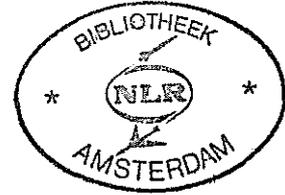


TWELFTH EUROPEAN ROTORCRAFT FORUM

Paper No. 2



HELICOPTER ACTIVITIES IN GERMANY

Volker von Tein
Vice President
Helicopter Division
Messerschmitt-Bölkow-Blohm GmbH
München, F.R.G.

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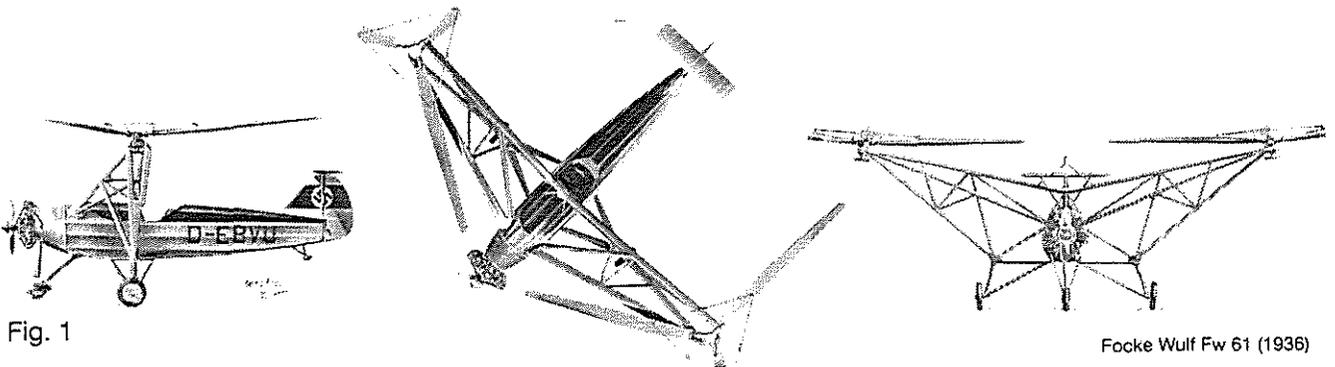
Abstract

After a short presentation of the history of helicopter technology in Germany the current activities are described. In this context an update on the BO 105 and BK 117 programmes is given. Next statistical informations about all types of helicopters operating in Germany and the related infrastructure are presented. Then the most important technology programmes covering rotor technology, vibration suppression, advanced composite airframes, avionics/cockpits and flight controls are presented. A further main topic is the description of the most important future helicopter projects with German participation, such as the PAH 2, NH 90 and ALH. In the concluding chapter an outlook concerning the German helicopter activities is sketched.

1. History of German Helicopter Technology

1.1 Phase of the Pioneers

Helicopters are amongst the most complex machines mankind has developed so far and today only a few very specialised companies can offer them. Its technical evolution was lagging behind the success of the fixed wing planes for a long time. A tremendous step forward was the invention of the autogyro by de La Cierva in Spain. It was the first time that the rotorblades were connected to the rotorhub by flapping and lead-lag hinges thus enabling a real STOL aircraft, however, not yet a helicopter.



The German contribution to helicopter technology was at least as big as to the technology of fixed wing aircraft. The FW 61 designed by Prof. Focke was in our opinion the first practically usable machine (fig. 1). The demonstration of the FW 61 in the Deutschlandhalle by the famous female pilot Hanna Reitsch – although misused by the Nazi propaganda – was nevertheless very impressive and a shock to the free world of those days. Only some names representative for the German pioneers of that period are called back in your memory: Flettner, Focke, Achgelis, Hohenemser, Sissingh, von Doblhoff, Laufer, Hoffmann, Rohlf, Hanna Reitsch and Bode.

This period, when Germany was leading in the field of helicopter technology, was stopped – as you all know – by the end of the second world war.

1.2 Phase of Maturity

As a consequence of the lost war there were nearly no actions in the aerospace field till the end of the 50ies. This is the period where the helicopters matured and started to take over their roles and tasks. Mainly due to the acceptance of the Federal Republic of Germany as partner in the NATO helicopter technology came back to Germany. First our army, airforce and navy had to be equipped, at the beginning with American, French and British helicopters. At this period the German industry started to participate in the fields of licence production, maintenance, repair and overhaul (see fig. 2).

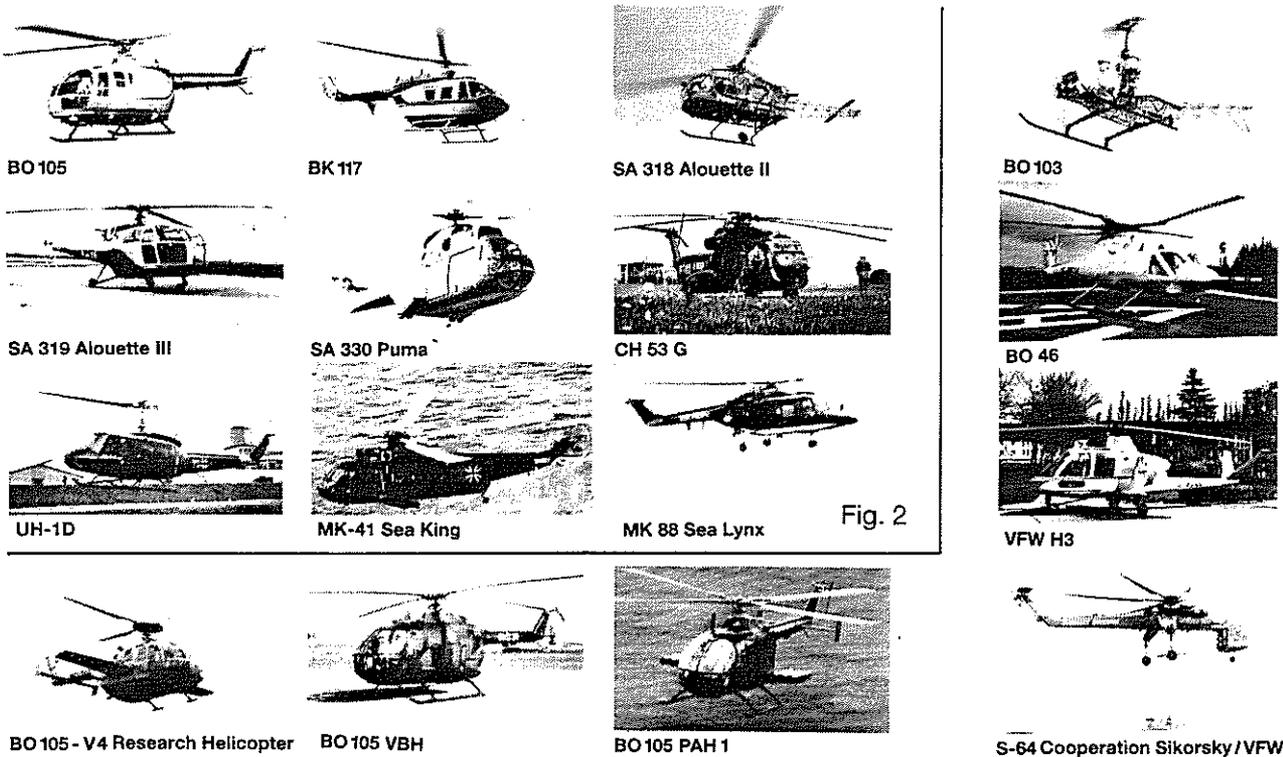


Fig. 2

Fig. 3

The late 50ies, early 60ies was the period when we began again to develop our own machines. At this time the German aerospace industry was full with novel ideas – type of an explosion after a period of forced inactivity (fig. 3). In this time we were “famous” for our many exotic wooden models. It was an exciting time for a young engineer. In 1963 when I started my career at Bölkow-Entwicklungen KG, working for Kurt Pfeleiderer, Emil Weiland and Günther Reichert, we were about 70 engineers studying at the same time the fastest helicopter of the world, the biggest helicopter of the world and also a little machine – called BO105 – featuring only “minor advancements” in comparison with the forementioned ideas, such as an hingeless rotor in combination with glass fibre blades (fig. 4).

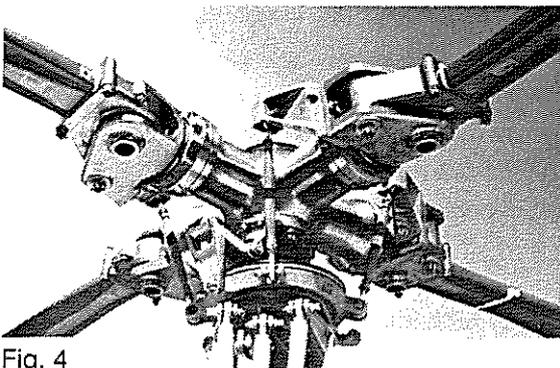
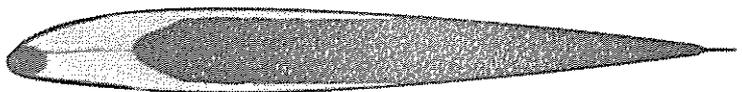


Fig. 4



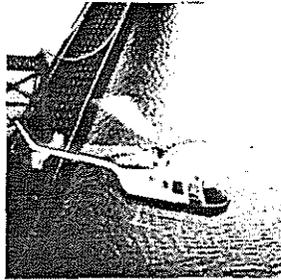
- Over 1.5 Mio. FH very successful service experience
- 105 and 117-Rotorblades on condition

2. Current Helicopter Activities in Germany

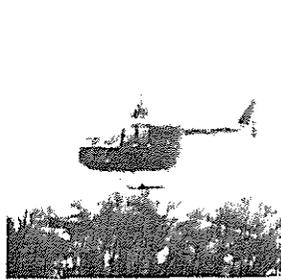
Thanks to the good concept and the mentioned innovations we really found a market gap and the BO105 – an expensive 5-seater but the most unexpensive twin-engine helicopter – became a success and we had to be accepted as new members of the helicopter community. The next pictures (fig. 5, 6 and 7) are self-explaining and give you an update on the BO105, BK117 and BO105 LS programmes.



BO105 CB



BO105 CBS



BO105 VBH



BO105 PAH-1

Fig. 5

- Over 1000 helicopters world-wide in operation
- 1.8 Mio. FH
- 15000 FH on high time helicopter



Fig. 6

- About 100 helicopters world-wide in operation
- 40000 FH
- 1500 FH on high time helicopter



Fig. 7

- Stronger engines
- Increased take-off mass (2.6 to)
- Increased operational envelope (high and hot)
- Production in Canada (MCL)
- Now entering service

	AS		Beli		Hughes		MBB		Sikorsky		WLH		Rest*		
	Type	No.	Type	No.	Type	No.	Type	No.	Type	No.	Type	No.	Type	No.	
CIVIL	313/318	37	47**	60	300	40	105	67	S-58	4			A109	4	(Publ. & Civil)
	316/319	3	205	15	500	10	117	2	S-76	2			R22	11	
	330	22	206**	41									F28/280	13	
	341/342	11	212	12									UH12	5	
	350	25	222	1									B2	2	
	355	4													
	360	2													
365	2														
	Σ	106	Σ	129	Σ	50	Σ	69	Σ	6	Σ	-	Σ	35	395
MIL	313	150	205 (UH-1D)	325			105P	212	CH-53G	110	Seaking	21			(Militt.)
			212	3			105M	100			Sealynx	14			
	Σ	150	Σ	328	Σ	-	Σ	312	Σ	110	Σ	35	Σ	-	935
	ΣΣ	256	ΣΣ	457	ΣΣ	50	ΣΣ	381	ΣΣ	116	ΣΣ	35	ΣΣ	35	1330

(Total)

* Agusta, Robinson, Enstroem, Hiller, Brantly
 ** Agusta built 47 and 206 included under Beli

Fig. 8

Fig. 8 shows a summary of all helicopters being in operation in Germany. (I have to admit that the quoted numbers may not be exactly right but they should be true within ± 5.)

An analysis of this table shows some interesting facts:

- there are 1330 German helicopters including 940 military machines
- only 30% in numbers of this market is served with German designs (in money it is even much less!)
- there is still a relatively big number of helicopters with piston engines
- there is also a big number of relatively old designs
- there are too many types of helicopters, a special problem of our branch as you all know.

To sum up this picture fig. 9 gives a short summary about the basic infrastructure in Germany related to helicopters.

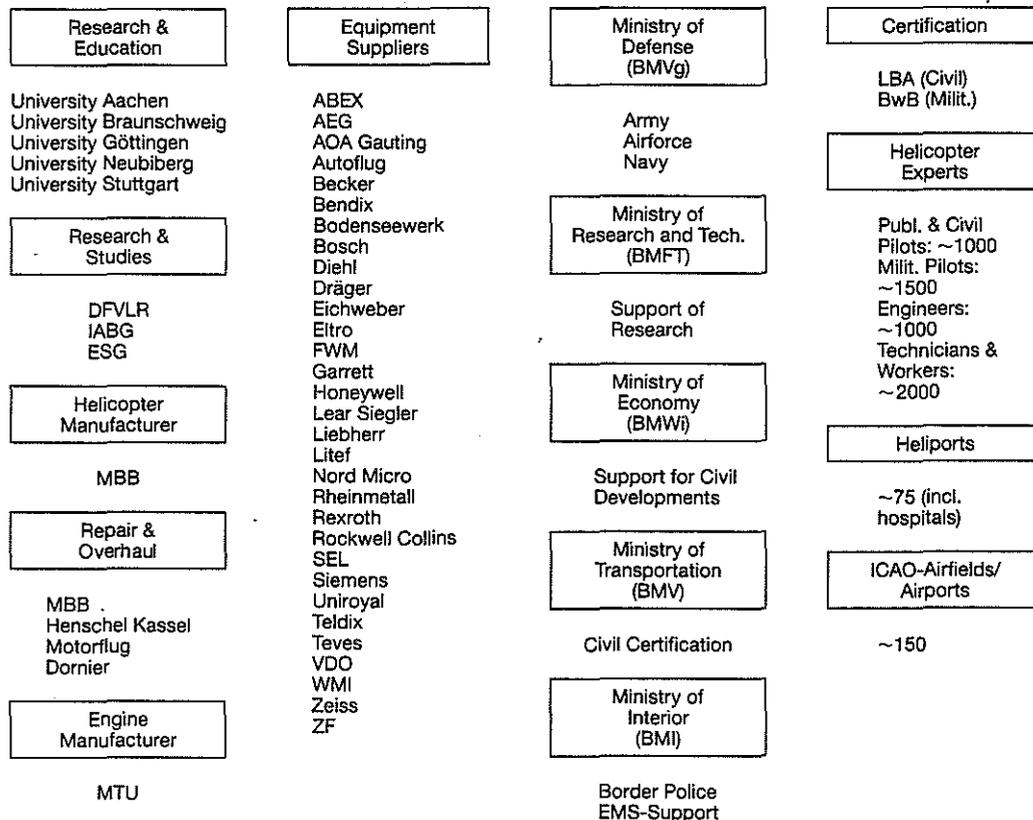


Fig. 9

2.1 Civil Use of Helicopters in Germany

The next picture (fig. 10) lists a distribution of the helicopters amongst the different users. If you exclude military and public tasks there remain only 240 helicopters for civil tasks, such as areal work and VIP-transportation. This surprisingly low number of helicopters may be a consequence of the unflexible laws restricting the VTOL capabilities of helicopters unduly and thus reducing the interest in them.

		No. of Helicopters
German Army	(313, UH-1D, 105M, 105P, CH-53G)	775
German Airforce	(UH-1D, 212)	125
German Navy	(Seaking; Sealynx)	35
German Border	General tasks (318, 330, UH-1D, 212)	70
Police		
ADAC, DRF	EMS-Service (105, 212)	45 { 30 } 100
Police	EMS-Service (105, 117)	
	(105, 117, 341/342, 360, 365, 318, 319)	40
Military and Public Tasks		$\Sigma = 1090$
Civil Airwork	1 Mot Piston	135
Executive Flying	1 Mot Turbine	90
	2 Mot Turbine	15
Civil Tasks		$\Sigma = 240$

Fig. 10

2.2 Public Use of Helicopters in Germany

According to fig. 10 about 150 helicopters are used by the police and by the border police (BGS). Here we find a high standard compared with other nations (number and types of helicopters). About 45 of these helicopters serve the German helicopter air rescue system.

2.3 The German Helicopter Air Rescue System

With the rapid expansion of motor traffic in Germany in the 70ies the number of traffic fatalities increased frighteningly. About 15% of the persons heavily injured in traffic accidents died in the period between time of accident and their arrival at hospital. The advantage of the helicopter as an emergency medical aid became evident. The helicopter was seen to provide a new dimension in post-crash survival. From November 1st, 1970 onwards a BO105 rescue helicopter was acquired by the German Automobile Club ADAC. Equipped with the latest standards of emergency medical services available at the time the helicopter was stationed at the Municipal Hospital Munich-Harlaching.

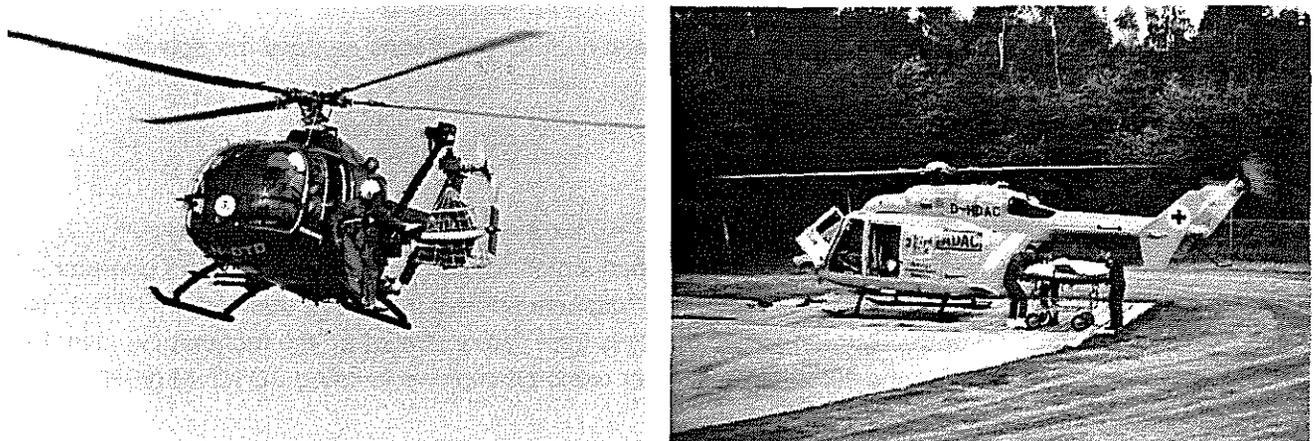


Fig. 11

With the "Munich Trial" the ADAC was pioneering helicopter rescue and laid the foundations for the subsequent nationwide air rescue system which meanwhile has been almost completed in the Federal Republic of Germany. Originating from the "Munich Model" today there is a network of 35 rescue helicopter stations distributed throughout Germany. This stations located at major hospitals are served by about 45 helicopters (mainly BO 105 and BK 117, see fig. 11), ensuring that most accidents can be reached in less than 15 minutes. All emergency calls from the various sources, such as police, rescue services or private individuals via telephone or via radio are channeled to the rescue coordination center (RCC) which is responsible for the geographical area (fig. 12). The RCC coordinates and activates all ground rescue vehicles and the rescue helicopter within its area of responsibility. For example the Munich rescue coordination center had to handle more than 250000 calls in 1983, in about 120000 cases rescue missions were performed.

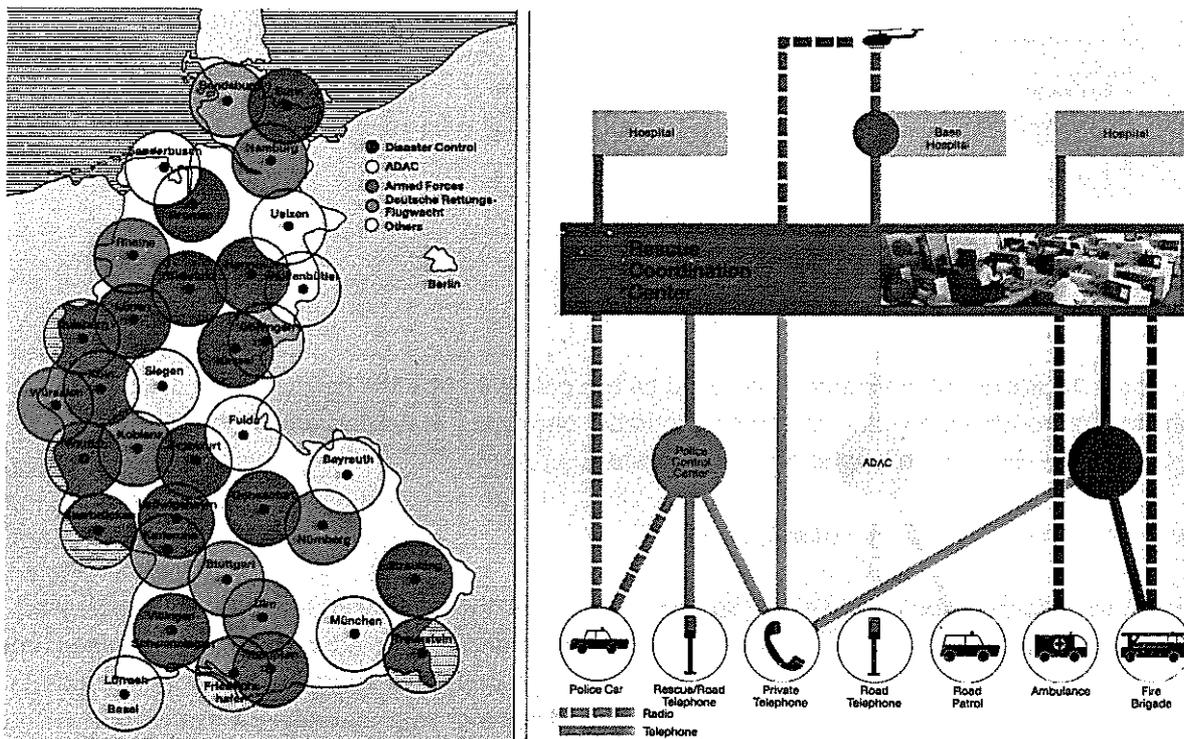


Fig. 12

Until March 1984 the rescue helicopter fleet had flown approximately 200000 missions and logged about 125000 FH. For 1983 the figures were approximately 27500 missions and about 18000 FH.

Statistics further indicate that for about 15 % of the total number of persons rescued the operation was life saving.

2.4 Military Use of Helicopters in Germany

70 % of the German helicopters are used by the German armed forces. The biggest user and operator is the German Army with a fleet of 770 helicopters and prospects for new machines, such as the PAH 2. The outstanding high standard of the German armed forces is best demonstrated by the fact that German Army Pilots won three times in series the aerobatic helicopter world championship using BO 105 M (VBH) helicopters.

3. Technological Basis in the FRG

3.1 Rotor Technology

Helicopters differ decisively in configuration from the classical aeroplane in consequence of their rotor. Naturally, this has been a major development concern and our significant contribution in the form of the hingeless rotor with composite blades was mentioned already. At present, we are carrying out comprehensive work to ensure further improvements. The aim is to produce completely hingeless, minimum maintenance tail and main rotors with extremely long, perhaps even unlimited service life (fig. 13).

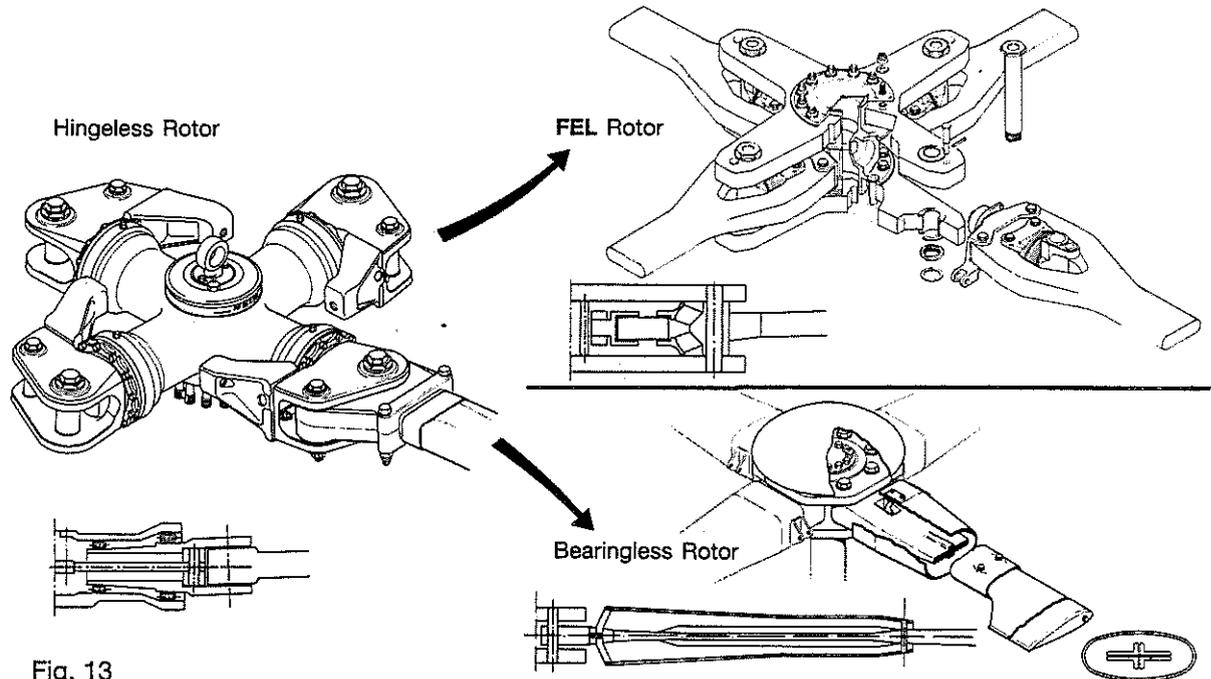


Fig. 13

Fig. 14 shows a five-blade rotor applying BO105 technology. The 5th blade is hoped to offer:

- further increase in takeoff weight
- reduction in cabin vibration
- reduction in rotor noise
- increased load factors

A corresponding experimental rotor was tested on the whirl tower and will be flown in a BO105 in the near future.



Fig. 14

An evolution of the hingeless rotor is the so-called FEL rotor which is shown in fig. 15. The aim is to further simplify the rotor while maintaining the control characteristics of the BO 105 rotor system as far as possible:

- further reduction in the number of parts
- replacement of the titanium hub by star-shaped plates of composite material
- replacement of the oil lubricated feathering bearings by maintenance free and damage tolerant elastomeric bearings
- optimum visual inspectability

This concept which has been proven very close to final size on a whirl tower is envisaged for the German Army PAH 2.



Fig. 15

In addition a completely bearingless rotor, designated FVW rotor is under development (fig. 16). The necessary free movement of the blade is effected by a component sufficiently flexible for all three types of movement (flapping, lead-lag, pitch). The fairing of this (aerodynamically awful) flexbeam is used to perform the individual and collective control inputs to the blade. A prototype version of this rotor is currently being flight tested on a BO 105 test bed.

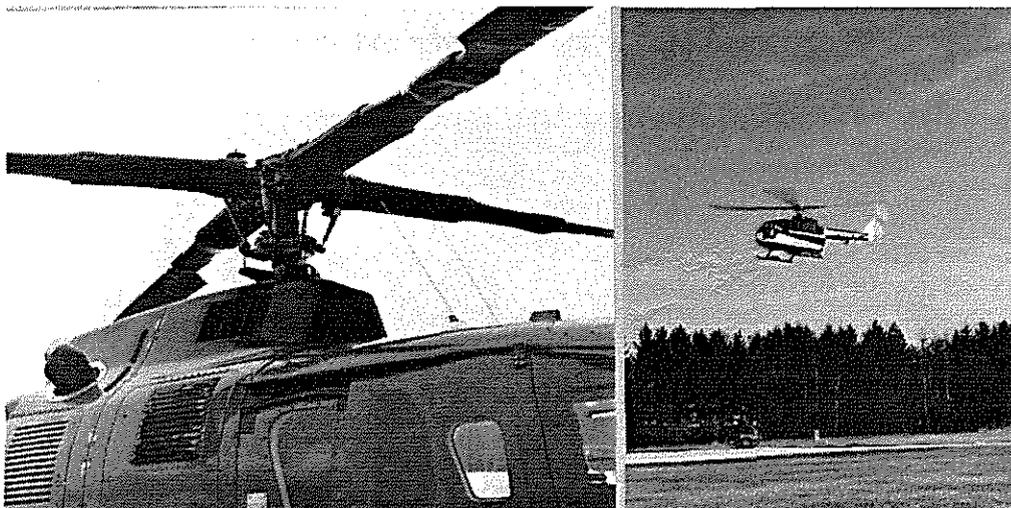


Fig. 16

Of course similar design principles can be applied to tail rotors. Currently three types of tail rotors are in different stages of development:

- An experimental version of a four-bladed bearingless composite tail rotor was flight tested on a BK117 (fig. 17). Now a productionised version is under construction.
- An all composite two-bladed seesaw tail rotor using elastomeric bearings was tested on the whirl tower (fig. 18) and will now be investigated in flight on a BO105. The rotor offers 11 % more thrust, 5 % less weight and 5 to 6 times higher service life.
- A bearingless two-bladed all composite seesaw rotor is also under development and will go on the whirl tower end of this year/beginning next year (fig. 19).

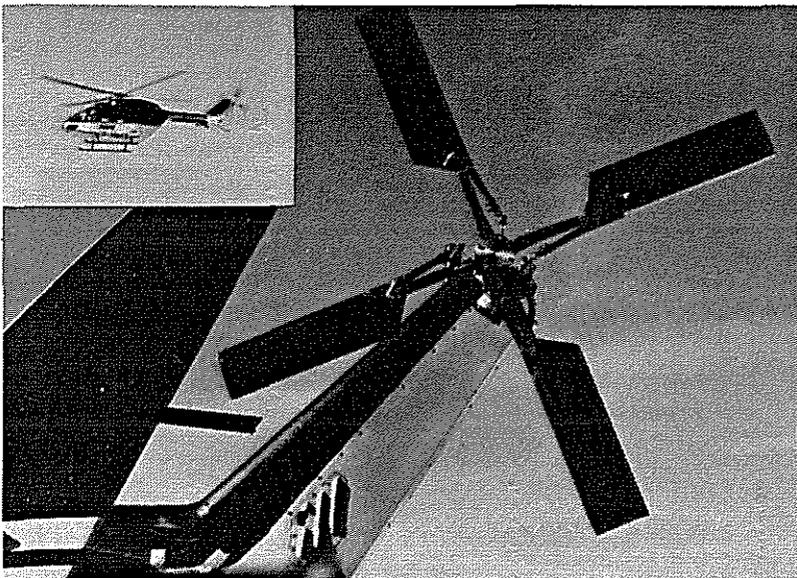


Fig. 17

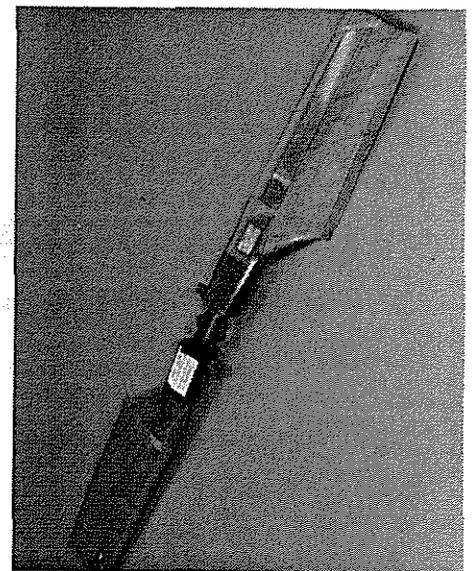


Fig. 19

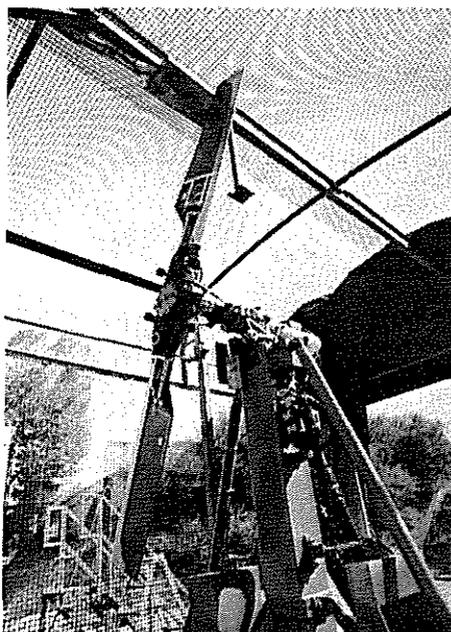
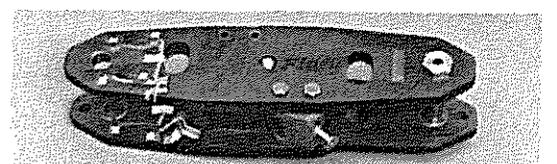
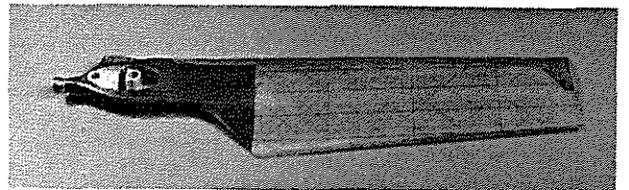
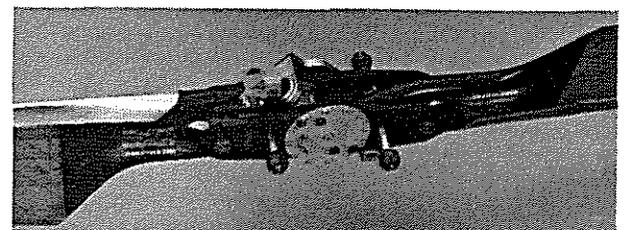


Fig. 18



In cooperation with DFVLR a new family of blade profiles with significantly improved polar curves has been developed. The composite construction of rotor blades permits the high degree of freedom in blade geometry necessary to utilize the new profiles and shapes (nonlinear twisting, deviation from rectangular chord distribution, transonic blade tips). All these measures were incorporated in the definition of a new blade for the BO105 rotor (fig. 20). The new aerodynamic properties were studied in the wind tunnel with a model rotor 4 meters in diameter. These measurements have confirmed our estimates showing the following advantages:

- 8 % more hoverthrust at equal power for the BO105
- shift of the Mach number induced drag rise by 50 km/h

Full scale blades have been built in 105-size and for the FEL main rotor. Both versions have been tested on the whirl tower. In the very near future the flight tests on a BO105 test bed will commence. Positive results assumed this type of new aerodynamics will be used for all our future rotors.

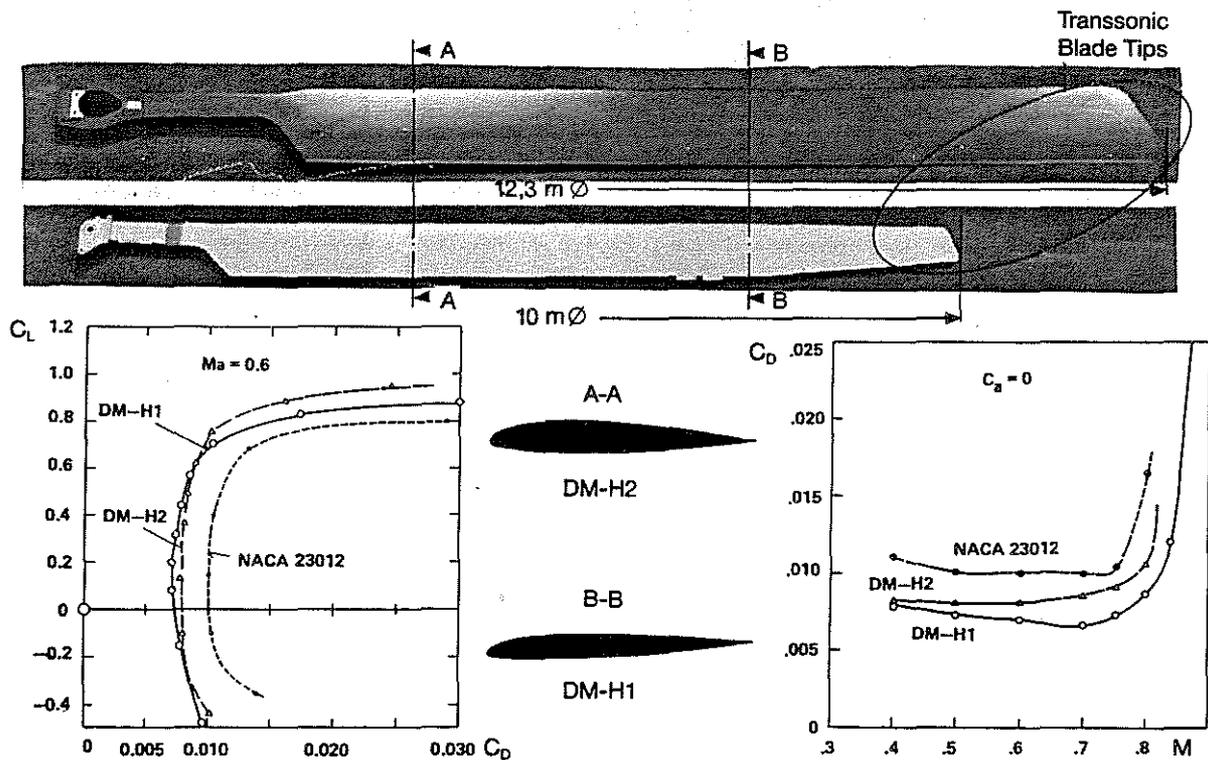


Fig. 20

3.2 Vibration Suppression

Cabin comfort in helicopters has always been affected by induced rotor vibrations. This can be remedied by passive vibration isolation systems in addition to favorable tuning of the rotor dynamics. MBB has developed a system which permits a considerable reduction in vibrations caused by the main rotor forces and moments through isolating suspension of the rotor and gear box unit. A system of this type was flight tested on a BK 117 and it reduced the cabin vibration level to below 0.1 g. The weight increase amounts to between 1 and 2 percent of the take-off weight (fig. 21).

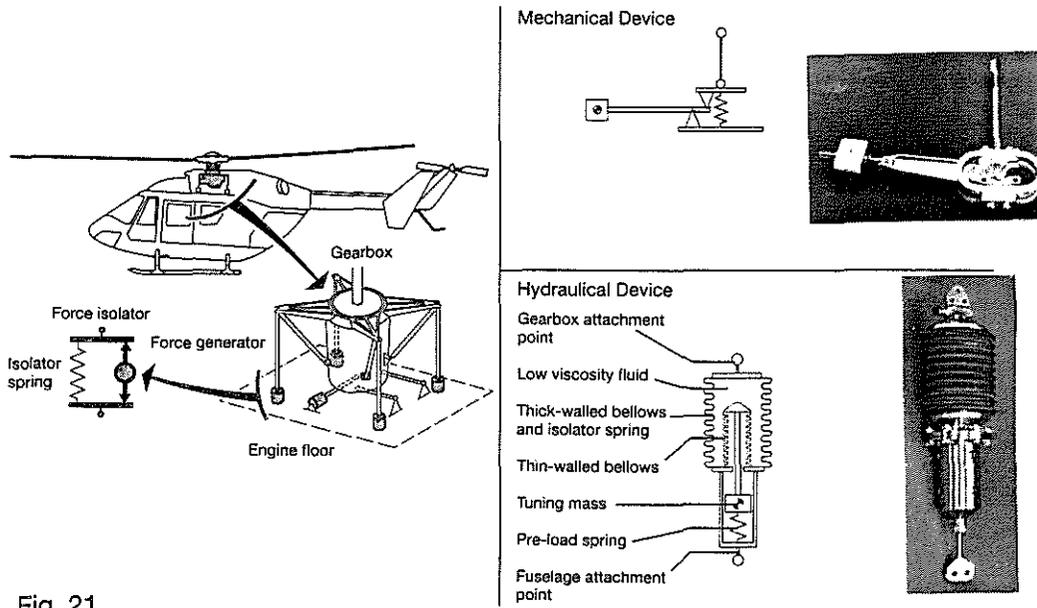


Fig. 21

Fig. 22 shows the principle of higher harmonic rotor control. The usual blade control movements are superimposed by regulated movements of limited authority. This technique permits active suppression (minimization) of rotor vibrations at the rotor, which represents an alternative to the passive isolation system. Basic tests were carried out with the four meter model rotor by DFVLR. A corresponding system is to be developed for flight tests as well.

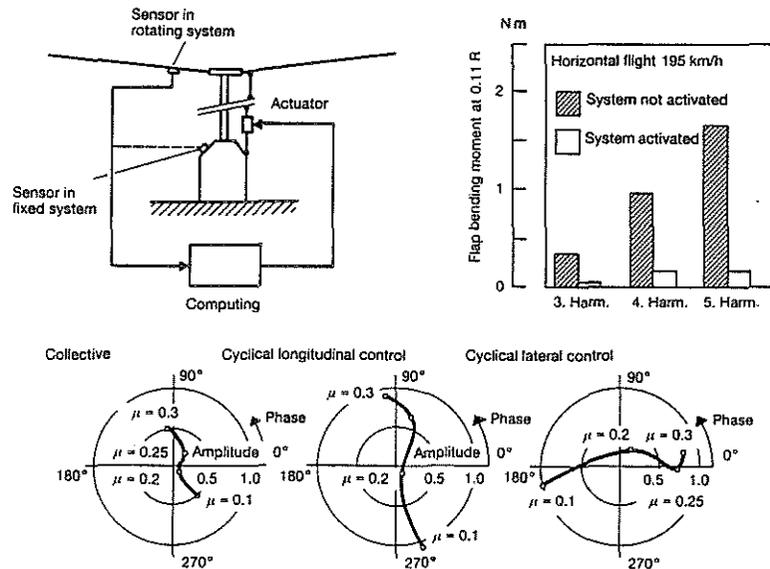


Fig. 22

3.3 Advanced Composite Airframe

MBB has pioneered the introduction of composite structures both for the BO 105 (rotor blades, secondary structures) and the BK 117 (rotor blades, horizontal tail unit, secondary structures). The composite airframe technology project is a major programme aiming at more frequent utilization of composite parts in primary airframe structures.

As illustrated in fig. 23 an airframe made mostly of fiber composite materials is currently under development, based on the BK 117 configuration. The prototype is to be flight tested in 1987/88. The development objective is to ensure both a weight reduction of about 20 percent as compared to metal parts and lower production costs. In addition to their favorable strain characteristics, composite materials offer a chance to significantly reduce the number of parts and joints per unit weight.

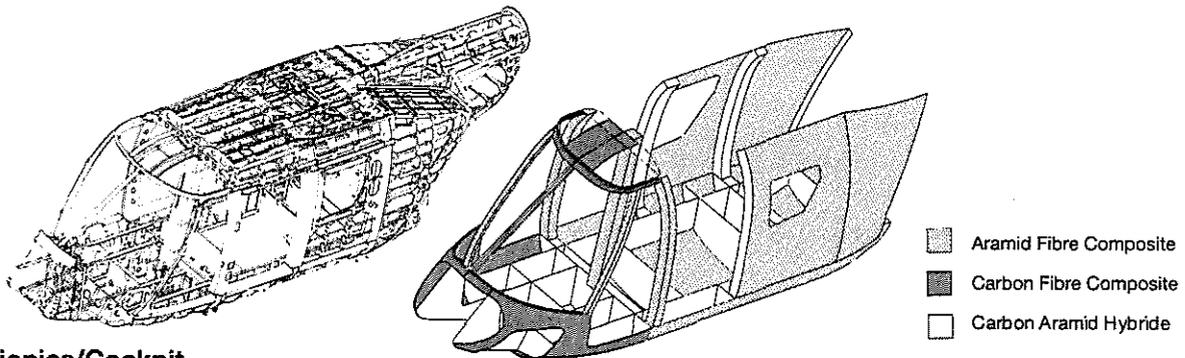


Fig. 23

3.4 Avionics/Cockpit

With a certain time lag compared to fixed wing aircraft, helicopters have come to be an important "platform", especially in military applications. Depending on the type of application, today's helicopters more or less utilize the most advanced avionics including sensors, digital technology, multiple displays, data bus, etc. Besides basic technology studies in the avionics laboratory, very high speed computers, and current applications with series helicopters, we have another important project on hand.

For a couple of years we have had a BO 105 equipped as an airborne avionics laboratory under Federal Ministry for Research and Technology funding. In cooperation with the European and the German equipment industry in particular, we have been carrying out significant basic studies. Fig. 24 gives a rough overview of the components and the technology we have examined.

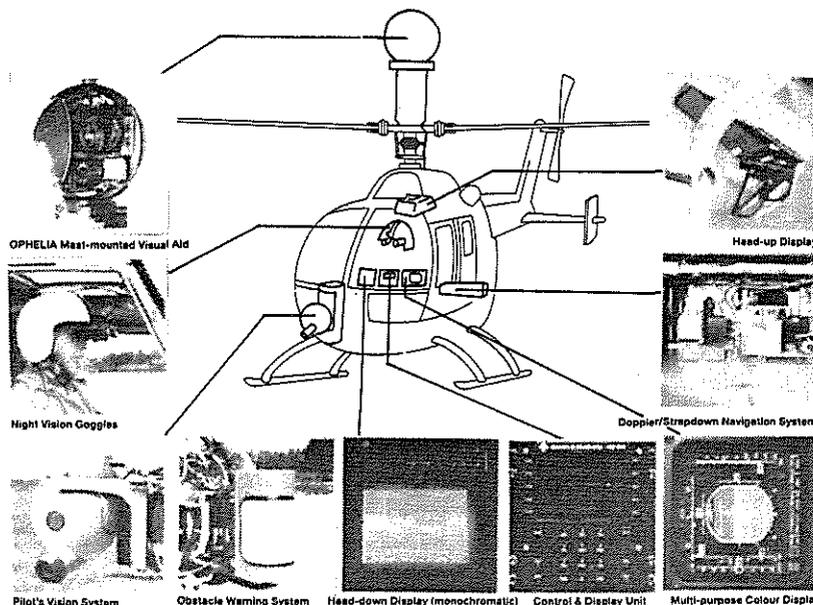
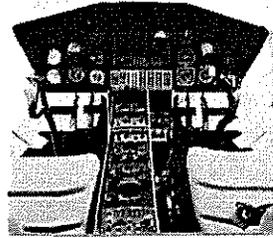
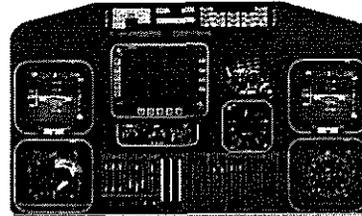


Fig. 24

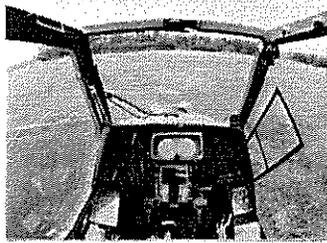
In the present phase we are primarily concerned with studies on advanced cockpits. Fig. 25 illustrates what flight panels might look like in future.



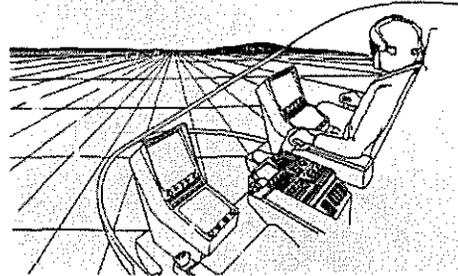
Modern Conventional Cockpit Layout for Light Helicopter



Future Instrument Panel for Light Helicopter



Cockpit Layout for Anti-Tank Helicopter (Pilot-Station)



How will the Future Helicopter Cockpit Look Like?

Fig. 25

3.5 Flight Control (incl. FBW/FBL)

Basic research to improve helicopter flight characteristics were performed by DFVLR on a flying simulator derived from a BO 105 and equipped with a simplex fly-by-wire system and a mechanical system for the safety pilot. Included were also tests with sidearm controllers (fig. 26).

Now a digital flight control system with fly-by-light signal transmission is to be developed in cooperation between Liebherr, DFVLR and MBB. The system covers all 4 control axes. The principle will be verified on the manned ground simulator at MBB. In a second phase the actual hardware for cost reasons limited to the tail rotor control will be flight tested.

The combination of modern avionics and flight control systems will change the future cockpits drastically.



Modern Conventional Cockpit Layout for Light Helicopter



Flight Tests on Side Arm Controllers



Fly-by-Wire Research A/C (BO 105 S3 at DFVLR)



How will the Future Helicopter Cockpit Look Like?

Fig. 26

3.6 Important Development Tools

The model rotor with 4 m diameter is in operation at DFVLR for some time and was used amongst others, as already mentioned, for the development of the new blade aerodynamics and the HHC-studies. Currently a full modular helicopter model using this rotor is under construction (fig. 27).

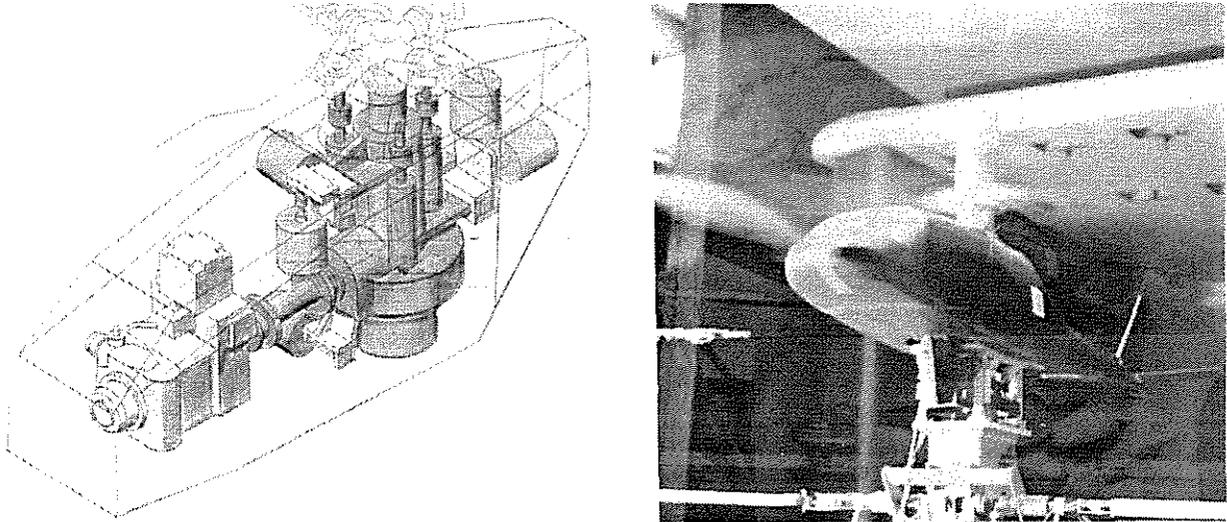
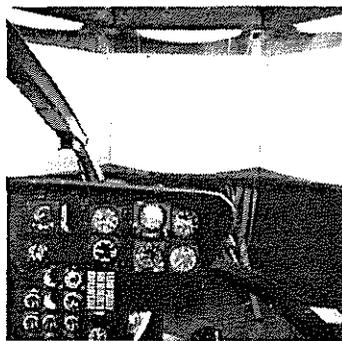


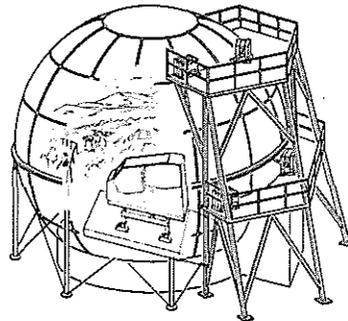
Fig. 27

The manned simulator is a major tool in developing innovative control systems, especially avionics and cockpit systems. We currently share such a development simulator with our colleagues from the combat aircraft department.

Fig. 28 shows a BO 105 simulation we carried out last year. Its purpose was to test the pertinent software for its suitability in comparison to the known BO 105 behavior. After some modifications, we now have a workable model for future applications.



- Beam Splitter Facility**
-
- Main features:
- Flight simulation computer (incl. buffet sim.)
 - Image generator computer (output: 3 video channels)
 - Visual projection system (field of view: 106° horizontal ±11,5° vertical)
 - Cockpit interface (mech.)
 - Quick change cockpit



- Advanced Dome Facility**
-
- Main features:
- Flight simulation computer (incl. buffet noise "G" sim.)
 - Image generator computer (output: 8 video channels)
 - Visual projection system (field of view: 230° horizontal +112° vertical -45° vertical)
 - Cockpit interface
 - Quick change, fully modular cockpit

Fig. 28

At present, the simulator is being extended to enhance its capability to offer more realistic conditions. The dome with its display system accommodates both helicopter and combat aircraft cockpits. This installation is presumably unique in Europe, as far as helicopter applications are concerned.

The flying simulator operated by the DFVLR was already mentioned in the context with the studies on advanced flight control systems (fig. 29). A more modern and powerful flying simulator based on the BK 117 was proposed by DFVLR and MBB, however, adequate financing so far has unfortunately not been found.

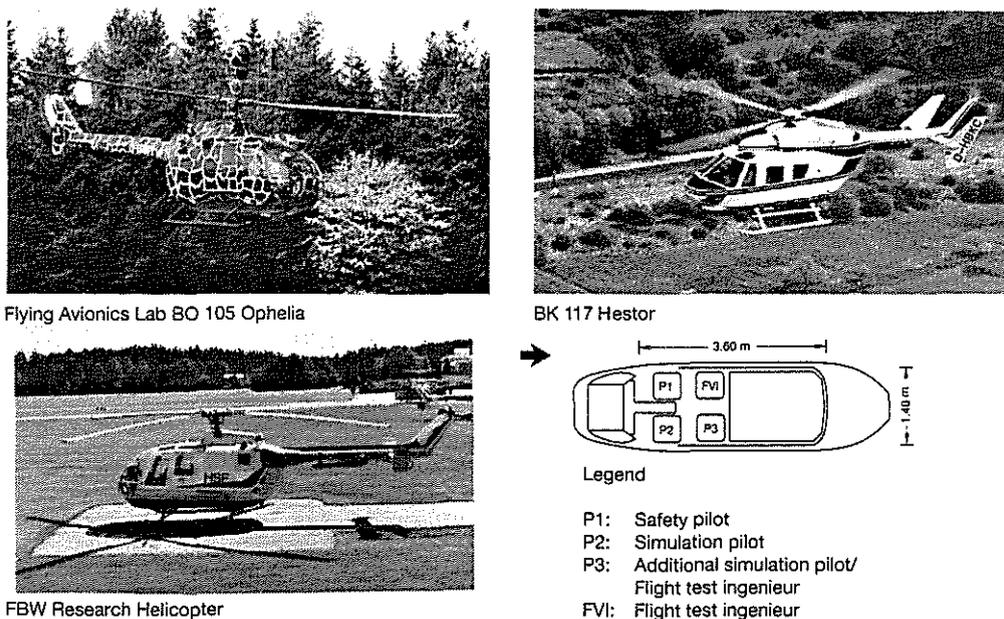


Fig. 29

4. NEAR TERM PROGRAMMES WITH GERMAN PARTICIPATION

4.1 New Technology for BO 105 and BK 117

Fig. 30 illustrates the various options available for improving the BO 105 by utilizing these new technologies. If a refurbished BO 105 is subjected to the full range of possible improvements, the outcome will be:

- 25 percent reduction in operating expenses
- 5 to 10 percent decrease in production costs
- considerable increase in performance, e. g.
 - cruising speed: 225 to 260 km/h
 - range: 620 to 700 km
 - hover out-of-ground effect: 1620 to 2900 m
 - payload up by 200 kg
 - empty weight down by 75 kg
- improved passenger comfort

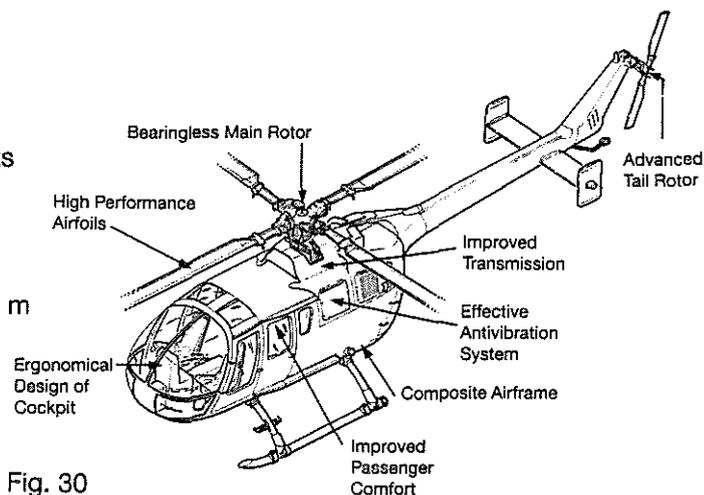


Fig. 30

Since all improvements involve considerable development costs, it will ultimately be the market which will decide just how far we will actually go. This applies to the BK 117 as well.

Of course, these technologies also offer considerable potential for maintaining and/or adjusting combat effectiveness of the German BO 105/PAH 1 antitank helicopters, if this should become necessary.

4.2 PAH 2/HAP/HAC 3 G Programme

These programmes are part of a Franco-German project which is concerned with the joint development of a standard helicopter version which can be converted into three weapon systems:

- PAH 2, German second-generation anti-tank helicopter
- HAP, French escort and support helicopter
- HAC 3 G, French anti-tank helicopter with third-generation AT-missile

As this project had already been discussed in detail in the past, only the most important technological characteristics will be mentioned. Fig. 31 shows the PAH 2, which is a specialized anti-tank helicopter featuring:

- narrow front silhouette through tandem cockpit
- tricycle landing gear with high energy-absorption capability
- low optical, radar and infrared signatures
- nose-mounted night-combat and flight sensors
- 8 anti-tank missiles (HOT 2 and/or PARS 3)
- 4 infrared self-defense air-to-air missiles
- high tolerance against ballistic impact through selected construction methods, armoring, system redundancies and two engines

The project features the following technology:

- FEL rotor with optimized aerodynamic properties
- hybrid construction in the fuselage using a large share of composite material
- redundant data bus according to MIL-STD-1553B
- modern "glass cockpit" with integral displays and multifunction control panels
- advanced weaponry

Germany and France intend to procure approx. 200 helicopters each. Budget problems currently are holding up the programme start. Both governments, however, have explained the strong will to perform this programme jointly. As a consequence, potential cost reductions by further standardisation of the variants are studied.



Fig. 31

4.3 NH 90 (MH 90 and LTH/SAR)

In the nineties, the German Navy will need about 60 helicopters for ship and land-based helicopter naval missions (MH 90). By about the same time, the German Air Force will also need approx. 60 helicopters for its transport tasks replacing the UH-1D (LTH/SAR). Both requirements may possibly be met by fitting a joint 8/9-ton standard helicopter with special mission equipment packages.

Within a similar period, France, Italy, Great Britain and the Netherlands will need comparable units. All together, about 700 are needed in Europe. France, Great Britain, Italy, the Netherlands and Germany have therefore decided to study whether these demands can be met, assuming there will be a standard helicopter. The aircraft industry in these countries, represented by Aérospatiale, Westland, Agusta, Fokker and MBB, has been instructed to carry out relevant studies. The study phase commenced on September 1, 1985 (fig. 32).

If this programme is implemented, most of the technology mentioned earlier will be utilized. The joint study conducted by approx. 100 engineers from the above five companies is to be completed by the end of this year. In 1988, a decision must be reached as to how Germany ought to proceed. Should the European alternative not prove viable, the only option left will be a suitable adjustment based on the helicopters available on the market.

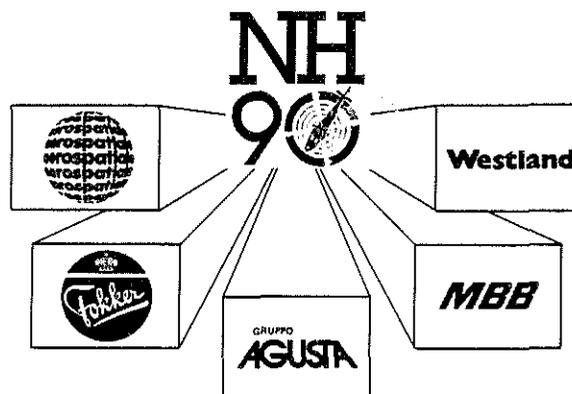


TTH
Tactical Transport Helicopter



NFH
Nato Frigate Helicopter

- Primary Missions**
- Heli-borne operations
 - Heli-transport



- Primary Missions**
- Anti-submarine Warfare (ASW)
 - Anti-surface unit Warfare (ASUW)
 - Anti-air Warfare (AAW)

Fig. 32

4.4 Advanced Light Helicopter (ALH)

Aided by MBB and its know-how, the Indian company HAL defined a multi-purpose helicopter dubbed ALH (fig. 33). The development phase commenced in mid 1985. This involves a twin-engine helicopter of the 4/5-ton class with an FEL rotor and multi-purpose airframe. The Indian Armed Forces need about 200 of these helicopters. Possibly, MBB will develop a commercial version and market it worldwide.

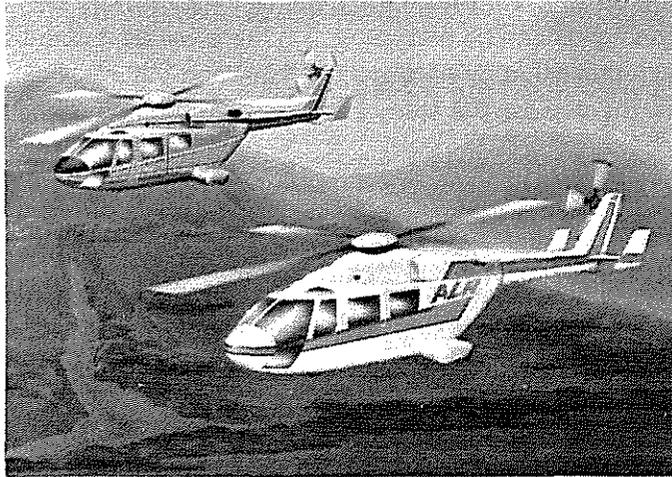


Fig. 33

Multi-purpose Helicopter

- Two Engines
- About 4 t Take-off Mass
- Big internal Volume, also from the rear accessible (12 Seats)
- Highly positioned Rotors

Big Performance Reserves

- Operation high and hot
- Excellent OEI Performance

Modern Technologies

- Hingeless Rotor with composite Blades
 - Composites also in the fuselage
 - Modern Avionics and Equipments
-

5. OUTLOOK FOR THE GERMAN HELICOPTER ACTIVITIES

5.1 Military Helicopters

The prospects for military helicopters in Germany are good. PAH 2, NH 90 (MH 90 and LTH/SAR), PAH 1 and VBH product improvements are clearly formulated and these programmes are contained in the relevant midterm military plannings.

Although not yet formulated officially it is not too difficult to predict further requirements. In the farer future the UH-1D's of the Army have to be replaced and it is also not too difficult to see the need for some type of escort for the many types of helicopters.

5.2 Public Helicopters

As it was shown, the helicopter fleet used for public tasks in Germany is impressive already and one would not expect additional great business in the future. Nevertheless some of the helicopters are of relatively old design and will have to be replaced. In addition, a further normal growth of these public tasks can be assumed. Perhaps new activities will come in the context with fighting terrorism and safeguarding nuclear power stations.

5.3 Civil Helicopters

The most difficult and demanding activities are civil helicopter activities because in these cases the bill is not payed by the taxpayer. In addition, the freeworld helicopter industry had not the best of times in the civil market over the past few years (fig. 34). The current situation is:

- still depressed sales
- underutilized fleets
- for-hire operators are in trouble
- too many products
- intense (“killing”) competition

Of course, MBB is also hit by this situation. Because the fleet of German civil helicopters is relatively small our operators do not have the same magnitude of a problem than the big operators, especially off-shore operators. Born as optimist I am expecting an upswing to the expectable trend, hopefully without “unhealthy” peaks like the Korea and Vietnam wars and the “oil shocks”.

Giving up civil business and concentrating only on military helicopters is in my opinion going the “easy way” and is not the solution. Taxpayers money is already spend more carefully and this trend will hold on. Probably in the future the rules of the civil business are the name of game for all types of helicopter activities.

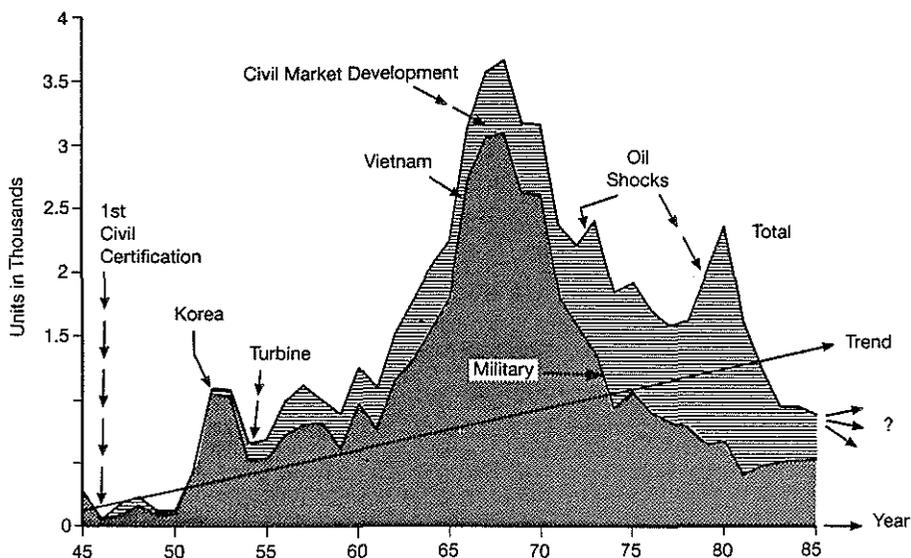


Fig. 34

5.4 Consequences for the German Helicopter Industry

Germany has very clearly demonstrated that we are going the way of international cooperation in the field of aerospace and this will also be the case in the future. It is, however, also clear that we want a bigger share on our military home market than in the past. The governments, users and industry have invested a lot in the future – as I hopefully could demonstrate a little bit – and now of course we want a return of investment, however, not only in form of bending sheet metal and doing repair and overhaul work for foreign designs. If this principle is accepted, Germany can start the PAH 2 and NH 90 immediately.

Judging the civil business is more difficult. Advancing only components of current designs, such as engines, composite airframe parts, electronics etc., will not have a major impact on the function, utility or application of civil helicopters. The marginal benefits will be greater than the cost but not by much. Only new configurations with the integration of the new technologies from the beginning will offer significant opportunities for the increase of productivity. Starting a new civil programme of course is risky, however, if it is a "calculated" risk which two partners share, it offers a great chance. In this context our plans concerning the conceptual studies on the BN 109 (fig. 35) should be seen. I believe there is a gap for a new helicopter which lies between the first generation piston engine small helicopters and the second generation light helicopters with one turbine.

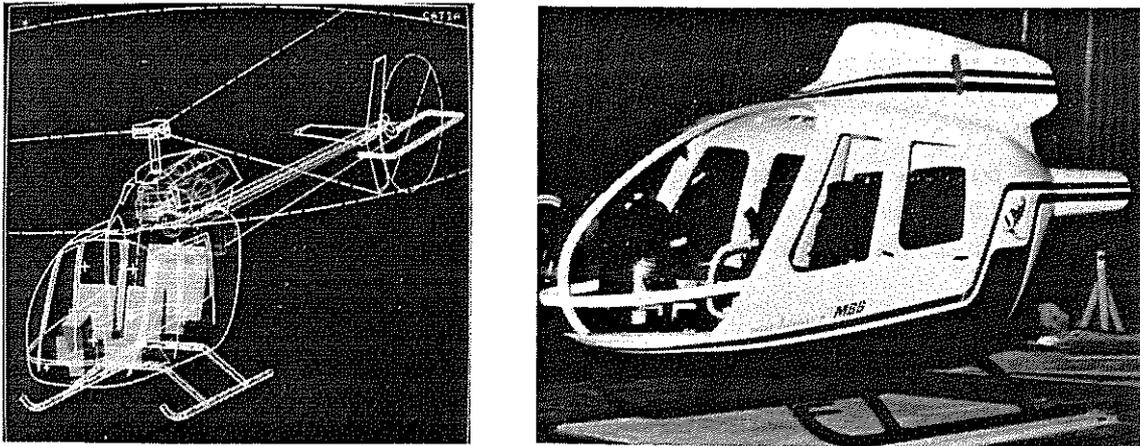


Fig. 35

5.5 New Concepts

Fig. 36 shows that there is a practical speed limit of about 450 km/h for helicopter configurations. There are military tasks which require VTOL and hover capabilities but may benefit from higher speeds. Also for civil transportation tasks there is a gap between the capabilities of helicopters and ultra STOL fixed wing planes.

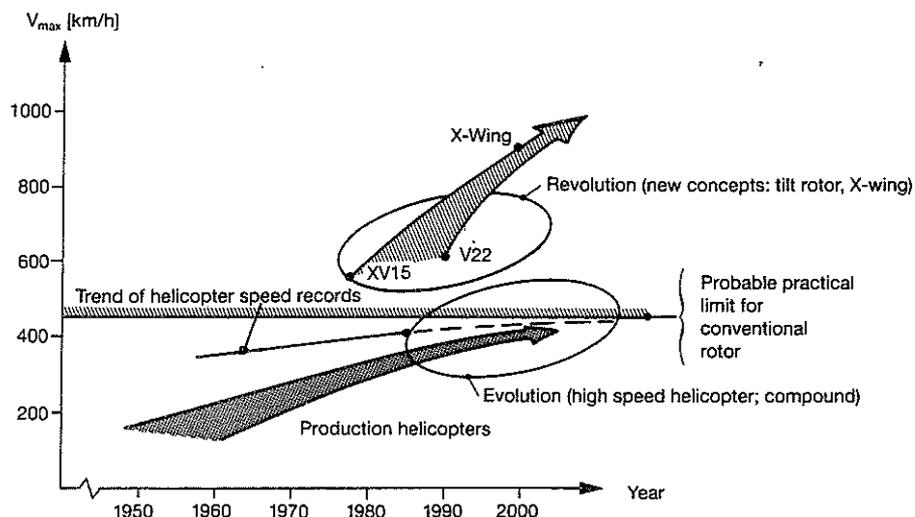


Fig. 36

One way, the way of evolution, is to go to the limits. That will lead to compound helicopters as sketched in fig. 37. However, also the way of revolution is ahead of us in form of new concepts up to the X-Wing-Project. Many people believe that the tilt-rotor aircraft will be the answer. Besides the V-22 project of Bell/Boeing, which is already under development, there has started an activity to launch a similar project in Europe (fig. 38). Of course we are supporting this project and are willing to participate.

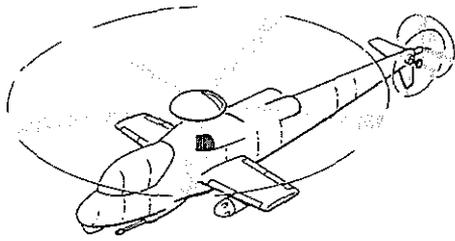
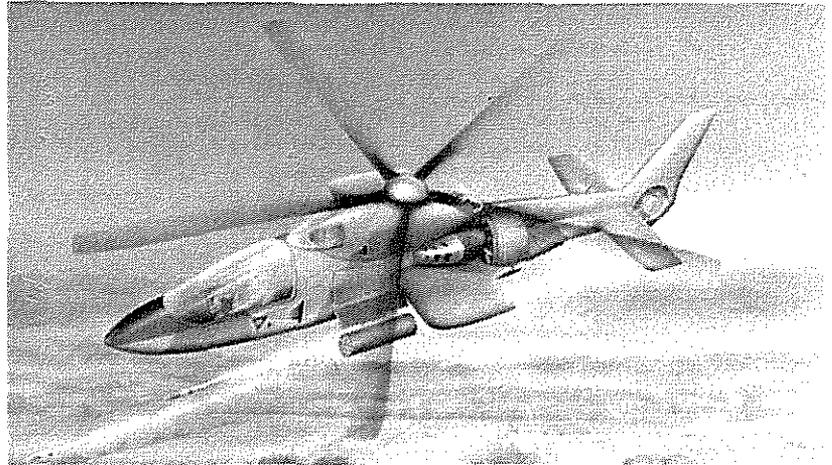


Fig. 37



5.6 Conclusion

There is an interesting German market, especially for military helicopters. Germany has built up a helicopter industry and invested in the future. The German Armed Forces have clearly specified their midterm requirements. Germany intends to go on with international cooperation, preferably with European partners. So far however, Europe was not very successful in coordinating its helicopter requirements and needs. The PAH 2 and especially the NH 90 are perhaps the last chance. If Europe fails, I am sure our American friends will help us to serve our market.

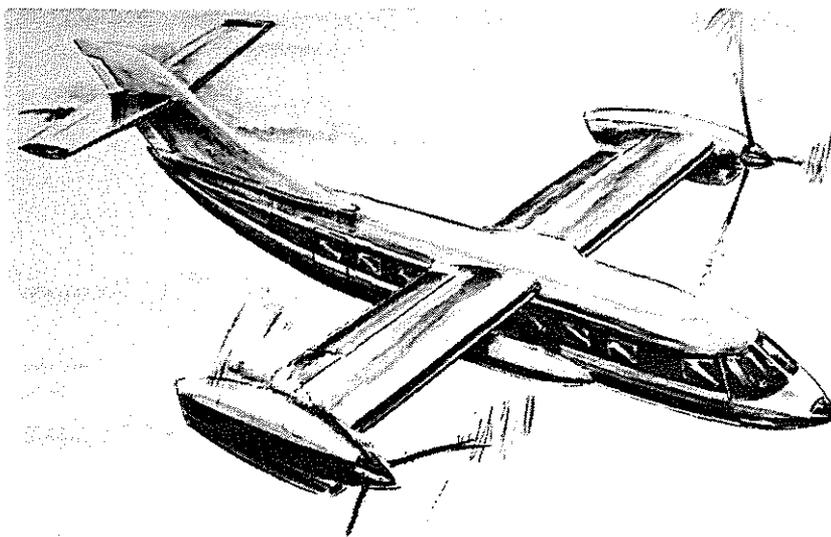


Fig. 38