

## **THE AVIATION INDUSTRY CORPORATION OF CHINA (AVIC) AND THE RESEARCH AND DEVELOPMENT PROGRAMME OF THE J-20\***

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### **Abstract**

China's development of a fifth generation fighter (J-20) was deemed inevitable over a decade ago, materializing a qualitative research and development leap forward in its military aviation industry.

This and other technological leaps were much more pronounced in the last decade and were a result of national support programmes to education, research and technology, of indirect technology transfer processes from the European Union, the United States of America, Ukraine, Israel, Brazil, and Russia and, not least important, of reform and reconversion policies of the defence industry, which started in the early nineties and continued in the first decade of the 21<sup>st</sup> century.

The present article analyzes and expresses some considerations and implications over the research, development and production process of the J-20 fighter.

\* This article does not represent the opinion of the National Defence Institute on the topic, and is the sole responsibility of the author.

### **Keywords**

China: defence industry; aviation industry; national defence; J-20

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## THE AVIATION INDUSTRY CORPORATION OF CHINA (AVIC) AND THE RESEARCH AND DEVELOPMENT PROGRAMME OF THE J-20

**Alexandre Carriço**

### Introduction

The official photos released on 11 January 2011 of the “first flight” test of the new stealth fighter JXX (J-20) of the People’s Liberation Army Air Force (PLAAF) triggered a variety of analyses and reactions – some more cautions, others more alarmist, among the various establishments and political and military think tanks, both Asian and North American, on the regional strategic implications of the manufacturing and future operation of the J-20.

The timing of the public announcement and the dissemination of the corresponding pictures were not innocent (as nothing is when it has the official seal of the Zhongnanhai), and a direct correlation was made with the visit to Beijing by US Secretary of Defence Robert Gates, which took place between 9 and 12 January<sup>1</sup>.

In fact, the way the entire process was conducted raises some intriguing questions for those who track and monitor not only the official media, such as Chinese websites, blogs and micro-blogs on generic or defence affairs. Through the systematic crossing of that information, which is often scattered and somehow incongruous, it is possible to discern and delineate potential operating mechanisms with regard to the methodology to disseminate the J-20 “test flight” over the Internet, the first pictures of the prototype doing runway tests beginning to appear on 22 December 2010, 3 weeks before the visit of Robert Gates, and the video made available on the actual day of the flight<sup>2</sup>. In terms of the progress of the 5<sup>th</sup> generation fighters testing programme, this occurred much earlier than what most western experts expected.

Regardless of these developments, which came as a surprise only to the less attentive, the manufacturing of 5<sup>th</sup> generation fighter by China was deemed to be inevitable for over a decade, which was further reinforced by recent declarations, such as those made by Lieutenant-General He Weirong<sup>3</sup>, suggesting a high degree of confidence of the People’s Liberation Army (PLA) on the progress made hitherto in this project.

<sup>1</sup> It is interesting to note that the test flight of the J-20 on 11 January was carried out exactly three years after the first anti-satellite and a year after the first antiballistic missile made by China. According to some Chinese military blogs, China’s future President Xi Jinping (currently Vice-President of the Central Military Commission) and Wu Bangguo (from the Politburo Standing Committee) were in Chengdu on 10 January, but due to bad weather conditions, the test flight was postponed to the following day.

<sup>2</sup> Through website <http://www.56.com>

<sup>3</sup> For example, in November 2009, the Deputy Commander of the People’s Liberation Army Air Force, Lieutenant-General He Weirong, stated in an interview to state television channel CCTV that the forth generation of Chinese fighters (the fifth, in West terms) would soon be entering into the testing phase and could be operational within eight to ten years. (Sweetman, 2011). We understand that being



The remarkable technological leaps undertaken by both the civil<sup>4</sup> and military Chinese aviation industry over the last decade were, to a large extent, the product of national projects supporting the development of education, research and technology (Programme 863<sup>5</sup>, Programme 973<sup>6</sup>, Project 511<sup>7</sup>, and Project 211<sup>8</sup>), in addition to the indirect transfer of technology from Europe (through the purchase of Airbus commercial aircrafts), the US (acquisition of Boeing airplanes), Ukraine (partnership with Antonov), Brazil (planes from Embraer), Israel (the J-10 fighter was developed after the Lavi fighter, which has a lot of North-American technology from the F-16) and Russian (co-production of Su-27 fighters agreements, imports of Su-30 and of Il-76 transport aircrafts) (Tsai, 2003: 158-162), and, not least, the restructuring and conversion of China's defence industry sector (Stratfor, 2011)<sup>9</sup>.

Still, Chinese aeronautical engineers still face huge technological obstacles, particularly in terms of engines, mostly if we consider that most J-10 and J-11 fighters (which are a Chinese version of Su-27 under a co-production licence) are equipped with Lyulka-Saturn AL-31F and AL-31-117S engines, built in Russia.

On the other hand, knowing that *stealth* technology is more difficult to develop in an effective manner, particularly in terms of the heat emissions from engines, which is essential for the non-detection of aircrafts by radar and infra-red sensors, this could become one of the major challenges that engineers from the Chengdu Aircraft Industry Corporation (CAIC) will continue to face.

Despite these difficulties, China's progress in this area has been remarkable, and, together with the Russian model Sukhoi PAK FA or T-50 – which is equally undergoing the testing phase and is expected to become operational between 2015 and 2017, they contribute to China and Russia nurturing the growing pressure of the US industrial complex (through Lockheed Martin, Boeing and Pratt & Whitney) not to buy "merely" F-22 Raptor stealth fighters, but also to strengthen funds for the acquisition of the F-35 (Hartung, 2010).

The present article makes a general analysis of the research process and development of the J-20 fighter, and lists some future challenges on its production.

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*operational means having at least one Regiment equipped with this aircraft and crews who have completed basic training about how to operate it.*

<sup>4</sup> The ARJ21-700, a commercial airplane totally made in China (built by AVIC), is now undergoing the testing stage. Its prototype was shown to the public in November 2010 on the occasion of the Zuhai aeronautical festival and exhibition (Deng, 2011).

<sup>5</sup> This Plan aims to promote the development of new technologies through civilian and military cooperation. It is run by the Ministry of Science and Technology, and comes as the Chinese response to the North-American Strategic Defence Initiative and the EU's Eureka (Feigenbaum, 2003: 160-170).

<sup>6</sup> National Research Programme.

<sup>7</sup> Programme of the Commission of Science, Technology and Industry for National Defence (COCTIDN) for the training and education of researchers for R&D in defence.

<sup>8</sup> Programme of the Ministry of Education aimed at improving the quality of teaching and research in one hundred Chinese universities.

<sup>9</sup> On 24 February 2011, the Chinese Government announced it would invest 227.3 thousand million dollars over the next 5 years in the aviation sector, and that this will include expanding the fleet of commercial aircraft from the current 2600 to 4500 by 2015 (Stratfor, 2011a). On the occasion of the visit of President Dilma Rousseff to Beijing in April 2011, an agreement to buy 35 E190 airplanes from *Embraer* and for the co-production of the Legacy 600 model between *Embraer* and AVIC was made (Stratfor, 2011b).



## Considerations on the Research and Development process of the J-20

The research and development (R&D) process of the J-20 (whose official name has not yet been disclosed) began just over two decades ago (1989) at AVIC, specifically in one of its subsidiaries: Chengdu Aircraft Industry Corporation (Fischer, 2011: 54). In 2001, company documents were analyzing the aerodynamic advantages of the configuration of delta fixed wings projected from the base of the bottom side of the fuselage, and not from the lateral side, as presented by the J-20 (Fischer, 2010).

According to some experts, these documents clearly show the similarities with the ill-fated Soviet design of the MiG 1.42, and it is likely that Russia has provided these plans under the existing bilateral military cooperation, despite the fact that Moscow has initially refused to participate in a joint development programme of the MiG 1.42 (Dzouza, 2011a and Tsai, 2003: 171). If this indeed happened, and in order to reassure the most conservative sectors of the Russian military-industrial complex – which are suspicious of the strengthening of this cooperation and wish to protect the competitiveness and added value of state enterprises such as Sukhoi – we can extrapolate a possible justification for the Kremlin's decision to cede the partial plans of the MiG 1.42, because it had already decided to move forward with the development of the more sophisticated Sukhoi T-50. It is also possible that CAIC has had some engineering support from its state rival Shenyang Aircraft Corporation (SAC), which earlier in the decade was also developing a similar project (J-9) and in 2007, due to political reasons, economies of scale and resource management, may have suspended this programme (called 2-03) and transferred its know-how to CAIC, authorizing the beginning of production of the first prototypes<sup>10</sup>. Indeed, SAC has better accrued experience in the design and building of twin-engine fighters, like the J-11 group, (the Chinese version of Su-27), which produces under Russian licence, although it has had problems with regard to the engines, as we shall see later on.

It is believed that the J-20 prototype, whose images of the "first flight" were widely divulged and shown in the media, is the first of a series of prototypes (two have been confirmed, but there must be a third<sup>11</sup>) to be manufactured, and it is possible that the final version for purposes of production will have some significant changes with regard to this first model<sup>12</sup>. It is not credible that the J-20 is a "technology demonstrator" as some commentators have said, given the operational importance that the entry into service of this type of airplane may have in the consolidation of China's strategy of denying U.S. forces access to the maritime areas and airspace over the first group of islands in the Pacific (Thompson, 2011).

The specific technological and avionic characteristics of the J-20 are unknown, although some general points have been disclosed (s.a., 2011a). The fact that one of the prototypes has two FWS-10 engines (in future possibly replaced by the WS-15 engine or equivalent) suggests that it will have a large range (about 1200 km) and a reasonable capacity to transport bombs and missiles, due to its size, as suggested by a few experts who compared the photos that were published against a tank truck parked

<sup>10</sup> Author's deduction following a conversation with a senior officer of the PLA Air Force during a visit to Shenyang in November 2007. Cf. (Fischer, 2011: 54)

<sup>11</sup> According to the "three moves in a chess game" strategy (*Sanbuqi*), which states that 3 prototypes of each model must be built for each of the three R&D cycles: preliminary research; design development, testing, reviewing and finalizing the design; and initial production (Stokes, 2009: 10).

<sup>12</sup> Unlike other prototypes of Chinese fighters, which are painted yellow, J-20 prototypes are painted green.



on the track (Kahotih, 2011). The design of its fuselage seems to indicate a low profile and an electromagnetic and thermal signature before radars. However, the delta-shaped wings of variable geometry and the presence of small fixed-wings at the cockpit junction (canards) – typical of 4th generation models such as Typhoon, Gripen or the Rafale – make it very similar to the Su-42, which favours performance and manoeuvrability at the expense of stealth- for which reason this model does not seem to be the most suitable for this purpose, in addition to the rear of the aircraft, in the area where the engines are located, which also appears to be little stealthy in terms of design.

Despite the presence of canards, the design of this part of the plane seems to indicate some concern with the acquisition of some tactical advantage in case of air combat beyond the visual horizon or ground attack missions, minimizing its detection by anti-aircraft defences (s.a., 2011b). In addition, the fact that it has two supersonic and steerable side intakes, instead of the more traditional and mechanically more complex intake of variable geometry, shows a clear similarity with the U.S. F-35; if we add the shape of the nose of the plane (including the cockpit) and the internal concealment of the weapons systems in the fuselage (typical of the F-22 design), it becomes absolutely evident that there is a clear intention to reduce the signature of the aircraft in the presence of radars.

As for the weapons and avionic systems, the radars and the engines, a reading of websites and specialist magazines reveal possibilities and versions that are too general, which, nonetheless, deserve a brief mention.

For most experts, the Zuhai air show and CDEX 2010 are a good gauge to assess the development potential of China's aviation and electronics industries in the field of precision missiles, both air-air or air-ground, and the several models exhibited in Zuhai may have a high degree of compatibility with the mission and capacities of the J-20, the same applying to the avionics systems, which have found in the J-10B fighter a good platform for testing and improvement<sup>13</sup>.

With regard to issues involving aerodynamics, the quick and consistent development of China in this area is almost a consensus. For which reason there are no insurmountable obstacles for the J-20. However, there are two areas where such obstacles and difficulties are conspicuous: the one regarding "stealth" composite materials, and engines<sup>14</sup>. Concerning composite materials, it can be said that China is capable of autonomous production of carbon polymers, titanium and other composites which, with modifications, can be used in 5th generation fighters, in part thanks to the commercial partnerships with Airbus and Boeing<sup>15</sup>.

<sup>13</sup> In 2006 a model of the J-20 cockpit was exhibited in Zuhai (Fischer, 2011: 54).

<sup>14</sup> For Richard Aboulafia, an analyst at the *US Teal Group*, there are at least eleven support systems that are essential to operate a fighter plane, of which we shall refer to only seven: good mission planning, high level of preparedness and professionalism of pilots, high level of technical training of the maintenance personnel on the ground, sophisticated weapons systems, advanced electronic and radar systems strengthened by a good command and control system and a reliable system for refuelling during the flight. This author argues that China is only proficient in one: the manufacturing of the frame of the plane, not including the engines. This author is completely mistaken. (Aboulafia, 2011).

<sup>15</sup> The plan to set up COMAC was approved in February 2007 by the National People's Congress, which delegated the start of operations of the company by the end of 2008 to a preparatory committee led by COCTIDN (Cliff *et al*, 2011).



This process started in the nineties by establishing assembly lines of McDonnell Douglas commercial aircraft in Shanghai and through the subsequent technology transfer in exchange for the acquisition of tens of planes from both Boeing and Airbus to strengthen Chinese airlines (Gill e Kim, 1995: 88-89).

Currently, there are a few joint-ventures between AVIC, General Electric and Good Rich to manufacture parts for the new C-919 commercial airplane. The O Harbin Industrial Aviation Group (HIAG) is a supplier of composite materials to the A350 plane of Airbus<sup>16</sup>. AVIC has a partnership with Hexcel and Boeing with respect to the production of the same materials, enhanced by the acquisition of the Austrian composite materials company Fischer Advanced Composite Components in December 2009.

The Shanghai Aircraft Industrial Corporation (SAIC) is responsible for the manufacturing of the entire fuselage in aluminium and lithium for planes of the Bombardier C series, as well as for supplying parts to CESSNA and Boeing. Baoji and Hong Yuan are two of the largest producers of titanium, providing 95% of the needs of the Chinese aviation industry (Andersen, 2008).

Additionally, and given the expansion of the Chinese commercial aviation, the China Commercial Aircraft Company (COMAC) was set up in May 2008, based in Shanghai, with the purpose of competing with Boeing and Airbus on the international market from 2020. It results from a partnership between the State-owned Assets Supervision and Administration Commission of the State Council, the municipality of Shanghai – via the Guosheng Business Group – the Baosteel Group, Aluminum Corporation, Sinochem, and AVIC (Liu, 2008: 16-18).

The latter will inject 1.52 billion dollars by 2015 and will be responsible for the manufacture of engines for the various models – through the Shanghai Aircraft Manufacturing Factory and the Shanghai branch of the First Aircraft Institute – the first of which will be aircraft to be used in regional routes not exceeding 1800 km (ARJ-21) and later for long haul flights commercial aircraft (C-919), in addition to the manufacture of civilian transport helicopters (Perrett, 2010).

The projects of these two planes will add value to the Chinese aviation as they will be the first to force the industry to manage a sophisticated international network of over fifteen suppliers of parts and components. The importance attached to this company is immediately shown in the fact that its chairman and vice-chairman, Zhang Qingmei and Jia Zhuanglong, respectively, were the former director, and deputy director of COCTIDN, and that He Dongfeng (another director) was the manager of Factory 211 of the China Academy of Launch Technology and of the space industry based in Sichuan.

These appointments illustrate the fact that the research and building programme of a long haul commercial airplane has been defined as one of the sixteen priorities listed in the Medium/Long Term (2006-2020) National Programme for Scientific and Technological Development, coupled by the fact that COMAC is under the direct purview of the State Council.

These recent developments and agreements signed by the Chinese government in the context of commercial aviation will certainly lead to a new upgrade in the technological

<sup>16</sup> By 2016 China will have bought 300 Airbus A320 aircraft which will be fully assembled in the country. The European consortium has established a new joint-venture to produce composite materials for A350XWB in Harbin (Lu, 2007).



spin off that the Chinese aviation industry may achieve, as some of this industry has military applications, particularly with regard to the J-20<sup>17</sup>.

Finally, with regard to the development of propulsion engines, the majority of experts agree that there are problems related to the manufacturing technology of high performance engines, which, despite considerable improvement, still remains the "Achilles' heel" of the Chinese aviation industry.

The video<sup>18</sup> analysis and the several photos of the J-20 test flight clearly indicate that it took off from a shorter distance than the J-10 planes that use the same track, without needing to resort to afterburners, exposing the upgrading of the FWS-10 engines. Eventually the FWS-10G version generates a power similar to that produced by the AL-31 engines manufactured in Russia and which may also have been assembled on the second prototype of the J-20<sup>19</sup>.

It is understandable that the PLA did not want to risk a test flight of its flagship projects – and divulge it publically – without having a reliable engine basis, even with the loss of stealth (in this case most likely FWS-10), as the reliability problems in the engines can only be discovered after they have been installed on planes and flight tested for many hours. Accordingly, it might be interesting to follow the successive charges of the various J-20 prototypes that will be produced, particularly with regard to the engines that will power them: WS-10G, WS-15 or 117S (Russian built and which the CAIC purchased in small numbers in 2007).

In this context, it is interesting to note that the second flight of the J-20 on 17 April 2011 (which coincided with the 60th anniversary of the creation of the Chinese aviation industry) took place in the same military airport in Chengdu, lasted 85 minutes and was part of a series of initial tests designed to gauge the plane in terms of stability, manoeuvrability and performance.

The photos available show that the engines of this model are identical to those used in the first flight in January, which may indicate that either it is the same prototype that flew in January, or that the two prototypes have the same engines, as stated earlier.

However, it seems that China does not wish to depend on other countries in regard to the supply of components for the 5<sup>th</sup> generation of fighters. Considering the recent Russian allegations about the technology reversal concerning the J-11 and J-15, which led to a reduction in the purchase of Su-30MK, it is believed that the Kremlin will no longer authorize the sale of sophisticated engines such as the 117S/Al-41 – which runs on the Su T-50 (s.a., 2011c).

Thus, this is a difficult path, but not necessarily a slow one, until Chinese manufacturers attain the production quality of General Electric, Pratt & Whitney or Rolls Royce, and it may be interesting to see which company will be assigned the production

<sup>17</sup> During his visit to France in November 2010 and to the U.S. in January 2011, Hu Jintao signed agreements for the Chinese commercial aviation sector that totalled 30.4 and 45 billion dollars, respectively (Wang, 2011).

<sup>18</sup> Available at <http://www.educatedearth.net/video.php?id=4518> [18 January 2011].

<sup>19</sup> It should be noted that J-10 and J-11 fighters still depend on Russian built AL-31F engines. The new J-11B which have recently started to be used in two Regiments (one from the Navy and another from the Air Force) are equipped with the new FWS-10<sup>a</sup> engines built by Shenyang Liming (or factory 606), which is known among its Chinese counterparts by the huge technical problems it has faced in the manufacture of engines, both due to quality control reasons and to poor management of projects, which have suffered systematic delays.



of the J-20 engines. At this point there are two likely possibilities: either Shenyang Aeroengine Research Institute (not to be mistaken with the Shenyang Liming) or Xi'an Aeroengine PLC (also known as Factory 410). If the choice falls on the first option, we may be facing a decision based on technical criteria associated with industrial and technical capacity to improve the current engine, as the Institute may benefit from the know-how acquired to transfer it to other engine projects under development, such as the QC-280, WS-10G and WS-10-118.

Choosing the second option may be based on the reliability criteria of Factory 410, which has been mass-producing reliable WS-9 engines for the JH-7 fighter and is responsible for supplying half of the components of the WS-10 engine, bypasses for engines of the Y-20 heavy transport plane, and for the construction of the WS-15 engine (the strongest candidate to equip the J-20), which should soon be ready to be mass-produced. The recent announcement that Factory 410 signed a joint-venture with Nexcelle (of General Electric) to produce the passenger commercial airplane COMAC C-919 may be another asset for the company to improve its project management and quality control mechanisms (s.a., 2011d).

However, one may pose the question why the government does not close down Liming and transfer the entire production to Xi'an Aeroengine PLC or any other manufacturer, for the benefit of deepening the consolidation process of the aviation sector, given that in 2007 the Guizhou Honglin Factory of CAIC acquired the plans of the WS-10 engine and started to build a more "muscle" version. One possible explanation could be the intention to foster competition internally, where other manufacturers with the standard of Liming, such as Guizhou Liyang or Chengfa Group, also co-exist (Factory 420). Another has to do with the negative socio-economic impact that this would bring to the city of Shenyang (the pivot of the Chinese rust belt) and which was quite affected by unemployment in the nineties due to the restructuring of the national steel sector. Only a deeper analysis of the real technical capacities of the potential of both – which goes beyond the scope of this article – will allow a glimpse of possible justifications for continuing, for the time being, this decision of the Council of State.

Within the conglomerate that AVIC is, the J-20 project appears to have catapulted the Chengdu Aircraft Industry Corporation and its Institute 611 to a position of supremacy over the Shenyang Aircraft Corporation and Institute 601, which was coming into position when CAIC won over SAC in the tender for the development and production of the J-10 fighter, as well as the export contracts of the J-7 and the JF-17 (with SAC keeping just the development and production of variants of the J-8, which always had technical problems in the radar subsystems and missiles that only recently have been resolved)<sup>20</sup>.

These projects – most notably the J-10 one – were like an "Apollo Programme" for the Chinese aviation industry, throwing a new and entire generation of engineers (currently just over thirty years of age)<sup>21</sup> into the complexity of the processes of research, development and production of military aircraft, which will be China's R&D backbone over the next two decades.

<sup>20</sup> It is estimated that each J-10 costs 27.8 million dollars compared to the 18.8 million that F-16 C/D costs. As for the J-20, its costs range from 100 to 120 million versus the cost of 143 million of the F-22 and the 11.1 of the F-35A, and 100 million less than the Su T-50 (Dsouza, 2011b).

<sup>21</sup> Conversation held in Beijing between the author and a Senior Officer of the PLA Air Force in October 2007.

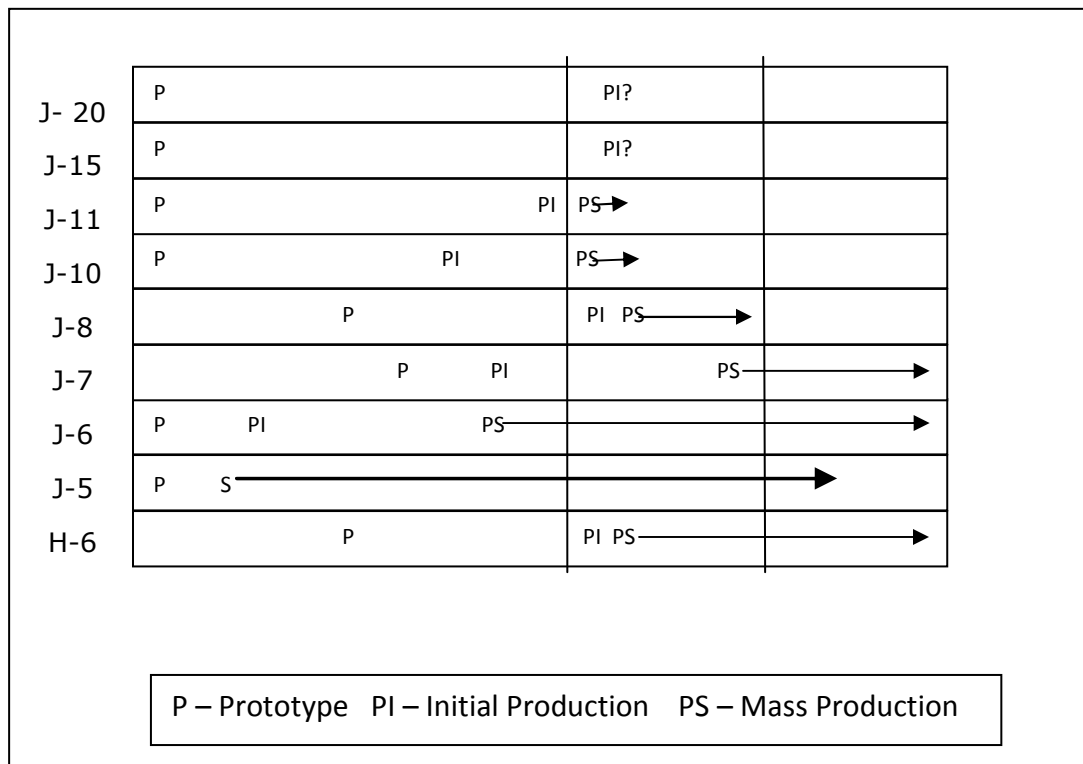




This accrued experience will be valuable and much more enhanced as these engineers become more mature and gain know-how to solve problems connected to this type of projects. In this light, and for CAIC, the best is yet to come.

However, it is fair to highlight that SAC<sup>22</sup> made a very commendable effort to produce Su-27 from plans supplied by Russia, and in a short time managed to start the production of J-11B and J-11Bs fighters, which caused some surprise among the Russian partners and accusations of technology reversal<sup>23</sup>. In fact, the J-11B has had huge problems in terms of the WS-10A engines manufactured by Shenyang Liming, and there are technical indications that suggest that the production of a larger number of J-11B only began in 2011.

Figure 1 – Research, Development and Production Cycle of Aircraft for the AF of the PLA



However, this may be a future asset, since SAC has been developing and testing the J-15<sup>24</sup> prototype, and its experience in the production of high quality titanium and

<sup>22</sup> Founded in 1951, it was pioneer in the manufacture of Chinese combat aircraft and supported the creation of other companies, such as CAIC. Its great blemish is the lack of innovative capacity, often attested by the tendency to resort to copy-paste or technology reversal.

<sup>23</sup> This technology reversal had previously been carried out with the MiG-21 and applied on the J-7. In fact, we believe that what must be highlighted is the short learning curve that SAC engineers showed in assimilating the design and manufacture of the structural elements of aluminium and titanium aircrafts (You, 1999: 159).

<sup>24</sup> Also known as J-18, it is modelled on the Su-33 and most likely will become operational in 2015 and is allocated to the Varyag aircraft carrier, which is in the final stages of refurbishment in Dalian. At the end of April, it was reported that this model underwent flight testing from an air base in Inner Mongolia (s.a., 2011e).



aluminium alloys used on the J-11 have been, are, and will be essential for the J-20 project.

Still, the disclosure of the J-20 flight has caused some misgivings about the Chinese indigenous capacity to develop this prototype in a relatively short time without resorting to external technical assistance, bearing in mind the references of previous models (Figure 1)<sup>25</sup>.

In fact, some rumours started to circulate, most of which referring to the strong possibility that Beijing had acquired plans and technology by means of industrial and military espionage, but minimizing the fact that the United States have a lot of sensitive and important technological information available through open sources, allowing China to direct its spying activities on to very specific targets (Gorma *et al*, 2011). Suspicion falls on the composite materials used in the fuselage, whose research and development may have been facilitated through the acquisition of parts of the F-117 – namely fuselage with inherent analysis of the coverage and painting technique employed, thermal stealth and engine radiation technology, and analysis of the navigation systems (Fischer, 2010: 35) – brought down by the Serbs in 1999 on the occasion of NATO's campaign and aerial bombing of Kosovo, during which the Chinese Embassy in Belgrade was accidentally bombed. Given the close relations and cooperation between Serbia, China and Russia, it is very likely that many parts of the F-117 were taken to Beijing and to Moscow (Gertz, 2011).

The benefits stemming from the cooperation with Israel regarding the Lavi and the J-10 fighters (Israeli and Chinese designations, respectively) should also not be overlooked, as both fighters are very much based on the F-16 technology, which, even if it did not influence the development of the J-20, may have generated synergies in terms of indigenous know-how.

Finally, the increasingly publicized examples of Chinese cyber-espionage, including the alleged obtaining, by Chinese hackers, of over three terabytes of unclassified information from the U.S. Department of Defence containing information on stealth technology, and the episode ten years ago when they also entered the internal network of a North American military centre located in California specializing in research and development of stealth technology – ironically called China Lake – may also have provided much vital information for the design of the J-20<sup>26</sup>.

## Final considerations

The new methodology adopted by Beijing as part of the restructuring and modernization of its defence industry and, in particular, its aviation, is based on the careful selection of projects considered as priorities, allocating them almost unlimited funds through the Weapons and Equipment Research Fund, the Defence Transversal

<sup>25</sup> For example, the first F-22 prototype appeared in 1991 (after fifteen years of studies), with the first aircraft being operational in 2003. Estimates on the F-35 point to a decade between the first prototype and the first entry into service, which is understandable, given the fact that it is a vertical take-off stealth fighter.

<sup>26</sup> See the annual reports of the U.S. Defense Security Service entitled *Technology Collection Trends in the U.S. Defense Industry* available at <http://www.dss.smil.mil>. The reports of this Pentagon agency responsible for investigating espionage on U.S., although not referring to the countries that carry out such activities, group them into regions, with China being part of the Northeast Asia region, where the number of detected espionage activities is higher, which implies the preponderance of China.



Technologies Fund (both from DGA), the Innovation Fund of the China Aerospace Corporation and from Programmes 863 and 973 (Stokes, 2009: 11).

However, as the country becomes more prosperous and attains a more sophisticated

Industrial and technological capacity, it is highly likely that this strategy will be changed and become more widespread as to its objectives. The military sectors of the electronic, aviation, shipbuilding and space industries currently lead the innovation processes, benefitting from a close cooperation with counterparts in the civil sector, the result of a top-down integration process that started in the late nineties and deepened since 2003.

The available data and the organizational and technological advances made in the last decade and the multiple indicators for measuring technological developments – such as budgets for R&D, private investment, number of registered patents, scientific publications, commercial products, quality of human resources, leadership, organizational flexibility and corporate management – allow us at present to infer the continuation of rapid progress in these sectors of the defence industry over the next decade<sup>27</sup>.

In the more inclusive sector of the aviation industry, these developments enabled China to make a qualitative leap in the context of R&D and in the production of fighter and transport planes, as attested by the J-10, J-11 and, more recently, the J-15 and J-20 prototypes. In the latter case, and however impressive this native evolution may have been, the extremely likely fact that China may have had access to parts of the F-117 shot down in 1999 and to partial plans to manufacture 5th generation fighters from the United States by means of cyber-intrusion, which facilitated and shortened the R&D process of AVIC, must be emphasized.

Also, the agreements for the co-production of the Su-27 planes were an important milestone, as they enabled SAC and, indirectly, CAIC to improve their internal systems for project management and quality. At the same time, it launched a generation of young aeronautical engineers on to crash projects almost requiring on the job training, and whose accrued experience was reflected on the J-10 and will be demonstrated over the next decades in more sophisticated projects, such as the J-15 and J-20.

If we add the priority given to this type of high profile projects in terms of funding, it is very likely that the J-20 will enter service of the PLA AF before 2018 – the year advanced by most experts – which will make a more psychological rather than truly strategic impact at regional level<sup>28</sup>.

However, this may require that countries like Russia and the United States, to start with, followed by India<sup>29</sup>, Japan, and South Korea, to rethink, respectively, both the construction plans and the purchase of 5th generation combat planes such as Su T-50 (or PAK-FA) and F-22, in a new but now “more stealthy” phase of the current regional race to sophisticated weapons, a move that Europe is completely out of (Bitzinger, 2011), and which is not expected to be involved in, despite the liturgy and political

<sup>27</sup> Funds for R &D have increased an average of 25.5% per year since 2006. In 2009, it invested 89.9 billion compared to the 46 billion spent in 2006. At a meeting that brought together more than 300 research institutes of the PLA in April 2011, the R&D priority areas for the 12th Five Year Plan (2011-2015) were approved, where the J-20 is undoubtedly included (Luo, 2011).

<sup>28</sup> For an excellent analysis of this potential strategic impact see Kopp, 2011.

<sup>29</sup> In September 2010, India signed with Russia a memorandum of understanding for the joint development and production of 250 5<sup>th</sup> generation PAK-FA fighters, with initial costs for each of the parties of around 6 thousand million dollars (Shukla, 2010).



rhetoric associated with the discourse of the European Union as a global actor in security and defence in terms of hard security in the Asian region.

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