Sikorsky Helicopter Development

By IGOR SIKORSKY

A lecture presented to the Helicopter Association of Great Britain on Saturday, 8th September, 1947, at Manson House, 26 Portland Place, London, W 1

H A MARSH, A F C, A F R Ae S IN THE CHAIR

Introduction by the Chairman

Ladies and Gentlemen,

It is my privilege this evening to introduce to you Mr Ivor Sikorsky, the eminent engineer responsible for the design and development of the helicopters bearing his name He is going to talk to us about the recent developments of these aircraft

I think it is correct to say that Mr Sikorsky is the earliest pioneer of helicopters alive today, having been engaged upon experimental work with this type of aircraft as far back as 1910, and he also has the distinction of being the first to produce the helicopter as a realistic and practical aircraft

We have to thank two of our Council Members—Dr Bennett and Wing-Cdr Brie—for suggesting to Mr Sikorsky that he should give us this talk and we all very much appreciate Mr Sikorsky's gesture in consenting to do so

On behalf of the Association may I extend a very cordial welcome to all our guests

Mr Igor Sikorsky

Mr Chairman, ladies and gentlemen, I consider it an honour and privilege to address you tonight on the subject of helicopters, which has been a subject of very great interest to me in the last fifty years or so

About the year 1900 I tried to make models of helicopters , later on, when 19 years or so of age, I became so firmly interested that I decided to go into this aviation game The first aircraft that I built was a helicopter

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The reason for deciding on the helicopter was partly serious and partly instinctive, or I may say, romantic The idea of flying existed in the world for nearly 600 years—very much earlier than any idea of the locomotive or automobile Always people associated the dream about flying with the solution of two problems—one was that of travel through the air This, as we know, has been partly solved by the aeroplane But there was a second problem to solve, the problem of free take-off and free landing on any spot of the earth In this respect, the aeroplane proved to be the most helpless vehicle ever designed by man, because an aeroplane operates with safety only in a large space Obviously, the problem of travel was not really solved by the aeroplane, but could be solved by another vehicle that could rise quickly from a confined space, stay over one spot, go quickly down and land on any spot—a roof-top or anywhere else where there is room For years that was a dream, but behind such dreams there has been a very great deal of technical construction Only a few years ago mention of the subject was thought a stretch of the imagination Now, fortunately, things are different

It is known that the helicopter has already accomplished things—there is a great deal of work done by the helicopter in spite of its very short career During the last year of the war helicopters were quite extensively used in the Pacific, India and Burma They were used for various rescue missions and a number of soldiers owe their lives to the possibility of being rescued by helicopter after descents and crashes behind the enemy lines A number of other valuable services have been rendered , for instance, helicopters have been used on board transport ships which were supplying spare parts In the most urgent cases spare parts could be taken from shipboard whilst the vessel was still steaming in the sea, and flown to those parts where they were most needed

In a number of cases B 24's and other large airplanes were kept in the air by the possibility to obtain quickly the necessary spare parts supplied by helicopter

There has been a number of other uses and by the end of the war the worth of the helicopter had been proved and now valuable information can be given in spite of a very short time after the end of the war Let us take a few cases at random Helicopters have been used for crop-dusting and undoubtedly their use will extend further, the value of this work justifying substantial expansion Another important use is fighting forest fires Nothing can be so valuable in controlling the fire as getting quickly to the beginning of the fire, when in ten minutes two or three men could extinguish it

There are other important things such as cargo carrying Strange as it may look at first, the employment of the aeroplane increases the necessity for some adequate service that will deliver mail to the airport, take it from the airport and distribute it quickly The average air-mail letter from Chicago to Los Angeles has taken much more time in covering a dozen miles at both ends than it has taken in the air to cover the distance (about 2,000 miles) between Chicago and Los Angeles Tests have recently been conducted and they have proved an outstanding success As soon as the mail plane arrived at the airport three helicopters were filled with mail Three craft were necessary because in the Los Angeles area it was necessary to visit about 45 places In these places the helicopter could land sometimes

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on the roof of the Post Office, sometimes in the back yard and sometimes very close to the delivery point The letters were then sent out right away to their destination The saving in time was considerable, amounting occasionally to from 10-24 hours

Next, of course, we come to actual passenger carrying This is perhaps the main and most important job to perform for the helicopter at the present time The value of the helicopter in this respect is obvious In spite of its low speed it will be by far the fastest vehicle for distances of 50-100 miles, taking into account the time necessary to go the the airport I know, for instance, that in our case the helicopter is now a very regular instrument for

The Sikorsky S 51

ferrying men of our factory who go by air It takes us about half an hour to drive to the airport, whereas it takes two or three minutes to fly a helicopter to the airport The importance of passenger transport by helicopter literally cannot be estimated I have not the slightest doubt that in future this will be as important in our every-day life as airplanes are today

Undoubtedly one of the most romantic and interesting services rendered by the helicopter was the large number of rescues It is of great satisfaction to all of us working in the helicopter field that it should be a means of saving life—life that in a great many cases could not have been saved by any other vehicle I cannot repeat all the details of these rescue missions and will just mention a few, of which you have no doubt read, in Burma, Newfoundland and Labrador Back in Labrador an air liner crashed and 11 people, some of them injured, were marooned for several months When a helicopter was sent to rescue them some of them declared that this was the most beautiful sight in the air that they had ever seen I hope they were sincere

Several other rescues have been made, one of the latest being on a very stormy day when the wind was of sufficient force to uproot trees and damage roofs The police rang up our factory to say that an oil-carrying barge with two men on board was in distress and was starting to disintegrate,

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water sweeping over the surface of the barge We immediately despatched a helicopter with a hoisting sling and in spite of a wind of about 60 m p h and gusty, the helicopter quickly reached the barge and was able to hover 20-25 ft over it, lower the hoisting sling and take the men off, one after another The rescue was made as the end of day was approaching and the general consensus of opinion was that these two would certainly not have been able to stay on the damaged barge overnight

Just when I was ready to leave on the " Queen Elizabeth " the latest information which I received was of another life that had been saved Here again, during a forest fire, a man became surrounded by flames, and his life was in great danger He was provided with a " walkie-talkie " radio by which he was able to communicate with someone nearby A helicopter was sent up and fished him out

It is difficult to tell you of all such cases but it is interesting to know that in spite of the very young life of the helicopter, so many cases have already been recorded

Many other cases have been recorded when a helicopter was used recently during a Navy cruise in the Atlantic In one case the pilot of the helicopter saw the airplane was in difficulties and was actually in the air before the plane crashed The pilot was injured—disabled—and already sinking, when he grabbed the hoisting sling The wheels of the helicopter at that time were already down in the water The life of the man was saved but—and this is an exceptional case—had assistance been delayed for only half a minute, this man would have been lost

It is a source of much satisfaction to us and a great encouragement to everyone connected with the helicopter industry that lives have been saved in emergencies like these

Another point is, what can a helicopter do and what is the present performance of a helicopter ? I will mention a few figures, but it is needless to say that the figures will be exceeded very soon by our helicopters as well as by other machines

Greatest speed (fully loaded)	114	m p h
,, altitude (light)	21,000	ft
,, altitude (fully loaded)	16,000	ft
,, load	2,909	lbs
,, payload	2,500	lbs
Maximum load	18	men

The Army have lifted a substantially greater load—at least 600 lbs more than that of the R-5 helicopter, but the machine would not hover nor take off vertically with this load

Official longest distance	700	miles
,, ,, duration	10	hours

Needless to say all these figures are going to be exceeded very soon

I would like to go over just a few points on the development of the helicopter I started to built the first helicopter in 1909 and built another in 1910 The first could not fly because of a great number of reasons I would say because the engine was too heavy and there was not much power The main thing was I did not have enough knowledge at that time Later in 1910 I turned my attention to fixed-wing aircraft, built my first aeroplane and climbed into the cockpit and tried to fly it without knowing how to Quite a problem indeed However, the aeroplane could fly and even did

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so—at least with respect to my ability to stay up The maximum speed, cruising speed and minimum speed were all just about the same—something which has not been achieved by any other designer !

Later on I built better airplanes, until in 1930 I started building four-engined ships and flying boats in America, but during all this time my main interests were still with helicopters and I still wanted to make one fly In 1939 we produced our first helicopter It was of very simple construction, being built of welded steel but was capable of easy adjustment, thereby enabling valuable information to be obtained This aircraft had a very interesting life of about four years, during which time it was tested extensively I was the test pilot during the first flight in October, 1939 It had a single main rotor with an anti-torque rotor at the tail This aircraft was crashed about two months after the first flight as a result of which the cyclic pitch control, which was installed in the first helicopter, was discarded and we went for control by way of auxiliary rotors We fixed two additional lifting rotors at the rear end, where also was mounted a third rotor for balancing torque and directional control The operation of both of these lifting rotors in the same direction gave longitudinal control, in the opposite direction gave lateral control After various experiments, by the end of 1940 the machine was able to stay up for 15 minutes or so About that time a minor trouble was the subject of a discussion I had with the President of United Aircraft He had mentioned that the aircraft was flying very well sideways and quite well backwards, but he had not yet seen the machine flying forwards like other aircraft, to which I replied " Sir, that is a minor engineering problem that we have not yet succeeded in solving "

Later on we arranged to fly forward very well because we found that controlling by means of auxiliary rotors, the auxiliary rotor should not be placed in the slipstream of the main rotor If they are behind they should be situated above the main rotor After early trials with auxiliary rotors in front they were placed at the tail and were all right Rearwards flying of the machine was very successful However, we decided, in making the next ship, to replace the two rotors by a combination which presented a more or less tandem rotor helicopter with one large and one small rotor besides a small tail rotor This craft gave very satisfactory results and could gradually be accelerated to a higher speed, which was of the order of 75 m p h

Early in 1942 we had a two-seater helicopter for the Army ready, with full cyclic-pitch control This machine, the R-4, is well known in this country and has given very satisfactory results It was flown for the first time in February, 1942, and subsequently made the journey from Bridgeport, Conn , to Dayton, Ohio, in a somewhat roundabout route in order not to meet high mountains There were all manner of very interesting experiences during the visit and I would say we attracted a great amount of attention

On arrival at Dayton the helicopter flew over the hangar, stopped in the air, flew backwards, stopped in the air in front of the hangar and then landed A mechanic came out of the hangar and said " I don't know whether I'm drunk or crazy ! "

The R-4 was designed only as a prototype for limited flying but it has done a large amount of practical work, and a number of successful missions

Some of the R-4's are still flying, although this craft had been designed mainly on early experience

After this several helicopters have been produced The R-6, similar to the R-4, but more refined The R-5, with 450 h p engine and planned originally as a two-seater but later transformed into a four-seater This is a very successful helicopter, capable of rendering services like no other airplane

Now I would like to show just a few examples about the job of an engineer in designing the helicopter and particularly during the pioneering period It was a most interesting work and quite a difficult one There was no knowledge available, and no reliable literature The aviation designer of 15 years ago had a considerable amount of reliable information on which he could base his designs, but the helicopter designer had practically nothing

In the helicopter we have a rotor which turns round but nobody knows what happens to the rotor We felt that this was wrong—we must study and learn what happened to the rotor So what we did was to observe it first with the aid of a camera Also we tried to observe the blades by means of stroboscopic effects, and one very dark night the R 4 helicopter was hovering about 30 ft from the ground, and lighted from the ground, with the camera alongside the blades I was sitting on the undercarriage watching the blades and it was very unpleasant to see them apparently stationary in the interrupted light !

We made a considerable amount of such studies, and now, once the stresses are established the rest is easy We can take the blade, reproduce the stress by bending, subject the blade to 20 million oscillations and determine that the blade is safe and will have an indefinite life If it is unsatisfactory it will fail much earlier than that This is now an established method which is very useful

Sikorsky R-4 in hovering flight Mr Igor Sikorsky converses with crew

The latest machine is the S-52, a two-seater, which has metal blades and is comparatively cheaper to produce , for instance, it has been possible to introduce a standard automobile clutch There have been many problems in developing the metal blades and much work has also been done to measure the stresses by means of strain gauges These gauges are very useful,

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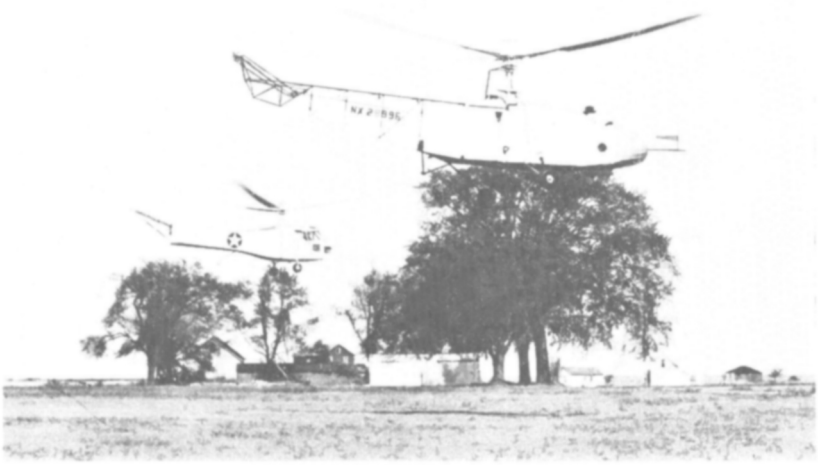

Sikorsky VS-300 and Sikorsky XR-4

but sometimes I would say they can play jokes In our first tests we found stresses which were much bigger than was expected and we could not believe them Later we found it so happened that the amplitude and frequency of vibrations made the needle in an electric oscillograph system installed in this machine jump up and down, corresponding with the frequencies in the blades Instead of marking accurately, it marked perhaps half an inch or perhaps two feet too high When this was corrected the stresses were found to be what we had expected

I would like to make one more point which is very necessary to mention and that is the absolute accuracy of the control of the helicopter I believe that a helicopter can be made with a control as perfect as any other system of control A most interesting experiment was carried out by Cmdr Erickson of the U S Navy with an R-4 helicopter The machine was on floats and a scheme was devised whereby the floats were dropped once the aircraft was in the air For landing a six-inch ring was mounted on the float gear, and a pointer fixed to the helicopter When Cmdr Erickson sighted the pointer in the centre of the ring, although he could not see the landing space, he could drop down accurately on to the attachments of the float gear

Finally, in the future we can expect much larger helicopters and I do not think we should be too dogmatic about the configurations The future will show which one is the best It is possible that future helicopters will be jet-driven, or power driven, not through the shaft, but through the tip of the blade

The future of the helicopter is immense and later the craft will be a very familiar sight in the air to everyone It will also be capable of rendering a great number of services which no other craft can render, and can be described as the greatest friend in need in the case of an emergency

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In reply to a question by Dr Thurston on de-icing for helicopters, Mr Sikorsky said

I believe that with respect to the airplane the question is too well known and I am not sufficiently informed with details to speak on it I shall be very glad to give you information about helicopters which I believe to be correct It has never been possible to accumulate enough ice to cause any trouble under ordinary conditions Extensive tests were conducted with a helicopter stationary on top of a mountain when conditions were very bad The helicopter was stationed there for two months, with instructions to pick up the very worst conditions It was found that ice would accumulate within a few minutes to such an extent that the helicopter in flight would have been in very serious trouble

Tests are being made to counteract icing by United Aircraft, using paste

Princeton University have made very extensive tests, using heat applicances, with electric conductors through the blades The best results have been obtained by sending current in pulsating waves—the current is applied to one portion of the blade, taken away and re-applied to another portion, and so on It has been found possible to de-ice the R-6 helicopter by using 2 k w , but with a slightly larger helicopter probably 3-3½ k w would be required

DR J A J BENNETT

Mr Chairman, members of the Helicopter Association and guests, I am sure that we are all deeply indebted to Mr Igor Sikorsky for coming here this evening and telling us about his recent helicopter developments It is strange to recall that only a few years ago I had the privilege of watching the initial tests of the VS-300 at Bridgeport , the helicopter was known as " Igor's folly," a designation given to it by those who did not believe in the future of rotary wing aircraft Today, however, the helicopter is recognised throughout the world as an outstanding achievement in aeronautics and we have the greatest respect for the genius of the man who brought this about We congratulate Mr Sikorsky on his successful family of helicopters and I have great pleasure in proposing a vote of thanks to him for a most interesting and enjoyable talk

Sikorsky S-52

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