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ADMINISTRATION FOR DEFENCE SCIENTISTS*

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Introduction

All scientific work must be carried out against a background of adequate administrative support if it is to become effective and produce useful results. Administration is not a job for which we, as scientists, are particularly trained; and it is a thing of which we tend to fight shy, partly because, I suppose, most of us associate the administrator with highly unpleasant matters such as income-tax, delays in getting our pay cheques, and so on For that reason we do not, I feel, always pay sufficient attention to administrative affairs; rather like the ostrich, we try to escape from them by merely ignoring them. But that is a wrong and unfruitful attitude to adopt. We all live so much under the activities of the trained administrator that we should, if we are wise, give a great deal of thought to our own administrative problems—deliberate and conscious thought to them—and make an honest and heart-searching self-analysis regarding our own possible failings.

Fundamental Aspects of Administration

With this object in view I propose to discuss some of the fundamental aspects of administration rather than talk about the refinements of the subject—such as whether or not a laboratory should be subdivided on "functional" lines (for example, chemical research, physical research, etc.), or on "process" lines (for example, basic research, development work, follow-up work, applied research, and so on). This is because it is important to be clear in our minds about the essential points—the fundamental principles which should govern administration at all levels and of all types—before we start arguing about how they should be applied in particular instances.

Now the first thing we have to do is to decide what we mean by good administration. My own definition would be something like this; the arrangement of affairs to the best advantage in order to secure a desired end. If we accept this view, then it is obvious that administration enters into most of the things that we do, both great and small. We are all of us making administrative decisions of one sort or another all the time, whatever our job is. Nobody can undertake (or at least ought not to undertake) even a simple experiment in the laboratory without consciously or unconsciously going through certain administrative processes. Is the necessary equipment available? Have I got all the chemicals I want, or must I draw some more from store before the storekeeper goes out for lunch? Must the experiment be completed in one operation, or at what stage will it be possible to leave it overnight? We all of us normally take things like that into consideration almost subconsciously; but they are all of them, in their way, administrative decisions. And before we even start an experiment we shou'd have asked and answered several other administrative questions of much greater and more fundamental importance; such as :—Is it essential that the experiment should be undertaken at all?

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Will the result give me a better understanding of the prob'em on which I am working ? How does it fit in with the work my colleagues are doing ? and so on.

We have, in fact, all the bas'c e'ements of all administrative problems present in the above very simple example. The main differences that we find when we consider administrat've problems in the much larger world that exists outside the laboratory are, firstly that the *scale* of the problem is enormously magnified ; secondly, that the consequences of a wrong administrative decision may be very serious indeed, and lastly, that a much larger number of factors—financial, political, and so on,—are involved. Some of these additional factors are often very difficult for us to assess in scientific terms or even in any terms at all ; questions of human reactions to a new situation, for example, to say nothing of all that is summed up in that nightmare of the administrator—the dread word " repercussions ".

Main Rules of Administration

Administrative decisions are so fundamental and enter so deeply into everything that we do that it seems to me that before we try to decide major questions of policy and organisation in the field of scientific work we should first try to work out the rules of the game, and decide what are the basic principles which govern good administration or at least we should try to discover some of them ; the present state of the world certainly does not suggest that anything like a full appreciation of more than a few of them is available anywhere. Or perhaps it is that the rules, although known, are not properly applied. However that may be, the main rules of administrative action appear to be as follows :—

Correc' selection of the objective

The first is that when faced with a new situation we must at once decide what our objective is to be. Unless we have a definite object in view we cannot hope to control events ; rather, until we have a definite object events will in fact control us, and any action that we take to deal with them will be more or less haphazard, and unlikely in the extreme to lead to any useful result, except by the merest chance. Having a definite aim is therefore one of the fundamentals of successful action, but this does imply that the objective we have chosen is in truth the correct one. The first rule of administrative action should therefore be worded to read :—the selection of the *right* objective. This is not only the first step to take, it is the decisive one, in the sense that if the wrong aim is selected we shall be unable to deal with the situation adequately. If the situation is that we have been given, say, a Service problem to solve, our own personal problem as scientists is not the original Service problem itself but finding a method of solving it. In the scientific world the fundamental quality required to select the objective correctly might perhaps be described as the ability to ask the essential question, implying of course that the objective automatically becomes the seeking of an answer to that question. This is to some extent a heaven-sent gift, granted freely only to the great scientists of the world, and denied to lesser mortals. In the case of workers in applied science there are, however, a number of additional limitations which the very nature of the work imposes and from which the purely academic scientist is free, namely, that to some extent the objective is already laid down, and that the ways in which it can be attained are often restricted by practical and financial considerations.

There are one or two general observations to be made in relation to the selection of the objective. In the first place it is useless to attempt to make this decision until all relevant facts have been taken into account and their relative importance assessed. In the case of the applied scientist this means that not only must he consider all the scientific aspects of a given problem but also that he must bear in mind a number of non-scientific factors ; unlike the academic scientist he is not free to propose an ideal solution to the problems he studies ; the acceptibility or otherwise of his solution to a given problem is often governed by, for example, economic, financial and industrial considerations about which the academic scientist never has to worry. Let us suppose that in time of war we have been asked to recommend to the Armed Forces a suitable war gas for them to use in retaliation against an enemy. It will not be enough for us to recommend an extremely toxic gas ; we must decide upon one which possesses in addition to toxicity certain physical properties (in particular it must have a certain rate of evaporation under given meteorological conditions), and one which can be easily manufactured in large quantity—the elaborate synthesis so beloved of the organic chemist cannot be permitted here—and it must moreover be cheap and if possible it must be produced from raw materials not urgently required for other purposes, and of course these materials should be indigenous. In fact, the objective is not the discovery of a highly lethal gas ; the correct objective is the discovery of a lethal war gas which possesses certain special physical properties and is capable of being quickly, cheaply and easily manufactured from indigenous materials that are freely available. There is obviously a very great and important difference between these two objectives, and this difference affects and alters the lines of approach that one would adopt in trying to achieve either of them.

Tests for the objective

No golden rule can be laid down to govern the way in which we choose our objective ; it is largely a matter of the ability of the individual concerned. But there are a number of tests which can be applied to any objective that one has selected, and if it fails any of these tests it is most unlikely that the objective has been chosen correctly. These are :—Will the objective, when attained, lead to a definite result ? Is it the utmost that can be done ? Is it in accordance with overall responsibilities and instructions ? Is it capable of attainment with existing resources ?

All these tests are self-evidently important, but I should like to comment on them. The first test is in some ways the most important—if attaining the objective will not lead to a radical change in the situation, why pursue it at all ? Unless an experiment will give us information which we need and which we do not already possess, why perform it ? I need hardly stress the significance of the second test—if we are satisfied with second-rate efforts we shall only get, and deserve to get, second-rate results. I should like to say rather more about the third. Put in its simplest terms it means that a junior must only have objectives in his work which do not conflict with those of his superiors—

otherwise there will be chaos. Similarly a research organisation must not lightly undertake work outside its own proper sphere. An organisation for applied research, for example, must resist the temptation to wander into the alluring fields of academic work unless it is essential to do so to attain its overall objectives. The individual applied scientist must never allow himself to imagine that the principal aim of his existence is the production of laboratory reports, however beautifully prepared ; that is not " in accordance with overall responsibilities ", which, in the case of defence scientists, are all the time to assist the Armed Forces to attain *their* objectives. As regards the fourth test, it appears elementary, but is nevertheless all too often disregarded both in the scientific world and elsewhere. We are all of us very easily betrayed by our enthusiasms, our ambitions and our imaginations into trying to attempt the impossible ; and while we are wasting our strength in fruitless endeavour the man who has his imagination and his enthusiasm under control will beat us every time.

Maintenance of the objective

Having, let us hope, selected the objective correctly and having found that it passes the prescribed tests, the next rule is that this objective must be remorselessly pursued until it has been achieved. Everything that we do, and all plans that we make, must be considered all the time in relation to that objective ; and we must not allow ourselves to be deflected from attaining it by any consideration whatsoever unless, in the meantime, the situation changes radically.

Having selected our objective, and being resolved to maintain it, the immediate step is to prepare a course of action which will enable us to achieve that objective. Little can be said about this aspect of administration ; like the ability to select the aim correctly in the first place, it is largely a question of an individual's shrewdness and judgment. The essential features are that all factors affecting the situation must be taken into consideration before framing the course of action to be adopted ; and that that course of action must be such that it leads to the objective by the shortest and most direct route possible.

Having decided upon our line of approach to a particular problem we must with the utmost speed take definite and effective steps to put our plan into operation. Clear analysis is not enough ; problems are not solved by being left alone. We must adopt an aggressive attitude towards them all the time, both in the planning stage and when we are executing our plans.

Utilisation of resources

The next important point relates to the way in which existing resources in men and materials are used. Put in the simplest terms it means that when an organisation is faced with a number of problems simultaneously the resources available must be allocated in a rational manner having regard to the relative importance of the problems concerned ; but it also means more than that. If a problem can be handled by one man, obviously two men should not be allotted to it. If work can be performed adequately with existing equipment, financial resources should not be wasted by purchasing more expensive and elaborate apparatus unless there is some compensating gain in speed or accuracy. Many of these rules that we are discussing are best illustrated by reference to military affairs ; this present rule is known to the Services as the Principle of the Economy of Force. Nelson once expressed the idea very well when describing the outlook of one of his brother Admirals, a man of less ability than himself, when he said :—" Where I would use a penknife, my Lord St. Vincent takes a hatchet ".

Exchange of ideas

Returning again to the scientific world, I always feel that the one commodity in which a research organisation should be rich is its brain-power, and in my view far more care and attention should be devoted to the husbanding and proper use of that most valuable asset. Too often scientists are allowed to work in specialised and nearly water-tight compartments ; this is an almost inevitable consequence of the fact that most scientists are specialists. All too often the tendency is to hand a problem to one man and to leave him to get on with it ; and once that has been done it is a most natural and human reaction on the part of the man concerned that he should wish to solve that problem himself without reference to, or help from, anybody else. But it may be questioned whether this is really the best and most economical use that can be made of the collective thought of a research organisation. There is no real reason whatever why intellectual effort should not be pooled, coordinated, and organised in the same way as any other form of human endeavour. It is, of course, important that this should be done without cramping every individual's initiative, and without robbing the individual of pride in, and responsibility for, his own work.

Advances in one branch of science often have the most unexpected repercussions in other branches—repercussions that cannot always be foreseen. The needs of a particular branch of science, too, will often cause it to develop in fields that more properly belong to others ; sometimes the consequences of such trespass are rather pathetic—the use of out-of-date techniques, even outmoded theoretical conceptions—but to be fair sometimes the reverse occurs. I have been struck, for example, by the progress made in the U.K. by certain workers in pathological laboratories who have long laboured under the necessity of rapidly and accurately analysing biological fluids and so on ; in some respects they have in my opinion outclassed the generality of micro-analysts. Cooperation between the branches of science is thus essential so that we may perhaps save our colleagues from difficulty and learn from them ourselves at the same time ; even if we have the humiliating experience of learning something about our own line of business from some one else it will, in the end, to be our soul's good. A practical solution to the problem is in my opinion the holding of regular meetings between different sections of a laboratory at which each section should give a brief account of its activities, problems and proposed methods of tackling them ; even quite small establishments should do this. Of course the time devoted to such meetings should be kept within reasonable bounds : one period of one hour per three months is my estimate of the time to be allotted in a small laboratory consisting of only two or three sections.

Whilst on the question of co operation in the scientific field reference should be made to yet another respect in which the defence scientist is at a disadvantage as compared to his academic opposite numbers ; that is, his inability to discuss all his problems freely and openly because of security considerations. Some matters can of course be discussed, but many cannot, and great discretion must be exercised at all times. We must be careful about both what we do not say and about what we do say. A casual and innocent enquiry made by a defence scientist about, for example, the culturing of pathogenic organisms might easily lead to a belief that biological warfare was being contemplated.

Individual scientist free from problem of supply etc.

Lastly, the administrative background to a research organisation should be such that the individual scientist working for that organisation should be as free as possible from worry about details connected with the supply of materials, literature and so on. This implies that a laboratory, however small, should have a properly organised library, store-house, and store-keeping and store-issue system. There must be, also, centralised arrangements for such elementary but essential matters as the charging of batteries and the preparation of standard solutions, stock reagents and so on ; simple matters, but they mean a lot to the efficient running of a laboratory.

Guiding Rules for all Administrative Action

Summing up, the guiding rules for all administrative action should be :—

(*a*) The decisive step is the correct selection of the objective. One must be clear in one's mind the whole time about this.

(*b*) Any objective, if correctly selected, will pass the following tests :—

(*i*) Will it lead to a definite result ?

(*ii*) Is it the utmost that can be done ?

(*iii*) Is it in accordance with overall responsibilities and instructions ?

(*iv*) Is it capable of achievement in existing circumstances ?

(*c*) The course of action to be adopted to achieve the objective is decided upon in the light of all known factors which affect the situation and in accordance with the principles given below.

(*d*) The objective must be kept in mind the whole time and all action taken must be considered in the light of that objective.

(*e*) Aggressive action must be taken to achieve the objective.

(*f*) Resources in manpower, brainpower, materials, equipment and money must be utilised to the best advantage with two main principles in mind :—

(*i*) Concentration of a sufficiently high proportion of them on the *crucial* problems.

(*ii*) Avoidance of devoting to any problem a higher proportion of these resources than is necessary to solve the problem in a satisfactory manner within the desired period of time.

(*g*) There must be an adequate exchange of ideas between all sections of a research organisation, however small, and particularly between workers in different branches of science. Brainpower must be pooled.

(*h*) The individual scientist must be freed as much as possible from problems of supply, etc.; the organisation should deal with these matters on a centralized basis.

These rules are fundamental rules and they apply as much to the individual scientist working in the laboratory as they do to the organisation for which he works. The work of each one of us should benefit if we honestly ask ourselves each time we are faced with a new situation if our actions are in accordance with them.

I would like now to discuss certain *consequences* of these rules as they affect us as defence scientists.

Overall Objective of the Defence Science Organisation

In the first place what is the overall objective of the Defence Science Organisation ? Since it is part of the Defence Ministry—part of the war machine in fact—its objective must be exactly the same as those of the Armed Services themselves. The aim of the Armed Services is broadly the destruction of the armed forces of other countries ; what other aim can they possibly have ? That, therefore, must be in the last analysis our own aim also. We do not attempt to achieve this objective in the same direct manner that soldiers, sailors, and airmen do ; but it is our ultimate objective just the same, and we must not forget it. The acid test of all our work is :—does it help towards the attainment of the ultimate aim of both the services and ourselves ?

It was an ancient motto that in time of peace one should prepare for war. That means for us as defence scientists that our mental outlook towards possible wars should not be passive. Just as the Services plan for possible wars, so should we. We should have an aggressive outlook towards this question. This is particularly important because research is nearly always a slow business and if we wait till the shooting starts we may not be able to complete our tasks in time. Just as some philosophers advise us to conduct our lives as if we expected to die within the next few days, so ought we as defence scientists to work and plan as if we expected war at any moment. We have to cultivate this sense of urgency if we are to avoid letting the services down in an emergency.

More than this, it is the responsibility of the defence scientist to adopt a positive rather than a negative attitude towards planning for an emergency. There is a real danger that if we are not careful we shall find ourselves waiting for the Services to tell us what to do rather than initiating action ourselves. Obviously it is only right that we should carry out those tasks which the Services ask us to perform, but we should be failing in our duty if we left things on that basis ; it is up to us to think continually about new ways of applying science to warfare. Incidentally, this does not necessarily mean devising new weapons ; but I don't propose to discuss this matter now.

Another aspect of the same question is the necessity of being continually on the watch for existing problems which are capable of solution on a scientific basis. I am often surprised at the number of problems which exist but which nobody has brought out into the open. I once gave a lecture at the National Defence Academy at Dehra Dun, and afterwards a number of problems were suggested to me as requiring study. One was that medical research should be undertaken into the causes of and methods for preventing foot-blisters.

This is an Army problem, and I am not well versed in Army matters but so far as I am aware it has never before been put up to defence scientists. There must be many more such problems that we have never heard about, or at least, have never been asked to solve. But if they are not brought to us, then we have no alternative but to go and look for them. We must always make full use of any opportunities which come our way of discussing service matters with service people, with the object of discovering fresh ways in which we can help them.

Joint Planning of Scientific Work

Another important matter is this question of husbanding and using to the best advantage the brain-power of a research organisation. As I have already mentioned this is a complicated question, and is liable to become confused with all sorts of personal problems, questions of giving full scope to individuality, and so on. The usual method of dealing with research problems is not unlike that adopted in universities. A man is selected to tackle a particular job, and is then left to get on with it. The head of his department will normally discuss it with him first, and occasionally from time to time during the progress of the work, rather in the manner that a professor treats one of his research students. Although very widely adopted, indeed the present writer does not possess personal knowledge of any research organisation where it is not, the method has its disadvantages. In the first place the head of a research department is in some ways in a worse position than the college don ; he finds himself inevitably entangled in a mass of details of organisation and non-scientific administrative work, he has to attend interminable committees, he is continually engaged in coordinating the work of his department with service requirements, with long-term planning, financial matters, and so on ; but the university professor is either free from these troubles or else he suffers from them only to a relatively small degree ; he is, in a word, freer to concentrate his thoughts on his own special sphere of interest. A professor rarely if ever professes in more than one subject ; whereas the head of research institution may have working under him physicists, engineers, chemists and so on, and he has to familiarise himself with all their activities.

The situation of the head of a research organisation is in some ways not unlike that of a military leader engaged in combined operations, in that he is under the necessity of reconciling the conflicting needs and the various problems of several different kinds of people and of coordinating and combining their efforts in the best possible manner to achieve a desired end. During the last war the joint planning system was evolved to meet this difficulty. In very brief summary what happens is this :—a small committee of sailors, airmen, and soldiers prepares a review of all aspects of the operation which is under consideration, and on the basis of that review they prepare a plan which is submitted to the commander of the combined operation. It still remains his responsibility to approve the plan or not, or to suggest alternatives—or if he thinks his planners have done their job badly, to disregard their plan entirely-but at least he has been given a complete picture of the situation, with the separate Army, Navy and Air Force aspects adequately presented to him by men who are experts in their own field. The head of a research organisation does not of course control the efforts of soldiers, sailors and airmen, but he does have working under him chemists, engineers, physicists and any number of other types ; like the military commander in a combined operation, he does have to coordinate the efforts of a number of specialists, all with different problems to face and different lines of approach to a given problem. Is it not at least worth while considering whether the military planning system—without which complicated affairs like the Normandy landings could never have been undertaken much less successfully achieved—is not equally applicable to scientific planning ?

I personally think it is, with suitable modifications. Some modification is necessary if only by reason of the fact that the scientist in action works very much as an individualist. If, in fact he were deprived or limited in his freedom to think for himself he would lose one of the most essential qualifications for being a scientist.

Also, we are all human beings, and none of us like other people to interfere too much in work which we regard as our own particular property—and the good scientist regards his work as being part of himself in much the same way that an artist feels that a picture he is painting is part of himself. Some of us may feel, too, that any " joint planning " of scientific work sounds too much like trying to do research on a " committee " basis—which God forbid. Committees have an absolutely essential part to play in scientific work, but it is a coordinating and policy-making role, and most certainly not an executive role so far as laboratory work is concerned.

Brief Re-statement of Problem

There are so many conflicting considerations in this matter that it seems desirable to re-state the problem. The salient points are :—

The existing procedural methods of most research organisations do not make the most economical use of the total brain-power that the organisations possess.

This brain-power is their most valuable possession and should obviously be used to the best possible advantage in order to conform to one of the most elementary rules of good administration.

Many problems dealt with by a research organisation possessing wide interests, such as the Defence Science Organisation, do not fall in a clear-cut manner into any one particular branch of science : sometimes in fact they fall into many branches.

The scientist is essentially an individualist who must at all times be entirely free to think for himself and utilise such gifts of originality, initiative and judgment that he may possess.

A Solution to the Problem

There are, doubtless, several possible answers to the problem. My own solution is as follows :—A research organisation should on receipt of a problem create an *ad hoc* joint planning team to assess all aspects of that problem. The composition of the team would be varied according to the different branches of science directly or indirectly involved ; and in addition someone should be detailed off to study the Service implications of any possible solution. The actual members would normally, but not necessarily, be the more senior members of the organisation, but it would be up to the head of the organisation to coopt any acknowledged expert on his staff irrespective of rank, and to decide who should actually be included in the team. These persons would each, separately and not as a committee, assess the problem from their own particular point of view briefly pointing out all the major factors involved and suggesting what to them appears to be the most profitable line of approach, together with remarks as to what is necessary in the way of additional equipment, staff and so on. These would be in the form of written notes—the file system could in fact be used—and would be as brief as was consistent with completeness. A list of important references should also be included. The completed file would resemble in content, though not in form, a military appreciation minus the final plan. It would be returned to the head of the organisation who on the basis of the information in the file and his own knowledge of the subject would assign the problem to the appropriate section or sections of his organisation. This section would then have at its disposal all the information and the best advice that its parent organisation could give it. But this is the essential point—once the problem has been assigned, the section concerned would have a free hand in conducting the research. It would be in no way bound to accept the advice given, though obviously it would not lightly disregard it. The section would in this way be saved from wasting its efforts in pursuing a line of approach which was inappropriate by reason of some consideration external to its own particular field, of which it might not be aware.

The great advantage of this procedure from the organisational point of view is that it enables a more rational assessment of the effort involved in solving the problem to be made, and permits of a satisfactory distribution of work between individuals or sections. It *does* avoid the situation that so often arises in practice, where a scientist works hard on a problem, produces a report, and the report is then circulated for comment and criticism—surely in the name of all reason the comments and criticism should as far as possible be made *before* the work starts, rather than *afterwards*.

Also, in my opinion there is nothing in this scheme that in any way deprives the individual scientist from exercising his own initiative and originality.

Needless to say, a procedure such as the above would usually only be appropriate in the case of major problems, though it is possible to imagine cases where it could be used with advantage in small matters. It must be the responsibility of the head of the organisation to decide when, and when not, to adopt this " joint planning " procedure.

Examples

To make the matter clearer, let us consider actual examples. First, the sort of thing that happens if a system such as the above is *not* used. Somebody once developed quite a clever and original detector unit for a form of pressure mine. Since the unit was in continual contact with the sea a considerable corrosion risk was involved, and because of the way the thing functioned, the designer found to his disappointment that he could not construct it out of non-corrodible metal, since these did not possess the requisite physical properties. He was not discouraged, however, and continued with the project to the end, confident that the materials experts would produce a satisfactory anti-corrosive paint for him when he asked them. In point of fact the requirement was impossible to meet, for reasons not worth while discussing now, but obvious to anybody knowing what paints can and cannot do. Clearly, if the materials people had been consulted at the beginning much time, effort, and disappointment would have been saved.

On the other hand, consider a problem such as a fundamental investigation into the adhesion of paint to metals. (This problem has more or less been solved on an empirical basis but has never been solved in the true scientific sense. It is not a problem that a defence research organisation would tackle, but is mentioned to illustrate the principle involved in a rational approach to such researches). Van der Waals forces are the most probable seat of adhesive power; a mathematical physicist would have to investigate this aspect. The structure of the metal to which the paint is applied has a very considerable bearing on adhesion; an expert on the structure of metals and on such subjects as the Beilby layer would therefore be concerned in this part of the investigation. The measurement of the actual force of adhesion between paint film and metal is extremely difficult to perform—plenty of scope for a good physicist here; he would also find that he had first to devise a way of estimating the effective surface area of a piece of metal—there is no doubt that it is considerably greater than the area measured by a ruler owing to microscopic surface irregularities. A chemist will be required to contribute essential information on the chemical constitution of paints. Work on paint films is also inherently difficult for various reasons; a mathematician would be required to advise on the design of experiments so that they could lead to results of statistical significance. Even on the basis of this brief and superficial assessment of the problem you will see there are five distinct aspects of the problem at the very least which must be considered and properly coordinated if a balanced and rational approach to the problem is to be made. Obviously this project could never be solved without a centrally planned and organised attack upon it, whatever one may say about the necessity of giving the scientist complete freedom in his work. The applied scientist must in fact be prepared to submit to some form of discipline if his efforts are to be successful. This problem of adhesion may be an extreme case in some respects but it illustrates what I mean.

How to Arrange Cooperation between Services and Scientists?

Any discussion on organisation would be incomplete without some detailed reference to the important question of how to arrange, to best advantage, co-operation between the Services and the scientist. Co-operation is a two-sided business; both parties must enter into it whole-heartedly and in the right spirit, In some respects this co-operation is more vital for the defence scientist than it is for the Service Officer. The Services must co-operate if they are to avail themselves of the benefits that science can confer on them ; but the defence scientist is in a rather different position ; he cannot hope to achieve anything at all unless he gets a very great deal of help from the Services.

The Machinery for Co-operation

Machinery for cooperation between Services and scientist means, for the Services, mainly a channel for feeding problems to the scientist ; but that same machinery of cooperation must do much more than that for the scientist ; mere liaison is not nearly enough. The scientist must know, *and there must be proper machinery for telling him*, the order of importance of the problems submitted to him. Which ones are regarded as of the most urgent importance by the Services ? Which can be deferred for the time being ? If there is only a limited amount of money available for research, on which projects should we spend it ? Another point is that the scientist will always be to some extent limited in his knowledge of actual Service conditions and of all the complications which may ensue if, say, a new piece of equipment is introduced ; he must therefore have the user's viewpoint presented to him in an authoritative and systematic manner before he commences work on a problem—*before*, not afterwards. Next, a defence scientist can rarely complete any investigation without undertaking actual practical trials sooner or later ; he may want to coat the hull of a ship with a new type of antifouling paint, or make some experimental modification to radar equipment, or try out an improved form of asdic display, or what have you ; but he cannot do any of these things without the willing help and assistance of the Services—" willing " is the most important word in that sentence. Human nature being what it is, the scientist is unlikely to get much assistance of this sort from the Services unless and until he has succeeded in convincing them that it is to their benefit to help him to conduct such trials. In some cases it is necessary for the scientist to work in such close collaboration with the Services that he almost becomes part of them ; consider, for example, the running of a degaussing range. First, the authorities have to be asked to arrange for the ships to pass over the range, and if anybody thinks that is a simple matter, let him recall that ships often have their movements planned in quite minute detail months in advance, and it is not easy to have such programmes disturbed at a moment's notice. Once a ship has been ranged, and its signature obtained, then the question of wiping the ship, altering the coil settings, and so on, has to be taken up with the Electrical Branch. Then the ship has to be sent over the range again, and the whole process repeated until a good signature is obtained. Obviously the scientist is entirely dependant on the goodwill of the Services if he is to do work of this sort smoothly, efficiently and quickly. To put the matter in a nut shell, a definite part of the scientist's plan of action to attain his aim must be to secure the enthusiastic and sympathetic interest of the Services in his projects. The machinery of cooperation to which I have referred should, therefore, provide for bringing the Service element into the planning stages of defence research not merely for the reasons already given but in order to ensure that the Service Officer has at least a moral if not an actual responsibility for providing all the facilities for service trials that the scientist may require later on, and, not the least important point, in order that the introduction of the results of research into actual service use is not hindered by lack of interest on the part of the Services.

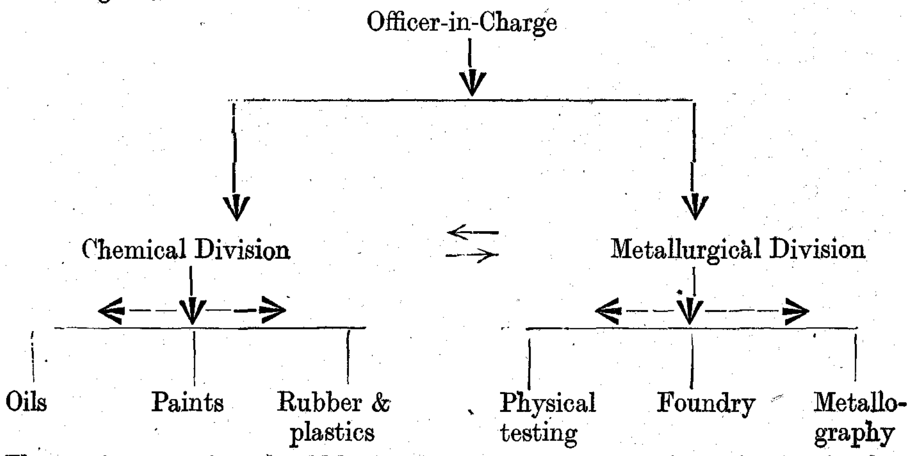
Several steps have been taken to try to secure the requisite degree of cooperation between the Service Officer and ourselves as far as the Navy is concerned. So far three coordinating committees have been created ; one, known as the "Human Material Committee" deals with physiological research, habitability problems on board ship, questions of diet, etc.; another known as the Technical Coordinating Committee deals with chemical and metallurgical matters ; and the third, known as the Committee for Physical Research, deals with the subjects that its name implies. The function of these committees is essentially the allocation of priorities, and to arrange and expedite the introduction into the Navy of any recommendations that may arise out of the research work that we do. These committees do not deal with the methods of carrying out research ; that is and must be the responsibility of the scientist and nobody else. We have as yet no very great experience of their actual working ; but I am satisfied from what has happened already that these committees will be of immense value in stimulating the interest of Naval Officers in research and development work, and as an automatic consequence, of gaining their willing help and assistance in those fields where we need it most.

It follows automatically that what has been arranged for the Navy could equally well be arranged for the Services as a whole. My own personal preference in this respect is for something of the nature of an inter-service planning staff. It would consist of not more than six or seven people, each Service being represented by one Officer and the most senior scientist attached to that Service, under the chairmanship of S.A. (M. of D). It would, in the last analysis, coordinate the final recommendations of various technical coodinating committees such as those I have described for the Indian Navy, and which, in my personal view, ought to be imitated by the other two Services. This overall planning team, which could perhaps be made responsible to the Defence Science Policy Board, would be in a position to allocate funds, laboratory facilities, scientific manpower etc., in a rational and equitable manner as between the three Services.

"Chain of Command"

The last point that I want to discuss is the question of what is known in the Services as the "Chain of Command", or to put it another way, how does the head of a laboratory pass his orders downwards to the individuals working under him. The military method is for orders to be passed from the officer commanding a formation to the officers commanding the various sub-units, and from them to sub-sub-units, and so ultimately to the private soldier, sailor or airman. Thus a battalion commander passes his orders to company commanders, they pass them to platoon commanders, who pass them to the non-commissioned officers who lead the sections which comprise a platoon, and so on. Although this may seem combersome at first sight, it is really the only possible way of doing things ; if a battalion commander were to pass an order to a platoon commander without going through the company commander, the latter's position would become extremely difficult. His authority would be undermined he would not be even aware of what is happening and may in consequence issue orders which conflict with those of his superior. The result would be chaos, and almost certain failure in battle.

Although the method seems slow & clumsy and perhaps might appear even to be unnecessary in a small laboratory, I am nevertheless entirely convinced on the basis of experience of working in laboratories of various types that it is really an absolutely essential method to adopt. A laboratory should always be organised in broad divisions, each division containing various sections, each section having possibly several sub-sections. Each division, section and sub-section must have an individual who is the recognised head of the unit concerned ; and through whom all orders for the lower formations pass. One can imagine a laboratory divided into two main divisions, chemical and metallurgical, thus :—



The passing of orders should be by the arrows. If say, the Foundry Section has to cooperate with the Oil Section, cooperation is arranged through the heads of divisions.

Another point to note in laboratory organisation is that normally every individual in that laboratory must be responsible to and receive orders from, one person only ; that is, his immediate superior. This arrangement should never be changed except in an emergency. No one should ever be placed in a position where he can receive orders from more than one person.

There is nothing in such an arrangement that in any way interferes with the natural desire of a head of an establishment to familiarise himself with every member of his staff, even the most junior, and with their work. The only limitation is that actual *orders* must always pass through the proper channel.

In a system such as this the officer in charge of each unit must assume a considerable degree of personal responsibility for the work done in that unit, even if it is not work which he has actually carried out himself. It is up to him to see that his subordinates do their work properly, and that they have received the necessary training or advice that they need to perform their work. I remember that in one U.K. Laboratory an analyst made a mistake which involved the authorities in accepting a consignment of sub-standard material.

It was a valuable consignment. The authorities took such a poor view of this that they demanded the name of the analyst concerned with a view to disciplinary action. The head of the laboratory who of course had had nothing whatever to do with performing the analysis but was a man of extremely high and rigid principles, refused this order, saying that he himself was entirely responsible for the work of his subordinates. This did not mean that the analyst escaped without punishment ; actually he got worse hell from his chief than he would have done from the authorities. I think this illustrates the principle involved clearly enough.