



DATCOM Beginner's Tutorial:

Modeling a MiG-17

The method of building a model in DATCOM can be confusing. There are no point-and-click interfaces (yet), only points in space. This tutorial aims at helping the novice user build a simple DATCOM model and test it. The numbers obtained may not be correct, but the model should be fairly accurate (except for a few assumptions).

THE MIKOYAN-GUREVICH MIG-17

In 1949, the Mikoyan-Gurevich (MiG) design bureau began work on a new fighter to replace the MiG-15. Two features of the aircraft were a thinner wing of greater sweep and a redesigned tail that improved stability and handling at speeds approaching Mach 1 (speed of sound). Although similar in appearance to the MiG-15, the MiG-17 has more sharply swept wings, an afterburner, better speed and handling characteristics and is about three feet longer. The wings of the aircraft are mid-mounted, swept-back, and tapered with blunt tips. They have wide wing roots. The engine is one turbojet inside the body and has a round air intake in the nose. It has a single, small exhaust. The fuselage is short, thick, cigar-shaped and tapered to the rear. It has a blunt nose and bubble canopy. The tail fin is swept-back and tapered with rounded tip. Flats are high-mounted on the tail fin, swept-back, and tapered. Flats and fin overhang the exhaust. (Taken from GlobalSecurity.org)

The MiG-17 was chosen for this tutorial because of its simple design. The fuselage cross-section is almost circular (and assumed to be), the wing shape is not complex, and the tails are not complex.

DRAWINGS AND DIMENSIONS

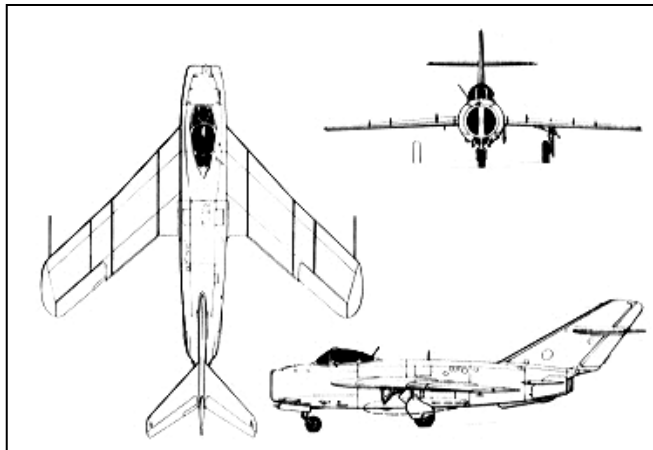


Figure 1: MiG 17 Views

The most difficult aspect of this project was finding adequate drawings of the aircraft which could provide accurate and consistent measurements. Eventually a drawing similar to the 3 view drawing pictured here was found. We can use the fact that MIG-17 has a wingspan of approximately 31 feet 7 inches and a length of 36 feet 5 inches to scale the drawing and get the dimensions needed.

It can be found (online) that the sweep of the wing and horizontal tail is 45 deg (approximately) along the leading edge. The

sweep of the large vertical tail is taken to be 55 deg along the leading edge. The dihedral

of the wing is -3 deg and its incidence is +1 deg.

As stated before, the fuselage cross section is conveniently circular, and for several stations, constant. It should be noted that the canopy was not implemented in the tutorial, which could possibly have affected the results (unimportant though).

A major hindrance of the project, however, is the airfoil. The MIG uses a TsAGI S-12 (12%) airfoil shape. Since planes don't fly without wings, and the airfoil shape has a profound impact on flight, the selection of the airfoil is critical. Furthermore, the Digital Datcom does not account for Russian

airfoils, so the assumption that a TsAGI S-12 (12%) is equivalent to a NACA 66-012 was made. Justification: none (aside from unverified information online). Since the data for TsAGI airfoils are not readily available, the characteristics cannot be inputted manually into DATCOM, therefore we are left having to make this assumption.

WRITING THE for005.dat FILE

It would be wise to read section 3 (Definition of Inputs) in Volume I of the USAF Digital DATCOM User Manual, especially 3.1 and 3.2, to familiarize yourself for what is coming next.

The for005.dat file (aka input file) defines the flight characteristics and geometry of the aircraft. It follows a very specific format and any deviance for the format will cause the analysis not to be run.

First we input the CASEID on the first line:

```
CASEID MIKOYAN-GUREVICH MiG-17
```

Every piece of data that defines the flight characteristics and geometry of the aircraft is contained in namelists. In the input file, namelists are preceded by a "\$" sign (ex. \$FLTCON) and the statements are terminated with "\$" signs. For this exercise we will use the following namelists:

- **FLTCON** - defines the flight conditions
- **OPTINS** - defines the stability reference parameters: S_w , \bar{c} and b
- **SYNTHS** - locates the cg, wing, horizontal tail, and vertical tail with respect to a reference line
- **BODY** - defines the body geometry
- **WGPNLF** - defines the wing planform geometry
- **HTPLNF** - defines the horizontal tail geometry
- **VTPLNF** - defines the vertical tail geometry

THE FLTCON NAMELIST

The FLTCON namelist defines the flight conditions such as Mach number(s), altitude(s), and angle of attacks to be analyzed. A full list of the inputs can be found on page 27 of the USAF Digital Datcom User Manual Volume I. We will use the following variables from the FLTCON namelist:

- **NMACH** - number of Mach numbers to be run. We will only run at one Mach.
- **MACH** - the aforementioned Mach numbers to be run. We will run at Mach = 0.60.
- **NALPHA** - the number of angles of attack to test. We will test at 10 AOA's.
- **ALSCHD** - the schedule of angles of attack. We will use (in deg): -4, -2, 0, 2, 4, 6, 8, 10, 12, 14 (ten total)
- **NALT** - number of altitudes to run. We will test only one altitude.
- **ALT** - the altitudes to run. We will test at 5000 feet.
- **WT** - the weight of the aircraft. We will use 13395 lbs for the MiG.
- **LOOP** - we will set to 1. A discussion of the important LOOP parameter will be presented at some other time.

We can input these variables into the FLTCON namelist. Note that each number must contain a decimal point. Also, the file can only be a certain number of characters in horizontal length, so do not go past 80 characters on each line. The order in which the variables are given are not crucial, but the following format is recommended. The following describes what goes into the input file:

```
$FLTCON NMACH=1.0,MACH(1)=0.6,NALPHA=10.0,ALSCHD(1)=-4.0,-2.0,
0.0,2.0,4.0,6.0,8.0,10.0,12.0,14.0,NALT=1.0,ALT(1)=5000.0,
WT=13395.0,LOOP=1.$
```

THE SYNTHS NAMELIST

The SYNTHS (Synthesis) namelist is very important because it sets up the c.g. location as well as the position of the wing and tail surfaces. So at this point you should know the dimensions of the aircraft pretty well. Page 33 in USAF Digital Datcom User Manual Volume I indicates exactly what dimensions you will need.

All horizontal measurements will be taken from the nose of the aircraft. All vertical measurements will be taken from a reference line conveniently placed at the center of the aircraft. The following variables from the SYNTHS namelist will be used:

- **XCG** - the horizontal position of the c.g. Since information of the c.g. position is not given, a c.g. position of 11.17 ft. was arbitrarily chosen (aerodynamic center of wing).
- **ZCG** - the vertical position of the c.g. with respect to the reference line. Arbitrarily chosen as 0 feet.
- **XW** - the horizontal position of the apex of the wing. Measured as 3.63 feet.
- **ZW** - the vertical position of the wing apex wrt the reference line. Measured as 0.42 feet.
- **ALIW** - the incidence of the wing in degrees. For the MiG, this is 1 degree.
- **XH** - the horizontal position of the apex of the horizontal tail. Measured as 28.73 feet.
- **ZH** - the vertical position of the horiz. tail apex wrt the reference line. Measured as 5.24 feet.
- **ALIH** - incidence of the horizontal tail. No data found for the MiG, so taken as 0 degrees.
- **XV** - the horizontal position of the apex of the vertical tail. Measured as 18.3 feet.
- **ZV** - the vertical position of the vertical tail apex wrt the reference line. Since this lies on the reference line, it is 0 feet.

These numbers can be inputted into the SYNTHS namelist:

```
$SYNTHS XCG=11.17,ZCG=0.0,XW=3.63,ZW=0.42,ALIW=1.0,XH=28.73,
ZH=5.24,ALIH=0.0,XV=18.3,ZV=0.0$
```

The following drawings will give the dimensions that will be used in this namelist and the subsequent ones.

THE BODY NAMELIST

Now we can start modeling the components. First, we'll start with the body. As stated previously, we will forget the canopy and model the fuselage as having a circular cross section at each station. Note that in the drawing above, we have 10 stations starting with the nose and concluding at the rear section of the fuselage. We will need the horizontal distance from the nose at each station (X-distance) as well as the cross section radius of each. The numbers are tabulated below:

Station	1	2	3	4	5	6	7	8	9	10
X (ft)	0.0	0.73	3.63	6.02	8.37	12.64	16.70	19.35	24.42	30.02
R (rad., ft)	1.28	1.73	2.14	2.33	2.23	2.33	2.26	2.26	1.88	0.69

The variables of the namelist BODY that we will use are:

- **NX** - number of body stations
- **X** - horizontal distance of each station
- **R** - the radius at each station (also known as the fuselage half-width)

With all of these values know, we can fully define the fuselage. The data is inputted as follows:

```
$BODY NX=10.0,  
X(1)=0.0,0.73,3.63,6.02,8.37,12.64,16.70,19.35, 24.42,30.02,  
R(1)=1.28,1.73,2.14,2.33,2.33,2.33,2.26,2.26,1.88,0.69$
```

THE WGPLNF NAMELIST

Now we can define the wing planform using the WGPLNF namelist. USAF Digital Datcom User Manual Volume I page 37 and 38 can be extremely helpful for all of the planforms. The drawings above fully prescribe the wing planform shape. The following are the variables we will use in defining the wing:

- **CHRDTP** - the length of the chord at the tip of the wing. Measured to be 7.02 feet.
- **SSPNOP** - the "Semi-Span outboard panel" which is " $b*o/2$ " in the drawing. If the wing has two sections, like the MiG, there is an inboard panel and an outboard panel. This dimension is taken from the break point of the two panels to the tip chord. Measured to be 11.32 feet.
- **SSPNE** - the "exposed" semi-span, which is the " $b*/2$ ". This dimension is from the side of the fuselage to the tip chord. Measured to be 13.41 feet..
- **SSPN** - the theoretical semi-span, which is $b/2$. This dimension is from the root chord to the tip chord. Measured to be 15.71 feet.
- **CHRDBP** - the chord at the break point between the inboard and outboard panel (the "cb" in the drawing). Measured to be 8.4 feet.
- **CHDRDR** - the length of the chord at the root of the wing. Measured to be 14.0 feet.
- **SAVSI** - the sweep of the wing at the inboard panel (refer to the manual). Although the sweep of the MiG differs slightly from the inboard to the outboard panel, we will take this as constant and keep it as 45 degrees.
- **SAVSO** - the sweep of the wing at the outboard panel. A stated before, it will be 45 deg.
- **TWISTA** - the twist angle of the wing (wash-out). For the MiG, it is 0 deg.

- **CHSTAT** - the % of the chord at which the sweep angle will be referenced. If the sweep angle is referenced from the leading edge, this value is 0. If it is referenced from the c/4, then this value is 0.25. Will be set to 0.
- **DHDAHI** - the dihedral of the inboard panel. If the inboard and outboard panel dihedral is the same (constant dihedral across the wing), then only DHDADI is inputted. For the MiG, the wing dihedral is -3 deg.
- **TYPE** - different planform types (refer to manual). Will be set to 1 for linear taper.

These values are inputted into the for005 file as follows:

```
$WGPLNF CHRDT=7.02,SSPNOP=11.32,SSPNE=13.41,SSPN=15.71,
CHRDBP=8.4,CHRD=14.0,SAVSI=45.0,SAVSO=45.0,CHSTAT=0.0,
TWISTA=0.0,DHDADI=-3.0,TYPE=1.0$
```

THE HTPLNF NAMELIST

The horizontal tail is described the same way as wing using the same variables. Because the geometry of the HT is simpler, we will only use the following variables: CHRDT, SSPNE, SSPN, CHRD, SAVSI, CHSTAT, and TYPE.

- CHRDT is 1.86 feet
- SSPNE is 5.42 feet
- SSPN is 5.43 feet
- CHRD is 4.69 feet
- SAVSI is 45 degrees
- CHSTAT is 0
- TYPE is 1

And so the values are inputted into the HTPLNF namelist as follows:

```
$HTPLNF CHRDT=1.86,SSPNE=5.42,SSPN=5.43,CHRD=4.69,SAVSI=45.0,
CHSTAT=0.0,TYPE=1.0$
```

THE VTPLNF NAMELIST

The vertical tail is described the same way as the wing using the same variables. Because the geometry of the VT is simpler, we will only use the following variables: CHRDT, SSPNE, SSPN, CHRD, SAVSI, CHSTAT, and TYPE.

- CHRDT is 3.76 feet
- SSPNE is 6.05 feet
- SSPN is 8.18 feet
- CHRD is 12.47 feet
- SAVSI is 55 degrees (not measured)
- CHSTAT is 0

- TYPE is 1

And so the values are inputted into the VTPLNF namelist as follows:

```
$VTPLNF CHRDP=3.76, SSPNE=6.05, SSPN=8.18, CHRDR=12.47, SAVSI=55.0,  
CHSTAT=0.0, TYPE=1.0$
```

AIRFOIL DESIGNATIONS

We cannot forget to input the airfoil shapes for the wing and tails. Page 74 and 75 of volume I has some information on this. If the wing was a NACA-2412, we would input into the for005 file: NACA-W-4-2412. The "NACA" indicates that it is a NACA airfoil, for which DATCOM has built in data. "W" indicates that the airfoil is to be applied to the wing ("H" for HT, and "V" for VT). "4" indicates that it is a 4 series airfoil (DATCOM accepts 1, 4, 5, and 6 series airfoils). And after that is the airfoil designation number, in this example it is "2412."

For the MiG, the NACA 66-012 airfoil will be used for the wing, and the 66-009 for the tails. They will simply be inputted into DATCOM as follows:

```
NACA-W-6-66-012  
NACA-H-6-66-009  
NACA-V-6-66-009
```

TERMINATING THE FILE

There are a number of commands that can be placed at the end of the file to specify information and give more data. We will use 3 commands:

- **DIM FT** - specifies that all of the dimension were given in feet for which the output will be in "English" units
- **BUILD** - show the data for all of the components, not just the aircraft
- **PLOT** - generate a plot file (for013.dat) to input into the MATLAB plotting program

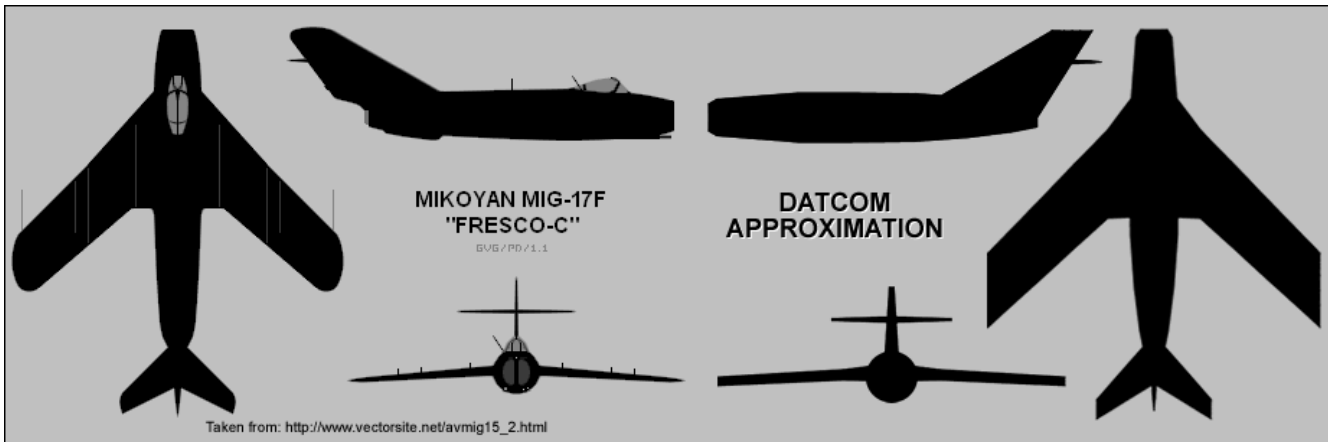
Finally, the file ends with "NEXT CASE". In the input file this looks like:

```
DIM FT  
BUILD  
PLOT  
NEXT CASE
```

THE FULL for005.dat FILE

Here is the full input file that will be run by DATCOM.

```
CASEID ----- MIKOYAN-GUREVICH MiG-17 -----
$FLTCN NMACH=1.0,MACH(1)=0.6,NALPHA=10.0,ALSCHD(1)=-4.0,-2.0,
  0.0,2.0,4.0,6.0,8.0,10.0,12.0,14.0,NALT=1.0,ALT(1)=5000.0,
  WT=13395.0,LOOP=1.$
$SYNTHS XCG=11.17,ZCG=0.0,XW=3.63,ZW=0.42,ALIW=1.0,XH=28.73,
  ZH=5.24,ALIH=0.0,XV=18.3,ZV=0.0$
$OPTINS SREF=243.0$
$BODY NX=10.0,
  X(1)=0.0,0.726,3.63,6.02,8.37,12.64,16.70,19.35, 24.42,30.02,
  R(1)=1.28,1.73,2.14,2.33,2.33,2.33,2.26,1.88,0.69$
NACA-W-6-66-012
$WGPLNF CHRDT=7.02,SSPNOP=11.32,SSPNE=13.41,SSPN=15.71,
  CHRDBP=8.4,CHRD=14.0,SAVSI=45.0,SAVSO=45.0,CHSTAT=0.0,
  TWISTA=0.0,DHDADI=-3.0,DHDADO=-3.0,TYPE=1.0$
NACA-H-6-66-009
$HTPLNF CHRDT=1.86,SSPNE=5.42,SSPN=5.43,CHRD=4.69,SAVSI=45.0,
  CHSTAT=0.0,TYPE=1.0$
NACA-V-6-66-009
$VTPLNF CHRDT=3.76,SSPNE=6.05,SSPN=8.18,CHRD=12.47,SAVSI=55.0,
  CHSTAT=0.0,TYPE=1.0$
DIM FT
BUILD
PLOT
NEXT CASE
```



REFERENCES

Data and History

- Blueprints of Mig-17, <http://www.the-blueprints.com>
- History, <http://www.globalsecurity.org/military/world/russia/mig-17.htm>
- History & Data, http://www.vectorsite.net/avmig15_2.html
- Pictures, <http://www.suchoj.com/galerie/index.htm?http://www.suchoj.com/andere/MiG-17/galerie.shtml>