The F-14 Tomcat

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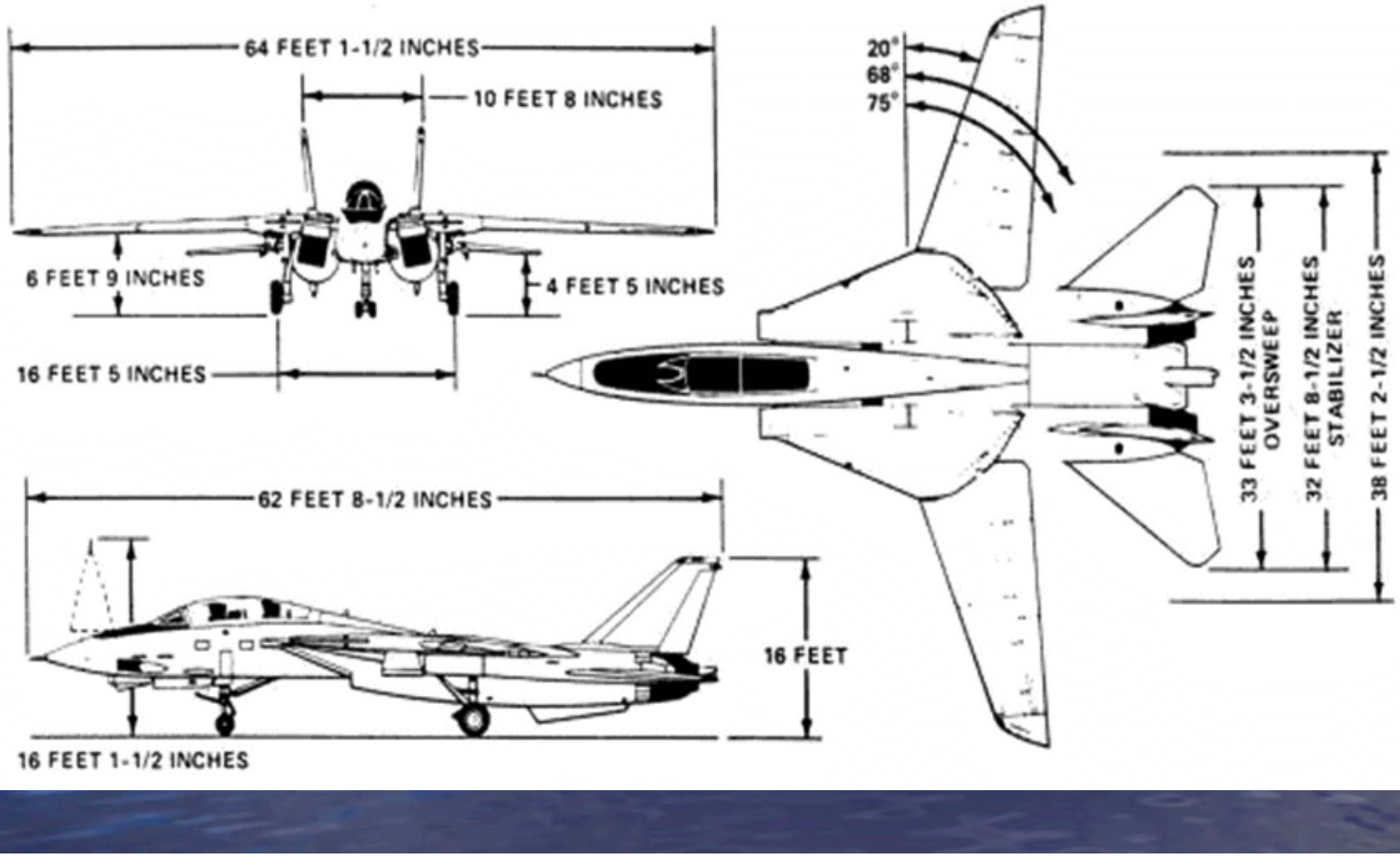
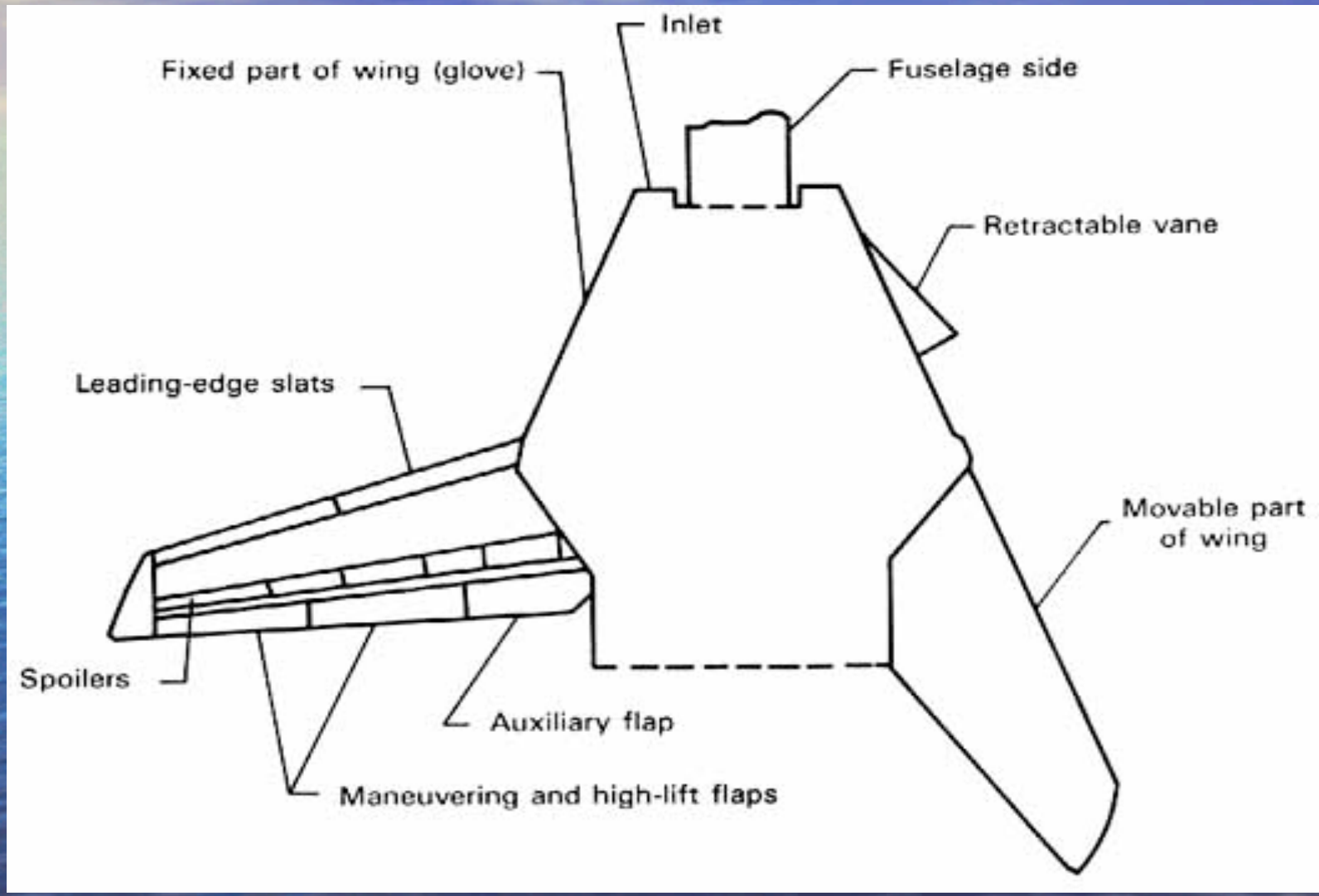
History of the F-14 Tomcat

- Designer
  - Grumman Aerospace Corporation
- First Flight
  - December 21, 1970
- Amount Made
  - 556 F-14As for US NAVY
  - 79 for the Imperial Iranian Air Force
- Variants
  - F-14A , F-14B , F-14D

Geometry – Whole



Geometry – Wing

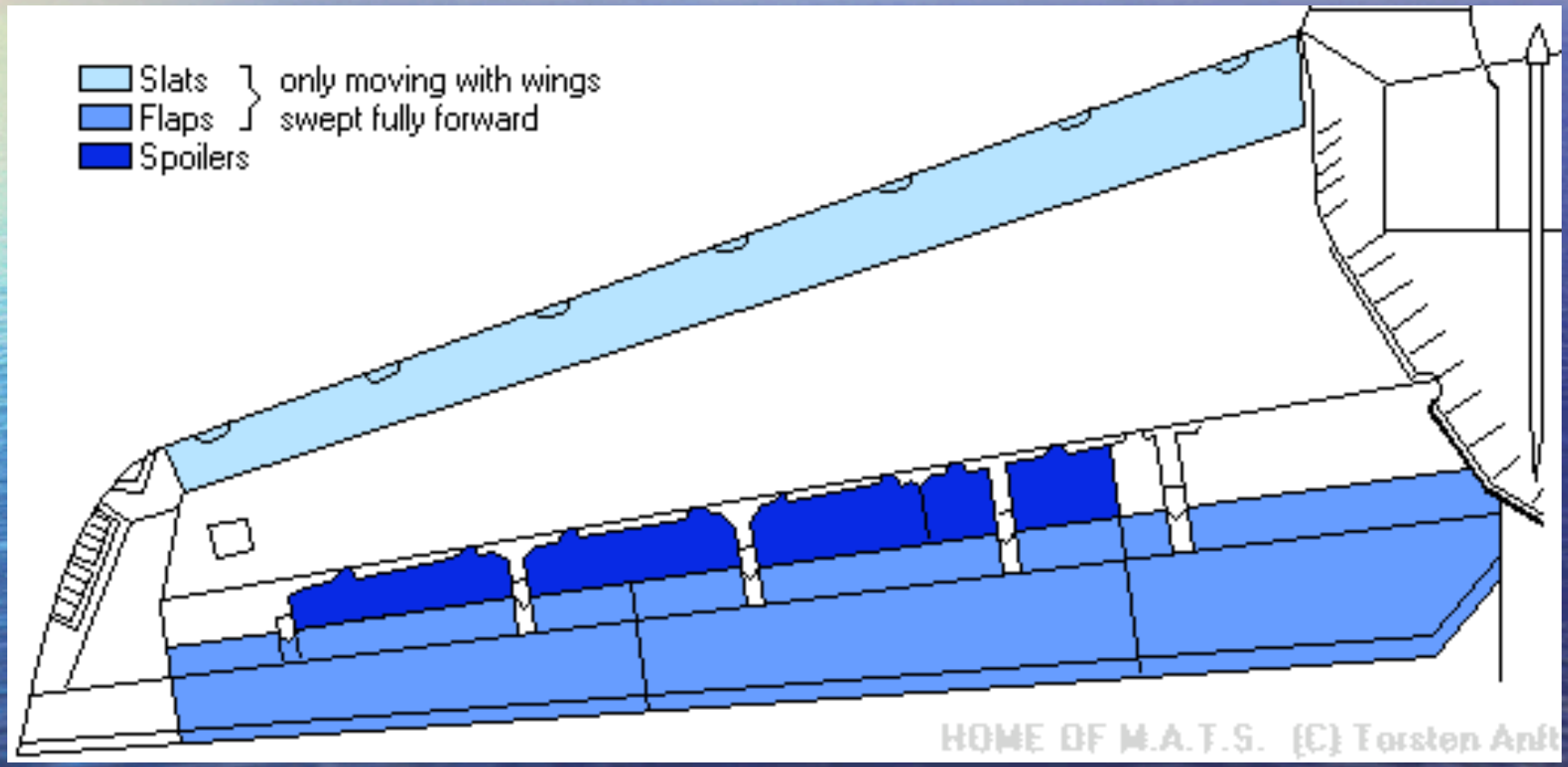


Geometry – Tail/Fuselage

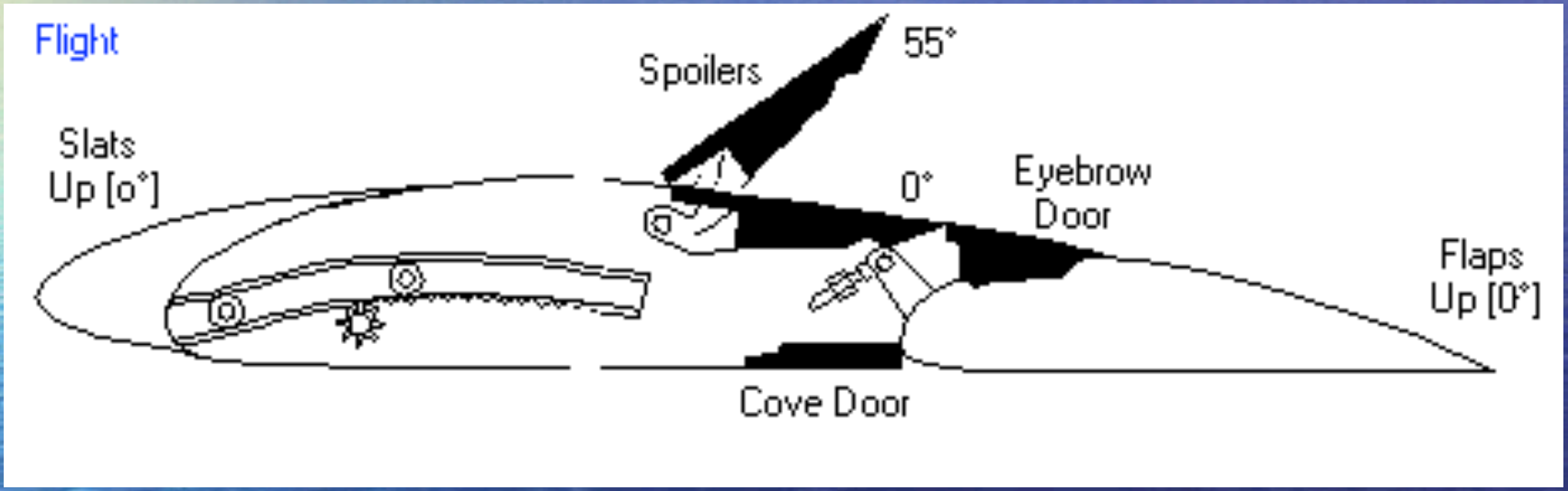
- Why the tail configuration?

- Extra lifting surface? Fuselage

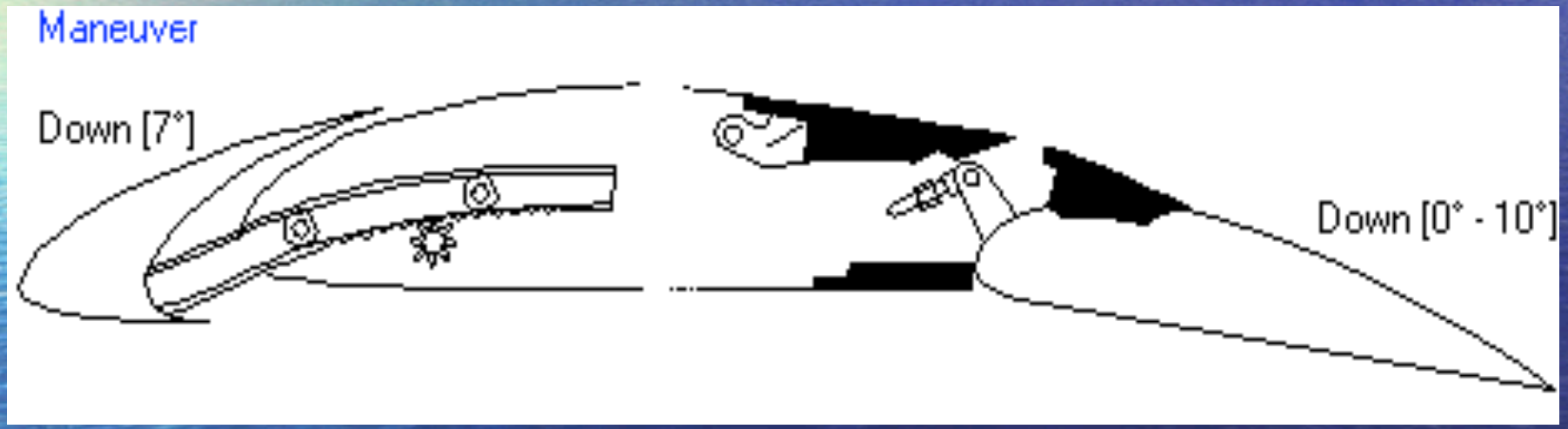
High Lift


Slats
Flaps
Spoilers
only moving with wings
swept fully forward
HOME OF M.A.T.S. (C) Torsten Anft

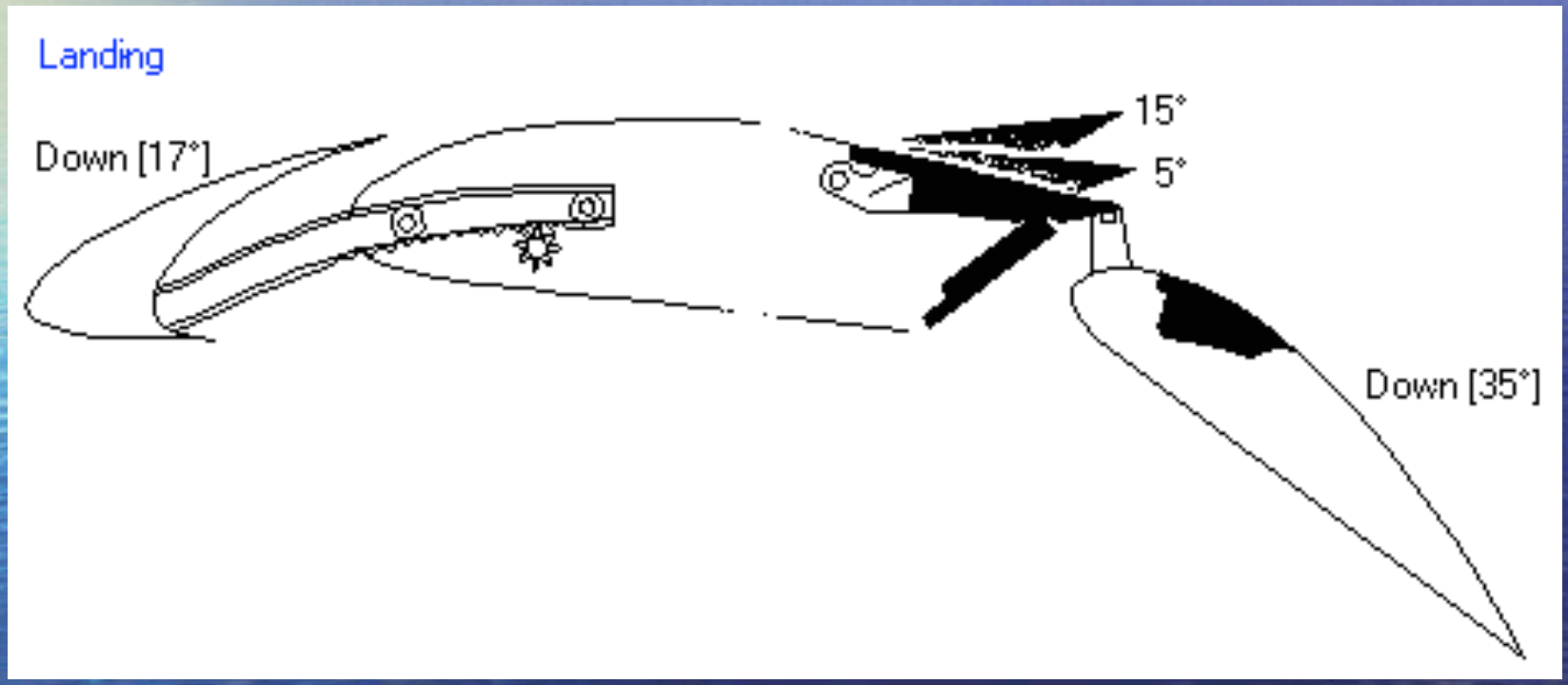
High Lift (continued)



High Lift (continued)



High Lift (continued)



Why Variable Sweep?

Pros

- Adjustable span for cruise efficiency
- Reduced wave drag
- C_{Lmax} at lower AoA
- Trailing edge devices don't lose effectiveness
- Low approach speed
- Versatility in mission

Cons

- Complexity
- Number of moving parts
- Weight of support structure
- Other options

$$M_{dd} = \frac{\kappa_A}{\cos\Lambda} - \frac{(t/c)}{\cos^2\Lambda} - \frac{c_l}{10\cos^3\Lambda}$$

$$C_n = C_s \cos\Lambda$$

$$M_n = M_\infty \cos\Lambda$$

$$t/c)_n = t/c)_s/\cos\Lambda$$

and

$$C_{Ls} = C_{Ln} \cos^2\Lambda$$

VLMpc Code Results

- A planform of the 20° and 68° swept wings were run at the cruise Mach number of 0.72
- Results
  - The $C_{L,\alpha}$ slope for the 20° case was 5.405 /rad and for 68° it was 2.366 /rad
  - The C_m/C_l for the 20 ° case was -0.7718 and for 68° it was -0.7586

High Speed Flight

Transonic Cruise

- Cruise at Mach = 0.72, max Mach at 1.88
- Transonics affect aircraft's handling characteristics.
- In extreme cases, control operations reverse in functionality.
- Automatic wing sweep control, based off of Mach
- Controlled trim and helped reduce drag and dynamic instabilities

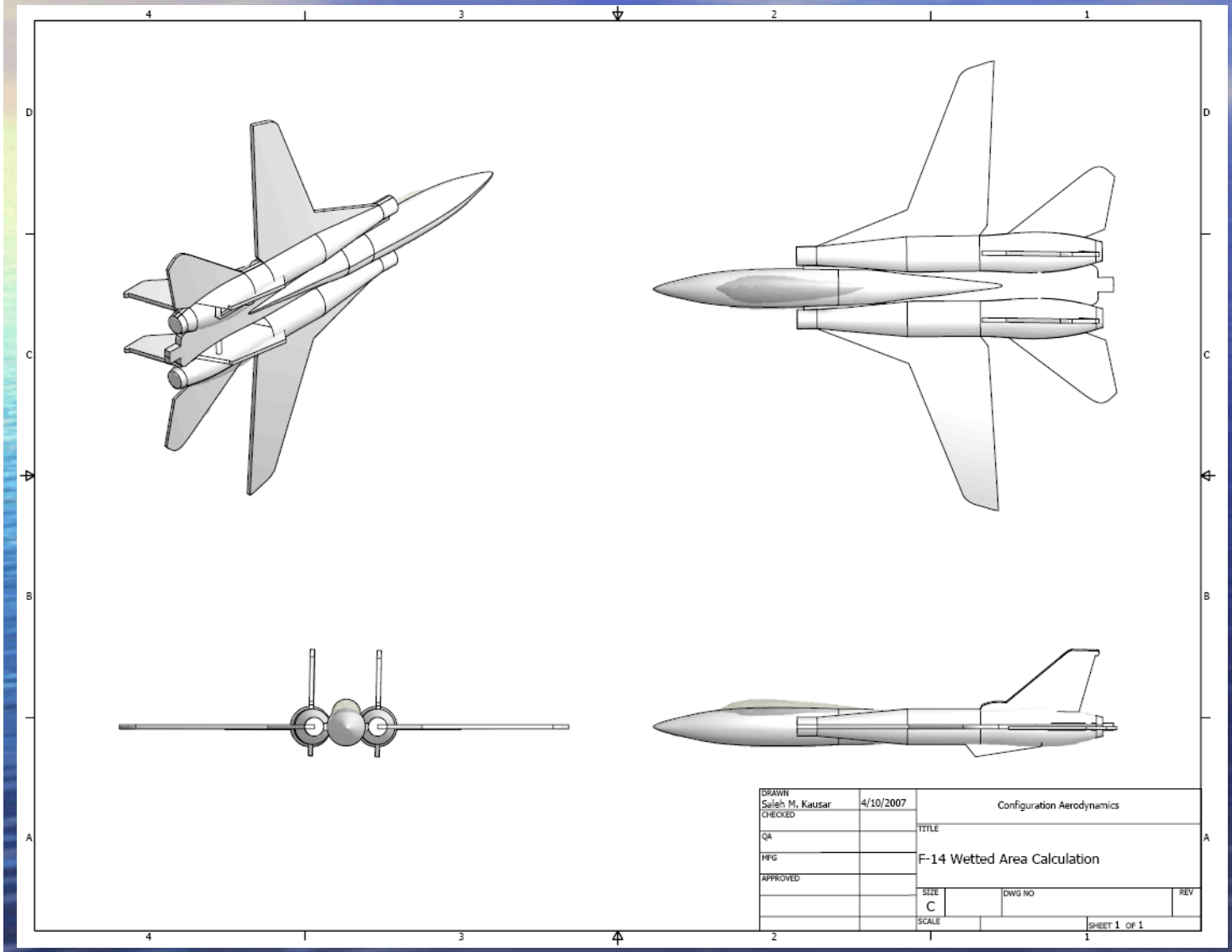
High Speed Flight cont.

- **At speeds above Mach 1.0, the glove vanes in the leading edge of the fixed portion of the wing extend to move the aerodynamic center forward and**
- **Shift also reduces loads on the tail sections.**
- **effective wing area about 40% greater than actual wing area because of flat, airfoil-like, section between the engines. Results in lower wing loading, but more wetted area and poor area distribution**

Drag

- Profile Drag
  - Pressure / Form Drag
  - Skin Friction Drag
- Induced Drag
  - Due to lift generation
  - Vorticity shed into wake
- Wave Drag
  - Drag due to lift
  - Drag due to volume

Wetted Area Calculation



4,131 ft^2

Friction Input

```
 F - 14  AIRCRAFT
739.      1.          6.          0.0
FUSELAGE            644.93      49.2      .10918    1.0       0.0
CANOPY              203.56      25.2      .07936    1.0       0.0
ENGINES             1142.86     42.9      .11694    1.0       0.0
WINGS               1478.23     11.4      .05422    0.0       0.0
HORIZ TAIL          310.08      8.8       .04522    0.0       0.0
VERTI TAIL          200.88      5.5       .04522    0.0       0.0
     0.200    35.000
     1.200    35.000
     2.000    35.000
     0.000     0.000
```

Friction Output

F-14

TOTAL SWET = 3980.5400

REYNOLDS NO./FT =0.480E+06 Altitude = 35000.00 XME = 0.200

FRICTION DRAG: CDF = 0.01593 FORM DRAG: CDFORM = 0.00171

F-15

TOTAL SWET = 2700.0000

REYNOLDS NO./FT =0.480E+06 Altitude = 35000.00 XME = 0.200

FRICTION DRAG: CDF = 0.01301 FORM DRAG: CDFORM = 0.00105

QUESTIONS?

References

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- [2] Hallissy, J, and P Phillips. *Wind-Tunnel Investigation of Aerodynamic Characteristics and Wing Pressure Distributions of an Airplane with Variable-Sweep Wings Modified for Laminar Flow*. NASA Technical Memorandum 4124
- [3] Mason, W.H. "Subsonic Aerodynamics of Airfoils and Wings." Virginia Tech.
- [4] http://www.globalsecurity.org/military/systems/aircraft/f-14-design.htm
- [5] http://en.allexperts.com/e/f/f/f-14_tomcat.htm
- [6] http://www.anft.net/f-14/f14-history-f14a.htm