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AUSTRALIAN ARMY JOURNAL

A periodical review of military literature

No. 220, SEPTEMBER 1967.

Contents

Photograph: *Australian War Memorial*

TROOPS of the 7th Australian Division entering the shattered town of Lae on 16 September 1943 along a road littered with debris from air and artillery bombardments. Advanced elements of the 9th Australian Division also entered Lae from the east on this day after an amphibious landing at Red Beach in the Huon Gulf twelve days earlier.

Civic Action in Vietnam 1965-66

Captain P. M. Arnison,
Royal Australian Infantry

Introduction

THIS paper covers the Civic Action carried out by 1 RAR round Bien Hoa from June 1965 to May 1966.

Origins of the Programme

After deployment in Vietnam and integration with 173rd Airborne Brigade, 1 RAR was assigned a tactical area of responsibility. The area included the small hamlet of Ong Huong. It became apparent after a month of patrolling that the hamlet and its inhabitants were the focal point of the eastern side of the TAOR. Two companies, 'B' and 'C', patrolled this region alternately, and before long the children of the hamlet began following the patrols, anticipating their routes, and eating with them.

Major McFarlane, OC 'B' Company, decided to visit the hamlet and establish liaison with the Chief, Tran Van Tai. The battalion medical officer, dental officer, and two interpreters (one Australian and one Vietnamese) accompanied him. They were invited to morning tea by the Chief and afterwards the OC offered medical and dental aid to the villagers. The Chief was most enthusiastic and suggested that his house be used for this purpose. Almost half the hamlet's population was medically treated, mainly for skin infections, and the dentist worked solidly for three hours and a half.

Out of this initial contact a spontaneous friendship and mutual respect developed between the company commander and the Hamlet Chief, and this provided the sound fundation that enabled the programme to grow and become the success it undoubtedly was.

Early Projects at Ong Huong

The medical and dental civic aid programmes ('Medcap' and 'Dentcap') continued, and combined with these the company distributed clothes, purchased from company funds, footwear and food, both fresh and tinned. The medical and dental aid provided kept the programme going, as the food and clothing handouts *en masse*

Captain Arnison graduated from the Royal Military College in 1962 and was allotted to infantry. He served with 1 RAR in Vietnam and since March has been attached to AAS Washington, serving with the US forces in Hawaii.

were a dismal failure. Some villagers and children fought over the handouts, and it was obvious that the majority of the people felt that they had lost face in front of the Australians.

The village elders were visibly upset by the spectacle, and after two visits this type of Civic Action halted. The Hamlet Chief then indicated that it would be more sensible if he were permitted to distribute the food, giving as reasons (*a*) that he knew the needy in the hamlet, and (*b*) that he could maintain discipline over the people. The Chief's advice was accepted, and results were immediate. The Chief's house was used as the centre both for 'Medcap' and 'Dentcap' and for the distribution of food and clothing. In this way also the importance of the role of local government in the hamlet was emphasized.

There was a sad lack of amenities for children in the hamlet; there was neither school nor recreational area. The RAEME detachment set to work with a will to remedy the need. They built swings, see-saws, a maypole and climbing bars, painted them in the national colours and presented them to the hamlet. The Chief allocated a vacant lot in the centre of the hamlet and there they were erected. They were an immediate success with the children and were in continual use. Similar items were also presented to the school at Tau Phu, the main village in the Cong Than District.

Battalion and Brigade Organization

In November 1965 a C5 (Civil Affairs) Section was established in 173rd Airborne Brigade. All units organized C4 sections and brigade headquarters exercised control over them. At battalion level the tendency was to appoint the Intelligence Officer to the section. In the writer's opinion, however, one of the prerequisites of a successful programme is the complete divorce of Civic Action from Intelligence. The Vietnamese would be quick to recognize and resent any programme conceived in the spirit of what can be gained. If intelligence matter flows from a successful Civic Action programme it should of course be utilized to the utmost, but it should always be the result of Civic Action, not the motivation for the programme. A second need is to appoint officers and NCOs to run the programme with a genuine feeling of compassion for the people, and a desire to help them improve their conditions. The civic action officer must be carefully selected.

Relationship with Vietnamese

This can be broken down into three categories:

- Officials (civil and military). The Hamlet Chief, Tran Van Tai and the head of Cong Thau District, Dai Uy Tien, were always pleased to see us and co-operated in every way pos-

sible, especially when projects required unskilled and semi-skilled labour. They extended the hospitality of their homes to us for meals and refreshments. The Dai Uy used Australian items such as cigarettes and whisky to offer his American visitors. This was his way of indicating to the Americans that he had freedom of choice, that he was not bound solely to them.

- Villagers. The villagers were initially hesitant in their approach, but as they became more accustomed to us and as their children talked about us in their homes, they warmed towards us. They strongly resented soldiers giving their children cigarettes, as the children were too young to smoke by any standard, and the parents generally too poor to buy tailor-made cigarettes and found it intolerable to see their children smoking them.
- The Children. The children were no different to children anywhere. They were in turn humorous, cheeky, honest, dishonest (not often) and loyal to the particular soldier they adopted. They were the easiest to reach and since they discussed our activities and conduct in their homes provided a useful link with their parents.

Expanding Projects

At Ong Huong the Chief decided that the most pressing of his hamlet's needs was a school. The nearest was two miles away and most families were too poor to pay bus fares. Also the area was patrolled by 1 RAR and there was the fear that the children would be involved in Viet Cong contact if they walked to school.

After discussion with the United States Aid representative (USAID) in Bien Hoa, we received a grant of 60,000 piastres (about $600) to build a one-roomed school. There were too many children in the hamlet for a one-roomed school, but there was no extra money available from USAID. So we went ahead with a two-roomed school, the Australian Government providing the additional 60,000 piastres needed out of Colombo Plan or SEATO aid funds.

Dai Uy Tien provided us with two Regional forces (RF) bricklayers, while we added the battalion carpenter, a field engineer (for technical advice) and six soldiers. The hamlet Chief provided a five-man force daily, and the children helped by carrying water and cleaning up. Thus we had the Vietnamese military, the villager and the Australian soldier all working together. We had warned the Chief earlier that we would not work unless the villagers shared our labours, and this warning, if needed, was evidently sufficient. The school when completed had a cement floor, brick and plaster walls and a galvanized-iron roof. It was handed over to the hamlet with appropriate ceremony in May 1966.

In conjunction with the school project, fences and culverts were constructed and floors in some houses were cemented. 'Medcap' and 'Dentcap' continued, and after four months there was a noticeable improvement in the general health of the villagers. Some patients were taken to the Australian Surgical Team at Bien Hoa for further treatment, and one child was sent to Saigon for the fitting of an artificial arm.

By May 1966 this hamlet, which had at best been apathetic a year earlier, was so pro-government that when eight VC one night attempted to enter it the Popular Forces (PF) from the hamlet ambushed them, killing two, wounding others, and capturing two weapons. In the past the VC had been allowed free movement into and out of the hamlet.

The aid given by the battalion was not confined to Ong Huong. At Tan Phu, the district capital, playground equipment was given to the school, toilets were dug and milk distributed. At Cay Da school, toilets were dug, a well provided and the fence and gate repaired, and at Binh Phuoc school toilets and a well were dug, milk was distributed and the playground landscaped.

In all cases the Vietnamese worked with the soldiers. When they failed to appear work was halted. Most of the problems in this regard, however, were caused by a lack of co-ordination between the Australia project officer and the hamlet Chief. When co-ordination was achieved, the projects proceeded smoothly.

Help was provided also in other ways. For example, English lessons, mostly for high school pupils and shop owners, were concluded in the late afternoons by the unit Education Officer and the battalion and company clerks. In January 1966 the Alfred Hospital in Melbourne sent a surgical team to operate the surgical wing of the Bien Hoa Provincial Hospital. The battalion worked very closely with the team, initially in helping them to overcome their early administrative problems, and later in the wards. The children's ward was repainted. Captured Viet Cong rice was distributed in one-kilo lots to discharged patients, thus providing their food for the next three days. One of the battalion's interpreters (Australian) was detached to the team when not required on operations, and occasional afternoon tea parties, organized by the soldiers, were held in the children's ward.

Ceremonies

On the completion of each project, a small ceremony was conducted to dedicate the project and to present it to the people. Such ceremonies came to be regarded as essential to the contract. In one instance, where one was not held, a latrine remained locked for a month, the school master believing that it was not to be used until

it had been officially presented. The ceremonies, for which the unit and the District Chief provided the refreshments, were of value in another way; they provided the occasion for the villagers to mix socially with the Australians, and the opportunity for each group to reach a closer understanding of the other.

Conclusion

The degree of success achieved by 1 RAR's civic action programme in Vietnam, to which ample testimony has been received from a variety of local sources, was the outcome largely of:

- The enthusiasm of the people employed on the programme.
- This was contagious. It was communicated to the Vietnamese, who were made to feel that we were genuinely interested in helping them, and were not doing so for our own benefit. □

Quality in Relation to Defence Requirements in Australia

J. Shilkin, ED,
Deputy Director of Army Inspection

MANUFACTURERS are, in general, engaged in a constant quest for customers. Customers are, in general, engaged in a constant quest for quality. Thus emerges the inevitable requirement for manufacturers to regard the matter of quality as one of the highest importance and to take such steps as will result in the production of quality goods and the hoped for expansion of their markets. The purpose of this paper is to indicate the overriding importance given to the matter of quality in supplies ordered for the Defence Services, to show what generally is expected of manufacturers in the matter of building quality into their products and, to some extent, discuss the part played by the Defence Inspection Services in general and that of the Army Inspection Service in particular in assuring that only supplies of the appropriate quality are accepted by the Defence authorities.

At this stage, if for no other reason than to capture interest and imagination, it would be appropriate to draw attention to the opportunities for sales which are open to Australian manufacturing organizations insofar as Defence supplies are concerned. The 1966 Defence Report presented to Parliament by the Minister for Defence, Mr. Allen Fairhall, reveals that the total estimated Defence expenditure on capital equipment for 1966-67 was expected to be 68.5 million dollars. This figure is exclusive of expenditure on naval construction, aircraft purchase and maintenance, building and works and maintenance of capital equipment. A sum of 87.31 million dollars was, in addition, estimated to be spent on maintenance stores. Whilst it is not possible to indicate how much of this 155 million dollars expendi-

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This article is based on an address to the Victorian Chamber of Manufacturers on 8 June 1967.

ture is in respect of Government factories production or supplies of overseas origin, there is no doubt that contracts placed on Australian manufacturing industry would represent a formidable sum. Overall, it goes to those organizations which are capable of meeting Government quality requirements. With the rapid rate of increase in equipment acquisition for the Services, more and more emphasis is being placed on examining the ability of tenderers to meet such quality requirements. This is not merely a matter of Defence policy; it is in the national interest and in the interests of individual manufacturing concerns to reduce high failure costs by concentrating on prevention.

It would indeed be interesting and possibly frightening if reliable statistics relating to the cost of quality failure of Australian-produced goods were available for study. Unfortunately, these do not exist, or certainly do not exist in a form available for public scrutiny. However, the following extract from a speech made in the United Kingdom some two or three years ago is pertinent. It says:

> Her Majesty's Government estimates that the value of goods produced annually in Britain—created value, that is—amounts to about 22 thousand million pounds. It is estimated that the costs of failing to produce to the correct standard plus the costs of post-mortem vertification, that is, scrap plus rectification costs plus inspection costs, amount to at least one thousand million pounds annually.

Thus, something of the order of 5 per cent of the total value of production is lost through inadequate control of quality. From my own observations and experience in my capacity as Deputy Director of Army Inspection, I would say that quality failure costs in this country are at least of the same order. In the matter of military stores submitted by Australian contractors, I would say that if Government inspection was dispensed with, between 5 and 10 per cent on the average of supplies delivered to the Services would be defective. In some cases, up to 50 per cent of items submitted would not meet military quality standards. This, to some extent, is due to the inability of manufacturers normally supplying a commercial market to adjust their thinking and their operations to the more stringent requirements of military stores, in addition to a lack of appreciation of quality control requirements generally and of experience and/or knowledge of the activities of such organizations as the Standards Association of Australia and the National Association of Testing Authorities. It would be unrealistic to suggest that there should be complete elimination of defects. Perfection at all times, together with the associated costs, is not necessarily justified or required even with many aspects of military supplies. I do suggest, however, that the intelligent application of modern quality control techniques will, in most manufacturing organizations in this country, reduce waste, reduce defects to the necessary minimum and most certainly in the long run increase profits.

The quality requirements of military stores differ significantly from those of commercial type items because of the following general attributes:

- The need for the attainment of maximum operational efficiency at any time.
- The complexity and diversity of the stores.
- The environmental circumstances associated with their employment.
- The safety of personnel.
- The long-term and often unusual storage problems associated with military stores.
- The tendency for new materials and the design of novel equipments to be introduced and tested under Service conditions.

These quality requirements may be unusual in the high degree of precision and in the high standard of conformity with specification demanded because of the serious consequences which can otherwise result. Perhaps at times this degree of conformity and the precision demanded may not be economic by ordinary commercial standards. However, the consequences of the failure of a quite minor and relatively inexpensive part in some wartime circumstances are quite incalculable and indeed could well prove disastrous.

The packing and identification of military stores, again uneconomic by ordinary standards, requires special attention for obvious reasons. It is not always possible to define packaging requirements to the extent that the contractor is left in no doubt as to what the ordering authority requires. In this connection, I might say that our experience with non-military supplies sent to nations under the Colombo Plan and other external aid programmes—these supplies being in the main inspected by the Army Inspection Service—is that the packing in too many instances is inadequate. I would say also that, in this respect, some Australian exporters at least have a lot to learn and apply in order to avoid damage to the contents of containers sent overseas.

Having referred to 'quality' and to a lesser extent 'inspection' and broken the ground in respect of military stores, it is appropriate that definitions of these two terms should now be provided. 'Quality' is a comparative term. The quality of an article is a measure of its ability to perform a certain function in a particular environment. It it a blend of aptness for purpose, functional efficiency and reliability compatible with the price one is prepared to pay. In the popular market for consumer goods, an article can be described as being of 'good' quality or 'reasonable' quality or of 'poor' quality, dependening upon the scope of judgment adopted by the person making the assessment. However, in the matter of purchases for the Armed Services, as little room as possible is left for such subjective opinions.

Apart from purely commercial pattern items, or what is often referred to as 'off the shelf' items, the quality of military supplies is dictated by the requirement for the article to conform with the drawings and specifications or other standards of supply. Quality then becomes a measure of compliance with design and specifications and the process of assessing the degree of compliance is referred to as 'Inspection'. I would like to point out here that the terms Inspection and Quality Control are not synonymous, inspection being but one of the tools of total Quality Control.

The Oxford dictionary defines 'Inspection' as the 'art of looking into or examining closely'. According to this definition, one is engaged in the act of inspection throughout the day — the five senses being called upon to permit examination and assessment of all that is happening about us. However, in the broader industrial sense, an inspection is a critical examination directed to some predetermined purpose: the purpose of establishing the degree of conformance of product with specification. Inspection has existed as long as man has lived, for man has always examined the many things he has made to determine their fitness for use. Inspection as it is related to production; however, is of relatively recent origin. It is an essential ingredient of a mass production economy which brings about a need for component parts, interchangeable in assembly. The mass production of goods initiated by the advent of specialization and interchangeability in manufacture has been accompanied by profound changes in factory organization. The individual craftsman as a producer of a complete end product has been almost wholly superseded by the highly integrated factory in which the designer, process engineer, machine operator, marketing specialist and inspector are all different persons in separate organizational groups. This evolution has also been accompanied by an increased dependence of human activity on the adequacy of the quality in design and the achievement of that quality in manufacture. Modern concepts of safety, health, travel, communications and comfort are all fundamentally dependent upon quality and, in the fields of essential services such as those operated by, say, Government organizations, the achievement of quality levels consistent with efficient functioning, safety and economic cost is of paramount importance.

It was not so long ago that the achievement of quality was left to the inspector stationed somewhere on the production line and mostly at the end of the line where good work was sorted from bad by a process of 100 per cent screening inspection. Apart from the fact that it has been conclusively demonstrated that screening operations do not necessarily produce 100 per cent good articles because of human fallibility, tiredness and other factors, there is the inescapable fact that no amount of inspection can make bad work good. The accepted modern situation is that the quality of the work must be

controlled from as far back in the production cycle as possible, and virtually built into the product. Modern management recognizes that it is responsible for controlling quality at all stages of the production process from the raw material to the finished article. Thus has arisen the modern concept of Quality Control as a management function whereby control of the quality of raw or produced material is exercised for the purpose of ensuring uniformity within known limits of the produced article.

Notwithstanding the exercise of the Quality Control function by management, customers such as the Defence Services must have an assurance that previously established quality level requirements are, in fact, being met and maintained by the Quality Control function. In fact, there is a statutory requirement for all Commonwealth Departments which is presented in Section 34 (5) of the Audit Act 1901-1965 and implemented by Treasury Form 12 which specifies that public expenditure must be supported by a prior certificate by an authorized departmental officer testifying *inter alia* to the 'faithful performance of services charged'.

The Armed Services do not have complete freedom in selecting the individuals or firms with whom or with which orders will be placed because of Government requirements governing the award of contracts to tenderers. Certain contractors produce marginal products; that is, supplies that only barely meet requirements. In such instances, Government inspection is indeed necessary, since the production can easily fall below the level of acceptable quality. Sometimes the low bidder awarded the contract hopefully expects that slight modifications to his commercial production will meet defence specifications requirements, but it is often a forlorn hope; quite often he does not even have measuring and/or test equipment of sufficient accuracy to know himself whether his product meets specification requirements. Thorough Government inspection is especially needed in such cases, both for the protection of the using Service and to prevent unfair discrimination against concerns which tender with the intention of supplying a satisfactory product and a knowledge of their ability to do so.

Having regard to the situations mentioned—the rather unique characteristics of military stores and the problems of quality and inspection involved—it is quite realistic for the Armed Services to exercise a Quality Assurance function in the matter of purchasing their supplies. They do so through their own inspection organizations, comprising professional and non-professional staff with appropriate professional or trade qualifications, training and experience. Quality Assurance is obtained by a process of surveillance of production processes, of monitoring essential production services and records and of verifying product quality at selected stages of manufacture.

The concept of Government inspection being concerned almost entirely with the rejection of supplies which do not conform to specified requirements by a process of screening the end product and sorting 'goods' from 'bads' has little foundation in the modern philosophy of Government inspection. Where formerly Government inspection proceeded almost entirely without regard to the contractor's inspection system and indeed might well duplicate it, today enlightened Government inspection tends to acknowledge contractor quality control and adjusts the nature and extent of its operations according to the degree of satisfaction and confidence the Government inspection authority finds in the methods and results of the contractor's total quality control system. The Department of Air, for example, has for some time now adopted the United Kingdom policy towards the aircraft industry of taking full cognizance of the contractor's quality control by a system of 'approved firms'—departmental approval being given to the firm's inspection system comprising organization, personnel, methods, test equipment and recording activities.

Since 1960, Army policy as regards inspection has been based on two axioms, namely:

- Responsibility rests on contractors for controlling product quality and for offering to the Army Inspection Service for acceptance only those items or lots of items considered by them to conform to contract requirements.
- Responsibility rests upon the Army Inspection Service for determining that contract requirements have been complied with prior to the acceptance of the product.

It can be said that, in general, Navy gives some cognizance to such a policy.

The standard inspection conditions in the familiar Department of Supply contract Form 'A' are quite inadequate to give effect to the Army policy on inspection. Accordingly, Army has introduced appropriate inspection conditions and requirements which are now mandatory contract requirements where the supply of equipment to the Army is concerned. These are spelled out in Inspection Specification No. C1—an official Department of Supply form and in Army (Aust) Specification No. 448. Any manufacturer engaged or contemplating engaging in contracts for supply to the Armed Services is strongly recommended to become familiar with the requirements of these two specifications. Army (Aust) Specification No. 448 is more demanding than Inspection Specification No. C1 which is in far more general use. However, both specifications require suppliers to perform or arrange for performance of examinations and tests set forth in the relevant product specifications so as to substantiate conformance of supplies to the relevant specification requirements. In those instances where suppliers cannot reasonably be expected to perform

tests, these will be performed by the Inspection Service but, in general, contractors are required to have available adequate test facilities or to make arrangements for the utilization of suitable test facilities such as those which are registered with the National Association of Testing Authorities. The inspection conditions permit the Inspecting Officer to use statistical sampling methods to assess quality levels, to waive inspection or defer inspection as the circumstances dictate. Whilst the inspection conditions may confer great power on the Inspecting Officer, the Army has no intention of departing from the principle that contractors remain autonomous in the conduct of their affairs. The prime purpose of its policy in respect of quality assurance is to encourage—indeed, make it mandatory for—a contractor to maintain an effective quality control system planned and developed in conjunction with his other planning functions and based on considerations of complexity of design, interchangeability, quantity under procurement, reliability requirements, manufacturing techniques and the standard of performance of his sub-contractors. In this way, he will have an acceptable quality control system which can assure compliance with contract specification with a minimum of Government inspection surveillance and verification procedures. Not only will this satisfy the Army inspection but, because of the continuous feedback of information associated with the monitoring, surveillance and verification activities, there will be constructive efforts directed towards the prevention of defects, the detection of unsatisfactory trends, the conservation of material, manpower and equipment and the pooling of quality data for utilization in design, maintenance, production and supply management. From the national viewpoint this means purely and simply an increase in national productivity which is the effectiveness of the human and material effort required to produce goods and services, and, after all, is this not the goal that all should be aiming for?

It would not be possible in this paper to provide detailed descriptions of the quality control techniques which may be adopted by a contractor and approved by the Defence Inspection authority. It would, however, be appropriate to mention some basic characteristics of the type of quality control system likely to meet the approval of the Inspection authority. These are as follows:

- *The inspection organization must be independent.* It must not be subject to pressures from production supervision to the extent that it cannot demand corrective actions from production to improve quality if and when necessary. Where a production supervisor is responsible for measuring the quality of material, as well as direct supervision of its production with no independent review by others to determine when corrective action is necessary, the system is not acceptable. Where operators are responsible for

inspecting their own product and there is an independent organization which performs inspection on the final product, the system is acceptable.

- *The creation of inspection points.* The amount and frequency of producer inspection performed must be such as to offer a fully effective and timely control over production quality.
- *There must be provision for feedback of data.* Effective feedback systems are those in which the results of inspection and other quality control functions are analysed, fed back to the responsible production authority and used as a basis for corrective action in production.
- *Record keeping.* Records must be maintained of inspection results and follow-up action taken as a result of inspections. The maintenance of satisfactory records with adequate notation of nature, frequency, cause, correction, etc of defects is indeed an essential requirement of an acceptable quality control system.
- *Stores Control.* There must be effective control over and assessment of the quality of incoming materials, whether raw or semi-finished, of components and assemblies and other sub-contracted supplies. There must be effective segregation of acceptable supplies, unacceptable supplies and supplies awaiting final assessment.
- *Measuring and Test Equipment.* This must be adequately maintained and calibrated by approved authorities at appropriate periods.

The above characteristics appear to have an engineering bias but, although sketchily presented, are equally applicable to any manufacturing activity.

A study of Army (Aust) Specification No. 448, which incidentally is applied on a somewhat selective basis to contracts involving the production of supplies which have a significant military specification content as distinct from substantially commercial items, will give a rather good insight into what is expected of an acceptable inspection system. In it will be found requirements covering basic responsibilities of inspection and testing, of treatment of non-conforming materials, of sub contractor inspection, of statistical assessment and the general administration of the Inspection part of the contract.

The popular conception of quality sought by the Defence Services is one of expensive quality in a product which will last for ever without attention. This is wrong except perhaps where the level of quality demanded relates to safety of personnel or other exceptional characteristics. Quality from the manufacturer's viewpoint means 'right first time and right for the job'—in short, value for money. From the Army point of view, quality means conformance to specifi-

cation and, in applying statistical methods to quality assessment, the Army Inspection Service shows that it does not insist on absolute perfection. Indeed, the whole basis of statistical sampling recognizes that there is a degree of risk involved and that, from the customer's viewpoint, a certain percentage of defects or defectives can be tolerated, having regard to the nature and implications of the defects. There is every reason to believe that modern Australian Defence specifications indicate a practical and realistic attitude towards quality, that there are few unnecessary refinements and little insistence on unnecessary standards of precision, even though many manufacturers, because of their limited experience of the nature, production and inspection of military equipment, may think so.

The role of the Government Inspecting Officer, in assuring the quality of supplies for the Armed Services, is a rather unique one. It is he who so often has to interpret the requirements of drawings and specifications to the manufacturers, to assess departures from such requirements having regard to safety, functioning, interchangeability etc, to assess workmanship and to judge what is submitted in 'good trade practice'. Apart from his professional or trade skill, he must have the ability to co-operate with all types of contractors, to be tactful yet firm, to handle difficult situations objectively and fairly, to help and guide contractors, and generally to reconcile properly the interests of designer, user, contractor and inspector.

The Defence Services in Australia are fulfilling an important role in fostering an awareness of quality control in this country and in motivating manufacturers to adopt acceptable quality control methods. This is beneficial not only to the Defence Services but to the country as a whole and is indeed vital to the welfare of Australian manufacturing industry. The status and importance of Inspection, or as it is becoming widely referred to—Inspection Engineering or Engineering Inspection—has been considerably enhanced in Australia and overseas since World War II. Advancements in technology have been so rapid and on such a wide front that Engineering Inspection has been able to advance from the position of a useful aid to manufacturing industry to a distinct technology in its own right—a technology based on the fundamental sciences which it applies to the particular type of problems with which it is in the province of the Inspector to deal. It is interesting to note that, in January of this year, the Commonwealth Public Service virtually recognized the quality control—quality assurance field as encompassing a distinct occupational category and an appropriate Arbitration Determination now provides uniformity of employment classifications in this field throughout the Defence Services. The forward thinking of the Defence Services inspectorates is reflected in the increasing activities of such quality minded organizations as the Australian branches of the Institution of Engineering Inspection (UK), the introduction of special courses of study in

inspection at the Sydney and Melbourne Institutes of Technology and the generally increased attention being paid by enlightened top management to the subject of quality in production.

An American author once said, 'Everybody is talking about the weather but nobody is doing anything about it'. Well, everybody it appears is talking about 'quality' and at least the Army is doing something about it. With clear cut specifications which are aimed to seek no higher quality in technical requirements than that necessary to accomplish the military mission, with well-defined inspection and testing requirements and conditions and with an insistent demand that quality control responsibilities must be accepted and discharged by contractors, we feel that we are making 'quality' everybody's business. In this role, the Army offers complete co-operation to every contractor. □

A story was told about 'Hunter Bunter' (General Hunter-Weston) when he inspected a detachment of British soldiers who had been posted on the sea front on the extreme left of the allied line. He paused in front of the last soldier nearest the sea and rather pompously remarked: 'Do you realize, my man, that you occupy a most significant post? You are the left hand man of the left hand platoon of the left hand company of the left hand battalion of the left hand division of the British Army! A most unique position, indeed, indeed!' As the general left the soldier stood gazing after him with an imbecile look on his face. Just then his sergeant came up and said. 'Ere you! Go on filling them sand-bags and never mind about your unique position and it ain't such a posh position neither. If Duggie 'Aig was to give the Army the command "Right wheel" you'd be running like 'ell at the double for the rest of your bleeding life!'

For my grandchildren — Reminiscences of Her Royal Highness Princess Alice, Countess of Athlone. (1966)

AMF Gold Medal and ASCO Prize Essay Competition

THE conditions governing the AMF Gold Medal and ASCO Prize Essay have been revised, and will apply to the 1967 competition. The main changes provide for the division of the competition into two sections: a Senior section for officers, and a Junior section for other ranks. Also competitors may select any subject of a military nature as the theme of their essay.

The revised conditions are set out below.

Eligibility to Compete

Officers and other ranks of the active and reserve lists of the Australian Military Forces are eligible to enter the competition.

Subject

Competitors may select their own subject of a military nature.

Sections

There will be two sections:

(*a*) Senior — for officers;
(*b*) Junior — for other ranks.

Prizes

The AMF Gold Medal and $100 will be awarded to the better of the winning essays from each section provided it is of a sufficiently high standard.

$50 will be awarded for the best essay in each section provided it is of a sufficiently high standard. In the case of two or more essays of equal merit from the same section, this prize money may be shared.

Submission of Essays

(*a*) Essays are to be typewritten and submitted in quadruplicate. Units are to provide typing assistance where so requested.
(*b*) Length of essays is to be between 3,000 and 5,000 words.

(*c*) Authorship is to be strictly anonymous. Each competitor is to adopt a motto and enclose with his essay a sealed envelope with the motto and section identification typewritten on the outside and his name and unit address inside.

(*d*) The title and page number of any published or unpublished work to which reference is made in the essay must be quoted.

(*e*) Essays are to be addressed to the Secretary of the Military Board, Army Headquarters, Canberra, ACT. The envelope is to be marked 'AMF Gold Medal and ASCO prize Essay'.

Judging

Essays will be judged by at least three referees appointed by the Chief of the General Staff.

The decision of the referees will be final. They are empowered to recommend that the AMF Gold Medal Essay and the ASCO Prize of $100 be not awarded if, in their opinion, no essay submitted is of a sufficiently high standard.

A prize of less than $50 may be awarded to the winning essay in either section if, in the opinion of the referees, the standard of the essay does not warrant the award of the full amount.

Promulgation of Results

The results of the competition will be promulgated in AAOs and in a notice to AROs for display on unit notice boards.

Closing Date for 1967 Competition

The closing date for the 1967 competition is 31 March 1968 and results will be announced by 30 June 1968. □

The Indian Army

Major L. A. Wright,
Royal Australian Engineers

Introduction

INDIA, with its rapidly increasing population of over 500 million people, is the world's largest democracy. As such, it is an exception in an area where military dictatorships or communism are the rule.

In the short time since its creation India has fought against its neighbours, Pakistan and China, and used force of arms to settle the Goa question and maintain its presence in Kashmir.

Plagued by a stagnant economy and the spectre of starvation, ringed by hostile nations or weak minor states and served by long, vulnerable sea communications the defence of India is no easy matter.

The purpose of this article is to outline the manner in which India's defence forces have been organized to meet this task, with particular emphasis on the Army.

Brief History

The histories of the warrior castes and private armies of India are a fascinating study in themselves. In the context of this article it will suffice to recall that the present national army had its beginnings in the watch parties raised by the East India Company to guard its trading posts. As the Company's interests developed it formed an army in each Presidency, using mainly troops to subjugate the independent rulers.

After the mutiny in 1857 these private armies were amalgamated into an Indian Army and control was exercised by the British Army rather than the Company.

The Indian Army made a considerable contribution in both World Wars and its volunteer soldiers served in most theatres. In the Middle East, in Burma, and elsewhere, it proved that, properly trained and led, its units were the equal of any.

Major Wright graduated from OCS in 1952 and was allotted to the RAE. He has since served with a variety of engineer units, including 11 Independent Field Squadron RE (BCFESR) as a troop commander, and as second-in-command of 17 Construction Squadron from 1961 to 1964 (including six months in New Guinea).

Major Wright is at present posted as SORE 2 (Int), HQ FARELF, Singapore.

In 1947, the Indian Army was divided between the new nations of India and Pakistan in the approximate proportions of two-thirds to India and one-third to Pakistan (except for the Gurkha regiments of which India received six, the other three remaining in the British Army). This division was a traumatic experience as it divided regiments and, occasionally, families, many erstwhile comrades finding themselves in opposing and increasingly hostile camps.

The years from 1947 to 1962 were difficult ones. The policies of non-violence and non-alignment gave no encouragement to maintaining strong defence forces. British officers were bundled out with indecent haste to the detriment of the general standard of administration and training and it required great dedication on the part of the remaining professional officers to maintain the traditions and standards of the Army. Participation in UN activities in Korea, Palestine and the Congo, the operation against Goa and the struggle for Kashmir all gave some opportunity for training but these were, at best, minor commitments.

The year 1962 and the Chinese attacks showed the failure of India's politicians, the years of neglect of the Army being tragically highlighted by the severe reversals suffered by the Indian forces. The resultant political and military upheaval gave authority and purpose to the expansion and re-organization of the Army. The defeat inflicted on the Pakistan forces in 1965 was satisfactory proof that this was successfully executed.

But the success of the operations against Pakistan still cannot conceal deficiencies in the organization and equipment of the Indian Army and its ability to fight a protracted campaign against a major aggressor must still be considered doubtful.

The Army Today

The Indian Army is a force of almost one million officers and men, making it one of the largest in the world. Its organization reflects its British parentage and the field formations are based on a triangular structure.

The basic formation is the infantry division which may be organized and equipped for plains or mountain warfare. There are some twenty-seven divisions of which six are organized for mountain warfare. In addition there is one armoured division and two independent armoured brigades.

There is little doubt that, at present, India is seriously deficient in armoured formations and that the infantry division is too road-bound and immobile for plains warfare.

Personnel

India is, in effect, comprised of many nations with varying languages, customs and religions. The problem of integrating such diverse peoples into common units has been avoided by adopting a regimental system. The regiment is recruited from a particular ethnic group and the soldiers are trained, administered and posted by their regiment. Recruits undergo some forty-four weeks of training, including instruction in Hindi, the language of the other ranks.

Officers are trained centrally at the National Defence Academy (NDA) or the Indian Military Academy (IMA) which correspond roughly with RMC or OCS in length of course and curriculum. On graduation officers are allocated to regiments, not necessarily ethnically, and are administered by the Military Secretary. The most interesting feature of officer-training is its tri-Service nature. Cadets are trained at the NDA for all Services and this common background makes inter-Service co-operation much easier to achieve. The Defence Services Staff College is also tri-Service in nature.

Promotion in the Army is by examination and time, and the rate of progress is equivalent to that in the Australian Army. Retiring ages are slightly lower, e.g forty-five years of age for a major. The rapid expansion of the army and the shortage of officers has meant that acting rank is often granted, particularly in mountain formations, and many officers are being retained after the normal retiring age has been reached.

Conditions of service vary a great deal; the sixty days accumulated recreation leave each year must be set against six years in nine (at least) in a non-family station to gain a proper perspective. Pay is low by our standards but high in comparison with the salary scales in other forms of Government and private employment.

There is a general shortage of suitable officer candidates and the general calibre of officers is apparently declining. As other opportunities for the suitable young man increase in the coming years, recruiting, particularly for the technical corps, is likely to lag and the standard to fall even more.

Recruiting for other ranks presents no problems and ceilings are maintained from voluntary enlistment.

Equipment

Though India has been able to solve its manpower problems satisfactorily it still faces serious problems in providing sufficient modern equipment for its armed forces. Shortage of foreign exchange, non-alignment and a developing economy have made it dependent on its own limited resources and international charity. The outcome is an

inventory of equipment of varied parentage and limited compatibility that raises staggering problems in training and servicing.

Realizing this, India has established an Institute of Armament Technology to carry out research and to develop new weapons and equipment. The 'lead time' for such development, even in countries more advanced technologically than India, means that the fruits of this programme will not be harvested in full for many years and India will remain dependent on outside help for sophisticated weaponry.

The current situation in respect of major items is:

Armoured Fighting Vehicles

The main battle tank is still the Centurion which achieved surprising success against the Pattons of Pakistan in 1965. It will be replaced by the locally produced Vijayanta, which mounts a 105-mm gun and is claimed to have a higher speed and better cross-country performance than the Centurion.

Some T54 and T55 tanks have been obtained to replace the ancient Shermans still in service, and the PT 76 is being used on the East Pakistan border.

Divisional regiments of the standard infantry division are equipped with AMX-13 tanks.

The Indian Army has no APCs, a serious deficiency for units employed on the Pakistan front. As an interim measure some ancient Stuart tanks have been converted into APCs but the long-term answer must come from foreign aid or local development.

Artillery

The plains divisions are equipped with 25-pounder guns and the armoured divisions with 25-pounder Sexton SP guns.

Mountain divisions are nominally equipped with the locally produced 75/24-mm Pack/How, but in fact a variety of weapons are still to be found, including 75-mm mountain guns and old British 3.7-inch mountain guns.

Some heavy artillery of Russian origin is now coming into service.

Infantry Weapons

Rifles and LMGs have been standardized to .30 calibre and are locally produced. Supporting weapons include 81-mm mortars, .30 Browning MGs and 106-mm RCLs (57-mm RCLs in the mountain divisions).

Missiles and Aircraft

No missiles have been introduced yet and there is no Army aviation. Helicopters are still a comparative rarity.

Other Services

Although this article deals primarily with the Indian Army a brief survey of the equipment used by the other Services should prove of interest.

The Indian Navy

The Navy is about the same size as the RAN with one light fleet carrier, two six-inch gun cruisers and a number of destroyers and frigates. One of the cruisers, INS *Delhi,* won fame during World War II as HMS *Achilles.* The Indian Government has undertaken the construction of Leander-class frigates in Bombay but the first ship will not be commissioned until 1971.

The Indian Air Force

Fighting aircraft in service include Gnats, Hunters, Mysteres and Canberras. Production has begun of MIG-21s and a locally-designed aircraft, the HF-24, may be brought into service although tests have apparently been disappointing.

Transport and maritime aircraft include Dakotas, Avre 748s, Caribous, IL14, Packets, Constellation and Liberators.

The air defence system now includes SAMs of Russian origin.

Conclusion

India possesses a numerically strong army with considerable expertise in operating in the high altitudes of the Himalayas. It still suffers from equipment and other deficiencies that would seriously impair its ability to fight a prolonged war, particularly on the plains.

The present political situation has meant that India, although a democracy and a member of the British Commonwealth, has been the recipient of increasing amounts of Russian aid, such aid having been refused by the United Kingdom and the United States of America following the 1965 conflict with Pakistan.

The long-term effects of this cannot be foreseen but India's concerns are with China and Pakistan and she is not capable of defeating this alliance without outside help. The amount of help she could expect from Russia in the event of war with China is a question that is not considered here.

It is, however, unfortunate that the sizeable army of democratic India is not aligned with other democratic powers against the encroachment of Chinese communism in South-East Asia. Such an alignment would probably help solve the impasse outlined above and give India more forceful place in world affairs. □

Sub-Machine Guns

Captain A. Parker,
Royal Australian Infantry

THE history of the sub-machine-gun in the Australian Army is relatively brief, dating back to the dark days of 1942, when the Japanese invaded New Guinea and threatened the Australian continent. In Europe its history extends over 50 years. Most countries at some time have tried to improve the firer's ability to hold a pistol accurately by the addition of a shoulder stock, and this reached its ultimate in the Luger 8" barrelled artillery carbine. This could be said to be the forerunner of our SMG's as it recognized a need for a weapon lighter and handier than the military rifle, but more accurate than the pistol.

The main combatants entered World War I with three basic infantry weapons: a bolt-action rifle, a pistol, and a medium machine-gun of the belt-fed, water-cooled type. Soon trench warfare presented two main problems. First the need to cross a no-man's-land dominated by barbed wire and machine-guns, and second a means of clearing the labryinth of trenches once a breach was established. The need for a close-range assault weapon had arisen.

The British answer was to sharpen their bayonets and introduce the Mills bomb and Lewis gun. The Germans looked to their Luger, tried a 32-shot snail magazine but decided this was not the answer. In 1918 they produced the Bergmann Muskete, designed by Hugo Schmeisser, the first of the blowback SMGs as we know them today, but a heavy and awkward weapon using the snail magazine of the Luger. It was developed considerably between the two World Wars and later became the Schmeisser of World War II.

The Americans experimented with their .45 Colt automatic, tried long barrels, increased-capacity magazines, shoulder stocks and full automatic change levers, but still were not satisfied. Next the Browning automatic rifle (BAR) appeared and gave valuable service until long after Korea. Shotguns were tried with mixed results.

Next was an ingenious contraption known as the Pedersen device. This was designed to turn each Springfield rifle into an automatic assault rifle. The bolt was replaced by a blowback device and .30

Captain Parker is a CMF officer and a school teacher by profession. He served in the ranks of the CMF from 1948 with the 30, 17/18 and 2 Bns and with the 15 Northern Rivers Lancers. He was commissioned in 1956 when serving with 2 Bn, and was OC 'A' Coy and captain of the regimental rifle club when the 1960 reorganization closed the depot. Since then his appointments have been with 2 RNSWR and 1 RNSWR (Cdo). He is currently IO with 1 RNSWR at Newcastle.

calibre rimless ammunition similar to but longer than .32 automatic pistol ammunition was fed from a magazine on top of the rifle. These were produced too late for war service and were then scrapped. It was, however, a most interesting and ingenious approach to the problem of producing close-range automatic fire.

Between the Wars

There were only three noteworthy developments between the two World Wars, although many European countries experimented.

In 1928 the Thompson sub-machine-gun—the 'Tommy' gun of the gangster era—appeared. It was an American commercial development and excited little interest in the armed forces. It was carefully machined but very heavy. It fired the .45 ACP round which had great stopping power but limited range and, except by American Marines in the 'Banana Wars' of Central America, was little used.

In their search for new and better weapons for their expanding armies the Germans developed the 9-mm Schmeisser in various forms, including a version designed for parachute troops but later used universally in the German Army. This weapon set new standards of SMG efficiency, was sighted to 200 metres and, with its special high-powered SMG ammunition, was most reliable.

The Finns developed the 9-mm Suomi, an improvement of the Bergmann. Unusual features were the bipod for use in the prone position, a long barrel and sights graduated to 300 metres. When the Russians invaded Finland in 1939 their greatest shock was the number of casualties inflicted by skilled Finnish infantry using this weapon in a mobile harassing role.

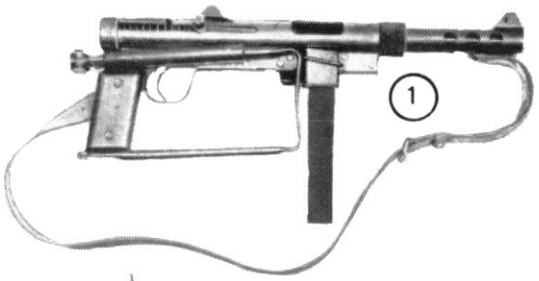
World War II Developments

The British Staff appear to have overlooked the widespread use of SMGs in the Spanish Civil War where their usefulness was unquestioned. World War II began with Britain regarding the SMG as a gangster's weapon; definitely not for gentlemen! Kipling may have had a few thoughts on that.

After Dunkirk there was a scramble for weapons, the attitude was reversed, and the Tommy gun was made part of the standard equipment of the infantryman. When Churchill formed the Commandos and commenced the small raids on the French coast only 40 Tommy guns were available in England. These had to be issued for each raid and returned to store after cleaning. The paper-work must have been immense.

The result of a crash-development programme was the Sten, a Buck Rogers-looking affair, which underwent many changes. Ammuni-

1.
The Carl Gustav (Sweden) 9mm with stock folded. Note safety slot for cocking handle.



2 & 3.
The Sterling Mk 4 9mm (Britain) with stock folded and extended, showing the bayonet fitting.

4 & 5.
Beretta (Italy) 9mm with stock folded and extended Note cocking handle and hooded foresight.

tion of 9-mm calibre was chosen because captured stocks were held and could be used. The ultimate was the Mark V, designed as an initial jump weapon for parachute troops. The three basic components, body, butt and magazine, could be carried across the chest in the X-type parachute harness to provide the soldier with a weapon while searching for the heavy weapons containers. It had marked improvements in the form of a rifle-type butt, and increased sight radius was achieved by placing the foresight at the end of the muzzle, using the blade from a No. 4 rifle, which allowed precise zeroing. Special 9-mm ammunition, heavily loaded to give a velocity of 1,425 fps, placed a weapon, effective to 200 yards, into the hands of airborne divisions and proved itself at Arnhem. It served in many trouble-spots in post-war years.

The Germans had a most efficient weapon in the Schmeisser. They stuck to it right through the World War II, a testimonial to its efficiency.

The Americans used the Thompson, simplified it, manufactured over two million weapons and then commenced making the M3 'Greasegun' to supplement production. A 9-mm conversion unit was designed for the Allied Services but saw little use. Even today Americans have not considered converting to 9-mm, leaning towards the .223 Armalite instead.

The Russians were so impressed by their experience of the Finnish Suomi that they immediately started to produce one of their own. This was the PPSH 41, firing the 7.63-mm Mauser pistol cartridge, so popular in their country. Copies of the improved version of this weapon, the PPSH 43, made in China as model 50, was the weapon most commonly encountered in Korea and it is still being brought along the Ho Chi Minh Trail today. It is probably the most widely manufactured SMG in the world. An interesting Russian development was the cutting of the old barrels in halves to make two SMG barrels. Entire Russian units were armed with this weapon which was easily manufactured in numerous small workshops. Used with the 71-round drum-magazine for assault fire in human wave tactics it gave the Germans in World War II many problems. In Korea a skirmish line armed with these weapons, advancing from cover to cover and sweeping the defenders' parapets with long bursts, was a force to be feared.

This weapon was in the hands of the Viet Minh assault troops at Dien Bien Phu and is still widely used by the Viet Cong today. A recent letter from South Vietnam told of how a long burst from one of these weapons knocked out a 3-man Australian gun group waiting in an ambush position, killing one and wounding two. It is, indeed, of efficient design.

The war in the Pacific brought home to Australia the need for a light automatic for close jungle fighting. Thompsons were used initially but gun and ammunition were heavy.

The Owen sub-machine-gun, which had so much publicity in the early part of World War II, was first brought to the notice of the Australian Army in July 1939, when its inventor, Evelyn Owen, interviewed a workshops ordnance officer at Victoria Barracks, Sydney. After the .22-inch calibre model which Owen produced had been examined and Owen had explained that this calibre had been adopted only for convenience and that the gun could be readily adapted to larger calibres, he was told that the Army was not greatly interested.*

This attitude was not really surprising. At the outbreak of war the only known examples of SMGs in Australia were a war trophy in the Small Arms School at Randwick—the original Bergmann machine pistol of the German Army of 1917—and a Schmeisser, the later development of the same weapon, which had been seized by the Customs in Sydney from the luggage of a German passenger and was held by the NSW police. Early in 1940 the Chief Instructor of of the Small Arms School, Captain E. W. Latchford, also contrived to buy for the Defence Department an American Thompson gun from a planter in the Solomon Islands, and this was used for instructional purposes. This roughly appears to have been the extent of the experience which the army was able to call on when asked to assess the value of the Owen gun. No small-arms of any kind had ever been developed in Australia.

For a year after Owen had made his first approach to the army authorities, nothing further was done about his invention. Despairing of making further progress with it, Owen joined the AIF, and in September 1940 was on final leave before embarkation for the Middle East. In a final attempt to enlist interest, he placed a working model of his gun in a sugar bag which he left anonymously outside the flat of Mr V. A. Wardell, Manager of Lysaghts Works Pty Ltd, Port Kembla. Wardell, who discovered that the owner of the gun was a neighbour, quickly realized that such a gun, if it were shown to be of military value, could be rapidly produced in large quantities. He took the matter up with Mr. Essington Lewis, Chief General Manager of B.H.P., and recently appointed Director-General of Munitions, who promptly sent Owen to see Captain C. M. Dyer, Secretary of the Army Inventions Board in Melbourne.

Dyer was much impressed with the possibilities of Owen's invention, and, though discouraged by some of his immediate superiors who knew that there were prospects of a similar weapon being

* This account of the early vicissitudes of the Owen has been drawn from D. P. Mellor, *The Role of Science and Industry* (1958), a volume of the Australian official history.

produced in Britain in the near future, did all he could to arrange for an early testing of the gun. Unfortunately, by now the army's peacetime machinery for the reception and assessment of inventions had lost its efficiency, owing to dilution of staffs by officers unfamiliar with the correct procedures, and also to the pressure of a large number of inventions stimulated by the war. Dyer decided that it would be expedient to arrange privately and unofficially through Lysaghts for the construction of further models of guns. Owen obtained duty leave and within three weeks, with the collaboration of Mr. G. S. Wardell, a brother of V. A. Wardell, completed a .32-inch (8.1-mm) calibre test model in January 1941; two months later a second model of .45-inch (11.4-mm) calibre was completed. Firing trials carried out in April on the .32-calibre model having proved reasonably successful, Wardell wrote to the Master-General of the Ordnance, Major-General Milford, and after some delay a meeting took place in Melbourne between Colonel L. E. S. Barker, Director of Artillery at AHQ, Colonel G. H. Adams, Assistant Director, Captain Dyer and Private Owen. By this time, however, although the Army had come round to the view that it did need sub-machine-guns, it considered that it did not need Owen's.

At the meeting Owen learned for the first time that the major obstacle to the development of his gun was that British Army experts, with far more experience than was available in Australia, were producing a sub-machine-gun that had already been given 12 months testing and had proved an acceptable weapon. This was the Sten gun, mentioned earlier, a version of the German Schmeisser. A number of Sten guns together with full drawings and all manufacturing details were expected to arrive in Australia before the end of 1941. In the belief that the Sten would prove to be a well-finished gun of high quality similar to other types in current use, the army was prepared to wait for it.

At this stage Lysaghts, of their own initiative, had done all the technical and developmental work on the Owen, and on the strength of the preliminary trials were convinced that the gun had possibilities and could be manufactured by them. Owen was paid a salary and it was agreed that he would receive any royalties from the gun which had by now been patented.

There were, however, extraordinary obstacles in the way of testing the gun properly, owing to almost endless confusion over the calibre required and over obtaining suitable ammunition. Eventually 9-mm calibre was decided upon and the manufacture of ammunition in Australia began. The Army, however, was very slow in giving a lead, being more inclined to await the development of the Sten gun. Impatience with the delays in reaching a decision

provoked questions in Parliament and comment in the press, and the Owen gun rapidly became a subject of controversy in the political world.

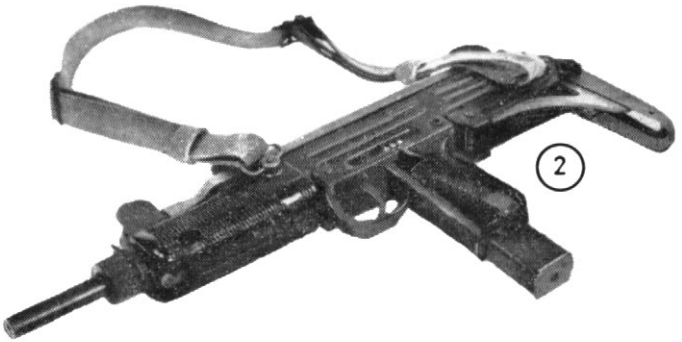
The Government then took an unprecedented and quite unorthodox step. It decided to take the matter out of the army's hands by placing an order for 100 Owen guns. This was a denial of the fundamental principle that the army should decide its own needs, and the army did not submit patiently to the overriding of its prerogative. The Military Board suggested that the order should not be placed, but that further trials should be made. The Minister for the Army, however, was adamant: the order stood and extensive trials on some of the first 100 Owen guns in both .45-inch and 9-mm calibres were carried out.

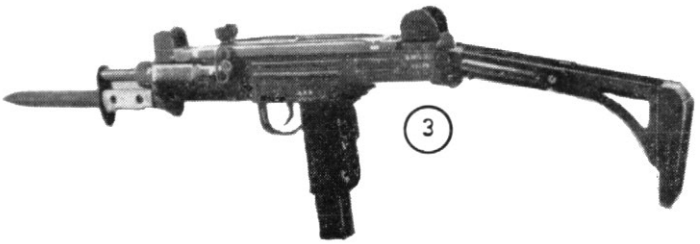
This time the performance of the Owen was thoroughly tested and compared with that of the Thompson and the imported Sten. Generally the Owen performed very well, and under extreme conditions—such as after being immersed in mud and water—much better than the other two. It gave definite promise of being a suitable and efficient weapon. On the strength of the trials the Minister for the Army increased the order from 100 to 2,000.

The troubles of the Owen gun, however, were by no means over. Production was held up not only by difficulty in securing the necessary machine tools but also by protracted arguments concerning modifications of design suggested by the Directorate of Ordnance Production. Before general agreement was finally reached Lysaghts had had to put about 70 requests for minor changes of design through the usual channels for the approval of the army and the Ordnance Production Directorate.

While Lysaghts were thus struggling to get the Owen gun into production the army had prudently placed an order for the local manufacture of 20,000 Sten guns. On making a detailed analysis of the requirements for manufacturing the gun, however, the Directorate of Ordnance Production discovered that the Sten was not in the advanced stage of development anticipated and that, in England, it had rapidly undergone changes and reached a Mark III model. The gun itself at that stage was by customary standards for small arms extremely crude, having been designed for quantity rather than quality. Fortunately, Die Casters Ltd of Melbourne, the Australian contractors to whom the gun had been assigned, had, through the drive and enthusiasm of their technical manager, Mr. R. W. Newton, developed the technique of diecasting to a high degree of efficiency, and by applying it to the Sten—or Austen as the Australian version was called—were able to attain a fast rate of production. Indeed the company claimed that the Austen could be produced in six hours and a half as compared with 37 man hours for the Sten.

1.
Star (Spain) 9mm with stock in folded position. Note cocking handle folded above magazine and double notched trigger, top half being for fully automatic fire.





2, 3 & 4.

Uzi (Israel) 9mm with stock folded and extended. Note pistol grip under the bolt movement. Number 4 shows the optional wooden butt and light attachment, the light being actuated by the trigger on the front pistol grip, an integral part of this attachment, the whole being attached to the bayonet clip.

The Austen was so designed that it could be taken to pieces and reassembled in 15 seconds, a feature by which the army set great store. Newton reintroduced into the design certain features of the Schmeisser which the designers of the Sten had rejected. His application of the die-casting technique represented a definite advance in manufacture. So also did several novel features which he added.

The ingenuity displayed by the manufacturers of the Austen and the Owen gained for Australia a notable reputation for its work on sub-machine-guns. Wartime figures for the output of sub-machine-guns were:

Owen Marks I and II	Lysaghts Pty. Ltd., Port Kembla,	45,477
Austen, Mks I and II	Die Casters Ltd., Vic., and W. T. Carmichael Ltd, N.S.W.	19,904

Soldiers who used both Austen and Owen guns in the South-West Pacific were, it appears, in favour of the Owen. In Latchford's view the handiness of the Owen put it out in front. It still had one or two minor defects when first used in New Guinea—reports on operations in the Aitape-Wewak Campaign mention defects arising from the design of the safety catch—but on the whole the Owen was the more reliable of the two guns in that after immersion in mud and slush it could still be relied on to fire. The Austen could not. The lighter 9-mm ammunition was far more popular with the troops than the .45-inch and the Owen earned a reputation for reliability due to simplicity of design, the top-mounted magazine which provided a reliable gravity feed and the bottom ejection port which removed fouling through the 'hole in the floor'. In time it became the 'forward area' weapon, and in an authoritative assessment of its qualities conducted by the Ordnance Board of Britain in December 1943, in competition with five other guns, the Owen was rated first in four of the five tests and first in over-all order of merit.

Post World War II

The period following World War II, characterized as it was by numerous small 'trouble spots' all over the world and the beginning of communist revolutionary warfare campaigns and counter 'police' actions, has been aptly described as 'the unquiet peace'. It was notable for the widespread use of SMGs when obtainable. The fact that many of these campaigns were in tropical and jungle-covered areas added to the value of SMG. Often, too, the simplicity of the weapon made it effective even in untrained hands.

The demand from both sides led to developments by many European manufacturers who strove to improve their products with a view to improved sales. As a result most of the new designs were notable for their reduced weight, compactness, accuracy, safety and reliability.

Nearly all the SMG produced by Western nations have standardized on 9-mm; but North and South America use mostly .45-inch and the communist bloc favoured 7.62-mm (Mauser pistol) before switching to the shortened 7.62-mm rifle round used in A.K. Assault Rifles and R.P.D. L.M.G.

SMG CHARACTERISTICS

World War II:

Weapon	Weight (lbs)	Over-all length (inches)	Barrel Length (inches)	Stock	Sights	Special Features
American Thompson	10.0	33.7	10.5	Detach-able	U Battle	Heavy weapon, reqd much machining
American M3A1	7.8	29.8	7.8	Tele-scoping	Fixed 100m	Bolt has recessed finger hole for cock-ing. Poor sights, short radius.
German Schmeisser	9.0	33.2	10.0	Folding	Dual Leaf U	Uses open partridge sight. U notch and hooded foresight.
British Sten Mk V	6.8	29.5	7.8	Detach-able	Fixed	No. 4 rifle-type fore-sight.
Australian Owen	10.2	32.0	9.8	Detach-able	Fixed Offset	Solid reliable weap-on. Only SMG in use in World War II with top - mounted magazine.
Russian PPS 43	7.2	35.4	10.5	Folding	Dual Leaf	Fires 7.62-mm pistol round. Extensive use of stampings. Now manufactured by China.
Current Weapons:						
Australian F1	7.6	28.0	8.0	Fixed	Fixed	Automatic fire only. Straight line stock, top-mounted mag.
British S Sterling	6.1	27.2	7.7	Folding	Dual Offset Peep 1-200m	Side-mounted maga-zine. Mag has roller platform. 34-rd mag weighs 1.6 lbs.
Danish Madsen	7.0	31.0	7.5	Folding	Fixed 100m	Receiver opens into 2 half shells for cleaning.
Swedish Carl Gustaf	7.7	31.5	8.0	Folding	Triple Peep 1-300m	Conventional design. Safety against dis-charge if dropped. Blank firing attach-ment. Indoor plastic ammunition.

Weapon	Weight (lbs)	Over-all length (inches)	Barrel length (inches)	Stock	Sights	Special Features
German Walther MP	6.6	29.5	10.3	Folding	Dual Peep + battle sight	Short (6.8" barrel) also made. Close-range battle sight. Weight of bolt rides above barrel.
Spanish Star Z62	5.8	27.5	7.8	Folding	Dual Peep	Lightest of current weapons due to alloy construction. Folding cocking handle. One trigger for both types of fire.
Italian Beretta M12	6.6	25.3	7.9	Folding	Dual Peep	Folding cocking handle. Hooded fore-sight. Grip safety. Bolt telescopes 6" of barrel.
Israeli UZI (also made by FN)	7.7	25.1	10.2	Folding or Fixed	Dual Peep	Regarded as best of current designs. Bolt telescopes 6½" of barrel. Most compact of SMG designs. Can be fired one handed due to balance.
American M16 Armalite (Cal 5.56m)	6.7	39.0	21	Fixed	Dual Peep 300-500 m.	Effective to 460m(?). Straight line stock and low recoil aids stability.

SMG Characteristics and Requirements

The SMG has now become part of the Australian Army's standard equipment and standard equipment of the armies of all European countries as well. Before looking at recent developments let us consider some of the roles in which the SMG has been employed.

Small Arms Training states that the 'SMG is a short-range weapon introduced for engaging targets at ranges up to 100 yards'. 'These weapons', it adds, 'are especially useful when on patrol or for fighting in close country, such as jungle, woods, etc., and in towns and villages'. *SAT* stresses the need for quick waist-firing, but states that when time permits the weapon should be fired from the shoulder. It also adds that the cartridge is essentially a pistol cartridge and that the weapon should not be regarded as an automatic rifle.

At present two SMGs are on issue to each infantry section, and it has become the main personal weapon of platoon commanders and specialists with other primary tasks but needing a weapon for close-range personal defence. It is a most useful weapon for scouts, where

close-range action requires a handy weapon capable of full automatic fire, and in either attack or defence its automatic fire can be a telling factor.

Today a school of thought is developing, hand in hand with increased skill in the use of the SLR, which believes that the SMG is no longer needed and only poses an ammunition problem. This school considers that as more training with close-range snap-shooting is introduced, using 'Instinctive pointing' and 'alignment shooting' aided by improved jungle ranges and the new DART systems, the SLR will be able to handle even the close-quarter role. Some consideration has even been given to replacing SMGs with Armalites. But this may be more of a reflection on the design of the present SMG and its handling characteristics than on the cartridge. Perhaps a 5-lb weapon of Armalité design, firing 9-mm ammunition and handling like a rifle, would be the answer.

It has, however, been accepted that there is a definite need for a light, handy weapon, capable of full automatic fire for close-range jungle fighting though not necessarily of full rifle power.

Small Arms Training states that 100 yards is the maximum range of the 9-mm cartridge as 'at greater distances, the speed of the bullet is so reduced that it has lost most of its ballistic efficiency'. Originally the 9-mm round was designed by the Germans for the Pistol 08, the Luger. Loaded with a 125 grain bullet and fired at a muzzle velocity of 1,040 fps, it was then a genuine pistol cartridge.

This is not true today, as it was soon found that velocity and effectiveness could be greatly increased with higher pressure loadings. German ammunition for machine pistols was loaded up to 1,500 fps, Mark 5 Sten ammunition to 1,425 and Australian wartime ammunition to 1,375 fps.

TABLE 1 9-MM BALLISTICS

Cartridge	Muzzle Velocity	Velocity	100 yds	200 yds	300 yds	Muzzle Energy
9-mm Pistol loading (125 gr bullet)	1120 fps	1115		975	872	345 fp
9-mm British CMG loading	1280	1185		1040	940	447
9-mm Aust SMG loading	1375					
.38-mm Special U.S. Police (158 gr bullet)	855					256

Today the Israeli's load their 9-mm UZI ammunition to over 1,400. Ballistically an increase in bullet weight increases striking energy in proportion. An increase in velocity quadruples striking energy. Thus these 40 to 50 per cent velocity increases have made the 9-mm a markedly more potent round.

Comparing the 9-mm round with today's standard American police cartridge, the .38 Special, which fires a 158 grain bullet at 855 fps, producing a striking energy of 256 ft lbs, it will be seen from the accompanying chart that the 9-mm round has a superior velocity at 300 yards to the .38 Special at the muzzle.

Standard criteria for the lethality of the projectile is its ability to penetrate one-inch pine-board. If it is capable of penetrating this thickness it will penetrate the equivalent of the vital area of a man's body. A glance at Table 2 will show that a 9-mm bullet will penetrate 9-inch pine at 25 yards and 7-inch pine at 200 metres. Thus, having lost only about 20 per cent of its ballistic efficiency over this range, it is still most effective.

TABLE 2. 9-MM PENETRATION

Material	25 metres	50 metres	200 metres
Loose soil	14 ins	13 ins	12 ins
Sand	10 ins	9 ins	8 ins
Pine wood	9 ins	9 ins	7 ins

The trajectory table of 9-mm shows that a soldier with a good SMG zeroed at 100 metres needs only to aim off about 2 feet to allow for drop to a 200-metre target and a European SMG with a 200-metre aperture needs only to be aimed off 18 inches to hit a 250-metre target. A 300-metre target, however, would be missed due to bullet drop.

TABLE 3. 9-MM TRAJECTORY

Range	20	50	75	100	150	200	250
Impact relative to line of sight	+1.7"	+2.2"	+1.5"	0	—6"	—20"	—38"

It is suggested, therefore, that the cartridge has ballistics that make it effective to 200 yards and can be utilized in this manner

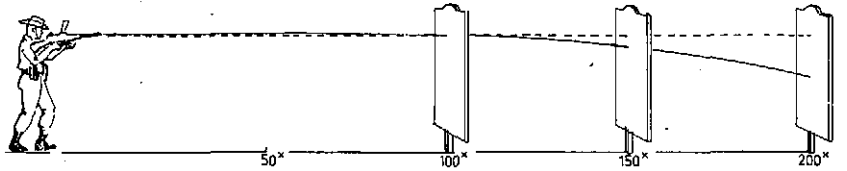


TABLE 4 9mm TRAJECTORY ZEROED 100×

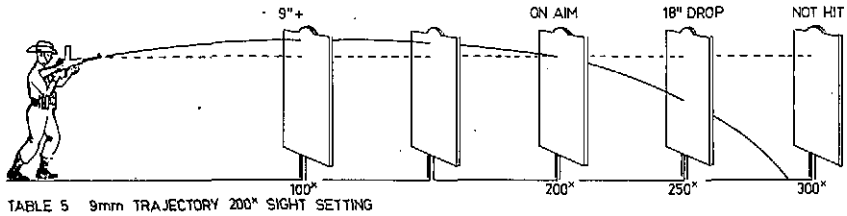


TABLE 5 9mm TRAJECTORY 200× SIGHT SETTING

when used in a suitable weapon with adjustable sights as seen in most European designs of today.

The design of the Owen and the newer F.1 with their top-mounted magazine and coarse offset sights does not allow for precise aiming when the situation offers, nor does it allow 200-metre sight setting, the answer to this criticism invariably being that the weapon is intended only for close-range work.

But why handicap the soldier with a weapon restricted in employment, where the ammunition obviously has the potential to do the job? If a target offers itself at longer ranges, between 100 and 200 metres, the soldier should be able effectively to engage it. The top-mounted magazine of the Owen, however, virtually restricts it to close-range waist firing.

Another advantage of the 9-mm cartridge is that its low recoil permits accurate burst firing, often more effective than single shots where a target is hard to pinpoint. The recoil of rifle weight with 7.62-mm weapons does not allow accurate burst firing with the present weapon design, whereas low recoil and quick recovery between shots allow placement of a very quick series of single shots with the 9-mm weapon. Accuracy is not lacking either. Using British Sterling an average marksman can achieve groups of 12 inches at 200 metres which is more than adequate against a man-sized target. At the British Small Arms School at Hythe a group of firers of mixed ability achieved an average group of 18 inches at 300 metres. Finally, the 9-mm cartridge has the advantage of weight, 34 rounds in a magazine weighing only 1 lb 10 ozs.

It must therefore be apparent that in a suitable weapon the 9-mm cartridge has adequate power for a general-purpose weapon to supplement the rifle at all ranges to 200 metres.

SMG Design

Most SMGs operate on the 'blowback' principle, the breech being unlocked and held closed by the weight of the heavy breech-block and return spring. This breech-block is the heaviest part of the weapon but is the reason for its simplicity.

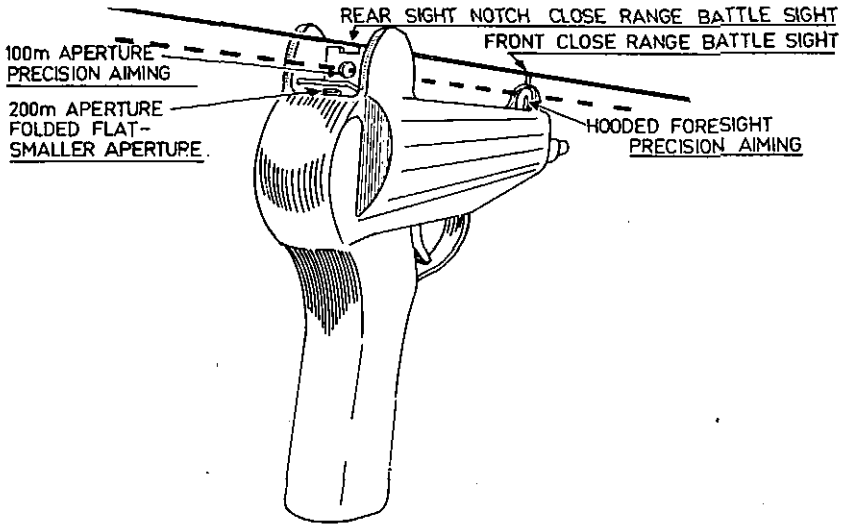
The weapon is fired from open bolt, the trigger and sear releasing the bolt which moves forward, picking up a round from the magazine on way, and firing it on chambering. This principle of operation is sometimes called 'slam-fire'.

A new mechanism design, such as the side-locking cammed rollers on the CETME and SIG rifles, could be employed with a consequent reduction in weight, but if a weapon becomes too light recoil would begin to cause disturbance of aim in burst firing. However, this could well be a field for the future development of a lighter, more efficient weapon.

Design Features

Some noteworthy features of SMG design are:

Sights. The adoption of adjustable rifle-type sights, with 100 and 200 metre apertures and able to be zeroed, is almost universal. The Walther has a smaller and more accurate aperture for 200 metres and a coarse notch on top for quick alignment to close-range battle shooting. The 9-mm cartridge has the range and accuracy and needs only a suitable handy weapon to fire it. The circular hood on the Beretta M12 and Walther foresight would be most desirable in increasing accuracy by ensuring a foresight centred in the aperture.



Construction. Mostly cheap stampings, many such as Star Z62, using light alloys and plastic grips. Simple take-downs mean ease of instruction and cleaning.

Attention is given to preventing access of dirt by use of retracting cocking handles to cover the slot usually left. Good examples are the F1 (SLR type), UZI, Walther and Beretta. Spring-loaded ejection port covers that open when firing are also important.

Magazines. All countries except Australia and Britain use a bottom-mounted magazine. Britain's Sterling adhered to the wartime side magazine, but improved it by curving to suit ammunition and the use of rollers instead of the conventional magazine platform. Australia used this magazine in the new F1 but mounted it on top, contrary to the recommendations of some members of the design board, as it was considered that the 'Australian soldier was accustomed to

having it there.' This, however, obscures the view of the firer in the shoulder position and interferes with the sighting plane necessary for quick point shooting and is therefore an undesirable feature. Also it probably leads to hip shooting as the most convenient method of firing. This is against all current experience, especially in Malaya and at the U.S. Infantry School, where it has been found that only the aimed or 'pointed' or 'aligned' shoulder shots are accurate over 25 metres.

The Carl Gustaf SMG has a special belled mouth to the magazine housing to permit quick loading of the magazine.

Best magazine design of all is the Israeli UZI, with the magazine in the rear pistol grip. This has the tremendous advantage of allowing magazine changing without looking at the weapon, or at night, using the principle of 'hand finds hand'. The pistol grip too acts as a support for the magazine. It also puts a controlling hand under the centre of gravity of the weapon.

Stocks. All current weapons (except the Australian) use some type of folding stock, many of which are quite ingenious. They recognize the need for compactness in carriage when not in use, yet appreciate the requirement of a support for shoulder shooting as required. A 'telescoping' plastic stock on the Armalite 10-inch barrelled SMG reduces the length of the butt by half. Many of these allow the weapon to be fired with the stock folded.

Compactness. Allied to compactness provided by the folding stock is the over-all length of the receiver of the weapon. Most SMGs have three main parts, barrel, bolt and spring, all adding to length. Latest trend is to 'telescope' the barrel into the bolt and put the return spring inside or through the bolt to add compactness, the best examples being the UZI, Walther and Beretta M12. The bolt on the UZI telescopes over 6 inches of the 10-inch barrel length. The Walther has a small bolt with weight above and forward on top of barrel.

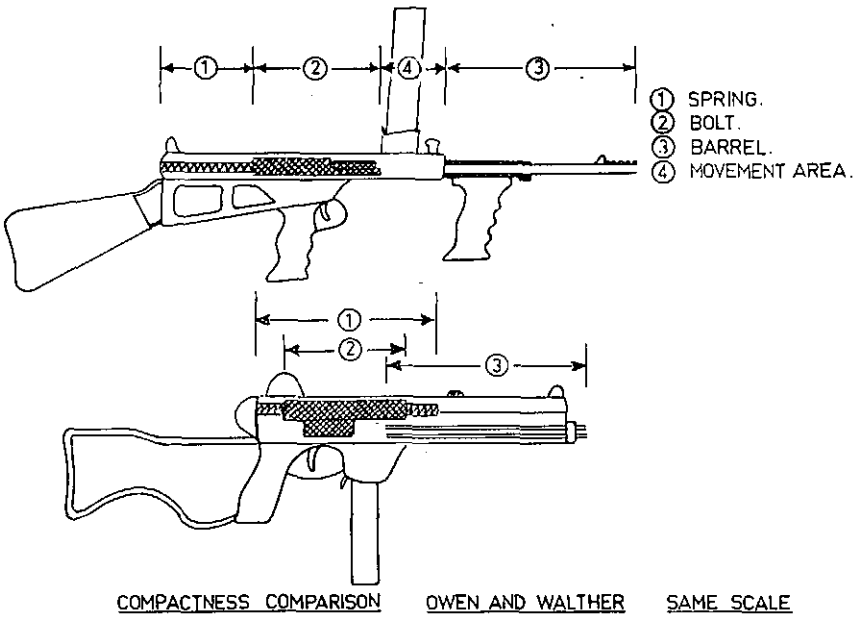
Reliability. With undamaged magazines all current weapons are extremely reliable. With bottom magazine opening most routine fouling escapes through the 'hole in the floor', the key to the Owen's reliability.

Balance. The two factors that contribute to balance and stability during firing, especially of bursts, is the ability of the firer to hold the weapon and the line of the recoil. The UZI design puts the rear pistol grip directly under the movement of the recoiling bolt which is the best position for control. The further the grip is to the rear, the more difficult it is to control the burst.

Straightline Stocks. If the line of recoil is directly into the firer's shoulder the tendency of the muzzle to rise during bursts is minimized.

The Owen, with its low butt, was a bad offender here, but the fault was corrected splendidly in the new F1. Also if the barrel is set low in the weapon rather than centrally or high the recoil is again lower and gives less disturbance.

A possible improvement would be to place the return spring in front of the breech block on top of the barrel rather than behind it as is usually done now. This may give sighting problems, requiring either high-mounted sights as on the Armalite or a stock with cheek-piece scalloped out like the SLR, and a low positioned barrell which will allow conventional sights set low on the receiver of the weapon, which is the ideal position.



Trigger. A trigger with a short pull for single shots and a longer pull for bursts is a desirable design feature; it does away with the need for a change lever and is a feature of the Star Z62.

Handling. It is considered that the most important requirement of an SMG in South-East Asia is for a general-purpose weapon suitable for close-quarter fighting, capable of close-range burst firing at often indistinct targets or accurate shots at 200 metres as the situation requires.

Most important concept to come from recent experience in jungle fighting is the inefficiency of hip shooting and the importance of fast,

aimed shots using 'point' or 'alignment' shooting with both eyes open using the self-loading feature of the weapon for quick follow-up shots or bursts. A comparable technique is clay pigeon shooting where, if the shot is not made within a second, the 'bird' is out of range and lost.

On the SLR the back-sight presents minimum interference to this plane and it is a most effective weapon for point shooting due to the pear-shaped section with a sighting plane similar to a shotgun barrel. The scalloped cheekpiece enables the firer to position his eye to line up the weapon without having to adopt an unnantural head and eye position.

An additional aid is the design of the foresight. The current European trend is to have the foresight protector in the form of a ring rather than the 'ears' we are accustomed to. This thin circle, with the foresight centred, aids quick shooting as well as deliberate, aimed shots, as it helps the eye centre the target.

The Walther, in addition, has a notch on top of the backsight leaf and a small post on top of the ring foresight protector for quick alignment for a close-range battle sight.

For deliberate shooting a weapon stocked in a manner similar to the rifle in use aids transfer of shooting skill from one weapon to another. A SMG with a different 'feel' is not a good thing. An example is a comparison of the SLR and the Armalite, which are quite similar. If sight picture, hand-grip positions, trigger, change-lever and magazine catches are in nearly similar positions and drills for loading, unloading and IAs are similar, the instructional time needed to develop the necessary skills will be greatly reduced. Practice with the SMG first will enable training with a lighter weapon of lesser recoil before firing the heavy full calibre rifle.

Conclusions

The Ideal Sub-Machine-Gun. It is suggested that the ideal SMG should be designed to fill the role of a general-purpose weapon, effective to 200 metres and suitable for issue to many of the troops at present carrying a rifle.

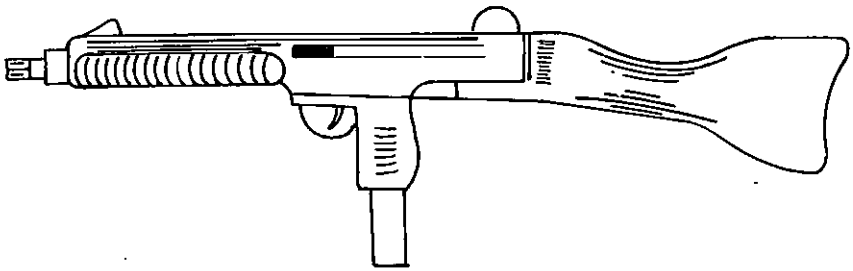
Desirable Features and Characteristics

- The most important SMG design feature would be similarity in feel and handling characteristics to the rifle in current use, and suitable sights for quick alignment shooting or precision aiming. The length of butt, the positions of safety and cocking handles should be similar to those of the current rifle.
- The weight of the ideal SMG would be about 6 pounds unloaded.

● It should fire high-powered 9-mm ammunition with a 115 grain bullet at 1,500 fps.

● It requires a 12-inch barrel in order to develop the full ballistic potential of the 9-mm round.

● A telescoping breech block with maximum barrel length is required for compactness.



SUGGESTED IDEAL DESIGN

● It should be constructed of light-weight alloy and plastic, except for the essential steel parts, all designed for easy mass production.

● It requires a bottom-mounted magazine housed within the rear pistol grip.

● Dual peep sight for 100 and 200 metres and a coarse notch on top for close-range shooting. The 200-metre aperture requires a smaller hole than the 100 metres sight. The opposing screws should zero laterally.

● Foresight 1/16-inch blade set within a hood, vertically adjustable by rotating, and a coarse 1/8-inch battle sight blade on top of hood.

● Available with interchangeable folding metal stock or plastic rifle butt.

● Available with 25 and 34 round magazines, interchangeable with the F1.

● Provision should be made for attaching night sights, either in the form of an extra large aperture and a luminous foresight similar to the Swiss SIG, or a simple, large-lensed optical sight with good light-gathering properties, and a suitable reticule such as fine cross-hairs and heavy side-bars. □

Visual Search by Night

F. H. C. Marriott,
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Introduction

THE performance of the eye under low illumination has been extensively studied under laboratory conditions. The conclusions reached are not necessarily valid in the field, but often suggest ideas that can be tested in more realistic trials.

The practical problem that concerns the soldier is how to use his eyes, or the eyes of the group of men he commands, at night. An enormous amount of work has been done on techniques of scanning and maintaining a watch by day, and the question has been studied by physiologists, psychologists, engineers and mathematicians from their different standpoints. In 1959 the American Armed Forces N.R.C. Committee on Vision held a symposium on Visual Search Techniques (Morris and Horne, 1960), but there has been scarcely any work on visual search at night, and the properties of the eye are so different by night and day that nearly all the work on daylight target detection is irrelevant.

It is not reasonable to expect a simple set of rules to cover all situations. The ratio of the highest and lowest luminances encountered by night is much greater than by day, and the variety of targets and conditions of viewing is just as great. New problems are encountered — dazzle, and illusions of movement, for example. Hearing becomes relatively much more important. In fact, each visual task at night may require its own special technique, just as in daytime, and all that can be done is to consider how these techniques are affected by the known properties of the eye and visual pathway.

The range of luminances considered here covers those conditions in which extrafoveal vision is used, that is from full moonlight to the darkest night, when sky and ground can just be distinguished. This represents a range of over 1000 to 1 in the illumination of the ground.

Method

Broadly speaking the threshold for detection of a target — light or dark — depends on the difference between the total *flux of light* from the target and from the same area of background. If the illumination is quadrupled, therefore, a given target can be

detected at twice the distance. The same considerations apply to the identification of targets; a particular feature that contributes to identification becomes visible if it emits, or obscures, a sufficient flux of light. (Pirenne, Marriott and O'Doherty, 1957.). This is generally true when the optimum retinal area is used but breaks down for very large targets, and for conditions of high illumination and low contrast.

The object of scanning is to bring the image of each part of the field on to the most sensitive part of the retina in such a way that any target is detected as quickly and reliably as possible. In daylight vision this part is the central fovea, and away from this very small area, acuity, and correspondingly the range at which a target can be detected, fall off very rapidly.

In night vision, on the other hand, the fovea is usually the least sensitive part of the retina, and the most sensitive part is an annular area round the fovea. This area depends on the illumination; in full moonlight small details may be seen with the parafovea 12° from the fixation point, whereas for detection of a 4° target on a dark night the most sensitive part extends from 15° to 30°, or even further from the fixation point. In general, as conditions get darker, the most sensitive part moves further from the fovea, and the most sensitive area gets larger.

Since at night the most sensitive retinal area is much larger than by day, close scanning is unnecessary and the visual field can be covered in a number of fairly large steps. The size of these steps is not critical, and the ideal size depends on the size of the field, and the level of illumination. Probably 8° — the width of a fist at arms length — is a satisfactory compromise under most conditions.

If possible, the fixation points should be associated with definite objects in the field of view. It is easier to maintain fixation on a tree trunk than on a point 'straight ahead' or '8° left', and there is less risk of illusions of movement.

In scanning an area in daylight, it is natural to move the eyes fairly rapidly, fixating quite briefly on a series of points at close intervals. When the light available is the limiting factor in vision, it is desirable to fixate for longer periods to allow the eye's capacity for temporal summation to have full effect.

For fixation times up to about 0.1 sec, the threshold intensity is inversely proportional to the time. For longer periods, up to 1 sec, it is inversely proportional to the square root of that time. It is difficult to maintain fixation for longer than 1 — 2 sec, but if it is maintained, either by conscious effort or by the use of some special device, the entire visual field seems to fade to a uniform grey and

all outlines disappear completely. This is known as the Troxler effect. It has been known for about 160 years to occur for peripheral vision in dim light; in bright light it is more difficult to observe, since the retinal units in use are of smaller size and very small eye movements restore vision, but is undoubtedly the same effect as is obtained with artificial stabilization of the retinal image. Vision is restored by eye movement, and movement in the visual field may still be seen (Clarke, 1962; Marriott, 1965). It is clearly desirable, therefore, to fixate for about 1 — 2 sec, in each position. Longer fixation leads to fading, and shorter loses some of the information available.

Exposure to light reduces the eye's sensitivity to faint illumination, and it takes time to recover. After leaving a lighted room at night, maximum sensitivity may not be reached until after twenty minutes in darkness. Bright flashes of light often cause extreme dazzle but, if exposure is brief, recovery is usually rapid. If light has to be used — e.g. for map-reading — intensity and duration should be kept to a minimum; red light has least effect on dark adaptation.

Results

In practice, the task of a look-out at night is not merely the detection of a lighter or darker patch on a uniform background, but the scanning of a complicated pattern of light and darkness to detect any change or movement, or any significant object such as a man or vehicle. The performance of a look-out under these conditions cannot be expected to reach the levels that would be suggested by laboratory experiments, but it is reasonable to suppose that the general theoretical considerations relating to fixation time and the spacing of fixation points remain valid.

Practical work conducted in the darkened indoor range at the School of Infantry at Hythe confirmed this expectation. It was difficult to obtain consistent differences in performance by giving different instructions about scanning, but the subjective responses of the men were definite and generally in agreement. The conclusions reached were:

(*a*) Scanning a series of fixation points, with a pause of 1 — 2 seconds at each, was undoubtedly superior to either rapid scanning with small eye movements (as in daylight) or steady fixation on the centre of the field of view.

(*b*) The spacing of fixation points seemed not to affect the results very much, but 20° was probably rather too wide a spacing at the luminance level used, and would certainly be so under brighter conditions.

Discussion

The practical problem is to work out a scanning procedure which will detect a target — darker or lighter than the background — in a given field of view with maximum speed, sensitivity, and reliability, under conditions of night vision. The most appropriate procedure may depend on the precise level of illumination, the size of the target, the area and shape of the field of view, and other factors peculiar to the situation, but it is clearly only practicable to lay down general rules to cover night vision conditions as a whole, and to suit these rules to as wide a range of practical conditions as possible.

Psychologists have done a considerable amount of work on the subject of 'vigilance', that is, the factors that affect the response of an observer to signals that are just above his sensory threshold. The typical test situation is obviously relevant to the task of a sentry; signals are presented at irregular intervals over an extended period, and the observer indicates that he has detected each signal. Even though his sensory threshold — as influenced, for example, by his state of dark adaptation — remains constant, the proportion of signals detected varies and is affected by different factors in the experimental conditions.

Among the large mass of experimental findings, three appear important:

(*a*) Vigilance decreases with the passage of time. One typical experiment showed a fall in performance after the first half hour of a two-hour task, followed by a steady lower level for the remaining hour and a half.

(*b*) The proportion of signals missed rises as the frequency of signals falls.

(*c*) Physical discomfort has an adverse effect on performance.

There seems to be no clear information about the way in which a scanning programme may affect the other senses, and particularly hearing. Listening will often give the first information of the presence of a target, and any task that distracts attention from auditory signals has very undesirable aspects. Whether scanning would have this effect, or whether it might, on the contrary, help to maintain alertness, is not known. This aspect is not covered here, but should be borne in mind when definite instructions are being considered.

Recommendations

Recommendations must be tentative in view of the factors that have not been investigated, but on the basis of what is known at present, the following instructions are suggested:

(*a*) In night scanning it is desirable to move the eye over a series of 'fixation points'. These points should be spaced about 8 —

10° apart (the width of a fist at arms length) and should be distributed over the whole area to be scanned. As far as possible, they should be associated with definite physical objects — a bush, an irregularity in the sky-line, etc.

(*b*) To scan the area, look steadily at each point in turn for about two seconds. Cover all points in order and then repeat. It is important to remember that targets will usually be detected by off-centre vision — not at the fixation point you are looking at.

(*c*) A careful scanning of the area should be carried out in this way every few minutes. Between these scannings keep looking and listening, and avoid staring fixedly at one point for more than a few seconds.

(*d*) If a possible target is detected, by seeing or hearing, use off-centre vision for identification. The best place to look depends on the illumination and on the individual eye; about 8 — 10° away is often best, but if this is indecisive, try looking at points nearer to, and further from, the 'target'.

(*e*) Stationary objects often appear to be moving at night. Check whether the 'target' changes its position relative to other objects. Illusions will thus be avoided. □

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