CHINA'S SAILPLANES AND MOTORGLIDERS–AN OVERVIEW

by Zhang Ruying and Ma Lungzhang, Nanjing, China

Presented at the XXI OSTIV Congress, Wiener-Neustadt, Austria (1989)

1. Early Stage

The first glider in China appeared in 1931, and some more appeared later, but they were all experimental or amateur built. Factory-built sailplanes and primary gliders were produced in small batches after 1939 by two airplane manufacturers and one airplane overhauling plant. The earliest glider factories, three manufacturing and one overhauling, were established in the Sichuan Province, during the anti-aggression period, 1941-1944, and they, and the airplane factories, produced a total of about 170 of which, about 110 were primary gliders (mostly imitating British Dickson, including 6 Zhongda XC-1, designed by Aeronautical Department, Central University), 31 were secondary gliders (imitating German Hutter H-17), and 30 sailplanes (imitating German Rhonsperber, which is called in China after the Dagung Press).

Also designed and built was a big transport glider with seats for two pilots and 13 passengers, by the Aeronautical Research

Institute, from 1943 to 1945. It was test flown in Chengdu being towed by C-47 Transport. It was of wooden construction, including "Layered Bamboo." (See 2.5 below.)

2. Wooden Gliders and Sailplane Manufacture

2.1 Factory

In the early fifties, another three Dicksons and three Rhondsperbers were built by an airplane overhaul factory, and also H-17's and primary gliders were built by amateur groups. Planning for really high volume development was started in 1954, with the help of Polish experts. The plan was comprehensive, aiming to promote the Gliding sport in China, including establishing a new factory. This factory was originally intended to be of a brand new Polish design and to be erected near the National Gliding School. But later, it was decided to adopt existing buildings of an old airplane factory in Shengyang, to a design made by Polish Chief Engineer Kokot in 1956.

The manufacturing personnel were initially trained in 1955 by learning to repair, and at the same time, to build two new primary gliders ABC-ter, under the instruction of Polish experts, in a shop at the National Gliding School. Next year, the shop and force were expanded to be a small factory, building primary and secondary gliders, ABC-ter and Salamandra, again under Polish instruction.

In 1957, the factory moved to Shengyang, and manufacture was started in full swing, with additional types of sailplanes, Mucha-100, Czapla, Bocian, and Jaskolka and new models of launching winches and cable retrievers with domestic engines. The Sailplane Factory of Chinese People (now called Shengyang Sailplane Factory (SSF)) was designed with a capacity of producing 500 gliders and launching devices per year, not only exceeding the entire existing fleet of gliders and sailplanes in Chinese history with the annual production of 1958, but also becoming one of the biggest sailplane factories in the world at that time, supplying all the gliders and equipment required by the newly expanding gliding clubs.

2.2 Designing

In 1957, we started to train sailplane designers under the instruction of Dipl. Ing. Nespal, by designing a 2-seat secondary training glider of improved performance, JIEFANG 1 (Liberation 1). Its prototype were made and tested, and first flown in 1958. See Figure 1.

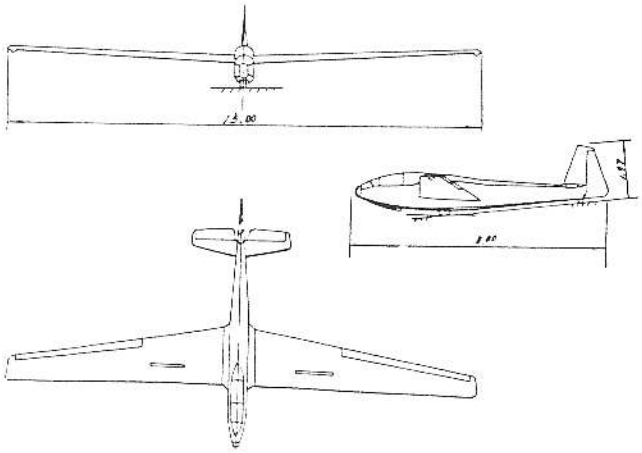

FIGURE 1. JEIFANG 1 (1958)

The second type of glider designed by engineers Li Jijun and Feng Dihuan of SSF is JEIFANG 2, The Tiny Catapult, which is suitable for catapult (bungee) launching from the ground in middle schools. The improved version JIEFANG 2A incorporated chord-extending flaperons, an aerodynamic refinement by Eng. Cai Zhenjiu, which increased the lift tremendously, enabling the glider to rise up to 4-5 meters and glide for about 60 meters, giving the students a proper feel for take off and landing. See Figure 2.

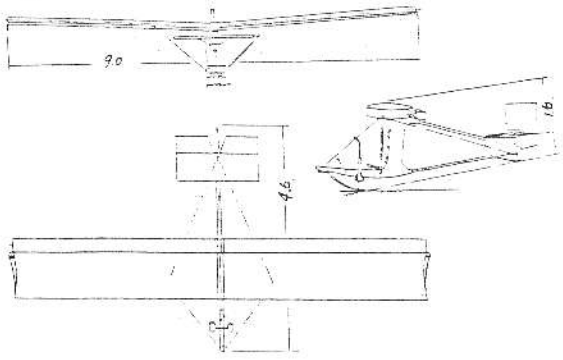

FIGURE 2. JEIFANG 2A (1958-1964)

In 1958, there had been a nation wide enthusiasm on developing new products. SSF were also active and succeeded in finishing the design, static test, prototype construction and first flight of another new model, JEIFANG 3, a two-seat high performance sailplane, within 48 days.

This brought great courage and confidence to the young factory. Its wing is made of "slotted panel" construction with the upper and lower surfaces first made in flat panels on an even platform with many small strips glued onto the plywood surface, the panels and a few ribs and a shallow web being then glued to form a semi-monocoque wing. The merit of this new idea, initiated by Eng. Li Jijun, is a smooth and stiff surface for improved aerodynamic quality, utilizing lower grade wood and thus minimizing the use of high grade wood as in conventional spar construction.

After further test flights and careful refining, the design was approved for production. The J3A was the first aircraft in China to incorporate a "V" tail, a conventional version being developed later. A total of 49 JEIFANG 3A's were built. The year 1963, when the J3A was put into production, made the completion of the

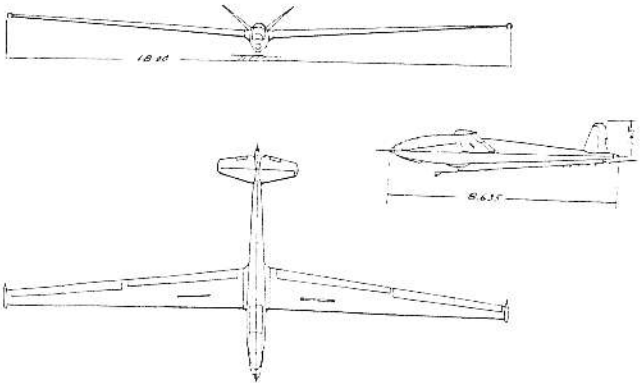

FIGURE 3. JEIFANG 3A (1958-1963)

transition from the learning and imitation stage to the completely independent stage in design and manufacture of the China Sailplane Factory. This transition had taken only 8 1/2 years.See Figure 3.

In 1960, SSF quickly completed the design of a development of the two-seater trainer, JEIFANG 5, headed by Eng. Chen Kuiwen, and put it into production. It was improved to JEIFANG 5A in 1961 and kept in mass production until it became superseded by a later model in 1978, with a total number of 1098 of the two versions being produced.See Figure 4.

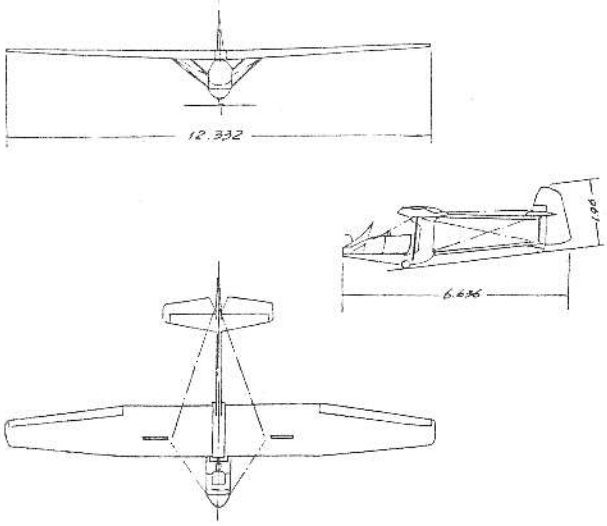

FIGURE 4. JEIFANG 5A (1960-1961-PRODUCTION TO 1978)

JEIFANG 9 designed by Eng. Feng Dihuan, SSF, was first flown in 1977. It utilizes the wings and tail surfaces of the JEIFANG 5 and has a newly designed fuselage with a steel tube and fabric covered front part, an aluminum monocoque rear part, an enclosed tandem cockpit with dual control and basic flying instruments in the front panel for training, and a shock absorbing monowheel. Its best glide ratio is 17. It can be winch launched or aerotowed. More than a hundred have been produced. See Figure 5.

In 1979, at the Fourth National Games, Beijing, there was, among other comprehensive aerial sports, a sensational vertical formation of 5 sailplanes. These sailplanes were the new products QIANJIN (FORWARD), of SSF, with a sing span of 17-

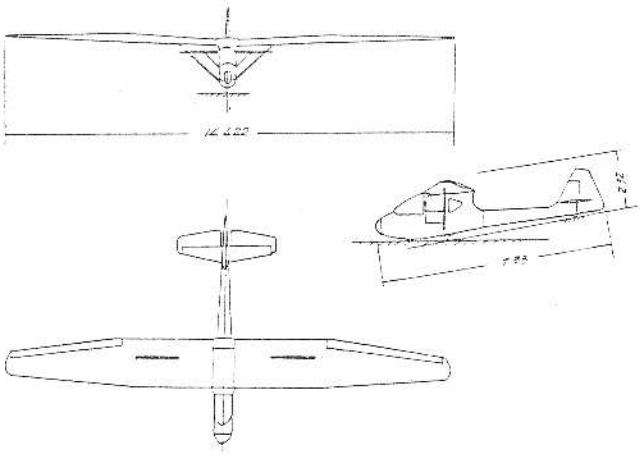

FIGURE 5. JEIFANG 9 (1977-1980)

meters, all wood monocoque construction, single seat, acrobatic, high performance with best glide ratio 26, with full set of flying instruments, no flaps, and fixed landing gear. This type belongs to the Club Class; 55 have been built, and many are used in every National Competition. See Figure 6.

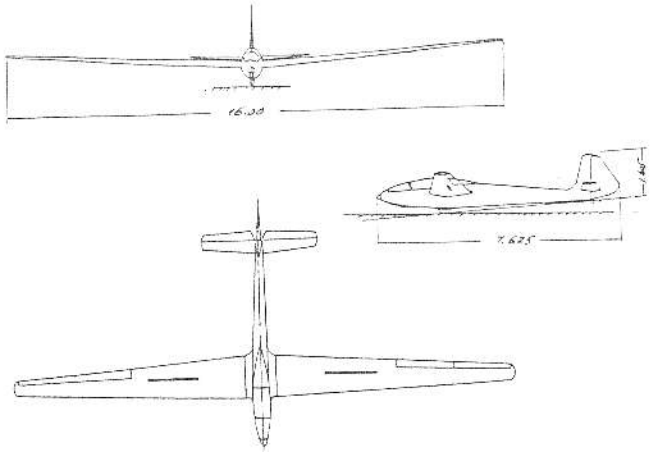

FIGURE 6. QIANJIN (1979)

2.3 Winches

Winches and cable retrievers were also important to the gliding clubs. The basic designs were made by Polish experts with our own refinements and developments through the years. The most popular product was the winch Model 5, capable of launching the 2-seater sailplane Bocian with a cable of 1200 meters, up to a height of 300m, or in a strong wind up to 400m or more. For improved operation at the clubs, SSF had been developing self-mobile glider winches. One was arranged laterally with a single drum and one was transverse with two drums. See Figure 7.

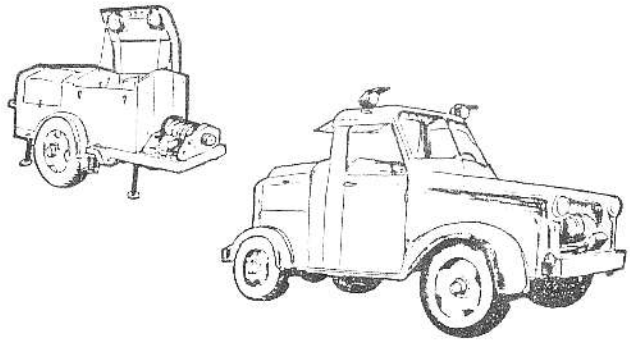

FIGURE 7. WINCH MODEL 5 AND MOBILE WINCH

2.4 SSF Total

Up to the end of 1986, SSF had built or developed 28 basic types, three thousand and one hundred units of sailplanes and launching devices, or which more than two thousand seven hundred were various types of sailplanes. Some types of glider/sailplane, launching devices or manufacturing drawings had been exported to Cuba, Vietnam, Albania and DPR Korea.

2.5 Chinese Aviation Wood

As early as 1945, the Central Aeronautical Research Institute had published a comprehensive report on all the woods they

had investigated and tested in a search for aviation materials. The wood which was mostly used in airplane and glider building at that time, in Sichuan Province, was Yun-shan Spruce (Picea asperata). In 1955, while preparing for manufacturing, we compared the characteristics of all wood in China and found that the Zhang-zi-sung pine (Pinus sylvestris var. mangolica) was closest to that of Polish pine used for glider construction. Zhang-zi-sung comes from the primeval forest in Da-xing-an-ling of Northeast China. Its utilization percentage is very low owing to only the outer portion being suitable, and most of that third grade, only a portion being of the special grade needed for the spars of sailplanes. That was why the "Slotted Panel" was developed.

Later, we preferred more Yun-shan despite the necessity for thousands of kilometers transport. After 30 years experience, recently SSF made an investigation and found that the strength of Yun-shan in actual practice had been 6-10% higher than their factory standard formulated in 1958. The utilization percentage of Yun-shar is high because there is no difference between outer and inner portions, and more higher grade wood is available. According to specimen testing results between 1979 to 1980 from 439 boards of Yun-shan, about 4% were super grade, 19% first grade, and 41% second grade.

In spite of the tedious process for inspecting the wood — cutting a piece of each plank near to the root, making it into a standard specimen, testing with a material testing machine, and finally deciding the grade from the test results, the condition of the whole plane being of a non-homogenious material, is still uncertain. A special tool was designed after a great many test data and inspection experiences of many years had accumulated. It consists of a hand tool with a knife edged narrow blade and a calibrated spring inside. An aviation plane can be graded by taking the mean result for four places checked with the tool in two positions — one is piercing the blade perpendicularly to a depth of 4 cm and reading the force to pierce in kg, and next, pierce the blade at an angle of 70 degrees and pick until the grain breaks noting various conditions of picked grains, color and smell. Of course, training and experience are necessary for using such a tool correctly. This method has been in use since 1959.

We used Chinese casein glue with satisfactory results. In the middle seventies, we investigated batches of gliders being stored or kept in the hangar for a very long time with difference service lives. We made a series of tests with specimens of wood, plywood and glued parts, as well as a static test of one JEIFANG 5A glider. All the tests proved to be safe and enabled a hundred gliders to be flown again. In recent years, we have changed to synthetic glue which suits better the moist condition of Southern China.

As for aviation plywood, Chinese Birch plywood has been available since the early sixties; for important or stressed parts, imported ply from Finland is used. It may be interesting to mention, that in the early forties, though plywood could be made by the Central Glider Factory, the "Layered Bamboo" was developed by the Central Aeronautical Research Institute as a substitute. This was a Chinese invention of that time. It consists of weaving very thin bamboo strips into mats, laying the mats in different directions and then gluing into sheets.

3. Composite Gliders

In the early sixties, when the Fiber Reinforced Plastic material was just coming into use, SSF started research in cooperation with Shanghai FRP Research Institute to use it on glider structures. After testing for several years, the first all-FRP two-seat basic training glider, JEIFANG 7, designed by engineers Shan Dezung and Hung Xinmin, was successfully test flown in 1966 in Shanghai. By that time, a second sailplane manufactory, using SSF technology, was under construction in Chengdu. Later, after a modern FRP shop, with autoclave, good ventilation system, etcetra was built. JEIFANG 7 was put into production. Its fuselage, wings, and tail surfaces were all made of FRP honeycomb, epoxy, sandwich construction. It has tandem open cockpit with wind screen, and is very suitable for operation in the southern part of china. Slightly more than a hundred J7's have been built, and the type is still available. See Figure 8.

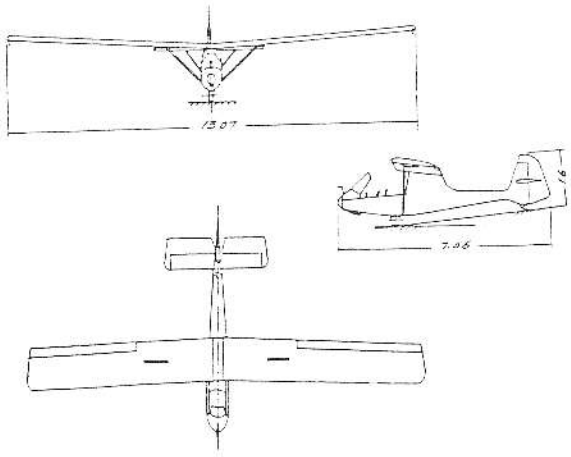

FIGURE 8. JEIFANG 7 (1967-1979)

4. MOTORGLIDERS

4.1 Serial Design Concept — Petrel Series

In designing the PETREL 550, 650 and 650B series, we practiced the "serial development" concept, following lightplane mass producers. All the PETREL wings were of J5 and J9 type, but with differences necessary to accommodate the various loads. The fuselage of 550 had a widened front portion of the J9, the rear portion and the tail surfaces being unchanged. The fuselage of the 650B was a new all-tubular steel construction, yet following the same configuration. The landing gear was initially of the tailwheel type, but later a conventional spring steel tricycle landing gear was developed as an option. A future mixed version of two series is being planned — using the wing of SEAGULL, and adding struts, to fit on the fuselage of PETREL 650B, making a 4-seater utility airplane. We find it advantageous to design new products in series with several usages foreseen; a low priced product offering features required by different users can then be available. See Figure 9.

Another feature of the Chinese motorgliders is the utility aircraft aspect. The aircraft are certified according to the CCAR Part 23, which is close to FAR Part 23, without the "2 persons" and "750 kg ' limits.

PETREL 650's were the first successful aircraft used by a research group who have developed a new system with light weight instrumentation and lightplane combination, suitable for making magnetic detection of low altitude flying over hilly regions, among other things. They have logged 1000 hours of flying time. Another PETREL 650 was converted to aerial photography for a surveying group, which developed a special universal camera platform and has made satisfactory large scale aerial surveying flights (making pictures of 18cm x 18 cm, and later 23 cm x 23 cm).

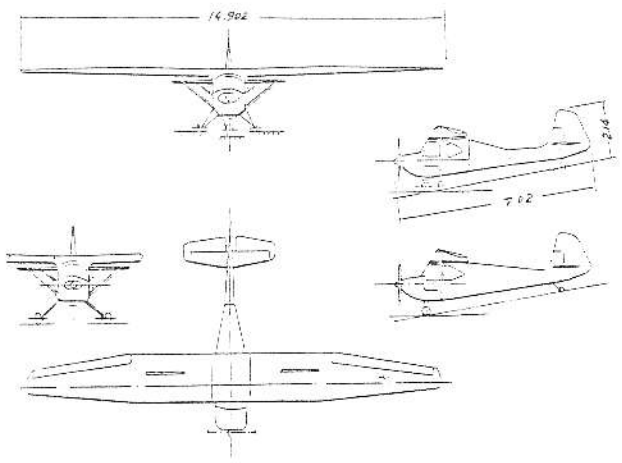

FIGURE 9. DJ9 PETREL SERIES-MODEL 550, 650 650B

In 1988, the PETREL 650B, with new fuselage roomy enough for 4 persons including pilot, or equivalent equipment, and incorporated a wide opening for camera operation, was used by the Education Center for Urban-Rural Surveying, Planning and Management (ECURSPAM) of the Wuhan University of Technology for Surveying and Mapping, China, which has been established with the help of the International Institute of Aerospace Surveys and Earth Science (ITC), Netherlands. This is an educational and technical cooperative project between Chinese and Dutch Governments for training advanced scientists and engineers to meet the urgent need of better utilization of state land, better development of city or town and better environmental protection in China, and other developing countries. The key advantage of this system: small format aerial photograph (SFAP) is to use a low priced lightplane, ordinary Roleiflex camera (6 x 6 cm pictures), operating near to the working area with transportation of airplane by ground, resulting in a cost of only 1/20 to 1/64 of the ordinary aerial photography system. Accurate results of mapping at a scale 1:1000 were obtained in Thailand.

4.2 All Metal Motorglider — SEAGULL

This powered sailplane HU-1, SEAGULL, of SSF, designed by Deputy Chief Engineer Chen Kuiwen and his group, is an all aluminum monocoque, side by side two-seater pusher type, with excellent view in front, cantilever wings with laminar airfoil E603 and a designed best glide ratio of 25 with feathered propeller. The engine being used is the 86.6 KW (116 horse power) Avco Lycoming 0-235-N2A. Its first flight was made January 11, 1988. Up to the end of January, preliminary performance test flights have been completed, with promising results: for instance, the rate of climb with TOW (take off weight) 750 kg. was 5 m/s, and with TOW 900 kg. was 3.9 m/s, from take off to 1000 m. Test flights for spin and maneuvers (e.g. loop, steep turns, etc.) as well as a maximum speed of 240 km/h have been made. The ceiling test reached 4000 m with the HU-1 still climbing at 1 m/s. The outside air temperature was -40 degrees at 4000 m, the estimated ceiling (with oxygen) of 6000 m has to be proved in warmer weather.

The HU-1 is designed for various applications and static tests have shown that the following load factors are met:

- OSTIV or JAR 22	TOW 750 kg.	+ 5.3g, -2.65g
- Utility category, FAR 23	TOW 900 kg.	+ 4.4g
- Normal category, FAR 23	TOW 1050 kg.	+ 3.8g.

That is, HU-1 may not only be used for aerial touring, sport flying and soaring with propeller feathered like a motorglider, it may also be used for certain utility services, such as: low altitude, large scale survey photography, forest patrolling, scientific observations, etc. It is designed for both domestic and U.S. markets. It is particularly suitable for aerial surveying with an opening of 340 x 400 sq. mm for camera, and good for forest patrolling with ultra red detector; its low fuel consumption permits prolonged, broad coverage, and low priced operation. See Figure 10.

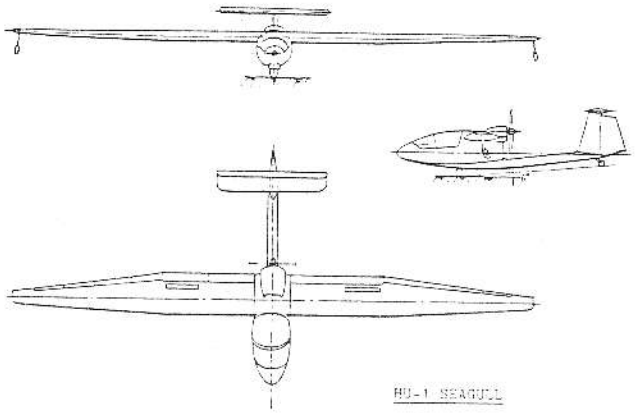

FIGURE 10. HU-1 SEAGULL

4.3 Amateur Built Motorgliders

Just putting an engine onto a proven existing glider is a simple short-cut for amateurs to build powered aircraft. I have also suggested the "serial development" concept to amateur builders and it has proved to be practical. Examples of such aircraft are:

- Fu-shun 2, converted from J5 by modifying the rear fuselage and powering by a 50 hp Rotax 503.

- Hummingbird 1 of Shengyang Aeronautical Sports School, the single seat motorized J9 with a Limbach engine.

-Hummingbird 2, pusher type, 2-seater version of J9, with the cockpit unchanged, tricycle landing gear, powering by a Limbach L2000 engine.

- Powered J7, by Guangzhou Aeronautical Sports School, by simply adding the Cuyuna engine set of an ultralight aircraft.

- Seaplane version of powered J7 is projected.