helicopters in this country should be given super priority

Before closing, I would like to pay tribute to Mr RAOUL HAFNER for what is, in my opinion, the best designed helicopter of its class in the World I am sure it is the forerunner of many other first class helicopters It is regrettable that his aircraft, the Bristol 171, could not have been produced in quantity in 1949/50 Britain could, and should, play a leading role in satisfying the insatiable worldwide demand for these expensive aircraft

This is the Elizabethan era , let us not be a poor second best in this new field , let us be more aggressive, and lead the world in rotating wing development , let us emulate our brothers in the fixed-wing field with their Comets, Viscounts, and Britannias The challenge is there, let us meet it with the dash and courage of true Elizabethans

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THE CHAIRMAN

Thank you, Captain Cameron You have certainly taken us behind the scenes, and I hope now certain early teething troubles with the 171 type have been overcome that the Bristol Aeroplane Company will have a satisfactory flow of orders

Before throwing the meeting open for discussion, may I exercise my privilege as Chairman to raise one or two queries with our speakers S/Ldr GELLATLY, I am not quite clear in my mind as to the nature of the difficulty with autorotation at altitude to which you referred I understood you to say that there is a likelihood of a dangerous contingency Would you enlarge on that

Mr HOSEGOOD, would you please express your views on the advantages or otherwise of the castor type of undercarriage From past experience I know of certain ground handling difficulties experienced by pilots

Well, Ladies and Gentlemen, I think you will agree with me that we have listened to three very interesting accounts of helicopter pilot activities The meeting is now open for discussion, and I will call upon Mr J S FAY, of Westland Aircraft Ltd , to present his comments

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Discussion

Mr J S Fay (*Member—Westland Aircraft Ltd*) We have had three very informative papers read here to-day The lecturers differ in their approach to the subject, and they are to be congratulated on the way they have performed their task of giving us a good idea of their recent flight testing experiences

I have not carried out very much high altitude flying, and for this reason I found the first part of Squadron Leader GELLATLY s paper particularly interesting There are few people who like flying high in a helicopter and I should be interested in hearing pilots' views as to why this is so The main reason must be that there is no visible means of support The pilot is surrounded by perspex and he feels that he is just dangling in empty space An idea which occurred to me recently was that when the nose of the helicopter swings longitudinally, say 3 degrees, when flying at low altitudes, any point on the perspex in front of the pilot swings through the angle subtended by a small field , whereas, at high altitudes, the same swing will subtend half a county or so This might tend to exaggerate instability in the pilot's mind and make it seem worse than it really is However, the decrease in stability and control at altitude is a serious matter

When a fixed-wing aircraft climbs, the pilot maintains a constant mass flow of air over the wings by flying at a constant indicated air speed Stability and control therefore remain the same To obtain a constant mass flow of air over his rotating wings, the helicopter pilot would have to increase the rotor r p m as he climbs

This he cannot do in present helicopters owing to engine, and, in some cases rotor limitations To improve matters, the helicopter must have a very wide range of permissible r p m Perhaps in future helicopters, the pilot will be able to change gear as he climbs so that for constant engine r p m , the rotor speed may be increased

Squadron Leader Gellatly refers to the tendency of some rotors to throw off pitch with positive G , thereby causing an increase in rotor r p m Presumably, he means that the blades have a pitch-decreasing moment which will be transmitted to the pitch lever Alternatively, some rotor blades will twist within themselves, which is much more inconvenient Anyway, in any rotor there is always a tendency for an increase in r p m with positive G owing to the change in blade angle of attack

On the instrument-flying section I have little to say, except to mention that when I was with B E A , we found that safe instrument flight with the artificial horizon obscured, proved to be impossible on the manually-controlled S 51 with fabric-covered blades That is why we had a second artificial horizon mounted on the panel as a safety measure The two artificial horizons should, of course, be driven by different means Incidentally, there is considerable improvement in stability in a metal-bladed W S 51 and blind flying should be much easier

May I also add to Squadron Leader Gellatly's remarks on slow-speed instrument flight, that this is useless without an accurate ground-position indicator otherwise, the absurd situation might arise where the aircraft is moving forward at, say, 10 knots, but is being blown sideways at 30 knots

I am afraid I cannot endorse his statement that instrument flying should be restricted to speeds below 0 8V_{max}, although I agree it is harder work for the pilot at speeds over 0 8V_{max} Also, the pilot should see that the c g position of the aircraft is such that the stick is not nearing the forward stops, even in gusty weather On several occasions on the B E A night mail service, the aircraft were flown at maximum speed in order to maintain a schedule against adverse winds, although naturally this was not possible in any marked turbulence

Now, Mr HOSEGOOD'S paper is really a statement of history, and when I came to read the draft, I found that although it was very interesting, there was little I could really comment on If by any chance he could let us have a peep into Chapter II of his " long book," could he tell us something of the autorotative characteristics of the Bristol 173 ?

Captain CAMERON stated that he believed the vibration level in a W S 51 with metal blades was much lower than in one with fabric-covered blades That is quite true, and at Westlands we generally have little trouble with once per rev vibrations on the production aircraft The vibrations which have to be ironed out on a new aircraft are usually tail-rotor ones, but that does not mean we are always free of any of the others We have had an interesting vibration cropping up once or twice lately and that is a twice per second beat caused by a combination of tail rotor vibration and a six-per-rev main-rotor vibration This can usually be cured by balancing the tail rotor statically

Concerning engine-off landings, mentioned by Captain Cameron, I feel that the lower restriction on rotor r p m in auto-rotation is laid down by the makers as the critical one (including the safety margin), below which the rotor will tend to cone up catastrophically

For training in the W S 51, I teach the run-on type of auto-rotational landing prior to solo and a vertical version of this after solo As regards Captain Cameron's remarks on loss of lateral control at low rotor r p m , the W S 51 has a greater all-up weight than the S 51, and in a vertical auto-rotation landing, the r p m initially observed to be around the 200 mark, are usually in the 150s on landing Despite these low r p m any loss of lateral control has not been noticed and—touch wood ! —we have not had a helicopter rolling over yet, but possibly this is due to the fact that with a wide wheel base and a fairly low c g , a helicopter tends to be very stable on the ground

Incidentally, I should like to mention that the flare-out type of landing is now OUT as far as I am concerned Except for spot auto-rotational practice, all auto-rotations at the Westland School are practised with the engine switched off

In a Training School, the engine warm-up period can cut down the utilisation by as much as 7 %and if a helicopter is wanted in a hurry for a job such as a rescue, a long warm-up period might completely nullify the helicopter's usefulness So I should like to endorse Captain Cameron's remarks and ask the engine manufacturers to do something to shorten warm-up periods

I agree with Captain Cameron that we want a large moment of inertia in the

rotor blades so as to make engine-off landings easier to perform I believe there is a French helicopter which can hover, on blade inertia alone, for ten seconds

Finally, as regards icing, I found some ice on a helicopter last Monday The accretion was of a mild form and consisted of clear ice about 1/10th thick on the leading edges of the inner third of the main and tail rotor blades No deterioration in performance was observed during flight and there was no extra vibration This accretion took place when hovering near the ground for five minutes in foggy weather, so what might happen in worse conditions, I dare not think Icing can be a serious problem and all future helicopters should have some provision for blade de-icing

Mr J S Shapiro (*Member—Consultant*) There are only two points I would like to make First, the experience Mr HOSEGOOD has told us about, which confirms my own experience with the Air Horse However, it is interesting to note that in the Air Horse there was no ground resonance attributable to the under-carriage, or at least, what there was of it, was of such low frequency that it could not, of course, be avoided On the other hand, vibrations similar to ground resonance, did appear This was one of the cases where theory as we know it and its practical application agreed very closely A mistake was made originally in what would have seemed to be a simple calculation, the determination of the structural stiffness Once that was properly done, the predicted vibration frequencies were confirmed in tests

I, or at least the pilot with whom I shared most of this experience, could repeat Mr Hosegood's accounts It was very interesting to hear these and indeed very gratifying that a pilot was so articulate and could give his experiences so openly Mr Hosegood and his Company deserve our gratitude for that

I don't quite understand what Sqn Ldr GELLATLY meant by an increase in sensitivity as the altitude increases I would have thought from his description that it was a decrease in sensitivity In other words that the aircraft did not obey the control as well as it ought to have done, or as well as the pilot is used to in low altitude flight

Apart from that, may I just say in a few words how much I endorse Squadron Leader Gellatly's opinions We must have complete freedom of flying and we must produce helicopters which will give us this complete freedom in all weathers and at all their legitimate altitudes I think this is the wrong time to sit down and say " We have had helicopters which do so much, let us now relax in our efforts to produce the one which will give us complete freedom " I believe we are not so far off this and the extra effort should be made

Mr E L Bird (*Member—Bristol Aeroplane Co Ltd*) I should like to add my congratulations and thanks to that of those who have spoken before me, and to say that we of the Design Staff at Bristol very much respect the opinions of all three Test Pilots who have spoken this evening , indeed we have been working very closely with them for some long while now In particular, I thought that Mr HOSEGOOD'S paper showed the close contact which exists at Bristol between Design and Flying teams and I would like to assure him (and the other two pilots) that we appreciate the criticisms and advice we get from them, and that we on our side will do all that we can to further the good spirit prevailing We would even like to extend this and get " Sox " on the Drawing Board occasionally, and if he accepts this invitation his first job will be to design the " pilot's perfect seat " I personally very much like the spirit in which " Sox's " paper is written as it helps us Bristolians to relive those very full days just before the last S B A C show I see that we have had a write up in the Technical Press this morning, helicopter designers being chided about ' treading warily " I hope that we at Bristol will always tread " warily," but never " wearily '

Turning to Jock CAMERON'S paper, we are all grateful for the nice things he has said about our ' 171 ' and our Chief Designer, and as regards his criticisms we have made every effort to get these things right on our Mark 4 which is in production this year I will not go into detail but I can assure him, and everyone else interested, that every point raised by Jock has been dealt with—in ways we can only hope will be satisfactory to all who have to deal with this aircraft

S/Ldr GELLATLY'S paper gives us much food for thought, and I can only say that I shall need to digest it a little more before commenting very fully upon it

His reference to instrument failures does not, we presume, refer to Bristol helicopters where the vacuum supply drive is taken from the main rotor gearbox , and with regard to the question of " miniature snow storms in the cabin " I can only say " not in the Bristol Mark 4 "

Mr Hosegood (*in reply*) I happily seem to have only one query to answer It concerns the castering of the undercarriage, but from the way the question was put I am not sure if the speaker was for or against castering wheels

If all the wheels are fully castering I think taxying would become a very difficult manoeuvre In the '173' Mk 1 only the front wheels are free to castor and in the Mk II these have been connected by a track rod

Apart from pushing the helicopter about in a hangar a fully castoring undercarriage does not seem to me to be an attractive proposition

Sqn Ldr W R Gellatly (*in reply*) I am less fortunate than Mr Hosegood in that I have 9 questions to answer First in reply to our worthy Chairman who asks what is the danger in autorotation at high altitudes, there is no danger in steady autorotation The danger lies in the transition period The true airspeed may be very high and this cannot be helped if we must have a high cruise speed In fact, we are obviously flying somewhere near the maximum design speed at 15,000 ft and 60 knots I A S The danger does not follow in a slow practice autorotation, but in the emergency case In fact, of course, it is always worse at height than it would be at a low altitude There is usually a change in position error to be allowed for and if it is a big change it will immediately induce pitching if the pilot does not take care

In answer to Capt Fay who asks what I feel about the effect on the pilot in high flight, frankly I don't find any effect Flying a helicopter at 15,000—18,000 ft is very similar to flight in a jet fighter at 40,000 ft The worry of having too much perspex and the effect of sitting out on a pole is frankly, a problem I have never noticed

Are two artificial horizons essential ? I would suggest not If we are to have a second indication of lateral level I do not think that the use of two horizons is the answer Rather, a different second instrument, perhaps the electric turn and slip indicator, would be better in that it would give that extra indication when the emergency use was not necessary He asked about restricting instrument flying to speeds below 0 8 V_{max} The effects of the change on stick-fixed stability, vibration, and, of course, c of g limits is very real Flying at the c of g limits is a definite requirement for military operation as we saw only too clearly in Holland recently

Mr Shapiro talked of the increase of sensitivity with height and he was wondering if I might have meant a decrease in sensitivity ? It is an increase as it increased with the rotor r p m with height The effect on r p m of a change in collective pitch or of an acceleration becomes much faster with height

Lastly Mr Bird, asked about instrument failures and I would remind him that there are many other failures to instruments than those at suction origin In fact that is one of the failures that we don't worry about a great deal Most aircraft suffer from occasional electric failures and it is this failure which we are thinking about

Wing Commander Brie It has been most gratifying to observe such a good audience here this evening, and I am sure our lecturers can feel complimented by your presence here Thank you all for coming along

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Written Contributions

Mr J N Dennis (*Fairey Aviation Co Ltd*) read by W/Cmdr R A C Brie I must, at the outset, make it clear that I speak as an individual and that my opinions do not necessarily represent the views of The Fairey Aviation Company Limited

I have read with great interest all three papers and will refer to them in order of their presentation

I congratulate Mr Hosegood on his "First Chapter" and I think that he can rightly claim to being the first helicopter test pilot to record before this association his experiences of testing a proto-type The fact that this helicopter was of a tandem rotor configuration makes it all the more interesting

It is worth noting in his paper that ground resonance was assumed to have been caused by the tethering ropes It is my contention that as little as possible tethered running should be carried out since ground resonance can be felt building up, and prompt action as described by Mr Hosegood kills it before damage is done Free flight has to be faced at some time, the aircraft may not be subject to resonance during the tethered condition but this does not necessarily mean that it will not break into resonance when free

I had hoped that Mr Hosegood would go further with his testing experiences and not confine them to the one type only since there must have been many other

problems, a description of which would have been very instructive to us all

Nevertheless, this paper has been most interesting to one who will be embarking on a " first-off " in the near future

I would also congratulate Squadron Leader GELLATLY on his very excellent paper I do feel he has provided the real meat of all three papers He has very clearly outlined the problems that we have to face by the increase of helicopter requirements

With respect to high altitude flying, there is no doubt that this problem has been with us for some years now but until very recently flight investigations at altitude have been very halfhearted, in part, probably due to the fact that the helicopter would not, for some time at any rate, be called upon to operate at the heights quoted by the lecturer I hasten to add that some helicopters of the past have not even been capable of attaining these altitudes, at least, not without some considerable display of endurance on the part of the pilot ! This does not follow that future designs of much improved performance will not be required for high altitude flying, indeed, to obtain the required range and endurance on new designs it will be a necessity both from a service and civil operators point of view to operate these aircraft above 10,000 ft , hence Squadron Leader Gellatly's warnings of the severe limitations already encountered in the helicopters of to-day It is obvious that some hard thinking has to be done and pretty soon too, to control rotor behaviour under manoeurve at altitude and as the lecturer infers, there are many more limitations to be considered

I would like, at this point, to appeal to all concerned in Cockpit Layout to soft pedal on Field of Vision requirements—have a look at the S 55 before placing us in veritable perspex globes—I am glad someone else has experienced miniature snowstorms in the cabin together with frosting inside and out ! I should be interested to hear the views of all three lecturers on this point as I consider crew comfort to be of the utmost importance

For some years now, investigation into the problems involved in the instrument flying of helicopters has met, on the face of it, with little measure of success

As Squadron Leader Gellatly has said, the restrictions on helicopter instrument flight to-day are due to instrument limitations and the inherent instability of the helicopter in manoeuvre All manner of instruments have been tried from time to time, yaw meters, desyn indicators and varying the sensitivity of various standard blind flying instruments in an endeavour to find instruments that will tell the pilot what he wants to know from the moment of unstick and throughout the speed range

From personal experience our troubles are, and always have been, at the low speed end of the scale from a handling and an instrument functioning point of view, but to enlarge upon this would only be to repeat the lecturer's findings

Captain CAMERON'S paper provides us with a very interesting comparison of the two most well-known helicopters in this country to-day but he has disappointed me I had hoped that he would have devoted more of his paper to the problems involved in instrument flying, a subject on which he has had considerable experience

Bearing in mind the ultimate aim of B E A to land in confined spaces in city centres, what difficulties has he encountered in steep ascent and descent under I F R and night conditions, both from a handling and an instrument point of view ?

What are his opinions on high altitude flying ? Although B E A do not require this at the moment they may well do so in the future

Mr J S Fay Squ idron Leader GELLATLY was of the opinion that two artificial horizons were not necessary for blind flying and that in the event of the failure of the instrument, control could be maintained by reference to the turn and slip indicator, D I , etc However, these instruments will enable the pilot to retain lateral and directional control only Since a helicopter's instability is more marked longitudinally, the most important section of any instrument is the longitudinal indication as given by the artificial horizon (the up and down movement of the little aeroplane) The A S I and the rate-of-climb indicator tell the pilot what *has* happened, the artificial horizon can tell him what is *going* to happen unless he does something about it In fact, the pilot can make a correction by reference to the artificial horizon before the other instruments have shown any significant change Tests with a limited panel on a B E A S 51 indicate that the artificial horizon is essential for blind flying in the present unstable helicopters

In referring to S/Ldr Gellatly's statement that he thought instrument flying should be restricted to 0 8V_{max}, I merely intended to convey the thought that the pilot would have to put up with the extra work involved in flying by instruments at speeds above, and press on !