Discussion

The President We are greatly indebted to Commandant BORIS for what has been, as I expected, a very stimulating challenge I think we all join in congratulating him not only on his paper but also on his command of English We congratulate you, Commandant Boris, on your delivery, which I think some of us could perhaps copy occasionally, and we thank you very much

Mr M J Brennan (*Member—Saunders-Roe Ltd*) I must thank you, Mr Chairman, for the privilege and honour of being allowed to open the discussion on this important occasion—the most important lecture of the year for the Helicopter Association We are one of the Companies interested in producing helicopters for Commandant BORIS and other users, and I should like to discuss their utilisation Having quite a background of fixed wing experience, I have thought that at present the helicopter has an extremely low yearly utilisation when compared with that achieved by operators of fixed wing aircraft, who get up to 2,500 hours and I believe in Australia nearly 3,500 hours When you look at the economics of the helicopter —the cost per flying hour of all types—as Commandant BORIS has shown, you will see that the first cost percentage is extremely high Would the Author like to comment on that and to tell us whether we shall be forced into the consideration of utilisations of 500 hours or whether we might go up to 1,500 or 2,000 hours ? When he referred to training he said he had 13 men to train quickly, and in the figures which he then gave he was almost up to a yearly rate of 1,500 hours Then he was making a handsome profit, for his hourly costs would be somewhere about £12

He raised an extremely important point from the design point of view concerning the simple helicopter Again, it is a question of cost per hour and of this low utilisation figure Consider both types of aircraft, including the larger Hiller type , if both aircraft had 2,000 hours a year they would have an hourly rate of approximately £10 But for the simple aircraft the fuel costs are rising, and if you are to make such extensive use of it your fuel costs for the simple helicopter will be 50 per cent That gives you the background to the simple helicopter—it is a machine which you do not use a great deal during the year The operator must say to the designer, " For one reason or another I can use it for only 400 or 500 hours a year " That makes the case for the simple helicopter—low first cost

Another interesting suggestion was that we should have a chassis on which to put different types of body On the small helicopter, particularly our Skeeter, I think we can do that easily I do not know whether other constructors of larger helicopters will be in the same position, but with our light welded structure there should be little trouble

I should like to ask for the Author's comments on how much he would sacrifice speed for lifting performance We have looked at this sort of thing on the Skeeter and these figures are relevant The Skeeter with its Bombardier engine and conventional 3-bladed rotor system has an A U W of 2,150 lb and a top speed of approximately 90 knots

With a new hub, designed to take two of these blades, we find that the disposable load is increased by 160 lb , while the top speed (based on the Hafner vibration criterion) falls to 75—78 knots This is the sort of thing that we can offer the Author , the adaption merely requires fitment of a new hub with interchangeable attachments and the same rotor blades used

Mr Fitzwilliam of Westlands has gone the other way and put an extra blade on his helicopter to obtain speed Perhaps he will tell us what happens in this particular case

Finally, in thanking Commandant BORIS for his excellent paper I should like to say that I am quite sure our staff at Saunders-Roe would strongly support the Author's idea of their joining the operating companies particularly the companies in the South of France !

https://doi.org/10.1017/S2753447200002912 Published online by Cambridge University Press

Commandant H Boris (*in reply*) Speaking first of the hours per year flown by the helicopter, I entirely agree that the helicopter can fly, maintenance-wise, 1,500 hours or maybe a little more—up to 2,000 hours a year The big problem is to get the necessary contracts to fly these 1,500 or more hours Because of the prices you have to ask at present, I would say it is exceptionally possible The school to which I have referred does not last all the year round There is extensive work for three or four months, or perhaps six months, but it is not an all-the-year-round job But there is no doubt that maintenance-wise, at our present stage, 1,500 hours could be achieved and, I would say, also 2,000 hours Facts being as they are, we have to consider that the operator will not reach this high level of flying hours, and he has to have a helicopter which will be profitable to him if he is flying 300 to 400 hours a year The small helicopter which I visualise mainly for agricultural work will not fly more than 300 hours a year Agricultural work is a dense work for three or four months, and for the rest of the year there is not much to do I can visualise some large agricultural co-operative having a small helicopter or a fleet of two or three which would be used for only three months a year, just as they use their large harvesting machine for only one month a year and still find it profitable If you can have a helicopter which can be used for only two months a year and still be profitable, then you will have a large number of prospective customers Eventually, you can have pilots flying three months in France, three months in Africa and so on to avoid high costs, but a ship which could be used profitably for three months in a year and could stay in the hangar for the rest of the time would be a valuable tool for agriculture Those are the terms in which you must think of the small helicopter

Mr BRENNAN spoke of speed and gave the answer himself It all depends on the job to be performed In most cases with a small helicopter speed is not important In most cases, the pay load is the thing that matters In fact, taking a heavier pay load means eventually more fuel and more endurance and therefore probably the same distance Exceptionally, speed is of importance for small helicopters, and if it were possible to build a machine with two sets of blades, one made for load and one for performance, that would be an ideal solution, for the machine would be a general purpose machine

Mr BRENNAN suggests that if the small helicopter is used a lot yearly, its comparative costs may reach and even surpass those of the normal helicopter, and he is right Small helicopters are made to be used for only a reasonably small number of hours a year Otherwise there is no reason for them

Mr John V Roberts (*Member—Short Bros and Harland*) I should like first to apologise to the Chairman and the speaker for arriving late, particularly because it is a reflection on our profession I had no helicopter to bring me from Farnborough to Hyde Park !

Commandant BORIS had no reason to apologise for his English , if some of us had to deliver a lecture in French we should find it very difficult to equate the pen of the grandmother's aunt, or whatever it is, to the portions of a helicopter, although the blades may look something like feathers I can, however, translate enough French to recognise the English equivalent of the proverb which the Author quoted —the familiar " Jack of all trades, master of none " , and I thoroughly agree with his thesis that if you try to make a helicopter do everything it will finish up by not doing very much at all

All aircraft are a compromise—a compromise between various perameters which vary in different ways Each aircraft is a success in so far as it chooses the correct proportion of those perameters for the job it has to do It is therefore very useful to have somebody like Commandant BORIS, with extensive esperience of operating helicopters, to tell us the sort of things he wants a helicopter to do If we design for a specific job we are more likely to get a successful aircraft The problem is a little stickier with rotary wing aircraft than with the average fixed wing aircraft In order to satisfy each condition, a number of things have to be varied For example, Mr BRENNAN said that by varying the solidity of the rotor and taking off a blade he could improve the lifting performance while reducing the top speed by bringing in vibration at an earlier stage The Author suggested having a helicopter like a car, with a

chassis on which you could put various bodies, but that is an analogy which you should not push too far with the helicopter After all, the Land Rover has about seven gears, and it has the inestimable advantage of standing firmly on four wheels and not having to expend any power in supporting itself To make a helicopter capable of doing a lot of different jobs with a minor amount of adapting would involve altering the solidity of the rotor, gear ratios of the transmission and other factors Another thing which makes it stickier for English designers of helicopters is that we are not in such a favourable position as Mr HILLER when it comes to choosing power plants for a specific job Owing to the fact that in the United States there is a light aircraft trade of quite considerable magnitude, there is a wide range of tried and useful engines in the small power field, from quite low powers up to the power rates at which our typical English engine range appears more or less to start Below the Leonides we have little more than double Hobson's choice when we want to pick a light power unit for a helicopter, whereas in the United States not only are the ordinary light aircraft power plants available but there are also power plants which have been developed in conjunction with helicopter manufacturers, including built in fly wheels and fans and providing their own cooling and still giving a decent specific weight at the end

I will not carry my comments any further but will leave the matter to others who have produced a helicopter since, at the present, I am only at the stage of the farmer who led the bull into the field I do not think you can expect a lot of calves just yet !

Dr G S Hislop (*Member—Fairey Aviation*) I will add one or two brief remarks to my sincere congratulations to Commandant BORIS for his lucid exposition in a foreign language

In the draft of the Paper which I was fortunate enough to see there was an interesting use of the word " exposure " of the helicopter designers, and manufacturers, concerning the development of small aircraft, and I was sorry that the Author eventually edited the word " exposure " to something more innocuous I thought it was a good choice of word because his varied experience showed clearly where he felt the current helicopters failed when they had to cater for the jobs with which his Company are faced

I think the deficiency is a reflection of the fact that current small helicopters have been designed out of the blue by the manufacturers, primarily with military requirements in mind It is not surprising, therefore, that these helicopters are a compromise and do not necessarily meet all the varied requirements of school flying, crop dusting, executive transport and so on I think Commandant BORIS has gone part of the way to pointing out to manufacturers what are the basic requirements He has given us two aircraft and a very useful target, although I think the target could be put a little further out of reach in order to add to the incentive He has given a target in terms of operating costs of £17 per flying hour on a basis of 300 hours utilisation To give the manufacturer a figure to aim at is a good way of setting a target because he has to analyse current operations and see where the costs are heaviest and what he can do to reduce them in his design

To my mind one of the items which stands out is the question of component life and the costs which are associated with their current relatively short lives, their replacement, the overhead costs associated with that and the consequential cost of the aircraft being out of service We should follow up one suggestion which has been made—that automotive practices should be adopted for gears, transmissions, rotor heads, etc Automotive practices are indeed aimed at getting very long lives for such items—not lives of the order of 200 to 300 operating hours before they are renewed but many thousands of hours It would benefit helicopter manufacturers if they paid a great deal of attention to this aspect, because even though weight may have to go up a little—possibly even 10 per cent on critical components or parts of components in a particular item—if it is possible at the same time to treble or quadruple the life of the item there would be a great reduction in operating costs under that heading Since overall maintenance and component charges are high, such a reduction would have a good effect on the charges as a whole

I should like now to touch on the large helicopter Commandant BORIS indicated that a disposable load running up to 50 per cent of the all-up weight is what he is after That is a pretty tough proposal if in the disposable load you have to carry fuel for three or four hours flying A disposable load 50 per cent of the gross weight could be done with jet powered aircraft—pulse jet or ram jet over short ranges—but I doubt very much if it could carry enough fuel for this endurance with such a proportion of disposable load to all-up weight It is much more likely to be nearer the 25% or so of current designs

Incidentally, if Commandant BORIS has got man-hours to flying hours down to 1 6 to 1, I congratulate him It is very good indeed Members of the Association will recall Captain Vernieuwe's lecture a year ago in which he quoted for the Bell the quite good figures of 3 45 to 1 on an operation showing a utilisation of the order of 800 hours a year A ratio of 1 6 to 1 is very good indeed considering that it is a comparable aircraft to that of Sabena

One example of the use of the small helicopter which has been cited is that of the transport of executives He would have liked the job of transporting Renault's staff from Paris to Le Mans—130 miles On such a job you cannot afford to neglect a reasonably high cruising speed, 100 m p h would be a minimum

Commandant H Boris (*in reply*) I think Dr HISLOP has answered a great many questions which I neglected to mention There is no doubt that the present helicopters are the children of the military machines, and we are suffering from this I am not a military authority, but the aims of the two aircraft are completely different There is no doubt that here is probably the basic reason why helicopters are not exactly what we should like them to be

I must have misinterpreted my figures about weight I will tell you how we figure out our weight for the future ideal lighter helicopter We have taken 1,750 lbs for empty weight, but this is for the chassis weight , it means with no equipment —just a single seater, very simple helicopter It may be that I have been a little optimistic, but I think the empty weight of a three seater Bell with all instrumentation is 1,400 lbs I have increased this to 1,750 on account of the increase in the engines from 200 to 350 h p , which would roughly mean an increase of 150 lbs , and I have deducted what can be stripped from those helicopters That is perhaps a little optimistic, but if we are looking into the future we should be a little optimistic Even if this is not within our immediate reach, it is an aim towards which we are tending The useful load has been calculated from the exact figures which derive from the Hiller We have taken the same tip speed of blade—the same blade increased in size —and the same blade shape, and we by so doing have established these figures They may not be absolutely correct but I do not think they are far from the possibilities

Mr J S Shapiro (*Founder Member—Consultant*) I should like to congratulate Commandant BORIS on his lecture, not only for the lucidity of his language but also because the lecture deserves praise for its striking simplicity Simplicity of statement is effective when it originates in unique experience I think the Lecturer's experience is unique in so far as he has persisted for many years as a general operator of helicopters in Europe and has made a success of it

I find that technicians are usually cross with accountants but only as some pictures seem to be cross with their frames In the end, if we want helicopters in civil life we must submit to the test of accountancy In giving his verdict, Commandant BORIS is not only gentle with technicians and constructors but he also goes out of his way to find remedies

As a designer, I am interested first in the lecturer's statement that it is not the first cost of present day helicopters which primarily makes their employment uneconomical in many cases I tried to follow his thesis that we must start thinking in " automotive " terms and came to the surprising conclusion that if we give a helicopter seven years' life and allow it a favourable utilisation, then we get a first cost per seat-mile during the life of the helicopter which is within the automotive range I am reminded of the beheading axe in the Tower of London which, the guide said, had

https://doi.org/10.1017/S2753447200002912 Published online by Cambridge University Press

done splendid work in its time but which, in its 300 years, had had 14 shafts and 28 heads It is not first cost which matters but how many times we have to replace it ! Nevertheless, I do not think Dr HISLOP's remedy of increasing the life of components at the expense of the weight is necessarily the correct one We must find to the optimum overall effectiveness

Very often we shall find that the operator and the constructor want different remedies and unless we are prepared to accept an irresistible force trying to move an immovable object we must try to look elsewhere and to find some ways of making life easier for both I should like to add only two main points to those already made One is at the expense of the airworthiness authorities I fully support the lecturer's plea for a more versatile machine—not of making a single machine do all the jobs but of having a basic type which can be adapted I believe that plea is very sound and technically very justifiable, but I think we are limited today by our conceptions of airworthiness The airworthiness people do not say, " You must fulfil certain conditions " They say " we don't know whether we believe this thing can fly but if you have flown 10,000 hours we might agree that you might fly another 10,000 hours "

This is perhaps unavoidable today, but I do not think we should be satisfied with this approach We must go ahead and find ways by which we can obtain rapid, accelerated airworthiness approval for modifications of quite a major nature required for conversion from one type of operation to another I do not think the present trend of thinking in airworthiness organisations is yet on the lines of finding ways of accelerated airworthiness approval

My second point is at the expense of the insurance companies I am not saying that they are the people who make money out of accidents but there is one aspect of insurance accountancy which completely passes my comprehension It is usually dangerous to assert that established conditions are entirely wrong, because there must be some logic in them, but I cannot find the logic in this case I cannot see why insurance is a fixed charge because the risk is entirely a matter of flying hours

In the lecturer's figures insurance accounts for about one-third of the fixed costs Commandant BORIS considers pilots' pay to be a fixed cost, and while that is probably correct for his organisation, it is not necessarily correct for others If we discount the pilot as a fixed cost we arrive at the fantastic state of affairs that insurance is about half the fixed cost The risk, which is really proportional to flying hours, for some unaccountable reason is made into a fixed charge

I know that in order to achieve a desirable result, it is sometimes necessary to devise a price structure which does not reflect the real cost structure For instance, in any form of transport the cost per passenger is lower when the vehicle is full in the rush hour than when the vehicle is half-empty in the off-peak periods Nevertheless it is sensible to charge more for travelling during peak hours and less for off-peak services This deliberate distortion helps to achieve a desirable result, namely an equalisation of load factors

The distortion of the cost structure of flying risks which is contained in the customary form of insurance accountancy, only accentuates an already existing undesirable situation, namely the extreme dependence of helicopter flying costs on its utilisation This dependence forces the operator to attempt an unnaturally high utilisation The artificial increase in the economic importance of utilisation does not seem to be in anybody's interest, but is particularly harmful to the non-scheduled operator

The argument put forward is of such quantitative importance that, if accepted, it would entirely alter the range of application of the mechanically driven helicopter In those cases, mentioned by the author, in which the minimum economic utilisation is 600 hours per annum, an insurance accountancy appropriate to the risk would reduce this minimum economic utilisation to 300 hours per annum

Commandant H Boris (*in reply*) I forgot to answer a question put by Dr HISLOP I think operators would definitely agree to any suggestions which would

extend the life of components Even when you are speaking of 300 to 600 hours, there is no doubt that the number of hours is very small when compared with the life of a Dakota, where they think in terms of thousands of hours rather than hundreds

I think Mr SHAPIRO'S idea about insurance is a very good one It comes as a reinforcement of my theory about a helicopter being used for only three months a year and still being profitable That would bring a great many new customers Furthermore, I think this solution could be reached if there were an understanding between operators If all the operators on a Continent agreed to this, they would probably be able to obtain very different terms from the insurance companies, but do not forget that the number of operators is very small and their voices are never heard in the big ears of the insurance companies

I also agree with other statements of Mr SHAPIRO If the future problems which he has mentioned—maintenance costs and accountancy—can be solved, that will help greatly to reduce the expenses of the small helicopter

Lt-Col F L Hodgess (*Member—The Fairey Aviation Company Limited*) Several speakers have suggested that the light helicopter would be greatly improved if it were possible to fit special blades for special purposes, *i e*, reducing the solidity or changing from three to two blades for specific purposes I would like to ask a simple question Assuming there was a job of crop spraying or something similar, where a slow speed and a good pay load was demanded, and assuming that the operation occurred about 1,000 miles from the base, how would the special equipment be carried to the site ?

Would the helicopter first of all be equipped with the three-blade rotor, with a reasonable cruising speed and be capable of carrying the modification set, *i e*, different rotor blades, different rotor head, different controls, etc, and the mechanics necessary to do the transfer on site, or would the economics of the situation demand shipping or other means of transport to get the ideal configuration to the site ?

Mr A E Bristow (*Member—Air Whaling Ltd*) May I answer that question for Commandant BORIS I think the question can best be answered by a little story which I recall from the happy days when I was Technical Manager and chief pilot in Commandant BORIS' Company Helicop-Air

It was early Autumn in 1949, and we had to send a Hiller 360 from Paris to Strasburg to fulfil an important publicity contract lasting seven days, the distance involved was about 500 kms or 310 statute miles On conclusion of this job the same aircraft was to be moved to North Africa for a spraying contract Such was the mobility of our operations To attempt to fly this distance with a small helicopter would be quite uneconomical Moreover, the charter helicopter operator has to work to an extremely tight programme if his operations are to be economical The helicopter in question arrived back in Paris from a crop spraying experiment at 4 p m on the day before the demonstration in Strasbourg It had to be cleaned and put in a spick and span condition so that everybody would say what a wonderful helicopter we were operating, and be in Strasbourg by 1 p m the following day This was no mean task, with such a commitment as this, and this is by no means uncommon in the helicopter charter field, the only method of getting the helicopter to Strasbourg was by road Quite apart from the tight planning margins in such work, one cannot entertain flying small helicopters between operating localities when these are situated more than 50 miles apart, otherwise operations become quite uneconomical This points to the fact that high forward speed in small helicopters is not essential, if high forward speeds were available in a small helicopter it could only be provided at a very high cost, which in turn would ruin the value of the small helicopter—and no doubt its operator !

To resume the little story, may I say that after working at tremendously high speed, everybody knowing his job, a little convoy consisting of a Citroen car, a lorry and special helicopter trailer, set off from Paris at midnight with Commandant BORIS leading the way in the Citroen About 150 kms out of Paris a dense fog descended on the convoy and persisted far into the late morning During the night slight rime

ice formed on the windscreens and they were constantly misting up a less determined and energetic person would have postponed the appointment—not Commandant Boris He drove all the way in his Citroen with the door wide open to keep a clear view of the road, and you can well understand the discomfort and cold he suffered, but the convoy reached Strasbourg in time and the demonstration was a success

This is the kind of man he is, and that is why he has got to the top in the helicopter business He has worked extremely hard and flown extremely hard, always setting a fine example to his team I would like to say that I have very much enjoyed paying this tribute to a helicopter pioneer for whom I have great respect, and to whom I am sure you would all join in wishing continued success

Mr A Reichel (*Student—Sweden*) I come from Sweden We have six helicopters They are Bells and they are doing a lot of agricultural work They are away from home base for this work practically the whole of the time That means that ground crews and flying crews have to be away from their base—they are highly skilled personnel—and there is the problem of getting supplies to them The country is 1,400 k m long, and there is nothing to compare with the topographical conditions, except perhaps in Norway and Finland They do spraying and crop dusting jobs As for flying time, it is seldom more than a quarter of an hour between landings

If the helicopter is to be owned by a combine which looks after quite a big area, they will utilise their machine for three months during the peak season What will the pilot and the mechanics—highly skilled men—expensive men—do in the rest of the year if each combine is to have a helicopter ? We could have a cheap helicopter if every combine around the world would buy one, but we have the expensive fuel to be taken to every place where the helicopter goes This one helicopter might be utilised for a few more hundred hours on different jobs after the high peak season, but that is about all

Would not the answer be blade tip propulsion—ram and pulse jet—and entirely simplified propulsion so that we could keep the skilled personnel down to a minimum ? We would be prepared to pay for considerable fuel use, but the fuel should be that used by standard surface aircraft and vehicles—diesel, kerosene or even automobile petrol This will save us the necessity of getting expensive aeroplane fuel I do not think range would be important If we had to take the aircraft further, there are the automobile refuelling points on the roads , we know where they are and we could land and re-fuel Why should we carry on building helicopters up to three seaters, *with piston engines and very expensive transmissions* ? Why not switch over entirely to jet propulsion at the tips ?

Commandant Boris (*in reply*) I think I agree with the speaker, who has once more reinforced my theory about the light helicopter Ram jets have many conveniences which have not yet been crystallised, but in referring to ram jets and pulse jets the speaker shows that he is aware of the possible uses of the small helicopter That goes to confirm my theory I know his Organisation—one of the best and largest in Europe and one of the first to use helicopters He is one of the possible customers for the small helicopter, ram jet or pulse jet

But do not forget that with ram jet or pulse jet the fuel consumption is very high If you want range or endurance you will be unable to take anybody on board It is therefore necessary for many other jobs which do not interest those in the Northern countries—but which interest other countries—to consider this long range and endurance It cannot be provided without a piston engine Not that I care for piston engines—but those facts must be remembered

The President I have no doubt that the discussion will rage more privately for the next hour, but we seem to have exhausted public discussion I know that everyone feels their indebtedness to you, Commandant Boris, for your stimulating talk—an extraordinarily simple concept put very clearly to us

https://doi.org/10.1017/S2753447200002912 Published online by Cambridge University Press