Collecting weather data from diversion points, manning of radio aids, monitoring flight director systems, checks on fuel figures and C of G and loading for quick turn arounds with the rotors turning, quite apart from emergency work in the event of equipment or powerplant failure will leave very little time for in-flight coffee or the Sunday papers

Discussion

The **Chairman** said that the two most interesting lectures which the Authors had given were based on a background of factual experience The many problems encountered had been tackled in a realistic manner and the objective was quite clear These papers indicated the manner in which it was hoped to achieve it

No one system would meet all requirements, and it was a significant comment by one of the lecturers that none of the engineering equipment described in the papers was radically new This indicated a broad minded approach, because there was always a great deal to be learned from other people, even from other countries

In exactly the same way that the Helicopter Association thrived on the enthusiasm of its members and a single track mindedness in relation to the goal, so the encouraging results being obtained on these problems of all weather operations were due to team work Tonight's lecturers were the outward expression of behind-the-scenes work that had gone on in the Helicopter Unit

The CHAIRMAN said that the mention of blind flying prompted him to dip into the past by recalling that twenty years ago a small handful of pilots were flying the Cierva Autogiro on instruments More recently, during the winter of 1949/50, a regular scheduled night mail helicopter service was operated for six months by the B E A Helicopter Experimental Unit between Peterborough and Norwich That was the first time in rotary wing aviation that such a thing had been done, and it had not yet been repeated elsewhere It was worthy of mention to ensure a sense of perspective and proportion

Mr K Reed (*Test Pilot, Saunders-Roe Ltd*) (*Member*), said it had been brought home to all of us here this evening that manufacturers and operators were faced with a tremendous task in a relatively short time

If it was agreed, and obviously it must be, that commercial helicopters needed to be capable of all-weather operations, particularly into and out of city centres, then in the next three years—this was the period during which a large British aircraft was threatened to be available, designers, manufacturers and operators, in his view, could not possibly produce the necessary answers in the form of accepted equipment unless immediate steps were taken at the highest level to produce practical policies and realistic requirements He said this because this evening we have been given a very fair coverage of the equipment more than likely necessary towards making it possible for helicopters to operate in all-weather conditions Nevertheless, it must not be forgotten that all this was going to present a considerable weight penalty and severe restrictions would obviously be placed on the smaller helicopter

The papers were, to say the least, most interesting concerning radio and navigational aids, etc , but, he felt that the fundamental problems still needed more elaboration in the form of discussion, thought and action

The first of these problems was stability As Mr Hearne pointed out, the helicopter was fundamentally unstable This obviously was a primary problem and it was encouraging to hear that the device fitted to provide artificial stability was producing desired results Nevertheless there was very little doubt that the authorities would require duplicated systems In consequence, the weight penalty might, together with other matters yet to be considered, be severe

He still thought that further serious investigation should be carried out concerning more aerodynamic stability improvements

For many years now it had been his personal opinion (and he should like Mr Hearne's comments on the matter) that as it was the rotor that was fundamentally unstable, then this should be that which the pilot flies, and not the fuselage The principle, broadly speaking, would be that signals should be passed from the flapping link of each rotor blade through the usual ' black box ' so that finally the rotor attitude

or path was presented to the pilot in a manner similar to the present artificial horizon It was felt that this would lend itself to improving low speed and turbulent flight characteristics, as corrective control action would be immediately recorded and, after all, the fuselage follows the rotor and, in consequence, control corrective movements must have a degree of delay if they are being made relative to fuselage attitude changes

This problem of icing had certainly not been under-rated, but again little was known of any developments taking place in this country Obviously, the rotor blades were the first consideration, but he should like to know what steps had been taken concerning fuselage icing

Again, whatever was considered to be the requirement was going to incur a weight penalty, and it was not necessarily unreasonable to assume that rotor blades themselves may have to go through a complete testing programme, including fatigue, depending on what was finally considered necessary to incorporate within them to overcome the build-up of ice Three years was not in itself a generous period of time for this development

The question of visibility from the cockpit downwards when the pilot was transferring from instrument flying conditions to visual flying conditions, particularly during steep ' let-downs,' certainly needed to be very carefully studied as it could so easily be overdone and ' static vertigo ' would be the next problem to face

The speakers this evening had not mentioned pitot position errors It was, of course, possible that the aircraft they were using had acceptable errors but there were other helicopters which have undergone tests and the results were quite definite in that the pitot position and the static vent position was in itself a none-too-easy problem to overcome, *i e*, one helicopter in autorotation of 45 kts I A S had a position error of +17 kts, another had +20 kts There were also large errors in level flight, climb conditions and cruise conditions, but of not such large orders, and tests had indicated that position error varied further if the aircraft was flown under the extreme longitudinal C G position Unless the static vent was positioned with every precaution and consideration, it was very easy to have altitude and I A S changes as much as 50 ft and 10 kts when the aircraft was yawed through 5°

He would like to ask the two speakers this evening if they had, in fact, any experience concerning such errors, and their effect on controlled let-downs

Instrument layout views were always good for an argument, however, here was a field that was worth exploring He would like to know the Speakers' views on a combined instrument To his knowledge there was not one in existence and, furthermore, he knew of no development

This combined instrument as he saw it would have in the centre an artificial horizon which, of course, gave pitch and roll indication, plus the two vertical needles giving slip and skid, the centre of the dial incorporating the directional gyro and the outside of the face would incorporate the rotor and engine tachometer needles

He agreed with Mr Reid that the horizontal presentation for instruments had tremendous advantages over the standard type, and he should like to see with this suggested combined instrument the I A S boost gauge and altimeter of the strip type either side of this main central instrument

In view of the considerable difficulties foreseen in the coming three years to produce a satisfactory all-weather helicopter, might it be more prudent to aim now at slightly more realistic minimas He said this because he was also considering the small helicopter which could conceivably be put out of business, as quite obviously restrictions would be placed on aircraft not having the necessary equipment and aids

Finally, we have been talking this evening about inter-city landings and operations with large helicopters The aircraft were expected to be in operation within the next three years and yet, to his knowledge, our major city was not preparing a Rotor Station and, furthermore, the noise factor was still a thorn to be extracted Again, were we aiming at too high a target and in so doing, not being realistic ?

Mr Hearne, in reply, said he would welcome aerodynamic stability improvements Last year, at the Massachusetts Institute of Technology, he had done some computer studies on the type of stability improvements which could be obtained by playing about with the aerodynamic derivatives There was no reason whatever why some quite startling gains could not be achieved provided that the designer was prepared to spend a little more time designing a stable aircraft than one which simply

got off the ground and flew One of the most interesting improvements in this line had been the work done in the United States with the movable tailplane connected with the cyclic pitch control, which greatly improved the flying characteristics from the pilot's viewpoint

Concerning the question of a tip path indicator, an experiment had recently been conducted in the United States on a helicopter with an artificial horizon which could have either normal body datums or some sort of signal such as Mr Reed had described, there was, also, a third alternative datum There was no difference in the ability of the pilot to control the aircraft with any of the signals and it was decided to revert to the normal gyro horizon on body datums, which had proved adequate

Mr HEARNE did not want to say much about fuselage icing Whenever he read manufacturers' brochures, they were always willing to promise complete freedom from freezing on the windscreen or similar place in the hope that people would forget about freezing in other parts of the aircraft such as the rotor blades

The problem of position error correction was a real one When pilots started to fly on instruments at 20 knots, they had got themselves right in the "clag" in every sense of the word The airspeed indicator was beginning to become wildly inaccurate Changes in power and speed, and particularly those which the pilot would make in the approach, would have a marked effect on position error That was one of the reasons why it was said in the paper that the ground speed indicator might be useful The accuracy of the altimeter was subject to these errors and this was one reason why a pilot-interpreted glide path aid was needed

Concerning minimum requirements, Mr Reed might, perhaps, be right in suggesting that the authors were aiming too "low" rather than too "high" It should, however, be remembered that the developments outlined in the papers were fairly major ones, and it was advisable to start with a system which was capable of development to those minima The system which was adopted must be capable of getting down to that standard, otherwise as operations developed it would be necessary to start again with a completely different system

Mr Reid said he hoped they had not given the impression that the small helicopter would be regulated out of using the proposed sites because it could not carry the necessary equipment The logical way was for the operator to decide his own limitations and to be allowed to fly their helicopters within the limits of the radio equipment they could carry

Mr D A Wilkinson (*A & AEE*), who congratulated the Authors on their excellent papers, said that Boscombe Down also had been concerned with instrument and night flying, but from the military rather than the civil point of view In many cases the two interests were the same and their experience supported Mr Hearne's analysis of the problems and their possible solution They had, for example, recommended instrument flying clearances for single rotor helicopters which had included certain limitations, such as a speed limit of 40 knots, since flight below this speed was extremely exhausting, even in calm air

Mr Hearne had pointed out that heading holding occupied a large proportion of the pilot's time A contributory factor appeared to be that, at constant rotor speed, any adjustments of collective pitch required simultaneous movements of the rudder pedals if directional disturbances were to be avoided So the pilot had to cope not only with disturbances from outside the aircraft, but also with disturbances initiated within the aircraft Boscombe Down pilots had found that large eye movements were needed for scanning instruments and they also had suggested that certain instruments might be combined in an attempt to reduce scan

Mr WILKINSON expressed agreement with the view that autostabilisation appeared to be the solution to the stability problems, at least of the current and the next generation of helicopters, and his Establishment hoped shortly to find out how much autostabilisation helped in extending existing instrument flying envelopes It would be interesting to see whether any appreciable increase in approach angles at night resulted from improved stability or whether, for example, a reliable low airspeed reference was also needed before considerably steeper approaches could be made than were practical at present

In that respect, he asked whether Mr Hearne's approach speed of 20 knots was chosen as being a reasonable limit of existing airspeed indicator systems or whether he visualised the use of substantially lower airspeeds with possible advantages of lower approach speeds in low ceiling conditions

Boscombe Down had been interested in low airspeed measurement for a long time, first as a test instrument for performance work and then as an operational instrument, and an instrument was at the moment under development It would allow the pilot to fly a constant meter reading, but the difficulties of accurate calibration at low airspeeds were quite considerable, particularly as this instrument was designed to operate in and make use of the rotor downwash It had to be borne in mind, therefore, that having obtained a low airspeed indicator, it must also be matched and calibrated to the particular aircraft

With regard to ground lighting, Mr Hearne had the advantage that his scheduled services would be operating from prepared sites with standard equipment , but for military operations, and even, perhaps, for civil charter work, it was not possible to count on permanent standard facilities The A & A E E had had to develop patterns which could be laid out at short notice and which used any equipment such as torches, flares or glim lamps which might be available The patterns had had to be kept small, first, because the site itself might be limited, and secondly, because with a small pattern it was easier to achieve the geometric accuracy that was needed With this different outlook, it was not surprising that the Boscombe Down patterns should differ from that shown by Mr Hearne, although they were all based on Calvert's centre line and crossbar principle

The A and A E E had also used as an approach path indicator and as an emergency ground lighting system a triangular pattern of three lights which gave horizontal, directional and approach path reference

Mr Hearne had not mentioned the advantages of carrying parachute flares on single-engine helicopters at night in case of engine failure This was probably because he had specified his need for multi-engined reliability for operating from city centres For the single-engine helicopter, however, parachute flares could be of considerable value in selecting emergency landing sites, provided there was one within range, although their use did not necessarily guarantee an unbroken helicopter

Was Mr Reid's landing lamp control fitted to the cyclic stick from choice, or would he have preferred it on the collective lever ?

Mr Reid replied that the landing lamp control happened to be on the cyclic stick when he found it It worked so well, certainly on the Bristol 171, that he had not thought about moving it elsewhere During the part of the approach when using it, the pilot's hand would always be on the cyclic stick anyway , and assuming that the pilot was sitting on the right-hand side of the helicopter, there was the possibility that he might want to do something like changing the element in the landing lamp from a wide beam to a pencil beam at a low altitude In such an event, the landing lamp control was a " must " for the cyclic stick

Mr Hearne, replying to the question of why 20 knots was chosen and whether the figure was limited by airspeed indications, said that although they spoke about 20-knot approaches, they had not yet managed to do them properly on instruments Because of the limitation on existing aircraft, the lowest they had got down to was 40 knots It was hoped later to get down to 20 knots

The reason for this choice was firstly that the forward speed had to be kept up to prevent the aircraft going into the vortex ring condition It had been found in approach trials that the average rate of descent of 700 ft per minute was often exceeded by 300 or 400 ft per minute, which would mean that an aircraft flying at very low speeds would be near the vortex ring

The problem of wind on the approach was a very real one If a pilot started the very low speed approaches at an indicated speed of about 10 knots or so on anything like a normal day, he would find himself in a great deal of trouble The real object was to achieve a constant glide path over the ground, which demanded a constant rate of descent and a constant ground speed On the majority of occasions the pilot would not be able to go forward at 10 knots because the wind would be blowing him backwards at 10—15 knots

Mr Reid added that in the low speed descents which had been done with the Bristol 173, he did not think the pilot was watching the airspeed indicator very much but was flying much more by his attitude information There was simply an odd check on the A S I He would not say that at that point it was *the* primary instrument

If the plan position instruments were good, the pilot would not need much cross-reference to the airspeed indicator

Mr R Swale (*Decca Navigator Co Ltd*), who referred to Mr Reid's description of the flight panel and the pictorial presentation unit underneath, asked whether there was room for improvement in making it smaller or whether its present form was acceptable

Concerning the static problem and reliability, he felt that the helicopter had been rather a Cinderella A lot of work had been done on fixed wing aircraft to improve the reliability and the static problem had largely disappeared It was time now to do a lot of work on the helicopter, so that the problem could be resolved and, perhaps, disappear

A great deal of work was being done on instrument lighting, and he thought that a suitable instrument could be produced very soon

Mr Reid replied that there had been much discussion concerning the Decca Flight Log The view of B E A , he thought, was that it could well be changed and that a rather more square presentation, slightly reduced in size, would be preferable There seemed to be a lot of waste room most of the time on the I light Log However, if a number of entry points were required for a complicated control zone then it might be difficult to get the information on a smaller chart Resetting up on a large scale from a navigation chart would present a problem If the pilot was simply following a pre-determined track on a Decca I light Log, there was a tremendous lot of waste paper running along all the time and experience had shown that the actual presentation could well be reduced

It had a little bearing on the instrument presentation shown in the lecture, because the width of the Decca Flight Log was less than that of the instrument presentation Mr REID visualised a total presentation 12—16 in wide, small and contracted It did not matter whether the Decca Flight Log was on top or below the primary panel It did not affect the total area of the primary flight panel

Lt Commander N Fuller (*D A W , The Admiralty*), said that much stress had been placed on the question of autostabilisation of helicopters to meet the problem of blind flying This in itself was probably commendable and necessary On the other hand, he thought they were losing sight of the fact that there was a lot of work to be done by manufacturers to find aerodynamic stability in helicopters

Autostabilisation could be forgotten He was not himself interested in it All he wanted was stability, aerodynamically built into the helicopter He had been told that this might not be completely possible, but it was present to a certain extent in the Bell 47-J, and, both the Westland Widgeon and the Fairey Ultra-Light had stability which was not present in certain helicopters It was to be hoped that that aerodynamic stability would not be completely lost sight of purely for the sake of autostabilisation

Mr Reid had shown a very ingenious instrument presentation This in itself was quite desirable, but at the same time it did not reach the answer The author had said that so far there were eleven instruments and that it would be preferable to have only six This was quite true, and one would much prefer to read six instruments rather than eleven On the other hand, although the number of instruments had been reduced, there was no reduction in the number of needles At the same time, therefore, the pilot must interpret, in terms of " what he knew," the same number of needles That was not what was wanted

In America, Sperry's had presented a flight director system Lt Commander FULLER said he would risk his neck by saying that although it had been presented, the fact remained that pilots did not like it They sat back, looked at the instrumentation and said " Fair enough, but there are eleven needles I do not want to read eleven needles I just want a simple little thing, with two needles or an I L S system, something that comes up in the centre telling you what you ought to do That is what we want "

Did Mr Reid consider that it might be possible to devise a system which called simply for one Zero Reader and which could give everything that went on at all times, except in the extreme case of, say, an electronic failure of some sort ?

Pilots now had to go back to basic instruments That being so, would it not be nice to ask the manufacturers of helicopters to provide those basic instruments that would allow pilots to get home ? At the moment, that was not what the manufacturer

was offering He was offering simply a system which was just as complicated as the existing one

Mr Hearne expressed full agreement with the plea for aerodynamic stability As he had said earlier, there were ways and means of achieving it which had been done experimentally but not yet on production aircraft Perhaps a good step in the right direction would be for the Air Registration Board to specify some handling qualities for unstabilised helicopters

The question of presentation of instrumentation was one which nowadays occupied a lot of the people for a lot of the time Mr HEARNE would not pretend to say that he had the answer, but on the flight director work that was done in America the naval pilots came up with an opposite opinion to people from other establishments They later had second thoughts and came to the conclusion that a flight director system was desirable

Mr Reid did not altogether agree that his suggested system was as complicated as the present one Nevertheless, he took the point He regarded his suggestion as being simply a step on the way In the United States, there were projects to give a pictorial presentation in forward-looking flight, where the pilot would simply see a datum with a false or projected horizon and would fly the aircraft normally There might be two displays to look at—a forward-looking display on a screen, and a downward-looking display Something on these lines was approaching the Zero Reader presentation His own suggested presentation was something which could be made up from existing instruments

F/Lt A O Sharples (*R N A S , Lee-on-Solent*) (*Associate*), said that a great deal of work seemed to have been going on about which he, as a member of the Royal Air Force, had heard nothing No doubt there were many present who would be in agreement with the view that a lot of work appeared to have been done in one part of the country, whilst people elsewhere knew nothing about it

Within the three Services, the limits of instrument flying would inevitably be lower than those to which the civil operating airline would have to conform , but as a practising helicopter pilot in the Service, he was staggered by the limits that the civilian operators were setting themselves At the same time, some of the limits stated in the paper seemed well within his capacity as a Service pilot—for example today, one of his pupils had flown down to a 200 ft limit simulated on Q G H in a standard S 55 helicopter, breaking out at 200 ft above the airfield

There seemed to be no co-ordination in effort between B E A , the R A F , the Royal Navy, the Marines and the Army, and F/Lt SHARPLES wished to see a lot more people getting together—apart from the Helicopter Association—thus cutting out the waste of time that took place He thought he could speak with authority, for he was an air force officer serving at a naval unit There were those in the Royal Air Force who would be designing wonderful cockpit layouts, but he shuddered to think what would happen if the cockpit standardisation committee got cracking He was interested in Mr Reid's layout, which appeared to be sensible If he were occupying a higher position in the R A F , he might have heard something about it before and so also might his naval colleagues

The biggest user of helicopters today was the Royal Navy, but very few naval officers could claim to have any knowledge of any of the work which had been done and which had been described tonight In the interest of helicopter development, there should be a great deal more co-ordination of effort within and without the Services

Mr Hearne replied that close liaison was maintained with various branches of the Ministry of Supply and the Royal Air Force He could only attribute the blame to the fact that there was a lack of liaison on the R A F side or on the part of the Ministry of Supply The information was supplied by B E A , but if it was contrary to military policy it would not be dissemminated inside the Ministries Comparing civil and the military operations, he thought that civil limits were usually lower than military limits

They had been talking about 200 ft ceilings which were relatively easy He had himself been in a helicopter a few days ago which broke cloud at about 90 ft with no trouble The problem arose on the dark, rainy night when there were forty passengers aboard He had expressed the view that it might be possible to operate

in 150 yards on 100% of occasions, but it might not always be possible to break cloud at 200 ft in an unstabilised aircraft

Mr J S Shapiro (*Consulting Engineer*) (*Founder Member*), recalled the disagreement which had been expressed at an earlier meeting a year ago In terms which had been used tonight, he would say that the target was not too high, but was too low , but when talking about cloud, it was as well to know what " high " and " low " meant

He firmly believed that in 1957 it was unrealistic for anyone to assume that they would get twin-engined helicopters with full stability and yet somehow would be behind with complete zero zero control He did not believe that there was very much difference in the rate of descent from 750 ft at 20 knots or from 400 ft at zero knots If there was a small difference, by the time that there were twin-engined stable helicopters it would have disappeared and those who planned these operations would be able to count on it

Mr SHAPIRO said that he was at one time concerned with the question of developing de-icing on helicopter blades The most difficult problem was how and where to carry out the tests Could anybody suggest where tests could be carried out on helicopter blades for which a de-icing system had been provided ?

He was surprised that when considering stable helicopters, nobody had mentioned Hiller It seemed to be a mute point among pilots He had certainly been present when the pilot had removed his hands from the control for quite a while, and it was impressive It was most important for small helicopters to have a degree of stability

Tonight's subject, however, was round-the-clock operation, and to stabilise helicopters aerodynamically involved doing so not only when the air was stable, but when it was not stable, and he asked what steps a designer could take to add stability without adding any very large weight

Mr Reid replied that unfortunately he was not present at the meeting in question, although he had heard of the argument about vertical descent It was a subject he had always wanted to discuss In tonight's lecture, he had not completely dismissed the idea In fact, he had mentioned things like hovering stabilisers which had an application for controlling vertical descent into sites The trouble was that the instruments which were available and which would work in vertical descent were almost nil It was not much good thinking about it until the instrument manufacturers did something It was also necessary to have a very high degree of control, so that the power settings and speed could keep the helicopter outside the vortex ring state

Recovery from vortex ring state on instruments was a much more difficult matter Everything at the moment was pointing the wrong way Nevertheless, he did not dismiss the idea, and he thought that the work now being done with hovering stabilisers might provide an answer

Mr Hearne said that aerodynamic means of stability involved a number of factors It was a question of which derivatives influenced it There could be variations by altering the hinge position or the solidity of the disc, or the addition of quite small tailplanes at cruising speeds might give improved stability As the advance ratio was brought down, however, progressively larger tailplanes were needed They were, therefore, an aid only to cruising flight

Another possible method was to reduce fuselage drag For some unknown reason, the m_μ term, which had quite a large amount of fuselage drag in it, had an appreciable effect on longitudinal response

Mr Reid added that in Canada de-icing trials were being carried out with an electrically heated mat system Icing had been simulated at minus 40 deg , with warm water being sprayed from above

Mr Shapiro expressed gratification at the panel which Mr Reid had illustrated It was only three years ago that he had found that for one particular purpose the vertical scale was the only obtainable solution

Practically all the pilots who were in some way connected with existing prejudices or opinions had told him that the idea had been completely dismissed and that a committee which had carried out a thorough investigation had rejected anything but the round dial He did not, however, believe this and he had gone ahead He

was very glad to hear that the idea had not been finally rejected, because he regarded it as very sensible

Lt Commander Fuller said he wished it to be recorded that he was completely satisfied with the co-operation with B E A

The **Chairman** repeated Mr Hearne's remarks that B E A had taken steps to circulate to the best of their ability information of the work done and the results obtained If the coverage was not as wide as could be desired it was because something was wrong elsewhere

Major R I Walton (*A & A E E*) (*Member*), who had been a pilot during the recent de-icing trials in Canada, pointed out that it was not strictly true to say that warm water was sprayed from above What was done was to hover in and out of artificial cloud The results of the tests were classified, and he could not say anything further than that the system showed great promise

F/Lt R N Vimpany (*J E H U*), said he was sure that if Colonel Scott had been present, he would have expressed the satisfaction of the Experimental Unit with the co-operation of B E A —and the Ministry of Supply too, no doubt In particular, both Mr Hearne and Mr Reid had always been most co-operative

Mr M C Curties (*R A E*), said he had been actively concerned in the development of the stabiliser equipment

He questioned Mr Reid's instrument display It was recognised that the tape or line type of presentation had certain advantages They were usually associated with the need to present a large scale movement on a single instrument For instance, in the case of height presentation on a high flying aircraft, it was useful to compress the high part of the scale into a small space—after all, the pilot was not very interested in height accuracy in that region—and to expand the lower parts of the scale to cover the approach case, and so on

In the helicopter, the need for this might not be so great The scale was not a long one, either for speed or for height The self-evident nature of the display—the fact that there were a number of pointers in line—could equally well be achieved by the conventional round instrument It was possible to mount the round instrument for, say, cruising conditions or for recommended rotor speeds, and the pointers could all point in the same direction, *e g* , vertically

It might be argued that by turning to this new display, cockpit space was saved, but this was questionable To get this type of display, it was necessary to depart from the single instrument It was necessary to have somewhere in the aircraft a data source from which one could compute the airspeed or height, for example, and transmit it through a servo link to the presentation instrument

Everybody knew that the servo link introduced some unreliability into the system It was sad but true that in systems in which this type of display was being proposed, standby instruments were also appearing They used up some of the space that was saved and cluttered up the cockpit again There was a very nice airspeed display, but in case it went wrong, or the servo link went wrong, there was tucked away in the corner an airspeed indicator , and soon the panel would be getting about as big as it was before What had Mr Reid to say about all this ? It might be doubtful whether, in the instrument system which had been described, any space would be saved by adopting it

The lecture, naturally enough, dealt with the civil aspects of the problem of all-weather flying The Service aspects were somewhat different and were worth mentioning Work was going on to enable Service pilots to fly in all weathers, but before they could do this, even though they were to be presented with complicated equipment to help them, they would need to develop a new outlook on helicopter flying The present approach which appeared somewhat " casual " as compared with that to fixed wing flying would have to disappear All-weather flying in helicopters would demand the same sort of considerations as applied to the fixed wing aircraft There would have to be proper flight planning, and crews would need parachutes and other safety equipment They would have to be persuaded to go through cloud and not below it To ensure that the aircraft was efficiently operated, they must be trained to use the equipment to do the job

Mr Reid replied that the ribbon type of instruments were based on something already built The instrument people at Gatwick, when the idea was put to them, drew up a presentation 18 in wide and 20 in deep, excluding the Flight Log Certain troubles, however, were encountered, apart from those mentioned by Mr Curties When the needles were travelling at the top or bottom end of the scale, inaccuracies arose

The aim was to try to give better vision forward in breakout When the helicopter pilot broke out at 100 ft into what might be a murky area below him, looking for lights, Mr REID did not want him to have to stand up in his seat and look over the top of the instrument panel to see what was below him

It was a quite different problem from making a break-out at 300 ft in a fixed wing aircraft with a nice row of lights showing ahead Fixed wing aircraft and helicopters face a very different problem in this respect The two men up at the front must be given much better forward vision

Apart from the mock-up, not very much work had been done on this project It was realised that there were problems in ribbon-type presentation, but a lot of work was being done in America for high flying aircraft In particular, the altimeter and the airspeed indicator should have a definite application for helicopters It was hoped that the amount of work now being done in America would solve many of the problems

Mr Hearne supported the view that pilots should have the right outlook towards flying The subject matter of the lecture demanded precision flying, which called for a great deal of concentration from the pilot The pilot certainly would not be able to fulfil all that was required of him if he walked out casually to his aircraft with nothing more than a copy of " Men Only " under his arm

Mr J W Leach (*A & A E E*), said that although he appreciated that most of the papers were devoted to development on the instrument side and to techniques for flying helicopters in all weathers, he was disappointed that Mr Hearne did not say more about the inherent or, say, engineering features in the basic design that could possibly be investigated and developed Icing and one or two other problems had been mentioned, but Mr LEACH wondered whether the small proportion of the lecture that was devoted to this aspect was indicative of the amount of attention which it had been given

It seemed that as helicopters became bigger, so there was more noise in them Little attention seemed to have been paid to the crew comfort side of helicopter development, especially in connection with fatigue There was a lot more work to be done, and far higher standards of comfort level for noise and vibration had to be considered

In the development of helicopters, the user had to conduct operational reliability trials What sort of engineering features did B E A have in mind for investigation when they received a new type ? Mr Hearne had referred to rotors starting and stopping and said that restrainers were required An important point in that connection was the speed with which one could start the rotor and get it up to control speed, and also stop it An improvement in that acceleration and also in rotor brakes would be a big help

Mr LEACH also acknowledged the good co-operation which existed with B E A in relation to the work they did

Mr Hearne replied that the problem was not one of what should be included in the paper, but of what to leave out He agreed that in many respects the existing helicopters were completely unsatisfactory for all-weather operation There had been one occasion when it was desired to carry out actual cloud flying that the aircraft had been grounded for a period of ten days The aircraft had been literally sitting on the ground because it was not equal to the job, not because of lack of instruments or radio aids—they were adequate—but because (*a*) it was not possible to start or stop the rotor in high winds, (*b*) it was not possible to fly in ice, the windscreen wiper had fallen off, there was no cabin heater, and so on

When somewhat bitter complaints were made to the aircraft manufacturers about these things, they often replied " What do you want them for ?" Recently, said Mr HEARNE, he had been asked why he wanted two V H F sets When replying that it was necessary to guard against failure to avoid the disorganisation caused in control zones and to safeguard the aircraft, he had been greeted with obvious signs

of disbelief It was a question of educating the manufacturers into what was required, and the more that everybody could do to this end, the better

In B E A , the engineering development was the responsibility of the Project and Development Branch It was hoped that when an aircraft was delivered from the manufacturer it was reasonably up to standard, but as a safeguard there was a strong development team to ensure that that was the case

Squadron Leader J R Dowling (*Central Flying School*) (*Member*), wished to express his appreciation of the papers and his gratitude to B E A for giving him a personal demonstration in a Sycamore of simulated blind approaches using a Decca Flight Log system, which he had found most impressive

He described some of the remarks of Mr Curties as a little odd, and said that as a member of the Central Flying School he would professionally be interested to meet the pilots who were so casual in wandering out to their aircraft

The determination to go up and through the cloud or over the top was all very well, but very often it was not necessary He was very much against the principles of " plankery " intruding on helicopting In saying this, he was referring to people who dealt exclusively with fixed wings applying their ideas to those who dealt with rotating wings

By far the largest number of helicopters now operating were operated overseas by the R A F , where the instrument problem rarely arose At home, where the R A F was as interested as everybody else in dealing with the instrument problem, nobody had developed the equipment It seemed extraordinary, therefore, to blame the R A F or the Navy pilot for not doing as much instrument flying as he might otherwise have done because he lacked the equipment

Mr H C Black (*Air Registration Board*), spoke of the minor details of the instrument presentation which had been suggested and said that he hated straight line instruments unless they were absolutely necessary, because it seemed to him that with them it was necessary to read the number on the instrument and that one often lost the ability to read the instrument simply from the position of the needle It was nice for the pilot to be able to remember that when he came in to land, the A S I was at the point say between 10 and 11 o'clock and thus to visualise the instrument reading without having to read the number against the end of a needle He recalled the propeller pitch needle on a German wartime aircraft The pilot took off at the half-past eleven position , no numbers were required, and the instrument could be used entirely satisfactorily simply on position It was a pity to lose the position indication unless it was unavoidable

In the approach to the problem of blind flying and round-the-clock all-weather operation, there was a danger of trying to run before learning to walk Mr Black had been struck by the emphasis shown this evening on the round-the-clock aspect as against the all-weather aspect The helicopter people must try to get to the stage reached by the fixed wing aircraft before the start of all the I L S nonsense which is necessary if one wants to come in with low visibility minima Before the war, all the current aeroplanes, even with the most rudimentary instruments and without even an artificial horizon, could nevertheless fly through some sort of cloud

He hoped that in the future the emphasis in the research work could be shifted from the QDM to the Cu Nim

Mr F J Twiney (*R A E*), referred to the comments that had been made concerning the Decca Navigator and expressed the view that by 1960 Tacan would be showing up on the operational front It seemed to overcome some of the disadvantages of Decca, which required a relatively large presentation unit and used a hyperbolic lattice, whereas the Tacan, with its relatively small presentation, appeared to be the ideal sort of system

He asked what degree of accuracy was required in *en route* navigation to keep lane separation Must the navigation be as good as was suggested in the lecture, or could it be looser ?

Mr Hearne, in reply to the question concerning Tacan, recalled the comment in the lecture that a secondary navigation for helicopters was currently being considered and it was hoped to be using it by the end of the year It would be nice to install but he thought they were in short supply

There were very definite advantages in the Decca system It could be used for a secondary approach aid, and additionally, the pilot was not dependent on a lot of ground stations As the helicopter was flying at about 3,000 or 4,000 ft for most of the time, stations would often be out of range It would, however, be a useful secondary aid if the main aid failed

The question of separations was a thorny subject in I A T A at the present time Some people were proposing separations as low as 1,500 ft , but obviously this would never be achieved on any navigational aid at present in existence It certainly could not be done on Decca or anything else

Mr Reid said that his own experience was the psychological one When flying these tracks visually with another helicopter on a multiple track going in the same or a different direction, at 1,500 ft lateral separation the pilot would feel certain that at times they would collide

When coming out of cloud when the other helicopter was about 70 deg off, one still felt that one was coming up in formation That was the unusual condition pilots had to get used to They liked to be properly separated from other aircraft in cloud He thought it would have to be nearer 5,000 ft lateral separation

The problem also arose with the crossing airway With helicopter routes constituted below 4,000 ft , Mr REID had tried the climb and ascent procedure to get over an airway which had to be crossed Although he had allowed 15,800 ft horizontally from the beginning of the climb to the bottom of the descent, one still seemed to be terribly close to helicopters on the crossed airway when commencing the climb and not far away when starting to descend He thought that the distance horizontally would have to be at least a mile from the centre of the crossed airway

The **Chairman,** in closing the meeting, said they had listened to two most interesting and extremely well prepared papers and the authors were deserving of great credit for their thought, care and method of delivery It must have been a source of satisfaction to them to have seen such a very good attendance at the meeting

A vote of thanks to the Authors, proposed by the Chairman, was accorded by acclamation

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