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*Authors alone are responsible for the statements made and the opinions expressed in their papers*

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# Editorial

*In Medias Res*

THE search for alternative sources of energy is a topical subject. The world reserves of fossil fuels are finite and diminishing. Although there is no real limit to the reserves of nuclear fuels, uranium and thorium for example, nuclear energy is currently highly unpopular with a vociferous, and generally speaking ill-informed, minority. The attraction of harnessing energy from the sun, the wind, the tides, the waves and the heat from the core of the earth etc is obvious. The difficulties, capital costs and practicability of harnessing such energy are often ignored in the highly emotional debates or are swept aside by generalizations like "If only sufficient effort and money were made available for research all problems would disappear". Much of the basis of these debates is based on either a misunderstanding or plain ignorance of the true facts, or, in the worst cases, on deliberate misrepresentation of the facts to make a media impact. In this issue Major M G LeG Bridges looks at the use of wind energy and puts the power from wind problem into perspective. The use of solar energy to heat houses was discussed by Lieut Colonel J M Guyon in the *RE Journal* of September 1976 (Volume 90/3). Who would like to tackle other sources of energy?

The effectiveness of the tank-stopping power of trees, whether in woods or forests, has regrettably been a subjective judgement. The judgement depended to some extent on whether the "judge" wanted the trees to stop the (enemy) tanks or to permit passage of the (own) tanks! This is remarkably reassuring on Exercises when convincing cases could readily be made in the certain knowledge that the judgements would not be tested! This issue publishes an article by Major A A Wilson which suggests a more objective basis for judgement and which could, given the will, be experimentally verified.

A report on the E-in-C Conference 1979 by Major A Clements is included in the belief that most readers would like to keep abreast with "what's happening". The Editor has reserved space in the next issue for the feminists and male chauvinists to lock horns on the subject of increased employment of women in the Corps!

The achievements of the Royal Australian Engineers in Papua New Guinea in WW2, of the Royal New Zealand Engineers in the construction of the magnificent Queen Elizabeth II Army Memorial Museum in 1978, and of the Madras Sappers and Miners in Burma in WW2 are also reported.

Without being complacent it is felt that this issue will rank fairly high in the league table of better RE Journals.

What's in a name? The lack of status of the "Engineer in Society" is always somewhere near the surface. The outcry over the careless use of the term "Engineer" has been gaining momentum. This is largely due to the media shorthand—"Engineers on Strike", "Engineers confront Bosses" etc. In nearly every case the title "Engineering Workers" would have been a more accurate designation. There is a school of thought that the title "Engineer" should be confined to members of Engineering Institutions, some would go further and suggest only members of the Chartered Institutions! It is argued that the title should be protected as are other titles such as Doctor, Dentist, Barrister and Solicitor. Thinking along these lines one asks should we use the title "Combat Engineer" to describe a Corps trade? Should we continue to use the term "Military Engineer" to exclusively describe the Officers of our Corps? Are not REME military engineers?

Is this important? It could be if the Finniston recommendation to introduce a Register of Engineers or similar be accepted!

# Flying in the Face of the Wind

MAJOR M G leG BRIDGES RE, B Sc

*The Author, who is somewhere in the Himalayas, did not provide a photograph and pen picture before departing with the latest Army Himalayan Expedition! The photograph used was taken on a previous Himalayan Expedition.*

*This article was written as the result of research carried out whilst on his Long E and M Course, more properly known as Professional Engineer Training Course.*

## INTRODUCTION

It has been variously estimated that the currently known world reserves of oil fuel will be exhausted within the next twenty to thirty years. This will leave some coal and nuclear fuels, anything else having to be synthesised. Faced with this prospect, and the spiralling inflation of the cost of the remaining oil stocks, the search is intensifying for alternative sources of energy. These range through solar, wave, and wind power, and also include low grade heat recovery, thermal energy, and others. Very large amounts of money have now been allocated to research into wind power generation, particularly in the United States. While large multimegawatt machines are still in the development stages, small machines can already claim successful working lives of thirty years and more. Further, small machines in a bracket of up to 20kW rated output are semi-portable and are priced within the means of the individual. They also have potential usefulness to the Army. This paper looks at some of these small machines, their characteristics and their applications.

## POWER FROM THE WIND

Lest the environmentalists have already persuaded the reader that wind power is the panacea of the energy crisis, it must immediately be pointed out that the wind is a very dilute source of power. Of this, due to a natural law identified by a German researcher called Betz, only about half could theoretically be converted into usable energy by an ideal machine. However real machines have inherent inefficiencies. If, for a real machine, we assume a rotor efficiency of 75%, a gearing/coupling efficiency of 95%, and an energy conversion system, say a generator, with an efficiency of 75%, we finish up with an output which is approximately one quarter of the power that was originally in the wind. To make matters worse, the rotor will only remain efficient if the ratio of its speed to the speed of the wind is kept constant. At other values we may be down to 20% efficiency or less. To emphasise the marginal nature of wind as a power source, compare the outputs of a hydro-electric turbine and a wind turbine. A hydro turbine with a 2½m diameter rotor, operating at 750m head, can produce about 60MW. To get just 2MW from a wind turbine, we need a gigantic machine with a rotor diameter of 100m and a strong wind of 12·5m/s to drive it.



Flying in the Face of the Wind
Major M G Bridges RE BSc

# "Tanks Through Trees"

MAJOR A A WILSON RE, B Sc, MIHE

*Major Alasdair Allan Wilson B Sc, MIHE was commisioned from Sandhurst in 1967. After a brief tour in Sharjah he returned to RMCS to read for a B Sc in Civil Engineering. Then followed a tour as troop commander and Corps Rugby Captain at Maidstone. He left Britain for Kenya in January 1974 and apart from Staff College has not been back since. A tour as 2IC 38 (Berlin) Field Squadron was followed by 18 months as GS03 2 Armoured Division during the reorganisation and Spearpoint Exercise period. After Staff training at RMCS he attended the RN Staff College Greenwich and was posted to USA in a GSO2 (W) intelligence exchange appointment.*

## BACKGROUND

In 1977 I was the GSO 3 in Engineer Branch, Headquarters 2nd Armoured Division, based at Lubecke. Whilst the newly formed Division Engineer Regiment was preparing for and carrying out a very successful tour to Northern Ireland, I was lucky enough to be responsible, under the CRE, for all the Division's engineer operational planning. This involved gaining an intimate knowledge of our area of operations, liaison with combat team and battle group commanders and discussing plans with task force brigadiers. The objective was to produce a divisional obstacle plan co-ordinated at all levels within our capabilities and share of the available resources.

The task was exciting and rewarding, but exposed just how little we really knew, or could find out, about the value of certain obstacles. In particular, the wooded areas. There was no readily available method of calculating the obstacle value of woods. Subjective judgement had to be used—and the Sappers' tentative assessment eventually became Gospel. However, this was an invidious position to be in. With all the technical and analytical resources available today a less subjective solution to the problem ought to have been available.

So whilst at Shrivenham in 1978 I undertook a project to produce a method of quantifying the value of woods as obstacles to tracked vehicles. Together with a REME friend, Tony Ball, we managed to produce what we thought was a revolutionary solution to the problem. We published the report and sat back expecting to receive widespread acclaim. A year later, older and wiser, I am writing to the *Journal* hoping that someone somewhere will be interested.

## THE PROBLEM

In most parts of BAOR woods are major features of the terrain. In the past they have almost without exception been treated as obstacles to tracked vehicles. Peacetime constraints against damage to woodland have tended to enhance this view. There is little doubt that movement through trees would be a slow, difficult operation and in fast moving, mobile battles something to be avoided. But, in more static, positional defence the obstacle value of woods becomes more critical. The Sapper reconnaissance officer needs a method of assessing the value of woods as an obstacle to enemy armour.



"Tanks Through Trees"
Major AA Wilson RE BSc

One further point about the power from the wind. The power available varies with the cube of the wind velocity. This means that the power available in a wind of 10m/s is half of that available in a wind of 12·5m/s. It follows that if we are to get our money's worth from a wind machine, it has got to be set up in a regime of high wind speeds.

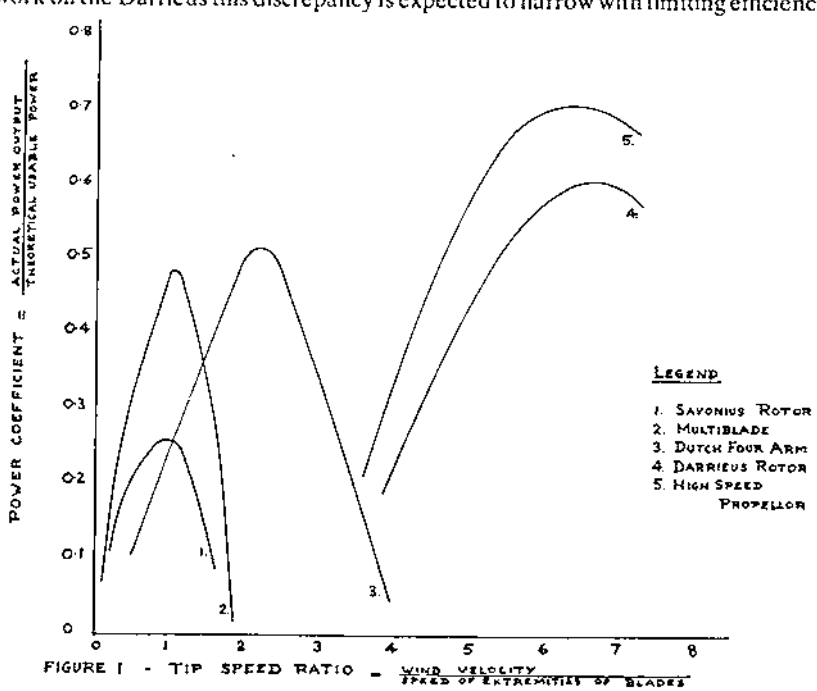
So far so bad. What of the machines that are available to utilise this power source?

## TYPES OF WIND TURBINES

Wind turbines may be divided into two types, vertical and horizontal axis machines. Before we do that, consider first two characteristics which are common to both types. The Solidity Ratio (SR) is defined as the ratio of the area of the blades of the rotor to the area that they sweep out. The significance of this is that rotors with a high SR (1:1), ie a large blade area, tend to create a lot of turbulence in the air and hence a lot of aerodynamic drag. For this reason they are intrinsically inefficient, having maximum efficiencies of 25% or so. They have an advantage however in that they are generally high torque machines, and the better designed ones are excellent for powering mechanical loads such as water pumps. The most efficient rotors are those with very low SR values (1:25 or less) with long slender blades.

The second important characteristic is the Tip Speed Ratio (TSR). This is the ratio of the speed of the extremities of the rotor to the speed of the wind. The higher the TSR of a wind turbine the higher will be its Coefficient of Performance (Cp) or, in other words, its efficiency in converting wind power to shaft power. By definition it follows that to obtain efficient energy conversion, the rotor speed must vary with the wind speed. Therefore the output from a wind turbine will be variable, matching the wind. Despite this a given rotor will be most efficient at a specific wind speed and at other values it will not perform as well.

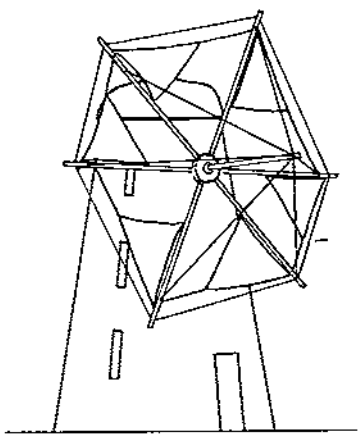
In Figure 1 are given curves which relate TSR to Cp for five typical types of machine. At the time of writing (1979) the high speed propeller has the edge over the Darrieus rotor in efficiency due partly to greater development effort. With more work on the Darrieus this discrepancy is expected to narrow with limiting efficiencies

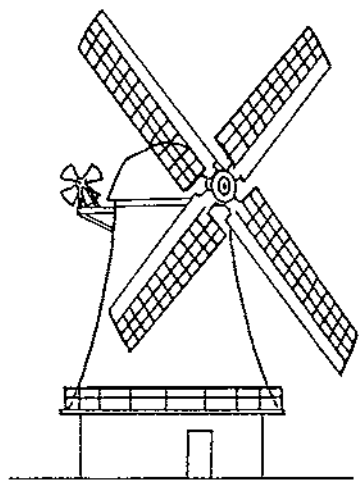


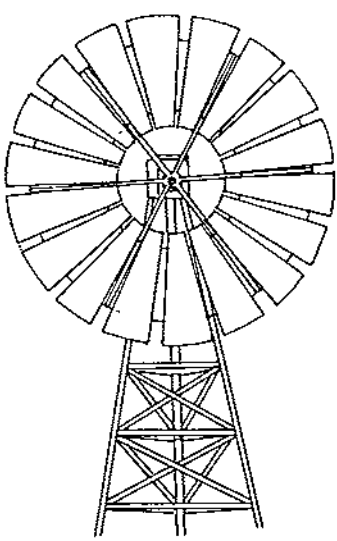
of over 75%. Well illustrated by the graphs is the great importance of keeping a machine operating at optimum TSR, diversion from which produces a large drop in efficiency.

Let us now look at some of the hardware that can be used.

*Horizontal Axis Wind Turbines (HAWT).* These machines are all tower mounted propellers of one form or another. The sail mill, Figure 2, is known to date back to 1700 BC in Babylon and still appears today in the Middle East and Spain. It is cheap, inefficient, flimsy, and a permanent structure, and is outside the scope of this paper. The Dutch four armed mill, Figure 3, is more recent, slightly more efficient, and is also a permanent structure. Of more interest is the multiblade mill, Figure 4, which is inefficient but makes an excellent power source for water pumping. It will work in a regime of relatively low wind speeds and is semi-portable. Finally, and of most interest to us, is the high speed propeller machine, Figure 5. This machine is the most







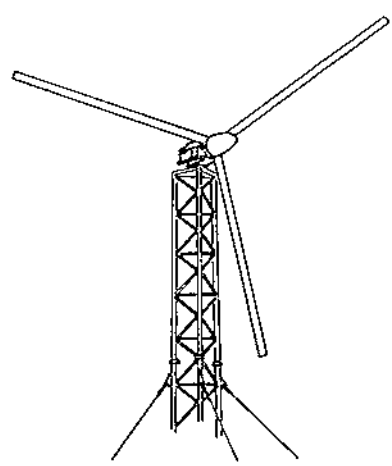


**Figure 2.** Sail Mill
**Figure 4.** Multiblade Mill

**Figure 3.** Dutch Mill
**Figure 5.** High Speed Propeller Machine

efficient, the most portable, and the most suitable for the majority of small "Wind Energy Conversion Systems" (WECS).

All HAWT machines must be aligned to the wind in order to operate, which calls for yaw control equipment. In most cases the energy converter, classically a small

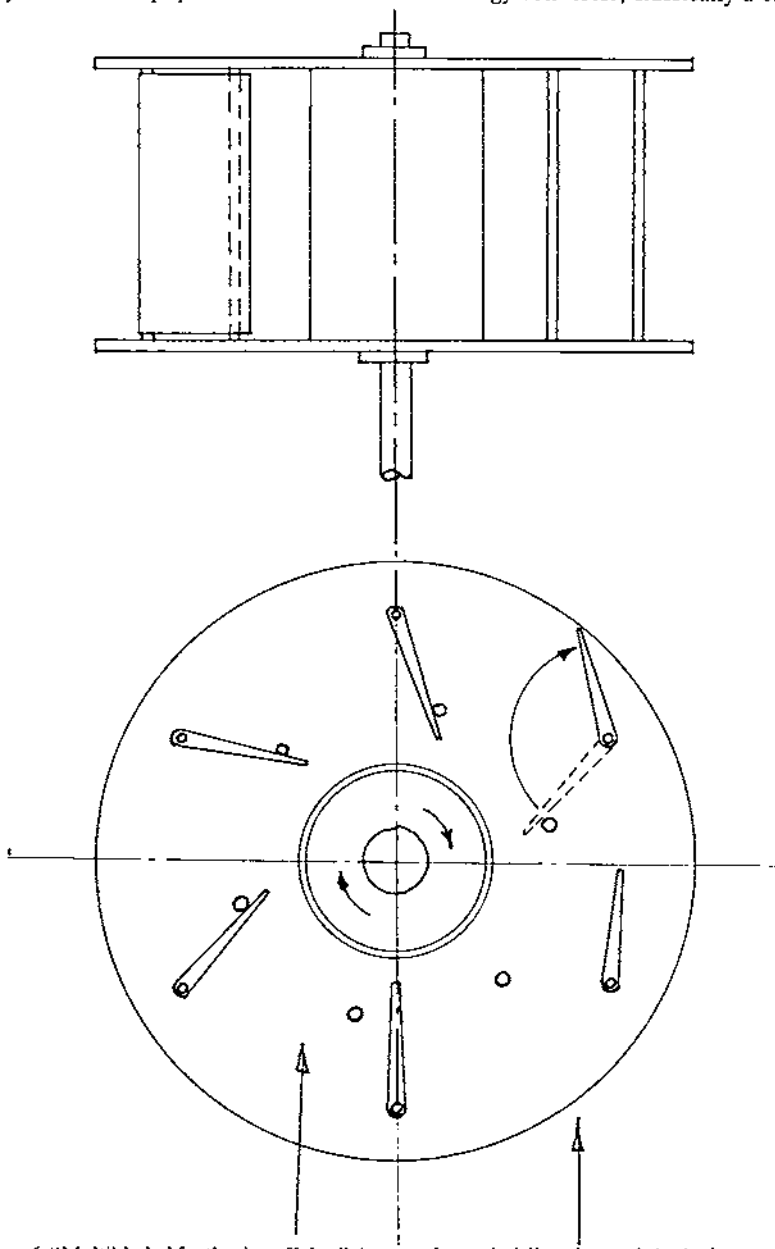


**Figure 6.** "Multibladed feathering affairs." Arrows show wind direction and clockwise rotation

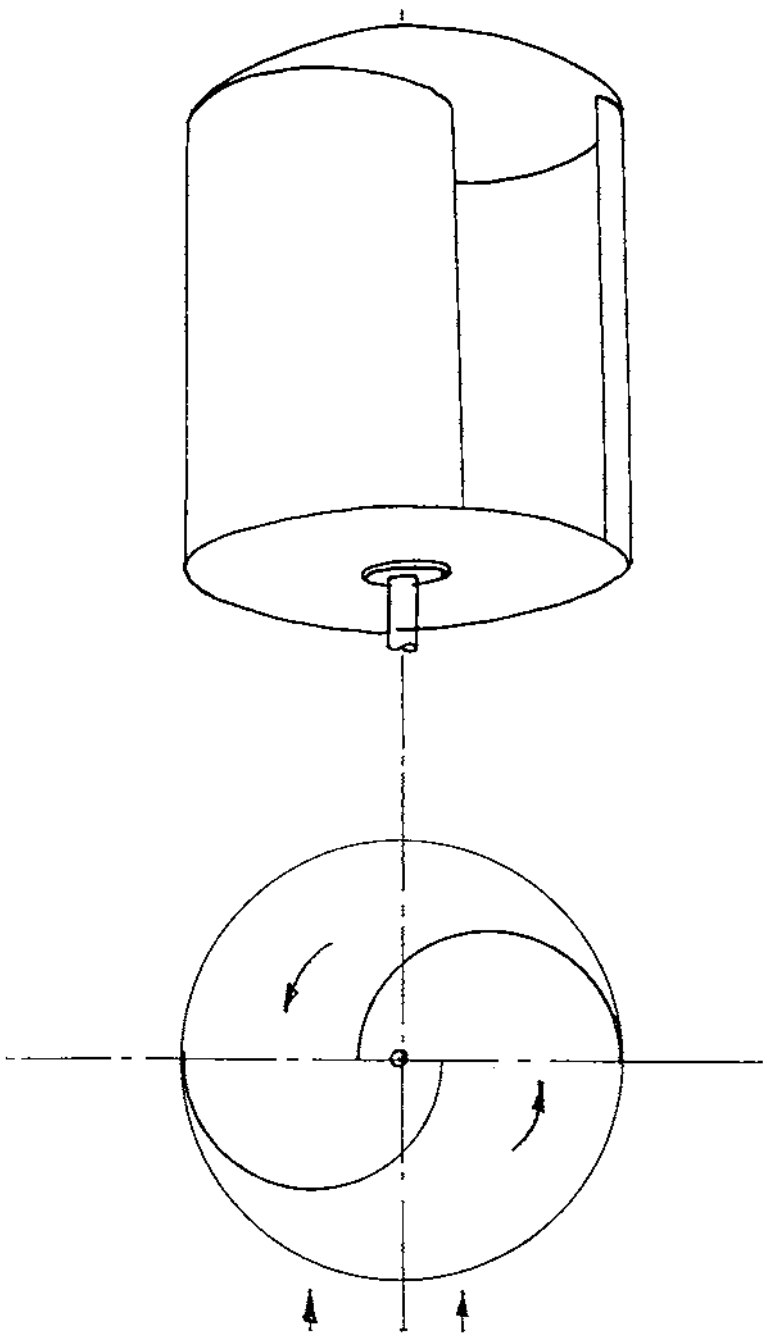


Figure 7. Savonius Rotor

generator, must be mounted atop the support structure to minimise losses in transmitting the power from the rotor. This increases maintenance problems and costs. By virtue of their configuration, variations in wind speed set up variations in the bending moments in the blades of HAWTs, and consequently these are susceptible to fatigue failure. This is more critical in the larger machines. The effects of these bending stresses can be partially relieved by coning the blades.

In smaller propeller machines, vibration tends to cause problems due to the high rotational speeds. These vibrations are caused not by mechanical imbalance but rather by the fact that either the blades pass through the wind shadow of the support structure, depending on whether the configuration has the rotor upwind or downwind of the tower. Like their vertical axis sister types, HAWTs are subject to damage in high winds and when a design critical wind velocity is reached, the blades must be feathered and rotation stopped to protect the machine. Control of HAWTs is usually by varying the pitch of the blades to match the wind speed or the power required. This control is usually automatic on small machines, frequently being exerted by some form of centrifugal governor.

*Vertical Axis Wind Turbines (VAWT).* In the layout design of VAWTs the scope for originality is much greater, although historically, with certain exceptions, this type is generally more recent in origin. The range of devices extends from multibladed feathering affairs more at home on a paddle steamer than a WECS, Figure 6, through delightfully simple but impossibly inefficient machines like the Savonius rotor, Figure 7, to the highly efficient and elegant Darrieus rotor, Figure 8. Derivatives of the Darrieus such as the Cycloturbine, Figure 9, and the PI Specialist Engineers machine, Figure 10, have similar characteristics and performance figures. The curved shape of the Darrieus rotor blades is that which would be assumed by a flexible cable when whirled about a vertical axis. The significance of this is that the blades carry no

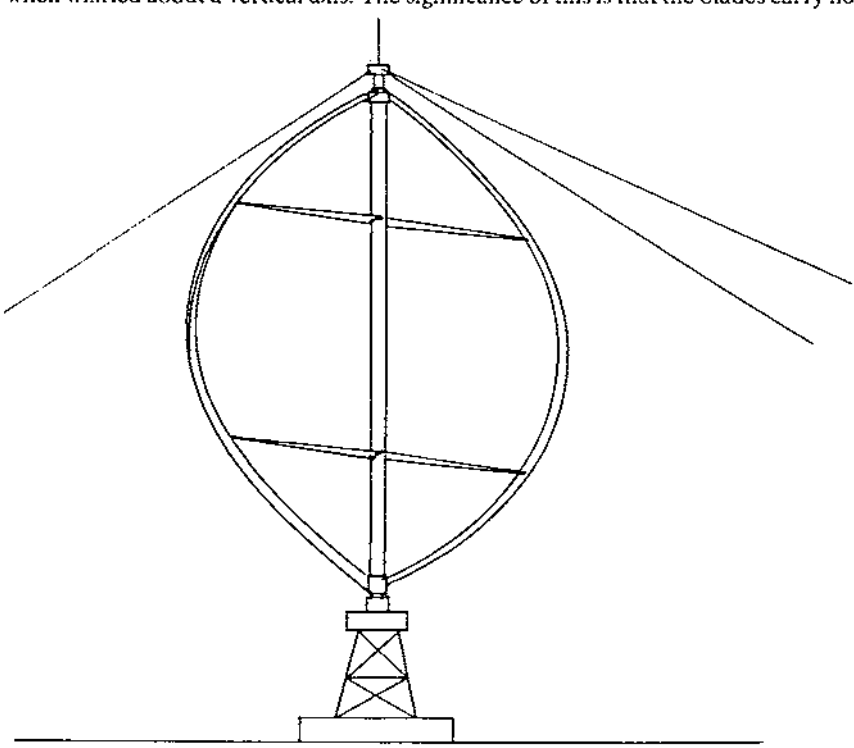


**Figure 8.** Darrieus Rotor

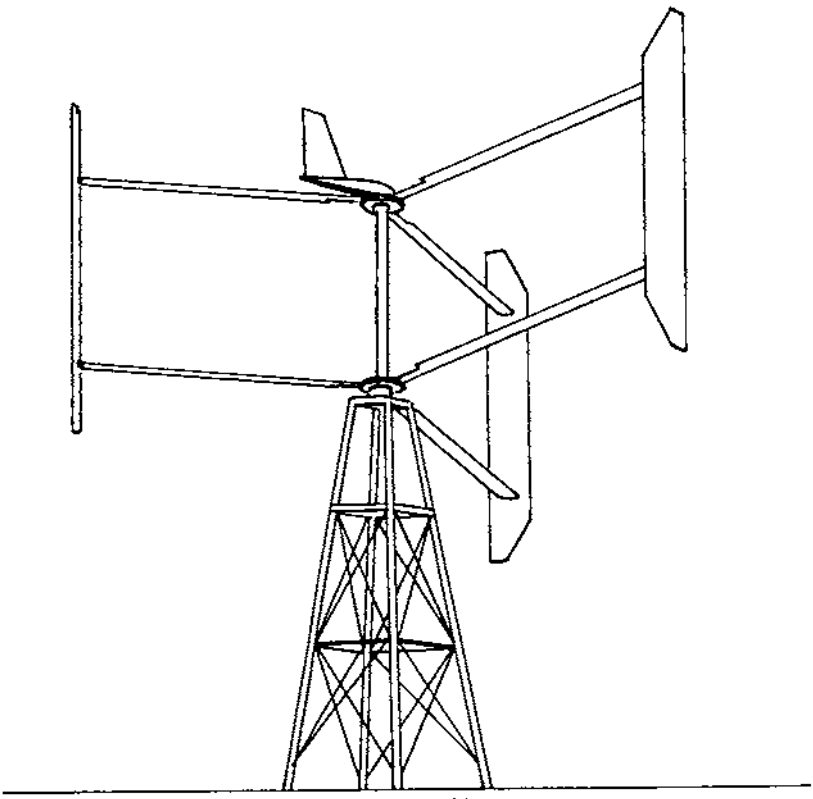


Figure 9. Cycloturbine

radial bending stress. However the torque output from each blade varies from a maximum positive value to a small negative value twice during each rotation. There is therefore a continously varying bending moment in the line of the blade chord. This variation in the output torque appears in the output of the two bladed Darrieus, Figure 11, as both blades reach their minimum output points at the same time. By installing a third blade the output torque characteristic is greatly smoothed but the solidity ratio is, of course, slightly increased.

In general, Darrieus rotors have no control surfaces, although their derivatives do. The Darrieus rotor is not self-starting, requiring to be spun up to speed by a motor. Once running, given adequate wind, the rotor will continue to produce power. It follows that the power output of these rotors is not easily controlled and will vary with the wind speed. Some of the Darrieus derivatives, like the two quoted above, do have blade pitch control, are self-starting and are more controllable in operation.

In this paper we will confine our interest to multiblade windmills, high speed propellers, and the Darrieus and its derivatives, as these are the machines whose high efficiency and/or size make them suitable for small WECS.

## WECS SITE SELECTION

Before a machine can be selected to provide power at a site it is necessary to find out about the winds at that site. Selection of a machine unsuitable for a particular site will result in an expensive fiasco. The list of factors to be considered in siting a WECS is very long, extending from the distribution of mean wind speeds, through terrain roughness and wind shear, to the expectancy of hazardous conditions such as icing,

flooding and earthquake. However for practical purposes, for a small WECS installation, we are chiefly concerned with the distribution of mean wind speeds at the height of the machine mounting to assess suitability and expected output, and also with maximum wind speeds in order to ensure survival of the machine.

The distribution of mean wind speeds is a grandiose term for a plot showing, on average, for how many hours per year the wind can be expected to blow at what speed. Such a plot is shown in Figure 12 for two different average wind speeds. The information may be obtained either from a large number of readings taken with a wind speed measuring device and recorded over a period of at least one year, and preferably three, or, given information on the annual average wind speed at a site, a good approximation of the distribution plot may be developed by statistical methods. The Rayleigh probability distribution gives quite good results. The important points to note from these plots is that for more than half the time the wind blows at less than half the average speed, and that for a relatively very small percentage of the time the wind blows at high speeds. say, in excess of 40 mph. This means that it doesn't matter if the wind turbine cuts out to avoid damage when the wind speed is particularly high, but it must start up and operate in as low speeds as possible.

## WIND TURBINE SELECTION

It has already been mentioned that a wind turbine must be selected to match the conditions prevailing at the site. A wind turbine's performance characteristic starts at the Cut-in Wind Speed when the machine starts to rotate. Its power output rises with the wind speed until the Rated Speed is reached at which point Rated Power is

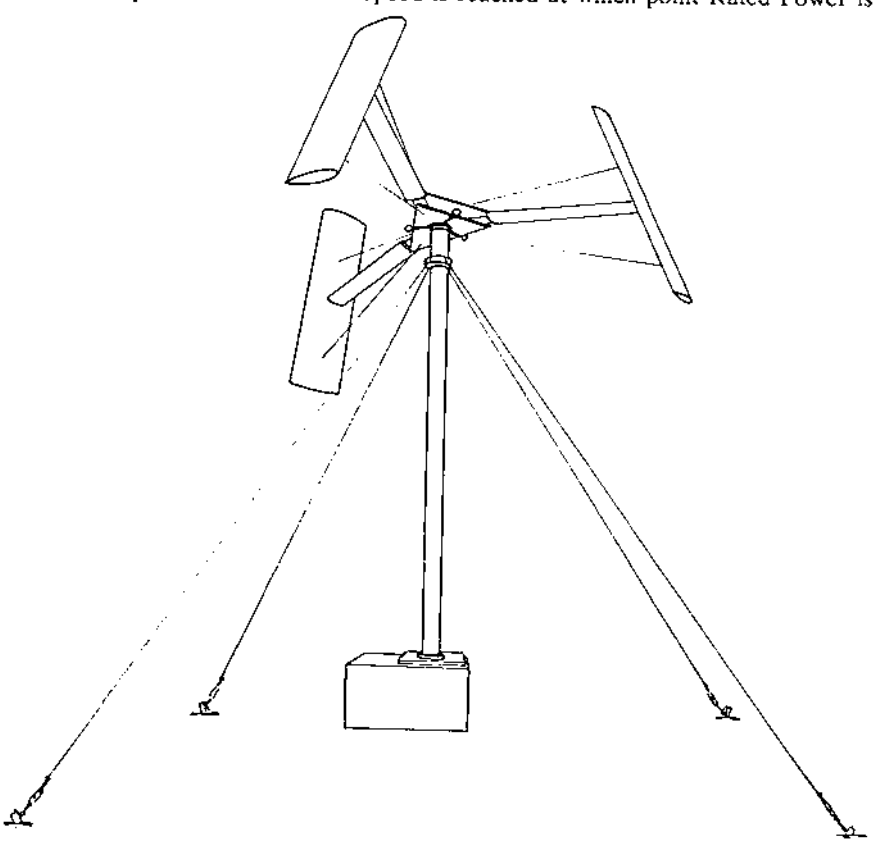


**Figure 10.** PI Specialist Engineers Machine by courtesy of PI Specialist Engineers Ltd

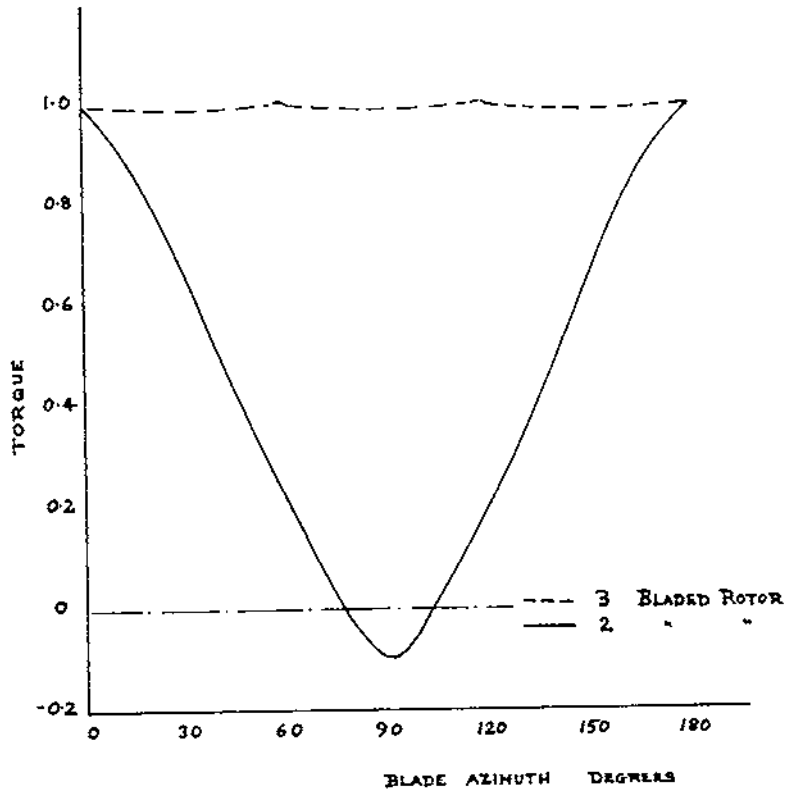



FIGURE 11 – CYCLICAL VARIATION OF TORQUE OUTPUT OF A DARRIEUS ROTOR

produced. At higher wind speeds the turbine will develop rated power or a little less until the Cut-out Speed is reached and the machine is feathered to prevent damage in high winds. A family of performance curves for various machines currently on the market is given in Figure 13. It will be seen that these machines, with rated outputs of between 0.5 and 3kW, have cut-in speeds between 5 and 10mph but do not reach rated power output until 20–25mph. Since the highest average wind speed in the British Isles is 16–17mph, recorded in the west of Ireland and in the Outer Hebrides, any of these turbines will be operating at well below rated power for the majority of the time. To illustrate this, superimpose a trace of Figure 12 onto Figure 13. It therefore becomes important to find both a rotor and a generator, or other energy converter, which will work efficiently not only at rated speed, but also at fractions of this output as it is in this area that it will work for most of its operating life. It is worth noting that the average machine produces about one third of its rated total output over a given period. It is this aspect of efficiency at part output that is the subject of much development work.

In order to make some form of assessment of the power that can be expected from a given machine at a given site, it is necessary to construct a table from the performance curve of the machine. This can be obtained from makers data. Take for example the Kedco 1610, a 2kW rated Wind Driven Generator (2kW WDG), working in a typical 22mph average wind speed area.

| No of hrs per year | Wind velocity mph | Output kW | Yearly Output kWh |
|---|---|---|---|
| 980 | less than 8 | 0 | 0 |
| 1030 | 8–12 | 0.25 | 257 |
| 1920 | 13–19 | 1.1 | 2112 |
| 1880 | 20–25 | 1.9 | 3572 |
| 1465 | 26–32 | 2.0 | 2930 |
| 1485 | 33 and upward | 2.0 | 2970 |
| 8760 | | | 11841 |

Compare this with the more simple calculation based on the average wind speed of 22mph. The power output at 22mph is 2kW. Therefore the average yearly output should be!

$$8760 \times 2 = 17500\text{kWh}$$

This is a wildly optimistic estimate of what we will get.

## APPLICATIONS OF WECS

So much for the wind turbine itself and the sort of site that it requires. Consider now the uses to which it can be put. It has been pointed out that if we require maximum wind energy conversion efficiency we must accept variable frequency of output, and that conversely constant frequency output is only available at lower efficiency. In practice since the output of a small WECS is very small anyway, none but imposed inefficiencies are really acceptable and variable frequency output is effectively a fact of life.

Most applications require a constant supply though some do not and some can be adapted to accept a variable supply. Applications of WECS can thus be divided into those requiring constant supplies and those accepting variable supplies.

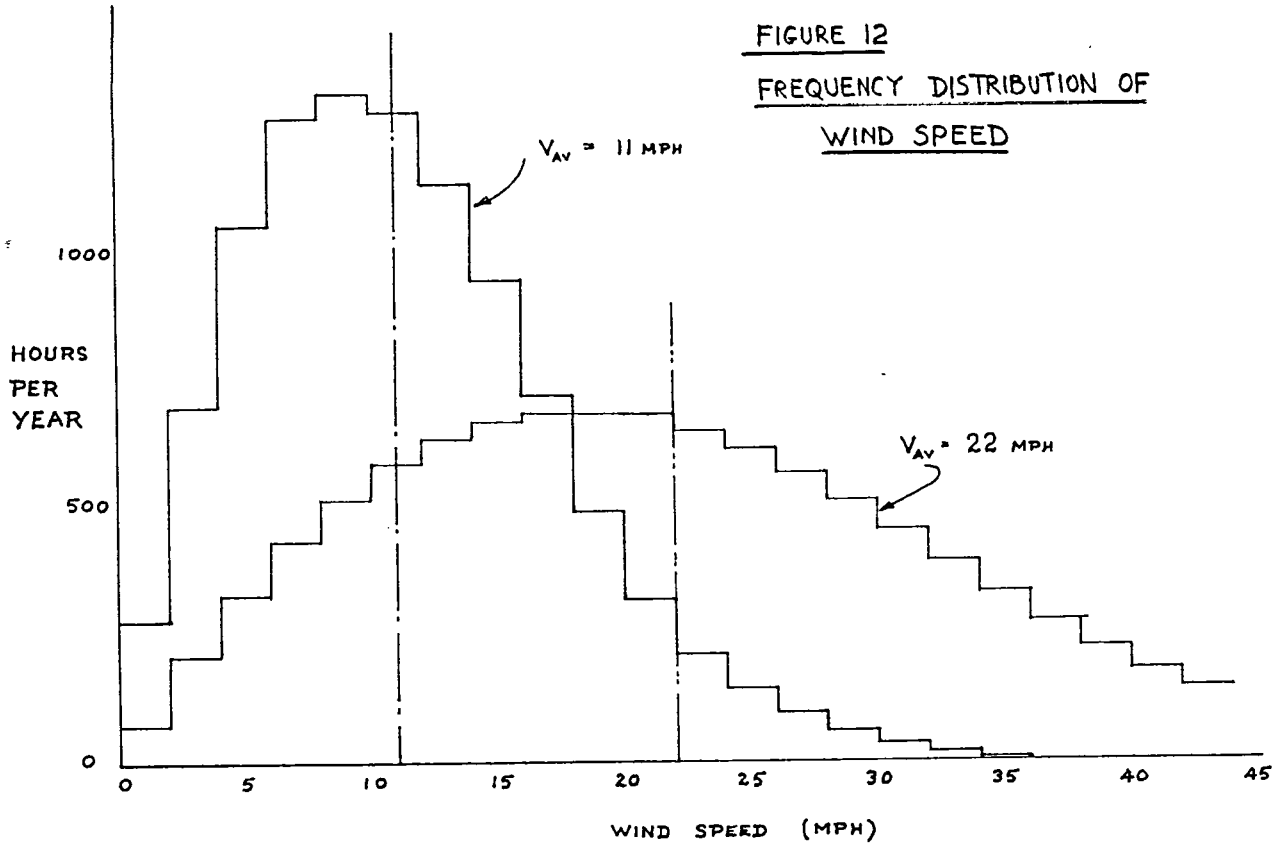
Constant supplies usually require two features; constant frequency and constant level of input. Having discarded constant speed operation as an effective method of obtaining a constant frequency output from a small WECS, there remains the use of some form of infinitely variable drive between the wind turbine and the load. Few sufficiently efficient methods of doing this have yet been evolved. However the use of energy storage permits variation in both the frequency and quantity of the input and can be made to deliver a constant output.

The options on energy storage are almost unlimited and cover such possibilities as pumped water, heat storage, compressed air, storage batteries, electrolysis of water into hydrogen for use as a fuel, and so on. The major problem with all energy storage schemes is that unless they are highly efficient they work more as energy sinks and are not worth having. In practical terms this means that within a complete system, there should be a minimum number of changes in the form of the energy, each of which represents a loss. Consider two systems, one an aerogenerator with a water electrolysis energy storage system, and the other an aerogenerator with storage batteries. It will be seen in Figure 14 that an extra stage has been introduced into the chain with the former arrangement, and since combustion engines are far less efficient than electric motors, System 1 is a poor option which would also be more expensive to install. It is worth comparing these two systems with the options of System 3 which is a variable supply system. It is apparent that this method is the most attractive both in terms of total capital outlay and power delivered for installed capacity provided that the load will accept this type of supply.

Variable supplies have applications suitable, typically, for farm and domestic purposes. On a farm, water pumping is the most frequently used but various heating systems such as grain drying, greenhouse heating, and storage heating in poultry houses, etc, all offer significant savings in other supplies. Domestic applications are similar, including water pumping to a service tank, space/storage heating, swimming pool heating, or the output could be used in conjunction with solar heating. One big

FIGURE 12

FREQUENCY DISTRIBUTION OF WIND SPEED



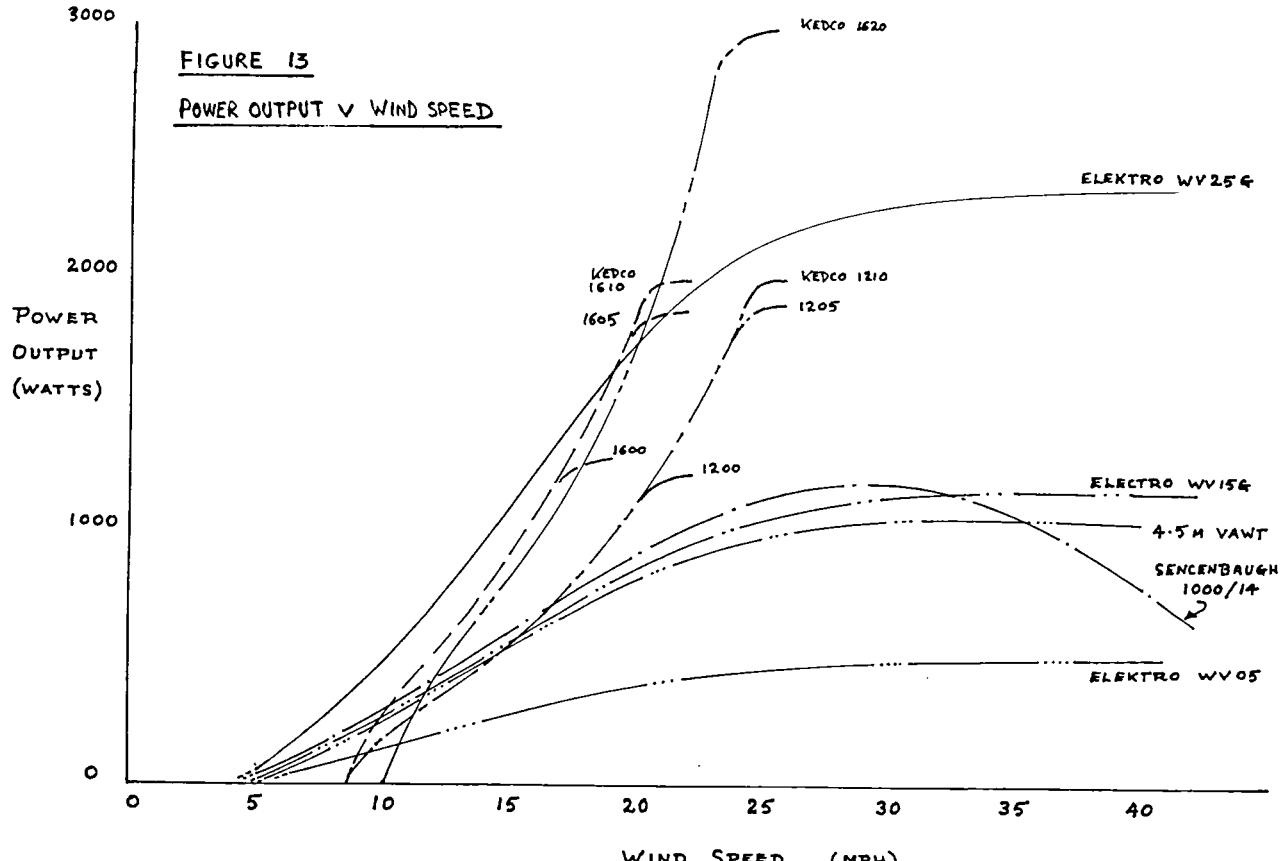


FIGURE 13
POWER OUTPUT V WIND SPEED
3000
2000
1000
0
POWER OUTPUT (WATTS)
0
5
10
15
20
25
30
35
40
WIND SPEED (MPH)
KEDCO 1620
ELEKTRO WV25G
KEDCO 1610
1605
1600
KEDCO 1210
1205
1200
ELECTRO WV15G
4·5M VAWT
SENCENBAUGH 1000/14
ELEKTRO WV05

advantage of windmills over solar sources is that the sun shines when the least heating energy is required, while the wind generally blows harder and for longer in the winter.

While variable supplies are generally the province of the private user of small WECS, the professional user in most cases requires constant supplies. Generally these are in the form of electrical power and a WECS is ideal for filling small power requirements in remote areas. These include lighthouses, radio rebroadcast units, navigation beacons, remote radar sets, microwave links, and such like.

Where larger scale supplies are required on a constant basis, one excellent application for a larger wind machine in say, the 20–50kW bracket, is in load sharing with another more reliable source. Again remote locations where mains supplies are not available offer most potential, so that a wind turbine could be coupled to the shaft of a diesel generator set via a clutch. When the wind was sufficient to bring the turbine up to speed, the clutch would engage and the turbine would start to drive the diesel. The diesel governor would reduce the fuel supply to match the turbine input, and thus the turbine is acting as a fuel saver, albeit at constant speed. This method has been researched in Canada and has shown a great deal of promise.

## ECONOMICS OF SMALL WECS

The assessment of the economics of small WECS depends extensively on existing facilities at the site. If a mains supply already exists at the site, then all the capital cost of the WECS installation must be charged against the cost of mains electricity saved. Where no supply exists, then the WECS installation costs can be balanced against the cost of providing any other form of supply, and only any difference need be charged against the saved energy.

The cost of a WECS installation varies with the type of unit. It is reasonable to categorise installations as "professional" or "amateur" implying a complete factory-made installation of the highest quality for continous automatic maintenance-free operation as contrasted with a simpler but none the less efficient factory-made installation which would have less automatic control equipment and would require more maintenance and more regular checks and inspections.

If we consider a 1.2kW rated machine with a rated wind speed of 25mph, and it is erected at a site where the average wind speed is 15mph, we can expect an annual average power output of around 3240kWh. These are quite typical figures. From a

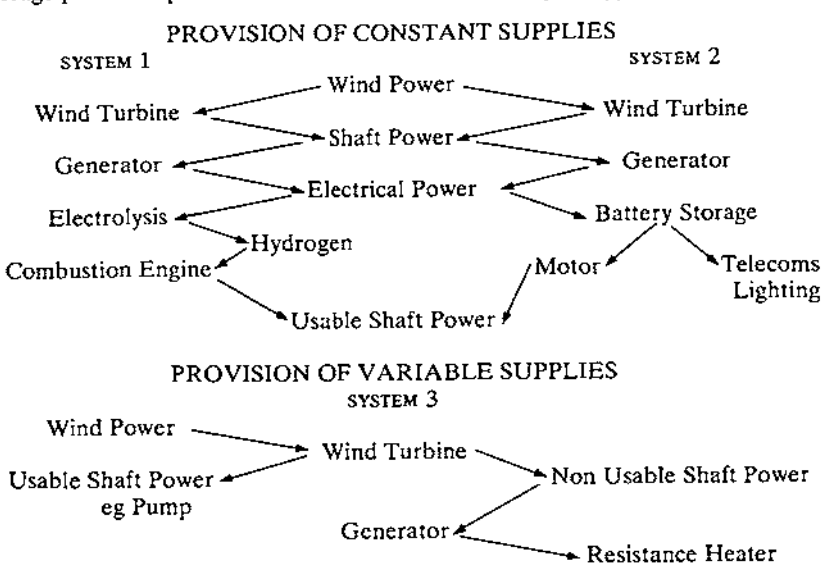



**Figure 14**

survey of the products of some twenty-five manufacturers, a "professional" installation of this size with all control equipment and 20kWh of battery storage would cost about £6000. An "amateur" installation could be made for about £4000. Assuming a life of twenty-five years for both machines, this represents a cost per kWh of 7.4p and 4.9p respectively. The current cost of grid electricity is around 3.5p per kWh, but the cost of diesel generated electricity is in excess of 8p per kWh, and this figure is continuously going up with the rise in the price of oil. It follows then that in remote applications a wind machine is a very viable proposition even where diesel generators are installed already. Where no power exists they are even more attractive, but as yet they do not compete with grid supplied electricity.

## EQUIPMENT SELECTION

The vital necessity of selecting a wind turbine whose performance matches the wind regime at the proposed site has already been pointed out. However even armed with this information there are an enormous number of potentially suitable competitors on the market. Of the twenty-five companies whom the author approached about their products, eleven supplied usable information and eight of these between them offered over 160 different WECS combinations. The potential user must firstly decide whether he wants a "professional" or an "amateur" installation and must then consider such parameters as application, rated power output, rated wind speed, efficiency below rated wind speed, control equipment required and included in the price, type of mounting, reliability, and of course, cost. There are obviously many others as well.

The application is normally fixed by the manufacturer in that nearly all machines are offered as a package of wind turbine and energy converter, be it generator, water pump, or something else. However a pump may for example be high head, low output or vice versa.

Rated power and rated wind speed are very important as some manufacturers quote rated power outputs at enormously high wind speeds like 28mph which are quite unrealistic. This selection process is really part of the wind turbine selection.

Efficiency below rated power is harder to get specific information on but it may be deduced from the manufacturer's performance curves. Compare the curve in Figure 13 of the Elektro WV25G with that of the Kedco 1210. Rated outputs are 2kW and 2.35kW but at 15mph the output of the Elektro is more than double that of the Kedco machine. The former is clearly more efficient at lower wind speeds.

The control equipment varies with the machine and the application. Most horizontal axis machines have automatic pitch control based on mechanical governor principles, but control gear can be supplied for such functions as generator output voltage control, battery charge rate control, automatic machine shutdown, control cabinet heating, and automatic switching in of alternative sources of power. The amount supplied as part of the standard package varies with the manufacturer. The amount actually required must be assessed by the user and balanced against the cost.

Mountings are more important with horizontal axis machines and the options are basically between unstayed lattice masts and guyed poles. The height of mounting depends on such factors as ground surface roughness around the location, rough ground with trees and bushes tending to keep the wind speeds low for a greater height above ground. An optimum height for wind speed versus mounting cost must be decided on during the site survey. An advantage of the guyed pole is that it can be hinge mounted, and the whole thing lowered when maintenance is required on the aerogenerator. This can thus be done at ground level rather than on top of the mast. Vertical axis machines tend to be on fixed masts but their generators are usually located at the bottom of the mast.

Reliability is much more difficult to assess and while some makes can already claim thirty years successful operating life, others new to the market undoubtedly make some excellent equipment. The user must use his engineering experience to decide on the merits and quality of individual products.

CONCLUSIONS

Wind power is free, non-polluting, and will be available when other conventional sources of energy have run out. It should therefore be made use of. Conversely it is a very dilute source of power and in order to utilise it economically, maximum efficiency of conversion is essential.

Correct site selection, and selection of a machine whose performance matches the prevailing conditions are also vital. Collection of site data cannot be carried out effectively in under one year and preferably three.

WECS can be used to provide either variable supplies or constant frequency, constant level supplies, the latter being most effectively provided via some form of storage.

Many methods of storage are theoretically feasible but the most effective ones use the minimum number of conversions of the energy derived from the wind.

WECS can be used for intermittent supplies of water pumping, heating and drying, but constant supplies are usually used for lighthouses, radars, beacons, and communications equipment in remote areas. It must always be remembered that the output from a small WECS is very small. Slightly larger WECS can be used in series with diesel generators in the role of fuel savers.

Given an estimated life of twenty-five years for a machine, a WECS is a more economical machine than a diesel generator even when the diesel set is already installed. A small machine is unlikely to redeem its cost when set in competition with grid electricity supplies at current prices.

# Engineer-in-Chief's Conference 1979

MAJOR A CLEMENTS RE

*After commissioning from Sandhurst in 1963 and attending the short course at Shrivenham, the author joined 36 Engr Regt where he served two tours in Aden before being posted to the Gulf as a Sqn 2IC. A tour as Adjutant of the Junior Leaders Regt preceded a posting to HQRE 1(BR) Corps as GSO3 Ops/Int. A spell in RSME followed, firstly in the Sigs Wing and later as GSO3 Trg. His last complete tour was as OC 131 Indep Para Sqn RE(V) and he took the Squadron through the conversion of its new Commando role. He is currently serving as a GSO2 in HQ E-in-C.*

MAJOR GENERAL C P CAMPBELL CBE held his third and last Conference as Engineer-in-Chief at the RSME from Monday 19th to Thursday 22nd November 1979. In comparison with the 1978 Conference, which studied operations on the Central Front of Europe and was attended by a large and varied audience, the 1979 theme of "Taking Stock of the Corps" was more parochial, and attendance deliberately limited. More time was devoted to discussion and the pace of the Conference was reduced to enable other business to be conducted. The social programme included the Sapper-Gunner rugby match which was regrettably marred by fog and defeat, and a successful Conference Dinner Night in the RE HQ Mess.

This article gives a brief resumé of what took place but is necessarily very limited when dealing with operations for security reasons.

*DAY ONE*

Major General Campbell opened the Conference by welcoming delegates and

Engineer-in-Chief's Conference 1979
Major A Clements RE

explaining how he wanted to use the occasion as a stocktaking exercise. He outlined the programme and stressed that in this smaller "in-house" gathering COs had the opportunity to air their views and be controversial. He hoped they would do so.

### RECRUITING AND MANNING IN THE ARMY

Major General M J Tomlinson OBE; VAG/DM(A)

Major General Tomlinson explained the background to the manning situation in the Army. He described the serious nature of officer and soldier PVR (Premature Voluntary Retirement) and in particular recruit wastage, but indicated that although it was early to judge, the recent pay award appeared to have had a favourable effect. Nevertheless barring an unprecedented improvement in recruiting and retention, soldier undermanning would remain a fact of life until at least 1987. Unless we planned carefully, the consequences of undermanning would be the vicious circle of more work, more turbulence, more overstretch, more separation, more PVR and even more undermanning. This must be avoided.

Therefore it was particularly important to increase retention and reduce PVR. The key to prolongation was the general satisfaction of the soldier and his wife with their life in the Army. Conditions of service were being examined and would be improved, but equally we needed to improve our management. This meant effort, conviction, inspiration and above all good communications at all levels. General Tomlinson stressed that we all had a part to play, whether in the Ministry, in formation headquarters or at regimental duty, and concluded by saying that the time had come to stop feeling sorry for ourselves and to get out and get on with the job.

### RECRUITING AND MANNING IN THE ROYAL ENGINEERS

Brigadier A C D Lloyd; D E-in-C
Colonel J B Wilks; Regimental Colonel
Colonel K J Marchant; AAG AG7
Colonel G W A Napier; OIC REMRO

The first of the three "wise men", as the Deputy Engineer-in-Chief described them, was the Regimental Colonel who explained that his prime responsibility was for the recruitment of officers and soldiers to meet the Corps manning requirement. He dwelt briefly on soldier recruiting, explaining the extra effort being put into recruiting juniors and apprentices and his concern over wastage.

He said the Corps was currently recruiting a high proportion of degree qualified Officers, but we were just as interested in quality as qualifications. We tried to pick out Officers as schoolboys at 15 to 16 years old and keep them interested in the Corps but we also recruited extensively from OTCs. The Regimental Colonel stressed the importance of publicising the Corps both inside and outside the Army, and asked CO's for their help here when organising demonstrations and displays.

The second "wise man", AAG AG7, explained the Officer undermanning and how it was affecting the Corps at staff and unit level. There were encouraging signs that the number of Officers retiring prematurely was reducing to traditional levels, which would indicate a more contented feeling. Opportunities for commissioning girls in the Corps were being studied and it was considered that there was scope for using WRAC, not only in Postal and Survey, but also in PQE posts. It was hoped to start a pilot scheme for training a small number of female graduates in 1981. AAG concluded by assuring everyone that policy on how and where to underman was monitored carefully by the E-in-C's Careers Board.

OIC REMRO used the analogy of a water-butt to explain the importance of not only recruiting aggressively, to top up the Corps, but also the necessity of reducing the outflow by cutting down on wastage. Turning to career planning the importance of early selection on a soldiers long term career prospects was emphasised. Perhaps it was too important, and some scheme should exist for allowing the late starter, or slow developer, to catch up. Finally the idea of twinning regiments was raised. This would mean that, for most of his career, a soldier would be linked to a particular regiment in

the UK and one in BAOR. It would help with housing, the stability of family life and engender the feeling of a family regiment. On the other hand it would have serious manning and career disadvantages.

In summing up, D E-in-C stressed the factors which would lead to an improvement in retention and identified them as motivation, confidence in the ability of the Army to fulfil its role, pay and conditions of service, quality of life, and job satisfaction. He invited delegates to give their views on the merit of twinning regiments, improvements to the NCO career pattern, and the employment of women in the Corps.

The points were taken up in a lively discussion period with the most controversial and popular topic being women in the Corps. Opinions ranged from support to outright chauvinistic opposition. Twinning of regiments also produced its share of controversy but the consensus of opinion was against.

### OFFICER TRAINING

Lieut Colonel D Brownson RE; GSO1 Engr6
Brigadier R F Vincent DSO; DMS(B)

Lieut Colonel Brownson outlined the training pattern for a non-degree short service Officer and compared it to a Regular Officer who took an in-service degree. This highlighted the short period of useful service given by the former, which could be exacerbated by proposals to lengthen the present RMAS course. The time spent at Sandhurst was likely to be substantially increased for all types of entrant. Army studies have included the hardy annual of whether potential Officers should do recruit training at basic training establishments before going to RMAS. Once again this had been rejected, although the Commandant RMAS had suggested an alternative proposal whereby basic recruit training would be done at RMAS.

The new pattern of RE YO training, effective from January 1979, was then described and the themes of personal leadership, tactical awareness, individual fitness and practical performance which run through it emphasised. The course was now in two phases, a 25-week combat phase and a 4-week construction phase.

DMS(B) explained the background to PQS 1 and PQS 2 and outlined the main changes. The PQS 1 written exam was to be abolished, and the practical exam made more demanding. The first PQS 2 written exam would take place in February 1981 and was to consist of two papers, the military law paper having been replaced by a short course.

Turning his attention to selection for staff training it was stressed that the Selection Board confined itself exclusively to confidential reports, and whilst no system can ever be perfect, immense care was taken to select Officers fairly and impartially. The system of selecting Officers for straight and weapons staff appointments was described and this year MS, for the first time, had selected Army Staff College students for their Grade 2 appointments. DMS(B) concluded with a comparison of career prospects in straight and weapons staff appointments. The figures suggest that, Armywide, *psc*† Officers had no grounds for believing that their chances of promotion to one-star rank were less than their contemporaries who had stayed in straight staff appointments. So far as Sappers were concerned Officers who were qualified *psc*† had so far done every bit as well as their *psc* and *psc*† contemporaries in other arms and services.

During the discussion period there were a number of questions on the balance of staff and weapons posts, and DMS(B) stressed the value of recent regimental experience to a Weapons Staff Officer. The subject of pre-PQS 2 training for candidates was raised and the difficulties CO's faced in training their Officers. DDAT said he was considering providing a guide to help CO's.

### SOLDIER TRAINING

Lieut Colonel D Brownson RE; GSO1 Engr6

Lieut Colonel Brownson started his presentation by outlining the reasons for the introduction of the new career structure and the principles upon which it was based.

Although it was early days, the signs were good, and in particular the Section Commanders and Field Sergeants courses had been well received. There were of course problems needing further study, in particular the best way of upgrading Class 3 combat engineers to Class 2, the question of whether Class 1 combat engineer training was best taught in regiments or at combat engineer training centres, and the poor attendance on Field Sergeant courses.

Focussing on other training problems, the undermanning of the clerical roster was serious and was the subject of a study, there were many potential artisan tradesmen delaying or declining training, and there was a shortage of drivers. This last topic was the one CO's wanted to examine, and the Corps establishment of drivers and the capacity for training them was outlined. Much of the answer lay in the Corps' ability to harness its considerable driver training potential to the best advantage. Nevertheless some in-unit training would be necessary for the foreseeable future.

Lieut Colonel Brownson finished by appraising the audience of three moves that were afoot, firstly the setting up of a RE training aid centre, secondly the proposed introduction of foreman of trades, and lastly the intention of RE Survey to stop training survey recruits as combat engineers and to introduce a combat surveyor trade. The discussion which followed was largely centred on the issues of clerical and driver training. The use of WRAC in both employments was suggested.

### AG ASPECTS OF LIFE IN UK UNITS

Brigadier R A Rickets; Chief Engineer UKLF
Lieut Colonel F G Sugden RE; CO 22 Engr Regt

The organisation, roles and tasks of UKLF units, and details of unit programmes were explained to demonstrate the varied and wide range of commitments that were undertaken. With this full programme there was a fine balance between the "satisfiers" of Service life, the benefits of travel, adventure and variety, and the "dissatisfiers", the penalties of overstretch and family separation. In particular there was a constant battle to reduce short notice commitments, and see to it that whenever a soldier was away from barracks he was doing something really worthwhile.

CO 22 Engr Regt reinforced what the Chief Engineer had said about travel, adventure and the variety of life in a UKLF unit. There were excellent opportunities for Squadron Commanders and frequently junior Officers and junior NCOs to exercise independent command. Young Officers got plenty of responsibility and benefited from it, but such was turbulence that by the time they were trained properly they were invariably posted away. This was not good for them, nor for the soldiers they led. Turning to dissatisfiers in Army life it was claimed that quarters and barracks were badly maintained by DOE, training stores were often in poor condition and there was a need to increase the scale of many items. In particular regiments needed their own small stock of commonly used items. Yet another dissatisfier was the pressure brought about by undermanning and overwork which took much of the fun out of life.

Units were over-burdened by a vast amount of rules, regulations and standing orders, (a wheelbarrow full of current "bumf" was wheeled onto the stage to illustrate this point). Turning to separation, the married soldier in 22 Regt was separated, on average, for about five months in each year, which particularly put a strain on young families. Attention was then drawn to the effects of an increasing number of Officers and Senior NCOs purchasing their own houses. The concept of unit family life as had been known and enjoyed for many years was being destroyed, and was a threat to unit identity and spirit. There was a need for a satisfactory Army house purchase scheme.

In summing up Chief Engineer UKLF agreed that the pace of life was hot, but provided it included variety, interest and travel most soldiers liked it that way. Overstretch within UKLF had meant shortages with no fat or anything in reserve. Consequently instead of getting on with the job sometimes enormous effort went

into just making both ends meet. PVR had recently reduced, but the soldier expected more and better equipment with which to train and do his job.

The presentation sparked off considerable discussion on the pressure of unit life and separation. A number of suggestions on the related problems of house purchase and empty quarters were made and considered. VAG/DM(A) considered that owing to the tight financial situation a complete house purchase packet was a long way off yet, but he reassured delegates that DMO and DASD were constantly trying to reduce unit commitments.

*DAY TWO*

SURVEY TODAY

Brigadier R M W Busk OBE; Brig Svy
Group Captain M J-C Burton OBE RAF; DD Ops/Nav (RAF)
Lieut Colonel E R Clowes RE; AD Svy2
Lieut Colonel S E G Fraser RE; AD Svy1

The E-in-C opened Day Two of the Conference by welcoming a team from the Directorate of Military Survey led by Brigadier Busk who explained the mission of the Survey Branch and introduced the speakers. The RAF requirement for projected map displays and its development by military survey was explained. The needs of the Army and the Royal Navy for maps and survey data were covered and it was explained how maps are out of date to an extent as soon as they are produced, and thus need continual revision. A short description followed of the resources of D Mil Svy, the allocation of manpower, the equipments in use, and an outline of a survey Officers career.

The team then turned their attention to likely future requirements. The RAF needed higher accuracy both for navigation fixes and weapon aiming, and additional resources were likely to be needed during the introduction of digital techniques. In BAOR, terrain analysis and digital topographic data bases would be needed, and weapon control systems required extra data and greater accuracy than ever before. Much satellite technology was used now, but it was in the field of automated map drawing that the main advances would occur.

Brigadier Busk concluded by warning that users must decide relative priorities for survey work. Although there was an increased demand for support, new commitments could only be undertaken at the expense of other work.

REVIEW OF RAF SUPPORT

Brigadier N R Sturt; D Engr Svcs
Group Captain J E Neville OBE RAF; DD Ops(OS & JW)(RAF)
Colonel F W B Carter; Col RAF Sp Major D Rowell RE; OC 516 STRE

Brigadier Sturt explained that the presentation would cover the RAF requirement for Royal Engineer support, our ability to give that support, and an example of a project carried out at short notice for the Royal Air Force. The current threat to NATO airfields, and the work done by the NATO ADR (Airfield Damage Repair) Working Party to evaluate damage levels which would result from an increased threat was outlined. The time taken to restore operational capability after an attack was critically dependent upon the speed and accuracy of the post-attack reconnaissance.

The challenge faced by the Royal Engineers in meeting their responsibilities for ADR in UK and BAOR was explained. The problem was how to meet the requirement technically, and how to find extra manpower in UK. The success of the pilot scheme was acknowledged, and a short film was shown of trials recently carried out using dynamic compaction. An interesting account of a project carried out at Decimomannu to provide fuel storage facilities for the RAF by a team from 516 STRE was used to close the presentation. It was a good example of the ability of the Corps to react quickly and overcome local difficulties to meet an operational requirement.

BRIEFING BY VCGS AND TEAM

Lieut General Sir John Stanier KCB MBE; VCGS
Major General R B Trant CB; DASD
Brigadier J N S Arthur; BGS(Int)
Brigadier G B Sinclair CBE; BGS(MO)

In a classified presentation VCGS, before introducing his team, outlined progress on the study to examine the structure of the Army worldwide. The team then described the threat, with particular reference to the 1980's, and the deployment of the Army to meet this threat. VCGS in summing up expressed his confidence that we could achieve an Army to meet the needs of the 80's and 90's and at the same time improve our capability and conditions of service.

*DAY THREE*

COMBAT DEVELOPMENT

Colonel J R M Hill OBE; Col GS RSME
Colonel A Whitehorn; Col GS GS(OR)7

In this classified presentation Colonel Hill outlined the likely changes he envisaged in battlefield engineering. Colonel Whitehorn then described the significant areas of recent equipment development which would be available to support these changes. Greater use of machines and dedicated manpower could improve our overall capability and enhance our ability to support the battle. The need for a long lead time to prepare the battlefield could thus reduce in the future and better close support of the battle would be possible. The way ahead was potentially very exciting and the opportunity for the Sappers to make a major contribution to the battlefield would be even greater in the future.

A REVIEW OF THE TERRITORIAL ARMY

Brigadier H F Everard; Comd 30 Engr Gp(V)

Brigadier Everard emphasised the need for a continual dialogue between the TA and the Regular Army. The knowledge of the TA by the Regular Army was ashamedly poor and the average TA soldier knew much more about his Regular counterpart. We needed a one-Army concept but, although we were one Army in spirit, intent and motivation, there were clear differences in commitment, attitude and competence. The audience were reminded of the words of the Defence Secretary, the Right Honourable Francis Pym; "the Territorial Army has a fundamental role to play in defence. It is fully integrated with the Regular forces in operational plans. It makes a major contribution to the reinforcement of BAOR and the security of the UK. In short it makes an important and economic contribution to our national defence." Indeed, as plans were now written the TA formed an essential cost-effective element of our contribution to NATO.

Brigadier Everard then outlined some of the problems facing the TA today, beginning with training which was always difficult with a part-time force in terms of continuity and completeness. The TA were most dependent upon the advice and assistance that they received from the Regular element of the Corps both in the form of direct training aid and the sponsorship of units at camp. He took the opportunity to thank all Commanders and units for their help, and assured them that the benefits of their assistance were out of all proportion to the efforts of the sponsors. He confirmed that the TA had welcomed the Shapland Report. The Army Board had agreed most of its recommendations and as a result there were early indications of an improvement in recruiting. In concluding Brigadier Everard reiterated the dependence of the TA upon the advice and assistance of Regular units. If the audience had the impression that the TA was healthy and enthusiastic and, more to the point, capable and effective, then the aim had been achieved.

ENGINEER-IN-CHIEF'S CLOSING ADDRESS

The E-in-C thanked all those who had made the conference possible and explained that he was going to concentrate on "the affairs of today" under the headings of

manpower, training, doctrine and equipments, touching on RAF support, and then concluding with "tomorrows world".

*Manpower*

It was clear that the manning deficiency which we were experiencing would be with us for a long time and we had to make use of every possible resource including women. There was a strong undercurrent of chauvinism evident in the discussion on the employment of women and whilst this was a controversial matter, WRAC must be given a chance. All was not gloom on the manpower front, there were encouraging signs. Recruiting was picking up and PVR was declining although the wastage in the training organisation was too high. The manning of that organisation therefore was to be given the highest priority for quality and numbers. It was also essential to ensure that our commitments were realistic and we did not get carried away with the enthusiasm to rush off to do every job which presented itself. Equally soldiers wanted a chance to go abroad and serve in exciting places.

*Training*

The new career structure was going well and had many benefits although we might have to make adjustments as time went by. Commanding Officers might have difficulty in providing people for courses but some improvement in attendance was required in the year ahead. The YO course now was right for the time in which we live, but the importance of the PQS stage in a young Officers life must be stressed.

On his tour around Germany earlier in the year, the E-in-C had seen for himself the state of training stores and he reassured delegates that action had been taken. There would be an improvement, and a lot of effort was going into providing more within the limits of our budget.

*Doctrine*

The Corps remained very much in the forefront of tactical thinking. The paper on "Battlefield Engineering" was an important one to which all must contribute. The symposium on "Survivability on the Battlefield" to be held at the RSME was also very important. We must concentrate on ideas to achieve the substantial break-through that was required in Airfield Damage Repair.

*Tomorrows World*

We had been working on what was needed to enhance our capabilities and to fill the gaps left as a result of the Army Restructuring Programme. Certain principles on which engineer support must be built had been established. Engineer advice and support was required at every level, Battle Group, Brigade, Division, Corps and Army. The field squadron was the brick upon which we built our organisation, and would be found at Brigade level in close support and in a more general support role at Division and at Corps level. It was essential to bear in mind that we must strike a balance between what was deployed forward and what was held back. Commanders had to have reserves at their disposal. There must be a proper measure of engineer support in UK to deal with the multiplicity of home defence issues including support for the Royal Air Force. There would be much discussion on the final shape of the Corps but once the discussion was over we had to accept that there was *one* Royal Engineer view and that was a view that had to be paraded without argument in the All-Arms environment.

*Conclusion*

The Engineer-in-Chief said that we were looking firmly ahead; we had established a number of signposts, we all had to work together following the principles that he had announced with unanimity of purpose. Once decisions had been made all must follow loyally and there must be no divisiveness because divided we should fall. For the longer term we must set our sights high. While we might have to adjust our aim as we went forward year by year, we would nevertheless have a very good basis on which to build our desired Royal Engineer organisation. General Campbell said he looked forward to seeing everybody as he went around in his final six months before handing over in July to Brigadier Sinclair.

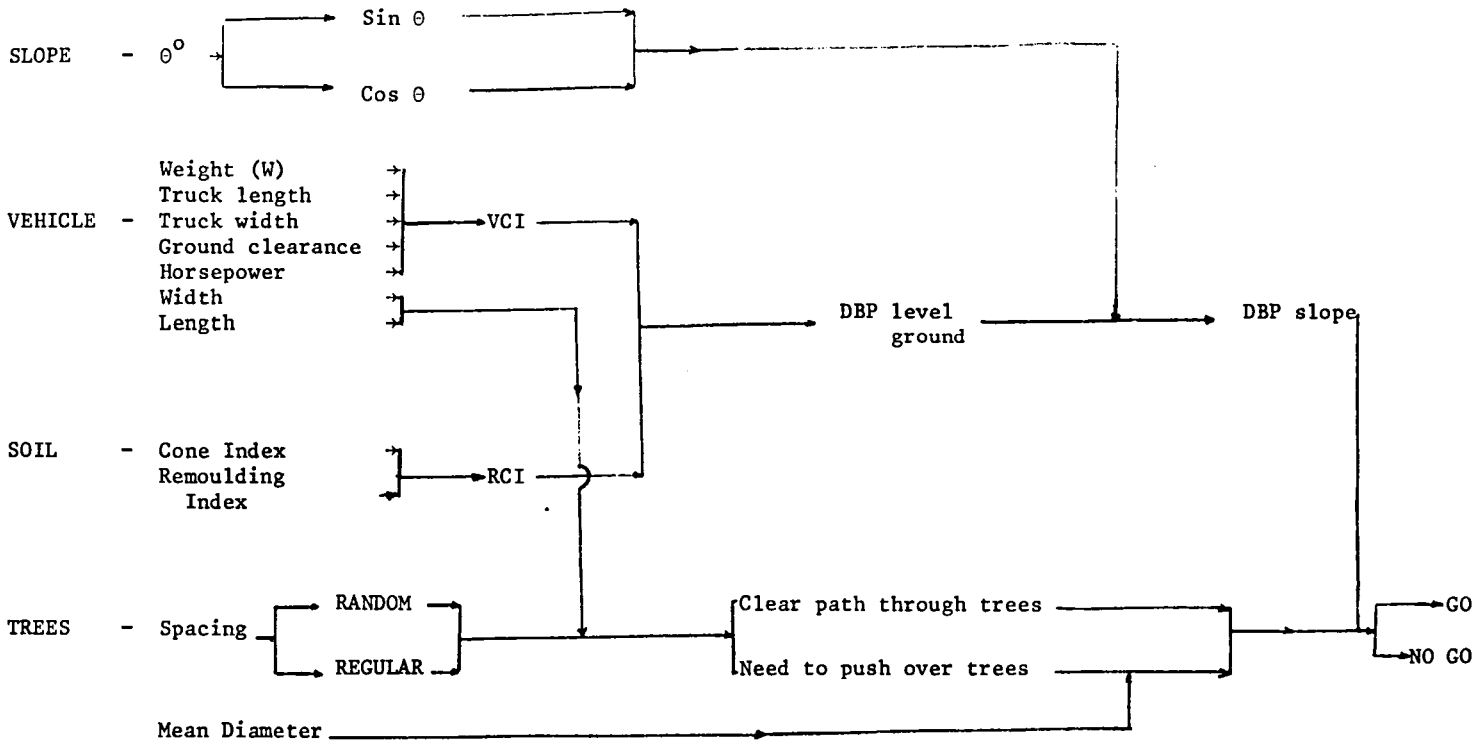



**Figure 1.** Network diagram

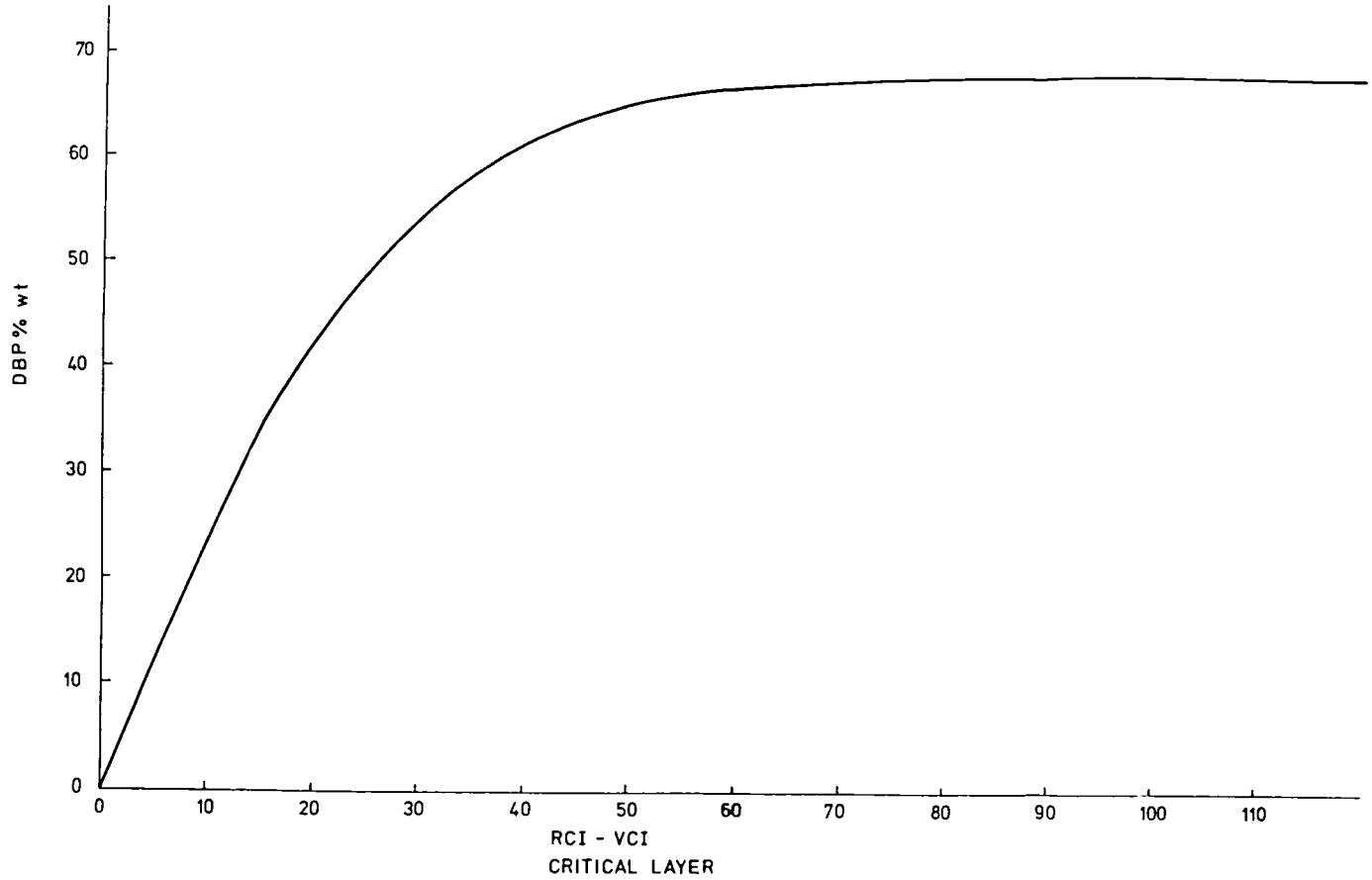



**Figure 2.** Maximum Tractive Effort %wt/RCI–VCI

## THE APPROACH

The factors involved in the problem were identified as:

(a) The type of tracked vehicle, its characteristics and the effects on it of trees, soil and slope.

(b) The trees, their size and spacing and resistance to knock down.

(c) The nature of the soil and the effect of it on the passage of vehicles and the strength of the trees.

(d) The slope of the ground and its effect on the ability of vehicles to knock down trees.

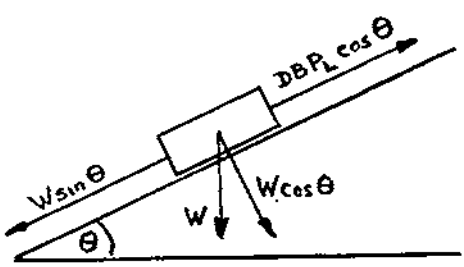
The complicated interaction of these factors can best be expressed in a network diagram—reproduced as Figure 1. The interaction must be quantified to solve the problem.

## VEHICLE/SOIL INTERACTION

There are many methods of evaluating vehicle soil interaction. Most are empirical and none was found that was better than the Vehicle Cone Index (VCI)/Rated Cone Index (RCI) method. The RCI of the soil is measured using that much underrated equipment, the "Cone Penetrometer". The VCI is calculated using a complex formula and is verified empirically by experiment. Some VCI values for the more common tracked vehicles are given at Table 2. By subtracting VCI from RCI and entering the graph at Figure 2 a value of the "Available Drawbar Pull" can be determined. This figure is the residual force available to the vehicle for knocking down trees on level ground. ($DBP_L$).

## VEHICLE/SLOPE INTERACTION

When a vehicle is climbing a slope, the component of its weight down the slope detracts from the available drawbar pull. Additionally the component of weight normal to the slope is reduced which also has the effect of reducing tractive effort (see Figure 3). The maximum slope a vehicle can climb unhindered is when $W \sin\theta = DBP_L \cos\theta$ or $\frac{DBP_L}{W} = \tan\theta$. From Figure 3 it can be seen that $\frac{DBP_L}{W}$ has a maximum value of 64. That is $\theta = 32°$. It appears, therefore, that all tracked vehicles behave similarly and that none can climb a slope greater than 32°. This has been experimentally verified and is a very close approximation valid for all known tracked armoured vehicles.




θ = Angle of slope
W = Wt of vehicle
$DBP_L$ = Drawbar pull on level ground
DBPs = Drawbar pull on slope

Figure 3. Slope Climbing

## VEHICLE/TREE INTERACTION

The force available to the vehicle to knock down a tree is calculated as described above. A simple model (Figure 4) shows the tree acting as a cantilever with the force F being exerted at a height h above the ground. If it is assumed that the trees are circular in cross section, the force F to fracture the tree can be derived thus:

Assuming the basic relationship $\frac{f}{y} = \frac{M}{I}$

then $M = \frac{f}{y} I$ and also equals Fh (Figure 4)

$$\therefore F = \frac{fI}{yh} \quad (1)$$

as $I = \frac{\pi d^4}{64}$; $y = \frac{d}{2}$ where d = diam of tree

and f at fracture = S (ultimate tensile stress of the timber)
substituting in (1)

$$F = S \times \frac{\pi d^4}{64} \times \frac{2}{d} \times \frac{1}{h} = \frac{d^3}{h} \times \frac{S\pi}{32} \quad (2)$$

For any given tree $\frac{S\pi}{32}$ is constant and $\frac{d^3}{h}$ is the variable.

As many trees as possible were pulled over and the experimental results plotted. For h of one metre, the graph of F against $d^3$ had a slope of $1.7 \times 10^5$. Equation (2) then becomes:

$$F = \frac{1.7\, d^3}{h} \times 10^5 \text{ kg force}$$

This result compares well with results of experiments carried out in USA and FRG. The agreement is particularly good when h is between 0.6m and 2 m (as it is for most tracked vehicles) and the diameter of the tree is between 0.2m and 1m.

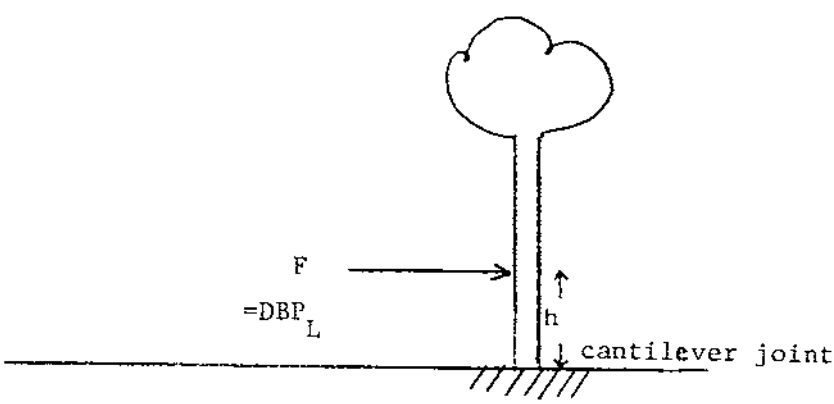



**Figure 4.** Simple model of a tree being pushed over

WOODS

The woods in BAOR can be placed in two categories; the husbanded woods, where trees are regularly spaced, and uncultivated woodland where research has shown that the trees are randomly spaced.

The wood is obviously not an obstacle if the trees are spaced far enough apart for the vehicle to drive between them. This is relatively easy to calculate for regularly spaced woods. However, for randomly spaced trees, the problem is more difficult. The solution adopted was to make a simple model using paper "fields" of computer produced randomly spaced dots and "driving" a paper rectangle representing a vehicle through the field. The vision of the driver was restricted so that he could only see a 60° arc to his front. The vehicle was then manoeuvred through the wood and its path marked (see Figure 5). The length of the path as a ratio of the shortest possible path through was taken as an index of the difficulty of navigating through a particular field. This "difficulty index" was then plotted against the mean tree interdistance calculated as $S_m = \frac{\sqrt{A}}{2\sqrt{N}}$

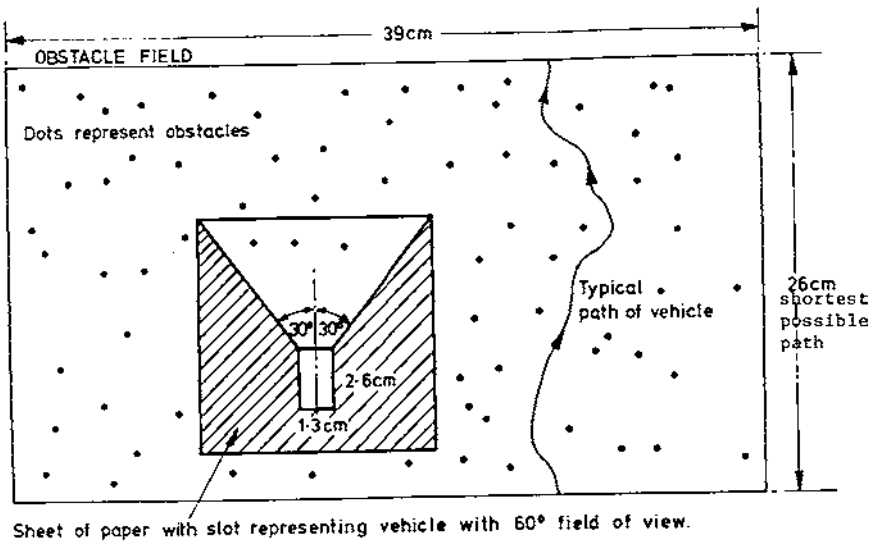



Figure 5. Diagram of model

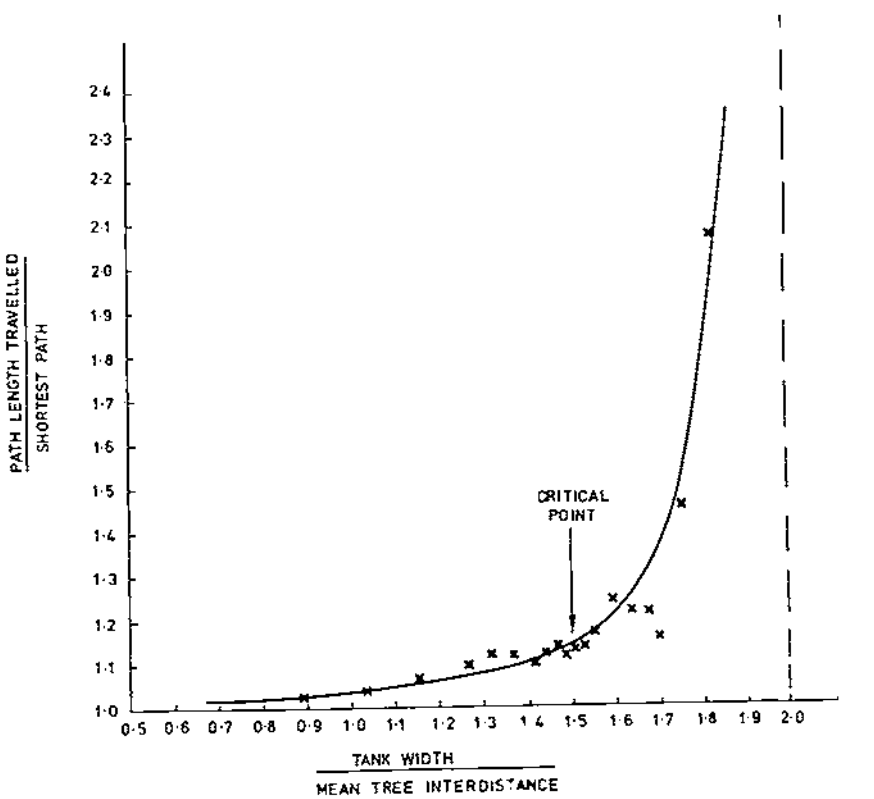



Figure 6. Graph of combined results

When $S_m$ = mean tree interdistance
A = a representative Area of the wood
N = Number of trees in the area A.

The results seen at Figure 6 show the graph as asymptotic to the line where tank width/mean tree interdistance = 2. There is, therefore, a clear sign of a "NO-GO" situation when $S_m$ is less than half tank width. Where this is the case, trees would have to be knocked down for the tank to pass.

### A METHOD OF ASSESSING GO/NO-GO SITUATION

With all the inter-relations quantified it was possible to go back to Figure 1 and produce a GO/NO-GO solution for any tracked vehicle attempting to pass through a given wood. To simplify the calculations a quick step by step method has been produced.

*Step 1.* Four measurements have to be made:
(a) Determine the Cone Index (CI) of the soil using a cone penetrometer.
(b) Measure the slope of the ground at the point of maximum slope.
(c) Count the number of trees in a given area. Tree stumps over 30cm high should be included.
(d) Measure the average circumference at a height of 30cm above the ground.

*Step 2.* Convert the soil CI to RCI using Table 1 and find the vehicle VCI from Table 2. Then obtain a figure for RCI–VCI. If negative the vehicle will not pass.

*Step 3.* From the above and the measured slope use Table 3 to obtain a factor "Q", which is a measure of the residual draw bar pull as a percentage of vehicle weight after overcoming slope and ground resistance.

*Step 4.* Obtain the mean tree interdistance, $S_m$, from Table 4. Compare this with the minimum $S_m$ which will allow the vehicle to pass. If $S_m$ is greater than needed the wood is not an obstacle to movement. If $S_m$ is not greater, go to *Step 5.*

*Step 5.* Enter Table 5 with the average tree circumference C and the vehicle type. Obtain a factor known as the R factor. This is the force required to push over a tree expressed as a percentage of the vehicle weight. The value Q–R is now determined. If:

Q–R Positive—GO
Q–R Negative—NO GO

TABLE 1

| Penetrometer Reading (CI) | Remoulding Index (RI) | RCI (CI × RI) |
|---|---|---|
| 0–60 | ·5 | 0–30 |
| 60–100 | ·6 | 36–60 |
| 100–150 | ·7 | 70–105 |
| 150–200 | ·75 | 113–150 |
| 200–300 | ·8 | 160–240 |

*Note*: There is no definitive method in the British Army for measuring Remoulding Index at present.

TABLE 2

| Vehicle | VCI | Weight kg | Bow ht m | L | W |
|---|---|---|---|---|---|
| Chieftain | 74 | 54000 | 1·0 | 9·75 | 3·66 |
| 432 | 67 | 18000 | 0·9 | 5·1 | 2·82 |
| T62 | 58 | 37000 | ·8 | 9·0 | 3·35 |
| T72 | 60 | 39000 | ·8 | 9·3 | 3·3 |
| BMP | 39 | 14500 | 1·3 | 6·75 | 3·0 |
| CVR(T) | 31 | 7900 | 0·6 | 4·39 | 2·18 |

TABLE 3 Q Factor from RCI–VCI and Slope

| Slope / RCI–VCI | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0–5 | ·100 | ·065 | ·030 | | | | | | | | | | |
| 5–10 | ·250 | ·215 | ·180 | ·144 | ·108 | ·073 | ·037 | ·001 | | | | | |
| 11–15 | ·340 | ·305 | ·269 | ·234 | ·198 | ·161 | ·125 | ·088 | ·051 | ·015 | | | |
| 16–20 | ·420 | ·385 | ·349 | ·313 | ·276 | ·240 | ·203 | ·166 | ·128 | ·090 | ·053 | | |
| 21–25 | ·485 | ·450 | ·414 | ·378 | ·341 | ·304 | ·266 | ·229 | ·191 | ·152 | ·114 | ·017 | |
| 26–30 | ·535 | ·500 | ·464 | ·428 | ·391 | ·353 | ·315 | ·277 | ·239 | ·200 | ·161 | ·062 | |
| 31–35 | ·560 | ·525 | ·489 | ·452 | ·415 | ·378 | ·340 | ·301 | ·263 | ·224 | ·184 | ·085 | |
| 36–40 | ·610 | ·575 | ·539 | ·502 | ·465 | ·427 | ·389 | ·350 | ·311 | ·271 | ·231 | ·130 | ·028 |
| 41–45 | ·635 | ·600 | ·564 | ·527 | ·490 | ·452 | ·413 | ·374 | ·335 | ·295 | ·255 | ·153 | ·050 |
| 46–50 | ·650 | ·615 | ·579 | ·542 | ·505 | ·466 | ·428 | ·389 | ·349 | ·309 | ·269 | ·166 | ·063 |
| 51–55 | ·660 | ·625 | ·589 | ·552 | ·514 | ·476 | ·438 | ·398 | ·359 | ·319 | ·278 | ·176 | ·072 |
| 56–60 | ·665 | ·630 | ·594 | ·557 | ·519 | ·481 | ·443 | ·403 | ·364 | ·323 | ·283 | ·180 | ·076 |
| 61–65 | ·667 | ·632 | ·596 | ·559 | ·521 | ·483 | ·445 | ·405 | ·366 | ·325 | ·285 | ·182 | ·078 |
| 66–70 | ·670 | ·635 | ·599 | ·562 | ·524 | ·486 | ·447 | ·408 | ·368 | ·328 | ·288 | ·185 | ·080 |
| 71–75 | ·673 | ·638 | ·602 | ·565 | ·527 | ·489 | ·450 | ·411 | ·371 | ·331 | ·290 | ·187 | ·083 |
| 76–80 | ·674 | ·639 | ·603 | ·566 | ·528 | ·490 | ·451 | ·412 | ·372 | ·332 | ·291 | ·188 | ·083 |
| 81–100 | ·676 | ·641 | ·605 | ·568 | ·530 | ·492 | ·453 | ·414 | ·374 | ·334 | ·293 | ·190 | ·085 |
| 101 + | ·680 | ·645 | ·609 | ·572 | ·534 | ·496 | ·457 | ·418 | ·378 | ·338 | ·297 | ·194 | ·089 |

Q factor is DBP available, expressed as a proportion of vehicle weight, after overcoming slope and ground resistance.

EXAMPLE

A wood on a forward slope is planned as an obstacle to T62 tanks.

*Step 1.*

(a) CI of soil is 160.
(b) Maximum slope is 20°.
(c) There were 40 trees in a 400m square of the wood.
(d) The average tree circumference was 110cm.

*Step 2.* From Table 1 RCI = CI × ·75
= 120
From Table 2 VCI = 58
RCI–VCI = 62

The vehicle can pass over the ground.

*Step 3.* From Table 3 with RCI–VCI = 62 and slope 20° the "Q" factor = ·285.
"Q" is positive, therefore, the vehicle can climb the slope.

TABLE 4

Mean Tree Interdistance in Metres

| A \ N | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | 2·5 | 1·77 | 1·44 | 1·25 | 1·12 | 1·02 | ·94 | ·88 | ·83 | ·79 | ·75 | ·72 | ·67 | ·63 | ·59 | ·56 | ·53 | ·51 | ·46 | ·42 | ·40 | ·37 | ·35 | ·34 | ·32 |
| 50 | 3·54 | 2·5 | 2·04 | 1·77 | 1·58 | 1·44 | 1·34 | 1·25 | 1·18 | 1·12 | 1·07 | 1·02 | ·94 | ·88 | ·83 | ·79 | ·75 | ·72 | ·65 | ·60 | ·56 | ·53 | ·50 | ·48 | ·46 |
| 100 | 5·00 | 3·54 | 2·89 | 2·5 | 2·24 | 2·04 | 1·89 | 1·77 | 1·67 | 1·58 | 1·51 | 1·44 | 1·34 | 1·25 | 1·18 | 1·12 | 1·07 | 1·02 | ·91 | ·85 | ·79 | ·75 | ·71 | ·67 | ·65 |
| 150 | 6·12 | 4·33 | 3·54 | 3·06 | 2·74 | 2·5 | 2·31 | 2·17 | 2·04 | 1·94 | 1·84 | 1·77 | 1·64 | 1·53 | 1·44 | 1·37 | 1·31 | 1·25 | 1·12 | 1·04 | ·97 | ·91 | ·87 | ·83 | ·79 |
| 200 | 7·07 | 5·0 | 4·08 | 3·54 | 3·16 | 2·89 | 2·67 | 2·5 | 2·36 | 2·24 | 2·13 | 2·04 | 1·89 | 1·77 | 1·67 | 1·58 | 1·51 | 1·44 | 1·29 | 1·20 | 1·12 | 1·05 | 1·00 | ·95 | ·91 |
| 250 | 7·91 | 5·59 | 4·56 | 3·95 | 3·54 | 3·23 | 2·99 | 2·8 | 2·64 | 2·5 | 2·38 | 2·29 | 2·11 | 1·98 | 1·86 | 1·77 | 1·69 | 1·61 | 1·44 | 1·34 | 1·25 | 1·18 | 1·12 | 1·07 | 1·02 |
| 300 | 8·66 | 6·12 | 5·0 | 4·33 | 3·87 | 3·54 | 3·27 | 3·06 | 2·89 | 2·74 | 2·61 | 2·5 | 2·31 | 2·17 | 2·04 | 1·94 | 1·85 | 1·77 | 1·58 | 1·46 | 1·37 | 1·29 | 1·22 | 1·17 | 1·12 |
| 350 | 9·35 | 6·61 | 5·4 | 4·68 | 4·18 | 3·82 | 3·54 | 3·31 | 3·12 | 2·96 | 2·82 | 2·7 | 2·5 | 2·34 | 2·2 | 2·09 | 1·99 | 1·91 | 1·71 | 1·58 | 1·48 | 1·39 | 1·32 | 1·26 | 1·21 |
| 400 | 10·00 | 7·07 | 5·77 | 5·00 | 4·47 | 4·08 | 3·78 | 3·54 | 3·33 | 3·16 | 3·02 | 2·89 | 2·67 | 2·50 | 2·36 | 2·24 | 2·13 | 2·04 | 1·83 | 1·69 | 1·58 | 1·49 | 1·41 | 1·35 | 1·29 |
| 450 | 10·61 | 7·50 | 6·12 | 5·30 | 4·74 | 4·33 | 4·01 | 3·75 | 3·54 | 3·35 | 3·2 | 3·06 | 2·83 | 2·65 | 2·50 | 2·37 | 2·26 | 2·17 | 1·94 | 1·79 | 1·68 | 1·58 | 1·50 | 1·43 | 1·37 |
| 500 | 11·18 | 7·91 | 6·45 | 5·59 | 5·0 | 4·56 | 4·23 | 3·95 | 3·73 | 3·54 | 3·37 | 3·23 | 2·99 | 2·80 | 2·64 | 2·5 | 2·38 | 2·28 | 2·04 | 1·89 | 1·77 | 1·67 | 1·58 | 1·51 | 1·44 |
| 550 | 11·73 | 8·29 | 6·77 | 5·86 | 5·24 | 4·79 | 4·43 | 4·15 | 3·91 | 3·71 | 3·54 | 3·39 | 3·13 | 2·93 | 2·76 | 2·62 | 2·5 | 2·39 | 2·14 | 1·98 | 1·85 | 1·75 | 1·66 | 1·58 | 1·51 |
| 600 | 12·25 | 8·66 | 7·07 | 6·12 | 5·48 | 5·0 | 4·63 | 4·08 | 3·87 | 3·69 | 3·54 | 3·27 | 3·06 | 2·89 | 2·74 | 2·61 | 2·5 | 2·24 | 2·07 | 1·94 | 1·83 | 1·73 | 1·65 | 1·58 | 1·58 |

N = number of trees in area; A = square area $m^2$; then $S_m = \frac{0{\cdot}5}{N/A}$

For own movement : $S_m > 0{\cdot}79$ width vehicle, clear paths available.
For en movement : $S_m < 0{\cdot}59$ width vehicle, wood is obstacle

| | | Chieftain | CVR(T) | 432 | T62 | T72 | BMP |
|---|---|---|---|---|---|---|---|
| ∴ | $S_m >$ | 2·89 | 1·72 | 2·22 | – | – | – |
| | $S_m <$ | – | – | – | 1·98 | 1·95 | 1·77 |

*Step 4.* From Table 4 with N = 40 and A = 400, $S_m$ = 1·58. For T62 $S_m$ must be <1·98 for trees to obstruct movement. Here $S_m$ is < 1·98, therefore trees obstruct movement.

*Step 5.* The average tree circumference C = 110cm. From Table 5 obtain the R factor for a T62: R = ·25

Q–R = ·285 – ·25
= ·035

Q>R therefore, the tank can push down the trees.

Therefore a wood of 35cm diameter trees spaced just over 1·5m apart on a slope of 20° in good ground conditions is not an obstacle to T62s.—A disturbing result.

TABLE 5 R Factor Required by Vehicle to Push Over Tree of Circumference C cm

| C | Chieftain | CVR(T) | 432 Series | T62 | T72 | BMP |
|---|---|---|---|---|---|---|
| 40cm | ·0064 | ·07 | ·02 | ·01 | ·01 | ·02 |
| 50 | ·01 | ·14 | ·04 | ·02 | ·02 | ·04 |
| 60 | ·002 | ·25 | ·07 | ·04 | ·04 | ·06 |
| 70 | ·0003 | ·4 | ·12 | ·07 | ·06 | ·1 |
| 80 | ·05 | ·59 | ·17 | ·1 | ·09 | ·15 |
| 90 | ·07 | ·84 | ·25 | ·14 | ·13 | ·21 |
| 100 | ·1 | | ·34 | ·19 | ·18 | ·29 |
| 110 | ·13 | | ·45 | ·25 | ·24 | ·39 |
| 120 | ·17 | | ·59 | ·33 | ·31 | ·5 |
| 130 | ·22 | | ·75 | ·42 | ·4 | ·64 |
| 140 | ·27 | | | ·52 | ·49 | ·8 |
| 150 | ·34 | | | ·64 | ·61 | |
| 160 | ·41 | | | ·78 | ·74 | |
| 170 | ·49 | | | | | |
| 180 | ·58 | | | | | |
| 190 | ·69 | | | | | |
| 200 | ·8 | | | | | |

## LIMITATIONS AND SHORTCOMINGS

The proposed method of assessing the obstacle value of woods has a number of limitations and shortcomings:

(a) Soil conditions vary from day to day, thus, the RCI of the soil is a variable. Furthermore conditions such as surface slip in frost or heavy rain cannot be quantified. However obstacle planning must cater for our worst case, the enemy's best case, or, in this situation, dry firm ground.

(b) The formula for calculating the force required to push down a tree is unproven. Many more experiments will have to be carried out to properly validate it. However we know that it gives the correct answer for Chieftain and 432 series vehicles. There seems no reason why all types of trees, deciduous and coniferous, should behave in the same way, but our limited evidence suggests that they do. Also some trees uproot whereas others break off near the ground. It is not clear why the same force should be required to achieve either effect. Perhaps trees put down roots sufficient to support the maximum load that their trunks can take. In dry weather the roots would be firmer and the trunk would snap, in wet weather when the soil is loose they are uprooted.

(c) When trees are knocked over by tanks they may create an obstacle which will prevent that tank moving forwards. This probability cannot be quantified and, therefore, has not been considered. Other imponderables which cannot be evaluated include driver ability, the likelihood of tracks being shed, the time taken to manoeuvre and many more.

(d) Finally this method gives a GO–NO GO solution when the movement through trees would be better expressed as a probability.

Despite the limitations, this method gives a reasonable estimate of whether or not a tracked vehicle can pass through a wood—and it is the only method currently available which does so. It is hoped that those Sapper officers who are responsible for barrier planning will be tasked (or will take it upon themselves) to check their subjective judgement by the quantitative method described above. The results may be surprising.

# George Barney—Pioneer and Soldier

*This short article was submitted by the Directorate of Engineers, Department of Defence, Canberra. We are indebted to the Directorate, Army Public Relations (for the photographs) and "Australian Army" (Volume 22/4 of 6 December 1979) for their permission to publish.*

A SIMPLE memorial to one of New South Wales most famous pioneer engineers Lieut Colonel George Barney RE was unveiled at The Rocks on 19 November 1979 by Mr Landa, the NSW Minister for Planning and Environment.

The memorial consists of two sandstone blocks which were taken from the original archway at Victoria Barracks during restoration. Plaques on one block mark Barney's achievements and include badges of both the Royal Engineers and the Royal Australian Engineers, indicating the dual heritage of this great engineer.

The construction of the memorial was undertaken by 17 Construction Squadron (RAE) under the supervision of the Sydney Cove Re-development Authority. The memorial was funded by donations from various organisations, including a donation of £1000 from the Corps of Royal Engineers.

George Barney RE arrived in Sydney in 1835 as the first military engineer to be assigned duty in the colony; he held the rank of Captain. His primary duty, "to take charge of military buildings and stores—", was soon overshadowed by civil responsibilities. Possibly two of the more outstanding tasks undertaken by Barney in this civilian guise were the dredging of the Parramatta River and construction of the Newcastle Breakwater, whilst the more important of his military duties was undoub-

**Photo 1.** A general view of the memorial

George Barney-Pioneer and Soldier 1

**Photo 2.** Mr Landa, NSW Minister for Planning; Mr Dennis Adams, the sculptor for the memorial, and Major R Smitherman RE, UK Exchange Officer to SME, admire the plaque on the monument. The plaque on the wall to the left of the monument commemorates the 60th Anniversary of the Institution of Engineers (Australia)

tedly the design and construction of Victoria Barracks which began 1841.

Barney's career had considerable connection with The Rocks and it was thought appropriate that his name be recorded there. It was also thought appropriate that Major R Smitherman RE, the UK Exchange Officer posted to the School of Military Engineering, be asked to speak on "behalf of sappers past and present" during the unveiling ceremony: Major Smitherman made the point that sapper ingenuity as displayed by Barney is still the trade mark of the RE and RAE of to-day.

It was particularly gratifying that Mrs Deane, a direct descendant of Barney, could be present at the unveiling of the memorial to our first Commanding Royal Engineer, a pioneer engineer who left an indelible mark on the colony of NSW.

The wording on the plaque is under a bas-relief of Barney and reads as follows:

LIEUTENANT COLONEL GEORGE BARNEY RE

| | |
|---|---|
| COMMANDING ROYAL ENGINEERS | 1835–1843 |
| COLONIAL ENGINEER | 1835–1844 |
| SUPERINTENDENT NORTH AUSTRALIA | 1846–1847 |
| CHIEF COMMISSIONER CROWN LANDS | 1849–1855 |
| MEMBER LEGISLATIVE COUNCIL | 1851–1856 |
| SURVEYOR GENERAL | 1855–1859 |

DURING HIS TERM OF OFFICE WAS RESPONSIBLE FOR
FORTIFICATIONS, MARITIME BUILDINGS AND ROAD WORKS
CONSTRUCTED IN THE COLONY OF NEW SOUTH WALES
AMONG THE MORE IMPORTANT WERE:
FORTIFICATIONS AT MIDDLE, SOUTH, BRADLEYS AND GEORGES HEADS
DAWES POINT BATTERY AND FORT DENISON, CIRCULAR QUAY, CUSTOMS
HOUSE, GARRISON CHURCH, NEWCASTLE BREAKWATER, ADMIRALTY HOUSE
NEW GOVERNMENT HOUSE AND VICTORIA BARRACKS, FROM WHENCE
CAME THESE STONES.

George Barney-Pioneer and Soldier 2

# The Queen Elizabeth II Army Memorial Museum

LIEUT COLONEL H E WEDDE BE(Civ), RNZE and MAJOR A ANDERSON MBE, RNZE

FOREWORD

*Lieut Colonel H E Wedde BE(Civ), RNZE joined the NZ Army in 1960 and graduated from Canterbury University in 1963. He served as Constr Offr 2 Plt Tp RNZE with OP CROWN in Thailand; as Constr Offr 5 Specialist Team RNZE on road construction in Thailand; has held the appointment of Trg Offr SME, OC 2 Constr Sqn, OC and CI SME; and during 1977–78 was Project Offr to the CGS for the Queen Elizabeth II Army Memorial Museum. Lieut Colonel Wedde was appointed Chief Engineer RNZE in December 1978 and was Institution Corresponding Member for RNZE 1978–79.*

THE New Zealand Army has a relatively short but proud history ranging from involvement in the New Zealand Wars through the Boer War, two World Wars and Korea to the more recent involvements in South East Asia. Much of New Zealand's national heritage has been shaped during the course of this history. However many historical items which are important parts of our heritage have been either lost or until recently have not been displayed for the community to see. To rectify this situation the then CGS of the New Zealand Army, Major General R P D Hassett CB, CBE, decided in March 1977 that a New Zealand Army Memorial Museum would be established adjacent to Waiouru Camp where it is readily available to the general public.

During the remainder of 1977 planning for the project proceeded. A Trust Board of prominent New Zealanders was established; a leading architect, Mr Miles Warren CBE, was engaged and he produced his working drawing by late November 1977; town planning amendments were processed, policies established for the Museum, and a start made with raising funds by public subscription for this $750,000 project. The culmination of 1977 was the laying of the foundation stone by the CGS on 26 November 1977 in the presence of the Minister of Defence, representatives of all New Zealand Army Units, and military representatives from the United Kingdom, Australia and the United States. At this stonelaying ceremony, the CGS invited those present to attend the opening ceremony on 15 October 1978.

1978 was a busy year! Construction of the Museum proceeded, fund raising continued, the design and installation of initial interior displays was accomplished, and approval was obtained for the title Queen Elizabeth II Army Memorial Museum.

The Museum was opened by the Governor-General on time on 15 October 1978—Sappers Day—the 76th Anniversary of the day in 1902 when No 2 Service Company, New Zealand Permanent Militia was redesignated the Royal New Zealand Engineers.

Construction of the Museum was undertaken by 2 Field Squadron RNZE assisted by other RNZE units and volunteers from other Corps. It is appropriate that the story of construction be told by the Officer in Charge of Construction, Major Anderson, OC 2 Field Squadron RNZE.



The Queen Elizabeth II Army Memorial Museum
Lieut Colonel H E Wedde RNZE and
Major A Anderson MBE RNZE

## CONSTRUCTION

*Major A Anderson MBE, RNZE was commissioned from the ranks in 1966 and has held the appointments of Trg Offr SME; Lands and Property Offr NZ Forces Far East; Wks Planning Offr Wks Directorate Defence HQ; 2IC 6 Fd Sqn; and during 1977–78 was appointed Constr Offr for the Queen Elizabeth II Army Memorial Museum. Currently Major Anderson is OC 2 Fd Sqn RNZE.*

In November 1977 the CGS (Maj Gen R D Hassett) issued orders to commence the construction of the QEII Army Memorial Museum at a site 200 miles north of Wellington on land at the Army Training Group Waiouru. Final drawings could not be expected until late February 1978 and the task was to be completed by 15 October 1978. The total task included the structure, site works and new dual carriageway roading to state highway standards for 700 metres, with massive landscaping in the surrounding areas.

Outwardly the QEII Army Memorial Museum is a fortress-like structure giving the appearance from the front, of castellated battlements and restricted entry across a moat by a simulated draw bridge from a forecourt. Isolated, the building has a total dramatic form, stark against the rolling tussock lands of Waiouru. Clad in deeply recessed broken rib panels it has two high towers breaking the line in front giving the almost brutal uncompromising form an impact against the rolling hills of the central

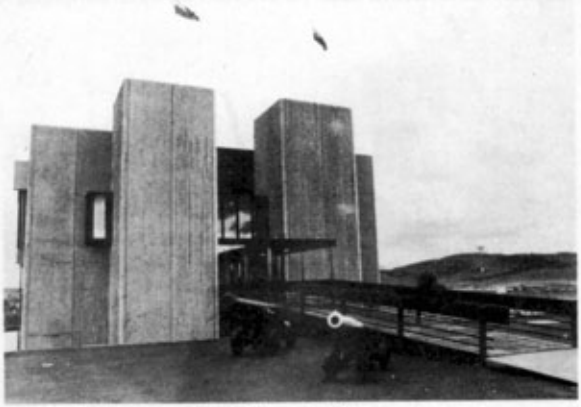


**Photo 1.** Entrance to Museum

The Queen Elizabeth II Army Memorial Museum (1)

**Photo 2.** View of site on 10 April 1978

North Island. The interior is at five levels comprising upper and lower display halls, tea-rooms, foyer and workshop, some 1300m$^2$ of floor space. It is serviced by a car park and has a large forecourt for the display of items too large for the interior. The main entrance to the Army Training Group was re-routed past the museum entrance.

The building is of reinforced concrete construction and incorporates both precast and cast in-situ elements. The foundations, floors and stair and lift towers were cast in-situ because their relatively complex nature made precasting impracticable; beams, columns and cladding panels were precast since their geometry, coupled with the standard of finish required, made precasting a more desirable technique.

Gravity loads at levels 4 and 5 are carried by a floor slab system which spans one way between precast concrete beams. The level 3 floor slab is a flat slab spanning in

**Photo 3.** 20 June 1978. North East Corner. Front stair towers and all five levels can be seen

The Queen Elizabeth II Army Memorial Museum
(2 & 3)

**Photo 4.** 12.5m Wall Panel being erected with strong back

**Photo 5.** The completed Queen Elizabeth II Army Memorial Museum

The Queen Elizabeth II Army Memorial Museum
(4 & 5)

both directions between precast concrete columns. The precast beam and column system was designed to carry only the gravity loads and nominal fixity is provided at the beam column junctions. The roof is supported by steel trusses which span clear across the building, their ends being supported directly on the wall panels, it has a hidden roof profile which tends to give an even more abrupt finish to the structure.

All the lateral loads are carried by the precast concrete wall panels. These panels are connected together by various weld plates so that a group of panels forms a channel-shaped element to resist the applied loads in each direction. Diaphrams distribute the loads from the various parts of the building to the resisting elements. The roof is a plywood diaphram with bolted edge connections; at levels 3, 4 and 5 the concrete floors were connected to the wall units with welded connections. The groups of panels can be considered as being fixed at their bases and thus cantilever from the foundations. Base fixing was attained with grouted-in rods penetrating into the panel. Because of the comparatively small stiffness in the stair and lift towers, only a small amount of lateral resistance from these contributed to the total structure.

2 Field Squadron, based 100 miles to the South of Waiouru, commenced preparation, including the estimates for the final cost ($605,000) in November 1977. The building location was extremely isolated from main material supply outlets, and the decision was taken to sub-contract only $30,000 of the work in areas where engineer experience or plant was not available.

2 Field Squadron supported periodically by elements of 1 and 3 Field Squadrons, 5 Support Squadron, and Army volunteers started construction on 1 January 1978.

Construction work proceeded with day and night operations through the New Zealand late summer and winter with temperatures of up to 35°C in the late summer and −15°C in the winter. Winds were constant and rose above 45 knots on more than twenty occasions including a snow and wind storm which plunged the region into civil emergency conditions for 48 hours under one metre of snow. However, the sappers dug out and kept on going. Carefully programmed and placed on the CAN (Critical Activity Number) chart, the activities were never more than four days in error and this had already been compensated for by an early chart finish date of 7 October. The foundations were strip and pad with maximum bearing pressures of 100kN/m$^2$ under gravity with 125kN/m$^2$ under lateral loadings. Included in the foundation was a hydraulic lift ram casing which extended seven metres below the invert levels through a volcanic boulder conglomerate. A cassion was sunk by hand using explosive and compressor tools to the final level. The excavation was making 23,000 litres per hour, causing difficult conditions to establish the ram casing which was required to be ±2mm to the vertical. Stair and lift towers were erected at a similar rate to the floor slabs so that the carcase of the building was stable under moderate lateral loads. For precasting of the 246 panels for the building and forecourt, special techniques were used in the site precast yard to ensure sufficient panels were available for construction. The precast unstressed panels, ranging in length from 1.5m to 12.8m, were poured daily on two beds and cured for a period of sixteen hours by raising the temperature of the mould to 76°C for five hours and allowing latent cooling. Daily tests were never less than 28MPa from 30MPa concrete. The complex detailing of outer surface and weld plate positions meant intense activity from 12 February to 1 October and, during this time, only two panels were rejected.

The precast panels, the largest attempted in New Zealand, were not strong enough, with a nominal thickness of 100mm, to be handled without additional support, and a strong-back was fitted for a special crane which was hired to place the panels into final location in the building. The remainder of the plant and cranage tasks were within the capability of internal resources.

Despite the, at times, frantic pace of construction the Engineers of the New Zealand Army now look back on the construction of the Queen Elizabeth II Army Memorial Museum as one of their greatest challenges.

# The Bulldog Road

LIEUT COLONEL R L JORDAN RE MBIM

*The Author has spent much of his service with either parachute units or the Queen's Gurkha Engineers. He was a troop commander in BAOR and 9 Parachute Squadron. He went to the Queen's Gurkha Engineers in 1960. Graduated from Staff College in 1965 and was GSO2 (Air) in Headquarters 16 Parachute Brigade. Commanded 67 Gurkha Independent Field Squadron and 71 (Scottish) Engineer Regiment. Was recently GSO1 (RE) at Headquarters United Kingdom Land Forces, and is now GSO1 (PR) in the same Headquarters.*

BETWEEN August and December 1979 I was fortunate in being given time off to take part in the Papau New Guinea Phase of *Operation Drake*. My task was to lead parties of Young Explorers along 2nd World War trails in the Wau Area (Map 1). One of the trails, named the Bulldog Trail, follows the alignment of a road built by the Royal Australian Engineers in 1943. This old road is now very overgrown, with many landslides blocking it with huge boulders and trees which have become entangled with undergrowth and secondary jungle.

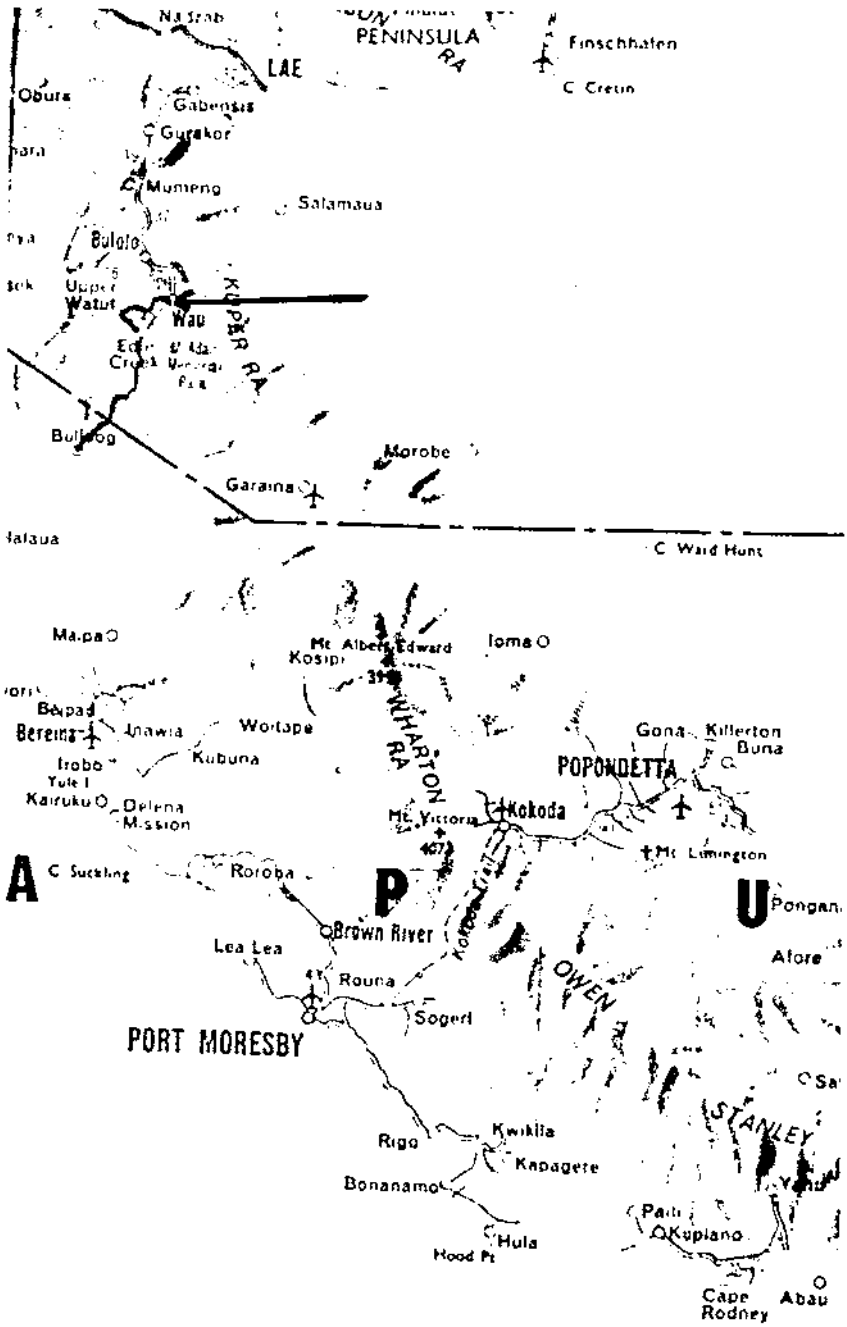
As soon as the road was completed in August 1943, a resupply convoy drove along it to inaugurate its opening. As events turned out, however, the road was not subsequently used as a resupply route, but left to the elements to deteriorate rapidly into a state of disrepair.

Having walked the seventy miles of trail through some of the most rugged and mountainous country in Papua New Guinea, I was impressed by the magnitude of the wartime task which was completed in six months. The road was constructed by men working in the most appalling conditions, from low lying high humidity jungle to near freezing temperatures at almost 10,000 feet. To have achieved such a task in so short a time, and then find out that it was not to be used, must have been a frustrating and trying experience. I hope this article will in some small way pay tribute to those officers and men of the Royal Australian Engineers who carried out this exacting and physically demanding task.

After Japan launched herself into War against America and the British Empire in December 1941, her drive southwards across the Pacific was undertaken with rapid precision. Within a month the Japanese had landed on the north coast of New Guinea, followed by the capture of Lae and Salamaua (Map 1) on the 8 March 1942. Buna, Gona and Kokoda, north east of Port Moresby, followed, falling into Japanese hands by July 1942. The Japanese became firmly established and spread their air force over the captured territory. Evacuation of civilians from remote areas was by air, but this soon ceased once the Japanese air force build-up diverted the RAAF to higher priority tasks. This left large numbers of civilians cut off, with the prospect of either escaping on foot overland, or remain to face the Japanese advance. In Wau 250 civilians faced this prospect, and not wishing to spend some years in captivity, opted to escape overland through unexplored and unmapped territory. The route chosen was south to the village of Bulldog (Map 1), and thence by river to the south coast. This evacuation was carried out successfully with determination and efficiency. Its success directed the attention of the military authorities to the possibility of the general alignment of the route as a Line of Communication.



The Bulldog Road
Lieut Colonel RL Jordan RE


PENINSULA
Finschhafen
C Cretin
LAE
Oburu
Gabensis
Gurakor
Mumeng
Salamaua
Bulolo
Upper Watut
Wau
KUPER RA
Bulldog
Morobe
Garaina
C Ward Hunt
Ma.pa
Mt Albert Edward
Kosipi
Ioma
Bepad
Bereina
Inawia
Wortape
Kubuna
Irobo
Yule I
Kairuku
Delena Mission
WHARTON RA
POPONDETTA
Gona
Killerton
Buna
Mt Victoria
Kokoda
Mt Lamington
C Suckling
Roroba
Brown River
Lea Lea
Rouna
Sogeri
PORT MORESBY
OWEN STANLEY
Pongani
Afore
Rigo
Kwikila
Kapagere
Bonanamo
Hula
Hood Pt
Kupiano
Cape Rodney
Abau

MAP I

The Commander-in-Chief, General Sir Thomas Blamey, realised that a supply route from south to north was essential to meet the threat of the Japanese advance down the north coast. There were three possible routes under consideration: (Map 1)

(a) Port Moresby via Kokoda to Buna

(b) Through the mountains further south east of Port Moresby

(c) To Wau and then north to Lae and north east to Salamaua

With the engineer resources available at that time, the Wau route seemed to offer the best prospects, and orders were therefore issued for its reconnaissance and development. Between July and December 1942 numerous reconnaissances were undertaken across this very rugged mountainous terrain in order to establish an alignment suitable for construction. The orders were to find a route suitable for a jeep track which could later be improved to an MT road as a Line of Communication.

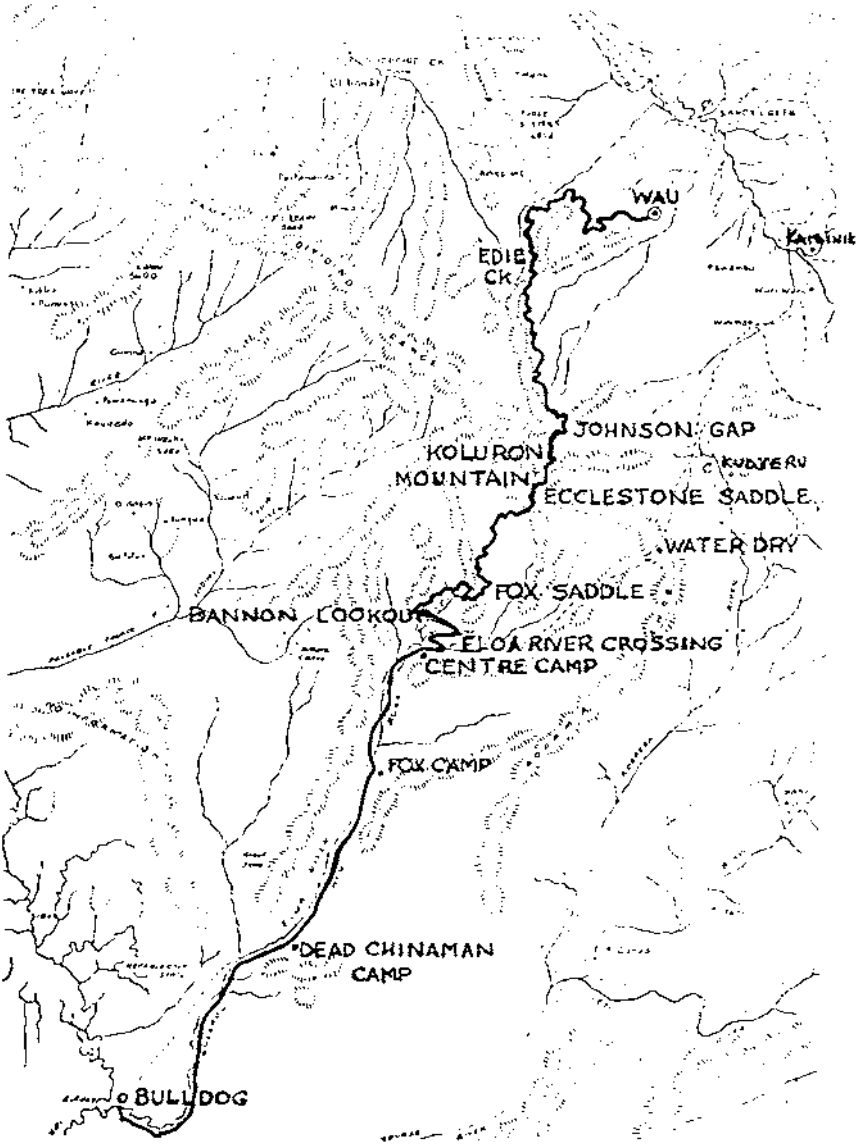
The route taken by the civilian evacuees was south east from Wau to Kaisinik (Map 2) and then southwest to Kudjeru and Waterdry to the Eloa River at Centre Camp. From here the route followed the Eloa River Valley to Bulldog. There were good military reasons for not building the road on this route. It was exposed to enemy action from Salamaua to the east, and should the enemy advance on Wau to capture its important airfield, this road alignment could be cut, or subjected to ambush or bombardment. This appreciation proved to be correct because in January 1943 the Japanese cut the track from Wau to Kudjeru and reached the edge of the Wau airfield. After some very bitter and determined fighting by the small Australian force in Wau, the much larger Japanese force was repulsed. It was therefore essential to find an alternative route. Suitable aerial photographs were not available. The country was, and still is, difficult to photograph for route reconnaissance purposes. It is frequently cloud covered and persistent mists shroud it most of the day. This limitation together with lack of aircraft, made aerial photographic selection unthinkable. The only way to select a route was from ground reconnaissance. The problem here however, was that the only maps available were inaccurate and of little value. The following information was nevertheless available to assist in the selection of a possible route:

(a) There was already a single track MT road from Wau to the goldmines at Edie Creek covering a distance of about 10 miles (Map 2)

(b) South of Edie Creek there was a water race built to direct water for sluicing purposes at the goldmines. This water race ran south to the Koluron mountains along a ridge for about 16 miles. From here the trend of the terrain was NNE to SSW at right angles to the mountain range, but in line towards Bulldog down the Eloa River Valley

(c) A road in this direction would also be protected from enemy action from the east.

The engineer appreciation however, was that the route should avoid the Eloa River Valley with construction being easier and quicker higher on a water shed than in the river gorges. It was therefore decided to reconnoitre routes high up on the sides of the Eloa River gorge and rejoin the valley at Dead Chinaman (so named because a Chinaman died there during the evacuation in 1942). After numerous exhausting reconnaissances the high route was discarded because of the unstable nature of the mountain terrain where landslides were common due to frequent earth movements. During the end of 1942 and early 1943 further hazardous reconnaissances were carried out in order to establish the alignment of the road. The route selected is shown on Map 2. From Wau it followed the mountain road up to Edie Creek from where it ascended along the ridge to Johnson Gap with the high ground of the Koluron mountains to the immediate west. The route continued to ascend to Eccleston Saddle with the highest point at nearly 10,000 feet and ½ mile further on. The selected route then descended gradually to Fox Saddle, Bannon Lookout, and down to the Eloa River valley. From here it recrossed the river many times following the line of the river valley down to Bulldog, with a total distance of approximately 70 miles.




MAP 2

With the final alignment decided in January 1943, speed of construction was paramount to support the forthcoming operations. Survey was therefore limited to an approximate graded centre line with survey parties allocated as follows, (Map 2):

(a) Lieutenant Ecclestone, Edie Creek to Ecclestone Saddle

(b) Lieutenant Smith, Ecclestone Saddle to Fox Saddle

(c) Lieutenant Fox, Fox Saddle to Centre Camp

(d) The survey from Bulldog to Centre Camp was well advanced by this time (January 1943), so Lieutenant Fox was given the task of completing that section when the line from Fox Saddle to Centre Camp was completed.

These survey parties endured conditions of extreme physical hardship ascending and descending steep slippery gradients in dense moss forest. The moss forest is a

grotesque tangle of horizontal and vertical tree trunks in thick muddy ground covered in moss several feet deep which collects and exudes moisture.

Actual construction of the road began in January 1943 with supervised native labour clearing from the Bulldog end. Lieut Colonel W J Rheinhold RAE arrived at Bulldog on 10 January 1943 to take command of the construction, and set up his headquarters at Edie Creek. With the Australian units placed under his command and the addition of a US Army Engineer unit with extra plant, Lieut Colonel Rheinhold issued the following instructions for the construction of the road, (Map 2):

(a) "Desnagging" of the Lakekamu River from Bulldog to the sea, 14 Australian Field Company. This was essential for resupply purposes.

(b) River section of the road from Bulldog to just north of Centre Camp, 1 Battalion, 91st Engineer Regiment, US Army.

(c) Mountain section from Eloa River valley to Fox's Gap, WOII Bannon with pack transport personnel and 200 natives.

(d) Mountain section, Fox's Gap to Ecclestone Saddle, 2/1 Australian Field Company and personnel from the Pack Transport Company and 200 natives.

(e) Mountain section Ecclestone Saddle to Johnson Gap, 9 Australian Field Company with personnel of the Pack Transport Company and 200 natives.

(f) Mountain section, Johnson Gap to Edie Creek, 2 Australian Field Company and 500 natives.

By mid April 1943 the various units had made their way to their respective sections, set up camp, and concurrent construction began throughout the length of the road. The next four months was an endless battle against the elements, testing the endurance and determination of all personnel, particularly those working in the mountain sections. Here the continual rain, bitter cold and physical hardship, demanded high qualities of leadership from the officers and NCOs. The stages of construction were as follows:

(a) Clearing the route
(b) Establishing the pilot track
(c) Jeep road
(d) Single MT road

Construction of the pilot track was confined chiefly to the mountain section from Edie Creek to the Eloa River. It was here that very steep sidehill cuts were necessary, hacked out of the mountain side using compressors, explosives and hand clearance. The construction was hampered by heavy tropical rain storms and the passage of essential supply traffic which turned sections into a quagmire. To prevent this it was essential to lay "corduroy" covered by sand and gravel along much of the road. Lack of sufficient tippers and dozers necessitated hand clearance in some sections. This of course was particularly difficult when passing through vertical solid granite rock and along sidehill cuts. Along the Eloa River valley a profusion of massive boulders were cleared using compressor drills, followed by the prolific use of explosive and hand clearance. The cruciform bits were quickly blunted and drill stems were frequently broken. Compressors were moved by dismantling and reassembling at new sites. The surfacing material for the road was mainly provided by the gravel in the breaking up and demolition of boulders and rock formations.

To ensure an effective supply system from the Bulldog end of the road, the Lakekamu River required constant desnagging. The river, fast flowing and subject to frequent violent fluctuations in level, was always heavily snag infested. Numerous sand bars made the establishment of a permanent channel extremely difficult. The method of dealing with snags was to dislodge them with explosives and winch them to the banks and again up on to high ground to prevent them floating away on the next rise in the river.

The bridging of the Eloa River and its subsidiaries was under the command of Major J W Maynes RAE, who was Second-in-Command to the CRE. Owing to the large catchment area, the subsidiary streams were swift flowing and subject to severe

floods carrying extensive debris and fallen trees. The bridging construction had to keep ahead of road construction to allow the passage of essential supplies and plant. In all seventeen bridges were erected of which thirteen were single span, three double span and one treble span. All the bridges were constructed using materials available on site with classification up to Class 24 to allow the passage of plant. All the abutments were of timber crib construction using timbers from 30 to 12 inch diameter, all securely spiked and wired together and backfilled with rubble. The abutments were erected in sheltered positions to prevent scour. Road bearers up to 60 feet long and 3 feet in diameter were used, with decking consisting of 6 to 8 inch diameter timbers. Sapper responsibility was the felling and dressing of all timbers and the bridge construction. Natives were used to haul the timbers. Bridge construction started on 28 May 1943 and was completed on 15 August 1943. The seventeen bridges, totalling 810 feet of linear bridging, were constructed in 80 days.

Despite the many difficulties in building the road, the sole remaining bar of rock to complete the route was blasted on 22 August 1943. The following day a triumphant convoy of jeeps made the journey from Wau to Bulldog. The Owen Stanley Range had been conquered and all that remained were the finishing touches to complete the road to MT standard.

The main construction difficulties and lessons learnt during the 6 months task were as follows:

(a) Where the road was constructed in heavy clays under wet conditions, great difficulty was experienced in providing an immediate running surface. This was due to the lack of suitable rock and gravel within easy distance, and the lack of tippers for moving and spreading it. Essential supply traffic using the unprotected formation quickly destroyed the surface. Corduroy was found to be the quickest means of repairing and preventing further damage. This corduroy was covered with selected material to form the pavement. Excessive mud oozing through the corduroy made the establishment of a stabilised pavement difficult, and considerable quantities of sand were required to prevent this. In the latter stages of construction with lessons learnt, corduroy was laid immediately after completion of the formation by dozers. This was then quickly covered by gravel and sand.

(b) The operation of plant in the wet conditions in heavy clay was far from efficient. Bogging was frequent and the wear and tear on plant excessive. Under such conditions bulldozers were only effective for the mass movement of earth and rock.

(c) Extensive and frequent landslides delayed work. On many occasions it was found that if properly drained, the material from the slide made good road material. A quick by-pass solution was to drain the seepage water from the slide and then use explosives to blow away the larger debris into the gorge.

(d) Lack of adequate workshop back-up for sharpening hand tools in isolated sections was a serious disadvantage.

(e) Men, equipment and supplies included in plans did not subsequently materialise. Completion dates were therefore frequently altered and plans changed. Under such demanding conditions, these changes were a threat to morale and it was not always expedient to explain to the men why they would be required to work longer on the job.

(f) The range of climate and topography was extreme. The country ranged from low lying high humidity flats where malaria was rife, to heights of nearly 10,000 feet. In the high mountain areas it was always cold and dank and rained almost every afternoon. Men worked and lived in these trying conditions with few comforts and amenities. Due to supply difficulties rations were often inadequate for men living and working in such an environment. All "game" went into the pot, and in the lower reaches of the Eloa river where fish was abundant, "explosive fishing" added to the menu!

(g) Nearly all the work in the Central Section was done by hand, picks, shovels and crowbars. Lack of blacksmith's kits meant that much of this work was done with blunted tools. Later on in the construction, compressors were dismantled and moved

to the Central Section by native carriers. Loss of tools and pilfering by the natives were common, with axes and knives being particularly attractive items, though the natives were partial to anything metallic or edible. One party proudly returned to work on the road with detonators through their noses!

Successful allied operations during the construction and almost immediately after the roads completion, rendered the route unnecessary as a Line of Communication. It was decided not to launch a major offensive from the Wau area, and the road was therefore abandoned and all the engineer units withdrawn to more important tasks elsewhere.

As I mentioned at the beginning of this article, I walked along the Bulldog Trail. Although well overgrown, the road is still there almost as an undying tribute to the men who built it. Having shed several pounds during my trek along it, I can appreciate the enormous difficulties the Royal Australian Engineers experienced in pushing the road through in barely four months. To have lived and worked in such conditions and to have successfully completed the task in time says much for the guts and determination of the Australian sappers and the high standards of leadership within the units of the Royal Australian Engineers who built the Bulldog Road.

*ANNEX A*

AUSTRALIAN TROOPS AND UNITS EMPLOYED ON THE CONSTRUCTION OF THE BULLDOG ROAD

1. HQ RAE 11 Australian Division (A1F)
2. 2/1 Australian Field Company
3. 2/4 Australian Field Squadron (less one troop)
4. One Platoon, 2/9 Australian Field Company
5. One Platoon, 2/14 Australian Field Company
6. 2/16 Australian Field Company
7. 9 Australian Field Company (A1F)
8. One Platoon, 14 Australian Field Company
9. One Section, 2/1 Australian Mechanical Equipment Company
10. Pioneer Platoon, 2/7 Australian Infantry Battalion
11. Detachments of 3 Australian Pack Transport Companies
12. ANGAU (supervisors of native labour)
13. Supply, Medical and Repair and Recovery:–
    a. 1 Australian Water Transport Company
    b. 2/34 Australian Transport Company
    c. 46 Australian Camp Hospital
    d. 2/55 LAD
    e. 8 Australian MT Company, AEME Workshops

# Plaque in London to General Roy

ON the 26 April 1979 the Director General Ordnance Survey, Mr Walter Smith, unveiled a plaque at No 10 Argyll Street, London, to Major-General William Roy FRS, who lived there from 1779 to 1790. The plaque is one of the series erected by the Greater London Council to commemorate famous people and to mark buildings in which they have lived, and it describes General Roy briefly as "Founder of the Ordnance Survey".

Roy was born at Miltonhead in Lanarkshire, and when barely twenty-one years of age, and still a civilian, he was employed in 1746 (the year after the '45 uprising led by Bonny Prince Charlie) to make an experimental survey around Fort Augustus at a scale of one inch to 1000 yards. This was to demonstrate to the Duke of Cumberland, the Commander-in-Chief, the value of formal mapping as an aid in opening up the Highlands to the King's forces. The survey was approved and was extended vigorously. By 1755 the entire mainland of Scotland had been mapped, a most notable achievement in those days. In that year Roy entered the Corps of Engineers as a

Practitioner, equivalent to the later rank of Ensign in the Corps. His promotion was rapid and he achieved the Army rank of Lieut Colonel by 1762, having spent two years in Germany during that period, in the Quartermaster General's Department, producing manuscript maps of the campaign there. When the war with France ended in 1763 he submitted a proposal for a survey of Great Britain, to embrace the earlier Scottish survey and to be carried out at the public expense. The value of such an undertaking was not then apparent, and it is not surprising that it was disallowed. He renewed his suggestion three years later in 1766, but nothing seems to have come of it that time either, perhaps owing to the military situation in the Northern American colonies.

In 1783 the Director of the Paris Observatory, Cassini de Thury, proposed a triangulation to link the Observatories of Paris and Greenwich to determine their relative positions. Roy was by now a Fellow of the Royal Society, well known and respected in scientific circles and enjoying the support of influential people. In 1784 he was entrusted with the British end of this operation, and its success lent weight to his advocacy for a survey of the whole of Britain. In 1791 approval was given for Roy's triangulation to be extended under the aegis of the Board of Ordnance, and it was this act which effectively brought the national survey into being. Regrettably, Roy himself had died eleven months earlier in the house in Argyll Street on 1 July 1790, but beyond doubt it was to his far-sighted determination that the Ordnance Survey owed its inception in the eighteenth century.

The ceremony was attended by Major-General B St G Irwin CB, representing the Chief Royal Engineer and the Corps, and by several past and present members of the Ordnance Survey and of the Survey branch of the Corps.

# A Prophet is Without . . .

"POM"

"You are a minute late" said the Commandant. I accepted the smug looks of the career officers present, apologised and hid behind the nearest large object which happened to be the Colonel GS. It had been one of those days when from the very start, events had escalated out of all sane proportion and I had been reduced to a cringing wreck before the I of E Meeting had even started.

Travel within the United Kingdom should never equate to a Blashford-Snell epic and certainly there should never be any problem driving from one part of the RSME to another, Rochester and the Medway excluded. Whilst Marchwood is a fairly far-flung portion of the RSME that might, with advantage, be flung further, nevertheless I do not normally dread a Summons to the Presence—well, not with regard to the journey.

It had really started the week before when my new staff car had been written-off on a journey to Plymouth. I therefore eased my six feet plus behind the wheel of the Minivan and headed up the M3 to London. Fired with that over-zealous enthusiasm for officer recruiting that has been the bane of so many E-in-C's Conferences, I turned off to visit ERLO (then based at Minley Manor-*Ed*). I knew at once that this was a mistake, not that ERLO is not interested in officer recruiting, for I believe he is, but that I had a premonition that things were going to go wrong from that moment on. So strong was this feeling that I would have returned at once to the M3 had not an impatient articulated lorry removed the element of freewill half way round the roundabout.

My business with ERLO concluded, and the name of another Field Marshal designate fed into the mighty maw of Minley, my progress through Camberley was arrested by the foreshortening of the Mini's bonnet by the vehicle immediately in front. Not that I could have avoided it, the choice being somewhat circumscribed by the oily surface at the Bus Stop, the bus and passengers and an oncoming lorry, so

suffice it to say that the Minivan which had already been technically "cast", now was.

Man in desperation will tackle anything, so I sought assistance from the nearest unit—the Staff College. To describe my reception there as welcoming would be an overstatement, interested perhaps but "guarded" was nearer the mark. Whether it was my oil-stained appearance in quasi Naval rig or because I was only "*sq*" I will never know, but I had to produce my identity card six times before I reached the Chief Clerk's office. Noting from the organisational chart that the administration of the Staff College lay largely within the keeping of Royal Engineer officers, it was not long before the Clerk had secured an urgent instruction from one of them to get me away from Camberley with all possible speed—or words to that effect.

Apart from the sprint across the platform at Ascot station, the rail journey to London is tedious and boring, it was therefore with genuine relief that shortly after leaving Feltham—alight here for Heathrow—I heard a woman screaming further down the carriage. Even allowing for the vagaries of 2nd Class Passengers, the noise clearly warranted attention. Having been required to return and close the compartment door and apologise to the passengers for my inconsiderate behaviour, I ran to the toilet where I became engulfed in an hysterical mass of Air Hostess' clothing, most of which was still on her but too much was in the excited hands of a "bovver-booted" boy. Here my quasi-Naval rig proved to be an advantage as I was mistaken for a Policeman by both parties who retired to their corners and the fight was awarded to the Air Hostess on a fall and a submission.

I locked the youth, who was on Day Release from his Institution to visit his Social Worker, in an empty compartment and then escorted the weeping Air Hostess to her seat in one of those open-plan, see-all smoke filled suburban carriages. Whether it was the way that I was covering her nakedness with my hand, or her tears, the impact was tremendous and the whole company of commuters hissed their hatred of me and an unwashed, bearded student assaulted me and called me a military rapist.

On our arrival at Waterloo I escorted the youth to the barrier, and as he clearly intended to make a break, I held him firmly by the hand. This was misconstrued by the gayer passengers around me and I was again mistaken for a sailor. The West Indian Ticket Collector at the barrier was most reluctant to leave his post and fetch the Station Police, but after some persuasion he left and I stood in the entrance of the Collector's bothy with the youth behind me. Naturally a number of the passengers gave me their tickets and, entering into the spirit of things, I had much pleasure in charging the bearded student with the excess fare from Feltham. At this point the Air Hostess had recovered completely and, becoming impatient at the delay, thanked me for my efforts, encouraged me to "Fly the Flag" and flaunting her own ill-covered credentials sought fellowship with the underwear ads on the Escalator. I thereupon released the youth and caught the train to Chatham.

In this compartment was a Gunner acquaintance who asked me why I appeared so drawn. I had just related my eventful morning when the man opposite, who had been enthralled by our conversation, suddenly said that that was nothing compared to what would happen next. At this he emptied a complete bottle of pills into his mouth, chewed them and swallowed them. We all had a good laugh and he appeared to enjoy the joke as much as anyone until he slumped to the floor, senseless and frothing at the mouth. My Gunner friend clearly wished to withdraw from the scene, but having prevailed upon him to at least help me lift the body onto the platform at New Charlton, I engineered it that he was still outside when the train pulled out. I admit now that this was not playing the White Man, but I needed to share my responsibilities and anyway, he was a Gunner and only one station away from Woolwich.

I will gloss over the fact that the cheerful WRAC Driver who met me at Chatham managed to miss an old lady on a zebra crossing by the adroit way in which she corrected her skid with a passing in—off a traffic bollard. All things considered, one minute late was not a bad achievement, and I was rather hurt when the RSME Staff verified the main facts of my excuse when the Evening Papers appeared later that day. A Prophet is without . . .

# The Strip Building Industry of Burma—Part 2

LIEUT COLONEL B R WHITE MBE TD

Part 1 took the story of 431 (QVOM) Indian Field Coy's involvement with construction of airstrips in Burma up to 9 January 1945. They had completed their work near Ye-U and were moving on to Tebaungwe.

### TEBAUNGWE

We crossed a Bailey Bridge over the Mu River and on the other side struck an extremely rough track, leading through paddy fields and over irrigation ditches. Our destination was only about twelve miles away and we arrived in the middle of the morning. The site was an old Japanese airfield, fifteen miles from Shwebo, where fighting was just beginning to take place.

As the convoy pulled in Frank met us and told me to detach the personnel and platoon stores vehicles whilst the remaining vehicles carried on under Ron who was to organize the camp. Whilst the men were unloading their tools Frank gave me a run down on what work was required. The strip had been heavily trenched and cratered but, as frequently happened, the parallel taxi track had only four trenches across its entire length of 1800 yards, and this, therefore, was to be used as the main strip. Its surface was very true and level and was covered in grass. At least there would be no dust problems for a while. Our immediate tasks, then, were to fill in the trenches and mark out the centre line and edges of the proposed strip. By this time the men were ready to start, so I allocated them to the various tasks. Supply dropping was in progress over on the old main strip and going over there I introduced myself to the DZ Officer and begged some parachutes from him. Using strips torn from these, myself and two surveyors, began flagging the centre line.

Frank, meanwhile, having spoken to me, had gone racing back up the taxi track to settle the camp details with Ron. His mind full of the cares of command he forgot about the trenches and drove into one, only seeing it at the last minute and braking hard so that he subsided gently into it rather than crashing in. He was hauled out of this incongruous position by a bunch of grinning sappers, none the worse for the incident. When he eventually reached Ron it was to discover that the camp was being set up in a direct line with the proposed strip and, indeed, the extension would run through the camp. An insubordinate Ron enquired why he had not been told this in the first place and blasphemously began to change his location. Frank, Ron and myself were the only officers with the Company on that job as Frankie had been sent back to Shwegyn, on the Chindwin, to guide some Mechanical Equipment we were at last going to get, and Jimmy Storrier was in Karachi on leave, with his wife.

When we knocked-off for the day the side lines were complete and the trenches were almost filled in. The men marched to the camp, now well clear of the strip, and were free to see to their personal comfort. Our location was at the north end of the strip away from the dusty road which lay at the south end. There was very little natural cover, being mostly scrub with only a few trees, but using bivouac tents and two larger tents for mess and office we were fairly inconspicuous.

It took only a little time the next morning to complete all work necessary to permit landing, but much still remained to do. An area free from obstruction on either side of the strip needed clearing, the extension had to be made and a control tower built. However, a forward fighter strip was urgently needed as the furthest forward at that time was still Kalemyo. Our strip, Tebaungwe, was to be ready on 12 January and today was the 10th. A signal was sent giving completion date as the evening of 11 January and a reply told us that Group Captain Goddard, CO of 221 Group would fly in himself on the 11th.

The morning of 11 January dawned and whilst we worked we kept one eye on the sky. About 1100hrs a lone Hurricane appeared which circled the strip and then, lowering its wheels, came in to land. Frank and I watched as the plane raced over the surface but there wasn't a ripple or the slightest bump, even where the trenches had been. We chased down the strip after the Hurricane and saw what appeared to be an extremely youthful pilot climbing down from his cockpit. When he got closer, however, it was evident that he was older than he appeared. We were later told that he was a very well known night fighter pilot. Frank and he went off to inspect the strip whilst I returned to look after the work. Group Captain Goddard stayed to lunch and seemed to appreciate Stephen's culinary efforts with a couple of chickens. After lunch he left but told us that the aircraft of his squadrons would arrive the next day.

On the following day, 12 January, the Group's arrival was heralded by several Dakotas which carried stores. These were followed by a quantity of RAF vehicles which had made the journey by road, and, finally, a flight or two of Hurricanes flew in, all landing without mishap. The only excitement of the day was when a Dakota very nearly landed on the old Japanese strip, which was still trenched, but seeing the danger in time it pulled away and landed safely. Our strip was now operational.

The Japanese, when they had built Tebaungwe Airfield had been "dispersal mad". Taxi tracks ran for miles and blast pens and ammunition shelters dotted the surrounding countryside. Local inhabitants told us that the Japanese had spent nearly two years building the airfield and, when it was finished, flew in only one or two planes.

Hurribombers and Spitfires were on daily patrol and operations from Tebaungwe. When one Hurricane failed to return from a raid on Mandalay we, who had repaired and maintained the strip, felt the loss deeply for we felt that we were sharing in the punches which the RAF were delivering. The highlight of our sojourn in Tebaungwe came on 22 January 1945 when the Supremo, Lord Louis Mountbatten flew in and landed on our airfield and went forward to visit the fighting troops. On his return he met several people, including Frank, who was introduced as the builder of the strip.

In constructing a strip one of the tasks was to mark out the sides and ends so that they were plainly visible from the air. This we did by constructing a number of bamboo frames, 6 feet by 2 feet, which were then covered by parachute cloth. There was no shortage of this cloth for practically all our food and fuel came in by parachute. Because of our particular role we were given permission to have all the parachutes we needed, which, otherwise would have been carefully collected and returned for re-use. We ensured, therefore, that we always had a ready supply of cloth for all eventualities. Amongst these eventualities was an honest desire to augment the eternal K Ration with something a little more palatable. The local Burmese usually had a surplus of chickens and eggs and, as we had a surplus of cloth, some bargaining took place to everyone's mutual satisfaction. The end result was that we became nearly as tired of chicken as we were of K Rations. The sappers saved their chickens for whichever festival was due next, and these Holy-days appeared very frequently, so that when the Company moved it resembled more a convoy of farmers headed for a poultry market than it did a unit of Indian Engineers.

On the occasion of one Hindu festival I was sitting in my tent writing home, when "51" appeared at my side with two halves of my mess tin. One was full of hot sweet tea and in the other reposed a whole chicken. I was not hungry but to show appreciation I tried a tentative bite. By whatever means it had been achieved the chicken had been curried whole and was absolutely delicious. In spite of a heavy lunch two hours previously I finished the whole bird.

### INDIAN INTERLUDE

Towards the end of January I was sent back to India, to the School of Military Engineering at Roorkee. At the same time the CRE, (later Major General) then Lieut Colonel I H F (Butch) Boyd was also returning to India so we travelled together. No transport planes were regularly landing at Tebaungwe so we drove to

Shwebo where our sister Company, 430, had built a strip. After a long wait we were able to board a C-46 which took us to Chandina Airfield, near Comilla in Bengal. At this point I began to appreciate the awe inspiring presence of the CRE, for we were told that there would be no chance of any further flight to Calcutta. The CRE snorted and disappeared. Whom he saw I do not know but a short while later he returned in a 3-ton lorry into which we bundled our kit and drove the twelve miles to Comilla. Here we drove straight up to a silver painted C-47 which was standing in a dispersal. We were expected and our kit was loaded immediately. We flew the remaining short distance to Dum Dum, outside Calcutta, in great comfort on upholstered seats. I left the CRE and went to the Grand Hotel, Calcutta to book accommodation as I had several days to wait before my train left. Whilst booking-in a voice said "Paddy, what are you doing here"? It belonged to Jimmy Storrier who was returning, somewhat late, from his leave. We spent two enjoyable nights together sampling the flesh pots of Chowringee and then he left to continue his journey back to the unit. On return to my room that evening I found him still there with all his kit. He had been unable to obtain a flight back and, so, we had another night together. He left the next morning.

I enjoyed my Mechanical Plant course at Roorkee but, during this time, the newspapers had carried stories of the crossing of the Irrawaddy and I knew that 431 Company would be involved. I wanted back. During the course an officer from 430 Company arrived in Roorkee and told me that my Company were in the Singu Bridgehead, supporting 19 Indian Division. They had built and operated rafts to bring elements of the Division across the river; a crossing that was made with some difficulty as it was opposed.

My return journey into Burma was much slower than the outward one. There was no prospect of a flight from Calcutta and I was forced into taking a slow train to the Brahmaputra, a slow but fascinating voyage up river by ferry and a further slow train to Comilla where my further progress seemed doomed by Comilla Transit Camp. I fretted and fumed for six days in 23 Reinforcement Camp, reporting each day at the Camp Office for news of a flight. When it was announced that those officers in transit would spend part of their days in route marches I decided that the Reinforcement Camp and I would part. Packing my kit I made my way to the airfield and sat there, thumbing a ride. I was lucky and in a short while obtained space on a load of empty stretchers being flown back in. Maybe, to this day, the records of 23 Reinforcement Camp show Lieutenant B R White RE as AWOL.

My obliging plane took me to Shwebo, the same airfield I had flown from a few weeks earlier. Here no one in authority at the local transit camp knew anything about my unit, but after my experience at Comilla this did not surprise me. However, a friendly Padre told me that he had seen our unit signs, the white aircraft silhouette flanked by the figures 80 and the wording "Airfd Engineers" written across the bottom of the vehicle windscreens. He was returning to Singu in his jeep and offered me a lift. We crossed the river by raft and on the way through Singu I saw our water truck carrying water to the strip. I finished my involved journey by riding in the water truck to the airfield where Jimmy Storrier's "Hello Paddy" told me I was back amongst friends.

## SINGU

I was regaled with stories of the river crossing which had somewhat increased the tempo of life in the Company and made a change from building air strips. On about 3 February the Company moved from Tebaungwe to the Irrawaddy to support the 19 Division crossing at Singu. They stayed on the west bank for three days under shell fire and continual harassment by Japanese jitter parties. The discipline of the Company stood the test and no one opened fire, which was what the jitter parties were trying to make them do to reveal their positions. For some time the Company worked ferries across the river under mortar fire, and, once on the far side, they were again under shell fire. The camp was entirely underground and blacked out. One evening in the mess dug-out dinner was in progress when a shrill whistle heralded the

imminent arrival of a shell. The officers present, to a man, went sideways off their chairs until the ground stopped vibrating and the dust settled. Climbing back to a more dignified position they were able to observe the mess orderlies who had been serving food. They were lying on the ground still balancing the plates above their heads with not a drop split.

This was the camp that Jimmy drove me to from the airfield at the end of my expedition to India and back. During my absence Frank had left the Company and returned to the UK on "Repatriation". I was sorry to have missed a chance of saying goodbye to him and, in fact, did not see him again until many years later when my TA Field Squadron were at Annual Camp in Norfolk and a meeting was arranged. The new Company Commander was Major Arthur Wright, an FE2 from 459 Forward Airfield Engineers HQ. He was already well known to all of us and fitted in well. The other new change was the attachment of a Mechanical Equipment (ME) Platoon under Captain Williams ("Willie") and Lieutenant Ashton.

I was glad to rejoin my platoon on the strip. This was the first strip which we had built from virgin ground, a transport strip 2000 yards long. The work was practically complete. Control tower, strip and one apron were finished and the machinery was working on a second apron. My men were engaged in pumping water from canvas tanks onto the strip surface to keep the dust down. This water had to be carried from the river, a factor which had aided me in my final stage of travel.

Shortly after my return the Company had orders to move, this time to Mandalay, which had been taken except for Fort Dufferin which still held out. The ME was sent ahead and a few days later the Company moved leaving me in, what appeared to be, my usual role of "Tail End Charlie" to continue maintenance of the strip. Willie had sent Lieutenant Ashton off with the machinery and he himself stayed behind with a few of his men. I was glad of his company for the situation around Singu was not clear. There were Japanese to the north who were being driven south and they were also in the hills to our east. I enjoyed the chats we had after dinner in our little mess when Willie would talk about his experiences on the Imphal-Tamu and Imphal-Tiddim roads and in that unpleasant area known as the Kohima Box. Regrettably these ended quickly for Willie was sent for and I was on my own. I hated sleeping in a dugout and always felt trapped. The sudden howl of a dog or sound of a falling teak leaf in the silence would raise me horizontally off the bed and I was very conscious that the only other troops anywhere near were an IEME Workshops and a Field Supply Depot.

My Platoon was busy by day, keeping down dust by watering and rolling between plane arrivals. There was little else to do and the strip wore remarkably well. After flying had finished for the day we rolled the strip and it was then usually good for a few hours next morning. Soon I was given my release and moved my Platoon south to catch up with the Company.

### MANDALAY

Our road was a deplorable one along the bank of the Irrawaddy until, coming within distant sight of Mandalay Hill, I saw a unit sign pointing left. I followed this, turning left at yet another sign and finally reached camp. This was located in an old Bhuddist Monastery known as a Poongyi Kyaung. I reported my arrival, saw the men settled in and climbed a ladder into a wooden building on stilts which was the mess. The airfield was just next door, reached by our own private road, thanks to the ME platoon. Work on the strip was almost complete and there was little or no work for us to do.

The entire area around Mandalay was a network of canals and drainage channels. Before leaving the area the Japanese had opened a sluice gate which had flooded the area, and finding a suitable location for the strip had been difficult. Eventually a site was selected which lay on slightly higher ground. As usual water was needed to lay the dust and whilst an irrigation channel ran past the strip, ironically there was insufficient water for our needs. Someone was dispatched to open a neighbouring sluice. This resulted in a mere trickle so the sluice was opened wide and left like that.

In the evening, however, the channel was flooded and the strip was in grave danger of inundation. The sluice was then shut altogether, diverting the water into another channel. This, unfortunately, swamped a nearby village and a sapper standing by the sluice gate only saved himself from an angry mob by firing a shot over their heads. The situation was sorted out with the aid of a Burmese speaking *Lance Naik* and, thereafter, we left drainage systems we didn't understand severely alone.

As there was little work to do Frankie and I took a day off to drive into Mandalay and see how the battle for Fort Dufferin was going. We drove to the race course and halted by the Grand Stand, in company with some sappers from 327 (QVOM) Field Park Company. Apart from ourselves there wasn't a living soul to be seen. Three or four hundred yards ahead were the massive walls of the fort and somewhere to our right a battery of Medium Artillery was firing into the area behind the walls. The Fort was eventually entered by Madras Sappers who went in by a sewer and found the Japanese had gone—rumour has it, by train, rather cheekily, out of the southern gate. There being nothing more to see we returned to camp and spent a fruitless afternoon combing the surrounding country for Japanese souvenirs.

MAYMYO

Our next assignment was to an airfield outside Maymyo, the hill station for Mandalay. This time Frankie fell for the maintenance routine and stayed with the rear party. Arthur and Jimmy went ahead to recce the site leaving Ron and myself to bring the Company. As we skirted the east side of Mandalay Hill we passed a mortar detachment lobbing bombs into the Fort. At the time I was struck by the incongruity of the scene. There were the mortar crew sweating away at their lethal work whilst near them, sitting outside a shelter, a soldier was darning his socks; another was drinking a mug of tea and reading; whilst a third busied himself in the engine of a jeep.

For the first six or seven miles the road to Maymyo led across open country and then, after crossing the Mandalay Canal, it began a winding ascent into the hills. As we drove through the rocky terrain we began to meet elements of the Brigade which had captured Maymyo three days earlier. First, a column of Gurkhas carrying packs as big as themselves, then a mule convoy, raising a heavy cloud of dust, passed down the road to Mandalay. Following them came a detachment of mountain artillery; great burly Sikhs padding along beside the mules carrying their dismantled guns. Remaining in Maymyo as a holding force was a battalion of the Welsh Regiment. After passing the comforting mass of troops our convoy carried on along a deserted road in an atmosphere of unease. We knew the Japanese escaping from Mandalay were heading south-easterly and who knew where the remnants of the defeated Maymyo garrison had scattered to? However, our fire power was high enough to be comforting. Bren gunners rode on the roofs of the vehicles and those with Sten guns were very much on the alert. All these precautions proved unnecessary, however, as our journey was accomplished without incident, and we drove on to the airfield at Annisikan, four miles out of Maymyo at 1400hrs.

Arthur met us with the news that the airfield was suspected of being littered with unexploded bombs (UXBs) and sown with booby traps. He had located a suitable camp site in another Poongyi Kyaung, and, with each truck carefully driving in the tracks of the one in front, the convoy moved up the airfield into the camp. The remainder of that day was spent in settling in and no work was attempted until the following morning.

The first task was to cover the whole length of the strip, spread out across its width, prodding for mines. We found none. Work had only just begun on clearing and levelling when orders were received to move. We were to concentrate at a point where the Mandalay-Maymyo road crossed the Mandalay Canal. Work was abandoned and preparations made for the move. Whilst this was being done some of us had the opportunity of visiting Maymyo. The town had not suffered badly from the recent fighting. The main street was lined with shops and stalls which were carrying

on a flourishing trade. It was difficult to persuade them to accept Indian or Burmese money—they preferred Japanese. We drove to Harcourt-Butler Lake and swam there. The water was very cold but refreshing.

The person hardest hit by the sudden move order was undoubtedly Willie. The machinery, travelling on its own tracks, was due to arrive the same day. A messenger was sent out to meet him and tell him to turn. He was eight miles from camp and another two hours would have brought him in. On his return journey he had almost reached Mandalay Fort when he stopped the column for their midday meal. Unfortunately his halt coincided with a pattern bombing raid on the Fort by flights of Mitchell Bombers of the USAF. Willie's horror can be imagined when the distant drone of planes developed into a succession of bomb bursts in and around the Fort. Willie could be considered to be "around the Fort" and hastily spitting out a mouthful of *chappati* he bellowed for his machinery to move. In very short time he had his four bulldozers, two motor graders and wheeled vehicles a mile or two further on. When he passed back over the road a day or two later he observed, with mixed feelings, that the approximate area in which he had been consuming *chappati* and *chae* had ceased to be a road and was, instead, a bomb crater.

### THE MANDALAY CANAL

The return journey towards Mandalay was effected without incident, and we quickly set up camp in a pleasant area on the bank of the Mandalay Canal. Arthur, Jimmy and myself took a jeep out to scour the immediate surroundings for any machinery or engineer stores that might be left lying about. Arthur had an obsession on this type of scrounging and it often paid off. When we eventually left Burma we had to leave behind a complete machinery lorry and equipped trailer which we had put together with bits and pieces found on such expeditions. We re-crossed the canal and investigated the area in which a Japanese notice stood, proclaiming "Tresspassers will be Death with". We had no luck there but an abandoned railway station was more rewarding and we returned to camp with our pickings. It was some time later that we learned the area we had been searching was the rendezvous for all Japanese escaping from Mandalay.

On our return we noticed a battery of Medium Artillery move into the field immediately north of our site. With thoughts of counter-battery duels in my mind I accosted a Bombardier who assured me that he didn't think they were going to fire. Being a beautiful night with a full moon we dined at a table in the open. Over cigarettes and a little rum we were peacefully chatting when we became aware of movement in our neighbours' camp. Ranges were called, and bearings, and other incomprehensible gunner noises, then a very clearly understood *FIRE*. There was an unmerciful crash which physically hurt, followed by a scream overhead. All the tin tumblers on the table were swept flat. As the scream of the shells subsided we heard four insignificant thumps from a general southerly direction. In the ensuing silence we marshalled our thoughts concerning our neighbours in particular and the Royal Regiment in general. Before we had time to voice them another salvo deafened us. Then the firing stopped. Half an hour later it began again and stopped. I had turned in for the night and was on the point of going to sleep when I was raised horizontally off my bed by another crash. Firing went on at regular intervals throughout the night and, to add to my misery, a small war was taking place about half a mile away. When the guns weren't firing, rifles, stens and machine guns were. Eventually I gave in, dressed and spent the remainder of the night sitting on my bed, smoking and clapping my hands to my ears every time I heard that fateful word *FIRE*. To my disgust I discovered that no one else had been the slightest bit disturbed. My tent was at that side of the perimeter only 100 yards from the gun muzzles, but everyone else had slept through the entire performance.

That morning there was an urgent request for some sappers to clear mines and Frankie was detailed for the job. While he was getting his men together Arthur called me to the map where he pointed out a certain village called Tamokso. According to

his information a whole string of abandoned Japanese workshop lorries were just waiting to be collected and I was required to collect one. We set out in my jeep with a 30-cwt Dodge full of Frankie's mine lifters behind. As we progressed down the road which ran alongside the canal it became apparent what had caused the shooting which had helped to keep me awake the previous night. The canal banks were littered with dead Japanese, dead horses and dead bullocks who had, presumably, been trying to cross to the east bank to their rendezvous.

When we reached the spot where Frankie's mine lifting services were required we discovered that the divisional sappers had already done the job (bless them). We pressed on to a road junction leading to Tamokso where a military policeman was directing traffic. We indicated our road and asked if it was clear. Receiving an affirmative we turned right and proceeded. The road ran beside a subsidiary irrigation canal feeding off the main canal. After about a mile there was a pronounced bend in the track and as we rounded this I heard a crack above my head, followed by another and then by a whole succession of cracks. I finally woke up to the fact that we were being fired on and got the men out of the vehicles into a ditch. Taking council together we came to the unanimous decision that it was no part of our task to take on the remnants of the Japanese Mandalay Garrison virtually single handed and, consigning the alleged workshops lorries to a four letter fate we turned the vehicles and withdrew. We were interested to observe that the military policeman at the road junction now wore his steel helmet.

### TADA-U

After a three day sojourn in the Mandalay Canal camp we were ordered to Tada-U. Some RIASC lorries were being sent to help us move and I went to meet them taking guides with me. We drove back through Mandalay to the Ava Bridge. We crossed the Myitnge River by a Bailey Bridge just where the Myitnge joins the Irrawaddy at Ava and met the vehicles coming towards us. I transferred the guides I had brought and sent the vehicles on their way. I was stirred by my proximity to structures bearing the names I had always associated with home, for Ava and Fort Dufferin are connected with the Viscount of Dufferin and Ava whose estate at Clandeboye, Co Down I had long known. It is of interest that my present home backs on to a part of that estate.

The second part of my task was to find a suitable camp site at Tada-U and I drove on to find the airfield. I located what I felt was an admirable camp, its chief attraction being that it overhung a river, and settled down to await the arrival of the Company. After a long wait they arrived but Arthur did not like my choice of site and selected instead a ruined village. Whilst unloading began the radio was set up and shortly after communications were established we were given orders to move further on. Unloading was stopped and stores were being reloaded when another signal cancelled the first order. A third signal repeated instructions to move and this time the order stood.

### DWEHLA

The Company moved to Dwehla but I was sent off to visit another airfield with a view to taking over the maintenance. On arrival I was told that the airfield was no longer in use, so I pressed on to Dwehla. The airfield here had been built by a sister group of Forward Airfield Engineers attached to 4 Corps, and was a transport strip. Our task was to build a fighter strip parallel to this but whilst Jimmy and his surveyors set out the centre line the rest of the Company began construction of aprons for the transport strip.

After lunch that day the CRE flew in piloted by his Air Liaison Officer, Squadron Leader Grubb. Shortly after his arrival mortar bombs began dropping on the strip in the vicinity of his aircraft and we then heard small arms fire break out. A party of sappers was despatched to look after the CRE's plane and the remainder of the Company stood to. In a short while the firing died away and we subsequently learnt that a party of Japanese in a nearby village had been detected and flushed out by the local infantry unit.

On the day following my good friend and second-in-command, *Jemadar* Syed Habibullah Shah, returned from a lengthy absence due to illness. He had reported sick whilst we were at Kalemyo and, having recovered reasonably quickly, had then suffered the slow agonies of returning to his unit through the channels of the Transit Camps.

The machinery had arrived on the same day as we did, but, having travelled forty miles on its own tracks it got into camp very late. As soon as it started working the 2000 yard runway began to take shape and was very quickly finished. The final stage was, inevitably, watering and rolling. Hundreds of yards of victaulic pipe was laid and each night parties of sappers were engaged in hosing water over the surface. Although other forms of dust palliative had been tried, (bitumen, oil), the strips we built were in use for such a short time it was more economical to keep a maintenance party watering for the period of the strip's active life.

KUME ROAD

When the Company moved on Frankie stayed to handover to a company of the Group's Engineer Battalion and then followed us, via Kyaukse to Kume Road. As usual Arthur and Jimmie went ahead to recce the site and locate a camp. This time they found another Poongyi Kyaung which was in very good condition and here we rapidly made camp.

During the afternoon we were told that a party of Japanese were located in a village two miles from us. We were half a mile off the main road and there were no friendly troops between us and the enemy. A party from the Welsh Regiment visited us to arrange for defensive fire to be laid down in front of us should we be attacked. Later one of their patrols went out and returned through our camp; after that we felt very alone. We had tried to draw no attention to our presence and had banned all lights. I was understandably annoyed, then, whilst making a tour of the camp, to see a sudden glow of flame coming from one of the buildings. This light subsided then glowed brightly again. Suspecting an illegal fire I went towards the light. The culprit was a venerable old monk, obviously the sole remnant from the Monastery we were occupying, who was quietly enjoying a very large white cheroot of the type immortalised by Kipling. When smoked, these cheroots don't glow, they burst into flame at each puff. With the aid of our Burmese speaker the old man was politely asked to restrict his smoking to daylight hours.

In spite of our fears the night passed without incident and morning saw the commencement of work on the strip. This was one of the easiest sites we'd had as the surrounding country was completely flat. The alignment was quickly settled and the machinery began work. By evening the strip was almost complete. My platoon task was the construction of the control tower, to obtain materials for which I had sent my men on a scavenging expedition. The afternoon was spent in constructing trestles and raising them, which we finished about 1800hrs. Meanwhile the CRE had arrived and was expressing his displeasure at finding the strip was aligned east-west instead of north-south as required by Combat Cargo Task Force, the American organisation who dictated strip construction policy. However, it was decided to leave the strip as it was but preparations would be made to convert it to a fighter strip. Conversion to a fighter role required the strip to be 2300 yards long and to have dispersals laid out. It was decided, however, that my control tower was now in the wrong position and should be moved to the other side of the strip. We did this and re-erected on the new site having it complete by that evening except for a few finishing touches. At that time, also, the strip was ready and a signal to that effect was sent.

The method we used for building a control tower was as follows: Two tree trunks, about twenty-five feet long, were obtained and formed into a trestle using top and bottom ledgers with diagonal bracing, all bolted together. A second trestle was built and the two placed foot to foot on the ground. Holes two feet deep were dug for the legs. Two winch lorries were then brought up and placed side by side, the winch

cables laid out and brought over two levers by means of snatch blocks. Careful taking in of the winch cables by the two drivers brought the trestle to an upright position, the legs dropping into the holes as they rose. The winch lorries were then driven round to the opposite side and the process was repeated, this time using the standing trestle as a lever. When both trestles were upright they were juggled into position by guy ropes and two more diagonals were bolted into position, making the whole structure rigid. The earth was then packed around the legs whilst, up aloft, joists were being laid between the two top transoms. All that then remained was to lay the choice piece of flooring which had been "liberated" from a convenient but deserted building, fashion some type of low wall, or railings, and attach a staircase, usually from the same source as the floor.

The construction of airfield control towers was the favourite task allotted when a strip was being made, and there was great competition between platoon commanders to build the most striking and ingenious edifice. Initially control towers had a vertical ladder and an escape hatch with a rope. Towards the end of the campaign, and when we had reached areas of habitation and, therefore, sources of supply, designs became more fanciful. The ultimate I saw was a tower with two curving staircases leading down, one on each side, just like the Grand Staircase in some Baronial Hall.

Kume Road airfield was now ready for use and, on the morning following, the first planes landed. I never tired of watching the strip begin its short, useful life, knowing that a few hours earlier the site had been covered by growing tomatoes or some other crop. The planes would circle over the strip then, one by one, would touch down and roll to the unloading bays. Only when they had touched down and were taxi-ing safely would I realise that I had been holding my breath.

### MEIKTILA

We spent a further four days in Kume Road then the Company moved to Meiktila. I stayed one day to maintain the strip then followed with my platoon. Meiktila was crammed with units of all types for it was here that the axis of 4 Corps and 33 Corps crossed. 33 Corps had advanced down Central Burma by way of Kalewa, Shwebo and Mandalay while 4 Corps had moved on the west flank by the Fallam Road from Kalemyo. Now 4 Corps crossed at Meiktila to the east flank on the road to Thazi on the advance which was to carry them to Rangoon. 33 Corps advance was due south from Meiktila.

Our job was to construct a transport strip, a straight forward task for the mechanical equipment, our sappers being used for watering, marking the runway and building a control tower. Two unloading bays and about a mile of road for supply vehicles completed the task. The most outstanding memory of Meiktila was that here we received a liquor ration which meant there was beer every night.

### MACHINERY ESCORT

We had been in Meiktila for a week when we again received orders to move forward a distance of some fifty-eight miles to a place called Natmauk. This distance was too great for the machinery to move in one bound on its own tracks, and so it was arranged to split the journey into two stages. 3 Platoon, mine, was detailed to act as machinery escort. For the first twenty-four miles, along a tarmacadam road towards Kyaukpadaung, the machinery was carried on tank transporters and my task did not begin, therefore, until the Company reached a place called Zayetkon where our road swung south for our destination Natmauk. At this point I pulled my platoon and the machinery off the road and waited for the Company to pass through.

At 1000hrs we set out along a foul road, rutted and dusty, through hilly scrub country. Two of my vehicles went ahead of the column and two brought up the rear. The lead vehicles would move forward at their own speed for a distance of two miles where the troops would debus and take up fire positions overlooking the road. When the machinery caught up they would embus and advance another two miles. The rear trucks lagged behind, caught up and lagged behind again. As escort commander I

roved up and down the entire column, swallowing lungfulls of choking dust each time we passed one of the machines. Travelling with machinery was boring in the extreme for the maximum speed was that of the tracked vehicles and this was four miles an hour. Even that speed was reduced after continuous running in the heat to three miles an hour. I had long since run out of cigarettes, of which there was an acute shortage, and I'd had no mail for a long time. I was hot, dusty and thirsty and every bump on that corrugated road caused my back to rub up and down against the seat back, the red dust acting as an abrasive powder. When we approached the location in which I expected to find the Company harboured for the night I went ahead and found them, some six miles on.

On arrival I was met by Stephen who handed me a mug of tea; then the HQ *Jemadar* brought me three letters he had collected earlier that day; finally, to make my cup of happiness run over, Ron approached with a box of cigarettes from a supply the mess had ordered. At that moment I was the most contented man on earth. I lit a cigarette, drank my tea and, putting my letters away to read later, I went back up that beautiful picturesque road to guide the column in!

### NATMAUK

By 0600hrs the following morning the machinery and I were once more on the road and without any trouble we reached Natmauk. A company sign reassured me and I carried on along the road until we reached a wide, dry river bed on the far side of town. I knew we had overshot and turning back found the camp. In forgetting to ensure the unit sign had been placed at the entrance Ron had, unintentionally, got his own back for my similar lapse at Tamu.

The strip presented no major difficulties and the work involved was a transport strip, two aprons, a service road and the inevitable control tower. 3 Platoon's task was the blowing of flying gaps; almost as popular as building the tower. In very short time the strip was operational and, after only two days the Company moved on, a distance of twenty-six miles, to a place called Taungdwingyi, leaving 3 Platoon to maintain the strip and hand over to A Company of 21 Engineer Battalion, who arrived the following day.

### TAUNGDWINGYI

Setting out at 0600hrs I left the platoon to come behind me under *Jemadar* Shah and, moving fast alone, I was in the mess in time for breakfast, which had been my ulterior motive for leaving early. There was the usual flock of rumours about large Japanese forces retreating eastward across our path and, certainly, there was a basis of truth in these rumours for the guns sounded closer here than we had heard for some time.

The Taungdwingyi airfield was no different from any other and having completed the strip, blown flying gaps, constructed two aprons and the control tower we had some time on our hands for leisure. Much of this was spent in roaming through the deserted town looking for useful equipment discarded by the retreating Japanese.

### ALLENMYO

We advanced again, this time to Allenmyo on the east bank of the Irrawaddy and sixty miles south. Arthur and Jimmy had gone forward to locate a camp site and look at the airfield whilst Ron brought the Company. We drove through Allenmyo and on the far side we overtook some troops sweeping the sides of the road for mines; then we passed tanks halted at the roadside and still there was no sign of the camp. Finally, after passing the leading infantry kneeling in the ditches, we came to the camp site, as usual, a Poongyi Kyaung.

The airfield was an existing one which had been cratered and our task was to repair the strip and build a control tower. We worked late each night until the work was finished and then moved on to Prome. On arrival we found that we were not required but, to keep our hands in, we built a light aircraft strip and then, for the first time, moved backward instead of forward. We returned to Allenmyo.

The strip, given the local name Ywataung to avoid confusion with another strip near by, had been built by the Japanese who had made a very presentable job of it. It was all-weather and we were now to extend it to 2000 yards, with an all-weather surface, and put in two all-weather aprons. This presented some problems as the ground was waterlogged and drainage was not easy. A specific grading of aggregate was worked out by the FE1 at HQ, Major Frederickson, and was called "Freddiemix". Major Frederickson himself came down to supervise.

Meanwhile we were told to make ourselves "Monsoon proof," which we proceeded to do with great gusto. Each officer designed his own hut and had this built; platoons vying with each other to see who could turn out the best accommodation. With justifiable pride I became the owner occupier of an attractive detached residence having a large verandah, a single bed/sitting room with a bathroom "en suite". Each platoon also built its own barrack room and had certain additional tasks. My platoon's task was the officer's mess and, whilst not exactly rivalling the Depot Mess at Bangalore, a very creditable construction was erected. Instead of walls, lattice screens, which could be rolled up, were used. There was electric light and even an overhead fan, picked up during a foray into the town. To complete the project a bar was built in one corner with stools in front. Having such a fine mess the proper thing to do was to have a mess warming party. A delegation was sent to chat up the female staff of a recently arrived Casualty Clearing Station (CCS) and, on the chosen night, along came three nurses and two ENSA (Entertainments National Services Association) girls who were staying with them. A tarpaulin on the floor made a better surface for dancing than the bare earth and an old portable gramophone provided the music. When the party ended five jeeps were brought up and five officers escorted five ladies home, the OC leaving first. It was with some delight that the other four passed Arthur's jeep pulled into the side of the road. As the fourth jeep passed he called out "I've run out of petrol". The driver of that jeep made a suitable reply and tactfully drove on. It was with some hilarity that Arthur was observed still to be there on the return of the others, but this was nothing to the hilarity when it was found that he really had run out of petrol.

Work on the airfield progressed more slowly than we had been used to on previous tasks but, obviously, whilst a fairweather strip took only a couple of days to complete an all-weather strip was quite a different question. Military Government was taking control all the way down Burma as we passed and soon it caught up with us. Civilian labour was made available and, with our ranks thus swollen, work moved faster.

Our stay at Allenmyo was pleasant for we were well housed and the war seemed to have passed us by. Admittedly the town on the West bank of the Irrawaddy, opposite us and called Yenanyaung, was still in enemy hands and we could observe air strikes going in on it. This did not, however, prevent us from enjoying swimming in the river on our own side.

After several weeks rumours began to circulate concerning our return to India and our likely destination there. In due course our Movement Orders did arrive and we began packing up, returning stores and passing over to friends the acquired loot in the form of an unofficial machinery lorry, trailer and electric lighting plant we had so carefully built up over the preceding months.

The date of our move was 6 June 1945 and the Company marched out to the airfield to await the transport planes. It was fitting that we should leave Burma via the medium with which we had so long been involved, taxi-ing for take-off over well compacted layers of Freddiemix. The ninth plane of the group carried me and some members of 3 Platoon. As we headed west over the Irrawaddy towards the Arakan and Bengal I observed that we were not leaving Burma behind completely. One sapper nursed a puppy picked up in Mandalay, another carried a tame tree rat in his shirt and in another plane was a Burmese chicken hatched out of a Burmese egg on Easter Sunday. A two-hour flight brought us to Chittagong and after a period of four days we left by rail, river and rail again to a small village in South India called Vaniambadi, eighty-eight miles from Bangalore and reasonably close to Madras.

Here the Company was sent on leave before getting down to the task of preparing for the invasion of Malaya in which we were to play a part.

But that is another story.

ANNEX A

14TH ARMY AIRSTRIPS
(Excluding Light Aircraft Strips)

| *Name* | *Length of Strips* | *Work Carried Out By* |
|---|---|---|
| Indainggale | 2 × 2000yds | 21 Engr Bn A & B Coys |
| Yazagio | 1 × 1700yds | 459 Forward Airfd Engr Gp |
| Budalin South | 1 × 1900yds | |
| Ye-U Strip | 1 × 2000yds | 430 & 431 Ind Fd Coys |
| Tabingaung | 1 × 2000yds | 431 |
| Shwebo | 1 × 2100yds | 430 |
| Onbauk | 1 × 1750yds | |
| Singu | 1 × 2000yds | 431 |
| Sadaung | 1 × 2000yds | |
| Ondaw North | 1 × 2000yds | |
| Allagappa | 2 × 2000yds | |
| Ywadon | 1 × 1600yds and | |
| | 1 × 2000yds | |
| Myitche | 1 × 1900yds | |
| Sinthe | 2 × 2000yds | |
| Monywa | 1 × 1500yds and | |
| | 1 × 2000yds | |
| Tilin | 1 × 1500yds | |
| Alon | 2 × 2000yds | |
| Kan | 2 × 2000yds | |
| Taukkyan | 1 × 2000yds | 431 |
| Thazi | 1 × 2300yds | 21 C & D Coys |
| Kalemyo | 1 × 1700yds | 430 |
| Anisakan | | 431 |
| Mandalay North | | 431 |
| Tada-U | | 430 |
| Dwhela | 1 × 1700yds and | 431 |
| | 1 × 2000yds | |
| Kume Road | 1 × 2300yds | 431 |
| Bonzukan | | 431 |
| Natmauk | | 431 |
| Ywataung | 1 × 2000yds (all weather) | 431 |
| Taungdwingyi | | 431 |
| Tamu | | 431 |
| Meiktila | | 431 |

# Memoir

MAJOR G V BIRD GM, TD, FRIBA, AA Dip

*Died 16 November 1979, aged 72*

GODFREY BIRD was a kind and gentle man but he had an inner strength and courage not known to many. Born in Hong Kong, educated at Stoneyhurst and qualifying as an Architect in 1934, he returned to Hong Kong to join a leading firm of architects, eventually becoming a partner.

When WW2 broke out he was mobilized in Hong Kong. When the Japanese

attacked Captain G V Bird RE carried out a number of dangerous missions at the height of the battle and was wounded. When Hong Kong fell on Christmas Day 1941 he, with many others, was captured.

It may not be well known but the British Army Aid Group (BAAG) were operating from South China and in March 1943 they managed to contact the POWs. Unfortunately the Japanese infiltrated their spies into the organization and arrested many brave men. They were all tortured but did not disclose that Captain Bird and his fellow officers were continuing to run the organization from within the camps. Three of the captured officers were executed and were posthumously awarded the George Cross.

Captain Bird re-established contact with BAAG but eventually he too was arrested and tortured. The Japanese gave up when they realized he was not going to tell them anything and he was returned to a POW Camp. His courage was recognized and he was awarded the George Medal.

The last military record which can be found is an entry in the Army List which shows that he was a Major with 10th Light Horse Regiment (West Australian Mounted Infantry).

In Dec 1934 he married Daphne Hutchinson in Shanghai. Both she and their son were evacuated to the Philippines and were later interned by the Japanese in Manila. To his widow, son and daughter we extend our sympathy.

# Correspondence

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### SAPPERS FIT FOR WAR—SOME PIONIERING THOUGHTS

Sir,—"Sappers change the face of the earth to suit the tactical commanders aim" (from: *Sappers Fit for War* by Lieut Colonel W M R Addison RE).

"However, I sense dangers which could imbalance the trim. The first is that the Army, pre-occupied with priority one commitments, might say we should reduce or play down our technical engineering skills and concentrate on combat engineering. In no time at all I suggest we would rapidly become a Corps of pioneers" (From the address by E-in-C, Major General C P Campbell CBE, to the 1978 Corps Annual General Meeting).

As you can imagine I had to do a lot of fast talking to the Commandant of the Pionierschule when he read that! As a temporary inhabitant of that establishment, albeit with a disruptive pattern combat jacket instead of an olive drab one, may I try to put a point of view which is dismissed more often than discussed.

First of all is there a real difference between a Corps of Pioniers and a Corps of Engineers? If the answer is yes, and I believe it is, what is the difference and finally what is it that is required from us by the Queen (—or do we really mean the tactical commander).

The German Army has long had a concept of operations known as creating a *Schwerpunkt*. This goes back at least as far as Frederick the Great, one of whose maxims was; "One cannot be strong everywhere—one has to be strong at the decisive point." This implies not only tactical and strategic concentration of effort but also concentration in training and role.

For the German Pioniers military engineering today means concentrating on that aspect of military relativity known as mobility/counter mobility in its widest sense. Survivability comes a long way third. Accommodation, Power Supply, Refrigeration, Water Supply, Bomb Disposal, Airfield Construction, Movement Light and the Corps Lighting Troop do not figure at all. Just think of the trades you don't have to train in. And why . . . ?

"On the battlefield, and also in most of the forward combat zone, every construction task has to be measured against the complete operational plan. A quick start and a quick finish. The intimate support of operations limit construction tasks to a few hours. Tasks which cannot be completed in the time required for the operational plan cannot be considered. In the rear area the tasks will be much more dependent on the importance of the object, the task length and the possibility of providing alternative solutions. In this case there is more time for planning and execution. Nevertheless the view of war at present must limit military construction tasks to about three days, tasks which require more time should be taken over by the civil power."

The Germans also recognize that they will be fighting in the Federal Republic of Germany—not a notedly under-developed country.

"In practically every square kilometer there are four kilometers of roads and tracks. This means that in dry weather practically every point of land can be reached by wheeled vehicles with a drive of less than 500m off the nearest road or track. In Germany, north of Frankfurt, this remains true even in wet weather for 90% of the locations." And so, there is no point in having rock crushers, motorized scrapers, bitumen plants, asphalt laying machines or concrete mixers. If you need them go to a civil contractor!

Now, of course the Queen expects more of the Royal Engineers than the tactical commander; a hospital in Riyadh, swimming pools in St Helena, accommodation for prisoners in the Maze. But how much of this is because we have a trained capability and have to use it? How many times has one read in reports "and the squadron tradesmen had an excellent opportunity to practice their trades"? If we didn't have the tradesmen we wouldn't have to agonize about their lack of skill and practice.

The tactical commander wants us to change the face of the earth for the tactical battle. This means we must be tactically aware, able to survive, fully integrated in an all arms team. It means that military engineer tasks must take predictable times unless there are very harsh limiting factors. A 30m MGB always in two hours from arrival on site. An M2 bridge across the Weser always in one hour from arrival on site. A group of road demolition shafts always in one hour by one section. 1000 anti-tank mines laid by one Field Squadron always in two and a half hours. The tactical commander wants this and he wants us capable of doing it on any day of the year, not just after Combat Engineer Camp.

Let us be clear, the tactical commander we are talking about lives in all probability in Germany. That is where the rest of the field army is going. Our commitment to the flanks of NATO is minimal. Hong Kong has got the Queen's Gurkha Engineers. The rest of our 19th century Empire with its jungle, swamp, desert and bad water to be pumped to hill tops has gone.

If a future war is a long war and NOT "over by Christmas" we have time to mobilize real practicing civil engineers and tradesmen. If it looks as though we will not be operating in Germany, then the rest of the British Army will have to be fairly thoroughly overhauled too.

No, there is a case for becoming a Corps of Pioniers. The Wehrmacht managed with one which provided us with formidable opposition both in attack and defence from 1939 to 1945.

One final thought: *Artificer*: A skilled or artistic worker.

*Sapper*: A military specialist in field fortification works.

*Pioneer*: A person or group that originates or helps open up a new line of thought or activity or a new method or technical development.—Yours faithfully, R D Garnett

Captain M F Kingsford RE(V), ARICS, MIH, LIOB
111 Engr Regt (V)
CVHQ RE

A FORCES MORTGAGE SCHEME

Sir,—I was delighted to read WO1 Diplock's article suggesting a Forces Mortgage Scheme. As Deputy Director of Housing for a London Borough I was most surprised to see the sort of article I would read in the *Institute of Housing Journal* not the *Royal Engineers Journal*!

The proposal, in its aims, would meet an obvious need, simply that service personnel are generally unable to own their own homes and benefit in the increase in valuation of their property. However, there are several points which should be made about the scheme.

The basic problem is that the scheme is not really, in pure terms, a mortgage scheme since the monies involved are not repayments against a loan on a particular property. The value of service married quarters obviously differs from area to area and postings naturally do not take such matters into account. However, if "comparability" is the aim then salary devices such as the London "weighting" system could overcome geographical factors. The real issue would then be: could the serviceman, in any case, afford to buy his own home.

Mr Diplock's scheme seeks to obtain tax relief but such tax relief for home owners can be seen as a means of economic distribution or subsidy as is the level of rents and rebates on Local Authority or Housing Association dwellings. In other words, the subsidy or tax relief is on the monies the individual puts into property, in balance to his income.

At a time when, as the Government has been saying, cold economic winds are blowing, I doubt if the Treasury could be persuaded to give up the "betterment" on such Crown Property as Service married quarters and I question whether the similarities between the MOD and Local Housing Authorities are really that obvious as to suggest the discounts outlined in the Housing Bill would apply to married quarters. Perhaps such discounts as proposed in the Housing Bill are for reasons that do not apply in the Services context?

Nevertheless, I recognise the need, in housing terms, for some kind of scheme as proposed by Mr Diplock. Consideration could be given to the establishment of a Housing Co-ownership Scheme under the 1974 Housing Act which could be jointly managed by service personnel with PSA support. Financial assistance, including the outright purchase of MOD dwellings, to the Co-operative could come from the Building Societies or the Housing Corporation with Income Tax Relief to the Co-operator (Serviceman). The MOD would gain financially from the sale to the Co-operative of such dwellings. (How many *MILAN*'s can you buy for a semi in Chatham?) The Building Societies could develop a captured-investor market and the Serviceman (or woman) gains by watching his investment grow as property values grow. The geographical problem could be overcome by having co-operative developments in the main Army locations and special arrangements could be devised for Germany using EEC rules.

Such a development on Mr Diplock's proposals as I have outlined above would need considerable thought and planning but could be attractive to the Serviceman and the Government especially since it would encourage home-ownership. Service personnel, especially in the junior ranks, do have a housing problem when they leave the Forces, a problem I have seen at first hand too many times.

However, a considerable amount of work would have to be carried out first to test the feasibility of such schemes.

Finally, I am also a Chartered Building Surveyor as is another Officer in my Squadron and although I do not know of any other Chartered Building Surveyors currently serving in the Corps I know four Chartered Building Surveyors who have served in the Corps.—Yours faithfully, Martyn Kingsford.

Brigadier L P Bennett CBE
Treasurer RE Corps Funds
Brompton Barracks
Chatham, Kent

KING EDWARD VII HOSPITAL APPEAL FUND

Sir,—You very kindly made space available in the Supplement for a notice inviting donations to the King Edward VII Hospital Appeal Fund. The Notice prompted Major General H Bainbridge to write as follows:

"Having had the privilege of being looked after at 17 Grosvenor Crescent, after returning from skiing with a badly broken leg, I was most interested to read the notice in the December Supplement about the Fund to endow a bed at the new Hospital. I recall "Sister Agnes" as a very charming old lady—though a bit of a Martinet! As an example I well remember one morning when she was doing her morning round before breakfast, she came into our "ward" (a bedroom which took half a dozen beds comfortably) stopped, sniffed, and said "who has been smoking before breakfast?" The culprit collected quite a rocket.

"Sunday before lunch was a pretty "safe" time as she had a standing invitation to take (and I am sure enjoy) a glass of sherry at the Palace. It was always understood that she had a personal key to the door in the wall of the Garden in Grosvenor Place.

"Through her good offices I was treated by the great Rowley Bristow himself for a fee within the capacity of a junior subaltern to pay. I am therefore pleased to send a donation to the Fund and hope it will be fully subscribed before long".

I am pleased to be able to report that the response to the Appeal was most encouraging and your readers will no doubt have heard that a cheque for the £1000 necessary to provide a bed named after the Corps has been sent to the Hospital. I am indebted to Major General Bainbridge for giving me permission to publish his personal recollections of Sister Agnes and to all those who have contributed so generously to the Appeal Fund.—Yours faithfully, L P Bennett

Captain A J L Stalker RE, BSc(*H*)
HQRE 1(BR) Corps Microfiche Team
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FOOD FOR THOUGHT . . . . .?

Sir,—I read with great interest the article by Major Jennings-Bramly in the March Journal. I agree with most of the points he raises and look forward to the time, hopefully in the not too distant future, when his concluding recommendations can be put into effect. I believe he has erred on the side of pessimism in his assertion that it would take a year for microprocessors issued today to units to "earn their keep". I think they would prove their worth within a couple of months, this being the time it takes to conceive and develop simple programs and to iron out errors through use. The major problem in developing programs within units will be finding the time as the programs should ideally be developed by the user, who is likely to be fairly busy in his normal job without this added task. The best hope here lies in the fact that working on computers is potentially very satisfying and a proportion of users will prefer to spend their "overtime" hours developing the programs that will, ultimately, free from the more tedious and repetitive parts of their jobs.

While the initial benefits of microcomputers will be felt primarily in the clerical and administrative fields, I believe that ultimately the use of computers in support of operational decision-making will become not only feasible but essential if our planning is to remain both economical and flexible, two hitherto mutually exclusive aims. There are two types of information possibly worth storing—Operational Data, such

as demolition reports and crossing site reports, and MGID (Military Geographic Information and Documentation). The use of computers for the storage of such information was considered a couple of years ago but was rejected in favour of microform. This was undoubtedly correct in view of the state of the art at that time but the growth in the power of computers to be expected over the next five years, coupled with likely reductions in their size and cost, leads me to believe that by the time Edition 2 of Engineer Information Microfiche requires updating it will be worth reconsidering whether computer storage might not be the most appropriate method.

There are two main advantages in using computers for the storage of this sort of information. The first is that amending and updating becomes very much easier. The second is that, since the information is held (probably on tape or disc) in a form that the computer understands without further action by the computer operator, it will be possible to write programs which instruct the computer to extract certain data from its stores and manipulate this data to produce an end result, be it a demolition schedule, works table or outloading plan, without further human interference. If this sounds like handing over the decision-making to a machine, it is not totally inaccurate. However, the only decisions one would ask the machine to make are the purely "arithmetical" ones. Remembering that the machine will produce its result in a fraction of a second, it will be possible to try out a variety of options by varying the input parameters. For example, given that the main storage banks of the machine contain the demolition details for all worthwhile targets in the area of interest, it should be possible to type in either a list of target serial numbers, or a list of grid references, together with the resources available, in terms of manpower, explosives, mines and vehicles, and ask the computer for its plan, and how long it would take to execute the plan. One would be able to feed in any additional factors such as the effects of NBC, weather, fatigue or breakdown of critical vehicles or plant. If the computer's plan was not acceptable for any reason, it would suffice to alter some of the input, for the computer to work out a new plan for the user's approval.

One word of caution is in order before I finish . . . It is essential that computers are seen by the Corps as just one of the many tools we need to carry out our tasks, and not as an instant solution to all our problems. No matter how good a plan the machine produces, and how accurate the data on which it makes this plan, the utility of the whole exercise still comes down in the end to the quality of the men and commanders who have put it into effect.—Yours faithfully, A J L Stalker.

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### FOOD FOR THOUGHT – A UNIT COMPUTER

Sir,—Like many a Sapper officer I have often read features in the Journal, been fired to respond in the correspondence columns and promptly forgotten to do so. However both inclination and duty require that I respond to Major Jennings-Bramly's article, in the March issue, on the need for microcomputers in units.

May I start by saying how encouraging it is to see this and other recent articles on computing. We are not as a Corps very computer minded and very few Sapper officers are trained in this field, not even, by his own account, the author. However the opportunities created by the spread of computers, and microprocessors in particular, throughout the Services will be enormous and limited not so much by financial and technical factors as by our ability to imaginatively comprehend, and justify, what is possible. The more Sapper officers with a working knowledge of the subject, the quicker we will get an "intelligent" mine and a "smart" minefield

recording system, to name some examples of possible applications.

Returning to Major Jennings-Bramly's theme of a unit administrative computer I believe he has underestimated the problem. In the first place £1,000 buys very little useful computing power. One of the key factors is storage which he all but dismisses. Computers required to do fairly simple "sums" such as the programmable calculators in many Sapper units need little storage but in information retrieval and records systems, such as he suggests, it becomes the predominant factor. Large amounts of random access storage (rotating discs, magnetic tape will just not do) increases costs, as well as making systems more complex and less resilient (tough) in both hardware and software terms. Some further problem areas in ADP which are relevant to the unit administrative tasks sketched in the article are:

(a) *Data Capture*. The task of converting data from manual records in a variety of formats would be significant.

(b) *Data Consistency/Currency*. Keeping data up to date and correct would require considerable effort.

(c) *Getting the User Interface right*. In non-jargon getting the computer to work for you and not you for it. Neatly illustrated by the example of the "conversation" with the computer in the article. It is clearly easier and quicker to fill in an AB 397 with a pencil stub (to be inked in later?) than to type answers to all those questions.

(d) *Ruggedness*. In his talk of power supplies Major Jennings-Bramly infers a vehicle-borne unit computer. Phase I of the *WAVELL* project has clearly shown the need for the full military specification in a field computer, and this is expensive.

There are many other grey areas which must be resolved before we get to the stage of a viable unit computer. For the present neither the computer industry nor, more importantly, the Army are ready for this step. In the meantime some units are going ahead on their own account and no doubt learning valuable lessons in the process. However Major Jennings-Bramly is right in saying that a piecemeal approach is inefficient. In the long term a standard product and standard software will be required. Currently the most hopeful approach lies in an RAPC study aimed at capturing data for the Army's pay and records much nearer its source (the unit) than at present which could in time lead to a unit machine.

Just at present I would not agree that "the Royal Engineers are in an excellent position to lead the way in the introduction of such equipment throughout the Armed Forces". RAPC, RAOC and REME are out in front which is all the more reason for us to study and become more expert in this fascinating and potentially significant subject.—Yours sincerely, David Cook.

Major R C Matthews MBE, TD, MIMI
Spur Cottage
Ratton Drive
Eastbourne, Sussex

### OPERATION CORKSCREW

Sir,—This article brings back memories of when I was commanding 211 Fd Pk Coy in North Africa. I called in at Sousse and lunched in "A" Mess HQ 1st (British) Infantry Division with my old friend John Foster. Apart from the staff, I met numerous senior RN and US Air Force officers and was much intrigued as to what was afoot. However, security was so tight that it was not until I was back with my unit a few days later that I learned of the successful capture of the island of Pantelleria.

On looking at Corps History Vol IX, page 1, which refers to the "Inception and Planning of Invasion of Sicily", I find that no reference is made of *Operation Corkscrew* which was imperative before the Sicilian landings could succeed.

John Foster's article describes a forgotten episode and is therefore a valuable contribution to the history of the Corps.—Yours faithfully, R C Matthews.

Captain R H Clarke RE
The Adjutant
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### CORPS CUSTOMS

Sir,—I read Lieut Colonel J A Coombs' letter in the March edition of the *RE Journal* with some surprise. Had he spoken to me, the Adjutant of the Depot Regiment, (Extension 245), I could have allayed some, at least, of his worries about Corps Customs.

First, saluting the Adjutant. Woe betide any Subaltern or Captain who fails to salute me first thing in the morning. However, as I arrive at 0800 or earlier in the morning, and generally stay in my office until at least 0930 not many Officers see me until lunchtime. I certainly have not been aware of Officers failing to salute me.

Second, wearing Sam Browne's in the Mess. It must be realised that in a typical month on about twenty-five days the Orderly Officer is a Warrant Officer and therefore does not frequent the public rooms of the Officers Mess. Regimental Standing Orders for the Depot Regiment do state that the order of dress for Orderly Officers is No 2 Dress with Sam Browne for Officers and Warrant Officers Class 1. In that excellent little book "Customs of the Service" it is stated that the Orderly Officer wears a belt in the Mess so that he may be easily identified by the Mess Staff. This was eminently sensible in the days when Officers normally wore SD as works dress and therefore could wear a Sam Browne. It is now rare for Officers to wear SD during the day and in the evening the Orderly Officer is normally the only Mess Member in uniform and is therefore readily identifiable without a Sam Browne. I know of no Sapper Regiment where the Orderly Officer does in fact wear a Sam Browne in the Mess (and I have done at least my share of duties!). I therefore concede that in some areas Regimental Custom as practised is changing faster than Official Corps Policy.—Yours sincerely, R H Clarke

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### MACHINES OR MEN?

Sir,—The article by Mr P A Green in the December issue brings to mind the feats of construction of the great Victorian Civil Engineers and Contractors, and more particularly of that great man Thomas Brassey. He is now nearly forgotten, but in his day he was the greatest railway builder of the age.

A Cheshire farmer's son, he was born in 1805 and initially trained as a surveyor. After early experience in laying out the line of a section of the new road between Shrewsbury and Holyhead (A5) he became a Land Agent, Quarry Manager and Building Contractor.

From these small beginnings he progressed to become an international railway builder employing some 85,000 men. He built many thousands of miles of railways and other major works in Britain and throughout Europe as well as in Russia, India, Australia, Canada and South America. For instance by 1848 he had built three quarters of the then existing French railway system.

In 1852 he went into partnership with Sir Morton Peto and Edward Betts and in that year one of their contracts was for the Grand Trunk Railway in Canada which included the Victoria Bridge over the St Lawrence at Montreal. Designed by Robert

Stephenson and A M Ross it was of a total length of 1944 feet. The iron work was entirely prefabricated at the Works in Birkenhead to such a high degree of accuracy that no alteration was needed on site.

In order to ease the supply problem in the Crimea, Brassey offered, in 1854, to construct and operate, on a cost-only basis, a railway from Balaclava to Sebastopol. The offer was accepted and the order to proceed was given on 9 December 1854; in the space of three days nine ships had been chartered and by 15 December the first, with the advance party, was ready to sail from the Mersey. Stores were purchased and loaded, in many cases hot from the rolling mills, and by 30 December the fleet was ready to leave the various ports in England.

The expedition was completely self contained and equipped to a very high standard. It arrived off the Crimea with 500 navvies and all the equipment for the task in early February 1855 and by 7 April thirty-nine miles of railway had been completed and was operating with seventeen locomotives.

This brief summary of the work carried out by Thomas Brassey and his associates is enough to underline the fact that machines are not the only key to efficiency and high output; that, given good management and organization, labour based methods are capable of producing a high volume of first class work.

Incidentally, it would be interesting to know if there is any record of the Crimea operation in the Corps records.— Yours faithfully, S M Hollway

*Editors Note*

This period is covered in Volume I of Corps History pps 437 and 443/4 in particular. The text refers to: "A tramroad was ordered to be sent out from England, and a corps of navvies was provided by Messrs Peto and Brassey for its construction" . . . "During the month of January (1885) the railway staff arrived with their men and stores, and a line was commenced which was gradually led on to the plateau and proved of the greatest possible use". It is of interest that there was an unsuccessful move to try and get the navvies to enlist as fighting men!

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## ESCAPE FROM SINGAPORE

Sir,— The four articles by Major Angell (Vol 93) and the letter from Brigadier Panet (Vol 94/1) about Noel Corrie prompt me to add to the story of "Escape from Singapore".

A Staff Sergeant at the time, I was in the party which left Singapore with Major Angell on the *Shu Kwang* which embarked on Friday 13 February and sailed at first light the next morning. Readers will see from his Appendix B that I was wounded during the first bombing of the ship. I was also picked up by the *Tanjong Pinang* and landed with Major Angell at Tembilahan. As I was one of the wounded I left his party at Rangat where I was hospitalized.

It was expected that more parties would use this route so with a few other wounded I was moved from Rangat on 19 February by ambulance for Padang on the south coast. There we came under command of Brigadier Paris.

On 26 February Brigadier Paris's party was divided into four groups:

(a) The first included Brigadier Paris and Noel Corrie, the civilian element and a large party of Fortress Signals, Singapore. They embarked on the *Rosenbloom* which sailed at 1430hrs. We know from Brigadier Panet's letter that it was sunk.

(b) The second, including myself and about ten other Engineer Services personnel, embarked on a small vessel, the *Tinombo*. We were delayed for some three hours while bombs were loaded into the vessel and we sailed at about 1800hrs on a SE

course for Java. We maintained this course throughout 27 February but early on the morning of 28 February we cut engines and remained becalmed for the whole day and night. We were told that it was a boiler defect, but it is now certain that it was because the *Rosenbloom* had been torpedoed ahead of us. Early on 1 March the engines re-started and when the sun came up we were proceeding SW! We reached Colombo on 12 March and disembarked the following day, some four days after Major Angell.

(c) The third group included about 70 members of 35th Fortress Company who had been stationed at Pulau Brani and who had made their escape, after the fall of Singapore, on 15 February 1941. This group embarked on 28 February and this vessel must also have been torpedoed as to my knowledge none were heard of again.

(d) The last group, including the remaining 10 members of 35 Company, were picked up by HMS *Danae* early in March. (Readers will remember that Major Angell disembarked from HMS *Danae* at Tjilatjap on 22 February). HMS *Danae* also cleared all the service wounded from the hospital in Padang. *Danae* overtook us, the second group in the *Tinombo*, when we were off Dondra Head, S Ceylon and disembarked her passengers in Colombo on 10 or 11 March 1941, a day or two ahead of us.

Luck certainly played its part in the Escape from Singapore.—Yours faithfully, T J Phelps

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### WEST AFRICAN ENGINEERS

Sir,—In my article in the March issue of the Journal there may be some errors of fact and there are certainly gaps that I have been unable to fill. I would like to make this history as complete as possible and would welcome any comments or additional information that readers may have.

In addition, I am completing for the Corps Library the story of 2 (WA) Field Company WAE (53 (WA) Field Company for the Abyssinia campaign) from formation in 1939 to disbandment in 1946. I would very much appreciate hearing from anyone who served in the Company or had knowledge of its activities.—Yours faithfully, H W Baldwin

# Book Reviews

## THE GMC—A UNIVERSAL TRUCK

JEAN-MICHEL BONIFACE and JEAN-GABRIEL JEUDY

(English Language Edition published by Frederick Warne Ltd. Price £9·95)

THE GMC was intended as an interim design of vehicle, hastily manufactured to meet the urgent needs of World War II. It can still be found in service today, all around Europe and in a host of countries besides. This new title in Warne's Transport Library shows the very wide range of activities in which this vehicle has excelled and the many adaptations to its design. The vast number of GMC's that were supplied to the European allies and to third world countries gives a truly international scope to this volume, and the photographs cover a time span of over thirty years—from the war to the late seventies. The final part of the book concentrates on the GMC's civilian use, with a special section dealing with the many ways in which it has been adapted as a fire appliance.

EEP

## WORLD ARMIES

EDITED BY JOHN KEEGAN

(Published by Macmillan Press Ltd. 850 pps. Price £22·50)

In the last thirty years the number of armies in the world have more than doubled. For example in 1945 there were only four independent armies in the African continent, none of real political significance. In 1979 there were more than thirty. The same pattern is perceptible in Asia and Latin America and armies have become the most crucial institution of national life almost everywhere outside the developed world.

The principle aim of this book is to provide a portrait of each of some 164 armies in its domestic, historical, social and political as well as military context. Each main entry is arranged in a standard form containing nine headings: History and Introduction; Strength and Budget; Command and Constitutional Status; Role, Commitment, Deployment and Recent Operations; Organizations; Recruitment, Training and Reserves; Equipment and Arms Industry; Rank, Dress and Distinction; and Current Developments. The picture of each army is therefore related to the government and administration of the State to which it belongs.

The Editor is a Senior Lecturer in War Studies at the Royal Military Academy (RMA) Sandhurst and most of the contributors have RMA associations. All are to be commended for achieving the aim, their research and efforts have produced the first reference book to provide details of every army in the world. It will be found indispensable by anyone concerned with national and international affairs.

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