Fog Begins to Clear in China

By Mike Hirschberg, Executive Director

Two Avicopter Z-19 helicopters conduct aerial maneuvers against a mid-day, smog-veiled sun. (All photos by the author unless otherwise noted.)

The 2nd Asian/Australian Rotorcraft Forum (ARF) was held in Tianjin, China on September 8-11, 2013, sponsored by the ARF International Executive Committee, Nanjing University of Aeronautics and Astronautics (NUAA), Aviation Industry Corporation of China (AVIC) Helicopter, the Chinese Society for Aeronautics and Astronautics (CSAA) and AHS International. The conference was also the 4th International Basic Research Conference on Rotorcraft Technology (IBRCRT) in China, with the last one organized in 2009. The event was held in conjunction with the 2nd China Helicopter Exposition, which took place at the Avicopter plant in Tianjin. An extensive photo gallery can be found on the AHS website through the link at the end of this article.

Tianjin

AVIC Helicopter Co. Ltd (Avicopter) was jointly established in February 2009 by AVIC (a 69% share) and the Tianjin Municipal Government (31%). With the foundation of Avicopter, AVIC consolidated helicopter development and production by AVIC subsidiaries Changhe Aircraft Industries Corporation and Harbin Aircraft Manufacturing Corporation. AVIC itself is a conglomerate of more than a dozen aircraft manufacturing and development companies.

Avicopter moved its headquarters to Tianjin in July to be close to its new production facilities. Once the facilities are completed, AVIC plans to produce all

Avicopter's greenfield headquarters opened in July in the Airport Economic Area of Tianjin.

of the company's civil helicopters at its Tianjin helicopter base.

Tianjin is the fourth largest city in China – after Shanghai, Beijing and Guangzhou (historically known as Canton in the West) – with 13 million inhabitants. Tianjin's old city center, founded around 340 BC, is on the Hai River and was historically a great seaport and gateway to Beijing, which is about 75 miles (120 km) to the northwest. Tianjin Port still ranks fifth in the world in terms of throughput capacity.

Tianjin is also one of four cities – including Beijing, Shanghai and Chongqing – that are directly controlled by the central Chinese government, and has numerous special economic zones that allow experimental use of more free market oriented economic policies and flexible governmental measures. As a result, 60% of Fortune 500 companies have a presence in the city.

The city is undergoing rapid and extensive development with an incredible amount of greenfield construction and the introduction of business and industry near the Tianjin Binhai International Airport. Aerospace is a central part of Tianjin's plans for economic growth. AVIC, Airbus, UTC Aerospace, Thales and many other companies in Tianjin contribute to an annual industrial output of 100B Yuan ($17.5B).

Tianjin is heavily affected by smog from Beijing, with more than 5 million cars and trucks, and coal burning from surrounding regions, as well as dust storms from the north and local construction dust. Recent smog storms near the capital have severely limited visibility and impeded both ground and air traffic, with some cities occasionally seeing visibility as low as 160 ft (50 m) due to dense smog. The central government has pledged 1.7 trillion Yuan ($277B) to reduce atmospheric pollutants by as much as 25% to improve air quality over the next five years. Already, mopeds and scooters in Tianjin and elsewhere are required to be electric. Electric vehicle technology is also an area of Chinese research; Tianjin is the home of the Tianjin Qingyuan Electric Vehicle Co. and the Tianjin Lishen Battery Joint-Stock Co.

Like the smog of the air, the dense fog obscuring China's rotorcraft industry – some due to the complexity of company relationships and multiple names or designations, and some due to government restrictions on the release of information – has also sometimes been impenetrable. Over the past year or so, however, the fog of security has appeared to be lifting somewhat. The recent ARF and China Helicopter Exposition in Tianjin were opportunities for Chinese and foreigners to get a closer look at the state of the art of research and development, production and operations of the vertical flight in China.

Mr. Yi Cai, General Manager of Avicopter, welcomes the ARF attendees to the conference, with the aid of a translator.

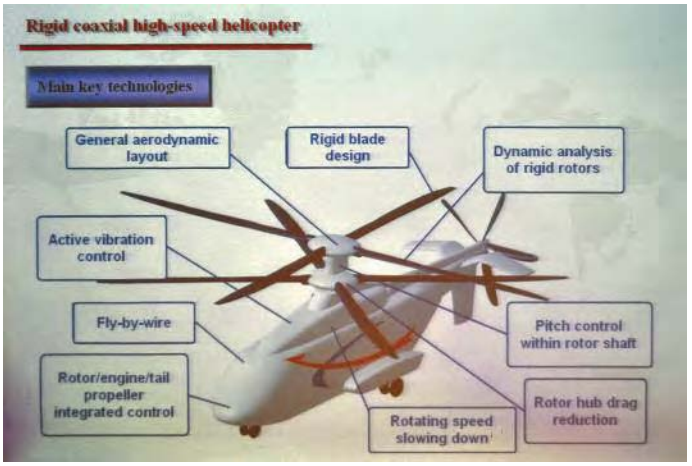
Second ARF is a Great Success

Over 120 participants attended ARF from nine countries: China, France, India, Italy, Japan, Korea, Netherlands, UK and USA attended this conference. Large contingencies from Avicopter, NUAA and other universities in China attended, supplemented by numerous researchers from Japan and Korea. A total of 64 conference papers were published in the conference proceedings (available on the AHS Online Store: **www.vtol.org/store**).

Welcome speeches were given by the Vice President of NUAA, Prof. Yimin Xuan; the General Manager of Avicopter, Mr. Yi Cai; and AHS. Keynote presentations were given by:

- Mr. Mike Hirschberg, Executive Director, AHS International, USA
- Mr. Xi Ming Wu, Chief Engineer of China Helicopter Research and Development Institute (CHRDI), AVIC Helicopter, China
- Professor Edward Smith, Director of the Penn State Vertical Lift Research, The Pennsylvania State University, USA
- Dr. James Wang, Vice President, Research and Technology, AgustaWestland, Italy
- Professor Dewey H. Hodges, Guggenheim School of Aerospace Engineering, Georgia Institute of Technology, USA
- Prof. Inderjit Chopra, Alfred Gessow Professor and Director of the Alfred Gessow Rotorcraft Center, University of Maryland, USA
- Prof. George N. Barakos, Department of Engineering, The University of Liverpool, UK

In his presentation, Mr. Wu presented AVIC's case for high speed tiltrotors or advancing blade concept (ABC) compounds in China, due to the country's vast distances and mountainous terrain (covering more than 50% of China). In fact, during the three day conference, several papers focused on ABC and tiltrotor analysis and testing, and Avicopter's display at China Helicopter Expo featured models of a quad tiltrotor and an ABC/X2-type unmanned rotorcraft, as discussed below. Wu also presented a number of advanced designs for high performance blades, advanced composites, low noise and vibration rotors and of projects that are part of the Chinese Green Helicopter Technology program under the 12th Five-Year Plan (2011-2015). Avicopter hopes to "push forward the helicopter



Mr. Xi Ming Wu, CHRDI Chief Engineer and designer of the Z-10, laid out AVICs plans to leapfrog technology generations of rotorcraft in order to meet China's future needs.

ARF attendees toured the Tianjin production line for AC301, AC311 and AC312 helicopters.

technologies, skipping from the 3rd generation to the 4th [or] even 5th generation" by 2020.

In the evening of September 9th, the conference organizing committee hosted a banquet to welcome the guests, and three awards were made. Dr. Jianhua Zhang from The Pennsylvania State University, USA, was the winner of the Best Paper Award for "Influence of Aeroelastically Tailored Wing Extensions and Winglets on Whirl Flutter Stability." Mr. Jingsong Yang from Nanjing University of Aeronautics and Astronautics, China, won the Best Student Paper Award for "Corotational Formulation for Nonlinear Static and Dynamic Analysis of Thin Shells with Finite Rotation."

In addition, the ARF International Executive Committee presented the second Wang Shicun Award for outstanding people in education, research and development of helicopter technology to Prof. Inderjit Chopra from University of Maryland. Professor Wang Shicun was a helicopter pioneer, educator and an inspirational leader for China's aeronautics and astronautics community. He passed away in June 2011 at the age of 85 (see *Vertiflite*, Jan-Feb 2012).

After the conference, on September 11, attendees were able to tour several very interesting facilities in Tianjin: the Airbus-AVIC A320 operations and final assembly line (the first outside Europe), the Tianjin Textile Museum, the Kingway Brewery and museum, and the spectacular new Avicopter R&D Center and development headquarters, which officially opened in Tianjin on July 27. The new center – of which CHRDI is a component – will lead and unify the expertise and resources for design, development and test. The Center is headed by Qiu Guangrong, who is the Deputy General Manager for Avicopter, under Mr. Cai, the Avicopter General Manager.

Jianhua Zhang (center) and co-author Ed Smith, both of Penn State, received the best paper award from ARF Chair, Prof. Pinqi Xia (left).

The 3rd Asian/Australian Rotorcraft Forum (ARF) will also be the 8th Australian Pacific Vertiflite Technology Conference, which will be held December 18-19, 2014 in Melbourne, Australia and hosted by the AHS Australia Chapter. The timing was specifically chosen to increase the possibility of attendees enjoying the traditional vacation season Down Under. Details will be posted at **www.vtol.org/australia** as they become available.

Growing Demand for Helicopters in China

In 2012, there were just 298 helicopters registered with the Civil Aviation Administration of China (CAAC, which also has offices in Tianjin) – this compares to more than 10,000 privately-owned helicopters in the United States.

In 2010, the central government announced that it would begin opening low-altitude airspace, which it did in January 2012. Airspace below 1,000 m (3300 ft) in northeast, central and south China, as well as above (now) seven pilot cities, was opened. This is planned to be expanded to the entire country by 2015, and eventually all of China is expected to be open to 4,000 m (13,100 ft). Currently, all helicopter flights are highly constrained by air traffic control. For instance, the Avicopter building includes a helipad with an incredible view of the surrounding area. Getting approval to allow the AVIC chairman to use it for the opening of the building this summer took an onerous amount of paperwork.

Estimates for growth in the Chinese civil helicopter market range from 1,000 to 3,000 by 2020 – more than a $2 billion market. Today, however, there are fewer than 40 companies that operate helicopters and a lack of pilots, maintenance facilities and trained support personnel further hamper desires to expand rapidly.

Eurocopter, which has a number of agreements with Avicopter and claims a 40% market share in China, estimates that the country will need about 500 civil helicopters within the next two years. Government and industry officials continue to express concern, however, that airspace is not opened so rapidly that it prevents Avicopter to meet the majority of demand in China. According to one Avicopter official, "If the government announces that low-altitude airspace will be totally opened to civilian aircraft in a short time, a huge market will be created and foreign companies will swarm in, occupying most of the market with their mature marketing skills and products." Thus, the central government is keeping a lid on demand through the airspace restrictions until Avicopter has a great product range and production capacity (as was discussed at Forum 68, see *Vertiflite* July-August 2012).

Expo

The 2nd China Helicopter Exposition (the first was in September 2011) was held at Avicopter's Tianjin production plant, in an as-yet unoccupied 20,000 m^2 (215,000 ft^2) assembly building. The Expo was hosted by the Tianjin government, AVIC and the People's Liberation Army (PLA) General Staff Department of Army and Aviation, and supported by eight different central government agencies.

The event, which ran September 5-8, featured as many as 300 exhibitors from over 30 countries and Chinese regions. More than 8,000 trade visitors and 40,000 members of the public visited the exhibits and static displays, and watched the frequent aerial routines. Over 100 helicopter orders were announced at the show, including sales contracts and letters of intent for 43 Avicopter aircraft on the first day of the Expo.

In addition to an extensive presence by Avicopter, most commercial western manufacturers, including AgustaWestland, Bell, Enstrom, Eurocopter, Guimbal, Marenco Swisshelicopter, Robinson, Russian Helicopters, and Sikorsky also had exhibits, as well as Aerokopter (Ukraine), Rotorway (US) and Cicaré (Argentina). In addition, many large international Tier 1 suppliers were present, such as Eaton, Finmeccanica, Honeywell, Rolls-Royce, Safran, SE Ivchenko-Progress and Thales, to name a few. A small two-seat, two-bladed helicopter built by the Jiangsu Yun River Aircraft Co. (China) was also on static display in the exhibit hall.

As part of the twice-daily flying displays, Bell Helicopter flew impressive demonstrations with its Model 429. China approved an increase in gross weight for the 429 last year to 7,500 lb (3,400 kg), sparking increased interest in the aircraft. Bell's deliveries have also been increasing, with 16 orders signed last November at the Zuhai Airshow (see *Vertiflite*, Jan-Feb 2013). More than 40 Bell helicopters, primarily 206 and 407 singles, are already flying in China.

Sikorsky extended its agreement with AVIC's Changhe Aircraft to be a second source for S-76D cabins, with deliveries to begin in 2016; Aero Vodochody in the Czech Republic is currently the primary fabrication source. Changhe makes tail units for the S-92 and had previously built several S-76C++ cabins. Sikorsky also signed contracts to deliver eight S-76Ds and four S-92s. There was also talk in China about assembling the S-92 in Taijuan, 600 km (370 miles) southwest of Beijing, although Sikorsky declined to comment.

Enstrom, now owned by Chongqing

A Sikorsky S-76D hovers in the smog behind an Argentinian Cicaré CH-7T two-seat agricultural helicopter.

The Red Bull Bell 427 conducted impressive aerial maneuvers during its frequent routines.

The Avicopter Z-19 scout/attack helicopter is a distant derivative of the Dauphin.

The indigenous Z-10 is a 7 ton attack helicopter built by Avicopter subsidiary Changhe Aircraft Industries Corporation.

Helicopter Investment Co., is hoping to capture 30% of the light helicopter market in China by 2020. Final assembly of Enstroms in China is expected in the coming years. As much as $10M of Chongqing investment is doubling capacity at Enstrom's US manufacturing plant in Menominee, Michigan, to 100 aircraft a year, as well as funding the development of new Enstrom models.

At the Expo, AgustaWestland announced that the Sino-US Intercontinental Helicopter Investment Co. had been appointed as an official non-exclusive distributor for AgustaWestland civil helicopters in China. Sino-US also ordered 20 AgustaWestland helicopters. AgustaWestland already has more than 40 helicopters in service or on order in China. The company promoted its AW609 tiltrotor for China saying that it would provide "a unique combination of performance and flexibility to cope with long distance and range requirements."

Meanwhile, the 1,800 shp (1,350 kW) WZ16 engine, being jointly developed by Turbomeca and AVIC's Dongan Company, is expected to make its first run by the end of the year, for certification in 2015. The WZ16 is a derivative of Turbomeca's Ardiden 3 engine and is being developed for the Avicopter AC352/Eurocopter EC175. The engine is predicted to have 15% lower fuel consumption than the current Pratt & Whitney Canada PT6C-67E engines used in the AC352/EC175.

AVIC also unveiled a new Tianjin joint-venture maintenance, repair and overhaul facility for civil and military helicopters, the Tianjin Avi-Jinjian Aircraft MRO Co. Ltd., during the Expo.

Avicopter

China has been developing helicopters for more than a half century, but a decade ago, the country only produced about a dozen helicopters each year. Since the reunification of AVIC five years ago (from AVIC I, AVIC II and the Commercial Aircraft Corporation of China) and the creation of the Avicopter helicopter division, production has expanded rapidly. In 2012, nearly 200 helicopters were built in China, though primarily for the military.

The PLA's Army Aviation force currently includes about 600 helicopters, primarily of foreign origin or derivatives of foreign design. About half of these are Russian Mi-8/Mi-17s, with most of the rest either Z-8 (based on the Eurocopter SA321 Super Frelon) or Z-9 (Eurocopter AS365 Dauphin) helicopters. With its new combat helicopters – the scout/attack Z-19 (a derivative of the Z-9) and the heavier attack Z-10, Avicopter has shown its ability to design and develop advanced technology helicopters.

Twice-daily flight demonstrations were conducted by the PLA "Thunder" aerobatics flight team, which was officially founded the week before and is comprised of Z-9s, Z-10s and Z-19s. The Z-10 and Z-19 combat helicopters were also on static display, though behind rows of barricades and dozens of paramilitary police officers. Although very little information was provided on the military aircraft, the fact that they were on display at all – one of the first times in public – shows that the fog of security is slowly melting away.

Avicopter actually provided ample information and close-up observation of its civil aircraft. The company exhibited a mockup of its AC352 (also known as the Z-15 for the military), as well as a fuselage mock-up of the 13 t (29,000 lb) AC313 transport. Actual aircraft on display in the exhibit hall included the AC301 (based on the Eurocopter AS350 Squirrel), AC311 (AS350B Ecureuil/AStar)

The 13 ton AC313 transport, a derivative of the Eurocopter Super Frelon, hovers in the noonday smog beyond a Z-19.

The AC312 is the license-built Eurocopter AS365 Dauphin.

At the China Helicopter Expo, Avicopter announced its completely new AC3X2 light twin, which is expected to fly by the end of 2014.

and AC312 (AS365 Dauphin). The AC313 conducted flight displays, along with Z-10 and Z-19 helicopters.

The company also had scale display models of every current helicopter type, including the new AC3X2. The Avicopter designations start with "AC3" (the number being a reference to a Tao saying that "Three gives birth to all things"), the next number indicates a technology level, while the third number indicates the number of turbine engines (0 is used for piston engine aircraft).

The AC3X2 is a new design 3 t (6,600 lb) helicopter that AVIC's CHRDI expects to fly by the end of 2014. Work began in December 2012 and certification is expected by the end of 2016. AVIC hopes to gain the US Federal Aviation Administration Part 27 certification within five years and compete on the world market against aircraft such as the AgustaWestland A109 Power and the Bell 429. The AC3X2 will be twin engine and twin pilot with an initial mission take-off weight of 3,100 kg (8,300 lb) and a growth weight of 3,400 kg (9,100 lb). With accommodations for 8-9 passengers and a maximum range of 600 km (325 nm), it is expected to have a useful load of 1,500 kg (3,300 lb) and a payload of 800 kg (1,765 lb).

The piston powered AC310, based on the Sikorsky/Schweizer S-300, was the first Avicopter design to be certified in China, in January 2012. This year, the AC311 and AC313 received CAAC type certificates.

AVIC also announced the 12 seat AC312C ("C" standing as a "challenge" to the global marketplace), a significant departure from the original Dauphin. With aerodynamic shaping changes, skids and a conventional tail rotor, the AC312C is being designed to reduce weight and complexity for lower operational and maintenance costs; initial service time is planned to be at 5,400 hours, with the service life of the rotor blades to be 20,000 hours. The 4-5 ton (8,800 – 11,000 lb) aircraft will have a Western glass cockpit, and an open cabin with a flat floor. The maximum cruise speed is 284 km/h (153 kt) with a range of 685 km (370 km), an endurance of nearly 4 hours, and a payload of 1,590 kg (3,500 lb). A further development is planned for a high altitude version with higher lift rotors and advanced airfoils. Since the AC312 lacks international certification, however, it was seen as unlikely that the –C derivative will be certified outside China.

The announced AC312C is another Avicopter derivative of the Dauphin that is unrecognizable from its progenitor. (Avicopter graphic)

Advanced Concepts

Very little information on Avicopter's current military helicopters was provided at the Expo, and nothing on aircraft in earlier stages of development. Observers, however, believe that the Z-20, a 10 t (22,000 lb) military utility helicopter that has been in development for about 15 years, is nearing flight testing. In addition, China's Army Aviation reportedly remains interested in a 40 t (88,000 lb) heavy lift helicopter.

Avicopter did, however, present some images, information and models of advanced concepts for the first time. An online article also appeared on the CHRDI website a few days beforehand, which provided some details given here.

The Blue Whale is a four-bladed, four rotor quad tiltrotor (QTR) with a 20 t (44,000 lb) payload, a speed of 538 km/h (290 kt), a range of 3,106 km (1,677 nm), a combat radius of 815 km (440 nm), and a ceiling of 8,615 m. Other design features included extensive use of composites, "intelligent" avionics and

Avicopter revealed several new concepts for high-speed rotorcraft at the China Helicopter Expo, including the Blue Whale quad tilt rotor (left) and Jueying (right).

flight controls, and cabin noise on par with an airliner. The aircraft uses four engines that are interconnected for safety. Development is underway. This concept builds on prior three-bladed conventional tiltrotor tests with swept tips revealed in January 2013 and discussed in one of the ARF papers. The Blue Whale is similar to the Bell Boeing QTR announced in 1999 and studied through early 2012.

The Jueying JY-8, also referred to as the K800, is an 800 kg (1,760 lb) unmanned high-speed ABC/X2-type compound helicopter demonstrator. "Jueying" means "Absolute Shadow," referring to its speed and expected stealthiness. First flight of the 5.12 m (16.8 ft) long aircraft is planned for 2015; a subscale demonstrator less than 2 m (6 ft) long has already been flown extensively. The Jueying uses three-bladed coaxial counter-rotating tractor propellers – in addition to the three-bladed rigid coaxial counter-rotating rotors – to achieve its predicted speeds of 450 km/h (245 kt). The aircraft is currently in detailed design. The rotor was stated as being 4 m (13.1 ft) in diameter; the propellers at 1.3 m (4.3 ft), though the model propellers were very undersized. During ARF, a four-bladed ABC rotor concept that was very similar to the Sikorsky X2 configuration was presented by Mr. Wu of CHRDI.

A third new concept, called Feihong, was an unmanned ducted rotor test vehicle. Although the display appeared to be a model, Avicopter indicated that it was an actual vehicle that had been flight tested. The aircraft, about 2 m (6 ft) long, had two coaxial, counter-rotating four-bladed rotors for vertical flight, perhaps driven by electric motors. A very small propeller at the rear appeared to be for forward flight. The outer wing panels also appeared to be removable, most likely for hover testing. The Feihong was developed by Avicopter's Changhe Aircraft in Jingdezhen.

Unmanned Rotorcraft

The 750 kg (1,650 lb) V750 unmanned aerial system (UAS) was also on display. China's largest unmanned helicopter first flew in May 2011 and is expected to receive CAAC approval soon. The aircraft was developed by the Weifang Freesky Aviation Industry Company, AVIC Xi'an Flight Automatic Control Research Institute, and the China Electronics Technology Group Corp (CETC-10) Institute. Freesky says the PLA Navy is interested in using the V750 to carry a small maritime search and surveillance radar. The aircraft has been flight testing

The Feihong is a coaxial ducted rotor aircraft that Avicopter says it has tested extensively. (The AC352 and AC311 can be seen in the background.)

The Freesky-AVIC-CETC V750, derived from the Brantly B-2B, is the largest unmanned rotorcraft to have flown in China.

a number of surveillance-type payloads. The drone is based on the Brantly B-2B. T he company was purchased by and Qingdao Haili Helicopters Manufacturing Co. Production is planned for Qingdao, 400 miles (650 km) southeast of Beijing.

In addition, a number of smaller unmanned AVIC radio-controlled-type helicopters were on display, each about 2 m (6 ft) in overall length. The AF811 is a small agricultural sprayer. The AV-200 was a larger surveillance helicopter. A display model of the AV-500 was also shown, but no scale was given.

Finally, Avicopter is developing an electric helicopter demonstrator, with first flight planned for 2014, using a high-power lithium-ion battery and a low noise rotor. Building on China's electric scooters, motorcycles and cars, AVIC's goal is to achieve energy savings, eliminate emissions and reduce noise. An operational helicopter could perform wire patrol, aerial photography, battlefield detection, attack and many other missions.

Conclusion

Although the government is clearly controlling the flow of information, the fog is slowly lifting from China's helicopter developments. The veritable explosion in Avicopter products, ideas and information over the past few years may indicate that the company feels it is in a race against time to develop models that can adequately fill the Chinese marketplace before a crush of demand hits with the change in civil airspace regulations. In addition, the military's sudden openness about its rotorcraft highlights China's ambitions to be a leading world power and bolsters Avicopter's credentials as a capable development and production enterprise.

Avicopter is preparing to compete for the anticipated thousands of helicopter sales in the coming decade in China, with ambitions to be a competitor in the global marketplace of the future.

A fourship of Avicopter's Z-10 helicopters conducted stunning aerial maneuvers as part of the PLA's Thunder aerobatics flight team.

*Scan this QR code or go to **www.vtol.org/qr/tianjin-2013** for a summary of all AVIC helicopter models and a gallery of more than 60 photos from the China Helicopter Expo and ARF.*