A User's Guide to AIRSET 2.40

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This document describes the use of the multielement airfoil manipulation program **AIRSET** .

Contents

1 Execution

AIRSET can be executed directly, or with an optional argument

```
% airset xxx
```

which will cause file `blade.xxx` to be read if it exists. Here, "`xxx`" is the usual **MSES** case designator and is arbitrary. If the `blade.xxx` file does not exist, then **AIRSET** will try to read the file xxx without the `blade.` prefix. This is intended for reading the common `.dat` format airfoil files. If the `blade.xxx` and `xxx` files do not exist, or there's a read error, then **AIRSET** will start without any airfoil coordinates. The LOAD or ADDE commands can then be used to read airfoil files. The Top-Level menu is

```
  Quit  Exit program

  Adde  Add on element(s) from single-airfoil file(s)
  DELE  Delete specified element

  Load  Read  multielement airfoil file
  Save  Write multielement airfoil file
  ACAD  Write elements to Autocad script file

  CDIR  Change x,y coordinate direction
  CLR   Clear element(s) and re-initialize

 .Posi  Edit position/size of element(s)
 .Modi  Modify contour shape and/or split off flap

 .OPER  Calculate operating point(s)
  Grou  Specify/eliminate ground plane

  Doub  Double the number of points in an element
  Half  Halve  the number of points in an element

  PLOT  Plot current airfoil
  Over  Overlay airfoil from disk file
  ANNO  Annotate current plot
  HARD  Hardcopy current plot
  PLOP  Plotting options

  NODE  Enable/disable element node plotting
  CORN  Enable/disable corner  node plotting
  NUMB  Enable/disable element number plotting
  SPLI  Enable/disable plotting via spline

  NAME  Change airfoil name
  COOR  Locate specified surface x,y coordinates
```

```
AIRSET   c>
```

The commands are not case sensitive. Some commands expect multiple arguments, but if the arguments are not typed, prompts will be issued.

The most commonly-used commands have alternative short forms, indicated by the uppercase part of the command in the menu list. For example, the menu shows...

```
  .Posi  Edit position/size of element(s)
  .Modi  Modify contour shape and/or split off flap

  .OPER  Calculate operating point(s)
   Grou  Specify/eliminate ground plane
```

The "P" command is the short alternative form of "POSI", and the "M" command is the short alternative form of "MODI". The OPER has no short form (as indicated by all capitals in the menu), and must be fully typed.

Some of the commands are executed immediately, while the ones with periods, e.g. POSI, invoke utilities with their own menus. The three major utilities are POSI, MODI, OPER, which are decribed in the subsequent sections.

2 Element contour modification editor (MODI)

This permits the manipulation of the shape of the current Target Element. The shape can be changed by a variety of routines driven from the .MODI menu:

```
 Target element:  1  (home)          LE   at     0.01014     0.02869
          Chord:    0.99028          TE   at     1.00000     0.00000
          Angle:    1.660           Point at     0.00000     0.00000

 M odify contour
 P lot refresh
 T angent-endpoints toggle

 B lowup
 R eset plot scaling, Replot

 O verlay airfoil from disk file
 D istance
 S plit into two elements
 C orner add/delete
 A lter camber line with splined input
 N ew target element

.MODI  s>
```

Most of these are self-explanatory, and a prompt is given for any requested input. In general, each element contour is kept splined as a continous curve from trailing edge to trailing edge. A "corner" can be specified on each element side with the `C` command. Two separate splines are then used on each side of the corner, permitting a slope discontinuity. A corner also has special meaning to the **MSET** grid initializer, which assumes that flow separation will occur off the corner, as over a flap cove. The OPER facility also assumes that flow separation will occur from the corner to the trailing edge, and models this by imposing a near-constant surface velocity distribution via wall blowing.

Explicit modification of the contour is initiated with command `M`, which then requests a sequence of points to be input by clicking on the screen. The points are splined in arc length s, and the resulting curve $x(s), y(s)$ is grafted into the target element between the two nodes closest to the graft-piece endpoints. The grafted piece is normally forced to be tangent to the existing contour at the graft endpoints, but this can be enabled/disabled with the `T` command.

An element can be split into two elements (e.g. main/flap) with the `S` command, which requests the surface break x/c locations and then requests the dividing line to be input in the airfoil interior with the cursor. The split line can be input again if it is not satisfactory. The option to abort the splitting is also given just before it would be implemented. Some "cleanup" shaping of the individual pieces will likely be necessary after the splitting is performed.

3 Element position/scale editor (POSI)

This permits the changing the location and orientation of the individual elements. The relevant routines are driven from the .POSI menu:

```
 Target element:  1  (home)          LE   at     0.10000     0.00016
          Chord:    0.90000          TE   at     1.00000     0.00000
          Angle:    0.010           Point at     0.00000     0.00000

 T ranslate Point by dX,dY      F ix   (save home position)
 M ove Point to X,Y             H ome  (goto home position)
 A ngle change about Point      P oint (set Point location)
 S cale about Point             C oordinate location

 B lowup                        D istance
 R eset plot scale, Replot      G aps between TEs and surfaces

 N ew target element            L ink element motions

 O verlay airfoil from file    sW ap element numbers
 I nstant-Cp plotting toggle    K ey definition

.POSI   s>
```

Again, most of these are self-explanatory. In general, the action is performed only on the current Target Element. The `T M A H S` commands will also act on any elements which are "linked" to the Target Element. Their action will propagate down the link chain. For example, if the link chain is

```
 Element 2 follows 1
 Element 3 follows 2
```

then performing any of the `T M A H S` commands on Target Element 1 will cause the same action to be performed on elements 2 and 3. The link chain is one-way, so that actions on Target Element 2 will only be propagated to element 3. The intent of the link chain is to simulate flap systems where each element is attached to its upstream neighbor.

Most of the above commands require one or more numerical inputs. The input prompts can be anticipated by placing the command's inputs on the same line. For example, a request to translate the Target Element by `dX dY = 0.1 0.2` can be issued at the .POSI prompt as

```
.POSI  s>   T .1 .2
```

or if the two numeric arguments are omitted, then prompts will be given:

```
.POSI  s>   T
Enter  delta X    r>  .1
Enter  delta Y    r>  .2
```

In some cases, a prompt will be followed by a default input, such as when the `O` (overlay) command is issued for the second time without an argument:

```
.POSI  s>   O
 Enter filename:  blade.yyy
```

Just entering `<return>` will take the default "blade.yyy" as input. The `O` command can also be followed by an input to suppress the prompt:

```
.POSI  s>   O blade.zzz
```

The action resulting from the `A M S` commands depends on the current position of the Target Element's reference point, or "Point" for short. This is selected with the `P` command, which will produce a sub-menu if entered with no arguments:

```
   O rigin (0,0)
   L eading edge
   T railing edge
   K eypad-specified location
   C ursor-specified location

Set point at...  c>
```

Option `K` will further request the `X,Y` coordinates to be input. All the inputs can be placed as arguments to the original `P` command. For example, issuing

```
.POSI  s> P K .3 .5
```

is equivalent to issuing the individual commands

```
.POSI  s> P
Set point at...  c> K
Enter REF x point   r> 0.3
Enter REF y point   r> 0.5
```

Spaces between and after the alphabetic inputs are always optional. The command above could have been entered as follows:

```
.POSI  s> PK.3 .5
```

The .POSI menu allows binding of any key on the keyboard to a command string to alleviate repetitive typing. Defining a key is initiated with the `K` command, which displays the current key bindings and asks for a new key or existing key to be defined or redefined:

```
.POSI   s>  K

 Current key definitions...
up-arrow:   T  0.0   0.01
dn-arrow:   T  0.0  -0.01
rt-arrow:   T  0.01  0.0
lf-arrow:   T -0.01  0.0
page-up :   A -1.0   0.0
page-dwn:   A  1.0   0.0

Press key to be defined   s> ^[[20~
Enter key definition   s> S 1.1
Enter key printname (8 chars max)  s> F8
```

This defines the `ctrl-[ [ 2 0 ~` sequence (F8 on most keyboards) to produce the same effect as issuing a "`S 1.1`" scaling command. The printname is simply the label in the menu above (e.g "up-arrow").

Some key definitions are already defined in SUBROUTINE INIT in `airset.f`, which can be customized as needed.

An important feature of the .POSI facility is the ability to immediately display Cp distributions after any geometric change. This feature is toggled on/off with the `I` command. The following items are plotted in solid or dashed lines depending on the status of this flag:

instant-Cp flag	current geometry	current Cp	home geometry	home Cp
off	solid			
on	solid	solid	dashed	dashed

The "current Cp" is actually a linearized perturbation about the panel solution corresponding to the home position of each element. The current Cp will therefore become inaccurate of the current and home geometries differ by too much. A new baseline panel solution can be established simply by setting a new home position with the `F` command. The baseline solution can be either for a specified α or a specified C_L. The airfoil panel distribution for this solution is viewed and possibly changed with the PPAR command from the .OPER menu.

4 Inviscid analysis (OPER)

This allows the calculation of an inviscid panel solution or sequence of solutions for the current geometry. The .OPER menu is:

```
<cr>     Return to Top Level

Alfa r   Specify alpha
ASeq rrr Specify alpha sequence
Cl   r   Specify CL
CSeq rrr Specify CL sequence

Mach r   Specify Mach number
Grou r   Specify/eliminate ground plane

VELS rr  Calculate velocity at a point
UEDG     List surface speeds

HARD     Hardcopy current plot
SIZE r   Change plot size
CPMI r   Change minimum annotation Cp

FORC     Display forces on individual elements
MREF rr  Change moment reference location
PPAR     Change/show paneling

.OPER  c>
```

This is largely self-explanatory. The `r` letters after some of the commands indicate the number of real arguments each command expects, e.g.

```
ASEQ 0.  10.  0.5
```

will generate an alpha sequence 0.0, 0.5, 1.0, ...10.0 immediately. If the three arguments are omitted, e.g.

```
ASEQ
```

then data prompts will be issued.

Some of the parameters set in this menu, such as Mach, alpha, C_L, CPmin, panel distributions, etc., will be used in the instant-Cp mode in the .POSI menu.

5 Windows and Hardcopy

AIRSET uses the Xplot11 (`libPlt.a`) plot library, which is geared for X-Windows and PostScript output. The geometry plots in the MODI and POSI menus are always scaled so as to fill up as much of the window as possible. If the window is resized during execution via the X-Window manager, it

may be necessary to reset the plot blowup parameters (command `R`) before **AIRSET** will recognize the change and rescale accordingly.

A PostScript version of the current visible plot can be written to the file `plot.ps` with the Top-Level `HARD` command at any time. The width of the hardcopy plots can be changed with the `SIZE` command.