

Engineering Sketch Pad (ESP)



Training Session 12 Building Large Models

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updated for v1.25

- Multi-X models
- Transport model
 - Multiple components
 - Multiple views
 - Multiple generations
- Homework exercises

- Define design and configuration parameters
- Generate the base Body(s)
 - primitives: box, sphere, cylinder, cone, torus, import, user-defined primitive (UDP)
 - grown: extrude, revolve, rule, blend, sweep
- Apply attributes
 - user-defined name
 - values can be (matrix/array of) numbers or strings
- Transform the Bodys
 - translate, rotate, scale, mirror
- Combine the Bodys
 - union, join, intersect, subtract

Note: all this can be done via the browser or by writing a `.csm` script.

- During the design of an aircraft, various coupled models are needed
 - different disciplines
 - structures
 - controls
 - aerodynamics
 - ...
 - different fidelities
 - conceptual design
 - preliminary design
 - detailed design
- There needs to be communication between these models

- **One** definition for each component:
 - wing — inboard and outboard sections (with controls)
 - fuselage — tube with cockpit and raked tail
 - horizontal tail — one section (with controls)
 - vertical tail — one section (with controls)
 - nacelle — flow-through
 - pylon — one section
 - payloads — cockpit, passenger compartments, galleys, baggage hold, fuel tank

- One of the strengths of ESP is to be able to have multiple “views” of a single configuration
 - tailored to a specific analysis method
 - driven by a single set of Design Parameters
 - attributed so that “common” features could be linked together
 - commensurate with the meshing requirements of the analysis
- Biggest problem is that such models can get very large
 - break up into nested user-defined components (UDCs)
 - generate in multiple generations



Multiple Views for the Transport

- Concept
- Panel
- Vlm
- CfdInviscid
- CfdViscous
- Bem
- Bones

	<i>fuse</i>	<i>htail</i>	<i>nacelle</i>	<i>payload</i>	<i>pylon</i>	<i>vtail</i>	<i>wing</i>
Concept	x	x	x	x		x	x
Vlm		x				x	x
Oml	x	x	x		x	x	x
Panel*	x	x	x		x	x	x
CfdInviscid*	x	x	x		x	x	x
CfdViscous*	x	x	x		x	x	x
Bem	x	x				x	x
Bones*	x	x				x	x

- transport.csm
- transport_setup.udc
- fuse/
 - Pmtrs.udc
 - Cals.udc
 - Oml.udc
 - Iml.udc
 - Waffle.udc
 - Bem.udc
- htail/
 - Pmtrs.udc
 - Cals.udc
 - Hinges.udc
 - Oml.udc
 - Waffle.udc
 - Bem.udc
 - Vlm.udc
- nacelle/
 - Pmtrs.udc
 - Cals.udc
 - Oml.udc
- payload/
 - Pmtrs.udc
 - payload.udc
- pylon/
 - Pmtrs.udc
 - Cals.udc
 - Oml.udc
- vtail/
 - Pmtrs.udc
 - Cals.udc
 - Hinges.udc
 - Oml.udc
 - Waffle.udc
 - Bem.udc
 - Vlm.udc
- wing/
 - Pmtrs.udc
 - Cals.udc
 - Hinges.udc
 - Oml.udc
 - Waffle.udc
 - Bem.udc
 - Vlm.udc
- view/
 - Concept.udc
 - Vlm.udc
 - Oml.udc
 - Panel.udc
 - CfdInviscid.udc
 - CfdViscous.udc
 - Bem.udc
 - Bones.udc

- 1 wing in Concept view (oml only)
- 2 add fuselage, htail, and vtail
- 3 add Panel view
- 4 add nacelle and pylon
- 5 add payload
- 6 add controls to wing, htail, and vtail
- 7 add Vlm view
- 8 add pyscript to run avl

- 9 add tip treatment to wing, htail, and vtail
- 10 add CfdInviscid view
- 11 add CfdViscous view
- 12 add pyscript for **fun3d** (inviscid)
- 13 add wing BEM (built-up element model)
- 14 add fuselage, htail, and vtail BEM
- 15 add Bones view



Generation 01 — wing in Concept view

ESP (Engineering Sketch Pad) v. X

file:///Users/tdannen/Projects/OpenCSM/ESP/ESP-localhost7681.html

120%

File Tool Graph/Tree Help

Up to date

Undo

Design Parameters Collapse All

VIEW:

- Concept 1
- COMP: wing 1
- wing:
 - area 4240
 - aspect 9
 - taper1 0.48
 - taper0 0.23
 - sweep 35
 - dihedral 7
 - break 0.37
 - alpha1 -1
 - thick1 0.1
 - camber1 0.08
 - alpha0 -3
 - thick0 0.15
 - camber0 0.04
 - alpha1 -8
 - thick1 0.08
 - camber1 0.01
 - xroot 50
 - zroot -8


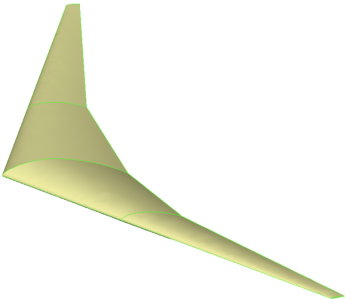
Local Variables Expand All

Branches Expand All

Display wingCtrl Via Ctrl

Axis Via Ctrl

Display Type Display Filter



Building wing01.
Entire build complete, which generated 1 Body(s)

"/data/MultiModels/Transport/gen01/transport.csm" has been loaded
uses: "/data/MultiModels/Transport/gen01/transport_setup.udc"
uses: "/data/MultiModels/Transport/gen01/wing/Petrs.udc"
uses: "/data/MultiModels/Transport/gen01/Calc.udc"
uses: "/data/MultiModels/Transport/gen01/view/Concept.udc"
uses: "/data/MultiModels/Transport/gen01/wing/0m1.udc"

- New files:

transport.csm	(18 lines)
transport_setup.udc	(21 lines)
view/Concept.udc	(17 lines)
wing/Calc.udc	(23 lines)
wing/Oml.udc	(106 lines)
wing/Pmtrs.udc	(26 lines)



Generation 01 — transport.csm

```
# transport (inspired by boeing 787)
# written by John Dannenhoffer

# define the views
CFGPMTR    VIEW:Concept          1

UDPRIM     $/transport_setup

IFTHEN     VIEW:Concept          NE 0
    UDPRIM  $/view/Concept
ENDIF

# catch any errors that were generated by the user
CATBEG     -999
    MESSAGE user-generated_signal_caught
CATEND

END
```

```
# .udc to set up DESPMTRs, CFGPMTRs, and critical locations and dimensions
# written by John Dannenhoffer
```

```
INTERFACE . ALL
```

```
# global tolerance
set EPS06 1.0e-6
```

```
# make a list of the components
CFGPMTR   COMP:wing      1
```

```
# define the DESPMTRs nd CFGPMTRs
UDPRIM     $/wing/Pmtrs
```

```
# by default, trailing edges are blunt
SET        SHARP_TE      0
```

```
# compute critical locations / dimensions
UDPRIM     $/wing/Calc
```

```
END
```

```
# .udc to make the Concept view
# written by John Dannenhoffer

INTERFACE . ALL

# make sure we have the necessary Bodys
IFTHEN    COMP:wing NE 0
          UDPRIM    $/../../wing/Oml
ENDIF

# now that we have all the Bodys, show them
IFTHEN    COMP:wing NE 0
          RESTORE    wingOml
          ATTRIBUTE _name $wingOml
ENDIF

END
```



Generation 01 — wing/Pmtrs (1)

```
# .udc to define the DESPMTRs and CFGPMTRs for a wing
# written by John Dannenhoffer
```

```
INTERFACE . ALL
```

```
# wing 0ml
```

DESPMTR	wing:area	4240	# area
DESPMTR	wing:aspect	9.00	# aspect ratio
DESPMTR	wing:taperi	0.48	# inboard taper ratio
DESPMTR	wing:tapero	0.23	# outboard taper ratio
DESPMTR	wing:sweep	35.0	# leading edge sweep
DESPMTR	wing:dihedral	7.0	# dihedral
DESPMTR	wing:break	0.37	# inboard/outboard
DESPMTR	wing:alphar	-1.0	# setting angle at root
DESPMTR	wing:thickr	0.10	# thickness ratio at root
DESPMTR	wing:camber	0.08	# camber ratio at root
DESPMTR	wing:alphab	-3.0	# setting angle at break
DESPMTR	wing:thickb	0.15	# thickness ratio at break
DESPMTR	wing:camberb	0.04	# camber ratio at break
...			



Generation 01 — wing/Pmtrs (2)

```
...  
DESPMTR  wing:alphat    -8.0    # setting angle    at tip  
DESPMTR  wing:thickt    0.08    # thickness ratio  at tip  
DESPMTR  wing:cambert   0.01    # camber          ratio at tip  
DESPMTR  wing:xroot     50.0    # xloc at root LE  
DESPMTR  wing:zroot     -8.0    # zloc at root LE  
  
END
```



Generation 01 — wing/Calc.udc

```
# .udc to calculate critial locations and dimensions for a wing
# written by John Dannenhoffer
```

```
INTERFACE . ALL
```

```
OUTPMTR    wing:mac
OUTPMTR    wing:wet
```

```
SET        wing:span      sqrt(wing:aspect*wing:area)
SET        wing:yroot     0
SET        wing:ytip      -wing:span/2
SET        wing:xtip      wing:xroot-wing:ytip*tand(wing:sweep)
SET        wing:ztip      wing:zroot-wing:ytip*tand(wing:dihedral)
SET        wing:ybreak    wing:ytip*wing:break
SET        wing:xbreak    wing:xroot-wing:ybreak*tand(wing:sweep)
SET        wing:zbreak    wing:zroot-wing:ybreak*tand(wing:dihedral)
SET        wing:chordr     wing:area/((wing:yroot-wing:ybreak)*(wing:taperi+1)+(wing:
SET        wing:chordb     wing:chordr*wing:taperi
SET        wing:chordt     wing:chordb*wing:tapero
SET        wing:mac        sqrt(wing:area/wing:aspect)
SET        wing:sharpte    SHARP_TE
```

```
END
```



Generation 01 — wing/Oml.udc (1)

```
# .udc to make the wingOml
# written by John Dannenhoffer

INTERFACE . ALL

SPECIAL    provides  $wing  $concept
SPECIAL    provides  $wing  $oml

# check to see if the Body already exists
RESTORE    wingOml

# if it does not exist, make it now
CATBEG     $name_not_found
    MESSAGE Building_wingOml

# lay out left wing
MARK
    # root
    UDPRIM    naca      thickness  wing:thickr   camber   wing:camherr   sharpte
    SCALE     wing:chordr
    ROTATEX    90  0  0
    ROTATEY    wing:alpar  0  0
    TRANSLATE  wing:xroot   wing:yroot   wing:zroot
```


...

```
UDPRIM    naca      camber  wing:camberb  thickness  wing:thickb  sharpte
SCALE     wing:chordb
ROTATEX   90  0  0
ROTATEY   wing:alphab  0  0
TRANSLATE wing:xbreak      wing:ybreak  wing:zbreak
```

left tip

```
UDPRIM    naca      thickness  wing:thickt  camber  wing:cambert  sharpte
SCALE     wing:chordt
ROTATEX   90  0  0
ROTATEY   wing:alphat  0          0
TRANSLATE wing:xtip    wing:ytip  wing:ztip
```

RULE

```
  ATTRIBUTE tagComp $leftWing
SET          ruledBody @nbody
```

...

...

```
SELECT    FACE ruledBody  1
  ATTRIBUTE tagType  $root
SELECT    FACE ruledBody  2
  ATTRIBUTE tagType  $tip
  ATTRIBUTE tagIndex $1
SELECT    FACE ruledBody  3
  ATTRIBUTE tagType  $upper
SELECT    FACE ruledBody  4
  ATTRIBUTE tagType  $upper
SELECT    FACE ruledBody  5
  ATTRIBUTE tagType  $lower
SELECT    FACE ruledBody  6
  ATTRIBUTE tagType  $lower
SELECT    EDGE ruledBody 3 ruledBody 5 1
  ATTRIBUTE tagType  $leadingEdge
SELECT    EDGE ruledBody 4 ruledBody 6 1
  ATTRIBUTE tagType  $leadingEdge
```

...

```
...
IFTHEN    wing:sharpTE EQ 0
  SELECT   FACE ruledBody 7
    ATTRIBUTE tagType $trailingEdge
  SELECT   FACE ruledBody 8
    ATTRIBUTE tagType $trailingEdge
ELSE
  SELECT   EDGE ruledBody 3 ruledBody 5 2
    ATTRIBUTE tagType $trailingEdge
  SELECT   EDGE ruledBody 4 ruledBody 6 2
    ATTRIBUTE tagType $trailingEdge
ENDIF
...
```

...

```
# right wing too
STORE      LeftWing 0 1
RESTORE    LeftWing
    ATTRIBUTE tagComp $riteWing
SELECT     FACE $tagType $tip
    ATTRIBUTE tagIndex $2
SELECT     EDGE $tagType $leadingEdge
IFTHEN     @iedge GT 0
    SELECT EDGE $tagType $leadingEdge
        ATTRIBUTE tagComp $riteWing
ENDIF
IFTHEN     wing:sharpTE EQ 1
    SELECT  EDGE $tagType $trailingEdge
    IFTHEN  @iedge GT 0
        SELECT EDGE $tagType $trailingEdge
            ATTRIBUTE tagComp $riteWing
    ENDIF
ENDIF
MIRROR     0    1    0
```

...

...

```
# join into single wing
JOIN
```

```
# attribute the root
SELECT    EDGE    ruledBody 3 ruledBody 3 1
          ATTRIBUTE tagType $root
SELECT    EDGE    ruledBody 5 ruledBody 5 1
          ATTRIBUTE tagType $root
```

```
# store the final Body
STORE     wingOml
```

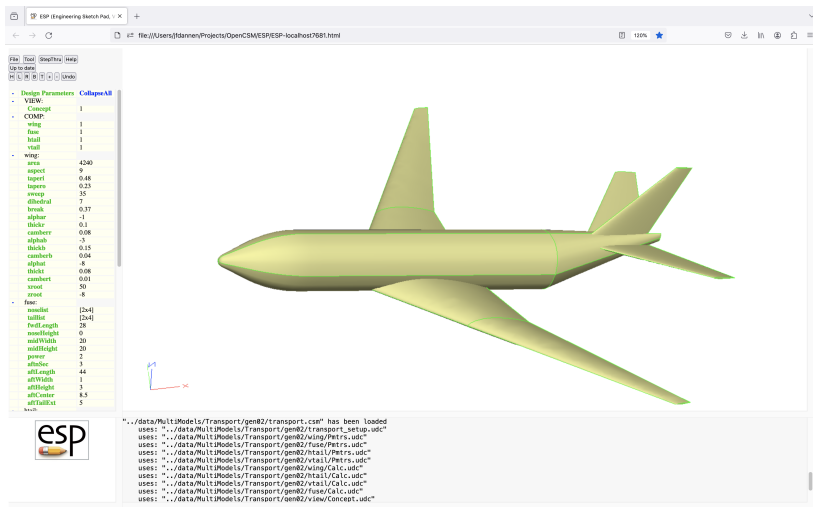
CATEND

```
# make sure the stack is empty
STORE     ...
```

END



Generation 02 — add fuse, htail, and vtail

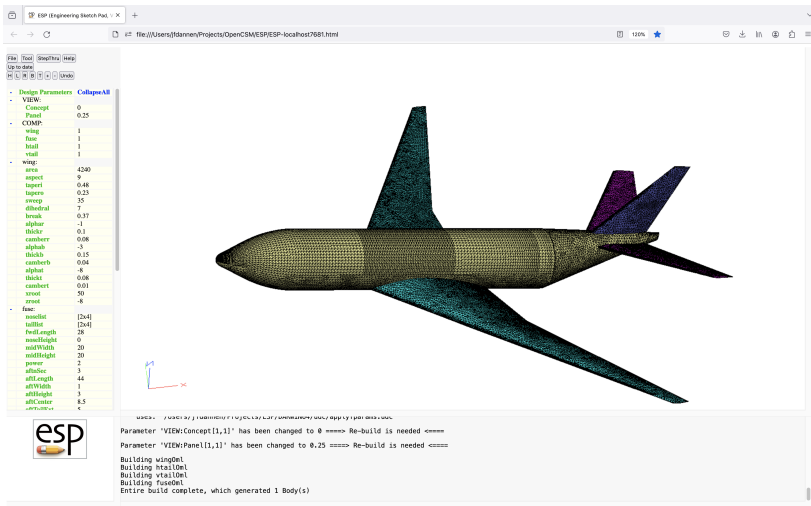


- New files:

<code>fuse/Calc.udc</code>	<code>(29 lines)</code>
<code>fuse/Oml.udc</code>	<code>(55 lines)</code>
<code>fuse/Pmtrs.udc</code>	<code>(28 lines)</code>
<code>htail/Calc.udc</code>	<code>(21 lines)</code>
<code>htail/Oml.udc</code>	<code>(78 lines)</code>
<code>htail/Pmtrs.udc</code>	<code>(19 lines)</code>
<code>vtail/Calc.udc</code>	<code>(19 lines)</code>
<code>vtail/Oml.udc</code>	<code>(51 lines)</code>
<code>vtail/Pmtrs.udc</code>	<code>(18 lines)</code>

- Modified files:

<code>transport_setup.udc</code>	<code>(9 lines)</code>
<code>view/Concept.udc</code>	<code>(24 lines)</code>



The screenshot shows the ESP (Engineering Sketch Pad) software interface. The main window displays a 3D model of a jet airplane. The left sidebar contains a parameter tree with the following structure:

- Design Parameters (Collapsed)
 - VIEW:
 - Concept: 0
 - Panel: 0.25
 - COMP:
 - wing: 1
 - fuse: 1
 - htail: 1
 - vtail: 1
 - wing:
 - area: 4290
 - aspect: 9
 - taper1: 0.48
 - taper0: 0.23
 - sweep: 35
 - dihedral: 7
 - break: 0.37
 - alpha: -1
 - thick: 0.1
 - camber: 0.08
 - alpha0: -5
 - thick0: 0.15
 - camber0: 0.04
 - alpha1: -8
 - thick1: 0.08
 - camber1: 0.01
 - xroot: 50
 - yroot: -8
 - fuse:
 - msl0: [2x4]
 - msl1: [2x4]
 - fwl0: 28
 - msl0: 0
 - msl1: 20
 - msl2: 20
 - power: 2
 - afw0: 3
 - afw1: 44
 - afw2: 1
 - afw3: 3
 - afw4: 8.5

Below the parameter tree, the ESP logo is displayed. The main window shows a 3D model of a jet airplane. The bottom status bar displays the following text:

```
Parameter 'VIEW:Concept[1,1]' has been changed to 0 ===== Re-build is needed =====
Parameter 'VIEW:Panel[1,1]' has been changed to 0.25 ===== Re-build is needed =====
Building wing0m1
Building htail0m1
Building vtail0m1
Building fuse0m1
Entire Build complete, which generated 1 Body(s)
```


- New files:

view/0ml.udc (43 lines)

view/Panel.udc (48 lines)

- Modified files:

transport.csm (4 lines)



Generation 04 — add nacelle and pylon

ESP (Engineering Sketch Pad) v. X

file:///Users/jtdannen/Projects/OpenCSM/ESP/ESP-localhost7681.html

120%

File Tool Snap/Thru Help

Up to date

Design Parameters Collapse All

VIEW:

- Concept 0
- Panel -0.5

COMP:

- wing 1
- fuse 1
- htail 1
- vtail 1
- nacelle 1
- pylon 1

wing:

- area 4240
- aspect 9
- aperi 0.48
- aperso 0.23
- sweep 35
- dihedral 7
- brook 0.37
- alpha -1
- thick 0.1
- camber 0.08
- alphaub -3
- thickb 0.15
- camberb 0.04
- alphaat -8
- thickt 0.08
- cambert 0.01
- xtot 50
- xtotc -8

fuse:

- noselet [2x4]
- taillet [2x4]
- fwlLength 28
- noseHeight 0
- midWidth 20
- midHeight 20
- power 2
- flwSec 3
- afLength 44
- afWidth 1
- afHt 1

Forced re-building...

Building wing0m1

Building pylon0m1

Building nacelle0m1

Building htail0m1

Building vtail0m1

Building fuse0m1

Entire build complete, which generated 1 Body(s)



- Modified files:

pylon/Pmtrs.udc (11 lines)

view/Oml.udc (55 lines)



Generation 05 — add payload

ESP (Engineering Sketch Pad) v. X

file:///Users/dannen/Projects/OpenCSM/ESP/ESP-localhost7681.html

120%

File Tool Graph/Tree Help

Up to date

Design Parameters Collapse All

VIEW:

- Concept 1
- Panel 0

COMP:

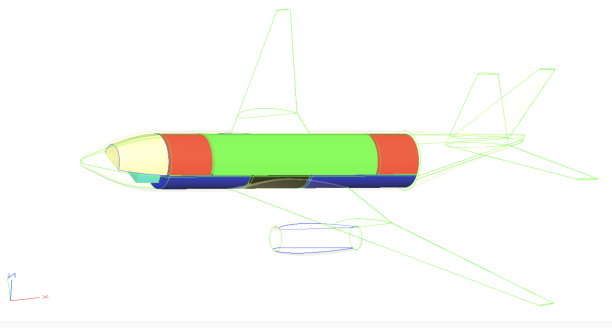
- wing 1
- fuse 1
- htail 1
- vtail 1
- nacelle 1
- pylon 1
- payload 1

wing:

- area 4290
- aspect 9
- laperl 0.48
- lapers 0.23
- arswp 35
- dihedral 7
- break 0.37
- alpha -1
- thick 0.1
- camberl 0.08
- alpha0 -5
- thickb 0.15
- camberb 0.04
- alpha1 8
- thicki 0.08
- camberi 0.01
- xroot 50
- yroot -8

fuse:

- modelat [2x4]
- tailat [2x4]
- fwl length 28
- nowl length 0
- mid width 20
- mid height 20
- power 2
- afsdie 3
- afL length 44
- afvL length 1



..../data/MultiModels/Transport/gen05/transport.csm" has been loaded
uses: ".../data/MultiModels/Transport/gen05/transport_setup.udc"
uses: ".../data/MultiModels/Transport/gen05/wing/Petrs.udc"
uses: ".../data/MultiModels/Transport/gen05/fuse/Petrs.udc"
uses: ".../data/MultiModels/Transport/gen05/htail/Petrs.udc"
uses: ".../data/MultiModels/Transport/gen05/vtail/Petrs.udc"
uses: ".../data/MultiModels/Transport/gen05/pylon/Petrs.udc"
uses: ".../data/MultiModels/Transport/gen05/nacelle/Petrs.udc"
uses: ".../data/MultiModels/Transport/gen05/payload/Petrs.udc"
uses: ".../data/MultiModels/Transport/gen05/htail/Calc.udc"

- New files:

`fuse/Iml.udc` (55 lines)

`payload/Pmtrs.udc` (15 lines)

`payload/payload.udc` (122 lines)

- Modified files:

`transport_setup.udc` (22 lines)

ESP (Engineering Sketch Pad) v. X

file:///Users/jtdannen/Projects/OpenCSM/ESP/ESP-localhost7681.html

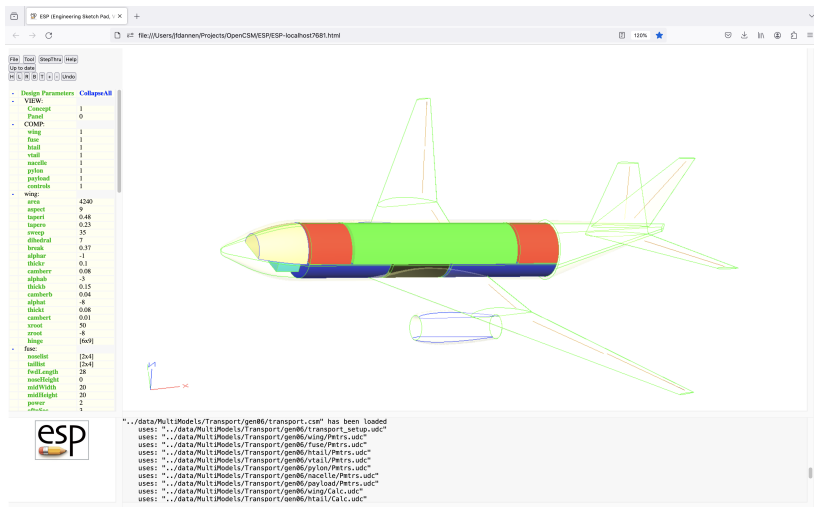
120%

File Tool Snap/Freeze Help

Up to date

Design Parameters Collapse All

- VIEW:
 - Concept 1
 - Panel 0
- COMP:
 - wing 1
 - fuse 1
 - htail 1
 - vtail 1
 - nacelle 1
 - pylon 1
 - payload 1
 - controls 1
- wing:
 - area 42.80
 - aspect 9
 - taper1 0.48
 - taper2 0.23
 - sweep 35
 - dihedral 7
 - break 0.37
 - alpha -1
 - thickr 0.1
 - camber 0.08
 - alpha0 -3
 - thickb 0.15
 - camberb 0.04
 - alpha0 -6
 - thicki 0.08
 - camberi 0.01
 - zroot 50
 - zroot -8
 - hinge [fwd]
- fuse:
 - nozzle [2x4]
 - tailkeel [2x4]
 - tailLength 28
 - noseHeight 0
 - midWidth 20
 - midHeight 20
 - power 2
 - alpha0 1



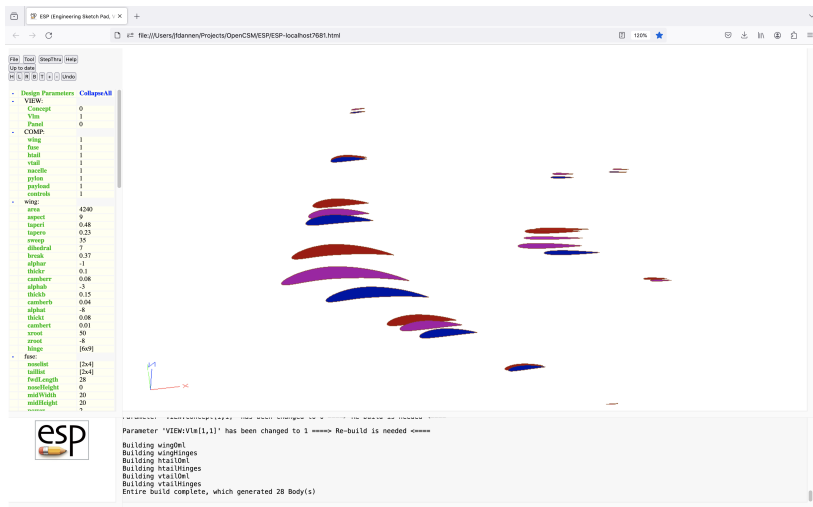
".../data/MultiModels/Transport/gen06/transport.csm" has been loaded
 uses: ".../data/MultiModels/Transport/gen06/transport_setup.udc"
 uses: ".../data/MultiModels/Transport/gen06/wing/Petrs.udc"
 uses: ".../data/MultiModels/Transport/gen06/fuse/Petrs.udc"
 uses: ".../data/MultiModels/Transport/gen06/htail/Petrs.udc"
 uses: ".../data/MultiModels/Transport/gen06/vtail/Petrs.udc"
 uses: ".../data/MultiModels/Transport/gen06/pylon/Petrs.udc"
 uses: ".../data/MultiModels/Transport/gen06/nacelle/Petrs.udc"
 uses: ".../data/MultiModels/Transport/gen06/payload/Petrs.udc"
 uses: ".../data/MultiModels/Transport/gen06/wing/Calc.udc"
 uses: ".../data/MultiModels/Transport/gen06/htail/Calc.udc"

- New files:

htail/Hinges.udc	(65 lines)
vtail/Hinges.udc	(65 lines)
wing/Hinges.udc	(66 lines)

- Modified files:

transport_setup.udc	(2 lines)
htail/Pmtrs.udc	(6 lines)
vtail/Pmtrs.udc	(6 lines)
wing/Pmtrs.udc	(17 lines)
view/Concept.udc	(18 lines)
view/Oml.udc	(3 lines)
view/Panel.udc	(153 lines)



The screenshot shows the ESP (Engineering Sketch Pad) software interface. The main window displays a 3D model of a wing with various colored sections (red, blue, purple, green). The left sidebar contains a tree view of the design parameters, including:

- Design Parameters (Collapsed)
- VIEW:
 - Concept: 0
 - Vlm: 1
 - Panel: 0
- COMP:
 - wing: 1
 - fuse: 1
 - htail: 1
 - vtail: 1
 - nacelle: 1
 - pylon: 1
 - payload: 1
 - controls: 1
- Wing:
 - area: 4290
 - aspect: 9
 - laperf: 0.48
 - lapers: 0.23
 - sweep: 35
 - dihedral: 7
 - break: 0.37
 - alpha: -1
 - thick: 0.1
 - camber: 0.08
 - alpha: -3
 - thick: 0.15
 - camber: 0.04
 - alpha: -8
 - thick: 0.08
 - camber: 0.01
 - srail: 50
 - srail: -8
 - hinge: [6x9]
- Fuse:
 - noset: [2x4]
 - tail: [2x4]
 - fuel: 28
 - noset: 0
 - tail: 20
 - tail: 1

The bottom status bar indicates: "Parameter 'VIEW:Vlm[1,1]' has been changed to 1 Re-build is needed". Below this, a list of building actions is shown:

- Building wingDefl
- Building wingHinges
- Building htailDefl
- Building htailHinges
- Building vtailDefl
- Building vtailHinges

Entire Build complete, which generated 28 Body(s)

- New files:

htail/Vlm.udc	(94 lines)
vtail/Vlm.udc	(79 lines)
wing/Vlm.udc	(94 lines)
view/Vlm.udc	(92 lines)

- Modified files:

transport.csm	(5 lines)
---------------	------------

ESP (Engineering Sketch Pad) v X

file:///Users/dannen/projects/OpenCSM/ESP/ESP-localhost7681.html

Copy Cut Paste Insert Search Next Prev Replace Comment Undo Cancel Save and run

File StepThru Help

Contents of: ./data/MultiModels/Transport/gen08/python/avl.py

```

1 #-----
2
3 # Import pyCAPS module
4 import pyCAPS
5 from pyOCSM import esp
6
7 # Import os
8 import os
9
10 #-----
11
12 # Load geometry (.csm) file
13 filename=os.path.join("../data", "MultiModels", "Transport", "gen08", "transport.csm")
14 print ("====> Loading geometry from file %s" % filename + "\n...")
15 myProblem = pyCAPS.Problem(problemName = "WorkDirAvl",
16                             capsFile = filename,
17                             outLevel = 0)
18 myProblem.setOutLevel("minimal")
19
20 # Set geometry variables to enable Vortex Lattice bodies
21 print ("====> Setting Build Variables and Geometry Values...")
22
23 # Change to VLM view
24 myProblem.geometry.cfgptr.VIEW.Concept = 0
25 myProblem.geometry.cfgptr.VIEW.Vlm = 1
26
27 # Enable lifting surfaces and controls
28 myProblem.geometry.cfgptr.COMP.wing = 1
29 myProblem.geometry.cfgptr.COMP.fuse = 0
30 myProblem.geometry.cfgptr.COMP.htail = 1
31 myProblem.geometry.cfgptr.COMP.vtail = 1
32
33 # Create AVL AIM (if it does not already exist)
34 if ("avl" in myProblem.analysis):
35     print ("====> Reusing AVL aim...")
36     avl = myProblem.analysis["avl"]
37 else:
38     print ("====> Creating AVL aim...")
39     avl = myProblem.analysis.create(aim = "avlADM",
40                                     name = "avl")
41
42
43
44
45
46
47
48
49
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51
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54
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60
61
62
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80
81
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85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100

```

Design Parameters Collapse All

VIEW:

- Concept 1
- Vlm 0
- Panel 0

COMP:

- wing 1
- fuse 1
- htail 1
- vtail 1
- nacelle 1
- pylon 1
- payload 1
- controls 1

Wing:

- area 4290
- aspect 9
- laper1 0.48
- lapers 0.23
- sweep 35
- dihedral 7
- break 0.37
- alpha -1
- thick1 0.1
- canibcr 0.08
- alphaub -3
- thickb 0.15
- canibcrb 0.04
- alphaat -8
- thickat 0.08
- canibcrat 0.01
- swool 50
- swoat -8
- hinge {609}

fuse:

- noset1 {24}
- tail1 {24}
- fuel1 length 28
- noset1 height 0
- midVtail 20
- mid1 height 20

payload:

- 1

..data/MultiModels/Transport/gen08/transport.csm has been loaded

uses: ../data/MultiModels/Transport/gen08/transport_setup.udc

uses: ../data/MultiModels/Transport/gen08/wing/Petrs.udc

uses: ../data/MultiModels/Transport/gen08/fuse/Petrs.udc

uses: ../data/MultiModels/Transport/gen08/htail/Petrs.udc

uses: ../data/MultiModels/Transport/gen08/vtail/Petrs.udc

uses: ../data/MultiModels/Transport/gen08/pylon/Petrs.udc

uses: ../data/MultiModels/Transport/gen08/nacelle/Petrs.udc

uses: ../data/MultiModels/Transport/gen08/payload/Petrs.udc

uses: ../data/MultiModels/Transport/gen08/wing/Calc.udc

uses: ../data/MultiModels/Transport/gen08/htail/Calc.udc



The screenshot shows the ESP (Engineering Sketch Pad) software interface. The main window displays a 3D model of a vehicle chassis, specifically focusing on the rear section with multiple wing and control surfaces. The left sidebar contains a tree view with the following sections:

- Design Parameters** (Expanded):
 - VIEW:
 - COMP:
 - wing:
 - face:
 - hail:
 - vtail:
 - pylon:
 - axle/c:
 - payload:
- Local Variables** (Expanded):
- Branches** (Expanded):
 - Display Via Gcd
 - Wing_1 Via Gcd
 - Wing_2 Via Gcd
 - Wing_3 Via Gcd
 - Wing_4 Via Gcd
 - Wing_5 Via Gcd
 - wingControl_1_1 Via Gcd
 - wingControl_1_2 Via Gcd
 - wingControl_2_1 Via Gcd
 - wingControl_2_2 Via Gcd
 - wingControl_3_1 Via Gcd
 - wingControl_3_2 Via Gcd
 - wingControl_4_1 Via Gcd
 - wingControl_4_2 Via Gcd
 - wingControl_5_1 Via Gcd
 - wingControl_5_2 Via Gcd
 - wingControl_6_1 Via Gcd
 - wingControl_6_2 Via Gcd
 - Htail_1 Via Gcd
 - Htail_2 Via Gcd
 - Htail_3 Via Gcd
 - hailControl_1_1 Via Gcd
 - hailControl_1_2 Via Gcd
 - hailControl_2_1 Via Gcd
 - hailControl_2_2 Via Gcd
 - Vtail_1 Via Gcd
 - Vtail_2 Via Gcd

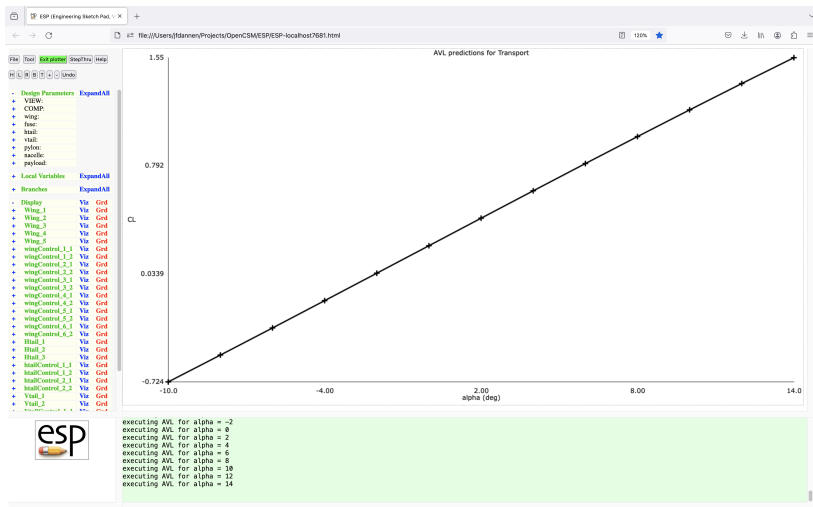
The console window at the bottom displays the following messages:

```

MESSAGE: Building vtail0m1
ERROR:: (name_not_found) in Branch Brch_001115 at [[/Users/jfdannen/Projects/OpenCSM/data/MultiModels/Transport/gen08/vtail/Hinges.udc:9]]
storage "vtailHinge" 1 not found
--> catching signal -253 (name_not_found)
MESSAGE: Building vtailHinges
  
```

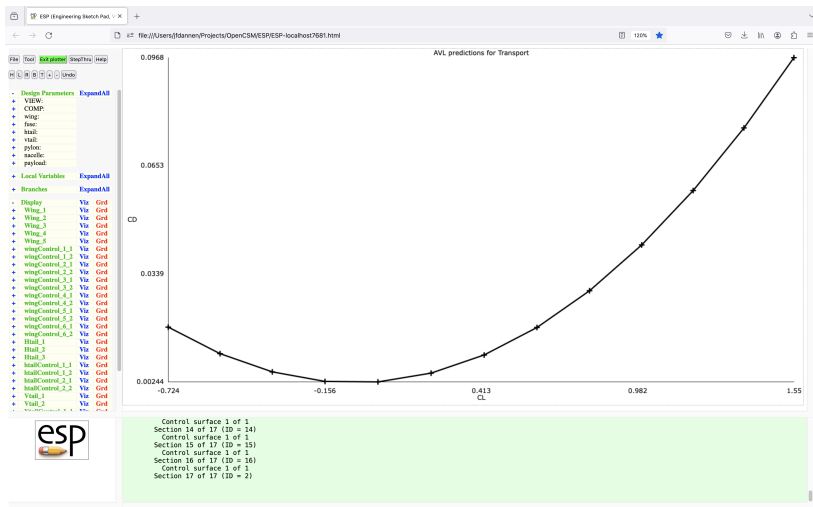


Generation 08 — add pyscript for avl



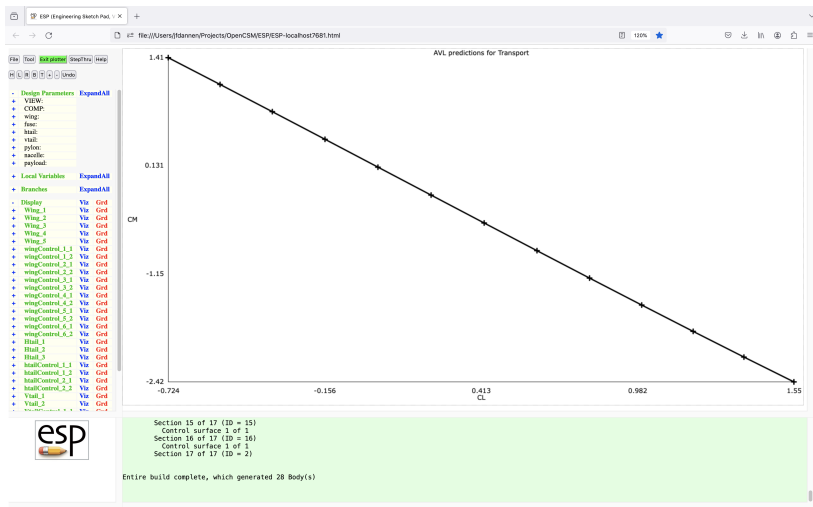


Generation 08 — add pyscript for avl





Generation 08 — add pyscript for avl

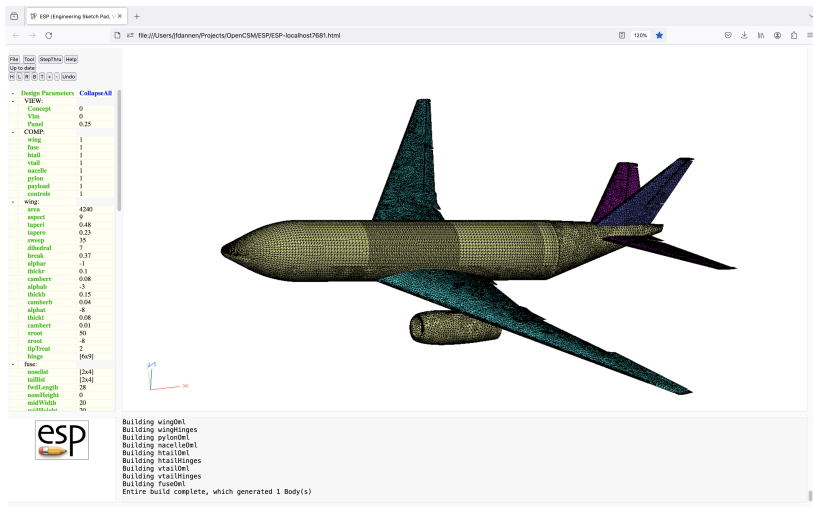


- New files:

python/avl.py (121 lines)

- Modified files:

<nothing>



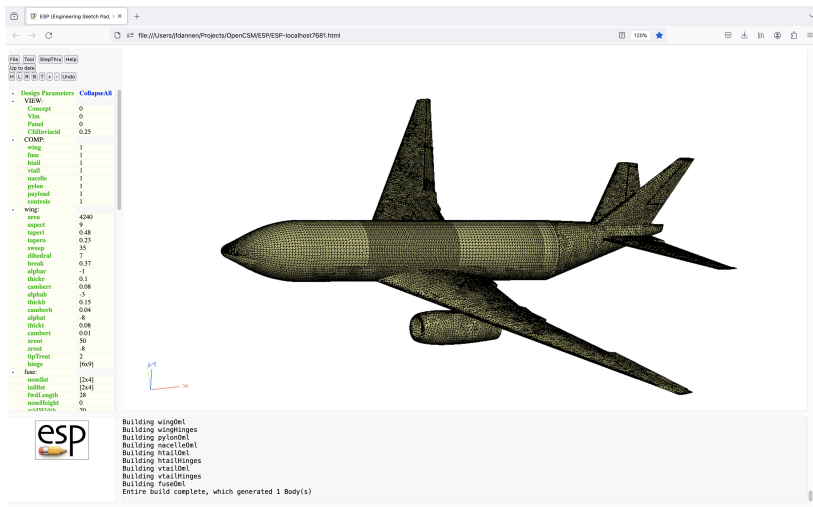
- New files:

<nothing>

- Modified files:

htail/Oml.udc	(7 lines)
htail/Pmtrs.udc	(1 line)
vtail/Oml.udc	(7 lines)
vtail/Pmtrs.udc	(1 line)
wing/Oml.udc	(12 lines)
wing/Pmtrs.udc	(1 line)

Generation 10 — add CfdInviscid view



The screenshot shows the ESP software interface. The main window displays a 3D wireframe model of a jet airplane. The left sidebar contains a tree view of design parameters, including VIEW, COMP, and wing. The bottom status bar indicates the build process is complete.

Design Parameters:

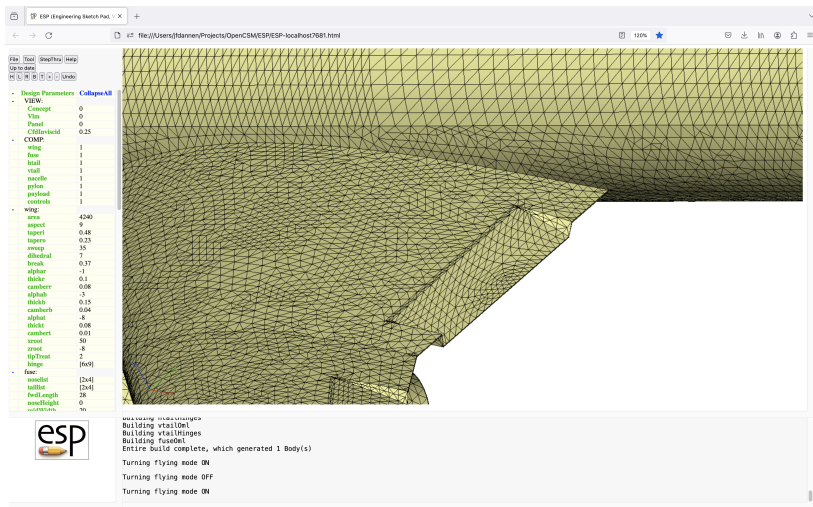
- VIEW:**
 - Concept: 0
 - Vin: 0
 - Pani: 0
 - CfdInviscid: 0.25
- COMP:**
 - wing: 1
 - fuse: 1
 - htail: 1
 - vtail: 1
 - macelle: 1
 - pylon: 1
 - payload: 1
 - controls: 1
- wing:**
 - area: 4290
 - aspect: 9
 - taperi: 0.48
 - tapero: 0.23
 - arvep: 35
 - dihedral: 7
 - break: 0.37
 - alpha: -1
 - thick: 0.1
 - camber: 0.08
 - alpha0: -5
 - thickb: 0.15
 - camberb: 0.04
 - alpha1: -8
 - thicki: 0.08
 - camberi: 0.01
 - zcot: 50
 - zcot: -8
 - tipTreat: 2
 - hinge: [609]
- fuse:**
 - macellat: [2x4]
 - tailfat: [2x4]
 - tailLength: 28
 - macellHeight: 0
 - macellWidth: 0

Build Log:

```
Building wing0el
Building wingHinges
Building pylon0el
Building macelle0el
Building htail0el
Building htailHinges
Building vtail0el
Building vtailHinges
Building fuse0el
Entire Build complete, which generated 1 Body(s)
```



Generation 10 — add CfdInviscid view



- New files:

`view/CfdInviscid.udc` (145 lines)

- Modified files:

`transport.csm` (5 lines)



Generation 11 — add CfdViscous view

ESP (Engineering Sketch Pad) v. X

file:///Users/jtdannen/Projects/OpenCSM/ESP/ESP-localhost7681.html

120%

File Tool Graph/Tree Help

Up to date

Design Parameters Collapse All

VIEW:

- Concept 0
- Vin 0
- Panel 0
- CfdViscous 0
- CfdViscous 0.25

COMP:

- wing 1
- fuse 1
- htail 1
- vtail 1
- nacelle 1
- pylon 1
- payload 1
- controls 1

wing:

- area 4240
- aspect 9
- taper1 0.48
- taper2 0.23
- sweep 35
- dihedral 7
- break 0.37
- alpha -1
- thickr 0.1
- camberh 0.08
- alpha0 -3
- thickb 0.15
- camberb 0.04
- alpha1 -8
- thickt 0.08
- cambert 0.01
- root 50
- root -8
- tipFront 2
- lunge [609]

fuse:

- naselle1 [2x4]
- taillet [2x4]
- tailLength 28
- naselle2 0

Building wing0el
Building wingHinges
Building pylon0el
Building nacelle0el
Building htail0el
Building htailHinges
Building vtail0el
Building vtailHinges
Building fuse0el
Entire Build complete, which generated 10 Body(s)



Generation 11 — add CfdViscous view

ESP (Engineering Sketch Pad) v X

file:///Users/tdannen/Projects/OpenCSM/ESP/ESP-localhost7681.html

120%

File Tools SketchTree Help

Up to date

Undo

Design Parameters CollapseAll

VIEW:

- Concept: 0
- Vin: 0
- Panet: 0
- CfdViscid: 0
- CfdViscous: 0.25

COMP:

- wing: 1
- fuse: 1
- htail: 1
- vtail: 1
- nacelle: 1
- pylon: 1
- pyload: 1
- controls: 1

wing:

- area: 4240
- aspect: 9
- taper1: 0.48
- taper2: 0.23
- sweep: 35
- dihedral: 7
- break: 0.37
- alpha: -1
- thickr: 0.1
- camber1: 0.08
- alpha1: -3
- thick1: 0.15
- camber1: 0.04
- alpha1: -8
- thick1: 0.08
- camber1: 0.01
- root: 50
- root: -8
- tipFront: 2
- hinge: [609]

fuse:

- naselle1: [2x4]
- tail1: [2x4]
- tailLength: 28
- tailAngle: 0

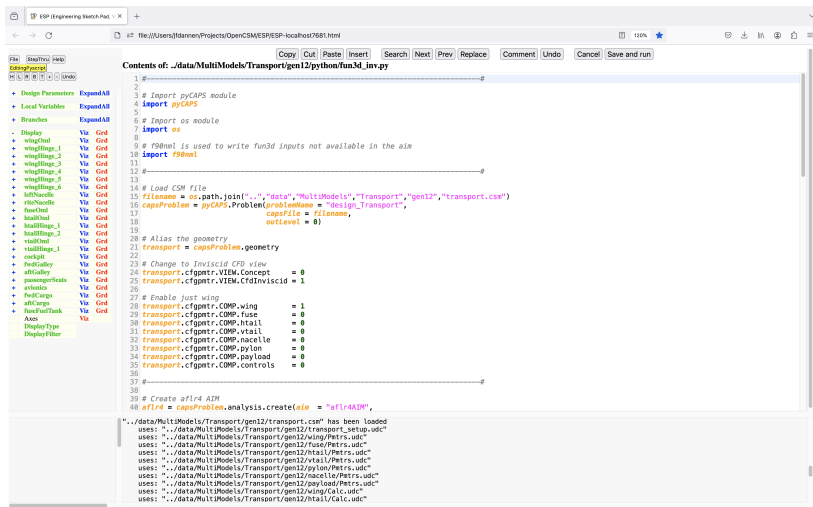
Building pylon0m1
Building nacelle0m1
Building htail0m1
Building htailWing0m1
Building vtail0m1
Building vtailWing0m1
Building fuse0m1
Entire build complete, which generated 10 Body(s)
Turning Flying mode ON

- New files:

`view/CfdViscous.udc` (344 lines)

- Modified files:

`transport.csm` (5 lines)



The screenshot shows the ESP (Engineering Sketch Pad) interface. The top bar displays the file path: `file:///Users/dannen/Projects/OpenCSM/ESP/ESP-localhost7681.html`. The main window is titled "Contents of: ../data/MultiModels/Transport/gen12/python/fun3d_inv.py". The script content is as follows:

```

1
2
3 # Import pyCAPS module
4 import pyCAPS
5
6 # Import os module
7 import os
8
9 # f90nml is used to write fun3d inputs not available in the aim
10 import f90nml
11
12
13
14 # Load CSM file
15 filename = os.path.join("../data", "MultiModels", "Transport", "gen12", "transport.csm")
16 capsProblem = pyCAPS.Problem(problemName = "design_Transport",
17                             capsFile = filename,
18                             outLevel = 0)
19
20 # Alias the geometry
21 transport = capsProblem.geometry
22
23 # Change to Inviscid CFD view
24 transport.cfgpntnr.VIEW.Concept = 0
25 transport.cfgpntnr.VIEW.CfdInviscid = 1
26
27 # Enable just wing
28 transport.cfgpntnr.COMP.wing = 1
29 transport.cfgpntnr.COMP.fuse = 0
30 transport.cfgpntnr.COMP.htail = 0
31 transport.cfgpntnr.COMP.vtail = 0
32 transport.cfgpntnr.COMP.nacelle = 0
33 transport.cfgpntnr.COMP.pylon = 0
34 transport.cfgpntnr.COMP.payload = 0
35 transport.cfgpntnr.COMP.controls = 0
36
37
38
39 # Create aflr4 AIM
40 aflr4 = capsProblem.analysis.create(aim = "aflr4AIM",
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
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83
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89
90
91
92
93
94
95
96
97
98
99
100

```

The interface also shows a sidebar with a tree view of the project structure, including folders like "Design Parameters", "Local Variables", "Branches", and "Display". The "Display" folder is expanded, showing various components like "wingOml", "wingflings_1", "wingflings_2", etc.

- New files:
 python/fun3d_inv.py (123 lines)
- Modified files:
 view/CfdInviscid.udc (132 lines)



Generation 13 — add wing BEM

ESP (Engineering Sketch Pad) v X

file:///Users/dannen/Projects/OpenCSM/ESP/ESP-localhost7681.html

120%

File Tool Snap/Free Help

Up to date

Design Parameters Collapse All

VIEW:

- Concept 1
- Vin 0
- Panel 0
- CfdVlocusd 0
- CfdVlocus 0
- Pem 0

COMP:

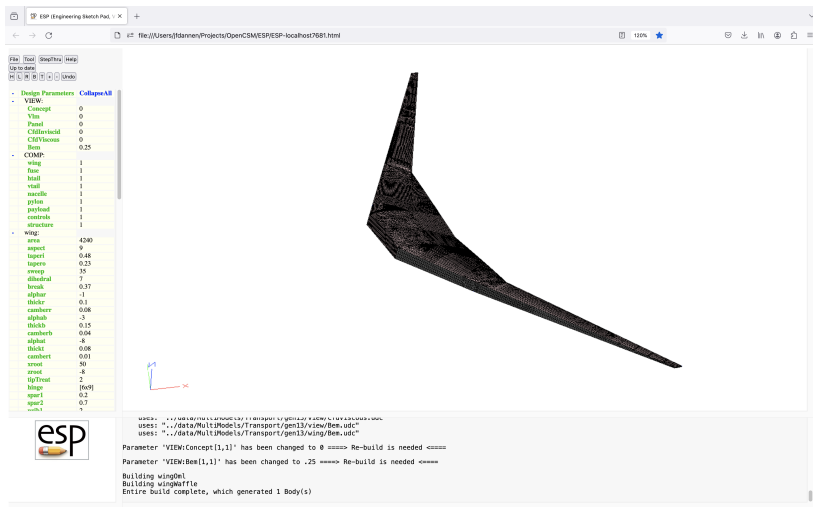
- wing 1
- fuse 1
- htail 1
- vtail 1
- nacelle 1
- pylon 1
- payload 1
- controls 1
- structure 1

wing:

- area 4290
- aspect 9
- taper1 0.48
- taper0 0.23
- areap 35
- dihedral 7
- break 0.37
- alpha 1
- thick 0.1
- camherr 0.08
- alpha0 -3
- thick0 0.15
- camherb 0.04
- alpha1 -8
- thick1 0.08
- camherb 0.01
- xroot 50
- zroot -8
- tipTreat 2
- hinge [609]
- spar1 0.2
- spar2 0.7
- root1 1

esp

../../data/MultiModels/Transport/gen13/transport.csm" has been loaded
uses: ../../data/MultiModels/Transport/gen13/transport_setup.udc"
uses: ../../data/MultiModels/Transport/gen13/wing/Petrs.udc"
uses: ../../data/MultiModels/Transport/gen13/fuse/Petrs.udc"
uses: ../../data/MultiModels/Transport/gen13/htail/Petrs.udc"
uses: ../../data/MultiModels/Transport/gen13/vtail/Petrs.udc"
uses: ../../data/MultiModels/Transport/gen13/pylon/Petrs.udc"
uses: ../../data/MultiModels/Transport/gen13/payload/Petrs.udc"
uses: ../../data/MultiModels/Transport/gen13/nacelle/Petrs.udc"
uses: ../../data/MultiModels/Transport/gen13/payload/Petrs.udc"
uses: ../../data/MultiModels/Transport/gen13/htail/Calc.udc"
uses: ../../data/MultiModels/Transport/gen13/htail/Calc.udc"



The screenshot shows the ESP (Engineering Sketch Pad) software interface. The main window displays a 3D model of a wing. The left sidebar contains a tree view of the design parameters, including:

- Design Parameters
 - VIEW:
 - Concept: 0
 - Vin: 0
 - Pan: 0
 - CdInviscid: 0
 - CdViscous: 0
 - Re: 0.25
 - COMP:
 - wing: 1
 - fuse: 1
 - tail: 1
 - vtail: 1
 - nacelle: 1
 - pylon: 1
 - payload: 1
 - controls: 1
 - structure: 1
 - wing:
 - area: 4290
 - aspect: 9
 - taper1: 0.48
 - taper0: 0.23
 - areap: 35
 - dihedral: 7
 - break: 0.37
 - alpha: -1
 - thick: 0.1
 - camherr: 0.08
 - alpha0: -3
 - thick0: 0.15
 - camhert0: 0.04
 - alpha1: -8
 - thick1: 0.08
 - camhert1: 0.01
 - xroot: 50
 - zroot: -8
 - tipTreat: 2
 - hinge: [6x9]
 - spar1: 0.2
 - spar2: 0.7
 - ...etc.

The bottom status bar shows the following text:

```
uses: ".../data/MultiModels/Transport/gen13/wing/Bem.udc"
uses: ".../data/MultiModels/Transport/gen13/view/Bem.udc"
uses: ".../data/MultiModels/Transport/gen13/wing/Bem.udc"

Parameter 'VIEW:Concept[1,1]' has been changed to 0 =====> Re-build is needed <=====
Parameter 'VIEW:Bem[1,1]' has been changed to .25 =====> Re-build is needed <=====

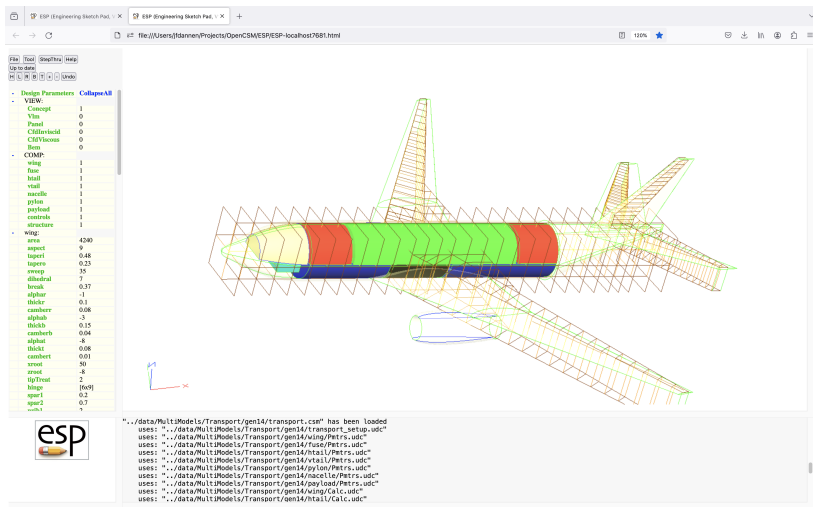
Building wingDel
Building wingWaffle
Entire Build complete, which generated 1 Body(s)
```

- New files:

view/Bem.udc	(31 lines)
wing/Bem.udc	(49 lines)
wing/Waffle.udc	(164 lines)

- Modified files:

transport.csm	(5 lines)
transport_setup.udc	(1 line)
view/Concept.udc	(8 lines)
wing/Pmtrs.udc	(11 lines)



File Tools SketchTree Help

Up to date

File Edit View Insert Help

Design Parameters Collapse All

VIEW:

- Concept 1
- Vin 0
- Panet 0
- CfdVlocus 0
- CfdVlocus 0
- Ven 0

COMP:

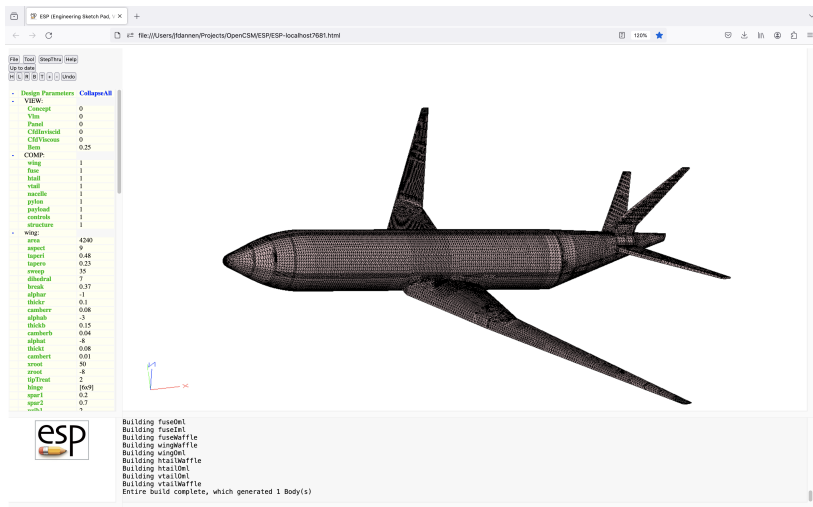
- wing 1
- fuse 1
- htail 1
- vtail 1
- nacelle 1
- pylon 1
- payload 1
- controls 1
- structure 1

wing:

- area 4290
- aspect 9
- taper 0.48
- tapero 0.23
- sweep 35
- dihedral 7
- break 0.37
- alpha 1
- thick 0.1
- camber 0.08
- alpha 1
- thick 0.15
- camber 0.04
- alpha 1
- thick 0.08
- camber 0.01
- sroot 50
- zroot -8
- tipTreat 2
- hinge [609]
- spar 0.2
- spar 0.7
- root 1

esp

"..data/MultiModels/Transport/gen14/transport.csm" has been loaded
 uses: "..data/MultiModels/Transport/gen14/transport_setup.udc"
 uses: "..data/MultiModels/Transport/gen14/wing/Petrs.udc"
 uses: "..data/MultiModels/Transport/gen14/fuse/Petrs.udc"
 uses: "..data/MultiModels/Transport/gen14/htail/Petrs.udc"
 uses: "..data/MultiModels/Transport/gen14/vtail/Petrs.udc"
 uses: "..data/MultiModels/Transport/gen14/pylon/Petrs.udc"
 uses: "..data/MultiModels/Transport/gen14/payload/Petrs.udc"
 uses: "..data/MultiModels/Transport/gen14/nacelle/Petrs.udc"
 uses: "..data/MultiModels/Transport/gen14/wing/Calc.udc"
 uses: "..data/MultiModels/Transport/gen14/htail/Calc.udc"



- New files:

<code>fuse/Bem.udc</code>	<code>(60 lines)</code>
<code>fuse/Waffle.udc</code>	<code>(174 lines)</code>
<code>htail/Bem.udc</code>	<code>(49 lines)</code>
<code>htail/Waffle.udc</code>	<code>(146 lines)</code>
<code>vtail/Bem.udc</code>	<code>(49 lines)</code>
<code>vtail/Waffle.udc</code>	<code>(98 lines)</code>

- Modified files:

<code>fuse/Pmtrs.udc</code>	<code>(2 lines)</code>
<code>htail/Pmtrs.udc</code>	<code>(4 lines)</code>
<code>vtail/Pmtrs.udc</code>	<code>(3 lines)</code>
<code>wing/Bem.udc</code>	<code>(1 line)</code>
<code>view/Bem.udc</code>	<code>(90 lines)</code>
<code>view/Concept.udc</code>	<code>(21 lines)</code>



Generation 15 — add Bones view

ESP (Engineering Sketch Pad) v. X

file:///Users/tdannen/Projects/OpenCSM/ESP/ESP-localhost7681.html

120%

File Tool Snap/Free Help

Up to date

Design Parameters Collapse All

VIEW:

- Concept 0
- Vin 0
- Panel 0
- ChildInUse 0
- ChildVlocus 0
- Bones 0.5
- Bom 0

COMP:

- wing 1
- fuse 1
- htail 1
- vtail 1
- nacelle 1
- pylon 1
- payload 1
- controls 1
- structure 1

wing:

- area 4240
- aspect 9
- taper1 0.48
- taper2 0.23
- sweep 35
- dihedral 7
- break 0.37
- alpha -1
- thickr 0.1
- canberr 0.08
- alpha0 -3
- thickb 0.15
- canberb 0.04
- alpha1 -8
- thicki 0.08
- canbert 0.01
- aroot 50
- arot -8
- tipTreat 2
- hinge {60}
- spec1 0.2
- spec2 0.7

Building fuse0m
Building fuse1m
Building fuseWaffle
Building wingWaffle
Building wing0m
Building htailWaffle
Building htail0m
Building vtail0m
Building vtailWaffle
Entire Build complete, which generated 1 Body(s)

- New files:

`view/Bones.udc` (58 lines)

- Modified files:

`transport.csm` (5 lines)

- Examine the **transport** model
 - **Note:** — do not run this from the directory that contains the **transport.csm** file as you will experience a bug that was recently found (and which will be fixed in versions beyond v1.25)
- Pick another example
 - how much of **transport** can you reuse?
 - how much of **transport** do you need to modify?
 - what problems will you face in building your configuration?



Backup Slides

```
wing:area          # area
wing:aspect        # aspect ratio
wing:taperi        # inboard taper ratio
wing:tapero        # outboard taper ratio
wing:sweep         # leading edge sweep
wing:dihedral      # dihedral
wing:break         # inboard/outboard

wing:alphar        # setting angle at root
wing:thickr        # thickness ratio at root
wing:camber        # camber ratio at root

wing:alphab        # setting angle at break
wing:thickb        # thickness ratio at break
wing:camberb       # camber ratio at break

wing:alphat        # setting angle at tip
wing:thickt        # thickness ratio at tip
wing:cambert       # camber ratio at tip

wing:xroot         # xloc at root LE
wing:zroot         # zloc at root LE
```

```
wing:hinge[i,1]      # deflection
wing:hinge[i,2]      # percent chord at ymin
wing:hinge[i,3]      # ymin/span
wing:hinge[i,4]      # z/t at ymin
wing:hinge[i,5]      # percent chord at ymin
wing:hinge[i,6]      # ymax/span
wing:hinge[i,7]      # z/t at ymax
wing:hinge[i,8]      # gap between control and wing
wing:hinge[i,9]      # group (for AVL linking)
```



Wing Parameters — Structure

```
wing:spar1      # fraction of chord for LE spar
wing:spar2      # fraction of chord for TE spar
wing:nrib1      # number of internal ribs in region 1
wing:nrib2      # number of internal ribs in region 2
wing:nrib3      # number of internal ribs in region 3
wing:waffleGap  # distance between fuselage and wing root rib
```

```
fuse:noselist[1]    # spanwise nose radius
fuse:noselist[4]    # vertical nose radius

fuse:fwdLength      # length of forward fuselage
fuse:noseHeight     # zloc of center of nose

fuse:midWidth       # width  of mid fuselage
fuse:midHeight      # height of mid fuselage
fuse:power          # super-ellipse power of mid and aft fuselage

fuse:aftnSec        # number of sectins in the aft portion
fuse:aftLength      # length of aft fuselage
fuse:aftWidth       # width  of aft fuselage
fuse:aftHeight      # height of aft fuselage
fuse:aftCenter      # zloc   of aft fuselage
fuse:aftTailExt     # length of fuselage aft of htail/vtail
```




Fuselage Parameters — Structure

```
fuse:bulkThick      # bulkhead thickness  
fuse:maxspace       # maximum spacing between bulkheads
```



Horizontal Tail Parameters — OML

htail:vc	# htail volume coefficient
htail:length	# distance between htail root and wing root
htail:aspect	# htail aspect ratio
htail:taper	# htail taper ratio
htail:sweep	# htail sweep
htail:dihedral	# htail dihedral
htail:thick	# htail thickness ratio
htail:zroot	# zloc of root LE

```
htail:hinge[i,1]    # deflection
htail:hinge[i,2]    # percent chord at ymin
htail:hinge[i,3]    # ymin/span
htail:hinge[i,4]    # z/t at ymin
htail:hinge[i,5]    # percent chord at ymin
htail:hinge[i,6]    # ymax/span
htail:hinge[i,7]    # z/t at ymax
htail:hinge[i,8]    # gap between control and wing
htail:hinge[i,9]    # group (for AVL linking)
```



Horizontal Tail Parameters — Structure

htail:waffleGap	# distance between fuselage and htail root rib
htail:spar1	# fraction of chord for LE spar
htail:spar2	# fraction of chord for TE spar
htail:nrib	# number of internal ribs



Vertical Tail Parameters — OML

<code>vtail:vc</code>	<code># vtail volume coefficient</code>
<code>vtail:offset</code>	<code># difference between vtail:xroot and htail:xroot</code>
<code>vtail:aspect</code>	<code># vtail aspect ratio</code>
<code>vtail:taper</code>	<code># vtail taper ratio</code>
<code>vtail:sweep</code>	<code># vtail sweep</code>
<code>vtail:thick</code>	<code># vtail thickness</code>
<code>vtail:zroot</code>	<code># zloc of root LE</code>

```
vtail:hinge[i,1]    # deflection
vtail:hinge[i,2]    # percent chord at ymin
vtail:hinge[i,3]    # ymin/span
vtail:hinge[i,4]    # z/t at ymin
vtail:hinge[i,5]    # percent chord at ymin
vtail:hinge[i,6]    # ymax/span
vtail:hinge[i,7]    # z/t at ymax
vtail:hinge[i,8]    # gap between control and wing
vtail:hinge[i,9]    # group (for AVL linking)
```



Vertical Tail Parameters — Structure

```
vtail:spar1      # fraction of chord for LE spar  
vtail:spar2      # fraction of chord for TE spar  
vtail:nrib       # number of internal ribs
```

```
nacelle:yb          # semispan location of nacelle
nacelle:dxnose      # x offset of nose from wing leading edge
nacelle:dznose      # z offset of nose from wing leading edge
nacelle:length      # length of nacelle
nacelle:diameter    # diameter of nacelle
nacelle:thick       # thickness ratio of nacelle airfoil
nacelle:camber      # camber ratio of nacelle airfoil
```



```
pylon:dxwing      # x offset from leading edge of wing  
pylon:dxnacelle   # x offset from leading edge of nacelle  
pylon:length      # length of pylon  
pylon:thick       # thickness ratio of pylon
```

```
payload:galleyLen    # length of galley
payload:space        # x-spacing between components
payload:cockpitLen   # length of cockpit
payload:fwdCargo      # length of forward cargo hold
payload:aftCargo      # length of aft cargo hold
payload:floorGap      # gap between floor and payloads
payload:zfloor        # height of the floor
payload:apuLen        # length of the APU
```