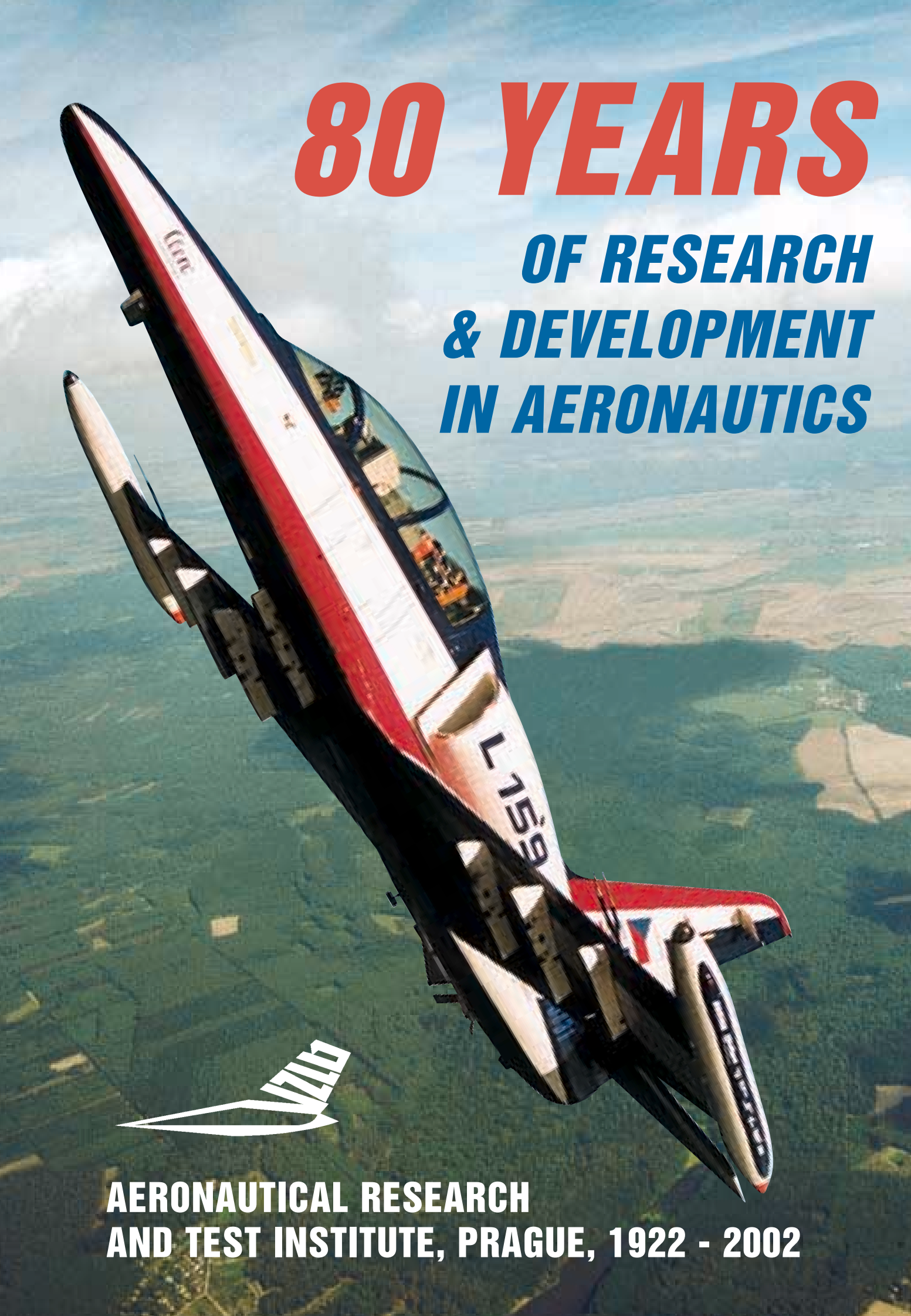
80 YEARS

OF RESEARCH & DEVELOPMENT IN AERONAUTICS



AERONAUTICAL RESEARCH AND TEST INSTITUTE, PRAGUE, 1922 - 2002

80 Years of Research & Development in Aeronautics

VÝZKUMNÝ A ZKUŠEBNÍ LETECKÝ ÚSTAV
AERONAUTICAL RESEARCH AND TEST INSTITUTE,
PRAGUE, CZECH REPUBLIC

1922-2002

Preface

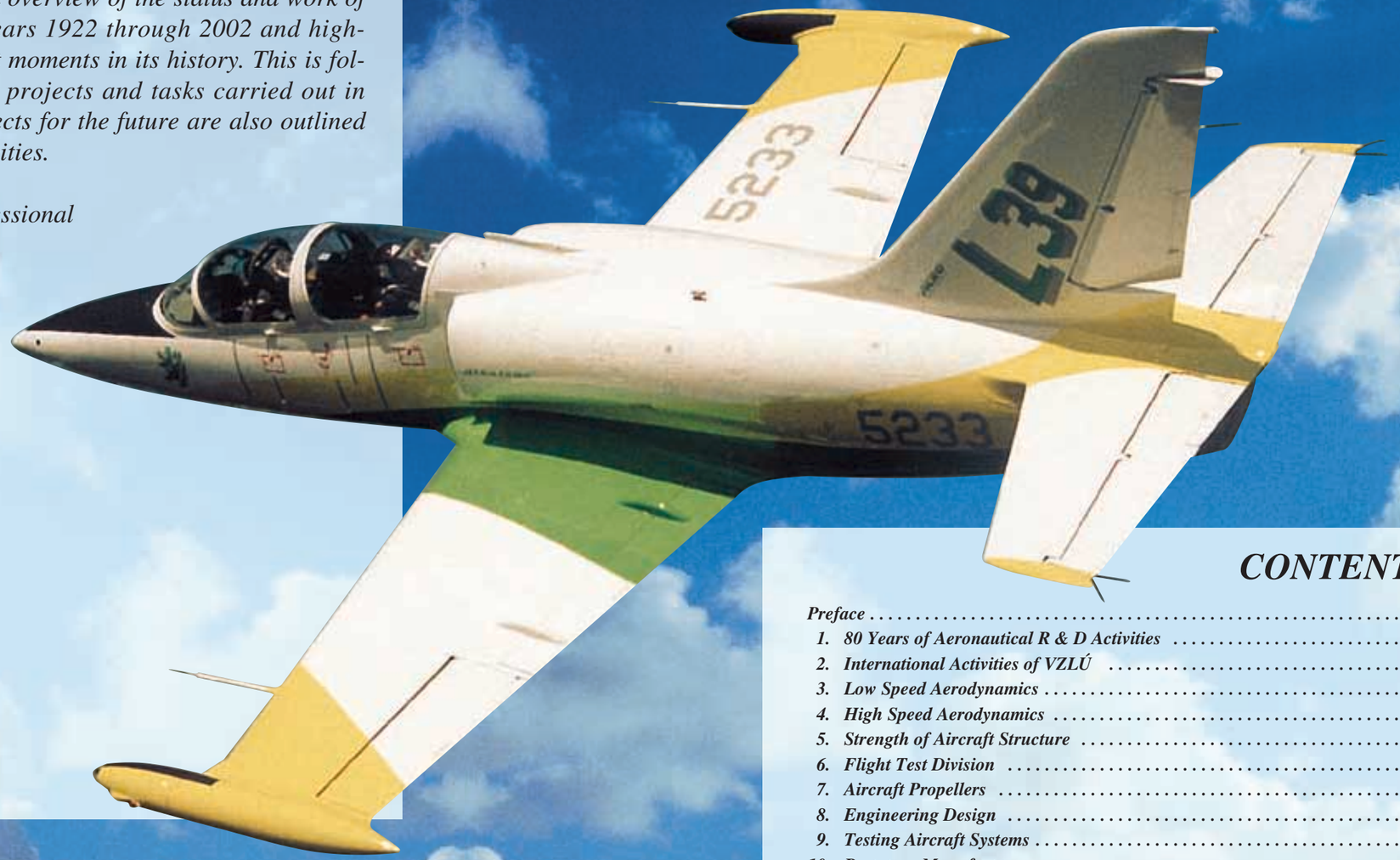
On 1 May 1922 the Air Navigation Study Institute of the Ministry of Defence – the predecessor of today Aeronautical Research and Test Institute, VZLÚ – was officially established. This book has been published to mark the 80th anniversary of that event, so crucial for the Czech aviation industry.

The first part gives an overview of the status and work of the Institute in the years 1922 through 2002 and highlights most significant moments in its history. This is followed by the current projects and tasks carried out in particular divisions and fields of interest. Prospects for the future are also outlined along with VZLÚ international co-operation activities.

Many men and women at various social and professional levels played remarkable roles throughout the Institute's history. This book is dedicated to all those who enthusiastically contributed to VZLÚ achievements, benefiting the Czech aviation.

Prague Letňany, 1 May, 2002

Ing. Milan Holl, CSc.
General Manager



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1. 80 Years of Aeronautical R & D Activities

Ing. René Pavlák, Ing. Jan Bartoň

There is a good custom when recapitulating an organization's history to start with ancient Greeks and Romans. Thanks to the fabulous Daidalos and Icarus it is easy to keep to this rule and recall that beating gravitation has always been man's inherent desire for which people are ready to make their ultimate sacrifice. Perhaps the greatest modern Icarus of ours was Ing Kaspar who just these days 91 years ago accomplished his long historic flight from the town of Pardubice to Prague. The enthusiasm and skill of this air pioneer laid foundations to the later transformation of what had rather been an extravagant hobby to a new industry, the powerful catalyst of the transformation being, as in many other fields, the first world war.

After the war, there were good conditions to establish an aeronautical institute for several reasons. The maturity of heavier-than-air planes proved good definitively and without any doubt during the war. Both the army and the beginning civil transport needed them. Newly built aircraft manufacturers LETOV, AVIA and AERO factories demanded theoretical and experimental background to build licensed planes or planes of their own design.

There were some institutions in Europe even before the war conducting research on flow. As early as 1919 the Ministry of Public Work and the Prague Technical University considered building a wind tunnel. In 1920, an Air Navigation Office was set up at the Ministry of Defense and since that time the existence of a new institute had become increasingly topical. The final decision to set up an independent organisation dealing with aviation was taken in the spring of 1922. The plan was to build a new establishment in Prague-Letňany where a new Military Airplane Factory had also been built so that both the organisation could share a common Kbely airfield.

1. VLÚS's chronicle founded in 1928 records events from 1922 on

2. Overall view of VLÚS under construction in 1927

So all the necessary conditions were fulfilled and the Ministry of Defence issued in its bulletin No 25 of 6 May 1922 the following decree 169:

"The Air Navigation Institute has been established on 1 May 1922. It is an independent military body. Its structure, authority, and personnel will be stated in a specific decree. In charge of all preparatory work is RNDr. Ing. Cpt. Bucháček, Head, Study Department of Air Navigation Office, Ministry of Defense – ref. No. 296.293."

At the beginning the Institute had only four rooms to work in, in the Prague-Pohořelec barracks, from which it moved house to Prague-Střešovice in February 1923. In fact it was not until four years later that it moved to the village of Letňany, its today site to the east of Prague.

The preparatory work took time. Dr. Bucháček made a study trip to French and German institutes to confront his plans with the status abroad. On 2 October 1922 a "**Preparatory meeting on the foundation of the Military Air Navigation Study Institute in Prague**", VVSÚ (stands for Vojenský Vzduchoplavecký studijní ústav) was called at the Ministry of Defence. Representatives of several ministries, Czech and German universities and the Czech Flying Club took part in negotiations. Lieutenant Colonel Kovařík, head of the Study Department, Ministry of Defence, who chaired the meeting, pointed out that the Ministry itself was not able to deal with all basic issues of aviation and therefore a new specialized organisation staffed with an expert working team and scientists was to be set up in collaboration with the ministries interested, universities

3. Founders of VLÚS at 126 Clam Martinic street in Prague-Střešovice in 1923. Fourth from right in top row Cpt. Bucháček

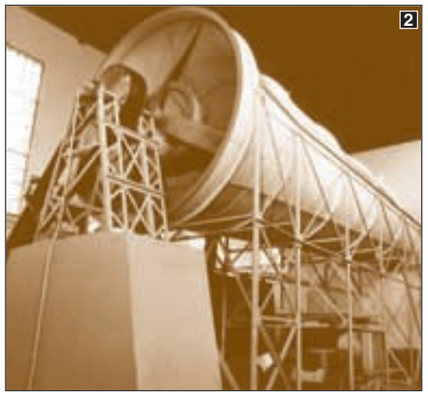
4. Prof. Ing. Dr. Viktor Felber, born 11. 10. 1880, executed by Gestapo 1. 6. 1942

5. Dr. Emanuel Hof, born 1896, died 3. 10. 1934

and professional bodies. The meeting resulted in recommendation that MOD should go ahead with establishing the new organisation, create an Advisory committee, define its authority and statute, respecting the wish of civil aviation to collaborate with civil professionals and representatives from the industry.

Chairman's note: ..."the Institute will go civilian one day, today the thing is to make its foundation easier".

Five weeks later, on 9 December the "First regular meeting of Advisory Committee was held". Apart from the preparatory meeting participants other important officials were present: Two French headquarters' officers, three university professors, director of State Meteorological Institute, two factory directors, three chief designers from airplane factories. Dr. Bucháček outlined the project to build VVSÚ, its overall concept and layout. New working commissions were set up responsible for different branches, such as aircraft engines, frames, aerodynamics, structure strength, air communications, aerial photography, weather, health and also a museum of war planes.



1. Static loading of tail plane, 1928

2. 1.8 m dia wind tunnel diffuser

3. Visit to Institute by first Czechoslovakia´s president Thomas Garrigue Masaryk, left: Gen. Ing. Fajfr, right: minister Dr. Vyškovský

4. VLÚS's Advisory committee 1923-1924

5. View of VLÚS, 1927

Regular Members of Military Aeronautical Study Institute's Advisory Committee 1923 – 1924

Gen. Ing. František KOLAŘÍK, chairman of MoD air section
Col. Henri ROZET, chairman of headquarters´ operation section
Col. Václav KOPAL, headquarters officer
Col. Alois HLÍDEK, chairman of topographic section, Military Geographical Institute
Col. Rudolf POLZ, president of Prague Military Scientific Institute
Col. MUDr. Rudolf PELIKÁN, MoD health department
Lt Col. Ing Josef RIFGER, chairman of MoD research and testing department
Lt Col. Dr. Bohdan VIPLER, MoD meteorological section
Maj. Ing. Josef HUBÁLEK, MoD civil engineering department
Cpt. Ing. Dr. Otto TOMSKÝ, MoD telegraph department
Ing. Josef STRNAD, chairman of Ministry of Post and Telegraph's XI Xth section
Ing. Zdeněk JANÁK, chairman of Ministry of Public Work's XII. b section (automobiles and Airplanes)
MUDr. Karel VARNER, secretary, Ministry of Health
Ing. Bohumil ČLUPEK, Czechoslovak's President's office
Ing. František HASA, professor of Technical University, Prague
Ing. Karel NOVÁK, professor of Technical University, Prague
Ing. Ludvík ŠIMEK, dean of Czech College of Machine and Electrical Engineering, Prague
Dr. Ing. Viktor FELBER, professor of Technical University, Prague
Ing. Jan KOŠŤÁL, professor of Technical University, Prague
Dr. Václav FELIX, professor of Technical University, Prague
Prof. MUDr. František MAREŠ, head physician of medical faculty, Charles University, Prague
JUDr. Antonín HOBZA, dean, faculty of law, Charles University, Prague
Dr. Augustin ŽÁČEK, professor of Charles University, Prague
Ing. Kamil KÖRNER, professor of German Technical University, Prague
Dr. Theodor PÖSCHL, professor of German Technical University, Prague
Dr. Rudolf SCHNEIDER, director of State Meteorological Institute, Prague
Antonín VLASÁK, designer, Aero Works, Prague
Antonín HUSNÍK, designer, Aero Works, Prague
Miroslav HAJN, designar, Avia Works, Prague
Alois ŠMOLÍK, designer, Military Aircraft Works, Prague
Alfréd FRANKENBERGER, director of Breitfeld & Daněk AG, Prague-Karlin
Dr. Ing. Vladimír SÝKORA, director of Škoda Works, Prague

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On 25 June 1923 the 2nd regular meeting of VVSÚ's Advisory Committee was held at which three more commissions were established: for air standards, terms and law. The Advisory Committee designated an Administrative Board consisting of, besides representatives from Ministry of Defence, senior government officials from other ministries such as Public Work, Education, Post and Telegraph, Trade and Finance. Administrative and personnel affairs were discussed and a proposal was agreed that the Government should issue a decree establishing the Institute's organisation on a broader-than-military basis. On 1 December1923 the Institute's name changed to **Military Aeronautical Study Institute, VLÚS** (stands for **Vojenský Letecký Ústav Studijní**). Finally, in August 1925 construction of new buildings began in Prague-Letňany, where an airfield was available, and November 1927 saw engineers and equipment coming to the new site. Ing. Col. Jaroslav Matička was appointed managing director, joined by Dr. Bucháček as his deputy. VLÚS had 7 departments at that time: aerodynamics, aircraft, engines, electrical and radio equipment, photo-optics, air health care and meteorology.

In 1928, all labs were fitted with new equipment coming partly from modern workshops of precision mechanics and in1929 the Institute construction was basically completed.

Most departments conducted studies, expertise and tests on demand by the Ministry of Defence. The Ministry was also interested in evaluating various designs and patents. Aircraft department helped in investigations of air incidents and accidents caused by technical failures. This kind of work provided the staff with experience and data useful for designing aircraft and their equipment.

Dr. Emanuel Hof, head of aerodynamics department, head lots of trouble with the Eiffel-type wind tunnel of 1.8 m in diameter delivered from France, which had to be rebuilt to take in a new balance system. The first airplanes' scaled models were not tested till 1929 for Military Aircraft Factory and AERO Work. Dr Hof worked on another closed circuit wind tunnel of 3.0 m in dia and a velocity of 60 m/s. The year 1931 was important for the aerodynamics department. The Ministry of Defence issued a request for bids for an advanced trainer. AERO and ČKD Praga Works had made two prototypes one of which was a failure. Aerodynamics was called for help, and a scale model was built. Unfortunately, re-designing the frame was no longer possible, showing on the other hand how important a close collaboration between the designer and the aerodynamic department was. From that time on, the MoD always demanded a model to be built before making a prototype. But the Ministry of Public Work did not pose this requirement with civil and sports planes.

The Aircraft and Propulsion Department was headed by Cpt Ing Gustav Benesch, a field pilot. It carried out framework strength tests, studied problems of strength and toughness. It also produced regulations for the construction and operation of aircraft, worked out technical specifications. There were also a number of tasks concerning airplane rigs including parachutes. In early 1928 strength tests of the Aero 12 plane were conducted using sand bags to load the structure, which was usual in those times. The first detailed job concerned strength tests and studies on the BH 26 plane carried out by Alexander Van der Fliet, professor at the Prague Technical University whose work resulted in issuing regulations for aircraft design. Later on in 1931, an attempt was made to load a plane wing with concentrated forces applied at different points but the attempt failed because of bad synchronization of acting forces. Therefore loading with sand bags filled with lead pellets remained in use. Problems of planes' strength were essential, which was evident during tests of a small transport plane Š-32. Its metal wing showed low rigidity, making the plane a failure.

5. Static test of a large biplane. Load is applied by sand bags

6. The BH-26 served to producing regulations for airplane construction

7. Col. Ing. Dr. Karel Bucháček, born 2. 2. 1888, died 10. 8. 1968. Photo taken in 1946

Prof. Ing. Václav Smolař, born 20. 10. 1903, died 27. 4. 1994

Dynamic drop tests of landing gears proved clearly that their performances should be improved. Oleo-pneumatic dampers began to be used. To carry out their tests, a drop tester was built in 1932 recording the course of forces involved.

In 1928 the engine department carried out first full tests of engines: Perun II with a power of 240 HP, on electric brake, Lorraine-Dietrich of 450 HP on water brake and then on propeller brake. The department worked on mounting engines onto airframes, on putting on fuel, oil, and water systems. Licensed engines were certified at factories. Much attention was paid to engine accessories: starter, dynamo, spark plug, cooler, most of them being licensed products.

Czechoslovakia had no oil resources and tried to use different liquid hydrocarbon mixtures. Based on research and co-operation with industry a mixture of petrol, benzene and spirit was developed. Different blend compositions were tested on a Waukesha one cylinder engine and at long running trials both on ground and in flight.

On board instruments were expensive to import and so domestic firms started to develop them themselves. By 1932 VLÚS certified 75 pieces.

VLÚS health department headed by Lieut.Col. Dr. Čapek produced new health regulatory requirements for future pilots, and brought in practice their regular health examination.

Air enthusiasts saw a good omen for the Institute's future in Czechoslovakia's first president Thomas Garrigue Masaryk visit to VLÚS. The President, a great aviation fan himself, paid a visit to VLÚS together with Gen. Bláha on 21 May 1931. They were welcomed by defence minister Dr. Viškovský and Air Force Commander Gen. Ing. Fajfr. The President visited all the departments and in the end saw a demonstration show of two planes dropping simultaneously two mock-up parachutists, and an aerobatic flight of two fighters.

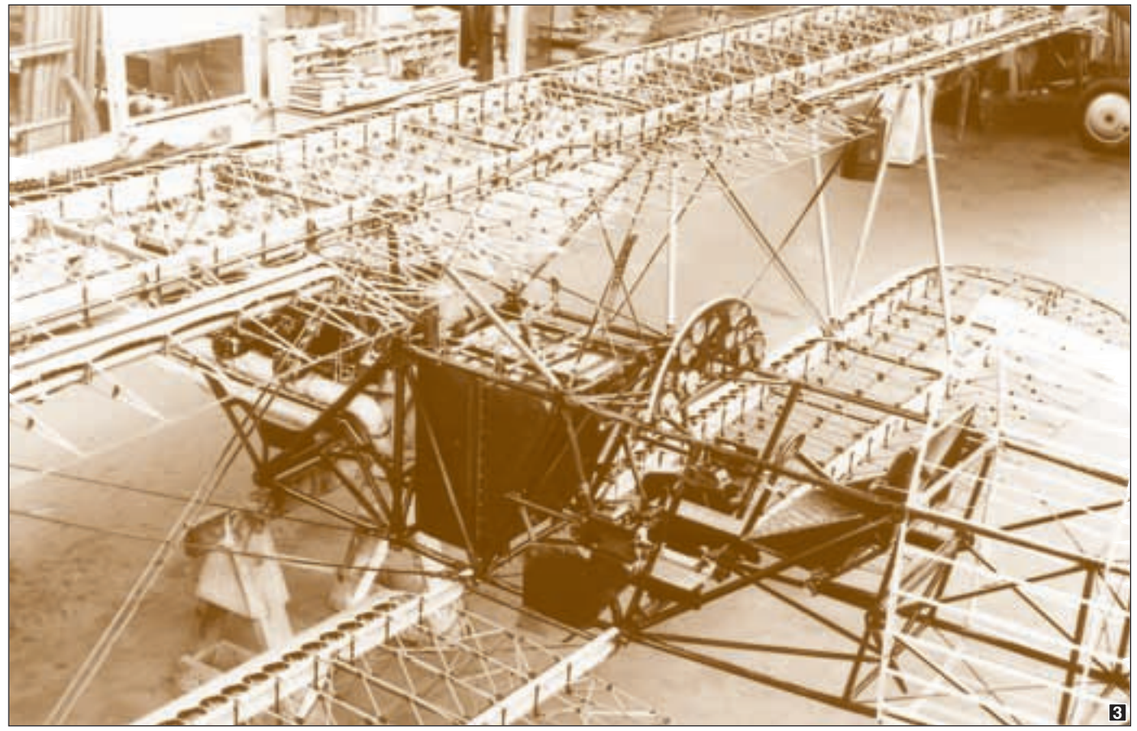
In the early 1930s, the ministry of defence was short of money due to the economic crisis. Following a reshuffle, the **Military Technical and Aeronautical Institute (VTLÚ – Vojenský Technický a Letecký Ústav)** was set up headed by Ing. František Kolařík, with the former VLÚS's director becoming his deputy. VTLÚ had four divisions and Dr. Bucháček became head of division IV. VLÚS name was changed to **VTLÚ 2nd Division**. The photo-optics department, electrical, and weapon departments were moved to Holesovice, another Prague neighbourhood.

The more powerful airplanes called for suitable testing facilities, with main projects as follows:

- In 1935 Ing. Smolař started a project of a closed circuit wind tunnel with a dia of 3 m and a velocity of 75 m/s. Following an initial study phase, its construction began in 1937 and finished at the beginning of the occupation. Czech firms built the whole tunnel including a six-component balance.
- For undercarriage taxiing tests, Ing. Zdeněk Růzha designed drums on which a simulating obstacle could be mounted to follow the performance of dampers and tyres.
- For testing undercarriage dampers, a simple drop tester was manufactured enabling recording of dynamic forces.
- The Power Plant Department put in a water brake of 1000 HP making it possible to brake Avia Hispano-Suiza 12Y engines. In 1935, construction of a lab to test air cooled engines up to 1500 HP began. A fan blew air into two channels in which the engines tested were placed. The brakes were outside the channels and the connecting shafts with engine were relatively long, causing vibrations and restricting full use. In addition, a few one-cylinder test engines were built.

1. Avia B-135 fighter prototype as tested in FVA Letňany in 1941. Bulgaria bought 12 planes

2. Prototype of Š-328 light bomber



- For avionics testing, a Škoda cooling chamber was installed to test instruments at temperatures down to -40 deg. Centigrade and simultaneously at low air pressure. It was used for certification, too.
- The first airplane prototype to be measured in the wind tunnel was the Š-328 made in the Letov Works.
- In 1933, a propeller group was established at the aerodynamics department dealing with study and regulatory requirements of propellers. Tests with variable-pitch propellers started just before the occupation.
- The structure strength tests were expanded to include control surfaces, control systems and seats. Airframes of Š-328, Š-50, Aero A-300, Avia B-534, B-112 aircraft, and Š-32 and Aero-35 transports were tested in this way. Metallic structures prevailed at that time and so attention was paid to fatigue strength of wing beams, suspensions and hinges. Therefore vibrators with eccentric masses were designed .Dynamic loads were determined through stylus tensometers (strain gauges were not available at that time).
- Dynamic tests started to be applied to the undercarriage as well, which soon led to use of oleo-pneumatic dampers of home provenience.
- 13 January 1937 was a red letter day for VTLÚ, Letňany, as President Dr. Edvard Beneš came to see the Institute accompanied by the Defence minister Machník. They were welcomed by the Army General Syrový and big brass. The chief of the aircraft department Major Ing. Benesch explained new design trends in aviation to the President, who visited all of the Institute's departments.

3. 1932 view of structure of B-534 fighter prototype

4. B-534 of first series, 2 machine guns removed from wing

5. B 534 of first series in flight in 1933. Letter „S" indicates the plane was tested at VTLÚ

- The strength of structure department was also involved in the developments of parachutes, wheels, brakes and tyres. Products made abroad were bought and tested and licensed production followed (air brakes, tyres), stress being laid upon long service life.
- In 1938, a flight mechanics group was founded headed by Lt. Ing. Vilém Kočka, a graduate of Paris Air College, who specialized at the discipline. He conducted thorough measurements of the Š-32 longitudinal stability at various configurations. The aim was to determine objectively the plane performances that had been so far evaluated only by pilots' subjective feelings.
- The flight tests department headed by Lt. Col. K. Mareš had trouble as no registration instruments were available at that time. The plane and its accessories were judged only by a pilot's personal evaluation and it was fully up to the air commander to decide whether or not the plane was suitable for military actions.
- The measuring station headed by Cpt. Ing. Štěpán tested airborne avionics and aircraft performances. From 1933 to 1939 it certificated 196 home made on board instruments of which many were highest level.
- The electrical department fitted aircraft with electric systems and radios for flight tests and measured the range of radio and telegraphic equipment in fighters.

The year 1936 saw the beginning of production of rather obsolete French bombers Bloch UD 200 powered by licensed engines Walter K 14. One year later, licensed production of Soviet bombers SB 2 was launched (our designation B 71) powered by Avia Hispano-Suiza 12Y drs engines. In 1937, the Ministry of Defence called for the Institute to participate in the design and testing of new prototypes: Aero A 300 bomber, Avia B 35 fighter, E 51 patrol plane made in ČKD Praga Works, and Letov Š 50 utility plane.

In November 1938, Gen. A. Vicherek of the Ministry of Defence issued a confidential order for selected Institute's employees not to leave the Institute in case the war should start to maintain its staff available for post war tasks. Col. Ing. Dr. Bucháček was called off to be replaced by a new commander Col. Ing. Jaroslav Paulíček on 1 December 1938. At first signs of the oncoming March occupation the Air Force Command gave an order to scratch some of the classified documents.

1. B-534 biplane fighter. Two machine-guns on fuselage, two on lower wing. Front fuselage is covered with removable metal sheets

2. Visit of Czechoslovakia's president Dr. Edvard Beneš (middle). Left: Gen. Ing. Dr. Kolařík, second right: Army General Syrový (defence minister)

On 27 March 1939, just a few days after the occupation had started, all .the activities of the Czech VTLÚ 2nd Div. were suspended. Fortunately, the Letňany Institute was maintained as a whole, because the air transport was still in operation and also due to the fact that some Institute's workers doubled as lecturers at Prague Technical University. This led to the Institute's incorporation in the Ministry of Education. There were also voices from Berlin calling for saving the Institute, as the "Deutsche Versuchsanstalt fuer Luftfahrt Berlin-Adlershof (DVL)" wanted its branch organisation maintained in Prague.

At last in autumn 1939, it was clear that DVL would control from Berlin its Prague branch called "**Flugtechnische Versuchsanstalt Prag (FVA)**". Ing Paulíček remained director but the reins were held by a DVL representative Dr. Barth. The staff remained virtually unchanged, working at three departments as follows:

1) **Aircraft** – aerodynamics, flight mechanics, structural strength, materials
2) **Engines** – testing labs, thermodynamics, fuels
3) **Equipment** – air instruments, electrical engineering, photography, air medicine, air traffic.

The work began to change as a result of the fact that most Czech designers passed over to Junkers Company.

- After finishing calibration of the ∅ 3 m wind tunnel, the aerodynamic department carried out tunnel measurements of scale model aircraft and their parts. Later on, a dynamometer for testing aerodynamic characteristics of propellers was developed, which was in great demand. Research in boundary layers, various airfoil shapes, was done systematically, as well as turbulence flow measurements on the wing with a heated wire probe to determine the transient vortex.

3. Aero A 100 reconnaissance bomber with Avia Vr-36 engine, test floun in 1933 at VTLÚ

4. Yugoslav Air Force Commander gen. Dušan Simovič visited VTLÚ on 18/6/1937

5. Static test of Š-50 plane´s wing. Load applied with lead weights (1938)

6. Š-50 multi-utility plane with new camouflage. Flight tests started in November 1938

- The propeller department built a test lab to check strength of propeller blades, their mounting on a hub and working of transmissions. The blades were made of resin- bonded laminated beech wood.
- From 1941 on, the flight department worked out a method for measuring take off and landing phases, plane performance at stall, carried out flight tests, and dealt with in-flight performance of training planes.
- The materials department conducted strength tests of selected parts of Czech planes for the Rechlin Test Centre. The workers got to know modern hydraulic systems. Ing. Z. Růzha redesigned the device for testing undercarriages so that effects of obstacles on forces during landing could be investigated. A dynamometric device with diamond cutters was used to measure dynamic response at undercarriage drop tests and taxiing.

1. Š-50 in flight

2. Wind tunnel construction in late 30s

3. Ing. Jaroslav Lebduška, CSc., born 8. 9. 1917

4. Ing. Zdeněk Růzha, CSc, born 9. 7. 1906, died 16. 7. 1995

5. Š-328 wind tunnel scale model

6. Propeller test in 1.8 dia wind tunnel. 1.5 m dia propeller was driven by d.c. motor of 150 kW, 6,000 rpm (around 1942)

- The engine test room examined engines of the enemy planes captured on battlefields. An attempt was made to use new brakes for air-cooled engines. However, the connecting shaft vibrated too much at some regimes and the noise of vibrating sheet deafened the operator and so the trials were suspended.
- Workers at the measuring station worked on various research jobs, e.g. heat transfer through a steel sheet during pressure expansion, and also did routine jobs such as adjusting instruments for measurement of angular velocities, etc.
- The air operation department was at first responsible for the air traffic of a few domestic airplanes, on which some parameters were tested. Later, it flew planes serving research on flight mechanics. The department got a few German trainers, and also Do 217 and perhaps FW 190.

In 1942 the Institute passed over under the control of the Ministry of Transportation and Technology but this move brought no organisational or personnel changes.

Institute's professionals learnt how to work with modern equipment such as hydraulic and electrical systems, radio navigation aids, etc. More importantly, they could study DVL's research reports, gaining knowledge to be used later after the war ended. For instance, Ing. Kočka worked out a methodology for verifying flight performances in 1943, a basis for further work in the years to come.
During the Prague Uprising in 1945 three people of the Institute were killed and another three of neighbouring Letov. In honour of their memory a memorial plaque was put up in the presence of air force commander Gen. A. Vicherek.

The post war period witnessed some disputes of competence between the Ministry of Technology and the Ministry of Defence about which ministry should take control of the Institute. The first called it **Letecko-technický zkušební ústav** (Aeronautical Test Institute), the second **Letecký výzkumný ústav, LVÚ,** (Aeronautical Research Institute). The first step towards agreement was the appointment of Col. Ing. Dr. Karel Bucháček as the Institute's chairman at the end of 1945, and Ing. Dr. Václav Smolař as vice chairman, with civilian employees being under the Ministry of Technology. The dispute came to an end on 30 June 1948 when the Institute was subordinated to the MoD with the official title **Aeronautical Research Institute, LVÚ,** (stands for **Letecký výzkumný ústav**). Gen. Vicherek appointed Ing. Dr. V. Smolař chairman and Ing. L. Goessel vice chairman, the latter being a disciplinary authority over soldiers. In 1947, Smolař was appointed professor at the Technical University, Brno, where he moved in 1949. His successor was Ing. Z. Růzha appointed by the MoD whereas Col. Ing. Šiška became his deputy. In 1951, the military influence was strengthened further as the Institute got a military management again, with Gen. František Rypl becoming the commander and Ing. Z. Růzha his deputy. Col. Ing. Abašin of the Soviet Union was installed in office as a counsellor to the Institute's commander.

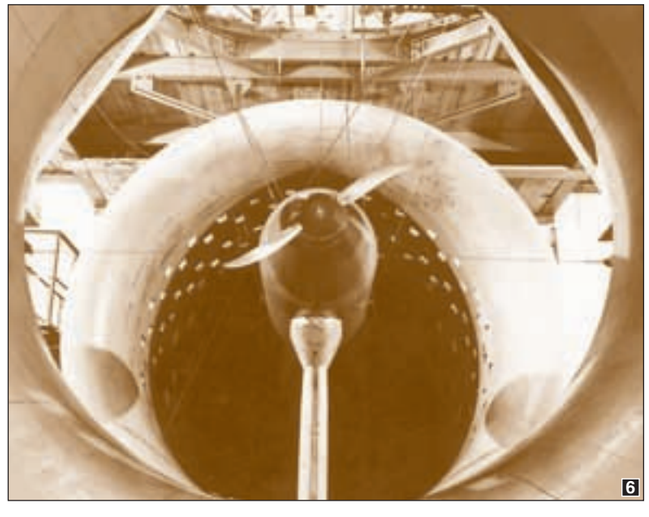
After the liberation, the Institute's activities focused on work on aircraft received following the war, which often lacked documents necessary for military operation. Investigation of accidents was part of the Institute's job too. Some research and tests concerned captured engines Jumo 211, Argus 410 and 411, jet engines Jumo 004 and BMW 003. They were successfully put in operation after a joint effort with Opravny Malešice Works, Závody Jana Švermy Jinonice Works, and Škoda Works.

The aerodynamics department had become the core of the Institute. New work orientation was sought to meet demands from the industry, such as the use of wind energy and prevention of its disastrous effects. Scale models and parts of captured planes were measured including Me 262 wing and Z-26 trainer.

Prof. Ing. Dr. Pešek had an original idea to use a big spherical town gasholder in Prague, which was damaged at the end of the war, as a high-speed wind tunnel. Switzerland had offered a tunnel with a 0.4 by 0.4 m test section designed by Prof. Ackert but it was very expensive and so Ing. Jaroslav Lebduška suggested that Pešek's idea should be put into practice. Design work started in 1947. As there was not enough money to repair the gasholder, prof. Pešek, prof. Smolař and Ing. Lebduška asked the Air Force Commander General A. Vicherek for help. Vicherek met their demand providing the money needed and the construction started in 1949. The tunnel of 0.4 by 0.4 m test section was launched in February 1951 and thus a new **department of high speed aerodynamics** came into being headed and expanded by Ing. J. Lebduška.

After the war, Cpt. Ing. Kočka revised his 1942 work on longitudinal angle manoeuvrability and published it in LVÚ reports. The work contained new physical laws on aircraft roll making it possible to test controllability in flight.

Military pilots who had fought in the West made the flight tests. Maj. Ing. Kočka trained them in carrying out in-flight measurements. The pilots' commander was Maj. Jiří Mrňák, who later became the first Czech pilot to fly a jet. In autumn 1948, all the pilots were sacked. The department of flight mechanics tested some modified German aircraft such as Arado-96 (with LETOV propeller), Me-109s with starting rockets, Siebel-204 flat rated (following several accidents), performance of Me-262 jet in the town of Žatec aeroport, M1-C Sokol and others.



After the war, the strength-of-structure tests were focused on airframes of the military aircraft handed

1. IF-Mk.IX-E Spitfire Spitfire fighter had its wing tested at LVÚ, in March 1948. On 20/1/1950 all of four Institute´s aircraft V-7, V-9, V-12 and V-20 flew over to town of Kunovice. Well known test pilots Jiří Bláha and Antonímn Osvald were behind controls

2. VZLÚ´s managing director František Horák (between 1. 8. 1954 and 30. 3. 1968)

3. Two-geat trainer TOM - 8 designed by Ing. Karel Tomáš

4. VZLÚ team that took part in TOM-8 construction

over to the Czechoslovak Air Force to assess their further potential use. They were Soviet fighters La 5 and La 7, German utility plane Si-204 and others. Other activities covered:

- Landing gears. The tests involved wheels and tyres at taxiing speed up to 110 km/h, drop tests up 5,000 kg of weight. Ing Růzha gave a lecture on this topic at a conference of applied mathematics and mechanics held in London in 1948.
- Eradication of nuns. On the initiative of the ministry of agriculture a spray device was designed and tested in a smoke tunnel. Two different prototypes were built for planes Si-204 and Čáp respectively. After finishing the tests in 1947, ten planes began spraying in 1948.
- Aircraft systems covered hydraulic, pneumatic, fuel systems, fuel tanks resistant topenetration, armoured glass, heating, cabin de-icing etc. When putting captured material into operation, missing parts had to be manufactured, which was hampered by lack of documents and experience. This was the case for instance of a Me-109 where glycol gases escaped from the engine radiator into the cabin, or leaks of fuel from vacuum bonded tanks (they only held fuel for five to ten hours at first).

From 1945 to 1954 LVÚ virtually worked as the representative of the MoD for the developments of new aircraft. Some new labs were built in those years.
Apart from work for MoD, LVÚ broadened collaboration with the aviation industry to launch licensed production of Soviet planes in early 50s. They were IL-10s and MIG-15s, later JAK-11s and IL-14. The Institute conducted mainly strength and flight tests.

In 1953 the low speed and high speed aerodynamics departments detached to become the **Aircraft Research Institute, ÚVL (Ústav pro výzkum letadel)**, a new civilian organisation. At the end of the same year a decision was made to bring the whole Institute under the control of the Ministry of Engineering (Ministerstvo všeobecného strojírenství). The Institute got a new name again, the **Aeronautical Research and Test Institute (Výzkumný a zkušební letecký ústav) VZLÚ**, a title it has held since. Its first managing director was František Horák.

The year 1954 starts a new era of the Institute. VZLÚ took on workers from research and development departments of industrial firms to became a real scientific and technical basis for aircraft manufacturers. This period lasted four years. The main programmes worked upon included the L-60 Brigadýr utility plane, L-40 Meta-Sokol sports plane and HC-2 helicopter. Advanced trainer TOM-8 (no series production) was the first airplane to be built entirely in VZLÚ, from drawings to flight tests. It first took the air in 1956.

The VZLÚ's biggest success is without any doubt the first Czechoslovak jet trainer L-29 Delfín (Dolphin) designed at VZLÚ and powered by a home made engine M-701. Piloted by Rudolf Duchoň, its first prototype took off from the Kbely (a Prague neighbourhood) airport on 5 April 1959. It was powered by a jet engine Bristol Siddeley Viper ASV.8, while an M-701 prototype

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was brake-tested at MOTORLET Works. A flying test bed was designed using a modified jet IL-28: the engine was mounted in place of the rear fire station. The L-29 powered by Czechoslovak engine M-701 made its first flight on 25 July 1960 piloted by Jiří Kunc.

In another development, VZLÚ designed the first all metal two-seat glider L-13 Blaník. Both Blaník and Delfín enjoyed great popularity due to their excellent performance and reliability. Their manufacture was the basic programme of the Czech aviation industry. In all, 3,650 L-39 Dolphins were manufactured in Aero Vodochody and Let Kunovice factories, while M-701 engines made by Motorlet Works totalled 9,250 pieces. Let Kunovice built 2,649 L-13 Blaník gliders. Such big series made major world manufacturers envious.

The TL-29 simulator was another successful product. It was developed as part of pilots' training system. Manufactured in the Letov Works, they totalled more than 100 pieces.

Other major projects included a powerful glider L-21 Spartak (manufactured in the town of Brno), the HC-3 helicopter, tow targets, a system for shortening the MIG 15 take off and landing runs, and lots of minor projects.


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1. HC-2 helicopter was at cutting edge of technology. Pilot Zdeněk Pondělíček made a surprise flying over from Prague to Brussels at EXPO-58. The copter held closed circuit international speed records: Rudolf Duchoň 120 km/h at category up to 500 kg, Zdeněk Pondělíček 114 km/h at category up to 1,000 kg

2. State trial of HC-3A helicopter powered by M-362 radial engine finished in 1965. No batch production

However, the ever-growing complexity of aircraft made VZLÚ incapable of meeting all the requirements coming from manufacturers and developing an airplane as a whole. Therefore in 1960, some of the design offices went over to the manufacturers to form new developmental departments there. In 1961 an Association of Precision Engineering was set up, which changed to AERO Company in 1965. VZLÚs mission partly changed again. It provided AERO with solutions to most sophisticated and demanding technical problems and carried out tests (including certification) needed to secure the quality of batch production.

Worth mentioning are also endurance tests.

- Piston engine endurance trials were made of:
  - M 208B engine on L-60 plane from December 1957 to April 1958 totalling 500 hours
  - M 332 engine on L-410 plane from April 1957 to August 1959 totalling 650 hours inclusive two world long-distance records by Jiří Kunc in two weight categories (4,963 km and 4,756 km, max. flight endurance 27h 45min.).
- Endurance trials of the L-29, batch No 0302.

Endurance reliability trial ran from 1963 till 1967 according to pilots' training programme. 12,000 flights were made in a total time of 2,300 hours. Flight tests were managed by a team of experts from VZLÚ, AERO Vodochody, and Research Centre Prague-Kbely (VZS 031).

Since the mid 60s, VZLÚ had taken part in developing new aircraft, L-39s, L-410s, Z-42s, and Z-43s along with designers from manufacturing companies. New engines, equipment, and systems had been designed for most of those planes. VZLÚ worked mainly on theoretical issues, in-flight and ground measurements, and the development of assemblies. One of the examples is research and design of an ejection seat, the VS1 type, manufactured later on by Moravan Otrokovice Works.

For all the successful versions of the aircraft, VZLÚ carried out complete wind tunnel measurements, major part of aerodynamics calculation, all strength of structure measurements inclusive fatigue tests, and tests aiming at life increase. In fact, measurements of this sort have continued up to now.

In the 60s, VZLÚ was designing successfully a new multi-utility helicopter HC4. However, after a mock-up had been built in 1971, the work was suspended in Czechoslovakia for political reasons to be continued in Poland.

In another developments, VZLÚ participated in developmental work on the AI-25 engine for the L-39 jet trainer. In 1967 the IL-28 flying test bed was redesigned to incorporate the AI-25 double-flow jet engine (electric starter). The tests showed that the ninth compressor stage must be redesigned for the plane to meet all of its requirements. The ZMKB Progress Zaporozhie Comp. in Ukraine did the work quickly and so a new engine, AI-25TL, came into being.L-39 flying prototypes with AI-25 W engines experienced surging when climbing at an altitude of 8 km. Modification of the inlet channels proved no good. In the end, taking special measurements on a flying test bed unveiled the cause and solved the problem. The IL-28 flying test bed

Four seater L-40 Meta Sokol with additional tanks

also tested technical specification of the Safir unit, a French APU made by Microturbo, before buying a license. Based upon the test results, Microturbo had to make some changes to its product.

From the 70s on, there was a growing demand for research work in many scientific branches and disciplines related to aviation that the respective state-controlled enterprises could not do on their own. So, an electronic department grew up at VZLÚ to deal with problems considered by many as fundamental research, e.g. development of electronic elements or integrated circuits. This activity helped solve the shortage of some badly needed components placed under embargo. At that time a checking and diagnostic system KDS 39 was designed, which was later manufactured in Letov Works and delivered to the USSR. Its follow-on, the KDS 40 was also designed at VZLÚ, manufactured in Letov and supplied to the Soviet Union. A measuring station designated CV 100 was designed in the Institute and batch produced by Elektroakustika Bratislava Works. In this connection one could name many other electronic and avionic products developed at VZLÚ and produced by various firms, such as AP 410 autopilot – Palmagneton Kroměříž, limiter of maximum parameters UEČO (central electronic limiting element) for M-601 turboprop – Mesit Uherské Hradiště, semiconductor strain gauges – OPS Zlín, force transducers – ZPA Nová Paka, and others.

The data collection sector had increased dramatically over the past decades. In the early 50s, only simple recording devices were used capable of recording five to ten values maximum. To develop the L-29 and M-701 engine, VZLÚ took delivery of loop oscillographs from the USSR that could register 24 values simultaneously with manual evaluation. Later on, measuring tape recorders were employed in which results were processed by computers. At the same time, the equipment to calibrate measuring chains had to be upgraded. It was possible to record as many as 200 parameters at a time in 1988.

In response to demand from industries, especially from the aviation industry, composites were developed systematically, a special shop with an autoclave being set up to carry out research and tests on these new materials. Here, some minor parts for L-39 and L-59 programmes were designed.

Upgraded from L-60 Brigadýr, L-160 featured one beam wing, largely metallic skin structure and simple struts. No batch production

VZLÚ played an essential part in developing power plants and propellers. The Institute took part in the design of M-601 engines by developing compressors, control systems, calculations and tests, V 508 and V 510 propellers. VZLÚ also carried out flight tests of M-601D + V 508, and M-601E + V 510 power plants on the L-410 plane aiming at enhancing the control of the plane. A number of strain gauges were mounted on the propeller and engine to conduct measurements aimed to increase the time to overhaul. The YAK-40 flying test bed served to in-flight testing of M-601 engine with V 510 propeller and other propeller types including an eight-bladed composite one.
The late 80s and early 90s saw large innovation programmes come in the aviation industry. An upgrade programme for the L-39 was launched in Aero Vodochody (later designation L-59) and the Let Kunovice began to develop the L-610 transport plane (involved in the dramatic adventures of its L-612 four-engined version).

VZLÚ fully engaged in both of these programmes, performing aerodynamic calculations, wind tunnel scale model tests, and many supplementary measurements. In the field of strength of structure, VZLÚ accomplished all static, dynamic, and fatigue tests, modal analysis tests, and tests of subassemblies including research in new materials.

1. Test pilots Ing. Rudolf Duchoň and Ing. Jiří Kunc after finishing reliability operation test of L-29 serial No 0302 lasting 2,300 flight hours.

2. Test of VS-1BRI ejection seat: shot through MIG-15UTI flying lab cockpit hood. Altitude H = 0 m, speed v = 150 km/h (1969)

3. View of VZLÚ, late 60s

VZLÚ participated a great deal in developing the M-602 engine designed to power the L-610, the engine project manager being the Motorlet Works. VZLÚ designed the two-stage radial compressor, developed a new technology to manufacture blades, worked on engine governing systems, and engine test runs. The Institute also took part in developing the V 518 propeller in Avia Letňany Works designed for M-602 engine. Based on the IL-18 plane, VZLÚ built a flying test bed on which the whole power plant, M-602 + V 518, was measured and flight-tested. This flying lab was the most sophisticated and best instrumented flying machine in VZLÚ's history. It was in operation from 1988 to 1992. By using digital technology the information on the power plant could be obtained in real time. Based on this information, the characteristics of the power plant's electronic control system could be changed directly during the flight, which shortened testing times dramatically. New equipment was designed for the L-610 powered by M-602 engine and V 518 propeller designated as version M. The equipment comprised a flight/navigation computerized unit, a computer counting critical flight regimes, a digital autopilot, an accident and operation recorder PARES. Unfortunately, all of these projects were also suspended just before being certified as the L-610 M programme was put on hold.

The situation around the L-59 jet trainer being developed at Aero Vodochody Comp. was much better as this programme was four years ahead of L-610. VZLÚ designed, tested and handed over to production an ejection seat VS-2 for this plane. The seat features leading edge parameters zero zero, enabling the pilot to leave the plane at zero altitude and zero speed. VZLÚ also designed a flight/navigation electronic system PES, which was the most sophisticated project the Institute conducted for the L-59 programme. The system provides for full navigation as well as control of weapon delivery functions, such as firing, bomb dropping, meeting highest requirements. In terms of the variety of jobs the system could do, the PES was on top level, but on the other hand, its robust structure and low reliability failed to measure up to expectations. In working on these problems, our designers faced typical difficulties: western parts were embargoed, Soviet ones were not available either due to the high degree of confidentiality. Despite all trouble, the system was developed, tested and manufactured after all. Another problem was the fact that VZLÚ took on the job of the PES end manufacturer, having to co-ordinate work of roughly ten sub-suppliers. In total 15 sets of the PES system were manufactured that are still in use on L-59s of Czech a Slovak Air Forces. On the L-59s that were exported abroad after the 1989 revolution the PES was replaced by an American system on customer's request. It may be interesting that the American manufacturer used some of our sub-systems in his product and drew over some of our researchers. US firm Flight Visions employed VZLÚ's intellectual property that was not protected properly.

The 1989 "velvet revolution" and the new political and market-oriented economic system affected the aeronautical industry dramatically. In terms of administration, it was restructured giving rise to foundation of a new corporation, the Aero Holding, consisting of several subsidiary companies. VZLÚ became one of them in 1991. Due to the political changes and decay of the Soviet Union, the Czech aviation industry suffered a sudden lost of virtually all of its clients and orders in both civilian and military sectors. Consequently, money shortage led to the termination of some of the programmes e.g. L-610, AE-270, L-420.

HC-4 helicopter model. Its development was handed over to Poland

The Aero Vodochody was relatively quick to manage the new situation by finding alternative markets (Egypt, Thailand, Tunisia), at least for some time. Demand for jobs to be done by VZLÚ decreased a lot and with the absence of State orders, VZLÚ found itself in financial difficulty, too. Its organizational structure had to be streamlined reducing the staff to one third of the original figure. Some departments spun off the Institute to create VZLÚ's subsidiaries, e.g. electronics, avionics, engines. In spite of these draconian measures VZLÚ was on the brink of economic collapse from 1991 to 1994 due to lack of work and insolvency of its customers. It worked on some small programmes for Let Kunoviceand Aero Vodochody firms, but the bulk of money came only from minor jobs.A number of aviation disciplines struggled for survival. The struggle was victorious in the end as the essential professions could keep on working at least to a certain extent.

From 1994 on, VZLÚ got gradually involved in projects part-funded by the State as a result of winning some competition programmes, whatever small in the beginning. It was decided to go on with development of the L-610 plane with a U.S. engine CT-7 and U.S. avionics Collins. A programme to design a new type of jet trainer, the L-159, was launched at Aero Vodochody, again with VZLÚ's participation. VZLÚ has been profitable since 1994, having paid all his debts and settled the bank claims.

In mid-nineties, State orders came to increase to achieve roughly 50 per cent of the VZLÚ budget. This economic structure has remained virtually unchanged to date. The period 1994 to 2002 may be seen as most favourable following the painful transformation. The Institute entered this period with much reduced but still highly qualified staff. Opening the barriers to the western scientific technical space brought not only big chances to creative people but also tough competition in seeking potential partners. To master the new situation with success, it was necessary to modernize facilities, methods, and to change the way of thinking.

At the end of 1996 VZLÚ got official permission by the Ministry of Industry and Trade (MIT) to do international business, including in the military sector, a prerequisite for international co-operation.

The year 1996 saw a breakthrough especially in terms of economics. VZLÚ put in for public tenders regularly and its bids were accepted in many cases, making the State orders go up considerably. Consequently, the VZLÚ finance system approached that of research establishments in the West. Most importantly, VZLÚ participated in a four-year project "Transport Engineering I – Development of Research Basis of Aviation Industry" advertised by the MIT. In addition, VZLÚ acted as project manager of many grants set by the Czech Republic Grant Agency in collaboration with universities and the Academy of Sciences. In 1966, the Institute obtained accreditation to run a scientific and technical park, an engineering institution sharing its facilities and staff, which had just been set up at the VZLÚ site. So VZLÚ qualified to get institutional support due to the presence of innovative, perspective firms placed in its locality. Contacts have been established with national research institutes associated within AEREA, now EREA, and others with the aim of participating in joint research programmes. VZLÚ began to build up the ISO 9000 quality control system. In 1996 the Institute's nine departments received internationally acknowledged certificates issued by the Czech Civil Aviation Authority. However, it was the inland industrial environment, in particular the situation prevailing in the aeronautical industry, that influenced VZLÚ most. Problems around LET Kunovice cleared up in 1996, unfortunately not for long. The factory resumed work; certification of L-610 was in full swing, with VZLÚ participating a great deal.

The development of the L-159 got started at AERO Vodochody, again with large VZLÚ participation.

1. *IL-28 flying lab rebuilt to conduct tests of licensed AI-25 two-flow engine*

2. *IL-14 flying test bed with finite version of power plant hood took the air on 17 March 1970. Picture taken in 1981 shows device for strain gauge measurement of V-508 propeller.*

YAK-40 flying lab with device for strain gauge testing of V-510 propeller

In 1996, for the first time in the past five years, thanks to the State orders and investment amounting to CZK 20,000,000, the Institute was able to have its facilities and labs largely modernized.

The year 1997, which marked VZLÚ 75th anniversary in the presence of many important personalities, was also remarkable from the economic point of view. The Institute had paid off all his debts and liabilities to bankers and commercial creditors, freeing itself from financial stresses jeopardizing its existence.

International co-operation made progress also due to integration into the EU structures and NATO. VZLÚ General Director Milan Holl has become representative of the Czech Republic to NIAG since 1997. VZLÚ had made bilateral contracts with most of the European aeronautical research establishments. The Institute also enjoyed a good reputation within the professional community of the country. It has become the place of business of ALV, the National Association of Aviation Manufacturers of the Cyech Republic. VZLÚ representatives have been appointed to the Grant Agency committees and selection procedure committees for MIT projects. VZLÚ has recommenced to publish, after a few years' break, its own professional journal *Letecký zpravodaj* (Aviation Journal), a follow-on to the previous *Zpravodaj VZLÚ* (VZLÚ Communications).

The Institute continued its innovation policy, with some CZK 28,000,000 invested in hardware and software in1997. Some unique equipment was purchased e.g. a special vibrator, a precision materials analyser, a system for transferring data from rotating parts, CADs and other computational systems.

Two big new projects were launched, Transport Engineering II, and Expansion of Scientific Technical Park. Work continued on Transport Engineering I project launched in 1996.

The stabilisation process continued, with State-sponsored projects amounting to 50 percent of the 1998 turnover. In that year a large set of projects was launched entitled the Aeronautical Research and Test Centre as a result of winning a public tender advertised by MIT. Besides VZLÚ, also Brno technical university took part in the programme. It included projects covering many technical disciplines. Testing of the L-159 got started and tests of a new plane, the Ae 270, were under preparation. Tests of L-610 and Loadmaster planes ordered by LET Kunovice were under way as well. VZLÚ played a major role in the design and testing of a new weapon system PLAMEN (flame) designed for the L-159. In December 1998 VZLÚ finished successfully its two years' effort to build up the ISO 9001 quality management system, with all the divisions being

First flight of M-601/V-508 power plant mounted on IL-14 flying lab on 24 November 1969

issued an appropriate certificate.

In another 1998 development, the Institute acted as the roof organization of ALV, the Czech Republic Association of Aircraft Manufacturers, with VZLÚ general director having been appointed ALV president. ALV has become a significant partner to the Government in international talks on the State's economic policy, in both particular matters and integration into European structures. Active collaboration resumed with the Polish partner research institute ILOT.

VZLÚ stabilization process continued in 1999. Following new legislation forbidding bankers to be members of VZLÚ statutory bodies, the Institute's Board of Directors changed to include the general director and representatives of the industry and trade ministry, education ministry (also responsible for research and development policy), a governmental commissioner for R&D, and a representative of the major shareholder Aero holding. Bankers' representatives only remained in the Supervisory Board.

List of VZLÚ managing directors as from 1954

František HORÁK	1. 8. 1954 – 31. 3. 1968
Ing. Josef SEDLÁČEK	1. 2. 1968 – 30. 6. 1972
Ing. Josef HAVLÍČEK	24. 5. 1972 – 31. 12. 1979
Ing. Josef KURZ	1. 1. 1980 – 30. 9. 1984
Ing. Josef POKORNÝ	1. 10. 1984 – 30. 6. 1990
Ing. Zdeněk PERNICA	1. 6. 1990 – 31. 1. 1992
Ing. Milan HOLL, CSc.	1. 4. 1992

The Institute modernization went on with big investments into its infrastructure and equipment amounting to1.5 million US dollars.

VZLÚ as the leading body of ALV played a major role in assisting this organization to get into AECMA. The effort was crowned with success, so since 1 January 2000 ALV has been the first national association of all post-communist countries to become an AECMA member.

However, VZLÚ in its effort to enter into European aerospace organisations struggled against difficulties stemming from the shareholder structure. It had become apparent that a company in which the State did not have a majority guaranteeing its stability was not acceptable for European partners. Therefore, every effort was made to change the situation and to get rid of the shares of Aero Holding, a major VZLÚ shareholder, which was to go bankrupt anyway. Finally, this endeavour was round off with success at the end of 2000 as the Aero holding shares went to the PAL, a company 100 per cent owned by the Fund of National Property. So with the State possessing 75 per cent of VZLÚ the way to participating in international projects cleared up, particularly in those supported by the EU and NATO.

2000 State-sponsored projects, which represented 40 percent of the turnover, included the ongoing Aeronautical Research and Test Centre programme, tests of L-159 and Ae-270 planes. L-610 tests were completed and the plane was to be certified. Also Loadmaster tests were set to start. Unfortunately, the LET Kunovice went bankrupt and had its programmes cancelled inflicting heavy losses upon VZLÚ.

The Institute home prestige has risen as its general director has been appointed to the Council for Research and Development of the Czech Government. Based on success in a research centres competition advertised by the education ministry, VZLÚ launched a complex programme in 2000 entitled the Aerospace Research Centre. Technical Universities of Prague and Brno also take part in the programme, manifesting a new trend in collaboration between research bodies and universities and creating a Centre of Excellence on the western model. The ARC programme is scheduled to run for five years. One of its projects, the Correlation of Aeronautical and Astronautical Methods, aims to provide support to VZLÚ intention to participate in space research, a promising activity for the years ahead. Deputy general director Bartoň has been appointed a member of the Council for Cooperation with ESA.

Collaboration with the Czech Academy of Sciences has been established to take advantage of the synergic effect of either establishment working together.

In another development, a new lodging house has been built in order to make the Institute an attractive place for young specialists.
The Institute modernization continued in 2000 and 2001 through heavy investment into its infrastructure and facilities, with nearly two million U.S. dollars spent. The expenditure has gone on purchasing or upgrading the following facilities: flowing air drying chamber for the high speed aerodynamics laboratory, numerically controlled loading machine for the strength of structure laboratory, database for acoustic fatigue tests, climatotechnology laboratory, electrical and mechanical test laboratory, NC plasma cutter, and some others.

VZLÚ entered into 2002, the year marking 80 years of its existence, as a stable and prosperous company. Its long experience in aeronautics research and good results achieved so far along with qualified staffs working with cutting edge equipment and enjoying institutionalised governmental support are factors that guarantee the Institute's future and make it a reliable partner for domestic as well as foreign customers.