The Development of Unmanned Aerial Vehicles in Germany (1914 – 1918)

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***Introduction.* Unmanned aerial vehicles (UAV), also remotely piloted vehicles (RPV), are widely used weapon systems in many of today's modern armies. The history of this weapon, surprisingly perhaps, dates back to the beginning of World War I. The aim of this article is to follow the development of unmanned aircraft during 1914−1918, with special focus on Germany.**

***Key words*: Unmanned aerial vehicles, Germany, Siemens, Mannesmann-Mulag**

PROFESSOR WIEN AND THE VPK

Already at an early stage during World War I the German military showed great interest in remotely controlled vehicles. On November 5th 1914, the Ministry of War ordered the Evaluation Commission for Transport Technology (*Verkehrstechnische Prüfungs-Kommission/VPK*) to develop remote control systems that could be installed both in naval vessels and aircraft. This project was to be headed by Max Wien, the director of the Institute for Physics at the University of Jena [1].

In September 1914, or before the ministry had taken its formal decision to support the development of remote control apparatus, the VPK had organized experiments using airplanes equipped with remote control apparatuses developed by the German engineer Ernst Röver [2]. After initial difficulties, largely successful tests were carried out with a receiver based on a Siemens-Brown relay (developed by Siemens for its remotely controlled boats [see below]) that was connected to a pneumatically working control system developed by Röver. Flight testing at Halberstadt, the airplane was manoeuvred manually by a pilot, showed that control signals sent from a ground station could be reliably intercepted by an onboard receiver over distances of up to 2 kilometres, using a 3-metre long antenna [3].

Wien's project went ahead with practical trials during winter 1914–15 by using small boats; one central focus was to investigate the range and sensitivity of the relay mechanism. Three different systems were evaluated – Wirth's, Röver's, and Siemens'. Different types of transmitters were installed that operated with different energy levels and bands of frequencies. Receivers installed onboard the boats consisted of antennas, amplifiers, and a Brown type relay from Siemens [3]. Receivers were in turn connected to the control system, which consisted of a distributer that channelled incoming signals to the control device, and from there on to the (mechanical) steering mechanism. In February and May 1915 experiments were moved to Travemünde and Kiel, using torpedo boats made available by the German Navy. From the start, control by wire was carried out from the shore, later on by wireless from airplanes. Joint tests by Siemens & Halske (S&H) and naval personnel showed promising results: "The control mechanism worked perfectly, both with indirect control via cable and with wireless control. Between the transmitter and the receiver onboard the ship at sea a perfect functioning of the relay mechanism could be achieved over distances of 30 km"[4].

In his final report Wien concluded that the relay mechanism worked satisfactorily also under unfavourable outdoor conditions [4]. One of its drawbacks, though, was that it was a complicated device which needed constant attention. Using a 400 W shortwave transmitter and a 3 metres long receiving antenna, transmissions of up to 5 km were possible; with longer antennas distances of up to 20 km were within reach. Regarding different control mechanisms studied during the tests, both Siemens' and Röver's had shown good results, supporting a reasonable number of control commands. Less than one second elapsed from the time a command was issued and until its effect was felt on the steering apparatus. Tests in Kiel and Travemünde had conclusively shown that remote control of seagoing vessels, seen from a technical perspective, was fully practicable. With the controller seated onboard an aircraft, observing the vessel and steering it to its target was uncomplicated.

Regarding the remote control of airships, Wien believed that more experiments were needed. An airship or airplane, different from a boat on water, had to be controlled in three dimensions, making remote control more difficult. "But it is clearly possible that also in this case this unusual type of guidance is far easier to obtain in reality than was first expected by the specialist. Anyhow, the VPK will as soon as possible conclude the tests that had been ordered regarding remote control of airships in order to determine the possibility or impossibility of remote control." Bombing ground targets from the air with some level of accuracy, according to Wien, was practically possible only from manned aircraft, be it airships or airplanes. Larger airplanes were preferable – they were less vulnerable to enemy fire than airships due to their smaller size and faster speed.

Wien was anxious to point out that more basic research was needed in order to come to terms with interference by enemy radio signals. Otherwise, work had progressed to a level of practical implementation. In the near to midterm future remote control, according to Wien, held a great potential for introducing new naval weapons for direct attacks of harbours, ships, etc, using remotely controlled ships or torpedoes. And with that conclusion the issue was turned over to the German Navy, which employed remotely controlled torpedo boats (FL-boats) in a frontline setting, albeit on a limited scale, in the English Channel.

SIEMENS' REMOTELY CONTROLLED GLIDERS

In January 1915, S&H registered a patent that addressed some of the principal issues involved in the remote control of aircraft [5]. The basic set-up was principally similar to the one used on the Navy's FL-boats:

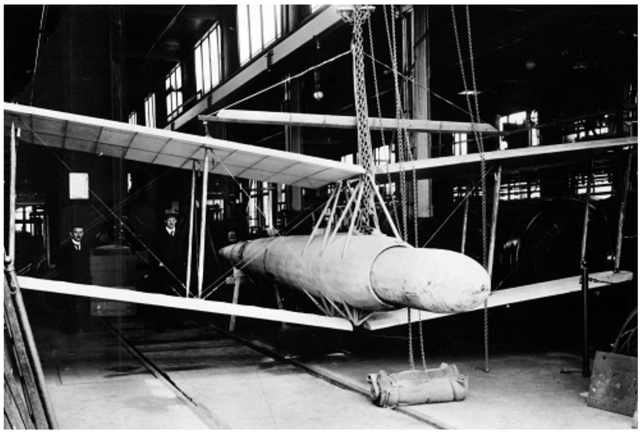
- the aircraft, equipped with winglets and control surfaces (rudder and elevator), was to be dropped from an ordinary airplane;
- gliding to its target it stayed connected to the airplane by a thin wire;
- controlling its course was done by sending electrical impulses from a command post located onboard the airplane to a steering device onboard the glider;
- the steering device activated the control surfaces.

From the start Siemens' gliders were based on a monoplane design; with increasing size and loads this was partly replaced by biplane designs. By the end of 1916 a total of 66 gliders had been launched. Over time, overall size increased considerably: the first model, the 1a, had a wingspan of 1.98–2.60 m, a wing-area of 2 m², and a weight of 14–28 kg; its successor, the 1b, already weighed 42–68 kg, having a wing-area of 1.6 m²; the 1c weighed up to 113 kg [6]. However, using radio control apparatus like the one installed on advanced FL-boats to control these vehicles was considered impractical due to the gliders' limited size and weight.

In 1916 a new biplane model was launched, the Torpedo Glider (*Torpedogleiter)*. The basic idea was to release a torpedo that was carried inside the fuselage before the glider itself hit the water. The drop was to take place at a range of 100–200 metres from the target, and the run of the torpedo controlled by a device located onboard the glider [7]. Although first experiments, organized in summer 1916, were partly successful, Hans Dietzius, the leading engineer of the project, had to admit that the transition phase, or after the torpedo had been dropped, remained a problematic issue [8]. A patent filed by Siemens-Schuckert Werke (SSW), a daughter company of S&H, in November 1916 suggested that the torpedo, once released, was to be remotely controlled by wire from land, with the glider serving as an intermediary platform [9]. This solution was similar to the one used on Siemens' advanced FL-boats.

In summer 1917, air drops with 300 kg gliders were made from the Z XII airship in Hannover; in the autumn of that year trials continued with 500–1,000 kg gliders dropped from the airships PL 25 in Potsdam and L 35 in Jüterbog. Most air drops were carried out from altitudes of between 1,000 and 1,500 metres. To keep the wings as small as possible (7–20 m²), wing-load had to be gradually increased from 50 kg/m² to 150 kg/m² [10]. During these experiments the gliders carried dummy torpedoes made of wood weighing 900 kg. The longest glides achieved were around 7 km. In general, results were believed to have been successful [11].

Siemens, between 1914 and 1918, tested approximately 100 gliders of different sizes and designs, meaning that over a period of 3–4 years the firm spent considerable resources to develop a new aerial weapon [12].



Picture 1. Torpedo glider built by Siemens - Schuckert 1917 - 1918

Wilhelm von Siemens, as mentioned by his iographer Rotth, never lost sight of his FL-boats or gliders, taking a personal interest in their development [13]. Inside the company work with the remotely controlled gliders, as was the case with the FL-boats, was placed in a separate department called "Labor Wilhelm von Siemens". The project was headed by Dietzius, with Friedrich Dorner from S&H playing a central role when it came to developing the remote control system [14].

Siemens' unmanned gliders, or glide-bombs, a project that had gotten started in late 1914, had by the end of World War I not resulted in a weapon that could be used at the front. According to Dietzius, "The remote control of aircraft by wire was a futile effort" [14].

IDFLIEG AND REMOTE CONTROL OF AIRCRAFT

In August 1917 the Inspectorate of the German Air Force (*Inspektion der Fliegertruppen/ Idflieg*) contacted Siemens with a proposal to jointly develop a radio control system for installation on aircraft. A meeting followed in Berlin, with SSW being represented by two of its top managers Reichel and Natalis, the military by First-Lieutenant Wittenstein and First-Lieutenant Niemann; present at this meeting was also the engineer Flettner [15]. It was quickly concluded that Siemens was fully competent to develop both radio control systems as well as unmanned aircraft. Since the start of the war, the company had accumulated a vast body of experience with regard to aerodynamics and structural issues related to aircraft construction by building R-type heavy bombers, fighters, and other airplanes, while S&H was turning out advanced rotary aero-engines.

Niemann and Wittenstein believed that it would be highly valuable, seen from a military perspective, for Siemens to develop a "wireless guided, automatic flying bomb" [16]. The aim was to develop the entire system, including "stabilization, remote control without interference, aero-technical questions, and the explosive charge". However, already solutions regarding individual elements of this highly complex system, the two officers were anxious to emphasize, would make a vital difference. What was needed was a new technical approach, one that differed from the one underlying Anschütz & Drexler: “By using the Siemens-Flettner stabilizer, or gyroscopic inclinometer (*Kreisel-Neigungsmesser*), gyrocompass, etc, a new technical direction different from the one found in the Anschütz-Drexler constructions will be followed” [17]. The meeting ended with a promise by Idflieg to sign a formal contract for the development of a new remote control system for aircraft. If #weather such an order ever reached Siemens is unclear. In the end, according to Weyl, the company declined further cooperation with the military on this issue [18].

In Idflieg’s last monthly report, published on November 8th, one of the German military’s arguably most advanced technical projects – wireless, remote control of aircraft – had still not progressed to the stage of practical testing. In Döberitz, a test facility run by the military, a control tower used for simulating the remote control of aircraft and aerial torpedoes was said to be almost completed, while “A crane, used to hold airplanes freely floating in the air for testing the wireless control mechanisms, is under construction. Testing will start after completion of these installations”[19]. This shows that practical tests showing the feasibility of remote control of aircraft had hardly started when the war ended. Experiments carried out during 1918 seem to have mainly dealt with directional bearing, location of (manned) aircraft in airspace, ground antennas, and attempts to try to better understand the influence of altitude, distance, and angle of the aircraft on incoming radio-waves [20].

FLEDERMAUS PROJECT

One German company that during World War I participated in the development of remotely controlled, unmanned aircraft was Mannesmann-Mulag (M&M). In mid-October 1918, only some few weeks before the armistice on November 11th 1918 that ended World War I, a meeting was organized at S&H in Berlin-Charlottenburg with representatives from Idflieg, S&H, and M&M. The topic to be discussed was the so called *Fledermausversuche* (experiments with bats), or experiments with radio controlled aircraft. By that time, experiments seem to have been ongoing for some time, both at M&M and S&H, while Idflieg’s first steps in this direction, as was shown, had been taken already earlier. At this meeting Idflieg was represented by the head of the Experimental Department for Wireless Telegraphy (*Funken-Telegraphie-Versuchsabteilung/ FT-VA*) Niemann, together with three fellow officers, i.e. Metzkes, Schneider, and Weigt. S&H was present at the table with two of its senior engineers, namely Ehrhardt and Zenneck. In addition, there was Professor Schmidt from Halle in the capacity of scientific adviser. The representative from M&M was well known to Siemens, an engineer who had played a leading role in the start-up of Siemens’ aircraft production during autumn 1914, i.e. Villehad Forssman [21].

The meeting started with a status report by Forssman regarding the *Fledermaus* project in M&M. This new aircraft, according to Forssman, was to make both pilot and observer redundant. In flight, the apparatus was to be controlled by two instruments:

– a special compass (*Selensteuerkompass*) that automatically corrected the aircraft’s deviations from a preset course;
– an anemometer that registered distance; at a preset distance after take-off it activated a bomb throwing mechanism while changing the aircraft’s course, directing it to head back to the home base; after having returned the anemometer was to trigger a large parachute that safely landed the aircraft.

Being controlled by a radio guidance apparatus (*FT Fernlenkung*) the aircraft could be operated irrespective of any adverse weather conditions. It had an aerodynamically advanced design, while a 100 hp engine allowed speeds of up to 200–220 km/hr. This engine, however, was to be replaced by a 160 hp model in order to increase the rate of climb (not speed). According to Forssman, three vehicles equipped with 100 hp engines had already been built in M&M’s factory in Köln-Westhoven, while more were in various stages of production. The only piece of equipment missing was the compass. In any case, flight testing was expected to get underway in the nearest future. What is not clear from Forssman’s account is the question of flight control: how was the aircraft to be handled in flight? Had some rudimentary form of autopilot been installed? Following what Niemann mentioned years later, flight control was handled by a system developed by the German engineer Drexler [22]. Forssman was followed by Niemann. According to the officer, the objective of the project was twofold: 1) to use the *Fledermaus* in air defence training; and 2) to employ the vehicle for “systematic attacks” on industrial centres of the enemy. Considering the advanced state of the war, the second task was of paramount importance. In order to protect the vehicle from ground fire, and to avoid attempts by the enemy to interfere with its radio guidance apparatus, Niemann suggested operating it only at night and at high altitudes, using strong radio beacons in combination with delay-relays. Regarding radio signals only some few basic commands were needed – right, left, turn around, bomb release, and landing (activation of a parachute). Commands for climb or descent, apparently, were believed to be redundant.

Ehrhardt and Zenneck entered the discussion by pointing out that S&H’s remote control system used on its FL-boats, with some minor adaptations, could be used also for the *Fledermaus*. S&H had registered a patent for remote control by wire early on in the war. Later on research in this field was broadened to include radio control. Modifying this control system to allow installation on the *Fledermaus* became S&H’s main task in the project.

The meeting summarized the responsibilities of each party, and also scheduled the next steps to be taken:

1. *Fledermaus* aircraft: M&M
   a. Production: factory Köln-Westhoven
   b. Flight testing: airfield Köln-Spich
   c. Assembly and test flights under radio guidance: airfield Döberitz
2. Radio control equipment: S&H
3. Flight testing, installation of control station, radio locations, personnel: FT-VA Döberitz
4. Scientific adviser: Professor Schmidt.

Quite naturally, the central player in this advanced project was the FT-VA. The authority was to sign a contract with M&M for the production of five *Fledermaus* vehicles, and to deliver five 160 hp engines to Köln-Westhoven together with three "D-generators 16" equipped with transmissions for direct start. Other tasks the FT-VA was to take care of was to organize parachute tests in Döberitz, and to contact the aeronautical laboratory in Göttingen concerning aerodynamic calculations and the testing of drag, using small-scale models. Military personnel were to be dispatched to the Spich airfield under the command of First-Lieutenant Schneider in order to assist M&M with field trials. Regarding S&H, the FT-VA was to sign a purchase order for five sets of radio equipment. Moreover, it was to requisition three specialist technicians for employment by S&H; this recruitment came on top of five precision mechanics already selected and waiting to be transferred to S&H. A radio command centre (3 KW station) was to be set up at the Telefunken factory in Berlin, while two radio beacons were to be installed at Lake Müritzsee and at Jüterbog or Naumburg.

To summarize – what the protocol from October 1918 shows is that Idflieg, some few weeks before the end of World War I, had met with two of its contractors, S&H in Berlin and M&M in Köln-Westhoven, in order to discuss the further development of a new aerial weapon. By the time of this meeting M&M had already built three *Fledermaus* which − most likely − had been designed by Forssman. The fact that 100 hp aero-engines were used for these vehicles, at that time access to engines was strictly controlled by the military, underlines the fact that the military had been involved in this advanced project from the very start. The *Fledermaus* was to be a new weapon in the German arsenal, an aircraft specially designed for its purpose to bomb industrial centres of the enemy. So far no documentary evidence has surfaced about the concrete design of the *Fledermaus*, nor its technical specifications.

The radio control equipment, judging from the protocol, appears to have been readily available: similar devices had been developed by S&H for Siemens' FL-boats and wire-controlled gliders. In addition, during previous years S&H had registered various patents related to radio control, i.e. for heavy gun-batteries, a distance measuring apparatus for localizing objects in space, and a device that automatically focused machinery such as artillery pieces and searchlights on moving objects. By 1918, radio control equipment installed on the FL-boats had been developed so far that it combined elements of the original Siemens system with Röver's. After modification it was this system that was to be used for the remote control of aircraft.

Exactly when Idflieg had started to engage M&M and S&H in the *Fledermaus* project is not known. As is shown in Idflieg's monthly reports, the project had been initiated already in autumn 1916; one of several companies that initially participated had been Junkers in Dessau, an aircraft manufacturer. These early attempts, however, seem to have come to naught. One year later, in August 1917, Idflieg and Siemens, as was shown, discussed the development of a radio controlled flying bomb; also this attempt had failed. At that time, or in late summer 1917, M&M's aircraft division had been hardly established. Therefore, the company most likely entered the *Fledermaus* project not earlier than autumn 1917.

In August 1918, M&M requested from the military an additional shipment of glue. A number of experimental aircraft were said to be under construction in Westhoven, based on contracts signed with Idflieg and the Naval Office (*Reichsmarineamt)*. Elements of these aircraft were said to consist of sheets of veneer that were glued together, a process that required large quantities of this adhesive. One can assume that the one in Westhoven who needed this material had been Forssman, who, in addition to his 10-engine triplane, was using this special plywood for constructing the *Fledermaus* [23]. The contract with the Navy mentioned in Forssman's request for glue must have alluded to the Navy's involvement with the Forssman tri-plane.

The *Fledermaus* project was not mentioned in Idflieg's monthly reports until April 1918, when it was stated that, "Remote control (Fledermaus). Discussions have been held with the Torpedo-Inspectorate in Kiel and relevant companies, while experiments carried out by several companies have continued"[24]. This means that research and experimentation with remote control of aircraft had been ongoing in different locations, probably since the initial launch of the project in 1916. Why nothing had been mentioned about this development until April 1918 could be related to the strict secrecy surrounding this project, alternatively that there were no concrete results to report.

Idflieg's report for September 1918, issued three days before World War I formally ended, included a short reference to the *Fledermaus* project at M&M based on a visit by Niemann on September 14th 1918 to Westhoven. When Niemann visited the factory two aerial torpedoes (*Lufttorpedo*) had been completed, while three were in various stages of production [25]. Niemann decided, together with M&M's management, including Forssman, on a specific work schedule:

1. test of the Selenium-compass guidance apparatus (*Selen-Kompass-Steueranlage*) on ground with the aero-engine running;
2. testing the parachute landing system, using large airplanes at Döberitz;
3. flight testing of the first aerial torpedo at the Spich airfield;
4. experiments in Döberitz, including an eventual switch from mechanical relays to new types; eventual substitution of the Selenium-compass with a gyroscopic compass;
5. advancing from *Fledermaus* flights powered by 100 hp engines without remote control to using 160 hp engines together with radio control (Döberitz);
6. testing bombs in order to maximize the blast effect (coordinated with Idflieg's Kdo Bomben).

Field trials were expected to get under way within 3–4 weeks, or by mid-October 1918. Idflieg proposed using the military airfield at Spich for this purpose, which housed an unused airship hangar. Niemann also promised to supply two 160 hp engines needed during the upcoming tests. On this occasion Idflieg also signed a formal contract with M&M for the construction of an experimental *Fledermaus*, pointing out that this new vehicle was to be built according to the FT-VA's specifications. Again, what was not mentioned, the same as during the Berlin-meeting in October, was the question of flight control.

Many years later, in 1938, Niemann would shortly mention the *Fledermaus* in a memorandum about the development of radio communication in World War I:

The Fledermaus was a C-type airplane that took-off independently with the help of a cable device directed against the wind. In-flight control was achieved automatically using a system developed by the engineer First Lieutenant Drexler. The altitude at any given moment was automatically transmitted from the aircraft to a ground station in such a way that the pointer of an altitude meter was running over electrical contacts, short-cutting these and thereby activating relevant relays of the ground station.

The position of the aircraft was determined by radio bearing in such a way that a transmitter inside the aircraft was constantly sending signals that were picked up by two ground stations, one at Lake Müritz, the other one near Potsdam; with that arrangement, ground control was at all times informed about the position of the aircraft.

Bomb release was activated by wireless. After dropping its bombs, the aircraft was directed back to the airfield by radio control. On arrival overhead the aerodrome, the throttle was pushed back by radio control and the machine was put on its head. After that a giant parachute, stored in the tail of the airplane, was released, which safely brought it to the ground; in the worst case, only the propeller and the specially designed landing gear got damaged [22].

This account, written 20 years after the event, does not fully correspond to what was stated in the protocol from October 30th 1918, the one that summarized the meeting between Idflieg, S&H, and M&M in Berlin, nor does it follow Idflieg's report regarding Niemann's visit to Köln-Westhoven in September 1918. According to these two documents, the aircraft in question had been built by M&M, not by another company. Also, it is not very likely that standard German C-planes had been used – why, otherwise, let the Göttingen laboratory carry out aerodynamic tests? Standard C-planes needed no further testing in this respect. Unclear in Niemann's account from 1938 is also the important issue of practical field trials: had any radio controlled flights taken place before the end of the war in November 1918? Looking at his report one gets the impression that this had been the case. It needs to be kept in mind, though, that only some few weeks separated the meeting in October 1918 from the armistice on November 11th 1918. It could have been the case, of course, that field testing had gotten underway in this short intermediate period. What partly talks against this is that a number of critical issues had not been fully resolved when the parties met in Berlin, especially the modifications of S&H's remote control system.

An eyewitness later mentioned that in September 1918 the hangar in Spich was being prepared to accept "smaller and larger battle planes and fighters" [26]. Seen in the light of Niemann's visit in September to Köln-Westhoven, these preparations could have been related to planned or already ongoing experiments with the *Fledermaus*. According to this eyewitness, the schoolteacher Scholtes from Libur, who could follow the activities at the airfield from his classroom, numerous airplanes had been taking off and landing in late summer 1918: "At the moment, one can observe each day four large battle planes taking-off from nearby the hangar. They manoeuvre in the vicinity of the hangar in the air for several hours, after which they again land close to the hangar" [27]. Had Scholtes been observing *Fledermaus* aircraft, or had he merely seen ordinary warplanes used to test S&H's remote control apparatus? Or maybe it had been different aircraft altogether, unrelated to M&M's remote control project. According to Niemann, two *Fledermaus* apparatuses were ready when the revolution broke out in Germany in November 1918. He then acted like other German officers responsible for advanced weapons: "In agreement with my superiors I at first hid the apparatus, later on I had it destroyed" [22]. Hence, it could well have been the case that the aircraft Scholtes had observed in Spich had been experimental aircraft from M&M.

The *Fledermaus* project has been briefly noticed by some historians. According to Lange, the project had been run under the auspices of Idflieg, which in 1918 organized a series of tests at Adlershof with remotely guided aircraft and missiles. The one who headed this project had been Niemann, assisted by Schmidt and Forssman [28]. Weyl shortly mentioned experiments by the German military with radio control, calling it the *Döberitz attempts* [29]. In his version, Idflieg had established a wireless command at its experimental facility in Döberitz which from the start had been charged to develop communication equipment used in aircraft. The one responsible for this unit had been Niemann. First attempts regarding remote control, including automatic flight control, got underway in 1916. Important inputs were received from Franz Drexler, who in time developed a gyroscopic control device, and from Anton Flettner, who experimented with radio guidance. According to Weyl, a newly developed flight control system for aircraft was in the making when World War I ended. Actual flight testing, using standard warplanes, had, according to Weyl, most likely not taken place. In a study that focuses on German aviation test centres experiments with remote guidance involving M&M and Siemens are said to have been based on a system developed by Wirth and Röver [30]. A fourth version, finally, advanced by Trenkle, specifically mentions five C-planes equipped with remote guidance apparatus developed by Siemens. In this version, test flights had been successful [31]. According to Trenkle, localizing and positioning the airplane in three-dimensional space had been accomplished by radio signals emitted from a ground station to a transmitter onboard the aircraft, which in turn was connected to an altitude meter; this provided concrete information about the actual flight level. Signals sent back from the onboard transmitter were picked up by two radio stations on ground, providing information about geographic location. In flight, the airplane was controlled by an autopilot (*Selbststeuergerät*) from Drexler that was activated by radio signals from the ground. The radio equipment in question, according to Trenkle, had been supplied by Siemens. Field trials had started already in 1917 [32].

These four versions, as is readily apparent, are not consistent with each other, nor do they conform to the documents referred to above: the protocol from the Berlin-meeting on October 30th 1918, and Idflieg's report about

Niemann's visit in September 1918 to M&M. Concrete talks between the parties involved − Idflieg, S&H, M&M – had started not earlier than during the second half of 1917, which means that practical experiments could not have taken place before 1918. Trenkle's reference to tests that had taken place in 1917 must refer to another project, not the one that involved M&M and S&H. Also, radio equipment from S&H and not Wirth & Röver, as mentioned by Weyl, had been installed. Furthermore, specially constructed aircraft from M&M and not standard warplanes, as Trenkle mentions, were to be used. In all likelihood, M&M's *Fledermaus* was equipped with a Siemens & Röver guidance system, whereby the distributor came from Röver. That automatic flight control was to be handled by a system developed by Drexler, as Trenkle mentioned, was also mentioned by Niemann.

Looking at relevant documents, the following scenario emerges regarding participants and tasks in the *Fledermaus* project:

- project owner Niemann/ Idflieg
- project manager Niemann & Forssman
- aircraft Forssman/ M&M
- remote control Dorner & others/ S&H (Siemens & Röver system)
- flight control Drexler(?)

Many years later, in 1944, Forssman's involvement in the project was summarized by Niemann:

In addition to constructing and building the so called Riesenflugzeuge, Mr Forssman was also contributing to the construction of an unmanned, wireless controlled aircraft. This work progressed successfully; by the end of the world war a number of machines were ready for use. They could carry a bomb load of 150 kg and had an operational radius of approximately 200 km. No enemy missions, regretfully, were ever flown, due to the November Revolution [33].

DREXLER AND EFKA

Franz Drexler had started to take an interest in autopilots for aircraft as early as in 1908–09. His first stabilizers were based on pendulums that activated major control surfaces such as elevator, rudder, and ailerons [34]. In 1912, he presented a stabilizer based on a gyroscope that was to control both pitch and roll, an apparatus that never passed beyond the experimental stage. During World War I, Drexler first served as a pilot at the front before being transferred to Idflieg in Adlershof. In 1916, Drexler was put in charge of the Remote Guidance and Gyroscopic Experimental Department (*Fernlenk- und Kreisel- Versuchsabteilung, Efka*) in Döberitz, a research unit responsible for developing autopilots, aircraft instruments, and remote control systems. A number of new instruments resulted from this work, like an artificial horizon (*Fluglagenweiser*) from 1917; another invention, patented in 1916, was a steering device for aircraft [35]. When moving to the Efka Drexler took his stabilizer with him. Already in summer 1916 an Idflieg report mentioned a stabilizer that was said to have been developed Drexler and that was to be installed on a Rumpler biplane [36]. By late August 1916 – by now the weight had been reduced from 40 kg to 18 kg – nothing much seems to have happened [37]. Reports from October that year indicate that Idflieg was still trying to install the system on an airplane. Two months later, in December, Idflieg again referred to Drexler's work in connection with remote control, noting that, "continuation of work with automatic stabilization System Drexler for tests with remote control" [38].

In August 1917, an autopilot for manned aircraft based on a gyroscope (*Kreiselselbststeuerung*) was said to be ready for testing at Efka's laboratory in Döberitz. In addition, a stabilizer for unmanned aircraft was said to have been completed, ready to be installed on a Rumpler C-plane [39] Soon, however, the apparatus for unmanned aircraft was to be reconstructed: "Because the gyroscopic device used together with the steering mechanism has worked extremely well, a principal reconstruction of the stabilizer has been initiated" [40]. A new model, summarily described in an Efka report one month later, was supposedly under construction at the workshop of the firm Loschitz in Dresden.

Kracheel mentions experiments with remote control in 1917–18 at the military installation in Döberitz based on a system developed by Drexler. The radio equipment in question was supposed to have come from Max Dieckmann [41]. These experiments, however, were never mentioned in Idflieg's monthly reports. Also, no concrete information has surfaced so far that point to Drexler's involvement in the *Fledermaus* project, neither in connection with flight control nor remote guidance, other than Niemann's short note from 1938 [22]. In addition, no concrete information exists about Drexler ever having developed a workable remote control system, quite to the contrary. According to Kracheel, "Until his death in 1929 Drexler was constantly engaged in the field of remote control, without, however, ever having experienced implementation"[42]. Had Drexler been involved in the *Fledermaus* project, it would have been natural for him to participate in the meeting in Berlin in October 1918. As can be recalled, the scientific expert at that time was Professor Schmidt from Halle.

EXPERIMENTS OUTSIDE GERMANY

Before and during World War I, experiments with remote control of aircraft were carried out by a number of scientists and others, among them Elmer and Lawrence Sperry, Peter Hewitt, and Curtiss in the Unites States (Curtiss-Sperry Flying bomb) [43]. Another

American who during the war focused on developing remote control for aircraft was Charles Kettering (Kettering Bug) [44]. In England, Archibald Low in spring 1917 successfully launched a radio controlled aircraft (Aerial Target). In 1917 Low and his team also presented a remote guidance system for rockets [45].

None of Germany's major adversaries in World War I succeeded to introduce pilotless aircraft, controlled by wire or by radio signals, into military service. The only successful practical attempts in using remotely controlled vehicles in combat were Siemens' FL-boats in the English Channel.

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Gunters Sollingers. Bezpilotu tālvadības lidaparātu attīstība Vācijā (1914–1918)
Bezpilota tālvadības lidaparātu attīstība sākās Pirmā pasaules kara laikā. Nozīmīgus eksperimentus Amerikā un Apvienotajā Karalistē veica Sperry, Curtiss, Kettering un Low. Šis darbs tomēr nenoveda pie ieroču sistēmām, ko varēja izmantot notiekošajā karā. Šajā pašā laika posmā milzum daudz darba tika ieguldīts arī Vācijā, kas centās attīstīt tālvadības pults un lidojuma kontroles sistēmas, kam līdz šim literatūrā nav pievērsta pienācīga uzmanība, taču tie bija nozīmīgi sasniegumi inženiertehnikas attīstības vēsturē. Šajā rakstā, balstoties uz literatūru un arhīvu dokumentiem, parādīts, kā pie tālvadības ieroču attīstības Pirmā pasaules kara laikā strādāja gan vācu militārā pārvalde, gan arī privātie uzņēmumi, galvenokārt "Siemens" Berlīnē. Sākot ar "Wien projektu" 1914. gada rudenī, analizēta šī perioda augsti attīstīto tehnoloģiju attīstība četros gados, ieskaitot Rover tālvadības aparatūru, kas tika testēta uz viena no viņa

lidaparātiem, "Siemens" tālvadības torpēdu laiva un" Siemens" "tālvadības planieris". Visprogresīvākais projekts ar segvārdu "Fledermaus" tika uzsākts 1917. gadā. To finansēja militāristi, iesaistot tajā rūpniecības uzņēmumus "Siemens" un "Mannesmann-Mulag" Ķelnē. Kad 1918. gada novembrī beidzās Pirmais pasaules karš, vairāki "Fledermaus" lidaparāti bija jau sagatavoti praktiskiem izmēģinājumiem, taču militāristi tos steidzīgi iznīcināja, lai tie nenonāktu uzvarētāju rokās.

Гюнтер Золлингер. Развития безпилотных летателъных аппаратов в Германии (1914–1918)
Развитие беспилотных, дистанционно-управляемых летателъных аппаратов началосъ в Германии к началу Первой мировой войны. Важные эксперименты проводили в Америке и в Соединенном Королевстве Сперри, Кертисс, Кеттерин и Лоу. В результате этой работы, однако, не были изобретены оружейные системы, которые могли бы быть использованы в первой мировой войне. За тот же период в Германии также были попытки разработать системы дистанционного контроля и управления полетом, которым до сих пор не не уделяется внимание. В этой статье автор на основе литературы и архивных документов исследует попытки немецких военных, а также частных предприятий, в первую очередь «Siemens» в Берлине, разработать оружие с дистанционным управлением. Начиная с проекта «Wien», осенью 1914 года в статъе сделан анализ прогресса в области высокоразвитых технологий за период с 1914 до 1918 года. Автор упоминает устройство дистанционного управления Rover, которое было испытано на одном из самолетов, а также работу фирмы "Сименс" - дистанционное управление торпедных лодок и дистанционное управление планеров. Наиболее важный проект был начат в 1917 году под кодовым названием «Fledermaus» (Летучая мышъ).Участие в этой работе, финансируемой со стороны военных, приняли участие предприятия «Siemens», а также «Mannesmann-Mulag» в Кельне. В ноябре 1918 года, когда Первая мировая война закончилась, аппараты "Летучей мыши" были готовы к практическим испытаниям. Они были разрушены в результате военных действий, чтобы не попали в руки победителей.