Helicopters in War and Peace

June, 1951

By I. I. SIKORSKY

On Tuesday, 17th July, a meeting was held in the Institution of Civil Engineers commencing at 5.30 p.m. Members and guests had the privilege of being addressed by Mr. I. I. Sikorsky.

MR. E. MENSFORTH, C.B.E., President Elect of the Helicopter Association of Great Britain, presided.

Not long ago it was usually taken for granted that heavier-than-air craft would always need a certain minimum speed in order to stay in the air, and that maximum velocity would forever be limited by a figure somewhat below the speed of sound. The continued progress in aeronautical science has permitted us within the last decade to eliminate completely both above-mentioned barriers. On the upper end of the scale, the meteoric jet- or rocket-propelled aeroplanes have by now substantially exceeded the velocity of sound. The ability of a man to fly faster than cannon shells travelled during the 19th century may be considered as one of the most brilliant and spectacular achievements of human genius.

Much less spectacular, but perhaps equally important to humanity, has been the elimination of the lower barrier. This was accomplished by the helicopter, whose characteristics and ability of direct ascent, motionless hovering, slow speed, etc., opened a new and immensely important field of usefulness for aircraft in peace as well as in war.

The value of the helicopter in war has been anticipated by many specialists. However, it has for the first time been indisputably demonstrated and proven, during the recent war in Korea. The details of the operation of the few helicopters which participated in this war are generally known ; therefore, in this discussion we will only mention a few statements which the military leaders have made recently on this subject.

Lieut.-General LEMUEL C. SHEPHERD, Jr., Commanding General of the Pacific Fleet Force, who used one of our helicopters to make the first landing on Kimpo airfield after its liberation, said :

"There are no superlatives adequate to describe the general reaction to the helicopter. Almost any individual questioned could offer some personal story to emphasise the valuable part played by the five HO3 planes available. Reconnaissance, liaison, visual flank security, movement of security patrols from one key locality to the next, posting and supply of security detachments and many

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more. There is no doubt that the enthusiasm voiced by the Brigade is entirely warranted. Moreover, the usefulness of the helicopter is not by any means confined to a situation such as encountered in Korea. No effort should be spared to get helicopters—larger than the HO3's if possible—but helicopters in any form, to the theatre at once—and on a priority higher than any other weapon.

Major-General MERWIN SILVERTHORN, Acting Commandant of the Marine Corps, speaking before Vinson's Sub-Committee of the House Armed Services Committee, testified :

" One of the four big lessons learned from the Korean War, is that use of the helicopter is practicable."

Major-General FRANK A. NEILEMAN, Army Chief of Transportation, stated :

" The Korean war has boomed the use of the helicopter. The army is organising helicopter companies for aerial distribution of supplies to isolated units. They will be of particular value to troops in mountain fighting. They will take the burden off the mule."

Brigadier-General EDWARD A. CRAIG, First Marine Division, declared recently :

" Any military force without them (helicopters) is back in the days of the Civil War."

(N.B. General Craig himself helped hoist a downed Marine pilot from the sea in a Sikorsky helicopter).

Lieut. GUSTAVE LUEDDEKE, U.S.M.C., helicopter pilot in the thick of Korean operations, says :

" One of the greatest contributions these things (helicopters) have made in war . . . is to Marine morale. Every kid down there knows that no matter what happens, we will get him out if he gets hit."

In line with the above, it is interesting to call attention to the following figures. Until the middle of April, 1951, our helicopters, in the hands of our armed forces, accomplished the following rescue operations in Korea (quoting from " The Sikorsky News," of May 11th, 1951) :

" Third Air Rescue Squadron, as of April 20—1,091 front-line rescues ; 413 behind enemy lines rescues ; 2 water rescues : *Total* 1,506.

(*b*) U.S. Navy, as of April 15—396 rescues from carrier, cruiser and battleship based helicopters.

(*c*) U.S. Marines, as of May 11—1,070 rescues, which include 36 pilots rescued from behind enemy lines. *Grand Total* 2,972."

At present, June, 1951, the total has already substantially exceeded the figure of 3,000.

Commenting on the rescue work, Lieut.-General GEORGE E. STRATEMEYER, Commanding General of the Far East Air Forces, said that one of the " great significant accomplishments " in Korea had been the saving of untold numbers of lives by U.S. Air Force Helicopters. Said General STRATEMEYER, " Approximately 90 per cent. of all flying personnel downed behind enemy lines have been picked up by U.S. Air Force helicopters."

The subject of the present discussion is very vast. Therefore, in the attempt of analysing the present and forecasting the future, we will limit the discussion to the subject of size, speed and configuration.

With regard to size, it seems to be certain that practical, serviceable helicopters carrying up to 50 people can already be designed and constructed at the present time, on the basis of our experience, materials, power plants, and so forth. Much larger machines of between 50,000 lbs. and 100,000 lbs. gross weight and more, are well within reach and can be constructed in the very near future, as soon as there would be requests for same.

There exists a considerable variety of opinions as to the preferable type and configuration of these large machines. There are also different opinions as to the best methods of applying power to their rotors. This may be by the use of conventional transmissions or by jets mounted at the tips of the blades, or by small auxiliary propellers and probably by other methods. In fact, aircraft utilising each of the three above-mentioned methods, have already been in the air. Only more extensive study and experimental work may demonstrate which method could definitely be considered the best. I believe, however, that up to 100,000 lbs. and probably substantially beyond that figure, the conventional transmission-driven helicopter may still give very satisfactory results and will very probably remain the most efficient type.

The question of speed of the helicopter is at present not yet settled. The following ideas, however, appear to point in the right direction. We may expect in the future the development along three basic lines which, for lack of established terminology, we will designate as first, the simple or classical helicopter ; second, the compound helicopter ; and third, the convertible helicopter. By the first, we will understand an aircraft in which all lift and all forward thrust is supplied by one or more lifting rotors. This aircraft would probably never exceed much the speed, equal roughly to one-third of the tip speed of its rotors. This in turn would place the limit in its speed, to some 150-175 miles per hour.

The term " compound helicopter " will be used to designate an aircraft which, besides lifting rotors, would have small auxiliary wings and some means of propulsion such as propellers or jets, which would supply additional thrust, while the wings would permit unloading of part or nearly all the load from the lifting rotors near the maximum speed of this aircraft. Such helicopter could probably attain a speed of some 200-250 miles per hour, which in turn will make it a very useful aircraft for intermediate distances. Its useful lifting capacity per horse power would obviously be smaller than that of the classical helicopter.

In what concerns the third, or convertible helicopter, there has been a very considerable number of designs proposed and patents taken out, covering a variety of configurations. In some of these, very considerable speeds up to 500 miles and more, were anticipated. The future will show how practical such designs would be, even though there is no doubt that the convertible helicopter of one type or another, or even several types, is possible. I believe that craft of this type will, however, be always considerably inferior in efficiency to either the ordinary helicopter or the fast aeroplane in its own field. Consequently, its use will probably be limited to certain special military missions.

Considerable diversity of opinions exist among engineers and students on the subject of the best configuration. The preference of a single rotor or tandem or some other configuration are debated and promoted with determination and enthusiasm. I still believe that, all around, the single rotor represents the best configuration for the helicopter because of factors that are similar to the ones which influenced the design of the aeroplane. The beginning of aviation saw bi-planes, tandems, tri-planes, etc. Finally, all multi-wing types became eliminated and the monoplane alone survived because, in spite of the definite structural disadvantages, the aerodynamic

efficiency of a single wing operated in unobstructed air is so superior as to justify this type. I am convinced that the case will be similar with the helicopter. It must indeed be added that an idea of this nature should not be accepted dogmatically and there may be room for other configurations according to special missions which the aircraft may be requested to serve.

The year 1950 may definitely be considered as the time when the helicopter reached its full maturity and when its military usefulness has been demonstrated beyond any trace of doubt. The commercial usefulness has already been demonstrated earlier, even though on a small scale by several local services, and in particular by the three and one-half years of uninterrupted operation of the Los Angeles air mail service.

The very creditable achievements of this service are illustrated by the following figures, giving the summary of operations until March, 1951 :

Pound miles	255,809,549
Pounds carried	12,816,134
Hours flown	18,443
Miles flown	1,140,312
Flights completed	110,658

The helicopter is the most universal vehicle of travel ever created or used by man. Every other vehicle that we can think about is limited either by the nature of the road surface over which it travels or, as in the case of the aeroplane, by an elaborate and very large platform for departure and arrival. The helicopter alone, particularly if mounted on floats, is virtually independent from the nature of ground or water for its departure and landings and obviously can travel in any direction. These outstanding characteristics will assure to the helicopter a fundamentally important place in peace and in war.

Discussion

Opening the discussion, **Captain Smeeton,** R.N. (*Deputy Director, Air Warfare, Admiralty*), commented first on the high favour in which the helicopter was held by the Navy, and then went on to ask if Mr. SIKORSKY could enlarge on his statements about transmissions. One was continually told, by the protagonists of tip-drive, of the difficulties attached to transmission systems for helicopters of the large size that Mr. SIKORSKY foresaw. The Compound helicopter seemed to him (Captain SMEETON) to have some commercial advantages over the classic type, in that the limitation on tip-speed of the classic helicopter might not appeal to some passengers. The classic type seemed ideal for city-to-airport traffic, and if this was so, he could see no reason why the type should ever be developed to a large size. City-to-airport traffic would, surely, be restricted to the classic helicopter, and the compound type be utilised for medium distances.

In reply, **Mr, Sikorsky** said that certainly there were difficulties about transmissions, but little was known of the difficulties and complications of other systems. The well-built transmission system could give excellent service, and was undoubtedly the most efficient way of transferring power from the engine to the rotor. On the analogy of motor-car gearboxes and differentials, there was no reason why an entirely practical and satisfactory transmission system, capable of several thousand hours' life should not be built and such a system would represent the most efficient type of transmission for a helicopter. Mr. SIKORSKY did not think he could enlarge on the question of speed ; it was in the hands of the operators, whether military or commercial. Nominally, speed had to be paid for with payload, and only the future could show to what extent the slower helicopters would be replaced by faster types ; it was probable that both would survive for a long time.

Mr. N. E. Rowe (*Member—British European Airways*) said that British European Airways had been experimenting with how to use the helicopter in transport. They had found it an excellent aircraft, and foresaw that, within ten years' time, the bulk of all (air) transport in this country would be undertaken by helicopter. We had

the ideal conditions for it, *i.e.*, large centres of population separated by comparatively short distances. Cruising speeds of the order of 150 m.p.h. could be expected, for experience had shown that with present cruising speeds the effect of head winds was great and this made helicopter operation uneconomical.

Concerning the use of centre-drive and tip-drive, and the weights at which they would be used, he would like to ask if Mr. SIKORSKY saw any difficulty in the transmission from turbo-prop-type engines. There were the problems of noise, gears and so on ; there might be limitations to disc loadings for passenger transport ; engine failure had to be catered for. These might have a strong bearing on the speeds which were practicable for cruising flight.

Mr. Sikorsky replied that he would repeat once more his complete conviction that a good, reliable and practicable transmission could be worked out. Present types were quite good, and the limit was in no way in sight. Practically all modern aircraft engines, and particularly turbo-props, used transmission systems to the airscrew. There was no need to be overawed by the transmission problem ; there were ways and means of designing reasonable transmissions with respect to weight ; systems considerably larger than those at present in existence would certainly come. The future would show.

Turning to the subject of higher disc-loadings, Mr. SIKORSKY agreed that, at the higher values, landings would certainly become more difficult ; but even if high disc-loadings resulted in damage to the aircraft (in an emergency landing) they should not result in damage to the passengers. In the multi-engined helicopter, it might well be possible in such circumstances to reduce considerably the force of landing in precisely similar a way as applied to the large, multi-engined fixed-wing aircraft.

Mr. Raoul Hafner (*Member—Bristol Aeroplane Co. Ltd.*), said that nobody could be more satisfied than he to hear Mr. SIKORSKY'S opinion that helicopters had come to stay. He then went on to say that, after investigations, he had tentatively come to the conclusion that there was a tendency towards favouring tip-drive as a function of size. There was the limit imposed by tip speed, and it was patent that, as rotor diameter increased, r.p.m. went down, and the gap between engine speed and rotor speed become considerable for rotors of great diameter. Gears also became heavier as rotor size increased. Perhaps the very large rotors would be jet-driven, whilst the smaller types would be gear-driven ; somewhere, there was a criterion of size, above which jet-drive would be used, and below which gear-drive would obtain. He agreed with Mr. SIKORSKY that gearing problems were difficult but were not insurmountable.

Mr. Sikorsky replied that there seemed a certain limit beyond which tip-drive would become considerably more attractive than centre-drive. Where that limit would come was hard to say, but the sizes with which we dealt were considerably below that limit. For a really large helicopter, the transmission would probably not be of the kind we now knew. It might well be that the shaft would not carry torque but that, instead, a large gear might form the basis of the rotor hub, torque forces being directly transferred from gear to hub. It might be that the gear would be driven by (say) four pinions, each from an individual engine, through whatever reduction gears might be necessary. By incorporating a free-wheeling unit close to each pinion, the loss of an engine would not affect the transmission, and the helicopter would still fly. In general, however, as size increased, there was no doubt that the preference for jet-drive would increase.

On behalf of the Association, **Mr. Wigdortchik** accorded an expression of thanks to Mr. SIKORSKY. Throughout aviation, he had been a leader and now the fruit of his life's work was beginning to show itself ; they could not hear from anyone in a better position to put the helicopter in true perspective.

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