

4 Aircraft Configurations

Aircraft can be categorized by several aspects. One way is to divide into:

- homebuilt
- single engine propeller driven airplane
- twin engine propeller driven airplane
- agricultural airplane
- business jet
- regional turboprop
- jet transport
- supersonic civil transport, SCT
- seaplane

In addition there are several categories of military aircraft.

4.1 Three-View Drawings of Conventional Aircraft Configurations

Three-view drawings are the most important medium to communicate within aircraft design. In the following, some examples of three-view drawings of conventional aircraft configurations are shown as an animation for own design ideas.

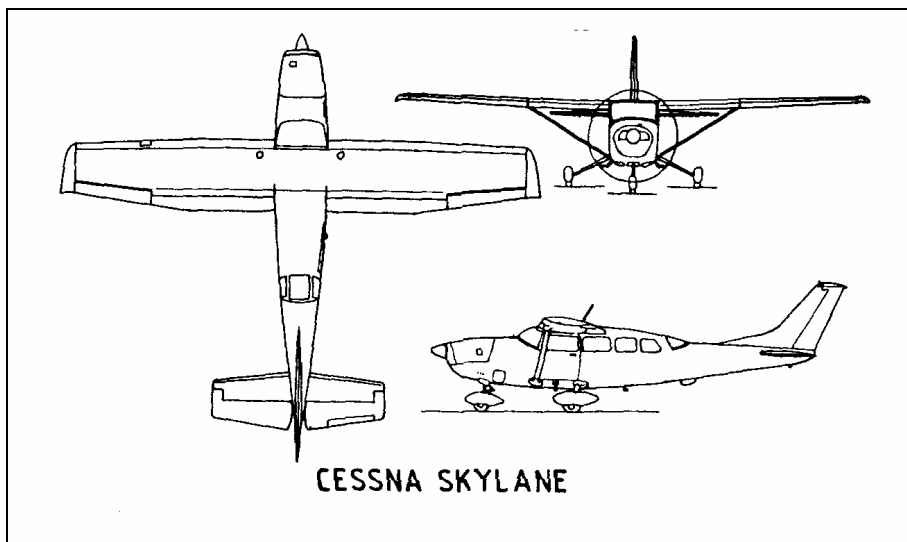


Fig 4.1

Single engine piston
prop.

Cessna 182S Skylane:

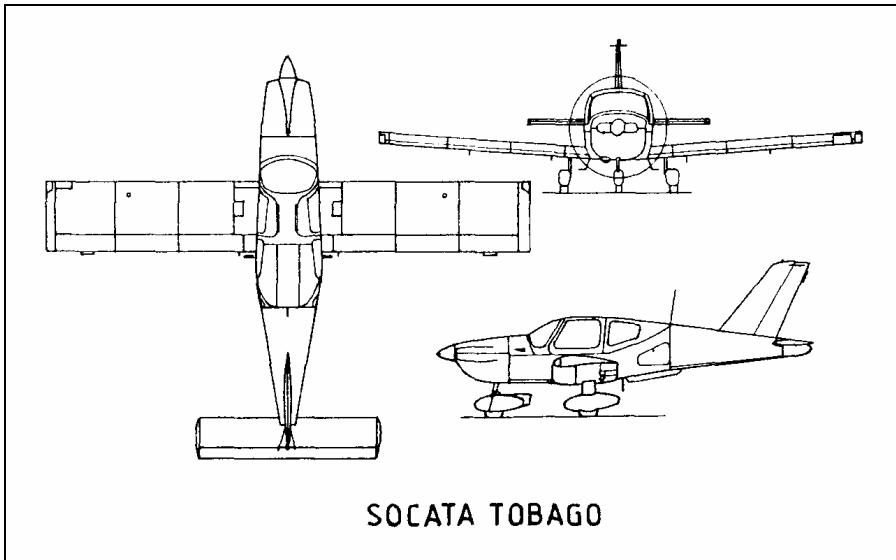
Pax: 4,

V_{CR} : 140 kt,

R : 820 NM,

MTOW: 1.4 t.

(Roskam II)

**Fig 4.2**

Single engine piston prop.

Aerospatale, Socata
TB 10 Tobago:

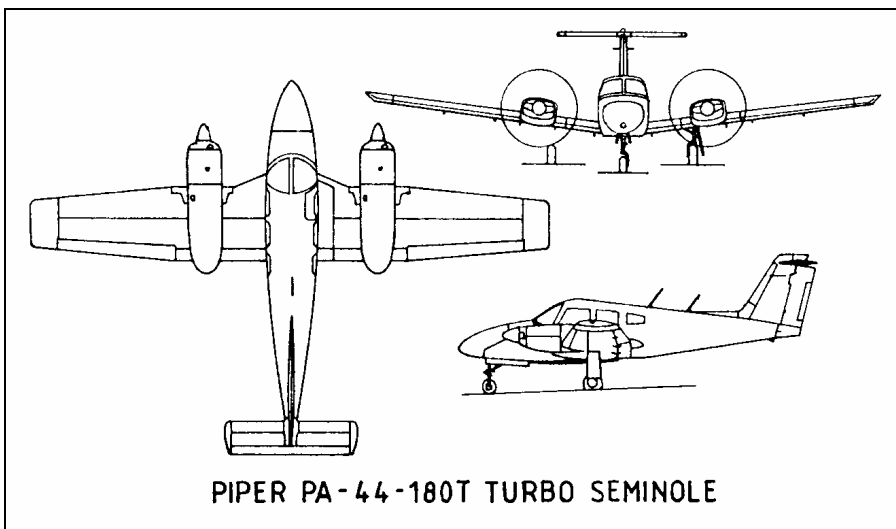
Pax: 4,

v_{CR} : 127 kt,

R : 688 NM,

MTOW: 1.1 t.

(Roskam II)

**Fig 4.3**

Twin engine piston prop. Piper Seminole

- PA - 44 - 180:

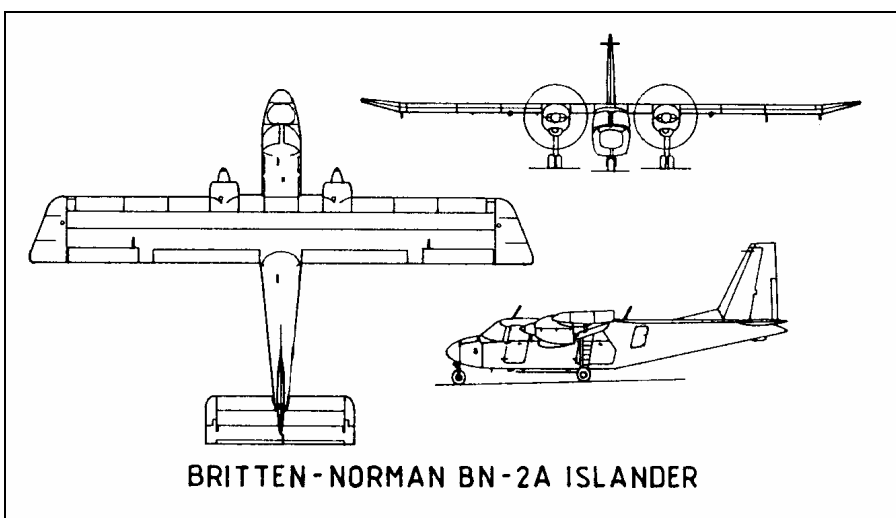
Pax: 4,

v_{CR} : 162 kt,

R : 770 NM,

MTOW: 1.7 t.

(Roskam II)

**Fig 4.4**

Twin engine regional.

Pilatus BN-2A:

piston engine.

Pilatus BN-2T:

turboprop engine.

Pax: 9, v_{CR} : 170 kt,

R : 140 NM,

MTOW: 3.1 t.

(Roskam II)

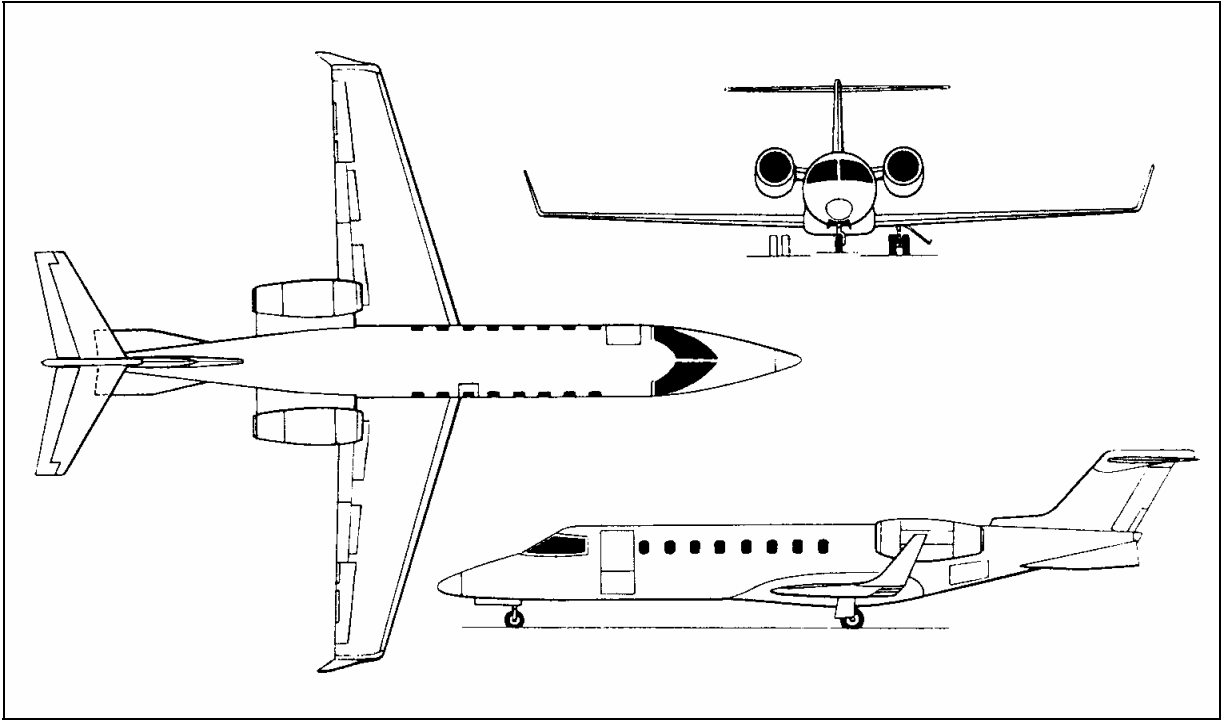


Fig 4.5 Business jet. Learjet 45: Pax: 9, v_{CR} : 464 kt, R : 1849 NM, MTOW: 4.0 t.
(Lambert 1993)

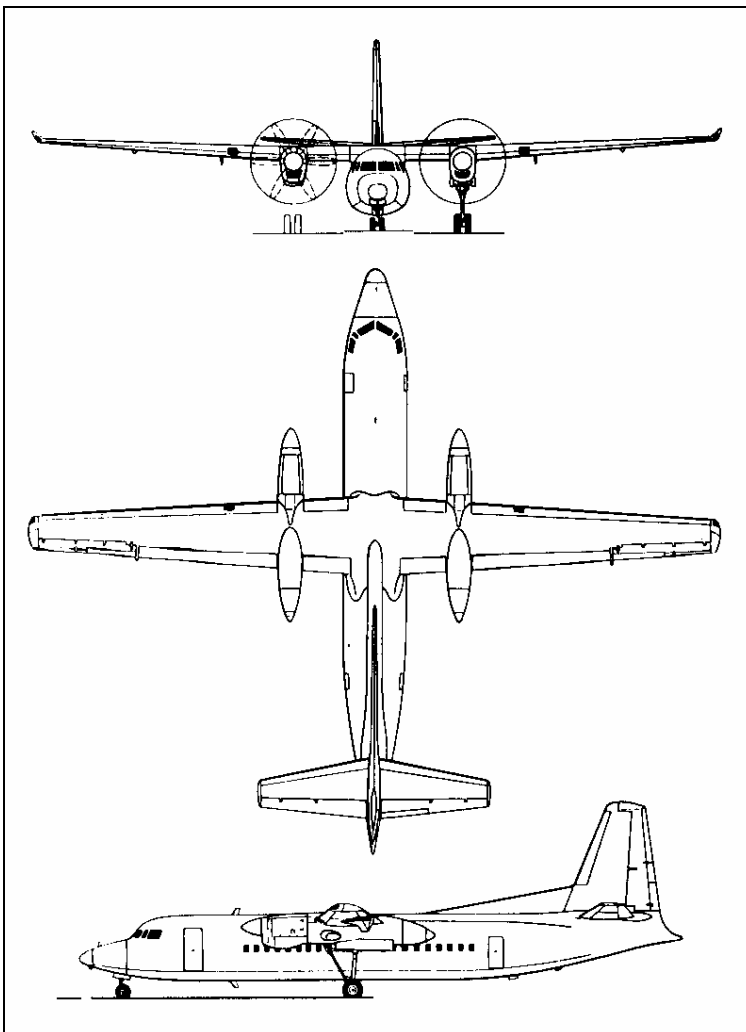


Fig 4.6
Turboprop regional.
Fokker 50:
Pax: 50,
 v_{CR} : 278 kt,
 R : 1610 NM,
MTOW: 20.8 t.

(Green 1988)

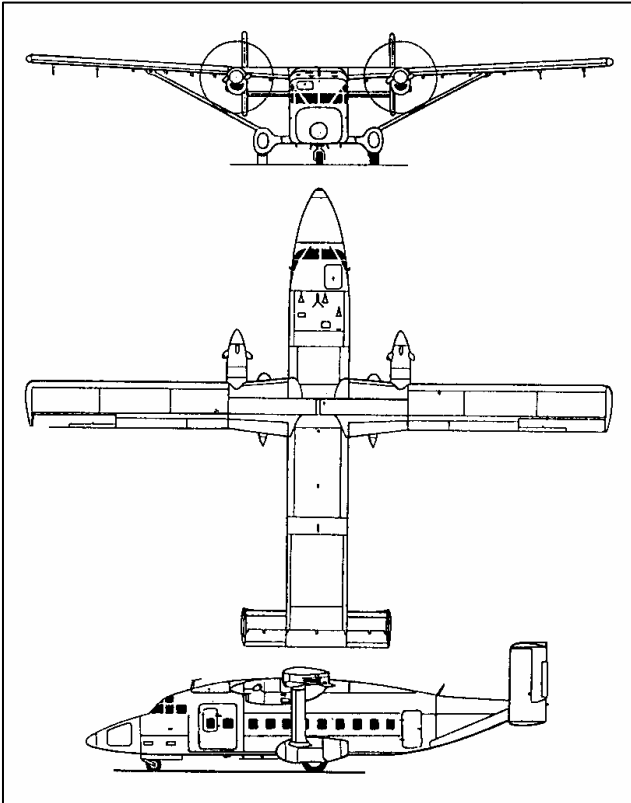


Fig 4.7
 Turboprop regional.
 Shorts 330:
 Pax: 30,
 v_{CR} : 190 kt,
 R : 473 NM,
 MTOW: 10.3 t.

(Green 1988)

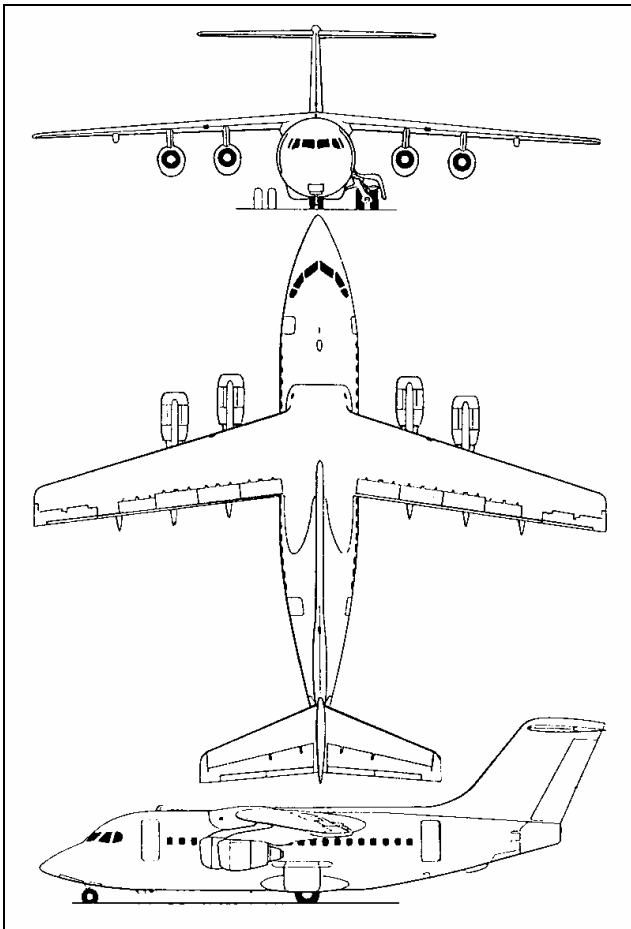
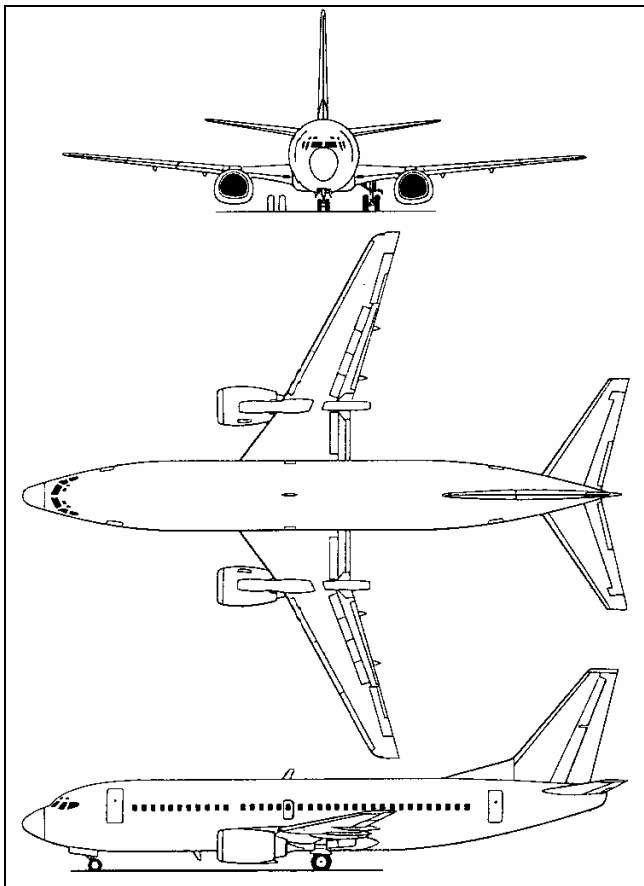


Fig 4.8
 Jet transport.
 BAe 146, later: Avro RJ85:
 Pax: 96,
 v_{CR} : 423 kt,
 R : 1176 NM,
 MTOW: 42.1 t.

(Green 1988)

Fig 4.9



Jet transport.
 Boeing 737-300:
 Pax: 128,
 v_{CR} : 490 kt,
 R : 1387 NM,
 MTOW: 61.2 t.

(Green 1988)

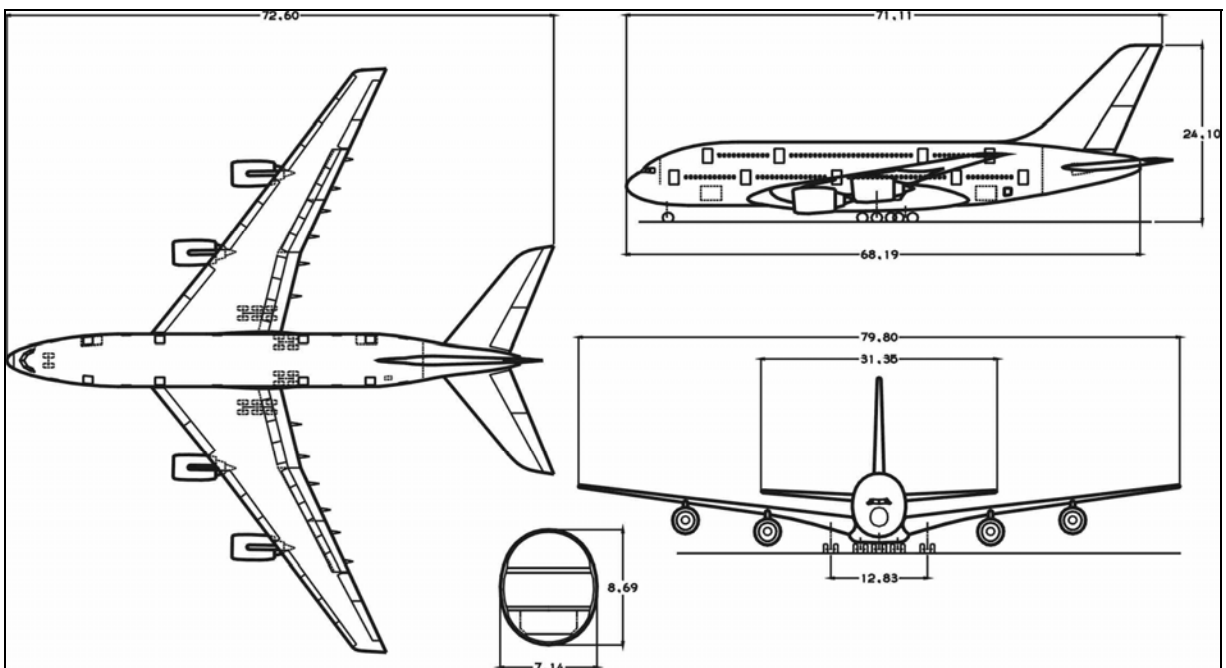


Fig 4.10 Airbus A380-800, Jet transport. Pax: 555, MTOW: 560 t. (Trahermer 2000)

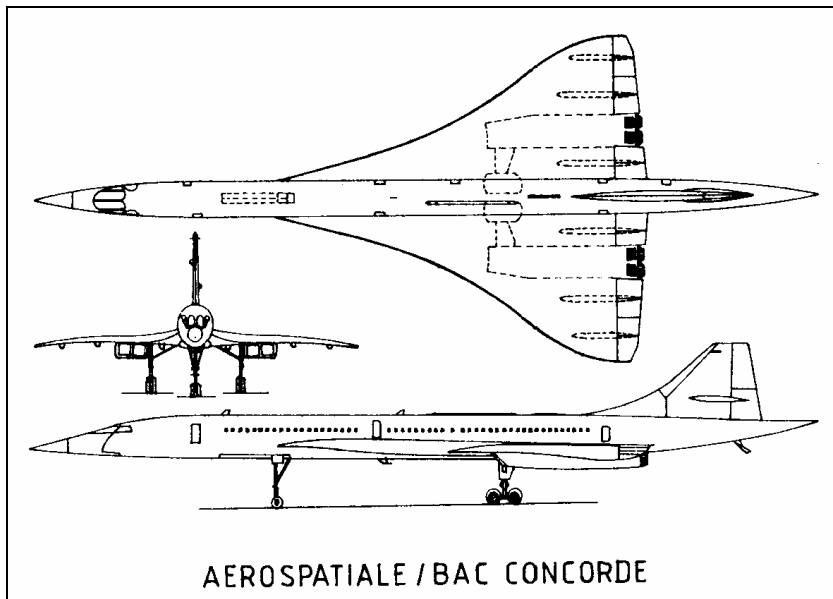


Fig 4.11
Supersonic civil transport.
Concorde:
Pax: 100,
 v_{CR} : 1160 kt, M_{CR} : 2
 R : 3209 NM,
MTOW: 185 t.

(Roskam II)

Each configuration has its **advantages and disadvantages**. In general, advantages in one place mean disadvantages elsewhere. Therefore, advantages and disadvantages **have to be assessed** during trade-off studies. For someone who was not involved in an aircraft's design process it is not easy to find out for which reason a particular design feature was chosen. When discussing advantages and disadvantages of several configurations one should always keep in mind that each person has its own subjective preferences. These personal views must not preclude to perform an assessment as objective as possible.

4.2 Three-View Drawings of Unconventional Configurations

Though conventional configurations differ in many aspects they all have a fuselage, wings and an empennage at their *rear end*. This configuration is called *tail aft aircraft*.

Unconventional aircraft configurations differ in at least one attribute from these main attributes of a conventional configuration. Examples of unconventional configurations are:

- The **canard (Fig 4.12)** has its horizontal tail at its front instead of its rear end.
- The **three-surface aircraft (Fig 4.13)** has in addition to its conventional empennage at its rear end an additional horizontal tail at its front end.
- The **flying wing (Fig 4.14)** has no fuselage. It only consists of a wing which also carries the payload.
- Unlike the conventional pivoting wing aircraft, the **pivoting oblique wing aircraft (Fig 4.15)** has only one swivel joint.
- The **oblique flying wing aircraft, OFW (Fig 4.16)** combines the ideas of a flying wing a swept wing.

- The **joined wing aircraft** (Fig 4.18) can be advantageous due lower mass at same stiffness.
- The **double fuselage aircraft** (Fig 4.19) can be advantageous due to e.g. the economically more efficient fabrication of twice the number of fuselages.

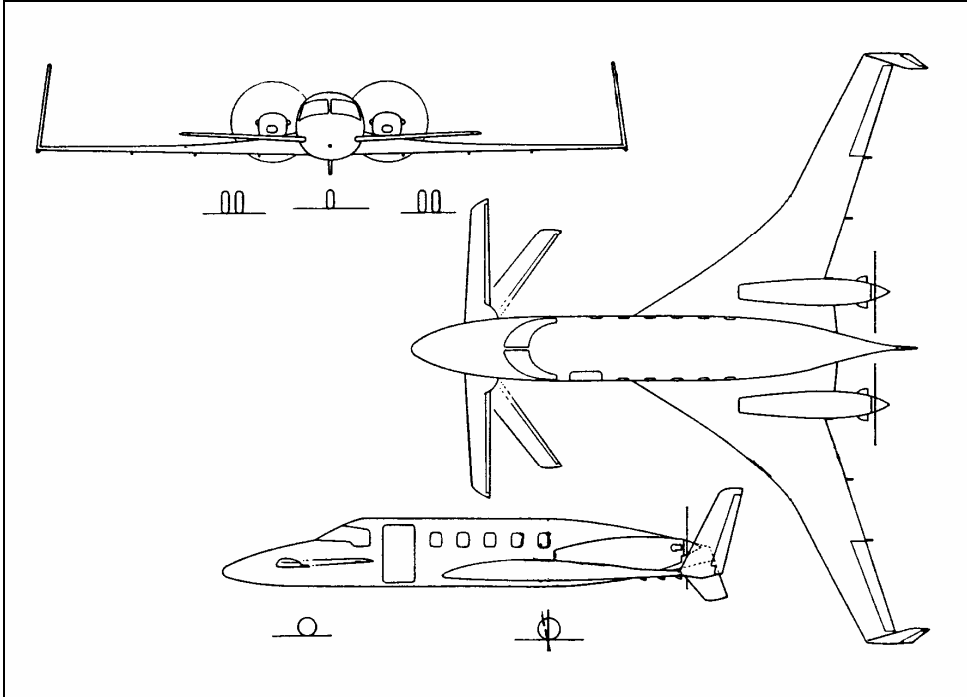


Fig 4.12
Canard:
Beech Starship

(Roskam II)

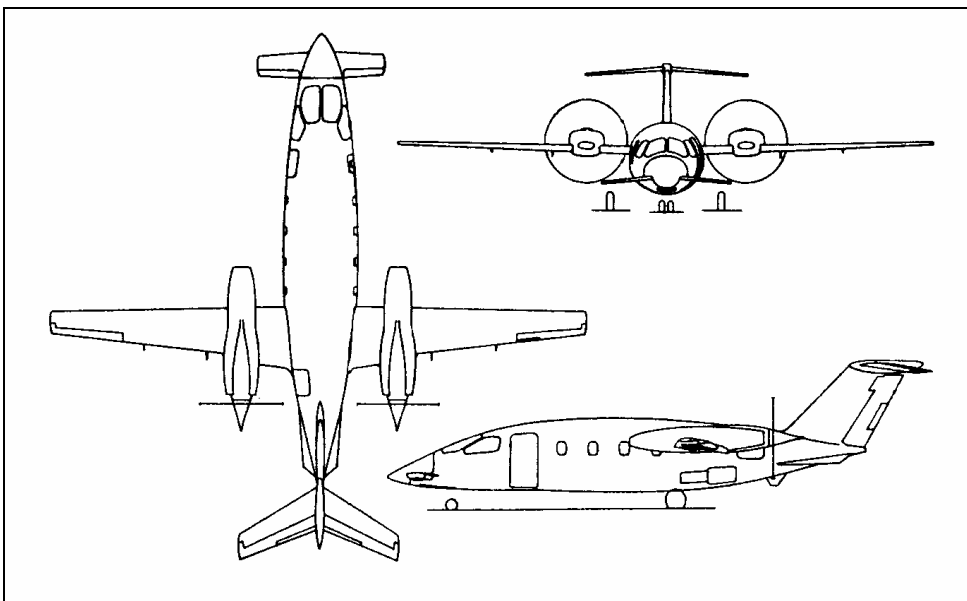


Fig 4.13
Three-surface
aircraft:
Gates Piaggio
GP-180

(Roskam II)

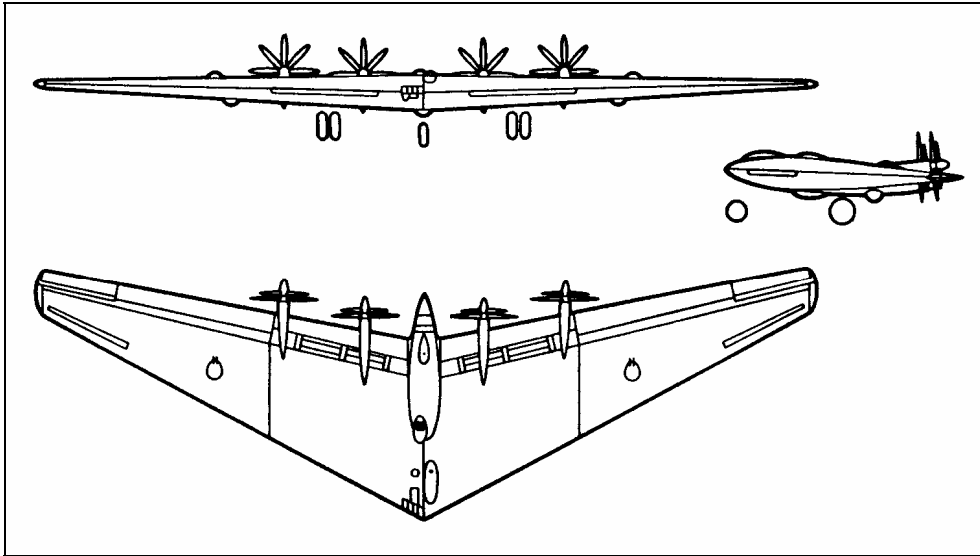


Fig 4.14
Flying wing:
Northrop XB-35

(Roskam II)

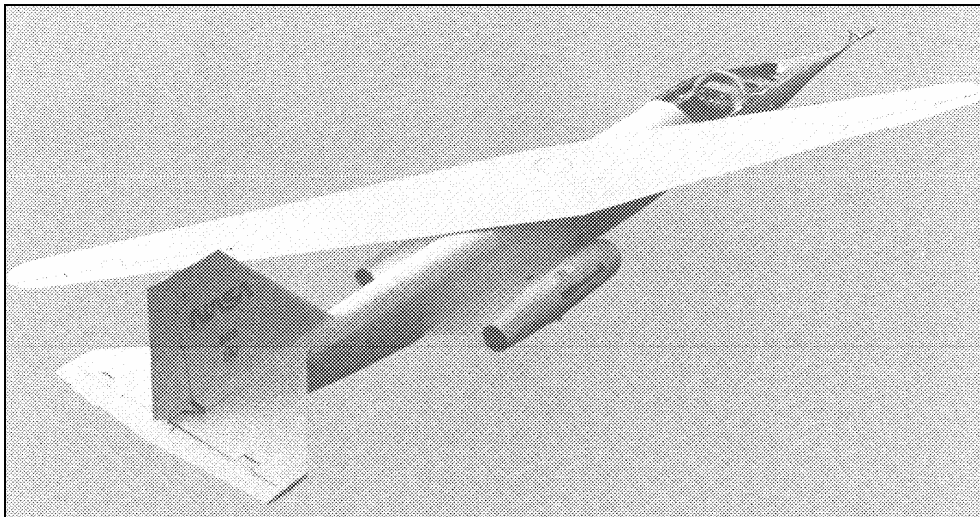


Fig 4.15
Pivoting oblique
wing aircraft:
NASA AD-1
Experimental
aircraft. Sweep
adjustable from
0° to 60°.

(Barnard 1991)

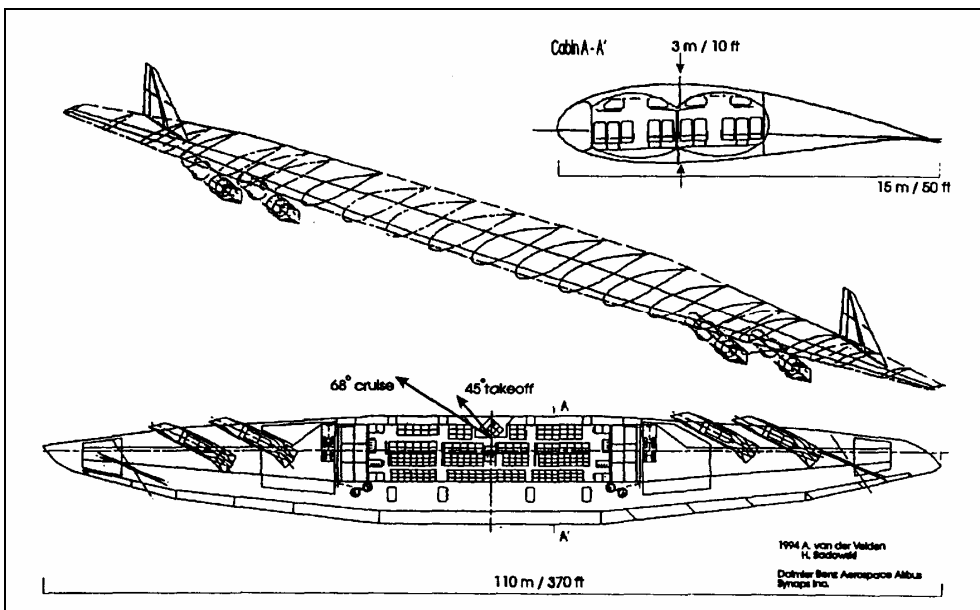


Fig 4.16
Oblique flying
wing aircraft,
OFW
Study:
DaimlerChrysler
Aerospace
Airbus.
Pax: 250,
 M_{CR} : 1.6,
Sweep:
45° ... 68°

(Li 1996)

The following figure holds a list of keywords for the description of several aspects of an aircraft configuration.

- *Overall configuration*
 - Land based aircraft
 - Sea plane
 - Amphibian plane

 - Conventional, also called: tail aft
 - Canard
 - Three-surface aircraft
 - Flying wing
 - Pivoting oblique wing aircraft

- *Fuselage configuration*
 - Conventional Fuselage
 - Double fuselage aircraft
 - Double boom central fuselage

- *Engine type*
 - Piston prop
 - Turbo prop
 - Turbo jet
 - Turbo fan
 - Propfan, unducted Fan

- *Engine integration*
 - Engine in nacelles on the wing or on the fuselage
 - Engine inside the wing or inside the fuselage

- *Wing*
 - Cantilever
 - Braced

 - High wing position
 - Low wing position
 - Mid wing position

 - Straight wing
 - Aft swept wing
 - Forward swept wing
 - Pivoting oblique swept wing

 - Wing with or without winglets

- *Horizontal tail*
 - on the fuselage
 - on two tail booms
 - T-tail
 - V-tail, butterfly tail

- *Vertical tail*
 - on the fuselage
 - on two tail booms
 - on each tip of the horizontal tail

- *Landing gear*
 - Fixed or retractable gear
 - Tail-wheel or nose-wheel landing gear

- *Landing gear integration*
 - in the wing
 - in the engine nacelles
 - in the fuselage
 - in fairings

Fig 4.17 Aircraft configuration aspects

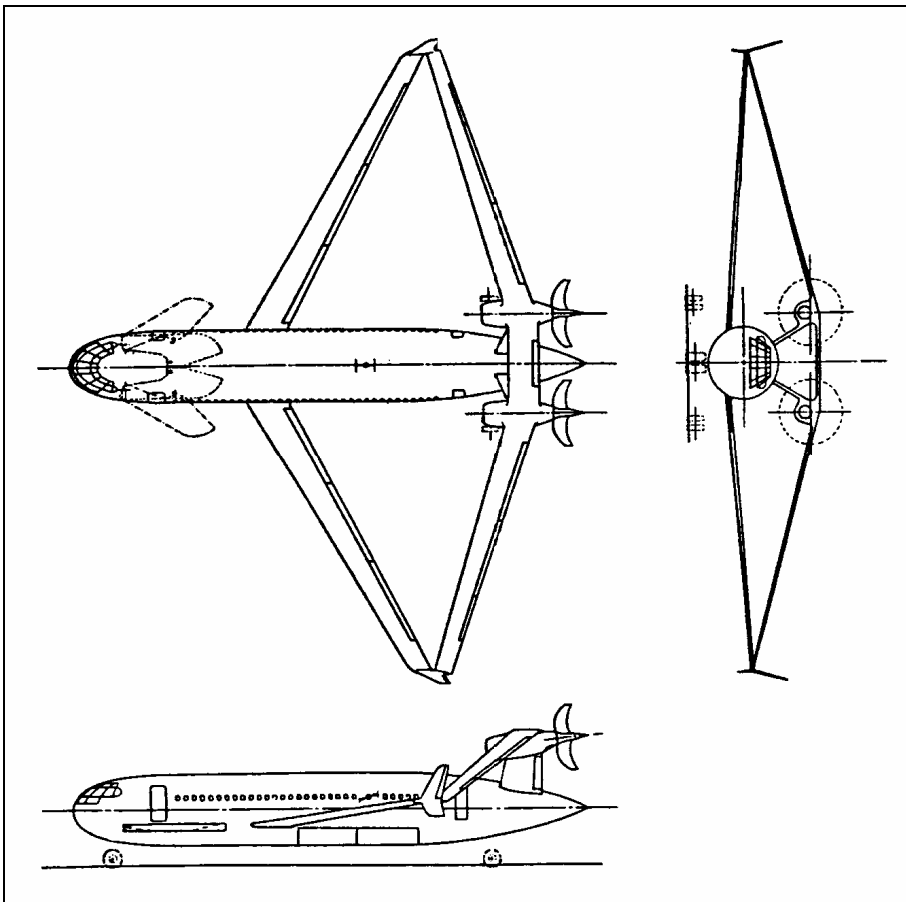


Fig 4.18
Joined wing aircraft.

Study

(Roskam II)

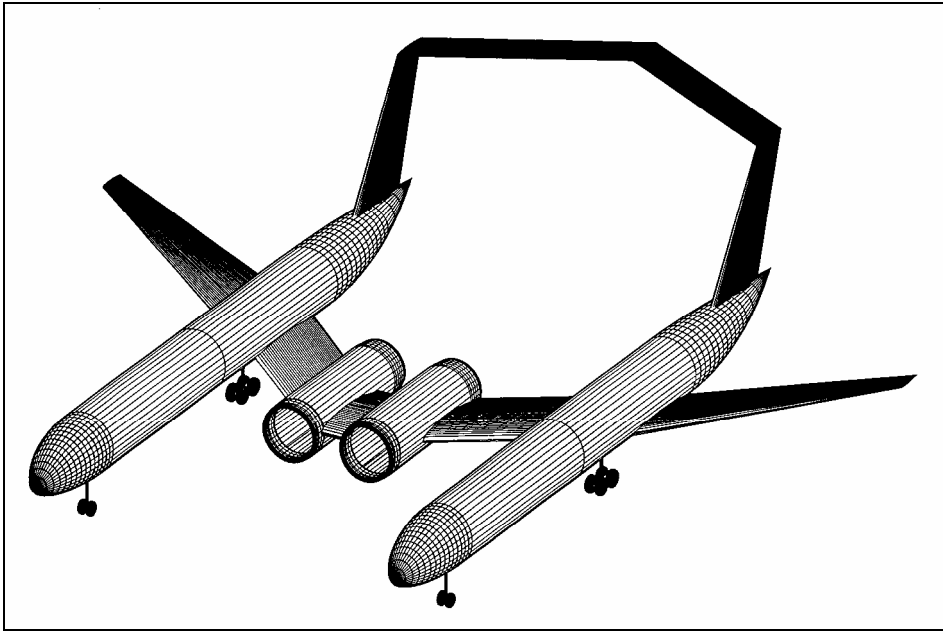


Fig 4.19
Double fuselage
aircraft.

*Exemplary design
for aircraft design
lecture*

Fachhochschule
Hamburg

(Marckwardt 1997)