= Sukhoi Su @-@ 37 =

The Sukhoi Su @-@ 37 (NATO reporting name : Flanker @-@ F) is an experimental single @-@ seat , supermaneuverable multirole jet fighter , designed by Sukhoi . A further development of the original Su @-@ 27 " Flanker " , it was modified from the first @-@ generation Su @-@ 35 (formerly " T10M ") prototypes . The Su @-@ 37 features an upgraded avionic suite and fire @-@ control system , but its most notable additions are the thrust vectoring nozzles . Only two prototypes were converted .

During the Su @-@ 35 flight test programme , active controls during dogfighting maneuvers could not be attained ; thus Sukhoi explored the application of thrust @-@ vectoring nozzles to give fighters better dogfighting attributes . The first Su @-@ 37 , converted from the eleventh Su @-@ 35 , made its maiden flight in April 1996 at Zhukovsky . It was joined by a second prototype in 1998 . Throughout the program , the Su @-@ 37 publicly demonstrated its attributes at numerous air shows , performing maneuvers impossible to complete with normal flight control methods , among which was a 360 ° somersault . Despite its potential advantages , the Su @-@ 37 did not enter production ; it has instead remained as a technology demonstrator for updated Su @-@ 27 family aircraft such as the export Su @-@ 30 and the modernized Su @-@ 35 .

= = Design and development = =

The earliest records on thrust vectoring technology research within Sukhoi began in 1983 . The design bureau studied two @-@ dimensional (2D) vector nozzle , which was believed by the West to be the best way of controlling thrust . Sukhoi modified an Su @-@ 27UB @-@ PS twin @-@ seater with a 2D nozzle to verify the feasibility of this kind of nozzle . However , the design bureau 's General Designer , Mikhail Simonov , believed asymmetrical nozzles (3D) to be more suitable . At the request of Sukhoi , experiments on both types of nozzles were carried out by the Siberian Aeronautical Research Institute (SibNIA) .

Meanwhile , Sukhoi was busy with the T10M (later renamed Su @-@ 35 in 1993) program , which was a comprehensive upgrade over the Su @-@ 27 . The T10M would incorporate aerodynamic modifications , improved avionics and armament , and have a better propulsion system , designed to give it greatly enhanced agility . The first Su @-@ 27M prototype (T @-@ 10S @-@ 70) made its maiden flight on 28 June 1988 . Changes from the Su @-@ 27 include canards , upgraded engines , new radar , and a digital fly @-@ by @-@ wire flight @-@ control system . Later Su @-@ 35 prototypes featured glass cockpits and modified vertical stabilizers . The Su @-@ 35 's construction made significant use of composites , including aluminium @-@ lithium (Al @-@ Li) alloy . The aircraft , like the Su @-@ 27 , could perform the previously unattainable " Pugachev 's Cobra " and tailslide , but during these low @-@ speed maneuvers , active controls could not be achieved because the flight control surfaces were ineffective .

In 1995 , the eleventh T10M prototype , T10M @-@ 11 , was delivered to Sukhoi 's experimental workshop to be outfitted with exclusive systems . Built by KnAAPO , its structure has increased carbon @-@ fibre and Al @-@ Li content . Installed was the 2D thrust @-@ vectoring Lyulka AL @-@ 31FP , an interim measure pending the availability of the AL @-@ 37FU (Forsazh Upravleniye , " afterburner @-@ controlled ") . The 3D thrust @-@ vectoring Lyulka AL @-@ 37FU was still in development . The Al @-@ 31FP , in fact , is a hybrid version combining the Al @-@ 31F and the vectoring nozzle of the Al @-@ 37FU . Being fitted with a 2D vector nozzle , the Al @-@ 31FP is only variable in pitch , plus or minus 15 ° . The engine not only incorporates a new @-@ generation 2D TVC nozzle but also is resistant to engine surge even during inverted and flat spins , giving better reliability and maneuverability even when the angle of attack is 180 ° .

The fire @-@ control system was also improved . An upgraded N @-@ 011M BARS Passive electronically scanned array radar was fitted . It can capable of tracking 15 aerial targets and guiding four air @-@ to @-@ air missiles . In the aircraft 's tail sting is an N @-@ 012 rearward facing radar , which has a 120 ° view horizontally and in elevation . The Su @-@ 37 also features an upgraded electronic warfare support measures package . It can carry air @-@ to @-@ air and air @-@ to

@-@ surface weapons on 12 hardpoints . The vast range of weapons , of which the Su @-@ 37 can carry 8 @,@ 000 kg (17 @,@ 600 lb) , is supplemented by the 150 @-@ round 30 mm GSh @-@ 301 cannon .

Instead of traditional analogue instruments , the cockpit has four T @-@ form Sextan Avionique (Thales) LCD multi @-@ function displays (MFD) . These display air data / navigation , systems status , weapons / systems selection and tactical situation information . The pilot , who is provided with a head @-@ up display (HUD) , sits on the K @-@ 36DM ejection seat inclined 30 ° to help counter the effects of high g @-@ forces . The pilot steers with a side @-@ stick and pressure @-@ sensing throttles . The two @-@ grip flying control configuration was designed to prevent the pilot from losing contact with the controls when the aircraft is engaged in fast vectored @-@ thrust maneuvers . Both the fixed throttle and the side @-@ stick controller provide secure points for the pilot to brace his hands .

Painted in a disruptive sand and brown scheme , the aircraft was given the code 711 Blue , later changed to 711 White . Its maiden flight occurred at Zhukovsky on 2 April 1996 , with Yevgeni Frolov at the controls . The nozzle was locked fully aft throughout the flight , and it was not until the sixth flight that tests on the thrust @-@ vector nozzles commenced . Frolov was joined by Igor Votintsev , and for the next twelve days , the two had amassed twelve flights between them .

= = Operational history = =

The 711 Blue was demonstrated to the press at Zhukovsky in spring 1996 , by which time it was re @-@ designated Su @-@ 37 . Its debut to the general public came in September that year at the Farnborough Airshow , piloted by Sukhoi test pilot Yevgeni Frolov . A big talking point of the show was its performance of the " Super Cobra " , when the aircraft pitched up to 180 ° , literally flying tail first , albeit for only a few seconds ; this maneuver evolved into the 360 ° " Frolov Chakra " somersault . The following year , the aircraft arrived on the fifth and last day of the Paris Air Show to perform five aerial displays , the fourth of which was marred by a minor incident when the emergency undercarriage extension handle was moved , preventing gear retraction . It appeared at that year 's Moscow International Aviation and Space Show and Dubai International Defence Exhibition , as well as the 1998 FIDAE air show in Chile ; for the latter two the Su @-@ 37 appeared under the enigmatic designation , " Su @-@ 37MR " .

In 1998 , there was a report about a second Su @-@ 37 (T10M @-@ 12) which was similarly converted before making its first flight on 23 March the same year . But this aircraft , No.712 , was never converted to the Su @-@ 37 specifications ; it was used in Aktubinsk for weapon and radar tests . Later , the No.712 (with the No.703 and all three serial produced planes , bort No. 86 , 87 , and 88) added to the Russkie Vityazi demo team , repainted . Flight tests and demonstrations at air shows continued until 2000 . In 2001 , 711 was outfitted with AL @-@ 37FU engines and updated fly @-@ by @-@ wire flight control system and avionics . In December 2002 , 711 crashed during a ferry flight , effectively bringing an end to the program ; the fault was later traced to structurally damaged right horizontal stabilizer , caused by the extensive load during high g post @-@ stall tight turns . The Su @-@ 37 did not reach the production stage , although by mid @-@ 2000 , Sukhoi introduced several modernizations of the Su @-@ 27 , such as Su @-@ 30MKI and second generation Su @-@ 35 , which feature similar improvements such as improved avionics and radar systems , and thrust vectoring engines .

= = Specifications (Su @-@ 37) = =

Data from Sukhoi Su @-@ 27 Flanker : Air Superiority Fighter , Sukhoi Su @-@ 27 Flanker
General characteristics
Crew : 1
Length : 21 @.@ 935 m (72 ft 9 in)
Wingspan : 14 @.@ 698 m (48 ft 3 in)
Height : 5 @.@ 932 m (21 ft 1 in)

Wing area : 62 @.@ 0 m ² (667 ft ²)
Empty weight : 18 @,@ 500 kg (40 @,@ 790 lb)
Max. takeoff weight : 35 @,@ 000 kg (77 @,@ 160 lb)
Powerplant : 2 × Lyulka AL @-@ 37FU afterburning turbofans with 3D thrust vectoring nozzles
Dry thrust : 7 @,@ 600 kgf (74 @.@ 5 kN , 16 @,@ 750 lbf) each
Thrust with afterburner : 145 kN (32 @,@ 000 lbf) each
Performance
Maximum speed : Mach 2 @.@ 35
Range : 3 @,@ 300 km (1 @,@ 833 nmi)
Service ceiling : 18 @,@ 000 m (59 @,@ 055 ft)
Maximum g @-@ loading : + 10 / ? 3 g
Armament
Guns : 1 × 30 mm GSh @-@ 301 internal cannon with 150 rounds
Hardpoints : 12 hardpoints , consisting of 2 wingtip rails , and 10 wing and fuselage stations with a capacity of 8 @,@ 000 kg (17 @,@ 630 lb) of ordnance , and provisions to carry combinations of :
Rockets : S @-@ 25L laser @-@ guided rocket
S @-@ 25 unguided rocket
B @-@ 8 unguided S @-@ 8 rocket pods
B @-@ 13 unguided S @-@ 13 rocket pods
Missiles : Vympel R @-@ 27R / ER / T / ET
Vympel R @-@ 77 ? the proposed R @-@ 77M , R @-@ 77T , K @-@ 77M
Vympel R @-@ 73E / M , and R @-@ 74M
Vympel R @-@ 37M 200 km
Kh @-@ 29T / L
Kh @-@ 31P / A
Kh @-@ 59ME
Bombs : FAB @-@ 250 250 @-@ kilogram (550 lb) unguided bombs
FAB @-@ 500 500 @-@ kilogram (1 @,@ 100 lb) unguided bombs
KAB @-@ 500L laser @-@ guided bomb
KAB @-@ 1500 laser @-@ guided bomb
Other : buddy refueling pod
Avionics
OLS @-@ 35 infra @-@ red search and track system
N @-@ 011M BARS Passive electronically scanned array
T @-@ form Sextan Avionique (Thales) LCD multi @-@ function displays (MFD)