermonuclear or fusion reactions. Recent experiments have shown that energy releasing fusion reactions, which may ultimately lead to the production of useful electrical power, can be initiated and to some extent controlled within a plasma. This plasma can be obtained by focusing a powerful laser pulse on a dense frozen pellet containing a mixture of the heavy hydrogen isotopes deuterium and tritium according to the following equation:

$$H^2 + H^3 \longrightarrow He^4 + \text{Neutron} + 17{\cdot}6 \text{ MEV}$$

The fusion-power option, however, has encountered technological problems because of two main difficulties. First, the task of heating the light element fuel to a sufficiently high temperature at the required density to initiate slow nuclear burning has proved harder than anticipated. The second problem occurs when the fuel is ignited; the hot dense mixture with high kinetic energy must be held in a compact form for a long enough time so that more energy is liberated through burning than is invested in the original ignition process. Attempts at confinement by means of intense magnetic fields of various geometries have so far yielded no practical solution. The potential return on the investment of time and money in the research of these problems is so great that all the major nations of the world have substantial controlled-fusion research programmes. The task of heating the fuel to a sufficiently high temperature has encountered technological problems because the end surface of a laser medium from which coherent radiation is emitted can withstand only a limited amount of energy per unit area. Generally it is felt that impurities in the laser material contribute to significant absorption of the laser light which can lead to ultimate fracture of the laser medium. For example, the energy handling capability of neodymium glass, a laser medium, ranges between 10 and 100 joules per square centimetre depending on the duration of the laser pulse.

At present solid state ruby and neodymium glass laser materials are frequently used to obtain the maximum power output in pulsed operation; liquids and gases also are used because they are not liable to structural damage. Solid state laser systems available at present are capable of delivering energies in excess of 1,000 joules in less than a nanosecond or 10^{12} watts, with a total angular divergence of less than one hundredth of a degree.

A typical high-power laser system consists of an oscillator like that shown in Figure 2, which produces a low energy laser pulse; in fact a string of pulses emerge from the partially silvered window. These pulses are then tailored to suit a particular application by passing them through an electro-optical shutter which allows only one pulse to go through. Pulses varying in duration from a nanosecond to one thousandth of a nanosecond have been produced in this way. Once the laser leaves the pulse shaping unit it is directed to a succession of amplifiers as shown in Figure 6. Each amplifier adds energy to the original pulse and it can be passed through the amplifier system a number of times (three times in Figure 6), in order to gain maximum power. The tilted discs in the disc amplifier solve the problem of the fracture of the laser medium by high energy beams; in a normal neodymium glass laser rod, the atoms are excited from light absorbed by external flash lamps. Since the light enters the rod from the outside, more atoms near the outer edges of the rod are elevated to an excited energy state than those in the interior. This undesirable situation becomes intolerable for rods more than two inches in diameter; in addition the rods are difficult to cool between pulses. If the laser medium is in the form of discs tilted with respect to the incoming laser beam, reflection losses are minimised and they have a larger projected area of minimal thickness facing the excitation of the flash lamps, which leads to uniform excitation. One such amplifier can produce a power of 10^{13} watts per square centimeter, which is power enough to initiate fusion reactions.

When high-power pulsed lasers began to emerge as working systems, one of their first applications was to produce plasmas in existing magnetic confinement devices. The question which was asked at that time was, "Can a plasma, produced by the laser heating a small droplet of thermonuclear fuel in a magnetic field, serve as the plasma required for nearly steady state continuous fusion reactions?". More recently with the technological difficulties encountered with producing a suitable magnetic field and the tremendous advances in the capabilities of high-powered lasers, a second question has replaced the first, "Is it not possible to utilize the focused radiation from a laser to heat a droplet of thermonuclear fuel to produce significant burning *without* the necessity of a confining magnetic field?".

GAS-DYNAMIC LASERS

The most fundamental limitation on the average power output of a laser is the waste energy resulting from inefficient operation; the waste energy appears usually as heat. Most laser devices, whether solid or gas, have an active medium in the form of a long thin cylinder. In the case of a solid, waste energy is conducted to the wall where it is removed by a coolant; in the case of a gas laser, energy is dissipated by diffusion and conduction of heat to the outer wall of the container. With only diffusion or heat conduction to remove waste energy a laser device, on an average power basis, is limited to a maximum power of the order of 1 kW/m of the laser medium length, regardless of the diameter. However, by using high speed flow to remove the waste energy more quickly, the average power capabilities of the device can be increased. For typical gas lasers the factor by which an average power density can be increased through the use of high speed flow ranges from 10^3 to 10^5. In addition, since the flow time is independent of gas density, the density of the laser medium can be increased to provide still greater powers. Gas-dynamic lasers can be electrically, chemically or thermally pumped to their excited state; it is the thermally pumped gas-dynamic laser which has been able to produce spectacular output powers.

The basic principle of the gas-dynamic laser is to expand the gas through a supersonic nozzle to a high speed, usually denoted by the Mach number. The object is to lower the gas mixture temperature and pressure downstream of the nozzle; with the use of such catalysts as water and nitrogen in this area, the molecules of the gas are found to have vibration energy levels associated with the hot gases before expansion. Basically this is a condition where an excessive population of lasing particles exists in the excited state; these particles can be made to release their stored energy to a laser beam. Figure 7 shows a typical setup of such a laser; because of the high gas densities involved and the high flow downstream of the nozzle, an inversion capable of continuous operation at very high powers is achieved.

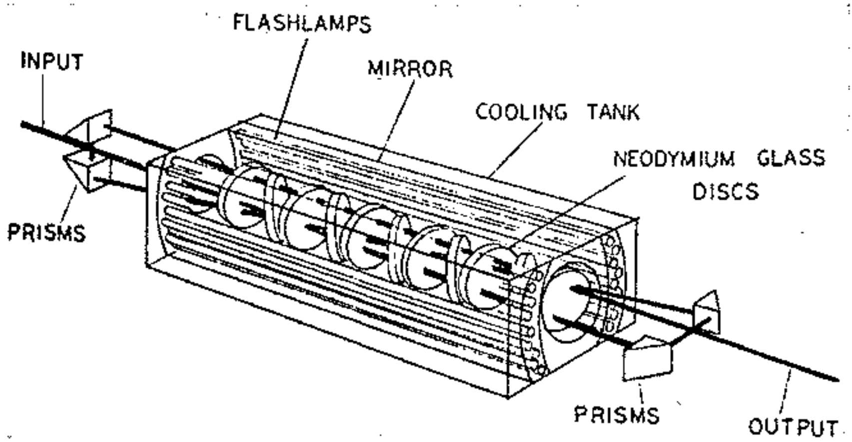

Figure 6. The disc amplifier which can increase the output power of a laser to 10 million megawatts.

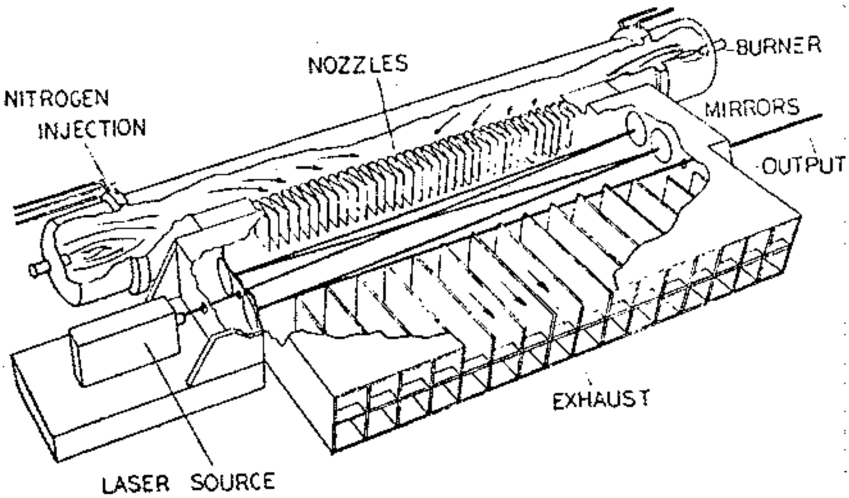

Figure 7. The gas-dynamic laser.

MILITARY APPLICATIONS

The laser owes the rapidity of its early development to the excitement it sparked in the United States Government circles as a possible weapons system; for a year before Maiman's results were announced several organizations were trying to operate a laser system with money supplied by the US Department of Defense and the US Air Force. The far ranging implications of these devices, in communications and radar especially, were clearly understood even then. There was a naïve idea at that time that the laser might constitute a step in the ultimate of weapons, the long sought elixir of weaponry, the death ray. The idea of a weapon whose destructive power can travel at the speed of light, rather than the comparatively snail-like ballistic pace, that could travel over great distances and that could concentrate its power into a narrow beam, was most alluring. The essential problem of missile defence is to find sufficient time to destroy the incoming warhead after it has penetrated the atmosphere, where it can be more easily detected and distinguished from accompanying decoys, as found in multiple re-entry vehicle warheads (MIRV's). Once the missile is properly identified and tracked, the position at which a defensive weapon can intercept it must be calculated and transferred to a hastily launched anti-missile missile. What makes the laser attractive is that with its beam travelling at the speed of light, it can intercept in milliseconds rather than minutes. Added advantages are that ground discrimination radar can delay its tracking job longer, permitting the atmosphere to burn up MIRV decoys and the weapon would be non-nuclear, lessening the hazards of radioactive fallout.

A hypothetical case is worth examining to find out what order of magnitude of power is required to destroy such missiles. Consider a warhead having 100 lb of steel shielding; 13·45 kilowatt hours are required to heat this to melting point; let us further assume that the missile is at an altitude of 50 kilometers and that the target must be destroyed in one minute. The total energy falling on the target must be at least 807 kilowatts of energy; but for a beam divergence of one minute of arc, at this altitude the cross sectional area of the beam would be 165 square metres or roughly 200 times the area of the hypothetical warhead. Thus only half a percent of the power at this altitude would strike the target; assuming no atmospheric loss, the laser would have to generate 161·4 MW of continuous power to do the job. In order to get this power requirement in perspective, the latest published information suggests that 50 kW continuous power is the present operating ceiling of laser power. It is obvious from these figures that the direct thermal application of lasers for ICBM defence is a long way away.

The latest thinking on the subject proposes an ABM interceptor getting its power from a laser source on earth; the rocket would be fitted with a nuclear warhead because X-rays and neutrons have a large killing range. There are three main advantages from this compromise system:

a. The payload of the rocket would be reduced because no oxidizer need be carried.

b. The accuracy would not have to be as great as the thermal laser because of the nuclear warhead.

c. The actual power requirement is much less than for a thermal laser.

In slightly less fanciful vein, the most practical present day military use of lasers is in target identification. In Vietnam, the "central error probable", CEP, of pilots on bombing missions has been reduced from 750 ft at the start of the war to around 250 ft nowadays by experience and instrumentation. This type of conflict requires superior accuracies and lasers were used under the Paveway Program to improve the CEP. A ground observer or forward aircraft controller with a laser source can illuminate a target for aircraft which can drop a bomb capable of locking onto the frequency of light reflected from the target. Although the operational results are secret, this has reduced the CEP to less than 12 ft under non-operational conditions. Although not strictly a high-power laser application, the results are showing defence planners that the laser is not a science fiction weapon.

PRESENT AND FUTURE TRENDS

In the search to find more powerful carbon dioxide lasers, the excitation voltages between electrodes at each end of the discharge tube were increased; at a pressure of 0·1 atmosphere such a laser required a 3 million volt excitation pulse. This was considered technologically inconvenient and unsafe; instead of an axial discharge, the idea of using electrodes to produce a radial discharge was investigated. This resulted in the development of the transversely excited atmospheric (TEA) laser, in which the gas is at atmospheric pressure and anode and cathode are mounted axially in the laser medium to produce a uniform discharge along the length of the tube. The Canadian Defence Research Establishment at Valcartier has built a giant TEA laser nearly 50 ft long which is expected to generate 150–200 joules per pulse with durations as brief as 1 nanosecond, corresponding to a peak power of 150–200 gigawatts. British research in this field is conducted at the Services Electronics Research Laboratory at Baldock in Hertfordshire, where considerable success has been achieved in the development of a trigger mechanism to produce a laser pulse of very short duration. The United States, Soviet Union and France have also reported results from TEA lasers which are expected to be used in optical radar systems.

Lasers which are pumped to high energy states by electrical or thermal energy have been considered, but it is also possible to elevate a laser medium to a high energy state chemically. In one such application, sulphur hexafluoride is made to combine with hydrogen in the presence of high velocity nitrogen. The hydrogen combines with the fluoride radical to produce excited hydrogen fluoride; a beam of infra-red energy is created as these molecules lase between two mirrors. As in the gas-dynamic laser, the rapid gas flow solves the cooling problem. Chemical lasers are attractive candidates for weapons because they require little or no electrical power and produce high energies in relation to their size and weight.

It might appear that the United States had a commanding lead in laser technology; this is what the Americans thought up until recently when a Russian scientific magazine published some results of laser initiated fusion experiments at the Lebedev

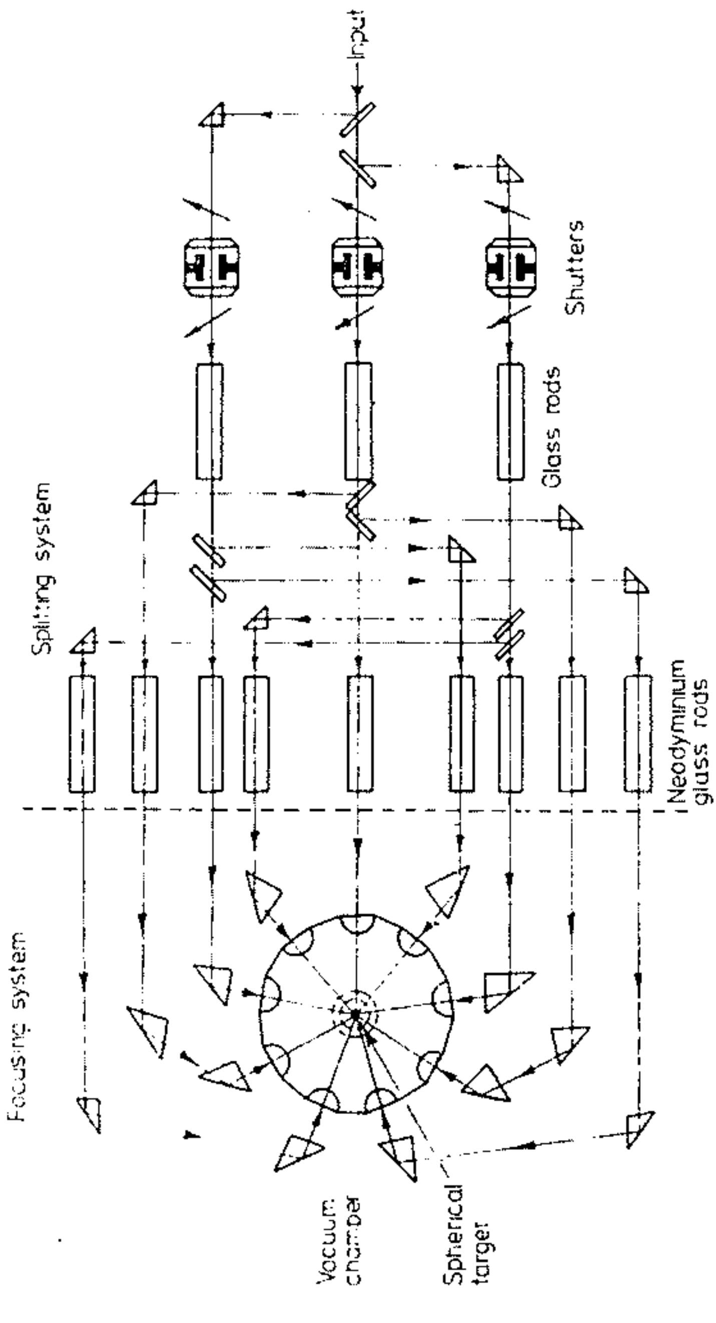

Figure 8. The Russian laser initiated fusion apparatus.

Institute in Moscow. It showed that the Russians had a lead on the rest of the world of about three years in this technology. As often found in Russian technology, the apparatus is simplicity itself and is shown in Figure 8; a laser beam is split into nine parts, amplified seperately and then converged again on the target. The target is a droplet of deuterium-tritium; three quarters of this mass is evaporated by the laser and accelerates away from the centre of the droplet but a quarter of the mass accelerates towards the centre, increasing the overall density by a factor of 10^4. The fusion reaction starts at the centre of this concentrated pellet and consumes the whole mass.

The fusion implosion concept is of tremendous importance in a divided world whose energy reserves are limited. It is revealing to see how the Pentagon spending on lasers has increased by a factor of 10 since 1969 and American Oil Companies are financing private research projects on the same lines.

CONCLUSIONS

The laser is only thirteen years old at the time of writing; its power has increased by a factor of 10^{14} in this time and there is no reason to suppose that the power limit has even been approached. It would be unwise for Britain to lag behind in this technology which will be of benefit to the soldier and citizen alike.

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Modern Translations

"There can be little doubt"	—I think
"It is a well known fact"	—I think
"It is a statistically proven fact"	—I think
"Percentagewise"	—a few carefully selected figures divided by 100
"It is not for me to say but . . ."	—prelude to any of the above

Solomons Diary
A Visit to STRE Solomons - May 1972

LIEUT-COLONEL R A S RICKETS RE

PREFACE

This is not a technical article. In fact technically it is probably not an article at all. It is no more than a few diary jottings. The jottings are my impressions of one of the most peaceful and delightful parts of this World and of the work done there by a small team of Royal Engineers.

Sunday. The QANTAS 707 leaves Hong Kong at midnight, half an hour behind schedule, arriving at Port Moresby, New Guinea, at 0730.

Monday. Moresby has a tiny terminal building but the airfield is quite large with two parallel runways. It lies in a valley some seven miles from the town and is the home of a host of light aircraft of all shapes and sizes which flit from strip to strip among the jungle-clad hills of Papua New Guinea. Scattered about the apron and constantly buzzing in and out are light and medium aircraft of Trans Australia, Ansett, Papua New Guinea Airlines and private operators; Beechcraft and Cessnas, the ever-faithful Dakotas and the popular and efficient Fokker Friendship to name but a few. There are no transit facilities and only a tiny magazine stall. You go through all the immigration process at one side of the building to get in and the reverse process at the other side to get out. A short walk takes you to the only other civilization in sight, the Gateway Hotel, a long low building with a full length verandah shaded by palms. A shower, a shave, a change of sticky clothes, then breakfast on the balcony with time to enjoy it. It is the best time of day, cool and fresh, the ground damp with dew, the heat of the day yet to come.

Air Pacific (formerly Fiji Airlines) with a new fast service by BAC 111 get you from Moresby to the Solomons in just over two hours, not bad for nearly 900 miles. We land at Henderson Field on Guadalcanal Island at 1130 am. It is an impressive sight, the only airport of its size in the Solomons and a product of the days of 1943 when the Americans landed on these beaches, fought the Japanese to a standstill, set up Henderson Field and began to push them island by island back the way they had come. The field was rebuilt and the terminal buildings constructed as the first stage of the STRE's work here a few years ago.

Mike Carter, OC the Team for nearly a year now, has come in by light aircraft to meet the flight and the Director PWD and some of his staff are also there.

The town of Honiara is only a few miles drive along the coast and Mike and I are booked into the Mendana Hotel, one of the only two here, in an idyllic setting on a beach of coral. A long low building of timber and attap and wood carvings with the sea lapping gently at the edge of the huge patio, it will cost you £20 a day to live here. The shark warnings forbid swimming. Mendana was the Spanish navigator who came here over four hundred years ago and died here on his second voyage. Looking for a route to Australia, he named these islands the Isles of Solomon for the gold that he found, probably iron pyrites which looks similar.

Honiara, capital of the Solomons, is small, quiet and peaceful. A few bungalow shops set back from a wide and dusty street, open grass and palm trees, pleasant bungalows set high up on the hillside, and a jetty where small freighters come alongside on their occasional visits. Boats which ply to the outlying districts and the other islands, small launches, dugout canoes, a couple of landing craft and several large and workmanlike diesel schooners lie to their moorings in the little bay.

I was last here a year ago when Mike Hunter was running the Team. They work entirely for the Public Works Department, using local labour, tradesmen, machines and stores for construction projects. The composition of the Team has varied but has usually been one officer, a chief clerk/administrator, one or two clerks of works, an

MPF, a sergeant fitter, a surveyor and a couple of plant operator mechanics. Some are accompanied by their families, others are on nine month unaccompanied tours. I was surprised a year ago to see the astonishing results that such a small team could achieve. By that time they had finished Henderson Field long since, and had opened up a number of new airstrips in the remotest parts of the Solomons Group. These new airstrips now give a communications network throughout the Solomons with regular scheduled flights by Solair in their little Beechcraft and Islanders, where formerly the only access was by boat, taking many days. Last Autumn the Team completed the last airstrip, at Fera. The main islands of the Group are mountainous and jungle-clad and do not lend themselves to airstrip construction. The custom has been to use the tiny flat coral islands just offshore, some of them hardly larger than the final airstrip, and by flattening them and surfacing with rolled coral to produce, with an accompanying jetty, access into the area by air. Fera was one of these, a couple of miles offshore from the mission station of Buala on the main island of Santa Isobel, we went there on my last visit. It was an 80-mile trip by PWD powered lighter. We boarded late at night after a party in the little club at Auki, and promptly went ashore again for an aerosol to kill the cockroaches which swarmed beneath the mattresses in the little two-bunk cabin. We cooked our own supper in the crew's galley and slept well. Early next morning as we ran along the coast of Santa Isobel, the crew caught a shark which they sliced into steaks and ate with rice for breakfast. Approaching Fera, we nosed through a narrow channel in the guarding coral reef and headed across the calm lagoon to a strip of silver sand backed by palms. Fera is about a mile long and moon-shaped. Most of it is jungle and mangrove, but the western end was flatter and planted with coconut palms, some of them seventy years old. The husks are discarded, the white flesh of the nut is dried over smouldering fires and the resulting copra is bagged and exported, the only real produce of the Solomons. The one European in the area at that time was Carl Greenstreet, a wiry young Australian in faded shirt and shorts who lived in a hut of bamboo and attap on Fera and worked the copra with labour from other islands. On that visit he showed us his island and we sweated, slithered, cut and splashed our way through wet luxuriant undergrowth and swamp to get a general idea of alignment for the new airstrip. It is finished now and Carl has moved to another area, perhaps to find solitude once more.

On completing Fera, the last of the airstrip network, the role of the Team changed and they moved to Malaita, one of the bigger islands about 130 miles in length and totally undeveloped apart from settlements along the coast and a narrow coastal road of coral. Malaita is northeast of Honiara and thirty minutes flying time. Here the Team took over the entire PWD responsibility for the island which includes maintenance of the existing Government buildings, maintenance and development of the road system and development of the little harbour at Auki, the station for local government. The Team lives in bungalows at Auki.

Tuesday. We take off early from Honiara in one of the little Barons, with a young Australian pilot. Islands pass below, tropical green, jungle-clad, palm fringed, the protecting coral showing emerald green through the deep blue of the sea. This is Borneo again. We land gently on the grass strip at Auki. The coast here is mostly mangrove and Auki is a tiny hamlet tucked beneath the palm trees with hills rising steeply behind it. It is hot and humid and sheltered from any breeze. The families have their own wooden bungalows, those unaccompanied share a bungalow. They have not been here long but have set themselves up well and the PWD Depot, Malaita, now bearing the STRE emblem, has an atmosphere of well-organised efficiency about it.

The Team has a considerable amount of PWD plant here and a variety of civilian vehicles from runabouts to heavy tippers. The repair workshop is run by the REME sergeant with locally employed PWD fitters. The Clerk of Works is concerned primarily with maintenance and improvements to Government quarters, buildings and offices, the hospital and the airstrip, the harbour and the utilities. With him he has a corporal surveyor who has a number of projects in his own right including control of a water supply scheme further down the coast. The Plant Foreman controls the maintenance and development of the road system with several road gangs under his supervision. The two plant operator mechanics are working at present on the far side of the island, on a site accessable only by a long drive and boat trip. Here they take turn about in charge of a plant team of locally employed PWD plant operators, opening up a new road across the island. Each is often alone as the only European in the area. Back in the Depot the sergeant clerk is the administrator, rapidly developing efficient military method with his PWD clerks in general office procedure, pay and accounting, tenders and book keeping.

The Depot has its own machine, painting and carpentry workshops and holds and manages all stores, equipment and materials for the island. The OC is in effect the PWD Area Officer for Malaita.

Having a free afternoon in the programme we take the assault boat up the coast inside the reef to Lunga Lunga Lagoon. These are remote parts and though largely converted by the many missions to some form of Christianity, I can't believe that these people are far from pagan and some are openly so. The reef runs parallel to the shore about a mile out to sea. In parts it is still a razor-edged barrier just below the surface of the water. Elsewhere it has broken the surface and trees have grown. The people are primitive fishing folk and the sea swarms with fish of many colours, big and small. In these seas are sharks, whales, the great 15-ft sailfish, marlin, tarpon, and in the shallows and on the coral are the clouds of blue fish and gold fish and striped fish and flat fish, totally fearless of our boat. The people build islands of coral on the reef. First a great wall of big coral boulders perhaps 7 ft high and 8 ft thick is put up to mark the perimeter of the island. Then they build up the inside and an open stilt house of jungle poles and attap (palm thatch). I suppose by coming out here they escaped the mosquitoes, gained safety from enemies and placed themselves right on top of their fishing grounds; and now it is their tradition. They visit the shore land only to farm their crops of sweet potatoes and bananas and papaya and to collect fresh water and coconut husks for their fires. Their canoes are pencil slim dugouts, each carved from a single tree. Their paddles are long and slim, some ornately carved, and taper to a point. The men wear the short sarong, originally made from bark-cloth or woven banana fibre, now from cheap cotton, or shorts.

Plate 1. An STRE Aircraft Carrier. Taro Island Choiseul Bay. The protecting coral clearly visible and the STRE jetty in the foreground.

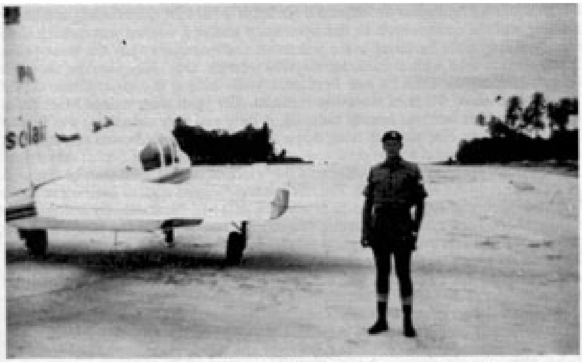


Plate 2. Cpl Battle and the airstrip on Taro Island in Choiseul Bay.

They are well built, muscular and pleasant-featured except for those few with obvious signs of Papuan or Aboriginal origins. Their hair is fuzzy, often the colour of pure yellow gold. The women are mostly very plump and dressed in short sarongs with nothing above the waist. Many have their foreheads, cheeks and noses tattooed.

As we drift past one of the islands a little west of Lau Lasi, a young European in shorts and open khaki shirt, a battered baseball cap perched at the back of a mass of blonde curls, steel-rimmed glasses on the end of his nose, is casting off his boat from a jetty. He is Father Arkwright, the Catholic Missionary of this area. Very kindly he offers to take us ashore and show us his island village. You do not go into such places without an invitation and someone who is known there. The old headman wears a faded shirt to befit his dignity. His ears and nostrils are pierced for the hanging of shell ornaments and the long nose stick. He shakes hands slowly but quite firmly. We visit the church, an imposing structure of attap and bamboo and see the prayer books written in the local language by some earlier devoted missionary. There are over forty different languages in these islands, with pidgin developing steadily as a common tongue. Next the "carpenters shop" where Father Arkwright is trying to produce with the villagers simple cupboards, benches etc which the village might sell. He has also bought four fishing nets which they had used for the first time the previous day. He hopes that they will sell the fish in Auki. On their first trial, the fish were rotten in the boat long before they could arrive at Auki and in a community as simple and basic as this such a problem may well prove insurmountable. These people of the Solomons group see little point in work. When fish and fowl and fruit grow in abundance about you, why work for money? Surely they are right; who is more satisfied, the London businessman battling for a seat on the 8.15 to Charing Cross, or the Solomon Islander paddling his canoe out to the reef. We saw how the facial tattooing is scratched into the cheeks with sharp bamboo, demonstrated on a little girl recently marked. A woman was cooking sweet potatoes, wrapped in a folded palm leaf and laid amongst and covered by hot stones, previously heated on a wood fire. A long process, they cook their fish in the same way.

Inside the village was another inner sanctum of half a dozen huts protected by a surrounding high wall of coral and stone. The entrance was narrow, just wide enough to pass through in an upright stance, with some stones missing lower down through which a guard might spear an unwanted visitor. It is not long since raiding and head-hunting was the custom here. In one open attap shelter a woman was making shell money, still used for bartering in the Solomons and essential to pay the bride-price. A sea shell is used with a thick, hardlayered interior. Our money-maker sat cross legged, holding the shell on one hard rock while hitting it with another, slowly breaking off shiny flakes of stone-like material. Her teeth were stained black from betel nut and her face was heavily tattooed. A dirty and very old sarong was tucked between her legs. Her stomach hung down with her pendulous bosom resting upon it. She was a jolly soul and rocked with mirth at the repartee of Father Arkwright and the other villagers. Having chipped a thin piece of shell, it must then be rounded to a disc and drilled in the centre. For this she had a round stick of hardwood, some 2 ft in length, and firmly bound to one end a point of flintstone. By holding this lightly in one hand and manipulating two strings, bound round the stock, with the other, she had a drill every bit as good as anyone has yet invented, but for the drilling bit itself. As even a small string of shell money comprises several hundred discs, and a large string many thousands, and the best money is the smallest with discs perhaps only a quarter of an inch in diameter, the work required justifies the value.

We were shown some of the skulls of ancestors, carefully kept and cherished, and some of former enemies, equally cherished.

We left in company with Father Arkwright and waved good-bye as he turned off in his little motor boat to spend the night in another village. Back in Auki the sun was setting.

Wednesday. We are out all day in pouring rain visiting the western end of Malaita by landrover and clambering up a muddy slippery hillside to see a water supply task in progress. We forded a river, driving axle-deep across a shingle bank. These rivers are subject to flash-flooding after storms. Maintenance teams are at work on the road. At one point running along a cliff of solid coral a huge hole has opened and the sea crashes into the cavern below. The story goes that the cavern was caused by two huge sharks in battle, the place is now haunted and the team will have difficulty getting any of the superstitious locals to go near it. A cool beer in the resthouse at Maloo is delicious, then back to Auki, soaked and filthy but a good day.

Thursday. A deputation at 0830, Father Peter Thompson, selected representative for Malaita on the Government Council, accompanied by his local council of three

Plate 3. Airstrip under construction on Fera Island Santa Isabel. The last of the Group.

Plate 4. New Roads on Malaita.

Malaitans. He is in sweatshirt, shorts and sandals. He has the build of a rugby player and a flashing grin, an ex-cleric now in business and politics. He is interested in the work the Team is doing for development and obviously most impressed by what he has seen so far. Knowing or guessing that I will be discussing our plans for the future of the Team with senior PWD and Government representatives in Honiara, he is obviously concerned that I should know his views on priorities for development between Malaita and other districts. It takes some time to persuade him that I have no say in such things nor do I wish one. We have a lively and friendly chat and his enthusiasm is infectious.

Before lunch, we have an "investiture" on the little balcony outside the Team's bachelor bungalow, to present WO1 Bamford with his LSGC medal, which we then celebrate in copious duty-free beer. At 5 pm two Beech Barons of Solair are waiting to make the schedule run back to Honiara, with a queue of passengers looking hopeful. The Britt-Norman Islander is wrecked on another island having hit a hole in the apron, one Baron is under repair so they are now down to the other. The second one here today has been flown down from Port Moresby to help out. The pilot is a young Australian crop-duster.

Mike Carter and I climb into the back of one of the aircraft. Already heavily loaded with kit, it promptly tips up on its tail. Two more climb into the centre seats, it rocks on the point of balance. The pilot and heaviest passenger climb in at the front. The nose wheel comes back to ground and we stagger into the air.

Friday. 0730 take-off in the little Beech Baron to try to get to Fera for a last visit. The weather is pretty thick, bumpy and raining. Forty miles north first, and the Florida Islands loom up. We are down at 600 ft below the thick cloud base but in front is a great mass of filthy cloud down to sea level. North-east to find a way round but there isn't one, south-west with visibility down to almost nothing. Circling in it we find the tiny island of Savu. No way through in any direction and there are no navigation aids in these parts. We give up and turn for home, somewhat to my relief.

Back in Honiara, we spend the rest of the day discussing present and future plans for the STRE with the Government and PWD officials concerned and hold a final meeting with the Director. All are full of praise for this little team and its work.

COMMENT

These islands are quite idyllic; a quiet, remote and beautiful haven in a rushing world. The islanders are happy people and take life as it comes. They have rich brown skin and fuzzy hair like the Papuans, but their faces are softer and more open like the Fijians to the east. They laugh easily. The pace of life is slow and relaxed.

Among the islands are the obvious traces of war. The hulks of warships and landing craft lie resting in the clear water. Fighter and bomber aircraft stand where they were left, now grown about by jungle. Littered through the islands are bombs, shells, rockets and mortars, stacked and buried in the thick foliage of nearly thirty years. On Guadalcanal, small painted signboards mark the ebb and flow of the battle and feats of valour still remembered. The population is small and scattered, the Islands are unspoiled.

STRE Solomons has contributed much to the peaceful development of this land. Now the time is running out and they have done what they came to do. It is likely therefore that they will say a sad good-bye to the Solomons next year.

My hotel bill is £90 for my four days in Honiara and I have only once been in for a meal. Slight consternation as I don't have this much left, but we find a bar purchase of £40. Drink here is expensive, but surely not that expensive. They have got their decimals wrong, which halves my bill and allows me to leave Honiara. A short stop in Port Moresby, another in Manila, and we are back in Hong Kong the same evening.

Oh to be in England!

MAJOR M. FRASER-ALLEN, RE

INTRODUCTION

THE aim of this article is to describe the life and work of 34 Field Squadron in the 3rd Division during one hectic year. The title is a direct reference to the fact that although the Squadron is based in Tidworth, that is the one place where we seem to spend very little of our time. Indeed in his first year as squadron commander the author spent precisely nineteen weeks in Tidworth.

In August 1971 the Squadron spent two weeks at the Southern Command Bridging Camp at Wyke Regis. During that time 3 Troop carried out an interesting MACC task in Dorset. From early October to mid December 1971 the Squadron, reinforced by a number of specialist tradesmen from 6 Field Support Squadron RE and a section of the Royal Pioneer Corps, was engaged in carrying out three Community Relations tasks in a remote part of Hong Kong. As this was a fairly complex project cum overseas exercise a disproportionate part of this article is being devoted to the description of its more important features.

The end of January 1972 witnessed the rapid departure of part of the Squadron for an exercise in British Honduras. Towards the end of March 1972 the Squadron returned to Northern Ireland, having served there now four times, either as a squadron or as individual field troops. However, as a great many field squadrons have served in the Sapper role in Northern Ireland, the Squadron's activities there will not be described in great detail.

MACC TASK IN DORSET

Early in July 1971 it was suggested that 34 Field Squadron should construct a Bailey Bridge as a MACC task for Dorset County Council. In due course it was confirmed that the bridge should be built in August, during the fortnight that the Squadron was to spend at the Southern Command Bridging Camp. During the previous winter the single span masonry arch bridge across the River Frome at Bradford Peverell had been damaged by flood water. Dorset County Council decided to replace it with a pre-stressed reinforced concrete bridge on reinforced concrete piles. Accordingly the Council decided to ask the Army to build a Bailey Bridge alongside the existing bridge to act as a relief bridge.

The MACC Initial Reconnaissance Report stated that a "50 foot Single Single Extra Widened Bailey Bridge" was required and that it would take "one troop day" to build. It seemed to be a pretty simple task, a confirmatory reconnaissance was duly arranged, even if only to provide an excuse for a rather pleasant helicopter flight down from Tidworth. As the Sioux circled over the meadow by the bridge it quickly became obvious that either the task had been somewhat understated or we had come to the wrong place.

The relief bridge had to be built not only across the river but also across a small mill stream which approached the river at right angles and then passed through a large culvert under the road. It was obvious that the far (south) bankseats would have to be built astride the mill stream, which itself would have to be run through a long culvert in order to allow the southern approach road to be constructed. The bridge would have to be built on the near (north) bank, where part of the meadow proved to be a flood plain, which was frequently covered by two to three feet of water. It also became obvious that the minimum length of the bridge would have to be 80 ft and this could only be achieved if the far bankseats were built as virtual islands. So much for the "one troop day" task!

In July a detailed site reconnaissance was carried out, from which emerged the final design of the bridge. It was agreed that the Army would rent the bridging equipment to the Council, that the Council would provide all other materials as well as any plant required and that we should carry out all the work except for the final tarmacadam road surface. The bridge was to be an 80-ft Class 30 Double Single Bailey Bridge with 10-ft level ramps at each end. All four bankseats were designed to be encased in trench sheet piling to prevent any erosion or flood damage, with the far bankseats being filled with concrete. The decking of the bridge was to be covered by a 2-in thick timber wearing surface on top of which the Council were to lay 2 in of tarmacadam. It was planned that 3 Troop should complete the task in eight working days.

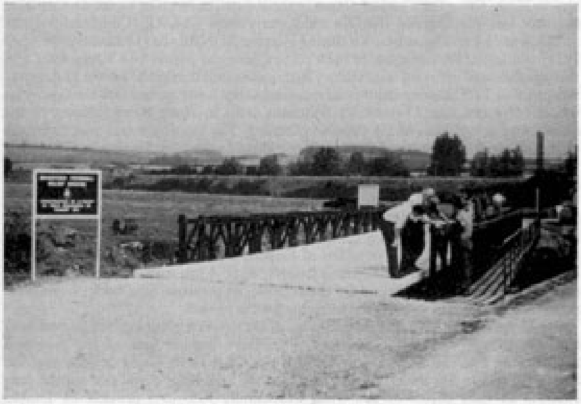


Plate 1. The completed Bailey Bridge at Bradford Peverell. The photograph was taken during the handover of the bridge to Dorset County Council.

The Squadron ferry marched from Tidworth to Wyke Regis during the morning of Monday 16 August 1971 and the initial setting out did not start until that afternoon. The next two days were spent moving the bridging stores from the Railway Station to the site, whilst on site a start was made on the bankseats and on the 80-ft long twin 18-in Armco culverting which was placed in the bed of the mill stream. By the end of the first week the bankseats were complete, most of the far bank approach road had been constructed and all was ready for the actual build of the Bailey Bridge. The bridge was built on the following Monday and was fully jacked down that afternoon. The next two days were spent laying the wearing surface and completing the approach roads. The task was completed that evening as planned and next morning the bridge was handed over to Dorset County Council, in whose care it was to remain for the next seven months. The completed bridge can be seen in the photograph at Plate 1.

This MACC task proved to be a first class project for one complete field troop. It provided excellent planning and control training for the Troop management, an obviously worthwhile task for all the soldiers and a good insight into the importance of good public relations. On this occasion there were no public relations problems as both Dorset County Council and the people of Bradford Peverell proved to be most friendly and helpful. Indeed the bridge site was visited practically every day by the Chairman of the local Parish Council, a retired Brigadier who invariably arrived on site wearing his old regimental stable belt, in our honour rather than as a means of keeping his trousers up.

One cannot conclude the saga of Bradford Peverell without paying tribute to the excellent Bill, the civilian operator of the hired MF 5000 back acter, who it quickly transpired was a T & AVR Sapper.

ENGINEER PROJECT IN HONG KONG

Planning and Mounting

From the outset Exercise BIRO was defined as one of a number of engineer training projects for which a field squadron from the Strategic Reserve would be sent to Hong Kong for a period of two to three months. In order to decide a suitable engineer task for Exercise BIRO a small party from 62 CRE (Construction) was attached to 11 Field Squadron RE during Exercise SUNBEAM (12 January–10 April 1971). An Initial Reconnaissance took place during the period 1 to 9 June 1971 and this was followed up by a Confirmatory Reconnaissance during the period 31 August–9 September 1971. During the second reconnaissance it was agreed that the Squadron would carry out four Community Relations tasks in Hong Kong, subject to the satisfactory completion of the detailed planning. The Priority 1 task was to be the construction of the last leg of the Luk Keng Road in the New Territories. The other tasks were a village electrification scheme, the extension of a jetty and the construction of a school playground, all in the Pak Mong area of Lantau Island.

The advance party, consisting of thirty all ranks, left the UK by scheduled RAF VC10 on 22 September 1971, arriving in Hong Kong on 23 September 1971. On arrival the advance party was accommodated by 54 (Hong Kong) Support Squadron RE at Sham Shui Po on the outskirts of Kowloon. The next day the advance party drew up the road transport (12 Land Rovers, 10 × 4 ton trucks and one 30-seater coach) which had been allocated for the exercise. At the same time work commenced on the second stage of the detailed planning for the project.

By 27 September 1971, the second stage of the detailed planning had proved conclusively that it would not be possible to carry out all four of the proposed tasks during Exercise BIRO. Consequently the CRE Hong Kong decided that the Squadron should not undertake any work on the Luk Keng Road and should concentrate all their efforts on the three Community Relations projects on Lantau Island.

On 6 October 1971 the advance party moved from Sham Shui Po to Fan Gardens

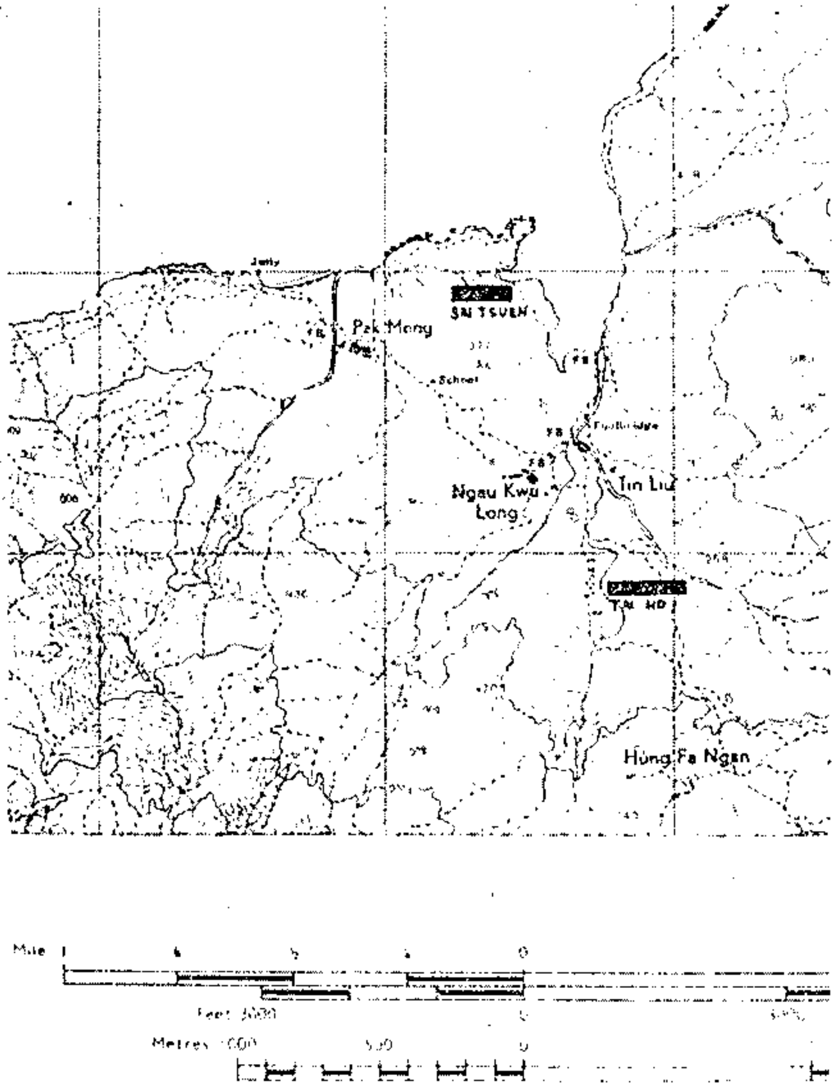


Figure 1. The Pak Mong area of Lantau Island.

Camp at Fanling in the New Territories, the camp having been taken over the day before.

As can be seen from the map at Figure 1, the Pak Mong area of Lantau Island is very remote. There are no roads of any description and the only practicable method of access to the tasks was either by landing craft or by helicopter. The three villages of Pak Mong, Ngau Kwu Long and Tai Ho and the associated hamlet of Tin Liu are all interconnected by narrow concrete paths winding through the hills. The total distance on the ground from one end of the project to the other was approximately 3,000 m. The concrete paths were too narrow and of too weak a construction to allow any form of mechanical movement (Dumpers, etc) between sites. This meant that all stores movement away from the beach area had to be either by helicopter or by hand using improvised local trolleys. Fortunately HMS *Albion* happened to be in Hong Kong during the latter part of the advance party's time. With the excellent co-operation of the Joint Air Tasking Cell, a total of some thirty-two hours of Wessex helicopter time was allocated to the movement of stores to Lantau. As a result some 125 tons of stores for the village electrification scheme and the school playground were airlifted from Gordon Hard, which is approximately six miles due North of Pak Mong, to the sites during the period 5 to 8 October 1971. A total of 100 lifts, mostly underslung, were carried out by the Wessex helicopters of 848 Naval Air Squadron from HMS *Albion*. The loads carried included concrete mixers, cement, sand, aggregate, timber, chain link fencing, drums of cable and numerous small electrical items packed into a variety of boxes.

The RAF VC10, carrying the bulk of the main party, arrived in Hong Kong during the evening of 7 October 1971. The Britannia, carrying the remainder of the men and some freight, and the Hercules, carrying the bulk of the freight, including one trials Mark 9 Land Rover fitted as a High Cycle Machinery vehicle, were delayed *en route* by twenty-four hours and fourteen hours respectively. As a result the Britannia did not arrive until the afternoon of 10 October 1971, whilst the Hercules did not arrive until the morning of 11 October 1971.

Execution

It had been planned that the main move of stores to Lantau should be carried out by landing craft from 415 Maritime Troop RCT on 11 October 1971. The stores to be moved amounted to some 200 gross tons, including some 45 cu yds of sand and aggregate in tippers, 8 tons of cement, a 27½ kVA generator, a 10/7 concrete mixer, two ½ cu yd dumpers, two fire pumps, timber and plywood and numerous small stores. In order to move these stores, 415 Maritime Troop provided two RPLs and one LCM. The RCT were not very happy with the gently shelving, and stepped, beach and we therefore planned to use our LFB Raft as a ship to shore link. The LFB Special Raft (which was in effect a Landing Bay Raft, a Floating Bay, a Wet Gap and another Landing Bay Raft, with a Landing Bay of three panels on one end and two panels on the other end, giving a total length of 102 ft 6 in), was primarily designed to provide a floating platform from which a Jones KL 66 crane would be used during the construction of the jetty extension. The LFB Raft was constructed at Sham Shui Po on 9 October 1971 and towed to Lantau on Sunday 10 October 1971, where it was firmly anchored and a field section left to look after it. That night a rather localized storm hit that part of Lantau and despite the efforts of the Mark VII tug, all the Johnson 40 OBMs on the raft and the anchors, the LFB Raft was driven on to the shore. Fortunately only one man was injured and this was only a minor knee injury. The morning of the 11 October found part of the LFB Raft high and dry on the beach with one corner protruding through the perimeter fence of the stores area. The tug, fortunately undamaged, could be seen neatly parked on the beach above the normal high water mark. By mid-day the sea had moderated and the LFB Raft had been refloated and the movement of stores continued apace. Everyone worked with a tremendous will and by the end of the day (shortly before 2200 hrs) all the stores had been safely deposited in the stores area. The landing craft kept going all the time and, at one stage, there were so many vehicles and stores on Pak Mong beach that it looked like a mini-Normandy. It was certainly quite a sight to see a swarm of Sappers and Pioneers manhandling awkward loads like the 27½ kVA generator and 10/7 concrete mixer up the beach.

Because all three projects were located in such a remote area it was realized from the start that the exercise would involve a very complex build up of stores and equipment. There were times when the logistical planning began to assume a greater importance than the actual work being carried out on the site. In the event there were few holdups on site due to shortages of stores, mainly because of the forward thinking of the Project Co-ordinating Officer (PCO) and the three Project Officers. There were two systems for the movement of stores to site during the construction stage. Under the normal system, Project Officers indented for stores and equipment through the PCO giving a date by which they were required on site. The PCO would then arrange for the stores or equipment to be drawn by our stores detachment which was based at Sham Shui Po with 54 (Hong Kong) Support Squadron. Wherever possible the stores would be collected by squadron transport and delivered to Fan Gardens Camp in order that the necessary accounting could be carried out. Subsequently the stores were labelled for the appropriate site and then taken by the morning or afternoon shift to Lantau. This system proved to be very effective and it enabled the PCO and the SQMS to know exactly where the stores were. The second, or priority, system was designed to cope with the urgent demand for stores, such as spare parts for a piece of plant which had broken down. The demand was made over the VHF radio link from Lantau to Fan Gardens Camp and then telephoned through to our stores detachment at Sham Shui Po. The item would then be sent by road direct to Gordon Hard to link up with the next available landing craft. This system worked very well although, because of the distances involved, it was seldom possible to achieve a time of less than four hours from the sending of the radio message to the arrival of the item on site.

At the Initial Reconnaissance stage of the exercise it was envisaged that the troop constructing the jetty extension would camp on, or adjacent to, the beach at Pak Mong. Indeed this appeared to be a feasible idea when the Confirmatory Reconnaissance visited the area on 2 September 1971, although on that day there was insufficient time (and very heavy rain) to carry out a detailed camp reconnaissance. When a detailed administrative reconnaissance was carried out on 27 September 1971 it was found that it would be very difficult to set up a tented camp for one field troop let alone an entire squadron. It was therefore decided that all the squadron would live at Fan Gardens Camp and that they would travel to and from Lantau each day. This meant that about three hours were used up each day in travelling to and from work. The usual method was to travel by road from Fan Gardens Camp to Gordon Hard (approximately forty-five minutes) and then by landing craft to Pak Mong beach (approximately forty minutes). Despite the long hours spent travelling this was undoubtedly the correct solution because it ensured that the soldiers returned each day to a properly administered camp rather than to a tented camp on Lantau with the huge administrative penalty which any tented camp entails.

The Three Projects

Our Priority 1 project was the village electrification scheme. This task consisted of the electrification of the "Three Villages" (as they are referred to locally) of Pak Mong, Ngau Kwu Long and Tai Ho as well as the associated hamlet of Tin Liu. In all, seventy houses were provided with two light bulb sockets, one power point and, for many of the houses, one external light in addition. The scheme was carried out in two parts. Pak Mong is a small compact village and it was therefore planned that its electrification should be carried out separately. Apart from the internal wiring requirements in each of the twenty-seven houses, the task consisted of the installation of a 12½ kVA generator and the erection of eight metal telegraph poles (30 ft long) and five stays to carry the overhead cables. The village of Tai Ho is quite close to

Ngau Kwu Long, as is the associated hamlet of Tin Liu. It was therefore planned that the two villages and the hamlet should all be linked to one 20 kVA generator installed in Ngau Kwu Long. Apart from the internal wiring required in each of the forty-three houses, the task consisted of the installation of the generator and the erection of twenty-nine metal telegraph poles and fifteen stays to carry the overhead cables. In the original plan it was envisaged that the construction of the two generator bases and their associated generator houses should be undertaken by a local contractor. This work was put out to contract by the District Office, but this was not a great success as the lowest tender was for HK $40,000. Naturally, the District Office refused to accept the tender and we agreed to construct the generator bases in order that we could complete the project. We realized that we would not have sufficient time available to construct the generator houses as well, and it was agreed that they would be built by the villagers with materials supplied by the Hong Kong Government. The work on this task was carried out by a composite section of electricians from the field troops with mates from Support Troop, two field sections (from 1 and 3 Troop) and a small RPC Section. Throughout the exercise this task progressed very much as planned and it was duly completed on time.

Our second project was the extension of the Pak Mong Jetty. This task consisted of extending the existing 77-ft long concrete and rubble jetty (Plate 2) by a further 95 ft in order to allow motor junks and large craft to moor alongside at all states of the tide. The length of the extension was determined by the need to have 5 ft of water at the end of the jetty at low tide. The construction consisted of twenty-one steel pipes of 10 in diameter which were water jetted in and subsequently filled with reinforced concrete. Each pair of piles was then capped with a reinforced capsill beam.

A temporary EWBB jetty was constructed to facilitate the driving of the piles by the water jet technique and also to support the shuttering for the concrete work. The first 65 ft of the jetty extension was constructed of timber decking, 7 ft wide, bolted on to three 8 × 4 in BSBs which in turn were bolted down on to the reinforced concrete capsill beams. The last 30 ft of the jetty extension was constructed of reinforced concrete slabs, which were cast in situ on to pairs of piles at 5 ft centres. The first three slabs were 6 × 7 ft and the lowest slab 7 × 11 ft. They were stepped

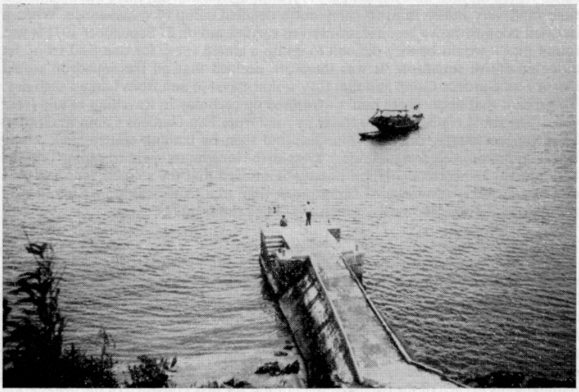


Plate 2. The existing jetty at Pak Mong. Photograph taken during the Confirmatory Reconnaissance.

down 2 ft per step from the top of the jetty. A triangular slab at the same height as the main jetty completed the task. A pair of mooring rings were cast into each slab. The work on this project was carried out by two field troops, each less one field section, assisted by a plant section who operated the concrete mixer, the water jetting fire pump, the 19 RB piling rig and also the Jones KL 66 construction crane which was mounted on the LFB Special Raft. Although this project was completed on time it was always at the mercy of the weather as the jetty was invariably on a weather shore. Altogether some eight working days were lost because of the heavy seas and the progress of the task was well behind schedule for most of the exercise. The completed jetty extension can be seen in the photograph at Plate 3.

Our third project was the complete reconstruction of the school playground at Pak Mong. This project consisted of a 100 ft square rolled earth playground surrounded by concrete surface drains and enclosed by a chain link fence. The task was perfectly straightforward although the site was most inaccessible and the majority of the equipment and stores required were airlifted in by helicopters. The task was carried out by one field troop less one field section, a small RPC section, a plant section and a further small RPC section for part of the time. The project was duly completed in time for the official opening with the other two projects.

Some Problems Encountered

It was inevitable that some problems would be encountered during the course of the exercise, but fortunately it proved possible to overcome them all without their resulting in too serious delays.

As described earlier much of the movement of stores for the village electrification scheme was carried out by Wessex helicopters during the period 5 to 8 October 1971. Unfortunately there were serious limitations to our use of helicopters for this task. First the thirty-seven 30 ft long telegraph poles could not be carried by the helicopters, either internally or underslung. They had to be taken over to Pak Mong beach by landing craft and subsequently carried by hand up the narrow concrete paths to their final location. As each pole was a ten-man load, it was no mean feat on the part of the Pioneers of 518 Company that they delivered each and every pole

Plate 3. The completed jetty extension at Pak Mong.

to its correct site. Secondly it was found that the down draught of the helicopters, particularly the Wessex and Sea King helicopters, tended to flatten the standing rice crops, not to mention lifting tiles off rather flimsy local houses. As a result it was not possible to deliver all the stores to their correct site and this in turn increased the logistic manpower bill.

As mentioned earlier altogether some eight working days were lost on the Pak Mong jetty extension because of heavy seas. The jetty extension was invariably on a weather shore and on more than one occasion the sea was breaking "green" over the EWBB falsework. Similarly considerable problems were encountered with the LFB Special Raft which did not take kindly to being anchored off a weather shore in a heavy sea. On two occasions the raft was driven on to the shore and, on many other occasions it had to be towed to Gordon Hard in order to achieve a safe anchorage.

It was realized from the outset that the tides would play a large part in the successful completion of the jetty extension. All those concerned with the construction found that a copy of the tide tables was essential. However, it was not realized what an effect typhoons and severe tropical storms, which passed near to Hong Kong, would have on the tides. In the event it was found that Typhoons Della (25 September) and Elaine (8 October) and Severe Tropical Storms Fay (13 October) and Hesta (25 October) all completely disrupted the normal pattern of tides, as well as causing the heavy seas referred to above.

It was found that the construction of the EWBB falsework for the jetty extension project was very much more difficult than had first been supposed. The main problem encountered was that of bedding in the mudsills at the foot of the grillages where the structure became in effect piers. Although the Public Works Department's soundings were accurate enough it had not been realized that there were a number of large rocks lying on the sea bed in the line of the jetty extension, as well as a number of hollows and depressions. Furthermore the heavy seas at the start of the project delayed the construction of the Bailey falsework at a time when the high tides should have been favourable. Consequently much of the actual construction of the Bailey falsework was carried out at a time when the high tides were unfavourable and therefore work was only possible for a limited number of hours each day. All these factors resulted in the Bailey falsework taking twice as long to be constructed as had been planned for.

Recovery

Regrettably the recovery from the exercise area proved to be the least satisfactory aspect of the exercise. Initially it had been agreed that the recovery phase would take place during the period 13–14 December 1971 and the completion dates and opening ceremony for the three projects planned accordingly. Towards the end of November it was discovered that the recovery phase had been brought forward to 11–12 December 1971 and fresh plans were made. During the evening of 9 December 1971 an Immediate signal announced the cancellation of the two aircraft due to lift out the majority of the soldiers and, subsequently, it was discovered that the aircraft had been diverted to lift British citizens from East Pakistan. In due course fresh flights were arranged for 18 and 21 December 1971. On 22 December 1971 the last aircraft arrived in the UK and Exercise BIRO had officially ended.

Value as a Training Exercise

As may be appreciated from the above description of the work carried out, the Squadron was able to practice a wide variety of skills. All these tasks were a challenge in their own particular way and provided very good training at all levels. There were a number of points of particular note:

a. Throughout the exercise the eight field sections (2 Troop was represented in Hong Kong by two field sections only) of the Squadron retained their separate identities whilst working on the three tasks. The only specialist group formed specifically for the exercise was the electricians section, which was made up of electricians from all the field troops, with mates provided by the workshop section of Support Troop.

b. The exercise provided most of the artisan tradesmen with the opportunity to practice their trades on worthwhile tasks. The three tasks provided particularly good training for the electricians, carpenters and joiners, welders, engine fitters and bricklayers (on concrete work). Alas the plant operators were denied the opportunity of working on a large earthmoving task, but they nevertheless gained valuable experience operating all the many and varied items of plant used in support of the three tasks. In general the standard of workmanship was satisfactory. The electricians were particularly commended for their high standard of workmanship by 54 (Hong Kong) Support Squadron, who were in overall supervision of the village electrification scheme.

c. There was virtually no repetitive work during the exercise. In general the three tasks provided sufficient work on each aspect to achieve the maximum in lessons learnt and the minimum risk of boredom.

d. To a large extent many of the individual tasks on each of the projects were within the capability of combat engineers rather than artisan tradesmen. On the jetty extension considerable experience was gained on unusual constructions and uses of EWBB and LFB.

e. Helicopters were widely used throughout the exercise, with some 250 sorties being flown by five different types of helicopters, from all three Services. Most of the loads were underslung and this provided excellent training for all the helicopter handling parties involved.

Lessons Learnt and Re-Learnt

The exercise served to emphasize once again the importance of detailed planning well in advance of the commencement of work on the projects. It is fully realized that on a relatively short exercise such as BIRO it will seldom be possible to carry out in full all the stages of reconnaissance and planning which are considered desirable for a large engineer project (those stages which are detailed in Royal Engineers Technical Directive No 1 of 1970). With the benefit of hindsight it must be said that a number of mistakes occurred during the planning sequence. The Confirmatory Reconnaissance took place too late, and as a result, it was not possible to complete the necessary detailed planning prior to the arrival of the advance party in Hong Kong. Regrettably the effect of this was that the decision had to be taken at that late stage, to reduce the number of tasks which the Squadron could undertake during the exercise. The task which had to be given up was the Luk Keng Road, with the consequent loss of the opportunity to work on a large road construction project.

From the very start of the exercise logistics proved to be the most vital factor in the conduct of the exercise. The logistical support for the base camp posed no problems. However, the three tasks on Lantau Island involved a very complex build up of stores and equipment. The timely movement of men, stores and equipment provided extremely good training at all levels. Once again the twin lessons of detailed forward thinking and a flexible approach to unforeseen problems were learnt by all ranks.

Good and reliable radio communications proved to be another vital factor in the successful completion of the three tasks. VHF radio communications were widely used, both at squadron and troop level, throughout the exercise. The maintenance of a link, throughout working hours, between the base camp and Lantau Island resulted in enormous savings in time, particularly in the forward movement of stores and spares.

Conclusion

Exercise BIRO was a most successful exercise. All three projects undertaken were completed in full, on time, and to the declared satisfaction of the Hong Kong Government. All the combat engineers and many of the artisan tradesmen were able to practice their trades on a wide variety of interesting tasks which contained very little repetitive work. All the soldiers became extremely fit, were generally healthy and their morale remained at a very high level throughout the exercise.

BRITISH HONDURAS

The weather on Salisbury Plain can be pretty miserable in January so it came as no surprise to the Squadron to find themselves digging in there in the pouring rain on 26 January 1972. The Squadron were out on a three-day deployment exercise and so the 1800 hrs O Group, gathering in the comparative warmth of the Command Post, were fully prepared to be told to move that night. Just as the Squadron Commander began to speak, the CO of 22 Engineer Regiment, who had not been expected until much later that night, arrived to say that our Spearhead Troop were now on twenty-four hours notice to move to British Honduras. In the still pouring rain the Squadron packed up and returned to Tidworth. By 2300 hrs the Squadron had re-packed all their kit and were ready for an airmove to the Caribbean. Meanwhile the Squadron Commander had accompanied the CO to HQ 3rd Division for briefing. During the briefing he discovered that this was to be an exercise to test the operational efficiency of the Spearhead Troop by attaching it, at very short notice, to a Caribbean exercise which had been planned many months earlier.

The next morning found the Squadron Commander on his way to HQ STRATCO, for further briefings and discussions as to the exact composition of the Sapper element on Exercise CADNAM. Exercise CADNAM had been primarily designed to provide the 2nd Battalion Grenadier Guards with a battalion exercise in British Honduras, during the course of which the resident company group could be relieved by another company group. At that time the company group was the major part of the garrison in British Honduras. After some discussion HQ STRATCO agreed that the Squadron would receive greater value from the exercise if more than one field troop were to be added to Exercise CADNAM. It was suggested that the whole squadron, less one field troop, should be sent. This plan was accepted by the MOD and arrangements were made to fly the 100 man squadron out in two waves of forty and sixty, with a very light scale of vehicles initially.

At 1430 hrs on 28 January 1972 the reconnaissance party, consisting of the OC and a Recce Sgt, took off from RAF Lyneham. This flight, which was Chalk 7 of Exercise CADNAM, landed at Belize at approximately 0900 hrs on 29 January 1972. Fortunately HMS *Phoebe* was visiting Belize at the time and her Captain kindly made his Wasp helicopter available for the reconnaissances. That afternoon the Squadron Commander was able to carry out an air reconnaissance up country, as a result of which he was able to suggest a number of possible Sapper tasks. During the next four days the remainder of the battalion arrived and with them the first forty men of the Squadron. Meanwhile the Squadron Commander had been able to carry out a ground reconnaissance up country.

Whilst the battalion airlift had been taking place the MOD decided that the Sapper element should not, after all, be any more than the first forty men. Whereupon the Squadron Tac HQ packed its bags and set off on the return journey to England, arriving there during the afternoon of 4 February 1972. This left 2 Troop, consisting of four field sections, in British Honduras where they remained until 20 March 1972. Whilst in British Honduras 2 Troop provided Sapper support to the Battalion, carried out a number of tasks up country and completed a few minor projects. All in all the short tour in British Honduras provided 2 Troop with a most interesting and useful time, although it did mean that their time in Tidworth before going to Northern Ireland was very short.

Tac HQ arrived back in Tidworth on a Friday afternoon. The following Monday morning found the OC and his reconnaissance party in Belfast. That dismal city certainly made British Honduras seem a very long way away!

NORTHERN IRELAND

Introduction

On 28 March 1972 34 Field Squadron RE took over the responsibility for providing engineer support to an Infantry Brigade in the Belfast area. The Squadron moved to Northern Ireland fully prepared to carry out a normal four months roulement tour in the Province.

Our arrival in Northern Ireland coincided with the start of the "Peace Initiative". The four months tour included the period following the announcement (13 June 1972) of the Provisional IRA Ceasefire, the ceasefire itself (27 June 1972) and the three weeks of intense operations which resulted from the resumption of hostilities on 9 July 1972.

The Squadron had known for many months that they were due for a tour in Northern Ireland in the spring of 1972. However, for various reasons, the actual dates of the tour were changed twice during the time that we were in Hong Kong. From the time of our return to England the whole of the Squadron's training was directed towards subjects which would be useful in Northern Ireland. Rather more than half of the Squadron had been in Northern Ireland during the 1971 tour and indeed, some of the soldiers were returning to the Province for the third time. Thus there was a considerable residue of Belfast experience within the Squadron although only one of the officers had previously served in Northern Ireland.

Operational Tasks

Most of our tour was taken up with barricade clearance, street clearance, bomb damage assistance, defensive works and other minor works assistance to units. Many of these tasks are by now well known to most people, and they will not therefore be described in any detail.

Throughout our tour we were regularly tasked with barricade clearance work in many areas of Belfast. During these operations a total of 132 cars, 129 tipper loads of rubble and many other items such as buses, lorries and pieces of plant were removed. On most occasions the work was carried out by our readiness force, but there were two periods of intense barricade clearance operations when more than half the Squadron were involved.

Street clearance tasks, known as Operation STEPTOE, were carried out at various times during the tour. A total of 352 burnt out or derelict cars as well as many other items such as rubble were removed. Operation STEPTOE assumed major proportions during the period of the ceasefire (27 June–9 July 1972).

Throughout the tour Plant and Readiness Sections stood by to give assistance with bomb damage. This assistance was called for on many occasions, mainly to remove rubble but also at times to cover damaged roofs with tarpaulins.

As with previous squadrons in Belfast, much of the work consisted of defensive works, which were allocated priorities by AQ Branch. The tasks in the main fell into five categories:

a. The construction, re-siting and repairing of observation posts or sangars. Many of these were elevated on scaffolding towers and several were armour plated. Altogether the Squadron dealt with fifty-two such tasks.

b. The bricking up of windows, doors and gateways and the boarding up of exits, doors, alleyways and buildings. A total of 129 tasks were carried out under this category.

c. The provision of anti-rocket protection in the form of high chain link fences, security wire fences, anti-bomb glissades and concrete block emplacements (to prevent the deliberate crashing of vehicles into OPs and buildings).

d. The erection of anti-sight screens either to shield open areas from view or to block off streets so as to protect sentries from aimed gunfire.

e. The humping of roads to slow vehicles. Initially a number of road humps were laid but the idea lost popularity because of the inconvenience caused to law abiding citizens.

Under the heading of minor works assistance to units many small tasks were undertaken, eg the Makroloning of windows in sangars and buildings, the construction of knife rests, the wiring and sandbagging of minor defences, the construction of various corrugated iron buildings and a variety of repairs and alterations to buildings.

During the tour the Squadron carried out a number of Internal Security tasks. These consisted in the main of the setting up of vehicle check points, various searches, checks on parked cars and foot patrols. Alas our only success with any of these tasks came when we found a shotgun in a car.

Some Unusual Tasks

One of the most rewarding features of a tour in Belfast in the Sapper role is the opportunity which occurs from time to time of carrying out an unusual task. During this tour a number of such tasks were carried out.

During April 1972 one of the battalions in Belfast decided that they would convert part of their complex into a virtual fort. In order to accomplish this, two rows of terraced houses had to be "mouseholed" and a total of fifty-nine first floor windows had to be bricked up, each with its own sniper slit. It was very much feared that the IRA gunmen would fire at the sections engaged in bricking up the windows. Accordingly two Armoured Platforms were constructed, from which the bricklayers could work in comparative safety. The platforms were designed to stand on the back of a 4-ton vehicle and were clad in armour plate. The effect was quite impressive as each platform stood 17 ft 6 in high. The two Armoured Platforms can be seen in the photograph at Plate 4.

Towards the middle of June 1972 it was decided that the Peace Line between the Springfield Road and North Howard Street should be entirely renovated. Initially it was decided that the task should be carried out in slow time. However, on 14 June 1972 the Brigade Commander decided that the task should be completed by the weekend. Thus 0700 hrs on Thursday 15 June 1972 found the entire Squadron effort concentrated on the Peace Line. There were eleven separate tasks to be carried

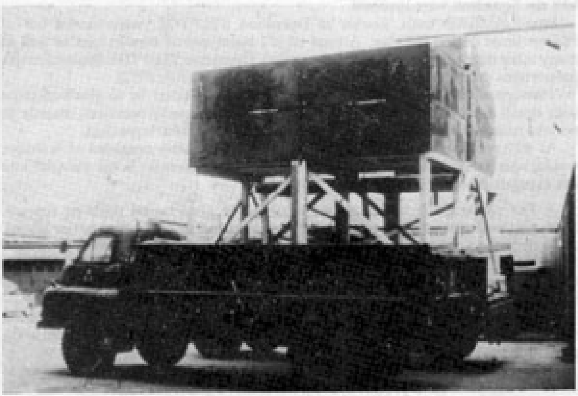


Plate 4. The two armoured platforms.

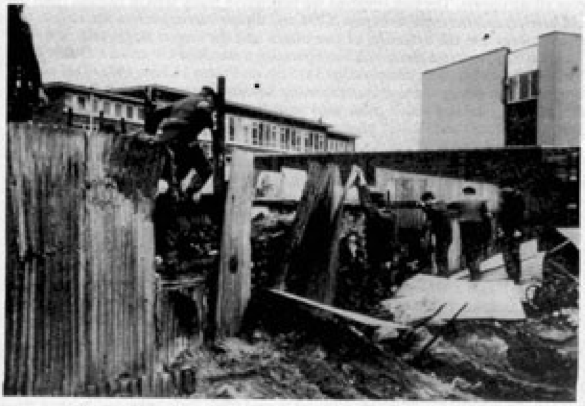


Plate 5. Removing the old peace line barrier across Conway Street.

Plate 6. The new peace line barrier across Conway Street.

Oh To Be In England 5 & 6.

out, which, because of their various sizes, meant that all nine sections were required to complete them in time. Throughout the task the field troops were supported by Plant Section with one Medium Wheeled Tractor and two Light Wheeled Tractors, plus all six tippers. The task involved the removal of many tons of rubbish from the old barriers and the erection of new XPM and timber barriers across five streets, two sight screens and the extension of two others and the largest single task of a 60 ft long 8 ft high concrete block wall incorporating a standard OP and a lockable door. The entire task was duly completed at 1815 hrs on Friday 16 June 1972. This was the only occasion during the tour that the entire Squadron was able to work together on one task, something which most field squadrons never do during their tours in Belfast. "Before" and "after" photographs of some of this work on the Peace Line are at Plates 5 and 6.

As the Protestant marches of 1 and 12 July drew nearer the fear of possible inter sectarian strife grew. It was decided that it would be necessary to erect sight screens along various parts of the route where the marchers were due to move through Catholic areas. Mobile Sight Screens were manufactured of hessian and timber and mounted on the side of a 4-ton truck. The resulting screens were 16 ft high when mounted on the truck and they each had two wings which opened out to provide a total length of 40 ft. A total of twenty Mobile Sight Screens were constructed for the march of 1 July 1972. They proved to be so effective that a stronger screen was designed and thirty-four of these were constructed for the marches on 12 July 1972. Three of the Mobile Sight Screens can be seen in the photograph at Plate 7.

Other Tasks

The Squadron was given a MACC task to carry out over our last weekend in Northern Ireland. During the afternoon of Saturday 22 July 1972 terrorists succeeded in blowing up more than half of the most Westerly span of Shaw's Bridge. That night it was decided that the Army would build a Bailey Bridge over-bridge across the damaged span as "a gesture of friendship to the people of Belfast". Accordingly a 50-ft Single Single Standard Widened Bailey Bridge was constructed on Sunday 23 July 1972 and the bridge was opened to traffic that evening.

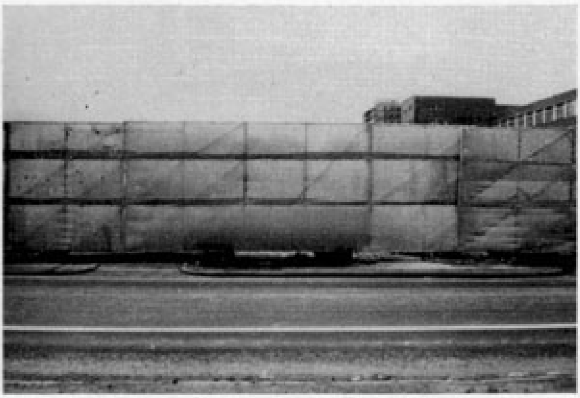


Plate 7. Part of the line of mobile sight screens erected along York Street on 1 July 1972.

Conclusion

Although there are times when the day to day political events tend to overshadow everything else, for the most part Northern Ireland continues to provide a field squadron in the Sapper role with excellent training for war. All the members of the Squadron can quite clearly appreciate that whilst they are there they are carrying out a most valuable and worthwhile task often in the most exacting circumstances. There is no doubt that many junior NCOs, particularly field section commanders, and many junior officers either learn very quickly what leadership is all about or all too soon reveal their limitations for everyone to see. Nevertheless there is a danger that too many tours in Northern Ireland could lead to the sort of inward thinking which can so easily result from an almost total involvement in a particular campaign.

CONCLUSION

By any standards it has been a very hectic year, during which we have managed to visit the tropics twice and also complete a four months emergency tour in Northern Ireland. Inevitably we have found that the resulting separation has not been very popular with our families, and equally inevitably our busy life has meant that we have been unable to carry out much of the training which we had hoped to achieve. Indeed early in September we found ourselves in the strange situation of exercising with our affiliated brigade for the first time in more than two years and the even stranger situation in which we found that some of our younger soldiers had been shot at in Belfast but had never until then spent a single night in a troop harbour area in the field.

At the time of writing the Squadron has settled down to life in England, with much of our time being taken up with a series of brigade and divisional exercises, interspersed with periods of training and administration. During next year we are due to spend some six weeks in Cyprus on exercise, followed by another tour in Northern Ireland. There are indications that next year could end with the Squadron taking part in a NATO exercise.

Meanwhile we continue to count ourselves most fortunate to be serving in the Strategic Reserve, with the very full and varied life that inevitably comes our way. Perhaps one day we will succeed in our aim of exercising in BAOR, but for the time being we look forward to providing, once again, engineer support to our BAOR Sapper friends whenever they find themselves walking the streets of Belfast as Infantrymen.

Experiment with Polypropylene Fibres in Reinforced Concrete to Increase Resistance to Small Arms Fire

MAJOR C SPOTTISWOODE BSc (Eng) MICE AMBIM RE

INTRODUCTION

THIS is an account of an experiment which failed. Even failure, however, produces dividends and leads to further, perhaps more fruitful, development.

The seeds of thought were originally sown by an article on piling in the Proceedings of The Institution of Civil Engineers. This mentioned that some manufacturers of concrete piles add polypropylene fibres to the concrete in the tops of the piles to increase the impact resistance. Further research into the literature on fibre reinforcement produced details of types, quantities and elaborated on mixing problems. The fact that the addition of fibre at 0·2 per cent by weight increased the impact resistance by 300–400 per cent implied that this could considerably enhance the resistance of concrete to small arms fire.

Here in Hong Kong, The Gurkha Engineers are working continously on improvements to border positions and some buildings still show the marks of previous attacks. Would the use of fibre reinforcement lead to improved protection and lighter construction? It was decided to hold provisional feasibility trials.

CONSTRUCTION OF TEST BLOCKS

Correspondence with The Institution of Civil Engineers led to contacts with Shell Chemicals, the patentee of Caricrete, a method of fibre reinforcement, and British Ropes Ltd, the supplier of the polypropylene fibre. The type selected was 12000 denier, cut into 2 in lengths. A test sample of 5 lb was supplied by the manufacturers free of charge.

In order to produce test blocks which were representative of typical strong point construction, were suitable as targets, and yet were manageable without lifting equipment, it was decided to construct six blocks at 3 ft. 6 in × 3 ft. 0 in × 6 in, with variations in reinforcement:

Block 1 No reinforcement
2 Fibre only
3 Mesh reinforcement
4 Mesh and fibre
5 XPM reinforcement
6 XPM and fibre.

Mixing was by hand and no great difficulty was experienced with the addition of the fibre. It was found better for uniform distribution of the fibre if the concrete was mixed dry, but a regular "final finish" was obviously difficult to achieve because of the "straw" effect. The blocks were painted white with a black cross to produce four target areas on each block.

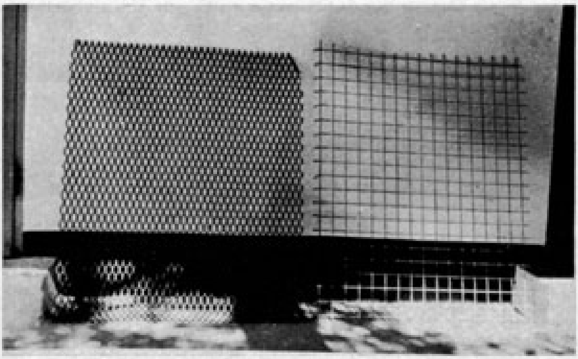


Plate 1a. The reinforcement.

Experiment with Polypropylene Fibres 1a

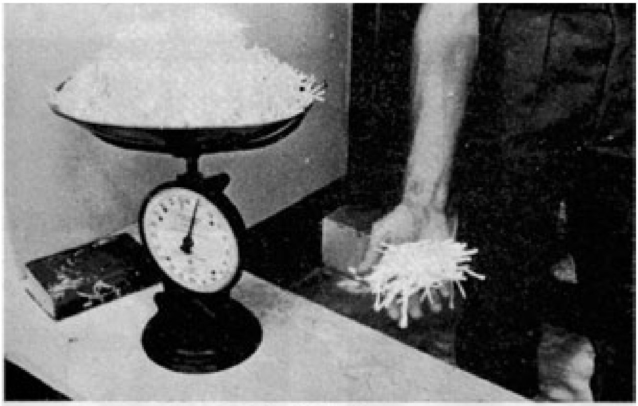
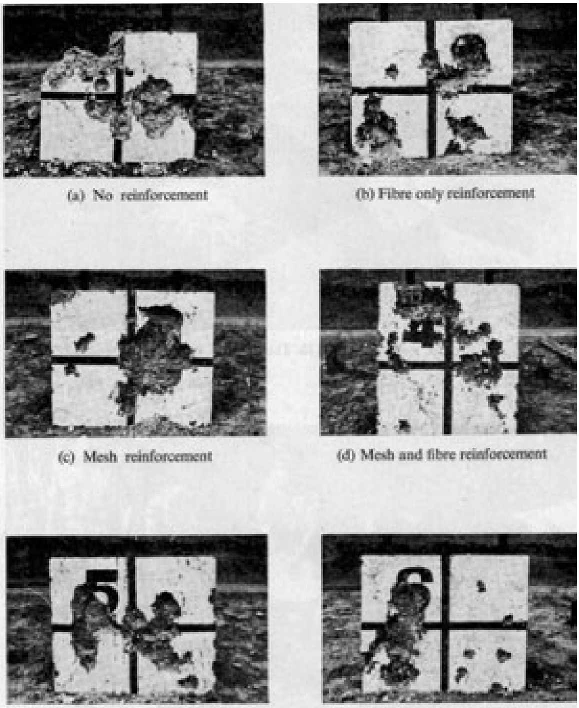


Plate 1b. The fibre.

Plate 1c. Mixing by hand.

Experiment with Polypropylene Fibres 1b & c



(a) No reinforcement

(b) Fibre only reinforcement

(c) Mesh reinforcement

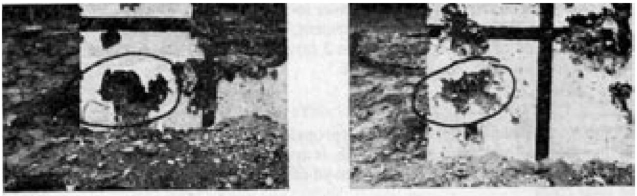
(d) Mesh and fibre reinforcement

(e) XPM reinforcement

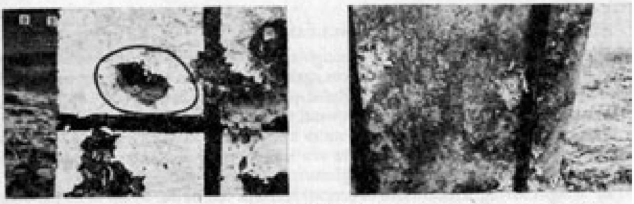
(f) XPM and mesh reinforcement

Plate 2.

Experiment with Polypropylene Fibres 2



(a) Mesh reinforcement. Effect of ten rounds fire



(b) Some consolation.

Ten rounds from an army rifle only just penetrates a block reinforced with fibre

Plate 3.

Experiment with Polypropylene Fibres 3

TEST FIRING

The blocks were taken to the range forty days after casting and set up on the butts. Firing took place from 100 m and the detail fired 1, 5, 20 shots and 2 magazines, respectively, at the four separate quarters of the six test blocks. Special selection of the firing party had not been possible and marksmanship varied. It was evident from this first attack, however, that the presence of fibre had made little more than a marginal improvement in resistance to rifle fire.

Further selective firing to penetration or destruction was carried out and although the fibre showed its ability to help shattered concrete hang together, its advantages were not impressive (Plate 3b).

It was noticed that the concrete cover to the XPM reinforcement spalled off in large sections in front of the reinforcement, presumably because the latter caused a definite plane of weakness (see Plate 2 (e) & (f)). XPM is not, therefore, recommended for this type of concrete work.

COSTS

The present (Hong Kong) cost of polypropylene fibre of the type used, and bought in quantities of between 120 and 240 lb, is approximately £31 per 100 lb. The Hong Kong unit cost is, therefore, £2·4 per cu yd of concrete, which adds about 50 per cent to total costs.

REASON FOR FAILURE

It is deduced that the impact area of a bullet is too small to allow the fibre to act effectively. This in turn means that the concrete in the immediate area is stressed beyond the fibres limits and the spalling effects are only reduced over a relatively small area.

CONCLUSIONS

Fibre reinforcement is easy to use (though expensive), but is of little assistance in conjunction with concrete in protection against small arms fire. It may well be of assistance in the construction of overhead protection against mortar or shell fire, however, where an earth overfill can spread the impact load.

Fibre reinforcement is being used more and more in civil engineering, a world where costs are paramount, and there are undoubtedly a number of advantages which are very relevant to military engineering. These advantages include:

a. Weight saving. Thicknesses of precast sections can be cut by up to 50 per cent for the same strengths, giving distinct logistical advantage.
b. Impact resistance, excluding bullet strikes!!
c. Ability to remain coherent after being cracked.
d. Residual strength after cracking.
e. Corrosion resistance.

As military engineers it behoves us to keep a close eye on developments in the civilian world and apply advances in technology and technique to our own special problems.

Fibre reinforced concrete may not be successful against small arms fire, but its properties offer intriguing advantages for further ideas.

* * * * *

Painting of Gazelle Bridge
Bukit Mendi
Malaysia

In April 1972, a painting by Norman Hepple, RA, of the construction of Gazelle Bridge at Bukit Mendi in Malaysia was unveiled in the RE Headquarters Mess.

Gazelle Bridge was the major construction task in the Bukit Mendi Project, and consisted of a 3-span concrete bridge across the Sungei Triang in Pahang, West Malaysia. This project was carried out as a training exercise in aid of the Malaysian Government, by troops from engineer squadrons in the Far East, from December 1968 to January 1970. In general there was only one field troop on site, but a second troop, formed from 54 (FARELF) Support Squadron RE, was deployed from June 1969 to January 1970 to carry out construction of this bridge.

The two abutments and two piers were each supported on 35 ft long reinforced concrete piles, some of which can be seen being cut back to expose the reinforcement for casting into monolithic capsills. The 40-ft spans consisted of precast prestressed concrete beams with *in situ* concrete infilling, deck and edge beams. A feature of the bridge is that it is designed to be over-topped by floods which often occur suddenly, and so had to be "streamlined".

Other principal tasks included in the Bukit Mendi Project were:

- Construction of 5 miles of main access road, leading up to Gazelle Bridge, and passing over a single-span bridge and eleven concrete culverts.
- Erecting forty-six timber houses for settlers.
- Building a Community Centre.

Apart from the houses, all the works were designed by 63 CRE (Construction),

Painting of Gazelle Bridge Bukit Mendi Malaysia who commanded the project and provided supervision. Australians and Gurkhas, as well as British Sappers, were employed.

This project, which saved the Malaysians over M300,000 and opened up a large area for development, provided excellent training and helped to strengthen international friendships. It is portrayed to represent the many construction tasks undertaken by the Royal Engineers in the Far East.

Presentation of Silver to 30 Field Squadron

CAPTAIN D F MASKENS, RE, has presented a silver statuette to 30 Field Squadron to mark his retirement from the Army after over thirty years service.

The 9-in high solid silver statuette was specially commissioned by Captain Maskens from Garrard and Company. It depicts a soldier armed and equipped for internal security duties and commemorates the squadron's tour of duty in N Ireland from November 1971 to March 1972. The statuette is particularly remarkable for the accuracy of the detail it shows, such as the rifle sling secured to the right wrist of the soldier.

This generous presentation is a very welcome addition to the Mess silver of 32 Engineer Regiment and for many years to come will serve as a token of the esteem in which Captain Maskens is held by all members of the Corps who served with him.

Presentation of Silver to 30 Field Squadron

Branch Meeting of the Institution of Royal Engineers

LIEUT-COLONEL K DONALDSON MICE ABIM RE

Brigadier E M Mackay CBE Chief Engineer UKLF chaired the Branch Meeting at which a paper on Project Planning was presented by Lieut-Colonel R D Holland MBE (62 CRE Construction). Though the title might create a rather boring initial impression, pace, point and force were given to the presentation by showing how our planning system was used for the construction of an emergency battalion camp at Long Kesh which had to be converted at short notice to an Internment Centre.

It was a full house; those attending included serving and retired officers, the civilian engineering profession, Scientific Officers from MVEE (Christchurch), University students and sixth form schoolboys. In his opening remarks Brigadier Mackay emphasized that Royal Engineers do have to produce and work to accurate cost estimates. However, our profit is the experience gained by our junior management and tradesmen. He added that another misconception was that, unlike civilian firms, we could not have labour problems. These we avoided by spending far more effort on the welfare and well being of our work force than any civilian firm. He then outlined the various stages in the Project Planning system such as Statement of Requirement, Initial and Detailed Reconnaissances, etc.

Brigadier Mackay introduced Lieut-Colonel Holland who dealt with the planning of Long Kesh camp which had to be done with considerable speed and in the face of changing Statements of Requirement. Lieut-Colonel Holland explained how the Long Kesh construction plan was built up, integrated with the provision of resources and showed how progress could be accurately reported throughout the construction phase. Lieut-Colonel R Dalton (HQ ESG) explained how resources were procured against one of the tightest time schedules ever. Once again the key to success was ESG involvement in the planning process at the earliest stage and the effective use of telephones both for ordering and progress chasing. The whole presentation was illustrated by vufoils and well chosen colour slides.

Question time was full of informed queries and comments from such eminent engineers as Colonel W C S Harrison CBE ERD ADC (County Surveyor Sussex) and his staff. Even the schoolboys joined in—one made the equivalent of "But the King's wearing no clothes" type comment about the use of man days as planning constants! The discussion continued over an excellent buffet supper in the 22 Engineer Regiment Officer's Mess. In all, a most profitable and successful meeting.

Correspondence

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AIRBRIDGE TO THE MISTY ISLE

Sir,—In a letter from Colonel D E Townsend-Rose in your December issue, the tag "Time spent on reconnaissance is seldom wasted" was mentioned.

I remember a slightly different version, which I first heard when attending a lecture by a Sergeant-Instructor in the Roads and Airfields School whilst on a Supplementary Course at the SME, Ripon in 1948—"Time wasted on reconnaissance is sometimes well spent".—Yours faithfully, Major Roy Hudson (Retd).

Brigadier M L Crosthwait MBE
Darwin College,
Cambridge.
8 January 1973

UNDERWATER ENGINEERING

Sir,—Recently the report of one lecture[1] and one article[2] dealing with developments and problems arising from the exploitation of the sea-bed have appeared in the *Journal* of the Royal United Service Institute for Defence Studies. Since under-water engineering could be a future task of the Corps, it may be appropriate to draw attention to this subject in the pages of this *Journal*. These are, of course, early days and information is hard to come by, especially to one who is not taking an active part in such matters.

In reply to the question, "Do you think that the military will be required some time in the future to produce fixed defences on the sea-bed—perhaps on the Continental Shelf?" the lecturer answered:

"This is a very interesting question. When we had only to defend harbours we put up very strong fixed defences around them, including gun defences around the coasts. If you have valuable oil and gas wells and well heads, or undersea pipes and storage, you probably will have to mount some sort of fixed defences, either on the sea-bed or by placing defence habitats in some form of area defence. I am told that if oil or gas lines in the North Sea are severed in winter it may well be very difficult to repair them in a short time. So some form of fixed defences may be needed for these."

This, perhaps, sets the general scene.

In his article, Mr Reed describes in some detail the problems arising from the Sea-Bed Arms Control Treaty 1971. These include the protection of sea-bed installations—both in their surface form (the hijacking or holding to ransom of oil rigs) and also undersea.

"These off-shore assets are extremely vulnerable to unseen submerged attack and they have a value which makes them attractive target for sabotage. . . . The real problem is to guard them against wrecking tactics in times of crisis, and the activities of terrorist organizations. . . . The protection of well-heads, pipelines and underwater storage facilities is more problematical. . . ."

The author goes on to say that in the long run the only way to protect our civilian investments in the oceans is for the Navy to develop a total underwater capability. This means starting now a major ocean engineering programme, preferably in conjunction with industry.

It is too early to expect the Royal Engineers to be mentioned in articles and lectures such as these. But for all that, the Royal Engineers are potentially "Civil Contractors" to the Royal Navy as well as to the Royal Air Force. Perhaps we should be preparing now for the implications of "Submarine Mining 1984".

I, for one, look forward to the time when there will be a proper article on this subject in these pages.—Yours faithfully, M L Crosthwait.

[1] Advances in Marine Science and Technology. Defence Aspects. By Dr J Tunstead, *RUSI Journal*, September 1972.
[2] "Control of the Depths. New Tasks for Navy." By Laurance Reed MP. *RUSI Journal*, December 1972.

Major (IREM) S Osborne (Retd)
Edgehill
14 Lower Port View
Saltash
Cornwall PL12 4BY

LIGHTNING PERFORMANCE OF OVERHEAD LINES

Sir,—On reading with interest the article entitled "Lightning Performance of Overhead Lines" by Captain M D P Young—much of which I must confess is now over my head—I was reminded of a problem we had many years ago when carrying out a re-distribution service at Didcot Ordnance Depot.

The load in the Depot was growing to such an extent that we considered distribution at 11,000 volts should be adopted and, since this was 1939, underground cable was to replace the then existing overheads.

Supply from the local electricity supply authority was 11 kV and the question that arose was what apparatus would give adequate lightning protection to an underground cable layout led direct from overhead supply.

Up to that time we had found Westinghouse Lightning Arrestors to answer this purpose, but, as this was a special case, we decided that special protection was necessary.

One suggestion, I remember, was the provision of a 1 to 1 transformer with earthed shields between the primary and secondary windings, the idea being that it would be far easier and cheaper to replace the complete transformer than mess about with unearthing the many cables radiating from the supply point.

I believe the matter was finally put to the War Office for a decision but I never heard what that decision was as I was sent to France at a few days notice. It would be interesting if any of your readers was sufficiently familiar with Didcot to be able to say what lightning protection method was finally adopted. It would also be interesting to hear some opinions on the questions of lightning protection in the circumstances described.—Yours faithfully, S Osborne.

Brigadier St Barbe Sydenham CBE
Langley
Misterton
Nr Crewkerne
Somerset
31 January 1973

MISS M E (Liz) EVANS

Sir,—It may be of interest to some of the older members of the Corps to hear that Miss Evans "passed on" early on the morning of the 20 January in the Alderbourne Nursing Home, Torquay, after a relatively short final illness. As far as we knew, she had no relatives living at the time of her death.

She was orphaned from an early age and was brought up by an uncle, who was an Archdeacon in the Church of Wales, and by his wife. She was trained in catering at the Gloucester School of Cookery, and was later employed to run the catering of the Officers Mess of the Depot Battalion in the early 1920s, and very well she did it. She then accepted a similar appointment at the Caledonian Club in London.

While there she was approached, so she told me, by a representative of the Headquarters Mess some time in the 1930s to take on the organization of the catering. At that time it was considered to be important to keep down the cost of daily messing for the YOs, who formed the great majority of the dining members there, while at the same time providing a fair standard of food. From my knowledge of the HQ Mess from February 1938 to the outbreak of war I would say she did so very well.

The outbreak of war certainly made her task more difficult, but she carried on very well. Some time after our great victory at Dunkirk it was decided to move the SME and the Depot Battalion to Ripon: the Training Battalion had moved to Shorncliffe early in the war. From what I heard, the move to Ripon was accompanied—as was only to be expected—by a certain amount of chaos, to which a woman would not be accustomed. I have never asked details, but I know that she "parted brass rags" with the President of the Mess.

While I was overseas, my wife gave her a home and she worked first in one of the "National" canteens and later in London, Liz then obtained a catering appointment with the Control Commission and went off to Germany; I heard from an acquaintance that she did a good job.

She came to stay with us for about a week almost every year for the past ten years. Last October she was clearly not very well, though by Christmas she seemed to have improved.

A life in which her undoubted capabilities never reached fruition; may one hope "her soul has gone back to Wales in peace".—Yours faithfully, P St Barbe Sydenham.

* * * * *

Modern Translations

"We had a discussion"	—they listened to my views
"We had a friendly discussion"	—they agreed with my views
"We had a meaningful discussion"	—I won
"We arrived at an equitable solution"	—I won
"We had purposeful talks"	—I won

Memoirs

Major-General Sir Eustace Francis Tickell KBE CB MC
died on 28 December 1972, at the age of 79.

Eustace Tickell was a great military engineer. In the Corps his striking and unconventional personality and his decisive leadership will be remembered with admiration and affection for many years to come; to future generations he will stand as the epitome of a sapper—an unrivalled expert in all the aspects of our profession and a man who in the dark days of war repeatedly cut through all difficulties and achieved what many at that time thought to be impossible.

His penetrating mind, breadth of vision and remarkable foresight were fortified by powerful moral courage; this happy combination of qualities enabled him repeatedly to take formidable decisions and sustain them on his personal authority alone, wherever the war effort so demanded.

Yet in his make-up there was no trace of intellectual arrogance: his decisions, strenuously argued with subordinates as well as superiors, were driven through with modesty and humour, and left no sore feelings even among those, and they were many, who failed to keep up with him.

At Bedford School, another boy destined also to become a sapper Major-General, remembers how Eustace Tickell even then stood out among his peers. A few years later, at Armentieres, another future Major-General learnt from the 23 year old Tickell "a very great deal about what was required of a sapper subaltern". His outstanding ability as an engineer founded on an expert knowledge of engineer trades had already greatly impressed his subordinates; there was deep anxiety among all ranks of the company when he received a serious wound from which, in those days, he was fortunate to recover.

As an instructor at the RMA Woolwich where his style of teaching anticipated future trends, he was regarded by cadets and brother officers with admiration and affection: admiration because his dominating and unconventional intellect, though clothed in utmost modesty, was evident even amongst such a picked band of exceptional officers; and affection because of his long suffering kindness to those who lacked his mental equipment. "He was always very kind to me about my military engineering" a retired gunner officer said recently to a fellow sapper cadet of that period.

The second World War gave him his great opportunity, and it was indeed fortunate for Britain that in the dark hours of 1940, Eustace Tickell's superlative talents were deployed in the build-up of a theatre of operations which two years later was to prove decisive. He was appointed Director of Works at Headquarters Middle East Command in Cairo in 1940 and here his uncanny foresight, his capacity for improvization and his determination to cut through all procedural and technical obstacles found full scope.

To those who served with him at the time it seemed this was the moment for which Eustace Tickell had been schooled from birth.

With untiring energy and remarkable ingenuity he roped in large numbers of the local population and of the British wives, including his own, to set up a vast and efficient organization producing almost anything the Army required and reaching far beyond purely sapper needs.

If something was needed—petrol cans and drums in millions, scores of self propelled lighters, vast camps and acres of sheds, deepwater ports and hundreds of miles of roads—the Director of Works made them, on a scale personally assessed which was far beyond the imagination of more pedestrian minds. Hastily designed factories in Egypt, metal presses scattered throughout the Delta, backyard shops in Palestine and shipyards in India were all pressed into service at a time when as one of his officers has written "most people were thinking of retreating".

Maj-Gen Sir Eustace Francis Tickell KBE CB MC

Another of those working under him at that time describes the scene in these terms:

"Eustace flung himself into every one of these problems with stimulating ability, grasping essentials at a flash and reducing it all to what seemed to be simple arithmetic. His way of debunking the unsound was so fast as to be a matter of bewilderment for the authors and amusement for the onlookers.

He never appeared tired or unable to give a new problem anything less than fresh, brilliant and cheerful attention. Indeed, new problems invigorated him by their intricacy. Awkward problems became easy as one discussed them with him, and he had that compartmented mind which never allowed the worry of one emergency to spill over into the next. He worked so fast that very seldom did he have to burn evening watts in the office".

Is this not the very epitome of the professional sapper officer, and were we not fortunate indeed that Eustace Tickell, who had declined to compete for the Staff College, should have been in this key position at this decisive hour?

Many are the tributes written of his vision, foresight and dynamic leadership at this time, including the story of his succint appreciation at the beginning of hostilities "Desert—water—order 1,000 miles of 9 inch pipe".

Yet vision and intellect alone could not have mobilized behind him such a motley but devoted band of supporters. He led with kindness and was a very charitable man. His sympathetic treatment of the gunner cadet of 1927 is mirrored in 1945 in his handling of those sapper officers who had been prisoners of war, many of whom grasped the opportunities he made for them and reached the highest ranks. Those who worked with him in those strenuous days when he had moved on to the European Theatre remember him as never ruffled or bad tempered: with all his efficiency he had great charm of manner and a lively sense of humour. It was these personal qualities combined with an unrivalled expertise in all aspects of the sapper business, that enabled him to draw so much so willingly from the devoted teams who supported him throughout his long and strenuous service.

In retirement he declined many offers from the civil engineering profession and devoted himself to his family, his garden and the Corps. He was President of the Institution of Royal Engineers 1948–51 and Chairman of the RE Association 1954–6.

This memoir might fittingly end with Eustace being dined out of the Headquarters Mess in 1949. An Officer who was present on that occasion describes him sitting on the table with his long legs swinging and, in reminiscent vein, beginning to talk. Some sat on the floor to listen and soon many more joined them. The stories were all amusing—some very funny—and each had a message, a lesson learnt. Within half an hour all Mess games had ceased and the anteroom was packed to the doors, with overspill in the conservatory.

There we can leave him surrounded by the next generation: a great military engineer: an inspiring teacher: a modest and charitable man ready always to pass on to others with a private smile the superlative product of his own intellect and experience.

The sympathy of the Corps goes out to Lady Tickell and the family, and particularly to his son Marston, who, following in his father's footsteps, became Engineer-in-Chief a few weeks before Sir Eustace died.

* * * * *

MAJOR J A CRAWFORD RE

As one of his batch it was with much regret that I heard of the death of John Crawford, though it was certainly a merciful release. I have only happy memories of him, as a cadet at the RMA and as a YO at Chatham, Cambridge and Aldershot.

John was a happy-go-lucky young man, of great physical strength yet idle in its application. I can remember him moving mountains of bridging equipment at Upnor, during a mid-morning break, with the sole intention of providing a screen for his own idleness later in the day. With his natural ability and speed on the Rugger field, it was always necessary to encourage him to do adequate training, and he was lucky to have the encouragement of Lew Harris, his fellow-Sapper at Pembroke College, Cambridge, which led to his Army and International successes.

At one time he owned, but seldom could be bothered to drive, a Bentley. Later he exchanged this for a £100 Morris, with which he used to venture to London from Aldershot. Returning along the Hog's Back in the early hours of one morning, he decided to take a short nap and pulled onto the verge; waking suddenly, and imagining himself still to be on the move, he wrenched at the steering wheel and it sheared off in his hands. He barely made the first parade at Gibraltar Barracks that morning!

It must be left to others to remember John's later life, but I am sure that they will remember him with affection, and his own generation especially, however much, as in my own case, they lost touch with him later.

KFD

After the War, John Crawford was involved in a Jeep accident in Japan and suffered compound skull fractures and damage to the brain tissue. After a remarkable but by no means complete recovery he married and retired to a small farm in Jersey. He tackled his new life with vigour and determination and for some years the little farm flourished. However, he was not as fit as he thought or appeared, and he had to give up the farm. After a long spell in hospital he sold the farm and bought a small modern house and devoted himself to gardening. By now his injuries were taking an increasing toll and he was persuaded to move to London partly to ease the problem of medical treatment but also to be near his relatives. He was soon happily settled in Edwardes Square and able to get around his garden with the aid of a stick when tragically and suddenly his wife died. This bitter blow began his final decline.

In health he was a sportsman and character of extraordinary power and versatility, but after his accident he was always fighting a rearguard action; as successive advances of illness diminished some further part of his faculties, he redeployed the remainder with skill, artistry and dedication until he was finally overwhelmed on 10 January 1973.

REC

* * * * *

On Growing Older

(An AAG, AG7 Prayer—on appointment)

LORD, Thou knowest better than I know myself that I am growing older, and will some day be old.
Keep me from getting too talkative, and particularly from the fatal habit of thinking that I must say something on every subject and on every occasion.
Release me from craving to try and straighten out everybody's affairs.
Keep my mind free from the recital of endless details, give me wings to get to the point.
I ask for grace enough to listen to the tales of others, help me to endure them with patience, but seal my lips on my own, for my love of rehearsing them becomes sweeter as the years go by.
Teach me the glorious lesson that occasionally it is possible that I may be mistaken.
Keep me reasonable; I do not want to be a Saint, some of them are so hard to live with, but a pompous Sapper is surely one of the crowning works of the devil.
Make me thoughtful, but not intense; helpful, but not overbearing. With my vast store of wisdom it seems a pity not to use it all, but Thou knowest, Lord, that I want a few friends at the end.

ANB-S

Book Reviews

FRETTING CORROSION

R. B. WATERHOUSE MA PhD FIM

(Published by Pergamon Press. Price £6·50)

Fretting corrosion is a phenomenon of considerable menace to the engineer. It can occur when two surfaces supposed to be clamped rigidly together, as in a rivetted, bolted or welded structure, are in practice just sufficiently loose for a small oscillatory movement to occur as a result of an outside vibration. The effect is not normally found in rotating or reciprocating machinery since sufficient lubrication is provided between the moving parts. However, ball and roller bearings which are stationary for long periods can suffer from fretting damage. Chapter 4 is therefore of great interest to the professionally trained Mechanical Engineer. However, the whole subject and therefore the whole book is essential reading for the professionally trained Civil Engineer in particular.

The effects of fretting corrosion may be direct, through the production of metallic debris which causes clogging or distortion and leaves grooves or pits on an originally smooth surface; or they may be indirect, through the production of cracks which develop—under conditions of fluctuating stress—into fatigue cracks.

Chapter 8, which discusses "Fretting and Fatigue", should receive special study. A disturbing feature is the way in which materials of high nominal strength are affected.

Chapter 11, describing methods of preventing damage, claims the attention of all Military Engineers, and the reader may be impressed at the diversity of remedies, each of which has proved helpful under some, but not all, conditions. Some depend on the application of liquid lubricants, greases, or coatings. Others depend on changes in geometry. In the case of pinned connections, a degree of clearance can be beneficial; perhaps surprisingly, tests by D J White show that pins with the closest fit give the lowest fatigue strength. But the main conclusion at the end of the chapter is that "there is no one method which can be recommended generally and a careful analysis of the situation is absolutely essential if any measure of success is to be expected". In other words, one must understand the cause before prescribing the remedy.

For that reason the final chapter, entitled "The Mechanism of Fretting", also deserves the attention of the Military Engineer.

Three main sets of causes are suggested. The first, which could reasonably be expected even if no experiments on fretting had ever been carried out, depends on the removal of a protective skin from the surface. Mainly owing to the need for lightness, there is today an increasing use of strong alloys based on such metals as magnesium and titanium which are essentially reactive substances, but which, on exposure to air, cover themselves, almost instantaneously, with a highly protective film, so that attack ceases. If this film is scraped or pushed off, the exposed metal surface will very soon form more oxide, which will be removed in its turn. If two surfaces in contact are in rapid and continuous relative movement (as in a bearing), the total production of debris may be appreciable, but the destruction will be well spread out, so that the degree of damage may be acceptable. If the two surfaces are supposed to be clamped rigidly together, as in a rivetted or welded structure, but in practice are just sufficiently loose for a very small oscillatory movement to occur, the damage, concentrated on a few points, is far more serious. Even motor cars, sent by rail to their destination, may arrive carrying indentations at bearing surfaces known as 'false brinelling", and the damage will exceed anything which the car would have suffered if driven to its destination under its own power.

There is a third possible mechanism which can occur after a certain amount of oxide debris has been produced by the first mechanism. It may be expected in cases where the oxide is harder than the metal or alloy so that the debris can then act as an abrasive, producing small deep holes if the hard particles are prevented from moving far from the place of their formation, and shallow dish-like depressions if escape is possible. At one time, abrasion by fretting debris was regarded as a main source of damage. Perhaps the situation has tended to change; today there is an increasing use of hard materials, unlikely to be abraded by oxide debris but more liable to intense chemical attack if the protective film is removed.

Dr Waterhouse started his research career in the Department of Colloid Science, at Cambridge, and was awarded his Doctorate for research on mechanical aspects of friction processes, which included fretting corrosion, in 1955. By invitation of the Institution of Mechanical Engineers, he presented a review of Fretting Corrosion which received a warm welcome; the same year he lectured at a Refresher Course on Corrosion Fatigue organized by the Institution of Metallurgists. A few years later he was appointed to a lectureship at Nottingham University, where he has carried out and organized much research work on fretting, fatigue and allied subjects.

The present book represents his practical experience and wide study of the subject. It deserves a warm welcome, and an engineer who has read and appreciated the treatment might be doing a service by bringing the book to the attention of his colleagues.

MJEA

MY SAPPER VENTURE

V F EBERLE

(Published by Sir Isaac Pitman & Sons Ltd, Kingsway, London WC. Price £1·80 net)

A number of excellent books about the First World War, based on letters and diaries written at the time, have recently been published. Some have been sponsored by the Imperial War Museum as the authors' narratives possessed such a true ring of authenticity, an absence of histrionics and no looking back in anger. However, these simple, straightforward autobiographies unanimously tell of the changes in the authors' mood as the war progressed: the heady elation and eager sense of patriotism when volunteering to serve King and Country on the outbreak of hostilities, the gradual growing realization that victory was not quickly nor cheaply to be won and the grim determination to see things through to the end, the returning sense of elation on the almost unbelievable suddenness of the crumbling and utter collapse of the enemy's resistance and, at the close of this great drama, the sombre thoughts of the Soldier from the War Returning.

Lieut-Colonel Eberle's account of his Sapper Venture, August 1914 to March 1919, holds its place with the best of this recent batch of factual accounts of First World War personal experiences, and to readers of this *Journal* it should be of greatest interest since he describes in detail the varied tasks undertaken by Divisional Engineers on the Western Front from 1914 to 1917 and later in Italy and the conditions under which RE field units fought, worked and lived.

Educated at Clifton College, which produced two First World War Field Marshals, and Trinity College Oxford, Eberle represented Gloucestershire on many occasions at Rugby, Hockey and Tennis.

On 5 August 1914, the day after the declaration of war, he enlisted as a Sapper and within two months was selected for a commission. He served throughout the war in the 48 South Midland Territorial Divisional Engineers as Company Officer, Adjutant, Stores Officer, Second-in-Command and finally as Officer Commanding 474 Field Company. He was awarded the MC and twice mentioned in despatches.

The Division was a truly territorially recruited one and the author writes of the many school friends and sports field acquaintances he met serving in units throughout the formation. The Divisional Commander is described in most affectionate terms. He must have been a great character, and he obviously valued his Sappers and employed them to the best advantage.

Their employment was multifarious. It included all the varied trench warfare tasks which were the constant chores of all sapper units in the line, the preparatory tasks before a major battle and engineer support in the assault and the holding of ground won.

The author describes how he was given the task of developing the use of the Bangalore Torpedo in the Division and how he produced a satisfactory and sure device for initiating them—this had been one of the early problems connected with their use. He describes also how his unit was employed on forestry work and the prefabrication of trench warfare stores and packing cases in which gas cylinders were unobtrusively carried to the forward trenches, on elementary tunnelling and quite sophisticated camouflage, and later on the construction of a heavy-traffic timber plate-girder bridge—Bristol Bridge—over the canal near Peronne during the German withdrawal in the Spring of 1917, the repair of several other bridges over the River Somme and the canal, the opening up of cratered roads and those blocked by felled trees and the clearance of mines and booby traps.

The author writes with great feeling for the Field Company Mounted Sections—so infrequently mentioned in Corps or Unit Histories. He recalls the quiet gallantry and devoted service of the Mounted NCOs and Drivers and the patience of the long-suffering horses and mules of these Sections, of the casualties in men and animals suffered, the often appalling conditions of the transport lines and the never-failing determination to deliver essential tools, stores and equipment often over ground where wagons and tool carts sank axle-deep in slime and mud and, when wheeled transport could no longer operate, Drivers, struggling on their feet, would lead forward by night heavily-laden pack animals bringing to the Sappers the stores they needed. Perhaps it is significant that the book's only illustration, other than an excellent map of the Western Front, is a 1916 photograph of an immaculate Temporary Captain V F Eberle, RE, then Second-in-Command of 474 Field Company responsible for the Company's Headquarters and Mounted Sections, riding his well-groomed and equally immaculately turned-out charger. From the rider's seat it is evident that he was no mean horseman and the charger's condition speaks wonders for the Mounted Section's horse management and of the turn-out standards achieved when conditions were favourable.

48 Division was transferred to the Italian front after the Caporetto disaster and the concluding chapters of the book describe the journey to Italy, the reception given to the British troops by the Italian people, the winter of 1917–18, the final Austrian attack in June which was only with the greatest difficulty finally held, the Allied counter-offensive and the Austrian surrender on 4 November 1918. It is remarkable that VI Day should have preceded VE Day by one week in both World Wars. Then came the run down of the Sapper units, Major Eberle, at that time commanding 474 Field Company, brought the remaining RE cadre back to England where it was disbanded in April 1919 thus bringing to an end his First World War Sapper Venture. However for the next eighteen years he served in the TA Reserve of Officers and, during the Second World War, raised and commanded a Company of Gloucestershire Home Guard which quickly became an over-sized Battalion.

Although quoting extensively from letters and diaries of the time, Colonel Eberle writes with a vivid memory of three historic episodes of over fifty years ago thus making his book most fascinating reading. He also includes it in a very charming reference to his own personal romance of three war-torn years.

JL

GERMAN/ENGLISH TECHNICAL DICTIONARY OF PRODUCTION ENGINEERING

Edited by Ing Rudolf Walther

(Published by Pergamon Press. £5·60)

It is not easy to review a dictionary. Between "A" (the symbol for Angstrom-Einheit) and "Zylindrizitat" (cylindricity, parallelity) lie some 35,000 terms concerned with the terminology of manufacturing processes and related production equipment. The dictionary has been compiled along similar lines to the English/German issue. The directions for use and the abbreviations used are clearly set out at the beginning of the book. Entry into Europe will be accompanied by many problems not the least of which will be communications. This book (and its sister volume), will certainly help and it is remarkably easy to use.

EEP

WIND FORCES IN ENGINEERING

PETER SACHS MA CEng MIMechE

(Pergamon Press. £12·00)

Mr Sachs has written a volume which has correlated and rationalized a very rapidly increasing and still very diverse fund of knowledge in this field. It is only in the last two decades that any serious effort has been made to analyse the dynamic loading of structures by the wind. The author covers a wide range of disciplines from the geographical distribution of winds, techniques in the use of wind tunnels, the measurement of wind and response variables, and the dynamic effect upon structures of various kinds to single and random frequency excitations.

As in any rapidly advancing subject, one would imagine that the time taken to collate such a work would not allow the contents to be very up to date. The science of analysing wind forces and of designing structures to withstand such static and dynamic forces is only now being born out of the amorphous mass of information on the subject. This volume shows signs of picking out gems from that mass and using them to draw the subject together. The result is a series of chapters which do not follow each other entirely logically but which, when read consecutively, give a good understanding of the subject.

For most structures the present British Code of Practice will not be found wanting, and most engineers will be relieved not to have to delve into the science of wind loading too deeply. There is such a breadth of information, however, that this book will be found invaluable to any engineer engaged upon the design of a structure, the loading of which is largely due to the wind and which is sufficiently costly that a wind tunnel test could be expected to be worth while.

JA J-B

SUSSEX SAPPERS

Compiled by COLONEL L F MORLING DSO OBE TD

(Price £4·95)

The history of the Sussex Volunteer and Territorial Army Royal Engineer units from 1890 to 1967 is a truly all-Sapper venture. The author (or should he be called the compiler?), the printer (C Hollington, a director of Christian—W J Offord and Sons Ltd), the illustrator (R J Mitchell) and the map producer (A Earthrowl) were all Sussex Sappers. The amount of enthusiasm and research that has gone into the producing of such a detailed and comprehensive history must have been immense. Despite the wealth of facts the book is still very readable and will be of great interest to all who have served in, or alongside, the Sussex Sappers.

Due to the efforts of Mr George Frederick Chambers, the first Sussex Sapper unit, "A" Company 1st Sussex Royal Engineer Volunteers, was formally established at Eastbourne in June 1890. From this one Company the growth of the Sussex RE Volunteers over the next few years extended along the coastal area from Brighton to Hastings and inland to Tonbridge. "B" and "C" Companies were established in 1892 and an Engineer Cadet Company was formed in connection with Seaford College in the same year and, as a result of the Boer War, eight more Companies were raised in 1901.

A Section of Sussex Volunteer Sappers was formed and left, in March 1901, for South Africa where they joined 23rd Field Company. This Section returned to England in 1901 and a second Section sailed for South Africa at the same time. The second Section served with 9th Field Company until returning home in 1902.

The Volunteer Forces ended in 1908 and were replaced by the Territorial Army. The proud history of the Sussex Sappers continues throughout the First and Second World Wars—and is reported factually and at length. The various Companies saw service in nearly all theatres of the wars and many men will be proud to see their exploits of past years recalled once again in the pages of this book.

The "Sussex Sappers" is obtainable from Mr Cecil Hollington of 1 Susan's Road, Eastbourne, Sussex. All proceeds in excess of printing costs will go to unit benevolent funds.

HJ

THE RHEOLOGY OF LUBRICANTS

EDITED BY D C DAVENPORT

(Published by Applied Science Publishers Ltd, 148 pp, £4.50)

The book contains eleven papers which were presented at Nottingham in 1972. The object of lubrication is to separate rubbing surfaces by a layer of lubricant; this layer will be subjected to shearing stresses and velocity gradients. Rheology is the science which deals with the deformation and flow of materials under such conditions. As machines are now expected to work at extremes of temperature, much investigation has been carried out on the rheological properties of lubricants. This book is not a text book, but indicates the areas where rheological problems occur and where theoretical investigations are taking place. This is clearly a book for the expert and would be a great help to the engineer involved in the design of lubrication systems. A copy is held in the Corps Library where it is a welcome addition to the professional engineering shelves. JWRM

THE STORY OF CATTERICK CAMP 1915–1972

LIEUT-COLONEL HOWARD N COLE OBE TD DL FRHistS

(Published by HQ Catterick Garrison, 92 pp. Price £1.25 (including p and p))

In AD 426 the Emperor Valentinian III withdrew the Roman troops from Britain and from their garrison at Cataractonium (Catarracton/Cataracta) or Catterick. Fifteen hundred years later Catterick became once again an area of military importance. The Story of Catterick Camp is a very interesting and comprehensive account of the development of Catterick from the mud and squalor of a First World War hutted camp into the permanent military centre we know today, a modern self-contained town with all the organisation and social amenities one would expect in a "civilian" town of comparable size.

The story, although factual and well referenced, is told with humour. The "off duty" activities of the soldiers are reported as fully as the details of unit moves and activities.

The Royal Engineers played an important part in the physical building of the Camp. During the years 1924–29, 55 and 59 Field Companies provided the nucleus of the "Works Force" under an augmented CRE Catterick Staff. 16 Fortress Company were also employed on this work for a few months in late 1928 and early 1929. Catterick must be indelibly engraved upon the hearts of the veteran members of 55 Field Company who were stationed there from 1923 (on their return from Turkey) until 1939, and on the hearts of the countless officers, warrant officers and NCOs of Works Services who laboured there from 1924 until 1960.

The story reinforces the belief that it is the people who have occupied the camp who have made Catterick what it is. Anyone who has been stationed there will know what I mean and will enjoy this book. JES

* * * * *

Modern Translations

"The silent majority"	—the people who agree with me
"It is reliably reported that"	—there is a vague rumour
"Compromise"	—an arrangement guaranteed to leave all parties involved unsatisfied
"Expert"	—X—unknown; spurt—drip under pressure
"Pedestrian"	—married man with only one car
"I cannot argue against the aim of the proposal but the method of implementation is open to some criticism"	—I wish I had thought of that, as I didn't I am against it.

Technical Notes

CIVIL ENGINEERING AND PUBLIC WORKS REVIEW— OCTOBER 1972

Bentonite Shield—This is a short interesting article on the use of Bentonite in tunnelling. The problems of tunnelling in bad ground have always inhibited the construction of tunnels especially where the alignment lies in water bearing sands and gravels. To test the principle of the Bentonite shield an experimental tunnel 33 m long and 4.1 m diameter is being driven in bad ground and is proving itself with virtually no risk of subsidences. It is also said to be costing significantly less; the figure being quoted is a saving of £0·75 m on a mile of tunnel of £2·25 m.

Protective Coatings for Structural Systems. Corrosion and other damage add millions indirectly to the real costs of structures in service. The science of protection is complex and specialized, and the applications that result require careful choice and expert advice. Those applicable to the principal structural systems are examined in a series of articles each of which gives further sources of information. Of the seven articles the ones of most value to officers of the Corps are:—

a. *Structural Steelwork Coatings.* The performance of coatings is influenced by such factors as surface preparation, thickness and application. These are discussed with particular reference to paints and metal coatings. Factors influencing the choice of coatings are also discussed.

b. *Preserved timber for construction work.* Whenever timber is to be used, there are certain factors which should be considered in determining the type or the need for preservative treatment. The durability, modes of destruction, the need for preservation and methods are all discussed.

NOVEMBER 1972

Joints Between Structural Hollow Sections. Early welded tubular structures were constructed entirely of circular hollow sections as there were the only available form. However these eventually developed into rectangular hollow sections which were much simpler to joint. Unfortunately the jointing of members onto a face of a rectangular hollow section presents difficulties to the designer as there is a possibility of large local deformation at the joint. This article describes 60 tests done on N type joints with circular hollow sections as branch members and rectangular hollow sections as chord members. The tests show that where care is taken so that branch members interset, a better stress distribution results with a reduction in deformation and an increased ultimate load of the joint. MFRC

THE MILITARY ENGINEER NOV-DEC 72

Articles of interest in this volume are:

The AGNES Disaster. This article is in 3 parts. The first part gives details of the intensity, path and damage caused by Hurricane AGNES. Part 2 gives some detail of the relief and clean-up operation mounted by the Corps of Engineers. Part 3 covers the organisation and planning necessary to restore the power supplies to houses in flood-affected areas. The lessons learned are given at the end of this section.

Water Surcharge for Marsh Consolidation. This article gives the method used for consolidation of marshland adjacent to New York Harbour. Lakes 26 feet deep were formed by constructing sand dikes and using PVC liners. Settlements of up to 4 feet were obtained. Problems encountered were the difficulty in removing the last 2 feet of water and the handling and seaming of the liner in cold weather.

Field Repair of Airfield Landing Mat Surfacing. This article explains a method of repair of AM2 landing mat airfield damaged by bombs. Special panels and closure bars are used to connect the replacement section of mat to that existing, after the damaged area has been cut out. An explanation of the explosive impulse welding used to complete the repair is also given. Other articles of interest are "Incinerator Heating Plant" where details are given of the construction and operation of a plant in Frankfurt. "Fusing Soils" gives information on heat treating in-situ soils with a high clay content. Temperatures between 700 and 1000 degrees centigrade are required to cause fusion so increasing the soil particle size. In the Field Notes section information is given on using barbed wire to reinforce concrete and photographs show the procedure for constructing plastic wrapped roads. RGO

"HISTORY OF SUBMARINE MINING IN THE BRITISH ARMY"

LIEUT-COLONEL W BAKER BROWN, RE PUBLISHED IN 1910

"THE Military Engineers of the British Empire had not been behind those of other nations in watching the progress of science and endeavouring, as far as the funds placed at their disposal allowed, to make improvements in war appliances.

"The story of one of these improvements—how it developed, and how, when it had arrived at a condition of considerable efficiency, it was handed over by its originators to another branch of the Nation's service—is told in the following pages."

So reads part of the introduction to the fascinating story of Submarine Mining from 1863 to 1905.

Only twenty copies of this book are available for sale to Members at £2·00 each.

WORK OF THE ROYAL ENGINEERS IN THE EUROPEAN WAR 1914–1919

THESE nine books present a series of records of works, prepared by those who had taken part in them and whilst the memory of them was still clear. As such they are of tremendous interest and value and very readable.

The titles are self explanatory, except for "European War" and "Miscellaneous", when one remembers that they were written in the early '20s.

Although the concentration is on Europe other theatres are not completely neglected and the term "European War" would now be "World War I". "Miscellaneous", the last book of the series deals with Organisations, Engineer Intelligence, Camouflage and indeed everything not covered in the other eight, including the Training Schools set up in the B.E.F.

The books are not a "set" in the sense that Corps History is a set and can only be sold as individual books. However a 10% reduction on listed prices will be made for orders of 4 or more books, excluding The Signal Service (France).

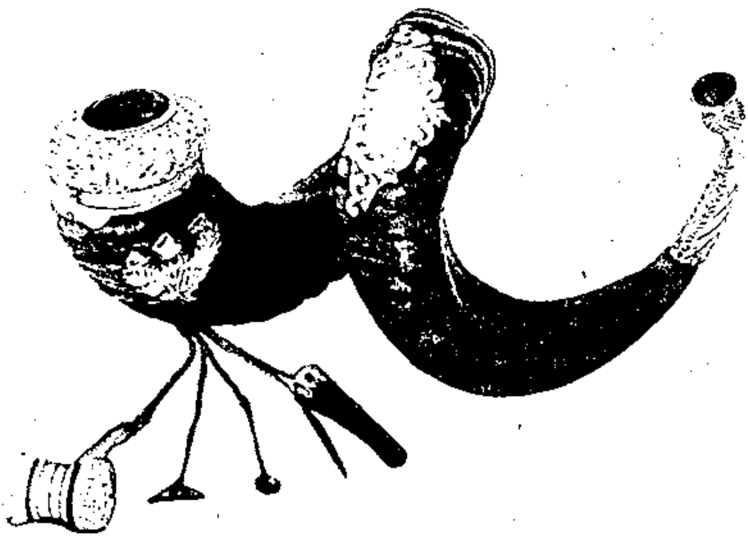
Titles	List Price	Number Available
Bridging	£0·75	40
Military Mining	£0·75	58
Geological Work on Western Front	£1·00	57
Supply of Engineer Stores and Equipment	£0·75	56
Water Supply—Egypt and Palestine	£0·75	45
Water Supply—France	£1·00	45
Work under Director of Works (France)	£1·50	79
The Signal Service (France)	£1·00	2 ONLY
Miscellaneous	£1·50	130

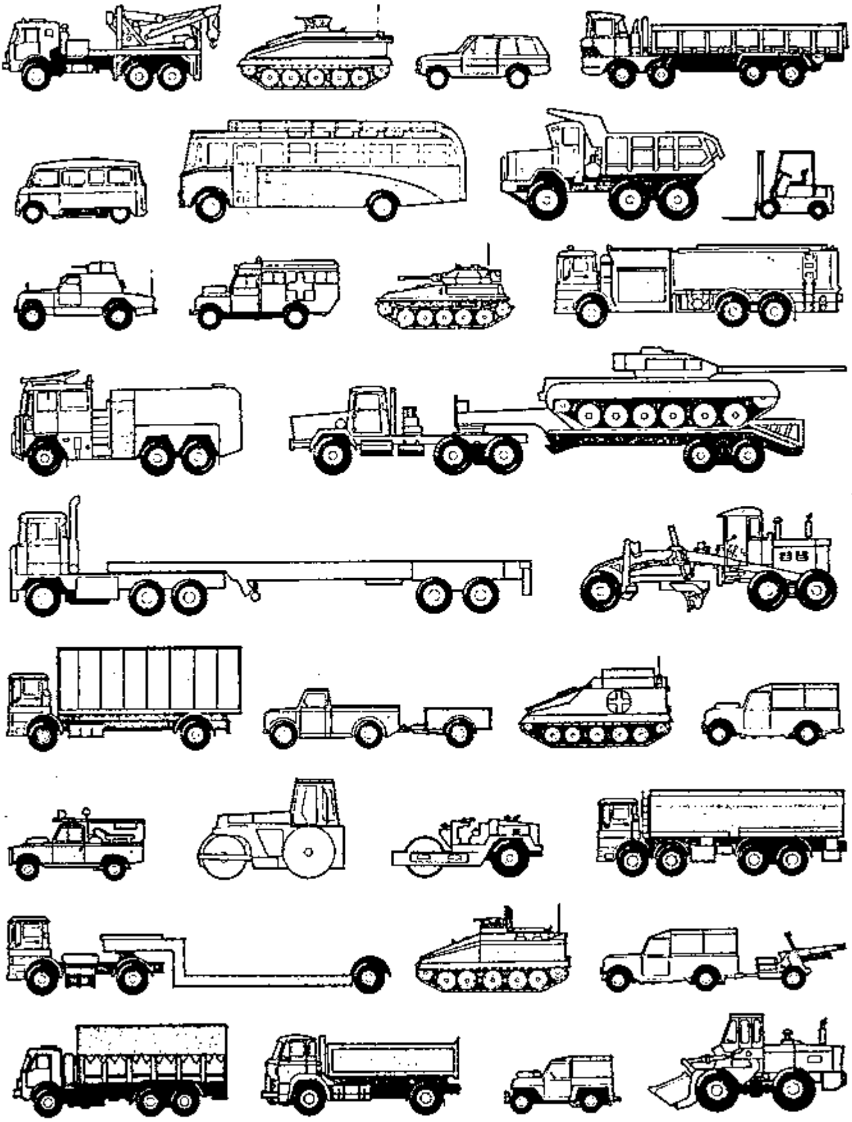
A HISTORY OF RE CRICKET 1862–1924

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

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

The book can be obtained from the Secretary, Institution of Royal Engineers. Price 50p.





Articles for the Journal

The *Journal* depends for its existence on articles submitted for publication on historical, professional and technical subjects of interest to Military Engineers.

They may be of any length, but preferably not more than 6,000 words. They should be typed in duplicate on one side of the paper only, double spaced with one-inch margin. A third copy should be retained by the author for checking with proofs.

Photographs to illustrate an article should be black and white prints on glossy paper. Usually not more than four photographs will be published to illustrate each article. More photographs may, however, be submitted from which the Editor will make a selection. The size of the photographs does not matter as they can be reduced in size for publication. Line drawings, maps, etc must be in black ink, and all lines, lettering, etc must be bold and clear to allow for reduction in size when reproduced. Scales must be drawn and not worded.

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

Payment for articles is at a rate decided by the Publications' and Library Committee. An extra £10 award is made at the discretion of the Committee for articles of particular merit published in each issue of the *Journal*. In addition two prizes, the Montgomerie and Arthur ffolliott Garrett Prizes, are awarded each year for outstanding articles by RE officers, not above the rank of Lieut-Colonel, published in the *Journal*.

Articles may be submitted at any time and correspondence is always welcome. However, the following dates are normally the latest for inclusion in the issues shown:

March issue	1 December	September issue	1 June
June issue	1 March	December issue	1 September

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