"applied research," which latter it is proposed to restrict to military institutions. This seems an unfortunate distinction. If a research is initiated in view of a definite application, then that application must never be lost sight of, and the whole should be co-ordinated by the same brains, or else the "pure" and the "applied" researchers will be at cross-purposes. The co-ordination should be done by the research worker himself, not by semi-scientific officials appointed for the purpose.

(4) The creation and development of firms willing to carry out experimental work ought to be encouraged and subsidised. Even during the war, and with the backing of a Government Department, it was often a matter of the very greatest difficulty to get firms not to neglect experimental work in favour of mass production.

(5) It would be well if officials would understand that a scientific man does not work in the same way or under the same conditions as, say, an orderly officer or a clerk, and that he should be given the utmost freedom of movement and of hours; that he should not be continually bothered with reports and returns or unnecessary official correspondence; and that usually he does his real work, not in an office, but in the solitude of his study, and sometimes during wakeful hours in the night. They will also have to realise that research work is individual, and that one cannot hand it over from one person to another every six months, as one does a platoon.

(6) Finally, the Services must be prepared to put up with negative results without making a wry face or putting a black mark against the worker. The trail of science is dotted with the bones of dead theories and the remains of unsuccessful attempts, yet it is largely by means of these that science has been built up.

Coming now to the other side of the question, namely, the employment of scientific workers in the Services in an emergency, this is a problem needing urgent and careful attention. Undoubtedly the treatment of it during the war left much to be desired. The only co-operation which the War Office apparently looked for from the universities, previous to the outbreak of war, was that, through the Officers Training Corps, they should provide a proportion of Reserve officers—chiefly infantry—with a minimum of military training of the normal pre-war type. The idea of using the specialised knowledge of the universities for the technical services of the Navy, Army, and Air Force took shape only very slowly, as the development of the actual fighting made it plain that science would play an increasing, perhaps eventually a predominant, part in modern warfare. By that time much of the promising human material which the universities might have supplied had already been wasted. The main difficulty, however, which was then encountered (and still exists) was that the regular military or naval officer upon whom devolved the choice of persons for appointments of a quasi-scientific nature had not, in general, a suitable education or training for estimating scientific ability. The inevitable result was that large numbers of young men with little or no qualifications got taken on in a hurry at their own valuation, while the best use was not made of such real experts as were available.

I feel that the writer of the article in *NATURE* has hit the right nail on the head when he says: "Until it is made obligatory for a proportion of them [the General Staff] to have had such a training [in science], the fundamental reform will not have been effected." The same, of course, applies even more strongly to the Air Force and the Navy. In the latter the scientific tradition is much more powerful, and there, on the whole, far better and more intelligent co-

operation was obtained. I would suggest, however, that what is most urgently needed for General Staff officers is a course of scientific classification and organisation where they would be taught the real meaning of scientific qualifications and the names of living authorities in various subjects. This would enable the military administrator at least to make an intelligent selection.

I also agree that "it is surely most desirable that, for the future, science should have some scheme of mobilisation ready." What is wanted is a mobilisation register of all scientific workers, carried out under the auspices of a committee on which the various scientific bodies and the universities should be represented. This mobilisation register would indicate, from the scientific side, the age, qualifications, and grade of the worker, the nature of the work which may be expected from him, and the remuneration which he is entitled to expect. The Service authorities could then add medical category, arm or branch of Service to which assigned, rank (if it be desired to give a commission), unit, and place of mobilisation.

So far I have dealt purely with the technical side of the Services; but brains are not unnecessary on the executive side, and the suggested register might well be extended to cover men with high intellectual (not necessarily scientific) qualifications who happened also to have had an adequate amount of military training, so that on the outbreak of war they might be ear-marked for Staff appointments. In 1914 we had a highly trained, if small, General Staff; unfortunately, most of them (to their own great honour, but the nation's loss) rushed to the front line, and a large proportion never returned. Their places and the new vacancies created by the expansion of the Army were necessarily filled in an unsystematic way, as emergency dictated. Many of the junior Staff appointments had to be given to men who had had an inadequate general education and no pre-war military training.

The War Office might well consider the possibility of instituting a General Staff Reserve, largely drawn from among university men. The officers of this Reserve should (by expanding the Officers Training Corps organisation or otherwise) be kept in constant touch with the growth of military thought and practice; they might be called up at fairly frequent intervals for courses, or attachments to Regular units, or manœuvres on a large scale, and they should be adequately remunerated for the time they gave.

L. N. G. FILON.

University of London, University College,
March 20.

I HAVE read the leading article on "Science and the New Army" in *NATURE* of March 18 with great interest but with mixed feelings. The meaning of the word "research" and the value of the investigator who researches have, in my opinion, never been fully appreciated by the official or military mind.

The attitude of repression and discouragement so general at the beginning of the war was particularly depressing for those of us actually in one of the Services, and therefore not free agents. Towards the end, however, there certainly was a distinct and gratifying change of front—a change which, at any rate in the section I knew best, produced excellent results. Yet, with the best intentions in the world, the authorities in their experimental establishments must needs call into existence a bewildering and unnecessary maze of organisation, or rather over-organisation, in which ten men did badly the work of one, and the few true investigators and designers, for whom presumably all this had been arranged, found

themselves so tied and hobbled as to be practically helpless.

It does not seem feasible, in fact, usefully to organise research on such lines. Research—and design, for that matter—speaking again of the little corner I knew, has been almost invariably the result of the strenuous effort of individuals, and not the fruit of the organisation in which these particular individuals happen to have been embedded at the time. It is not meant to imply that there should be no organisation in Government experimental establishments, but, speaking from experience, I feel most strongly that capable investigators and designers will not produce their best if compelled to work in an atmosphere of over-organisation.

What must surely be a matter for congratulation to the body of scientific workers in the country is the fact, which the article referred to brings out, that the Army (and presumably also the Navy and the Air Force) has learnt its lesson, and hastens to admit that there is something to be gained even in peace from the universities and other scientific and technical institutions. Yet here again one seems to detect—perhaps in pessimism—a touch of misunderstanding. The Government's policy (expressed in the following rather unfortunate words) is "to farm out to civil scientific institutions, such as the universities, the National Physical Laboratory, the Imperial College of Science, etc., all pure research that can be profitably farmed out." The universities will surely be only too willing to give the most sympathetic consideration to a co-operative scheme of this sort, provided that the subject-matter of the researches to be "farmed out" is sufficiently interesting and important.

Presumably the Department of Scientific and Industrial Research will be largely responsible for the allocation of these researches, but if at the same time the smallest step is taken towards "the detection of overlap [in research], where such exists, and its elimination," a feeling the reverse of sympathetic will be set up.

Investigations worthy of the name should surely be carried out in all freedom of both thought and action; even the suspicion of interference would be intolerable. The official interest now taken by the Army in scientific research is a great sign of regeneration—if, indeed, it is more than a surface interest, as we all hope. Let us pray that over-organisation of the Government experimental establishments and unsympathetic treatment of civil scientific institutions will not dwarf the growth of the new scheme.

R. WHIDDINGTON.

The University, Leeds, March 23.

THE leading article in NATURE of March 18 directs timely attention to the need for action by men of science if the lessons of the war are not to be forgotten in the Army of the future.

It was impossible in the war to scrap the old machine; years and experience are essential if a better new one is to be made. But no memorandum or paper policy, or even consultation with experts, will make a good machine unless the right material is used.

In peace-time the new Army should have technical education (in the broad sense) and scientific research as its two main functions; they are the only sound bases upon which an efficient fighting machine can be built. That appears to be accepted. But these functions can only be performed by an Army with an educated staff, led by scientific men who combine originality with administrative capacity. If the main body of the staff consists of men without the rudiments of a scientific education, who will "administer."

the men of science and control the allocation of funds, then there will be a largely unnecessary sacrifice of the Army if a great emergency arises.

With regard to the co-ordination of research, it is true that a good deal of duplication must inevitably occur if the independence essential for great discoveries is to be maintained. But there is much unnecessary waste which can be avoided without real restriction of independence. The direct economy is, however, of minor importance; the greatest advantage comes from forming the habit of consulting the right department or the right expert; and this is as necessary for the man of science as for any other man. The late Lt.-Col. W. Watson, whose untimely death deprived the nation of an expert with an almost unrivalled knowledge of the applications of science in war, once related how a board of chemists spent half a day discussing a meteorological problem which could have been solved in half an hour by a single meteorological expert.

E. GOLD.

March 22.

ALL scientific workers whose research has brought them into contact with military authority during the war must appreciate the leading article on "Science and the New Army" in NATURE of March 18, especially the sentences in which it is urged that "science linked to the Army by fussy research co-ordinators acting under a nescient soldier will not solve the difficulty," and that "science will not occupy its rightful position in the new Army" until the General Staff includes a due proportion of officers who are endowed with a scientific spirit and have received a scientific training. Until then some of the outstanding defects manifested during the war will continue. These defects are:—

(1) *The unthinking application of scientific research.* A good instance of this occurred in the issue of the ridiculously excessive diet (based on research under active marching conditions) to our soldiers in Flanders who were unexercised in the trenches, whilst wholly inadequate rations were being supplied during the period of the soldiers' strenuous training in England.

(2) *The delay in seeking expert advice.* Too often G.H.Q. failed to realise how expert advice could help it, and did not trouble to seek it until too late.

(3) *The choice of expert.* The truly scientific worker rarely asserted himself spontaneously during the war; he waited until his advice was asked. The man who forced himself to the notice of the General Staff as an expert was usually unscientific. Thus G.H.Q. was "taken in," and came to rely too often on those whom the scientific world considered as being pretentious in greater or less degree. Their one source of strength was that they were usually "practical" men, whereas the men of science in some cases offered suggestions which could scarcely be carried out during service in the field. But in the long run the Army suffered.

CHARLES S. MYERS.

30 Montagu Square, W.1, March 29.

Knowledge and Power.

THE leading article "Knowledge and Power" in NATURE of March 25 strikes a resonant chord. I am a newcomer into the realms of officialdom, but my experience relates to a Department of State which is of new growth and not yet rooted in tradition. Aeronautics in Britain has had its foundations laid on a scientific basis, and technical staffs have been able to build on trustworthy data. In view of the fact that British aircraft obtained an absolute ascendancy over the craft of any other country, Allied or enemy, and that Britain was the only country with this scientific