

Discussion

Mr D L Hollis Williams (*Westland Aircraft, Ltd*) (*Member*), said that as a civilian, it was with some doubt and hesitation that he opened the discussion, among such a galaxy of military talent. Colonel Mead was an expert and convincing spokesman in the cause of the military helicopter, nobody could wish for a better presentation. Having listened to him, one formed the impression that an army without its due proportion of helicopter strength was a pretty inefficient army. There was also the terrifying thought that to be faced with an enemy with such capability could lead to astonishing results in a very short time.

One had, however, the feeling that the Author was still thinking of the helicopter as an ancillary device, as something that was useful in a tight spot. Comparison could be made with a factory. The more efficient the tools the workers were given, the more efficient they became, and production increased or less manpower was required. To provide the Army with helicopters would give much the same kind of solution in that the job could be done with less manpower. Thus the apparent high initial cost of helicopters might in the end prove a saving by greater efficiency.

It was interesting to note the change in thought concerning the arming of helicopters. At the time of the Suez operation, the helicopter was merely a vehicle to take troops into action. Since then, however, the French had armed their helicopters in Algeria and the Americans, following the idea of "cavalry of the air", were working out formations leading an assault by heavily-armed helicopters to batter down the fire of any strong point which tried to oppose.

Mr HOLLIS WILLIAMS regretted the absence of a projector, because he had intended to show what he described as a magnificent slide of an H 34 (S 58) with a total of 72 rockets, four forward-firing 0.5 in. guns and two other 0.5 in. guns firing out through the windows at the side, as a test vehicle, to find out what could be done in the way of an offensive screen to clear the way for a formation of troop-carrying helicopters coming in behind with the main force. It would be interesting to know whether Britain was thinking along the same lines.

Lt-Col Mead replied that he had stated in the lecture that the helicopter would result in a saving of manpower in certain roles because it would be possible to keep troops ready to go into any position, with helicopters to carry them, instead of having to place them in advance in all areas from which the enemy were likely to approach. Unfortunately, however, until there were a very large number of helicopters indeed—and this was basically a decision for the taxpayer—the reductions in manpower that would be achieved would be marginal. Helicopters would have to be used as maids of all work, carrying supplies in the forward area as well as carrying troops on assault operations. It was difficult to see how great manpower economies could be effected until a large number of helicopters was available.

Concerning the arming of helicopters, Lt-Col MEAD said that he must throw a damp squib into the discussion by reminding his audience once again that he was speaking as an individual and not as a War Office spokesman. His views on the arming of helicopters might not be generally shared in the War Office. What was much more important, they might not be generally shared in the Air Ministry, which at the moment was responsible for all aircraft of more than 4,000 lb all-up weight. It would be false to assume that it was possible to spray an area inaccurately and get away with it. When helicopters were, in fact, armed, they would have to be ready and able to put down very accurate fire indeed. The days of the semi-civilised gentleman on the ground who would run off at the first burst of fire were gone. He was now a seasoned soldier commanded by a graduate of one of the major universities. He would not run, but he would stay put unless he was shot at very accurately indeed.

Mr T L Ciastula (*Saunders-Roe, Ltd*) (*Member*), said that it was delightful to hear the lecture so well delivered and so clearly expressed in terms of what the Author thought the Army needed.

The main point appeared to be that the Army would require basically six different types of helicopters, although the smallest of them, a single seater, may not necessarily be a helicopter. For various reasons of which finance was perhaps the most important,

it was very unlikely that all six types would exist. It was always a bad thing in any Service to have too many different types, since the number of types increased the training, maintenance, servicing and spares problems. One of the fundamental questions, therefore, is to decide how one can logically combine some of the types of these helicopters in order to arrive at the smallest possible number of types. The Author has suggested that it might be possible to combine the utility helicopter with the liaison machine. An elementary sum may provide the answer here. The utility helicopter was required to carry 10 fully armed men at 250 lb each, i.e., 2,500 lb payload. Because of all-weather operation, one would have to allow 500 lb for radio and other specialised equipments. It would require 2-crew at 200 lb, i.e., 400 lb, thus giving a disposable load less fuel of 3,400 lb and a disposable load of 6,400 lb. On the basis of 2 hours endurance, about 3,000 lb of fuel will be required, this fuel we will check after arriving at the total all-up-weight of the machine. For the modern turbine powered helicopter design, a 40% disposable load was a good average. Thus, with the fuel weight already assumed, would give an aircraft about 16,000 lb A U W.

Since we are discussing a British helicopter, which would have to operate in extremes of temperatures and altitudes, for instance, at 4,000 ft in tropical conditions, it was possible to derive the power required. The actual power loading required at say 4,000 ft in tropical conditions, is about 8 lb /S H P which taking the average drop of power of the modern turbine with temperature and altitude, would give a nominal power loading in I S A conditions at sea level of 5 lb /S H P, the turbine being suitably derated. Thus, for 16,000 lb A U W and the power loading quoted, the total S H P required is approximately 3,000 S H P which could mean 2 turbines at approximately 1,500 S H P nominal rating. If we now assume disc loading of 6 lb sq ft which is a fairly high figure, this gives us a rotor diameter of 58 ft. The fuel content of 3,000 lb assumed earlier can be simply checked by taking the power actually used at 8 lb /S H P which gives 2,000 S H P. With the specific fuel consumption of 7 lb /S H P /hr and 2 hours duration, this gives 2,800 lb of fuel, i.e., it gives a small reserve on the 3,000 lb of fuel assumed earlier. These figures are, of course, only approximate and by reducing performance requirements and perhaps weight of the equipment, the helicopter could be made 10 to 12% smaller in terms of A U W. Nevertheless, it can clearly be seen that a utility helicopter is a fairly large machine and cannot intelligently be combined with the liaison machine which is a 5-seater and the size of which should be kept to an absolute minimum. Combination of the utility machine with the reconnaissance machine will present a much better picture. Whilst it is quite true that a 2-seater was sufficient for the reconnaissance role, one has to remember that if one adds armed reconnaissance to its duties, as the Lecturer appeared to do, this reconnaissance helicopter, and particularly its performance capabilities, will have to be larger than for a 2-seater machine. For instance, any worthwhile weapons, possibly in the form of rockets or cannons with a reasonable amount of ammunition, would certainly correspond to the weight of two people. Thus, a really good reconnaissance 2-seater would require a 4-seater lifting capabilities which, of course, would bring it quite sensibly into the category of a 5-seater liaison machine. It would be interesting to have the Author's views on this important point.

Coming to the larger helicopters, it seems that it would be logical and, perhaps even unavoidable, to combine the duties of the utility and light cargo helicopters. It is true that if one did this, the utility helicopter might become a little too large and the light cargo helicopter a little too small, but it is perhaps logical to rather have a larger number of smaller units because this would give greater flexibility of operation and factors such as unserviceability, combat damage, etc., would immobilise a smaller proportion of the force available.

Coming back to liaison and reconnaissance machines it was perfectly feasible to retain their remarkably small size, their basic simplicity and reasonable cost. These machines will have nothing like 50 ft diameter rotors. It was also possible to retain their excellent handling qualities without any artificial means.

Considering the all-weather operating conditions, it was absolutely essential that at least in the group of smaller machines only the minimum of equipment was installed. They were small aircraft, they could not carry a great deal and their performance and usefulness can be greatly reduced by overloading them with large quantities of equipment. Such specialised equipments, of course, pose a number of problems such as specialised maintenance and cost. In the liaison helicopter, it was quite easy to put

into it the equipment which would account for one-third of its cost. It was necessary to think very carefully about how much equipment was needed.

Finally, it was a most encouraging paper because nowadays, the aircraft industry mainly hears of what is not wanted. For a change it was refreshing to hear what is wanted.

Lt-Col Mead, in reply, said that Mr CIASTULA had mentioned six kinds of helicopter. The first, however, probably would not be a helicopter, thereby leaving only five.

Most of what Mr Ciastula had said was an impassioned plea in favour of a certain degree of standardisation, but only in the lower levels, and he did not propose to accept the invitation to follow Mr Ciastula into the jungle of technicalities.

What an army would like to have was the five forms of helicopter. If the designer said that they could not have them, then they could not have them. If the taxpayer said that the Army could not have all five types, it would be necessary to standardise and reduce the number. By reducing the number of types, however, the probability was that the Army would get something which was not quite what it wanted.

It might be possible, for example, to combine the liaison and the utility roles. A utility machine might be provided to carry six or seven men instead of a section of eight or ten men. There would then be the choice of using it as a liaison aircraft or as a utility aircraft. This, however, would be inefficient, but in the cause of satisfying the taxpayer it was often necessary to be inefficient.

Lt-Col MEAD said that he bowed to the greater knowledge of Mr Ciastula on the question of the reconnaissance and liaison aircraft and would merely remark once again that the Army did not wish to hamper its reconnaissance. If, as Mr Ciastula had said, an aircraft of the five-seater type could be produced which would be a very good reconnaissance aircraft also, any army ought to be satisfied.

The Army was responsible for saying what it wanted and it would certainly say that it wanted the reconnaissance, liaison and all the other roles to be carried out round the clock whatever the weather. If the designer said that the Army could not have it, they would not be able to have it until a rival designer, or a designer of some other kind of equipment, produced something that would give the required capability.

One did not doubt that in due course something else would be produced, even though it might not be for ten years. One day, however, the Army would find that it had its five-seater liaison aircraft, and fitted with enough instrumentation to enable it to be flown safely in all weathers.

Mr D M Mostyn Davies (*Farey Aviation Co, Ltd*) (*Member*), congratulated the Author both on his excellent paper and on his able and fluent manner of presentation. From what Col Mead had said, it was clear that nuclear weapons confronted armies with most appalling difficulties. On the one hand, a successful attack demanded concentration of offensive effort. On the other hand, any concentration of troops or supplies would invite obliteration by nuclear bombs. Furthermore, a country such as Britain must be prepared to mount efforts ranging from limited police actions to major wars on a continental scale.

His one criticism of the paper was that although the Author mentioned large-scale warfare, he had perhaps stopped short of the full implications of such a war and its demands on air transport. In particular, the paper contained a specification of a cargo vehicle to carry three tons over a radius of 200 miles. Concerning the cruising speed, the Author indicated that the current low speed was no serious disadvantage, with certain qualifications. In the case of the cargo helicopter, it was a serious disadvantage. The faster an aircraft flew, the greater was the amount of work it did in a given time, and time was at a premium in building up an attack. With current cruising speeds of the order of 80—100 knots, the effect of, say, a 50 knot headwind could be crippling.

The load of three tons was apparently chosen because it was the same as that carried by the standard road supply vehicle. "Only in this manner", stated the paper, "can true flexibility be ensured." This, however, was a matter which should be considered with the greatest care.

The three-ton truck was presumably chosen largely because it could be used on

most roads. It was the roads which constituted the limitation. On the German autobahnen, for example, there were enormous trucks—certainly far more than three tons—and they were chosen because the bigger size gave more economical transportation. There were plenty of ten-ton trucks even on the indifferent roads of the United Kingdom. In the same way, one would imagine that the cargo helicopter would ideally have a much bigger capacity—nearer ten tons. In fact, this sort of capacity, coupled with a good cruising speed, was vital if an army was to cope with its enormous supply problems.

In laying down a requirement, one was to some extent conditioned by what was available. In terms of existing operational helicopters, an 8–10 ton load for a 200 mile radius aircraft was a tremendous jump. The Fairey Rotodyne, however, was a vehicle which could be developed to this order of capability. There were, in fact, already civil airline orders for a developed aircraft of the Rotodyne category. Certainly such development was expensive, but costs could be shared. In any event, it was not likely to add much to the nuclear weapon bill. Remembering the picture of modern warfare that the Author had described, such a vehicle would surely be indispensable. Furthermore, one big one cost probably less than three smaller ones.

Given such a heavy-lift helicopter, the main requirement—bulk transport—was met. The same aircraft could also be used for flying crane duties. In using one type to do the work of two, a very considerable overall economy would surely result.

There was a suggestion in the paper that the fuel used should be that used in the ground vehicles. It was one thing to do this for a small reconnaissance helicopter, based on the front line, where operational demands would override questions of economy and efficiency. It was an altogether different proposition to do this also for big transports. The future of these was surely linked with the development of efficient gas turbine engines and aviation kerosene had many big advantages. Since the big aircraft would be based at the rear, the supply problem should not be acute.

It was encouraging to see the Army coming out with its V T O L requirements. As the Author had intimated, this would bring in its train questions of who flew, maintained and paid for these vehicles. Purely administrative questions of this sort, however, should not militate against the choice of a big rotary wing aircraft if study revealed it to be necessary.

Lt -Col Mead, in reply, said that only somebody who was very rash would start to be too definite about what the next war would be like. The views of Mr MOSTYN DAVIES deserved as much consideration as anybody else's, and so he did not propose to comment on them.

He would only say once again that in the lecture, the Army had *not* come out with its detailed requirements. The paper referred to *an* army, and the views expressed were his own.

It might well be that a very large V T O L aircraft would be needed and that, therefore, it might be possible to make do with lesser numbers than if there were smaller machines. It would be no good having a very few aircraft.

Squadron Leader J R Dowling (*Air Ministry*) (*Member*), said that he had very much enjoyed listening to the very lucid plea for the P 531, followed by the more obvious plea for the Rotodyne! He could only presume that the silence of the Bristol Aeroplane Company was intended to indicate confidence that they could meet all these roles with, perhaps, two or three aircraft.

He did not mean to point out or mention in detail some of the startling aspects of the Army requirements for helicopter manoeuvres that were associated purely with Army tactics. It would be as rash to predict that the problem of night flying at 100 ft in a thunderstorm would be insoluble as to say that a flying motor-bike which everybody could fly was impracticable, although it was only rash in the sense that all prediction was dangerous. There might be some danger in seizing on the helicopter to make easy the many and varied existing tasks of the Army without paying enough attention to modifying those tasks themselves when the helicopter made a whole different philosophy possible.

The arguments about nuclear war itself should not be taken in too great detail. Small boats might indeed land upon open beaches, but this assumed that they had

themselves come from an undamaged base. It might well be that if the chaos was really widespread, the winner would only be decided by who was able to move. This would be the side with the biggest number of helicopters which remained serviceable. Similarly, if air superiority was lost, the war would be lost anyway.

The Author was to be congratulated on giving his lecture, which was not only clearly understandable but was especially refreshing since it was not only spoken throughout in the English language, but it was also clearly audible. There had been many meetings of the Society when this was not the case. It was most refreshing to hear the many varied capabilities of the helicopter expressed so clearly. There was, however, a certain danger here, and it might be of interest to quote an historical analogy.

In 1950, the R A F was having considerable difficulty in explaining to the Army in Malaya just what the helicopter could and could not do for them. It was Col "Mad Mike" Calvert, of 22 S A S, who first grasped the import of what the R A F was saying and, as a result, he was able to use the helicopter successfully more than all the other units in Malaya put together for almost eighteen months. The significant fact was that having succeeded in practically monopolising the small force available, he then proceeded to misuse it for his own purposes—justifiably to himself, but at everybody else's expense. The fact was that there were never enough helicopters to go round, and, one ventured to suggest, there never would be that was, not until every single individual in all the armed Forces—and, indeed, most of the civilians as well—could all be picked up at a moment's notice and taken absolutely anywhere and then kept fully supplied with all their needs for an indefinite period.

There was a second point to be put forward, and the Author was invited to comment on the conclusion that was drawn from it.

There were certain basic principles to be borne in mind if everybody was not to seize on his own particular problems and then try frantically to collect together as many helicopters as he could for his own particular solutions. Not all of these principles were by any means yet fully formulated, but there were two which must surely be placed first for military helicopters.

The first was enshrined in the magic word "flexibility", which one was glad to hear the Author use so frequently. The converse—specialisation—spelt death to the military helicopter, although the opposite probably applied to the civilian market. Squadron Leader DOWLING said that he was referring both to the essential purpose of conferring flexibility on the Army from a manoeuvring point of view and also to the flexibility of the helicopter itself in doing different tasks. A specialised military helicopter was in grave danger of becoming an extremely expensive white elephant.

The second principle was that the helicopter was never used when anything else would do. This went a little further than the Author in suggesting that the helicopter might not always be used. The criterion was operational necessity as opposed to convenience, but this was always bound to be a matter of opinion and was, therefore, likely always to become a subject of disagreement.

The conclusion on which the Author's comments were invited was that the main helicopter force in any theatre must be under the centralised control of professional specialists—i.e., centralised from a theatre point of view rather than centralised in any field unit headquarters—so that priorities could be allotted to various tasks and the feasibility of new tasks could be properly assessed in relation to the potential available.

That was not to say that groups of helicopters should not be attached to individual units faced with a particular task at a particular time. But as much of the force as possible should be able to be allotted here and there for a whole variety of tasks as the situation altered, and this was where professional control came in. Perhaps the biggest consideration was the question of servicing, but this was so obvious that it was mentioned merely in passing.

The Author, having asked for no fewer than six differently specialised helicopters, had mentioned the complexity and expense of the helicopter and had foreseen some insistence on standardisation of types. Never was a truer word spoken. The R A F was the fully professional flying service in the Armed Forces, but who would deny that the Army was infinitely more experienced in demanding equipment from stores? It would be inappropriate for the Army to question the R A F on pure flying matters, and one supposed, therefore, that it would be equally impertinent for the R A F to

question whether the Army was perhaps using too rashly the principle of deliberate overbidding in this matter. It was quite understandable that a demand should be initiated which involved an absolutely shattering expense in the hope that the bemused Treasury would regard the actual amount allocated as a saving. In the privacy of a meeting of the Society, would the Author admit using this technique?

Squadron Leader DOWLING had never before been in the position of even appearing to advocate cutting down somebody's bids for helicopters, and he hastened to add that he was, in fact, doing just the opposite. The more efficiently and effectively that helicopters were used, the more they would effect financial economies in other directions and the more easily would the money become available to pay for further development.

Standardisation, correctly applied, could, in fact, increase a helicopter's flexibility and not reduce it. The principle, which sounded anomalous, was that the helicopter must not be too big for its task, otherwise it could never be obtained when it was wanted. It was not a matter of some clever technical consideration or even finance. It was simply that when the helicopter was too big for what it was wanted to do, it was never possible to let anybody have it, it was too expensive. It was better to have small helicopters where they were wanted, even if they were a little too small, than to have helicopters that were sufficiently large to meet a planned task, because if they were enormous machines they would always be somewhere else.

A truly practicable reduction in the number of types needed could be suggested. It might be possible to produce a machine that was so easy to fly that anybody could fly it. Concerning the two- and the five-seater reconnaissance machines, one would imagine that these two could most reasonably be put together. With a helicopter which carried only two people, one immediately wanted, justifiably, to put in a third person.

It was no use stating that this kind of argument was expected. What happened in practice was that the helicopter was obtained, a great deal of effort was spent in making it acceptable to all sorts of people and then it was no good. The two-seater and the five-seater offered the best chance for combining helicopter designs, as Mr Ciastula had suggested.

A general purpose helicopter was needed to fill what was called the utility role. Again, it should not be too big, it was most important that it should not be too big to be available in quite large numbers. It was always possible to have more of them, that was comparatively simple. Even to somebody who was no expert in financial matters, it appeared that money could be saved by buying helicopters that worked rather than trying to buy helicopters which merely got bigger and bigger on the drawing board. In any case, the original principle applied that if there were more of them, even though they were not quite as big as one would like, they were more likely to be where they were wanted. There was thus a better chance of getting one instead of none. Furthermore, this was a case where overbidding for payload might have the effect of denying use of a helicopter altogether.

Large trooplifts were better done with more helicopters temporarily concentrated, especially in the face of enemy opposition. The helicopter should also be small enough to be economical in the ground attack role.

One must not be too specialised in not being specialised, and so a heavy lift helicopter must be admitted. Once again, however, it must not be too big. Very large loads over long distances might well be better done by something like the Roto-dyne, or even an S T O L fixed-wing aircraft, but very large loads over short distances could possibly be lifted by the light cargo helicopter, or a combination of two or more light cargo helicopters put together. It was understood that work was already being done by Vertols. This obeyed the original principle of flexibility by leaving the individual machines still free for their original task after they had done the occasional very heavy lift. In any event, it was not something that would be required every day.

As a final plea for flexibility, he asked the Author to say a word or two on his view of the importance of having a helicopter that would land equally well on concrete, snow, mud or water. No apology was needed for speaking at such length. It was, in fact, a tribute to the stimulating effect of the lecture.

Lt-Col Mead, in reply, said that the Air Ministry appeared to have agreed with him in considerable measure, and so he did not propose to comment on most of what Squadron Leader DOWLING had said.

In reply to the request for comments on the necessity for a helicopter to land on concrete, snow, mud and water, Lt-Col MEAD said that he was not sure about concrete. He did not think there was any doubt as to the helicopter's ability to land on concrete, and, of course, there was not much concrete in a theatre of war. As for the rest, the more flexibility the helicopter had, the better. The more surfaces it would land on, the better.

It would probably be useful to an army to have a helicopter that would land on mud, water and snow. The most important of these was snow, because when snow fell in large quantity it was apt to cover vast areas, and not to be able to land on it would restrict the operations quite considerably. Water and mud should be regarded as advantages to be gained, but not at the expense, for example, of sacrificing a lot of weight and having, therefore, to have a very big helicopter to carry a small load.

As there was one point in the middle of Squadron Leader Dowling's remarks with which he was not sure that he agreed, it might be as well to make his opinion clear. There was a lot of talk about the holding of helicopters under centralised control. Admittedly, to get full flexibility, helicopters, like everything else, must be liable to centralised control. What tonight's lecture had been dealing with was helicopters in support of an army. Therefore, one would agree that these helicopters must be under the ultimate control of the senior Army commander in the field.

Another principle with which he disagreed was that of never using a helicopter if something else was available to do the job. Possibly he was mistaking the point made by Squadron Leader Dowling, but as it had been expressed he disagreed strongly with it. It was a typical taxpayer's argument. If it was applied to all weapons, the Army would be using a mediocre weapon to do everything all the way round. Since the balance between two armies in a battle was a very small one, an army which had mediocre weapons with which to do everything would never succeed in winning. There must be some specialised weapons.

If, for example, an army had a tank which was equally good for doing swift movement across country in a reconnaissance role and for the support of infantry, in which role it would be slow moving, heavily armoured and carrying a heavy gun, a compromise between the two would result in something that was good for neither role. Therefore, it would lose both battles. It would lose the battle in reconnaissance because of its lack of speed and it would lose the battle in supporting the infantry because of its lack of armour. If there were to be helicopters, they must be good machines for their role. If they were not good for it, it would be better not to attempt to use them for it.

Squadron Leader Dowling had mentioned briefly the necessity for armies to adapt their tactics to the helicopter to a certain extent instead of asking for the helicopter to support their particular tactics, and one agreed with this. The ultimate aim was to take the fullest advantage of what vehicles or weapons were available. Therefore, if something like a helicopter was available, one should undoubtedly work out one's tactics around it and adapt and modify it—and modify the size of the units to the size of helicopter that was allotted beforehand.

It was, however, necessary to have quite a large quantity of weapons or vehicles. Not until a commander could rely on having helicopters in his support on important occasions would he begin to modify his tactics, his equipment and his organisation to fit the helicopter role. Until helicopters were available in that quantity, an army would always have to squeeze a helicopter in to fit the normal tactics that it would be adopting in nine battles out of ten.

The use of the adjective "bemused" as applied to the Treasury was amusing. In his own meetings with members of that establishment, he had never found them bemused.

Mr B H Arkell (*World Helicopter*) (*Founder Member*), asked whether the Author had considered for the reconnaissance role the use of a light autogyro, which, presumably, would have the facility of jump take-off and vertical landing. Such a machine was quite possible technically. It would be easier to fly, easier to maintain, considerably cheaper on first cost and much cheaper to operate.

Lt -Col Mead replied that he had certainly considered the possibility. In fact,

at least one member of the audience had had his life made a misery by him on the matter during the last six months

His conclusions about the use of the autogyro were based entirely on what the technicians had told him, and would tell him in the future, about the capabilities of the machine. It appeared that it would be simpler and cheaper and, therefore, it would have enormous advantages. The only doubt was to what degree the advantages conferred by the hover capability of a helicopter would be provided in a modern autogyro.

If the autogyro would be able to land steeply into small clearings and take off from them, and if it would be able to fly slowly in bad visibility in visual contact with the ground, for instance, one would have gone a long way to replacing the small helicopter.

In the past, all the advice on the technical side had been that it would not be able to achieve those qualities and that its jump take-off would not, for instance, take it out of clearings with trees around them or into such clearings, and that it would not be able to fly at low level at very low speeds. If, however, the past advice had been wrong, a great future awaited the designer who could prove it to be wrong in the future.

Mr Colin Faulkner (*Saunders-Roe Ltd*) (*Associate Member*), added his congratulations to the Author. He too, perhaps also because he was a taxpayer, would like to cut down on the number of helicopter types proposed.

It appeared to be unanimous that a reasonable compromise could be arrived at with the second and third categories on the list, but on behalf of his company he would like to have a crack at the fourth. The key was perhaps to be found with the tables on the right-hand side of the chart.

How rigidly were the figures in the radius-of-action column to be adhered to? The later marks of the P 531, for example, were quite capable of lifting the weight of seven or eight fully-armed men or three-quarters of a ton of stores, but only for, say, a 25 nautical mile radius of action. This was a big range reduction, but it represented also a big reduction in the price, and particularly the size, of the helicopter. As Mr Ciastula had said, the utility helicopter to meet this full requirement would have, say, a 58-ft rotor and an all-up-weight of 15,000 or 16,000 lb. The P 531 was a 5,000 lb helicopter!

The right-hand side figures were indeed important. For instance, in the case of Nos 5 and 6, a combination could be arrived at by reducing say, the requirements of No 6 in the way of radius of action down to 25—50 miles. How certain were the Author's figures? They represented a great difference in the size of the vehicle.

Not only would one like to see some of the Army roles combined, but was there no possibility of the other Services collaborating in this matter? There were quite a few roles in both the Navy and the Air Force which approximated to the roles suggested by the Author for the Army. Helicopters were expensive items, both in terms of time and of money to develop. The fewer types there were, provided that the jobs were done, the better for the taxpayer and the Services, and the better the helicopters.

A plea should also be made about the business of over-complication, particularly with the small helicopter, as any addition represented such a big percentage of both aircraft weight and aircraft price. Would the Army prefer 50 per cent fewer helicopters with full all-weather capabilities, or the initial number with rather less elaborate instrumentation and equipment?

It would be interesting to have the Author's views concerning the use of drone helicopters, a matter which the Americans seemed to be already studying in some detail.

Lt-Col Mead replied that the discussion seemed to be coming round to the question of what the British Army wanted, but he was not really in a position to help very much in giving the answer. War Office policy ground out very slowly but, it

was hoped, surely. When War Office policy on a particular flying device was announced, it usually meant that the order had already been given and the items were half manufactured. Therefore, it was not possible to say more in this direction.

He agreed that in general, with small armies in particular, it would be necessary to compromise and, by standardisation, to reduce the number of types. In a big army, however, this was not necessary in the same way. One could afford to specialise and, therefore, to have more efficient performers.

He emphasised Mr FAULKNER's use of the words "reasonable compromise" and "provided they do the job". As had been stated in reply to an earlier question, it was no good having something which was an unreasonable compromise and which did not do the job.

The question concerning the drone helicopter was rather a "fast ball". He had not given a tremendous amount of attention to the helicopter form of drone. Drones would certainly be necessary to investigate and carry surveillance over enemy territory, but one did not know whether helicopters would be used over enemy territory. They were likely to be rather vulnerable. No doubt drone helicopters could be used on one's own side of the front line carrying surveillance devices pointing into enemy territory. There was probably a future in this direction, but it was early to say much about it. Even if he were to say anything definite or emphatic on the subject, it would probably be proved to be silly within a short time, if not by somebody present tonight. It was not possible, therefore, to go further.

The figures on the right-hand side of the chart were far from rigid. They would vary in every army according to the probable theatre in which the army expected to fight. In the utility role, however, a 25 mile radius of action would be a very small figure. At best, it would mean that the helicopters could not be based further than 25 miles behind the front line. This was an absurd figure, because it would mean that there was no allowance for any delay in landing troops or any question of moving from one position to another. It was necessary to be able to get the helicopters clear of the forward area and back 35 miles or more from the front line, concealed and out of the way when not operating. Troops must be dispersed in that kind of area and flow forward to their objective to do their job and be brought back again. Seventy-five miles was probably the sort of figure that was needed, although in certain theatres it could, perhaps, be reduced.

Similarly, the figure of 200 miles for the light cargo machine was based on the assumption that one would avoid bringing forward stocks of fuel and dumping them forward. They would be kept dumped away at the back. The helicopter would fly forward, pick up its load, go back and refuel again in the backward area.

If an army was faced with an alternative of having no helicopter or a machine with a radius of action of only 30 miles, it would have to do some hard thinking to decide what compromise it would accept. The basic requirement, however, was undoubtedly something of that order.

In Service standardisation, one accepted something which in the taxpayer's interest was most desirable. Once again, therefore, there remained the query: What is a reasonable compromise in the way of getting a helicopter that will do the job?

Mr J S Shapiro (*Servo-tec, Ltd*) (*Founder Member*), said that the Author had neatly divided the labour between the Services who stated their requirements and the designer, who gave not what the Army wanted, but what it was prepared to pay for, but, in reality, the matter did not end there. Considering the army helicopter in particular, the two aspects are interwoven and discussions have been going on for years.

For a long time, the opinion was held that the helicopter was altogether too vulnerable for almost any of the suggested roles, except in the rear, although this outlook had been somewhat changed, especially during the Korean war. If a designer was prepared to propose a particular helicopter type, could the Army help him to design one which was less vulnerable? In other words, was the analysis of vulnerability a little more advanced than it used to be ten years ago?

The Author had mentioned weapons but not armour. Again, this was a question of vulnerability. It was an extremely important question.

When one considered the problem rationally, the passion for reducing the number of types was completely incomprehensible, especially in a designer or anyone who was trying to sell development work. The more types that were needed, the more would be designed and developed. There seemed to be some sort of pre-conceived idea that if there were fewer types, there would be a cheaper all-round helicopter reserve. Mr SHAPIRO was utterly unconvinced of this and felt that he could put forward a very good case in support of the opposite view.

When thinking of the most economical helicopter force, one should start with the single seater and never make a helicopter much bigger than it need be. This was a fairly logical general view. It was one of the disadvantages of standardisation that everything was made a little bit too big. To standardise upwards was a principle that was sometimes worth while but was very much a matter of proportion. The matter should not be approached with the sort of general idea that by making three types instead of five, one would have an all-round, more economical helicopter force.

Turning to various devices that had not been mentioned, had the rotor chute been considered by the Army or by the Author? If so, what were his views about it?

Mr SHAPIRO could not agree with the somewhat emphatic statements that it was not possible to have a helicopter that was easy to fly without using a lot of black boxes. It was not one of those things that might some day be achieved, it was something which on paper could already be achieved.

What was needed was more research. In view of the Army's definite ideas, it was surprising that more research had not been done on the vital question of inherent stability and on the real silence of rotors. Very much better results might be achieved if a lot more research were done on single-seaters and two-seaters with these particular requirements in view.

Lt-Col Mead replied that the question of the rotor chute had completely caught him out. He would have to know more about it before he could think about it, let alone say what he thought.

Vulnerability was extremely difficult to assess in advance. Every time that a new battle device was produced, there would always be people who said "This is far too vulnerable. It will never survive. It will be shot out of the air." A recent example was the Auster aircraft, which, it had been said, could never survive, and yet an astonishingly small number were shot down during the war and the bulk of those that were shot down were brought down by their own artillery.

The utility helicopter particularly was potentially very vulnerable when carrying out its assault role. This was why it was necessary to look seriously into the question of arming it and getting it armed with an accurate weapon. Armed with an accurate weapon, its vulnerability would probably not be a limiting factor. Like everything else, this was a personal view.

Concerning armour, it was necessary to do something to protect the pilot of the helicopter that was to carry troops into the proximity of the enemy. It would be nice to protect the whole helicopter and have it heavily armoured, but this would make its weight altogether prohibitive. Perhaps one should be content with giving the pilot a bullet-proof waistcoat and, perhaps more suitable still, bullet-proof pants, in order that he at least had a decent chance of survival, and, with him, the load on the helicopter behind him.

Lt-Col MEAD said that he could not quarrel with any of the arguments which had been used tonight either for standardisation or against it. Any specialist in any army would be keen to have the maximum number of types in order to enable him to carry out all his roles with the maximum of efficiency. He would also want the manpower to man the various types, and he would want the money to pay them, to buy the spares and to buy the petrol and everything else, but any taxpayer, anywhere, would prevent him from having too many. From the taxpayer's point of view, standardisation was an attractive idea. He would argue that instead of having ten of one kind and ten of another, it would be possible to make do with fifteen of one

in the middle which could do both jobs. Countries whose taxpayers habitually won the battle would probably standardise, and those whose armies habitually won the battle would probably specialise.

Mr T G G Newbery (*Ministry of Supply*) (*Member*), said that during the lecture and the discussion, his mind had dwelt on how best to meet the requirements in the supply of an engine. The requirements expressed by the Author led to a rather difficult situation. On the one hand, he wanted an engine that would operate on M T fuel. On the other hand, he wanted the helicopters to be of the maximum efficiency, which of necessity meant that the engine must be of the lightest possible weight. In addition, the Author wanted the helicopter to be as quiet as possible.

For lightness and quietness, one would naturally turn to the turbine, but the turbine as now known, would not run continuously on M T fuel. It did not like the lead in it. To operate on M T fuel, it would be necessary to use a piston engine. Here again, however, to operate successfully and continuously on M T fuel would mean that the engine would have to be larger than would be required if it was operating on aviation fuel.

Would the Author, therefore, give a little more guidance on how he considered that the problem might be solved?

Lt -Col Mead replied that "No guidance can be forthcoming from this source!" He would, however, say that it was perfectly reasonable for the designer to ask the Army to state its priorities, and he would expect any Army to say that a high-performance helicopter was more important than one that would run on M T fuel. If it was not possible to combine both, the Army would probably plump for a high-performance helicopter and accept the fact that it must get a special fuel brought up into the forward area.

General Sir Kenneth Crawford (*Member*), congratulated the Author on a very good lecture and said that two points had occurred to him. One was that instead of considering the surface on which the helicopter landed and what one would pay in extra weight and cost to make it capable of landing on mud, snow and other things, the answer was to let it do the job without coming down in those circumstances and use its characteristic of hovering.

The second question was whether helicopters in the Army would enable a reduction to be made in fighting manpower. He agreed with the Author's categorical assertion that this would not be possible for the reason that throughout its history the British Army had never yet entered a war, or even an incident, with a sufficiency of manpower. Therefore, no one in his senses would ever agree to reduce the manpower of the Army because it had helicopters or anything else. When the time came, what the helicopter could do was to increase the efficiency of the available men and thereby to some extent offset the Army's gross inferiority in manpower.

The **Chairman**, in closing the meeting, said that as an ex-very-amateur soldier and an ex-very-amateur helicopter pilot, he could not possibly comment on anything that the Author had said. All he could do was to hope that in dealing with the difficulties, which undoubtedly he would have to face, of combining so many requirements together and then discovering how the cash to meet any of them could be raised, the Author would remember that there was something to be said for simplicity.

Because of the sad history, it was worth while bearing in mind that by keeping down the number of instruments in small helicopters, the fewer would be the complications and the lower the weight.

The meeting had listened to an extremely able lecture and one which had been beautifully put across. It had given everybody a great deal to think about. This was evidenced by the large audience, few, if any, of whom had left before the end of the meeting.

A vote of thanks to the Author, proposed by the Chairman, was accorded by acclamation, and the meeting then ended.