ADS V4
User's Manual
Part III
Airfoil Dataset

Rev A

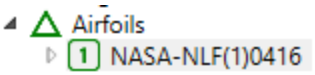
August 07, 2020

Table of content

1. Introduction

1.1. The root node Airfoils

The Airfoil dataset is created from the root node **Airfoils**



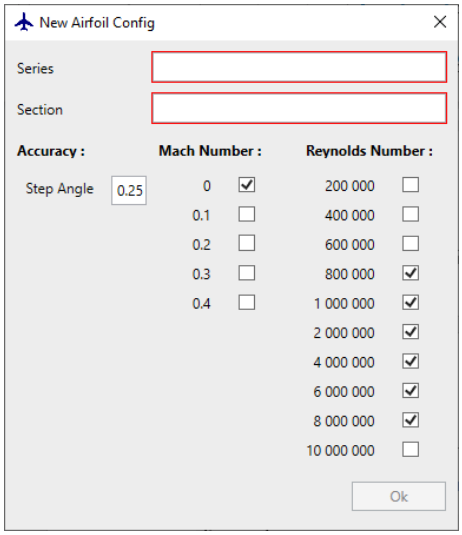
Contextual Menu :	
Right click :	
New Airfoil	To create a new Airfoil dataset in the current session
Open Airfoil	To load an Airfoil dataset in the current session
Duplicate Airfoil	To duplicate an Airfoil dataset and load it in the current session

Several Airfoil datasets may be loaded in the same session

1 ...	The airfoil datasets that will be loaded in the current session
2 ...	
3 ...	
4 ...	

1.2. To Create a new airfoil dataset in the current session

Commands :	
Right click :	
New Airfoil	To create a new Airfoil in the current session



1. Enter
    a) The name of the Airfoil Series (NACA)
    b) The name of the Airfoil Section (23012)
    c) Define Airfoil Dataset conditions
        a. Mach Number
        b. Reynolds Number
2. Click on OK

The New Airfoil is displayed in the TreeView

Notes:

For NACA Airfoils, 4-Digits and 5-Digits, XFoil will automatically generate the coordinates of the airfoil and will compute the aerodynamics characteristics for all combination of the selected Mach Numbers and Reynolds Numbers.

For other Airfoil, the user will need to define the coordinates of the airfoil and then compute with XFoil the aerodynamics characteristics for all selected Mach Numbers and Reynolds Numbers.

XFoil (XFOIL V6.99) may be downloaded from http://web.mit.edu/drela/Public/web/xfoil/

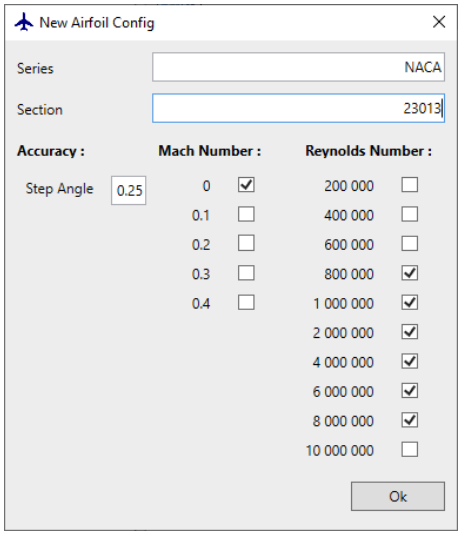
The .exe file (xfoil.exe) must be copied in the folder ADS-Data/Airfoils/XFoil

1.2.1. To Create a new NACA 4/5 digits airfoil dataset

This is done in 3 steps

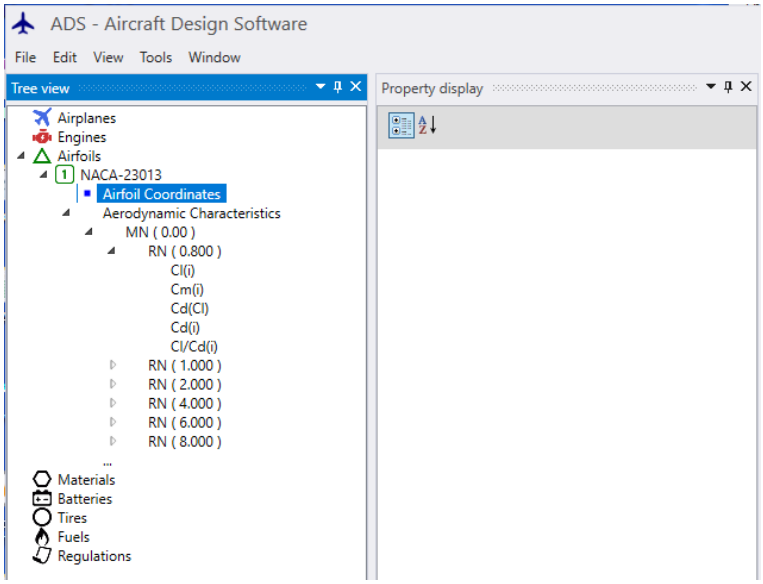
Step 1 Enter NACA to define the Series

Step 2 Enter 4 or 5 digits to define the Section



Step 3 Click on OK to launch XFoil and automatically generate the coordinates of the airfoil and to compute the aerodynamics characteristics for all combination of the selected Mach Numbers and Reynolds Numbers

At the end of the computation XFoil closes, the dataset is automatically saved and the TreeView is automatically updated

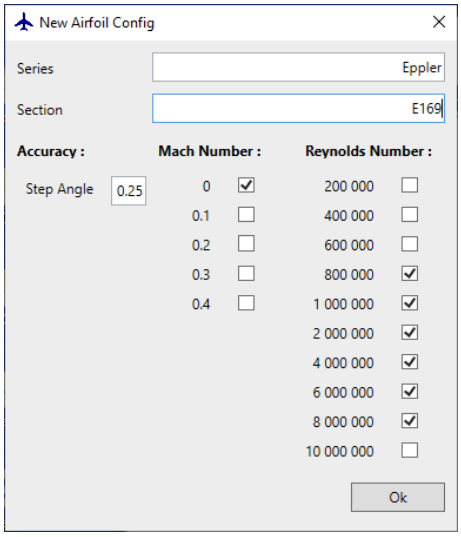


1.2.2. To Create a new airfoil dataset (not NACA 4/5 digits)

This is done in 13 steps

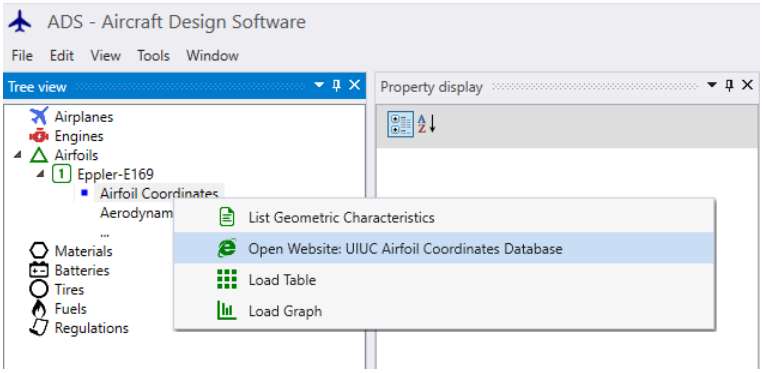
Step 1 Enter a Name to define the Series (Eppler)

Step 2 Enter a Name to define the Section (E169)

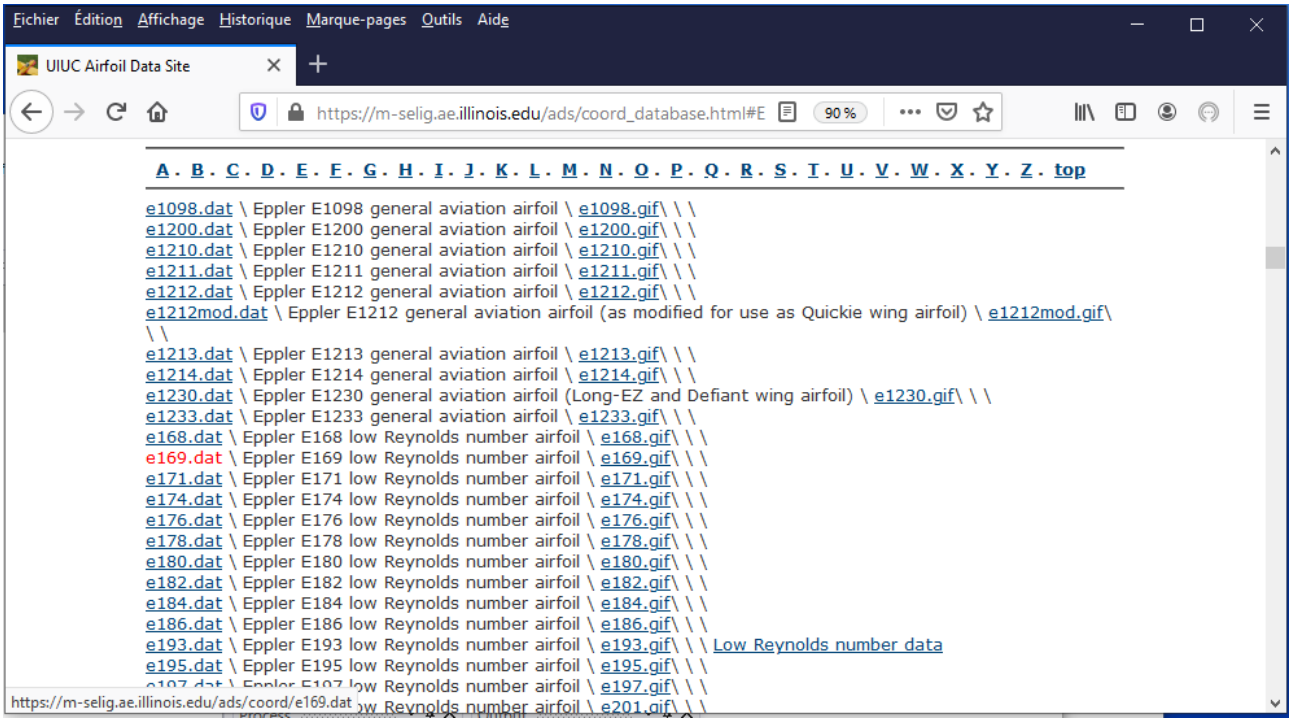


The TreeView is automatically updated

Step 3 Go to the web page ***UIUC Airfoil Coordinates Database***.
Most of the airfoils are available on this website



Step 4 Scroll the page to reach the desired file (e169.dat)



Step 5 Click on **e169.dat** to edit the file

```
E169  (14.4%)
  1.00000  0.00000
  0.99640  0.00022
  0.98598  0.00115
  0.96948  0.00290
  0.94737  0.00514
  0.91970  0.00771
  0.88673  0.01081
  0.84899  0.01458
  0.80708  0.01904
  0.76168  0.02416
  0.71346  0.02985
  0.66316  0.03596
  0.61148  0.04231
  0.55912  0.04866
  0.50675  0.05477
  0.45499  0.06036
  0.40442  0.06516
  0.35555  0.06889
  0.30884  0.07127
  0.26456  0.07202
  0.22289  0.07110
  0.18408  0.06858
  0.14839  0.06450
  0.11605  0.05896
  0.08721  0.05212
  0.06206  0.04427
  0.04085  0.03567
  0.02379  0.02657
  0.01106  0.01729
  0.00290  0.00819
  0.00000  0.00000
  0.00290 -0.00819
  0.01106 -0.01729
  0.02379 -0.02657
  0.04085 -0.03567
  0.06206 -0.04427
  0.08721 -0.05212
  0.11605 -0.05896
  0.14839 -0.06450
  0.18408 -0.06858
  0.22289 -0.07110
  0.26456 -0.07202
  0.30884 -0.07127
  0.35555 -0.06889
  0.40442 -0.06516
  0.45499 -0.06036
  0.50675 -0.05477
  0.55912 -0.04866
  0.61148 -0.04231
  0.66316 -0.03596
  0.71346 -0.02985
  0.76168 -0.02416
  0.80708 -0.01904
  0.84899 -0.01458
  0.88673 -0.01081
  0.91970 -0.00771
  0.94737 -0.00514
  0.96948 -0.00290
  0.98598 -0.00115
  0.99640 -0.00022
  1.00000  0.00000
```


Step 6 Copy/Paste these values in Excel

1. On the web page, Ctrl+A + Ctrl+C
2. In Excel, Ctrl+V
3. In Excel, Remove the first line to keep the numbers only

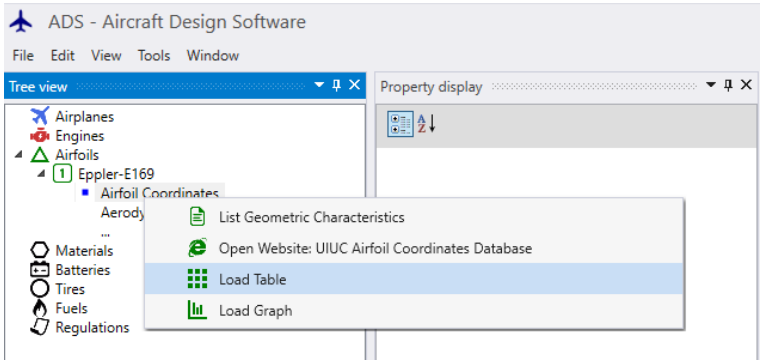
	A	B	C
1	1.00000	0.00000	
2	0.99640	0.00022	
3	0.98598	0.00115	
4	0.96948	0.00290	
5	0.94737	0.00514	
6	0.91970	0.00771	
7	0.88673	0.01081	
8	0.84899	0.01458	
9	0.80708	0.01904	
10	0.76168	0.02416	
11	0.71346	0.02985	
12	0.66316	0.03596	
13	0.61148	0.04231	
14	0.55912	0.04866	
15	0.50675	0.05477	
16	0.45499	0.06036	
17	0.40442	0.06516	
18	0.35555	0.06889	
19	0.30884	0.07127	
20	0.26456	0.07202	

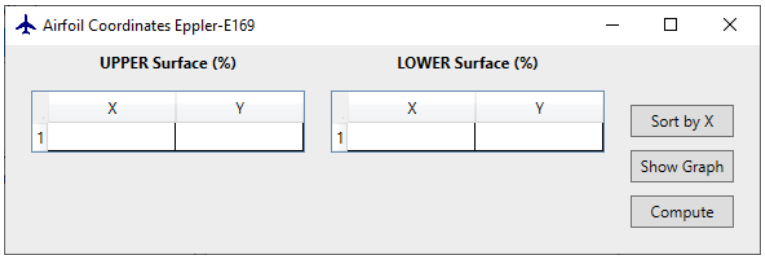
Step 7 In Excel, Convert the data, to split the selected column of text into multiple columns of numbers

1. Select the header of the first column (A)
2. On the top menu, select **Data**, then **Text to Columns**
3. In the **Convert Text to Columns Wizard**, select **Delimited,** then press **Next**.
4. Select the **Delimiters** for your data (= **Space**)
5. Select **Finish**.

	A	B	C	D
1		1	0	
2		0.9964	0.00022	
3		0.98598	0.00115	
4		0.96948	0.0029	
5		0.94737	0.00514	
6		0.9197	0.00771	
7		0.88673	0.01081	
8		0.84899	0.01458	
9		0.80708	0.01904	
10		0.76168	0.02416	
11		0.71346	0.02985	
12		0.66316	0.03596	
13		0.61148	0.04231	
14		0.55912	0.04866	
15		0.50675	0.05477	
16		0.45499	0.06036	
17		0.40442	0.06516	
18		0.35555	0.06889	
19		0.30884	0.07127	
20		0.26456	0.07202	

Step 8 In ADS, Load the Airfoil Coordinates table



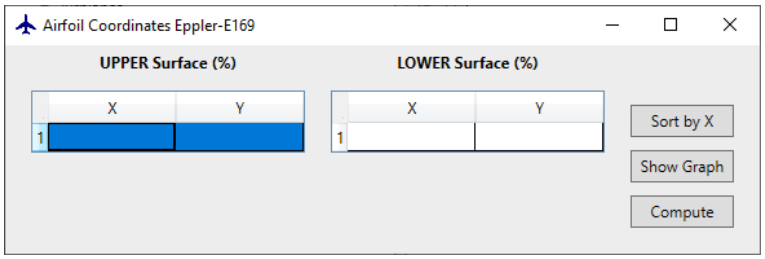


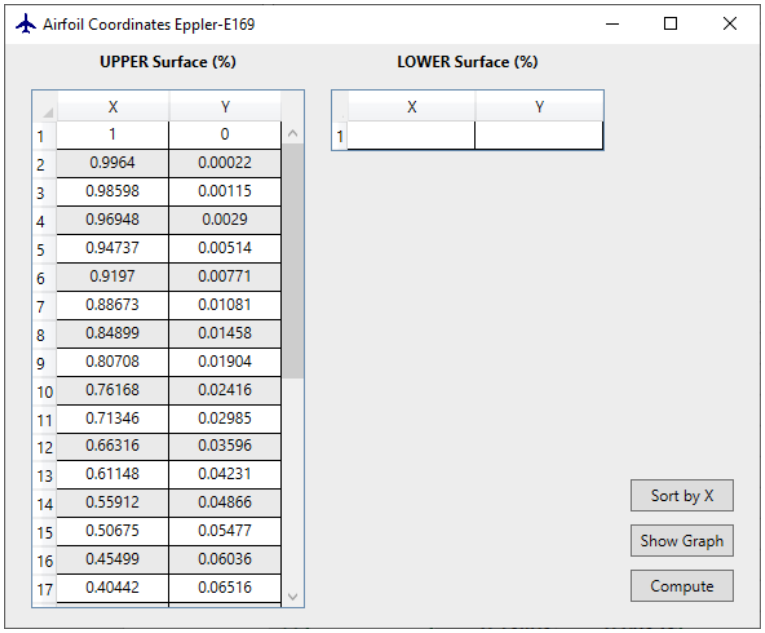
Step 9 In Excel, S**elect** the data relative to the Upper Surface of the airfoil profile (positive values in column C), then **Ctrl+C**

	A	B	C	D
1		1	0	
2		0.9964	0.00022	
3		0.98598	0.00115	
4		0.96948	0.0029	
5		0.94737	0.00514	
6		0.9197	0.00771	
7		0.88673	0.01081	
8		0.84899	0.01458	
9		0.80708	0.01904	
10		0.76168	0.02416	
11		0.71346	0.02985	
12		0.66316	0.03596	
13		0.61148	0.04231	
14		0.55912	0.04866	
15		0.50675	0.05477	
16		0.45499	0.06036	
17		0.40442	0.06516	
18		0.35555	0.06889	
19		0.30884	0.07127	
20		0.26456	0.07202	
21		0.22289	0.0711	
22		0.18408	0.06858	
23		0.14839	0.0645	
24		0.11605	0.05896	
25		0.08721	0.05212	
26		0.06206	0.04427	
27		0.04085	0.03567	
28		0.02379	0.02657	
29		0.01106	0.01729	
30		0.0029	0.00819	
31		0	0	
32		0.0029	-0.00819	

Step 10 Paste these values in ADS

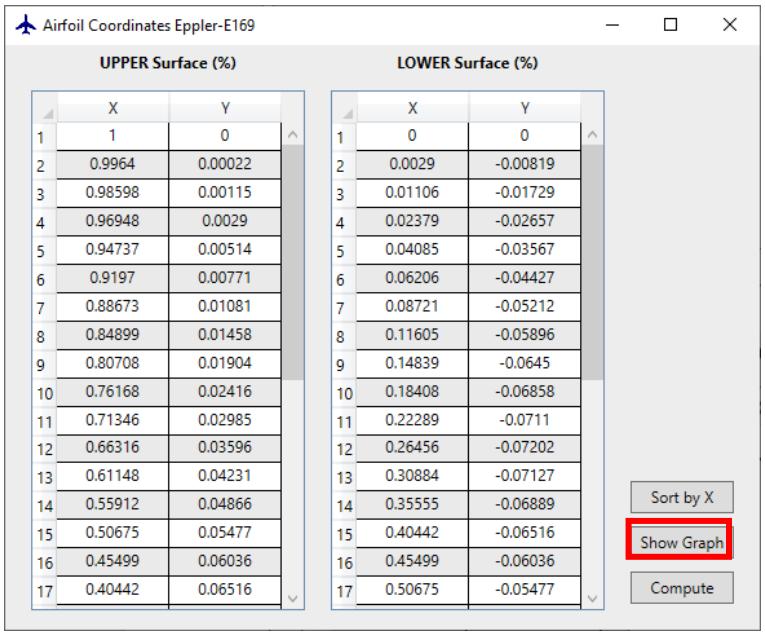
1. Select the first row (click on the Row Header (1))
2. Ctrl+V





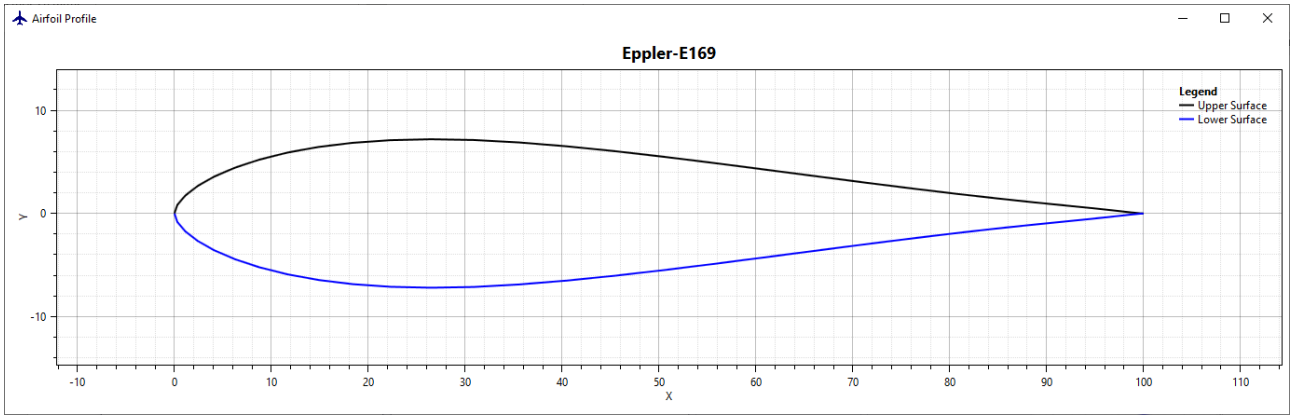
Step 11 Repeat Step 9 and Step 10 for the lower surface of the airfoil profile (negative values in Column C)

Step 12 Click on Show Graph to display the shape of the airfoil profile. The coordinates will be automatically sorted (increasing order)

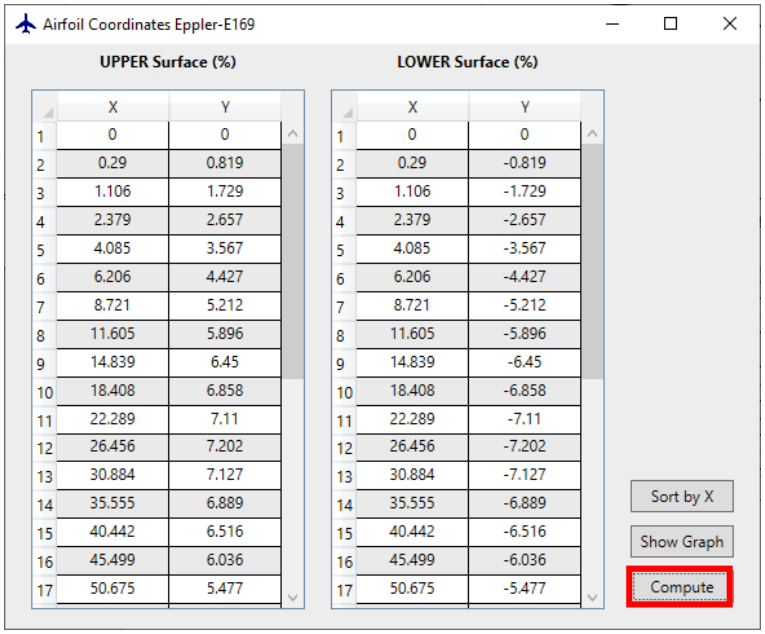


	X	Y
1	1	0
2	0.9964	0.00022
3	0.98598	0.00115
4	0.96948	0.0029
5	0.94737	0.00514
6	0.9197	0.00771
7	0.88673	0.01081
8	0.84899	0.01458
9	0.80708	0.01904
10	0.76168	0.02416
11	0.71346	0.02985
12	0.66316	0.03596
13	0.61148	0.04231
14	0.55912	0.04866
15	0.50675	0.05477
16	0.45499	0.06036
17	0.40442	0.06516

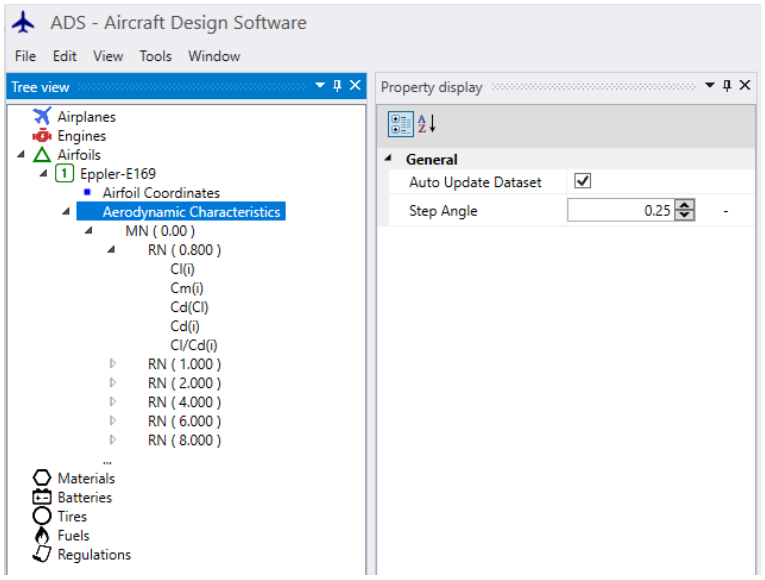
	X	Y
1	0	0
2	0.0029	-0.00819
3	0.01106	-0.01729
4	0.02379	-0.02657
5	0.04085	-0.03567
6	0.06206	-0.04427
7	0.08721	-0.05212
8	0.11605	-0.05896
9	0.14839	-0.0645
10	0.18408	-0.06858
11	0.22289	-0.0711
12	0.26456	-0.07202
13	0.30884	-0.07127
14	0.35555	-0.06889
15	0.40442	-0.06516
16	0.45499	-0.06036
17	0.50675	-0.05477



Step 13 Click on Compute to launch XFoil and to automatically compute the aerodynamics characteristics for all combination of the selected Mach Numbers and Reynolds Numbers

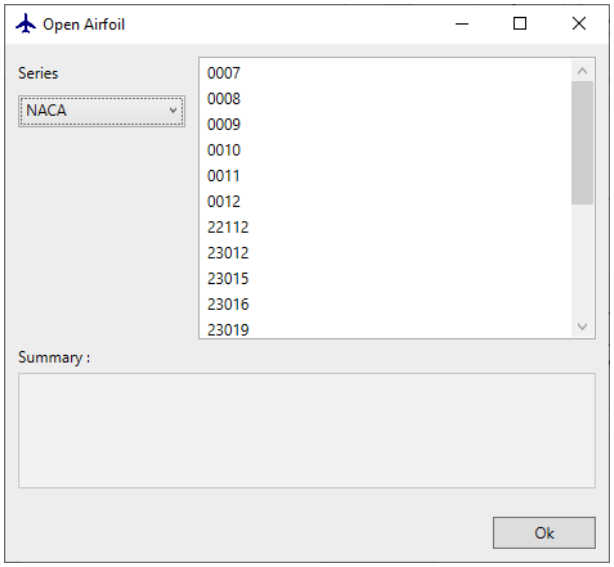


At the end of the computation XFoil closes, the dataset is automatically saved and the TreeView is automatically updated



1.3. To Load an airfoil dataset in the current session

Commands :	
Right click :	
Open Airfoil	To load an Airfoil in the current session



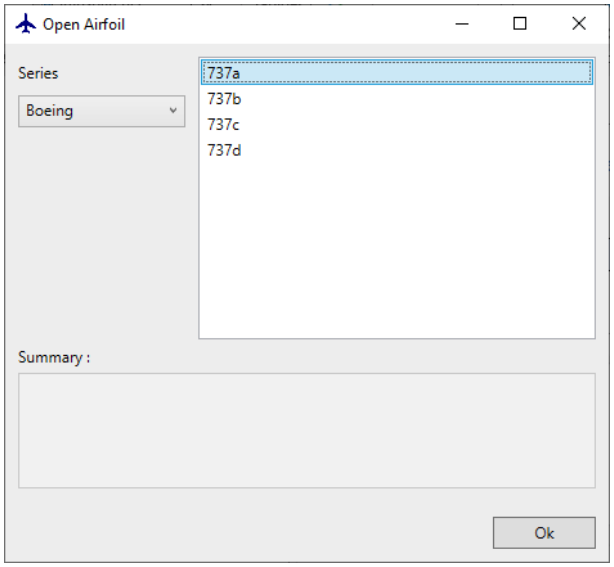
1. Select
   a) Series

   to filter the list
2. Double click on the name of the Airfoil **or** click on the name then click on OK

The selected Airfoil is displayed in the TreeView

1.4. To duplicate an airfoil dataset and load it in the current session

Commands :	
Right click :	
Duplicate Airfoil	To duplicate an Airfoil and load it in the current session



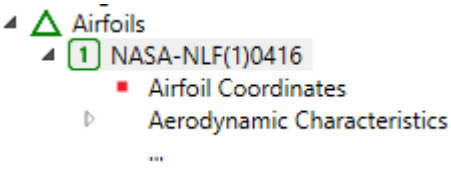
1. Select
   a) Series

   to filter the list
2. Double click on the name of the Airfoil **or** click on the name then click on OK

One copy of the selected Airfoil is displayed in the TreeView

2. Description

The structure of the airfoil dataset is well defined. The data are put together according to the subitem to which they belong.



Subitems:	
Airfoil Coordinates	Data relative to the geometric characteristics
Aerodynamic Characteristics	Data relative to the aerodynamic characteristics

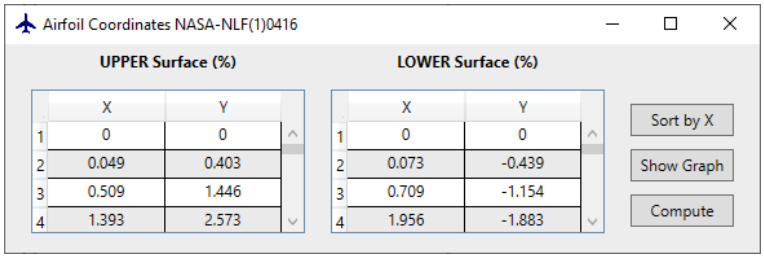
2.1. NASA-NLF(1)0416

Root branch of the current dataset. The header is the concatenation of the Series Name and the Section.

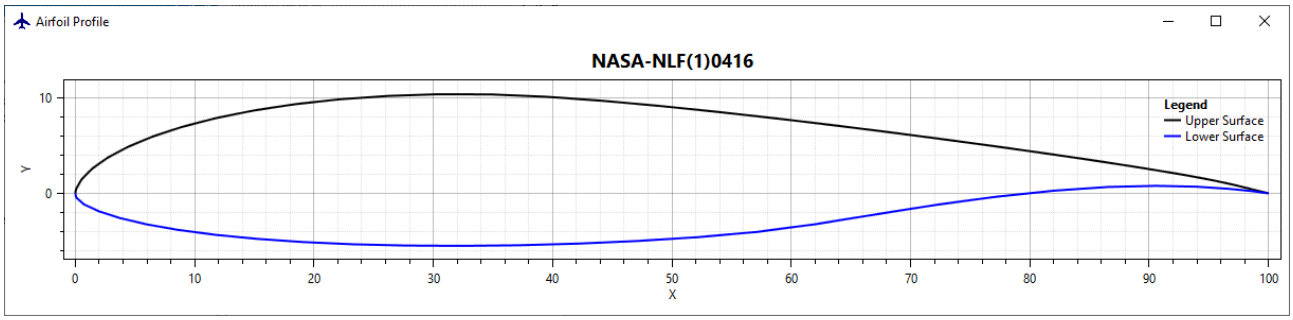
Properties :		
General	Reference	NASA-NLF(1)0416
	Series	NASA
	Section	NLF(1)0416
Fudge Factor	Cp(0)	Fudge Factor to apply on the Minimum Pressure Point on the Upper Surface of the Airfoil @low speed (used to compute the wave drag)
Commands :		
Right click :		
Duplicate		To duplicate the current dataset
Remove		To remove the current dataset from the current session
Save		To save the current dataset
Save As		To save the current dataset and change its name

2.1.1. Airfoil Coordinates

Commands :		
Right click :		
List Geometric Characteristics		To list in the output window the geometric characteristics of the airfoil
Open Website UIUC Airfoil Coordinates Database		To open the website UIUC Airfoil Coordinates Database
Load Table		To load the Table with Airfoil Coordinates
Load Graph		To load the Graph with Airfoil Coordinates



Commands :	
Sort by X	To sort the coordinates by X-ascending
Show Graph	To load the Graph with Airfoil Coordinates
Compute	To Compute with XFoil the aerodynamic characteristics for different Mach Numbers and Reynolds Numbers



Notes:

The aerodynamic characteristics are computed with XFoil.

XFoil (XFOIL V6.99) may be downloaded from http://web.mit.edu/drela/Public/web/xfoil/

The .exe file (xfoil.exe) must be copied in the folder ADS-Data/Airfoils/XFoil

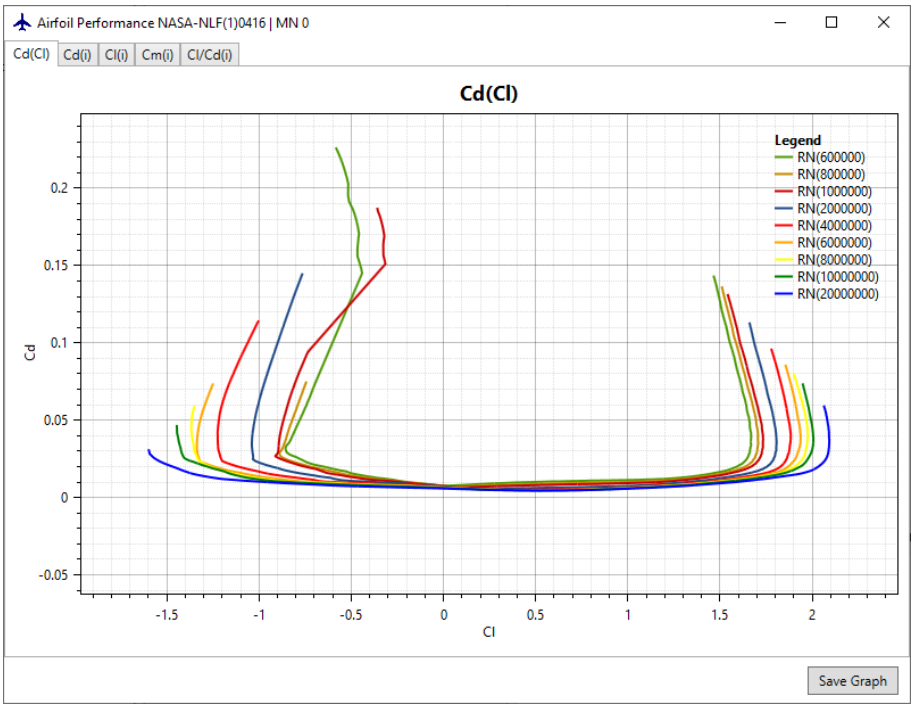
2.1.2. Aerodynamic Characteristics

Commands :		
Right click :		
Add New MN		To Add a new Dataset for a given Mach Number
List Aerodynamic Characteristics		To list in the output window the aerodynamic characteristics of the airfoil for all Mach Numbers and all Reynolds Numbers

2.1.2.1. *MN*

Data relative to one Mach Number

Properties :		
Mach Number	MN	Mach Number of the current Dataset
Commands :		
Right click :		
Add New RN		To Add a new Dataset for a given Reynolds Number
Remove MN		To remove the current dataset from the current session
List Aerodynamic Characteristics		To list in the output window the aerodynamic characteristics of the airfoil for the given Mach Numbers and all Reynolds Numbers
Load Graph		To load the Graph with Aerodynamic Characteristics for the given Mach Number



2.1.2.1.1. RN

Data relative to one Reynolds Number

Properties :		
Reynolds Number	RN	Reynolds Number of the current Dataset
Aerodynamic Center	Position	Aerodynamic Center Location (% Chord)
Performance Curves	Has Curve Cd(Cl)	Specifies if it has Curve Cd(Cl)
	Has Curve Cd(i)	Specifies if it has Curve Cd(i)
	Has Curve Cl(i)	Specifies if it has Curve Cl(i)
	Has Curve Cl/Cd(i)	Specifies if it has Curve Cl/Cd(i)
	Has Curve Cm(i)	Specifies if it has Curve Cm(i)

Commands :		
Right click :		
Remove RN		To remove the current dataset from the current session
List Aerodynamic Characteristics		To list in the output window the aerodynamic characteristics of the airfoil for the given Mach Numbers and the given Reynolds Numbers

2.1.2.1.1.1. Cl(i)

Commands :		
Right click :		
Load Table		To load the Table with Airfoil Aerodynamic Characteristics
Load Graph		To load the Graph with Airfoil Aerodynamic Characteristics

2.1.2.1.1.2. Cm(i)

Commands :		
Right click :		
Load Table		To load the Table with Airfoil Aerodynamic Characteristics
Load Graph		To load the Graph with Airfoil Aerodynamic Characteristics

2.1.2.1.1.3. Cd(Cl)

Commands :		
Right click :		
Load Table		To load the Table with Airfoil Aerodynamic Characteristics
Load Graph		To load the Graph with Airfoil Aerodynamic Characteristics

2.1.2.1.1.4. Cd(i)

Commands :		
Right click :		
Load Table		To load the Table with Airfoil Aerodynamic Characteristics
Load Graph		To load the Graph with Airfoil Aerodynamic Characteristics

2.1.2.1.1.5. Cl/Cd(i)

Commands :		
Right click :		
Load Table		To load the Table with Airfoil Aerodynamic Characteristics
Load Graph		To load the Graph with Airfoil Aerodynamic Characteristics