The reality behind the assumptions: Modelling and simulation support for the SAAF

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Military Aerospace Trends & Strategy
Military aerospace trends

- National security includes other dimensions: social, economic development, environmental, energy security, etc.
- Military budgets constrained
- Changing nature of the threat, asymmetric, non-conventional, innovative, etc.
- Proliferation and availability of technology, information, skills and experience
- Defence Review: official strategy to respond to global, continental and regional military threat
Complexity in modern aerial warfare

From this

http://www.aviationartprints.com/wip_the_final_curtain.php

http://rchangar.hu/wp-content/gallery/sopwith-camel/
Complexity in modern aerial warfare

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1. Pilot head
2. Vertical generating strakes
3. Glass-fibre-reinforced plastic (GFRP) radome
4. Radar scanner
5. Scanner mounting and tracking mechanism
6. Radar mounting bulkhead
7. AGF antenna
8. Access hatchets, port and starboard
9. PS-45 multi-mode pulse-Doppler radar equipment
10. Cockpit front pressure bulkhead
11. Yan valve
12. Lower UHF antenna
13. Incidence vanes
14. Low-voltage electronic luminescence forming lighting strips
15. Rudders pedals, triple-digital flight control system
16. Instrument panel, triple head-down CRT displays
17. Instrument panel shroud
18. Single-piece glassless windscreen panel
19. Wide-angle head-up display (HUD)
20. Cockpit canopy, hinged to port
21. Canopy breaker miniature detecting cord (MDC)
22. Starboard air intake
23. Martin-Baker SJ15LS zero-zero ejection seat
24. Cockpit sleeping rear pressure bulkhead
25. Siding engine throttle lever
26. Port-side console panel
27. Cockpit section structural composite skin panel
28. Noosehead door with integral taxing light
29. Retraction actuator
30. Twin-wheel nose undercarriage, aft retracting
31. Hydraulic steering jacks
32. Cannon nozzle
33. George blast suppressor
34. Port air intake
35. Boundary layer splitter plate
36. Air conditioning system heat exchanger intake duct
37. Avionics equipment compartment, access via noselook bay
38. Retractable telescopic flight refueling probe
39. Cockpit rear avionics shelf
40. Starboard canard foreplane
41. GPS antenna
42.5 Foreplane side, port and starboard
43. Heat exchanger and exhaust ducts
44. Environmental control system equipment for cooling, pressurization and equipment cooling
45. Self-sealing fuel tank between intake ducts
46. Canard foreplane hydraulic actuator
47. Refueling probe hinged door
48. Foreplane hinge mounting transom
49. Port intake ducting
50. Cannon barrel
51. Temperature probe
52. Port navigation light
53. Centerline external fuel tank
54. Ammunition loading door
55. Ground test and diagnostic panels
56. Formation lighting strips
57. Port canopy foreplane, carbon-fibre composite structure (CFCS)
58. Ammunition magazine
59. Center fuselage machined aluminum alloy frame structure
60. Aluminum alloy skin paneling
61. VHF antenna
62. UGCAH antenna
63. Dorsal spine tailing housing bleed-air ducting and calibrator
64. Center fuselage integral fuel tank
65. Port hydraulic system, dual system
66. Wing attachment fuselage main frames
67. Engine compressor intake
68. APU antenna
69. Wing attachment CFC cover panel
70. Starboard wing integral fuel tank
71. Fuel system piping
72. Starboard wing missile carriage
73. Missile launch rails
74. Leading edge dry touch
75. Starboard leading edge two-segment manoeuvring flap
76. Combined wing tip DWD tip and missile launch rail
77. Wing tip missile carriage
78. Rear position light, port and starboard
79. Starboard fuselage fairing
80. Inboard elevon
81. Oversizing elevon actuator housing
82. Blood air spill duct
83. Formation lighting strips
84. Automatic control system equipment
85. Rudder steering joints
86. Rudder hydraulic actuator
87. CFC skin paneling with honeycomb substrate
88. Flight control system dynamic pressure sensor
89. Rudder warning antenna
90. EW equipment housing
91. Fire extinguisher paneling
92. UHF antenna
93. Strobe light anti-collision beacon
94. CFC rudder with honeycomb substrate
95. Variable area afterburner nozzle
96. Nozzle control actuator (3)
97. Port air intake panel, open
98. Airbrake hydraulic jack
99. Afterburner ducting
100. Viper AAM IRF2 (General Electric F404-400 afterburning turbofan engine
101. Auxiliary power unit (APU)
102. Vertical airframe-mounted accessory equipment gearbox
103. Titanium wing root attachment fittings
104. Port wing integral fuel tank
105. Multi-wing wing panel primary structure
106. Inboard elevon hydraulic actuator
107. Port inboard elevon
108. Elevon CFC skin paneling with honeycomb substrate
109. Port outboard elevon
110. Rear quadrant radar warning antenna
111. Rb 4AAM-9, Sidewinder close-range air-to-air missile
112. Wing tip missile Launch rail
113. Port forward quadrant radar warning antenna
114. Leading edge manoeuvring flap outboard
115. Leading edge manoeuvring flap inboard
116. Outboard wing leading edge
117. Outboard wing pylons
118. Port manuhold
119. Leading edge manoeuvring flap, inboard segment
120. Leading edge flap powered hinge actuator
121. Pylons mounting hardpoint
122. Landing light
123. Main undercarriage leg strut
124. Hydraulic retraction jack
125. Leading edge flap operating torque shaft from central drive motor
126. Mainwheel leg-chassis strut
127. Fixed inboard landing gear segment
128. Mainwheel door, closed after cycling of undercarriage
129. Wing inboard ‘wet’ stores pylons
130. SANAB 100 anti-ship missile
131. Mauser K27, 27mm cannon
132. Recce reconnaissance pod
133. GBU-28 Paveway II,2000lb laser guided bomb
134. AIM-9G Maverick air-to-surface missile
135. Rafael Spice guided bomb
136. MBDA Meteor advanced beyond visual range (BVR) air-to-air missile
137. BGL IRST advanced close-range air-to-air missile
138. AISL Antenna

http://xbradtc.com/2013/12/19/cutaway-thursday-saab-gripen/
DEFENCE SCIENCE, ENGINEERING & TECHNOLOGY CAPABILITY – GUIDELINE

49. Science, Engineering and Technology (SET) will be one of the major power bases of the future South African State. As a developing nation, South Africa is currently fortunate to have a strong SET capability in some areas which can be used as a future force multiplier for the Defence Force.

50. A growing percentage of relevant defence technologies are developed in the commercial domain, resulting in defence forces becomingly increasingly reliant on the use of commercial technologies. An agile SANDF will need to exploit technology opportunities through:

- rapid technology acquisition,
- use of civil technologies and infrastructure, and rapid adaption and creation of new doctrine and tactics, as well as their implementation.
51. Further thereto, fewer single nations are able to design, develop and produce new weapon systems due to the rise in complexity and cost to do so. Current trends indicate that there will be increasing multi-national collaboration to develop new weapon systems. This requires the concerted development of a strong Defence Science, Engineering and Technology (DSET) capability to become a

- smart-buyer of weapon systems,
- to effectively participate in international collaborative efforts and
- have the required depth of know-how to support and upgrade technologies.

52. Having a strong DSET will further allow the Defence Force to leverage the capabilities of the national SET spectrum to meet future defence demands.
Modelling and simulation
Simulating the fight

- Mathematical representation of reality
- Appropriate level of fidelity for task at hand
- Battlespace level simulation with multiple interacting entities
- Unpredictable emergent behaviour
- Tactics, doctrine evaluation and development
- Training
- Acquisition
- Operations planning
- Innovation
Simulating the fight

- Critical to account for security sensitive engineering data
- Understanding the drivers of a mission outcome
- Thousands of missions faster than real-time at a fraction of the cost
- Design the mission or platform for success
- Canvas for collaboration, experiments, analysis, understanding and innovation
Simulating the fight

Screen shot from IMAX production: Operation Red Flag
Nellis Air Combat Training System
Simulating the fight

Screen shot from IMAX production: Operation Red Flag
Nellis Air Combat Training System
Simulating the fight

“In-house” developed Mission Simulation Framework
Simulating the fight

“In-house” developed Mission Simulation Framework
Unmanned systems

- Autonomous flight a reality
- Significant platform advances
- Ongoing payload advancements
- Thousands of COTS systems
- Reduced Cost and improved access in some classes
- Increased cost, complexity and restricted access in other classes
- SA developing unmanned systems for decades and has operated a UAV squadron previously
Unmanned systems

- Understanding the entire problem
- Identify Friend or Foe
- Can you see and confirm the nature of the threat
- Required system functions and performance
- Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR)
- Acquisition
- Bringing into service and integration into operations for mission effectiveness
Unmanned systems

- Concept of Operations including C4ISR
- Sensor Performance
- Data Management and Data Fusion
- Damage tolerance for hostile environment
- Endurance and mass (including power)
- Time and distance
Thank you