

Engineering Sketch Pad (ESP)



User Training Session 12 Building Large Models

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updated for v1.28

- 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

- 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

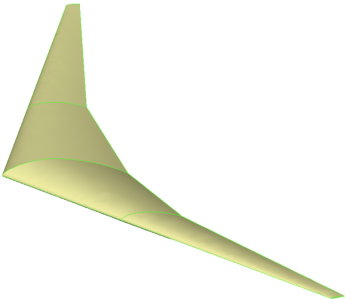
Local Variables Expand All

Branches Expand All

Display wingCtrl Via Ctrl

Axis Via Ctrl

Display Type Display Filter



Building wing0n1

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/Petrus.udc"

uses: "/data/MultiModels/Transport/gen01/wing/Calc.udc"

uses: "/data/MultiModels/Transport/gen01/view/Concept.udc"

uses: "/data/MultiModels/Transport/gen01/wing/0n1.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
```



Generation 01 — transport_setup.udc

```
# .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
...
```

```

...
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:alphan  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
```

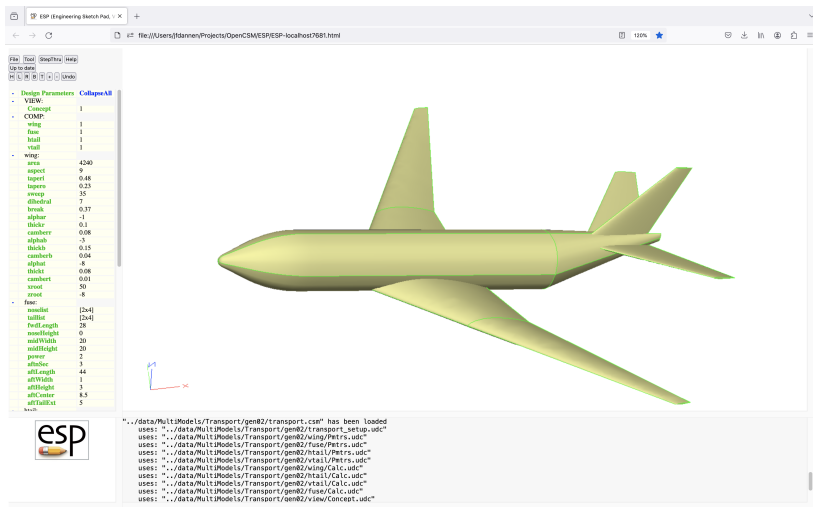
CATEND

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

END



Generation 02 — add fuse, htail, and vtail

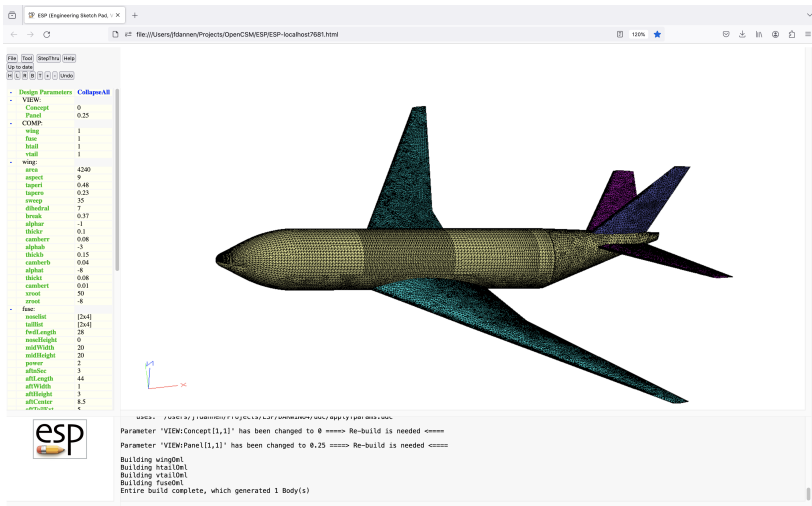


- New files:

<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:
 - modelist: [2x4]
 - tailist: [2x4]
 - fwlLength: 28
 - noseHeight: 0
 - midWidth: 20
 - midHeight: 20
 - power: 2
 - afwSec: 3
 - afwLength: 44
 - afwWidth: 1
 - afwHeight: 3
 - afwCenter: 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)
```

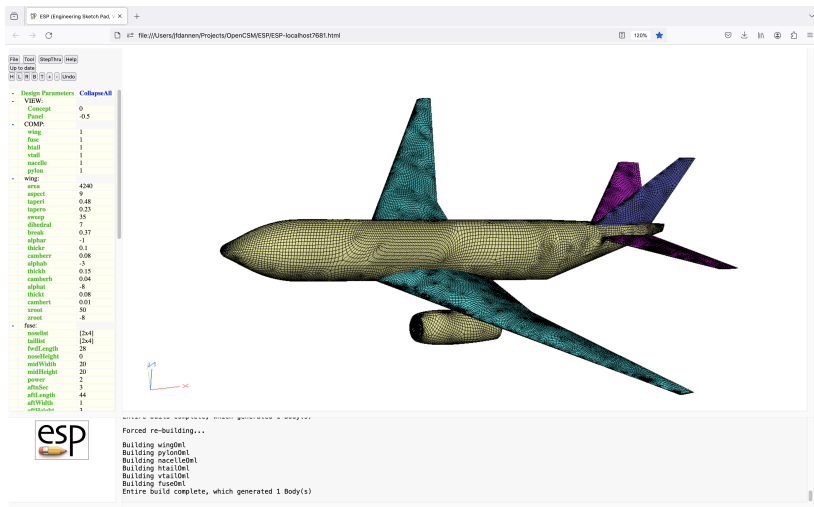

- New files:

view/0ml.udc (43 lines)

view/Panel.udc (48 lines)

- Modified files:

transport.csm (4 lines)



ESP (Engineering Sketch Pad) v. X

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

120%

File Tools 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
 - apers 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:
 - nacelle [2x4]
 - tailht [2x4]
 - fwlLength 28
 - noseHeight 0
 - midWidth 20
 - midHeight 20
 - power 2
 - afnSec 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)

- New files:

<code>nacelle/Calc.udc</code>	<code>(10 lines)</code>
<code>nacelle/Oml.udc</code>	<code>(40 lines)</code>
<code>nacelle/Pmtrs.udc</code>	<code>(14 lines)</code>
<code>pylon/Calc.udc</code>	<code>(16 lines)</code>
<code>pylon/Oml.udc</code>	<code>(28 lines)</code>
<code>pylon/Pmtrs.udc</code>	<code>(11 lines)</code>

- Modified files:

<code>transport_setup.udc</code>	<code>(5 lines)</code>
<code>view/Concept.udc</code>	<code>(14 lines)</code>
<code>view/Oml.udc</code>	<code>(55 lines)</code>

ESP (Engineering Sketch Pad) v. X

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

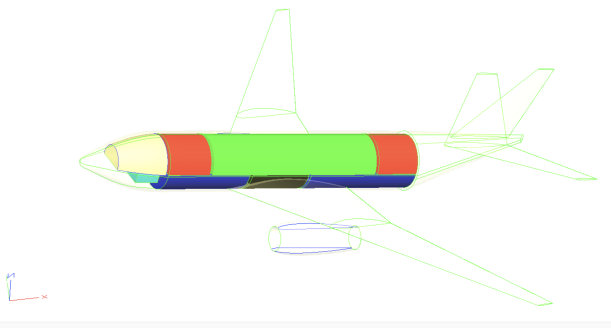
120%

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
 - arsweep 35
 - dihedral 7
 - break 0.37
 - alpha -1
 - thick 0.1
 - camberl 0.08
 - alphaub -5
 - thickb 0.15
 - camberb 0.04
 - alphaat -8
 - thickt 0.08
 - cambert 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
 - afvtx loc 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/wing/Calc.udc"
 uses: "...data/MultiModels/Transport/gen05/htail/Calc.udc"

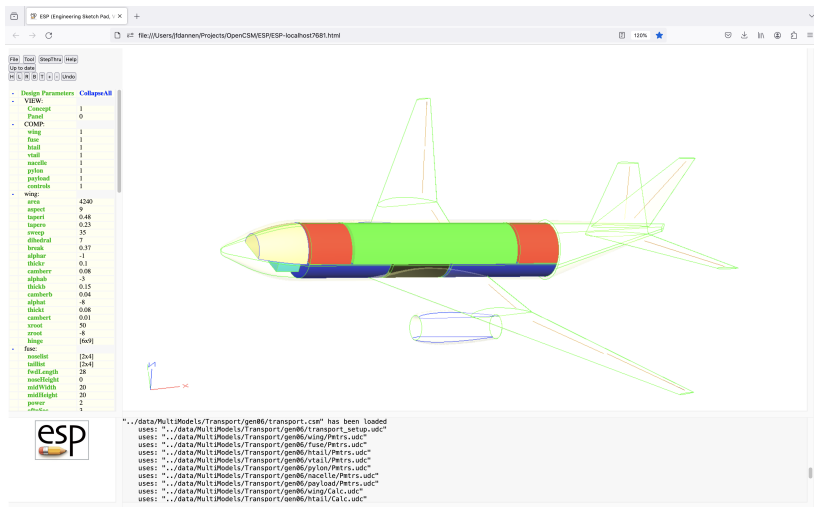
esp

- New files:

<code>fuse/Iml.udc</code>	<code>(55 lines)</code>
<code>payload/Pmtrs.udc</code>	<code>(15 lines)</code>
<code>payload/payload.udc</code>	<code>(122 lines)</code>

- Modified files:

<code>transport_setup.udc</code>	<code>(22 lines)</code>
----------------------------------	--------------------------



ESP (Engineering Sketch Pad) v. X

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

120%

File Tool Snap/Free 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
 - alphaab -3
 - thickb 0.15
 - camberb 0.04
 - alphaa -6
 - thicki 0.08
 - camberi 0.01
 - zroot 50
 - zroot -8
 - hinge [foc]
- fuse:
 - nozzle [2x4]
 - tail [2x4]
 - tailLength 28
 - noseHeight 0
 - midWidth 20
 - midHeight 20
 - power 2
 - alphaCm 1

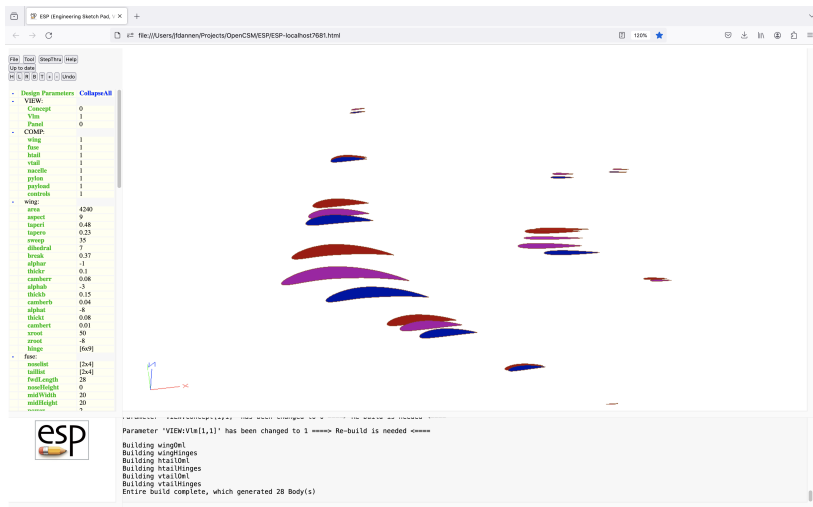
..../data/MultiModels/Transport/gen06/transport.csm" has been loaded
 uses: "../data/MultiModels/Transport/gen06/transport_setup.udc"
 uses: "../data/MultiModels/Transport/gen06/wing/Petrs.udc"
 uses: "../data/MultiModels/Transport/gen06/fuse/Petrs.udc"
 uses: "../data/MultiModels/Transport/gen06/htail/Petrs.udc"
 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 software interface. On the left is a parameter tree with the following structure:

- Design Parameters
 - 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
 - laper1: 0.48
 - lapers: 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
 - alpha1: -8
 - thickt: 0.08
 - cambert: 0.01
 - xroot: 50
 - zroot: -8
 - hinge: [6x9]
 - fuse:
 - nosetlet: [2x4]
 - taillet: [2x4]
 - fwlLength: 28
 - nosetHeight: 0
 - midWidth: 20
 - midHeight: 20
 - tailWidth: 1

The main workspace displays a 3D model of a wing with various colored sections (red, blue, purple, green). A small coordinate system is visible in the bottom left of the workspace.

At the bottom of the interface, a status bar shows the following text:

```
Parameter 'VIEW:Vlm[1,1]' has been changed to 1 Re-build is needed
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)
---------------	------------

Including attributes for avl

- Attributes need to be put on the ESP model in order for CAPS to set up the appropriate avl inputs
- These are mostly set in the `view/Vlm.udc`
- `capsAIM = $avlAIM` — on all Bodys (cross-sections) that the avlAIM will use
- `capsGroup` — string that tells avl which Bodys are in a single avl surface
- `capsLength = $ft`
- `capsDiscipline = $Aerodynamic`
- `capsReferenceArea` — for aerodynamic coefficients
- `capsReferenceSpan` — for aerodynamic coefficients
- `capsReferenceChord` — for aerodynamic coefficients
- `capsReferenceX` — for aerodynamic coefficients
- `vlmControl...` — defines control surfaces



Generation 08 — add pyscript for avl

The screenshot shows the ESP (Engineering Sketch Pad) software interface. The top menu bar includes File, StepThru, Help, Copy, Cut, Paste, Insert, Search, Next, Prev, Replace, Comment, Undo, Cancel, Save and run. The main window displays a Python script titled "Contents of: ../data/MultiModels/Transport/gen08/python/avl.py". The script is a Python module that imports pyCAPS, pyCAMS, and esp. It defines a myProblem object and sets up various geometry parameters and controls. The script also creates an AVL AIM file and sets up the analysis. The left sidebar shows a tree view of the project structure, including Design Parameters, VIEW, and COMP. The bottom status bar shows the current file path: ../data/MultiModels/Transport/gen08/python/avl.py.

```
1 #
2
3 # Import pyCAPS module
4 import pyCAPS
5 from pyCAMS 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")
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The screenshot shows the ESP (Engineering Sketch Pad) software interface. The main workspace displays a 3D model of a vehicle chassis, specifically focusing on the wing and tail sections. The left sidebar contains a tree view with the following structure:

- Design Parameters (Expanded)
 - VIEW:
 - COMP:
 - wing:
 - tail:
 - vtail:
 - pylon:
 - 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
 - tail_1 Via Gcd
 - tail_2 Via Gcd
 - tail_3 Via Gcd
 - tailControl_1_1 Via Gcd
 - tailControl_1_2 Via Gcd
 - tailControl_2_1 Via Gcd
 - tailControl_2_2 Via Gcd
 - vtail_1 Via Gcd
 - vtail_2 Via Gcd

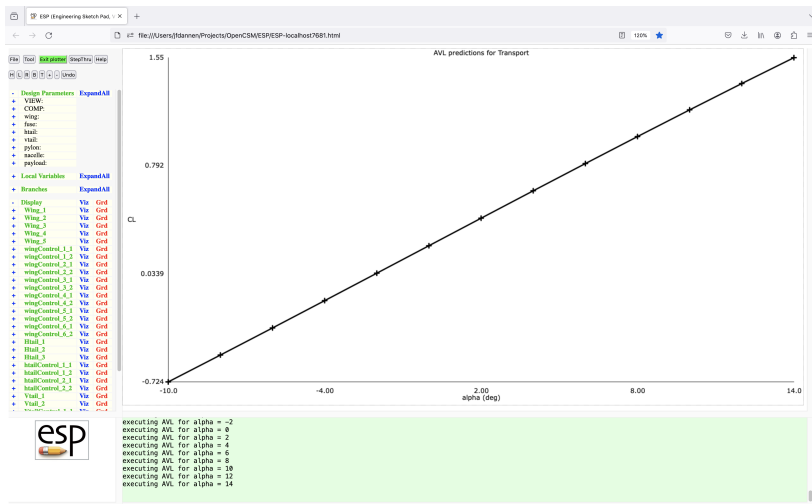
The console window at the bottom displays the following messages:

```

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
  
```

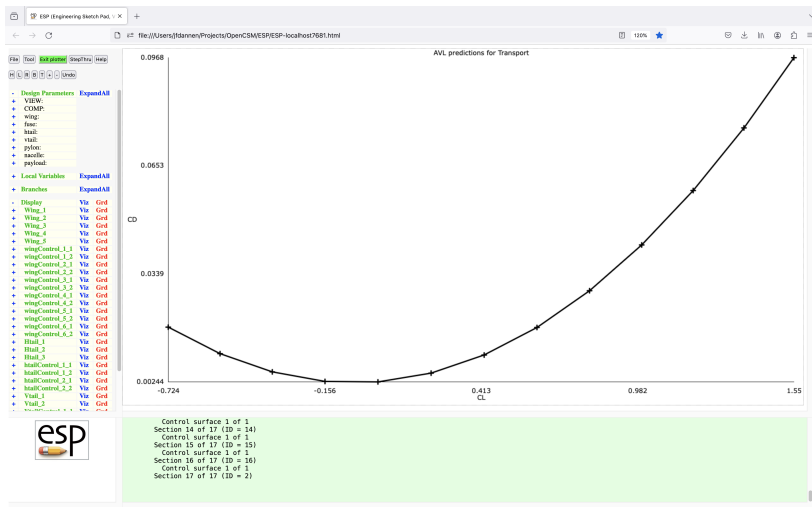


Generation 08 — add pyscript for avl



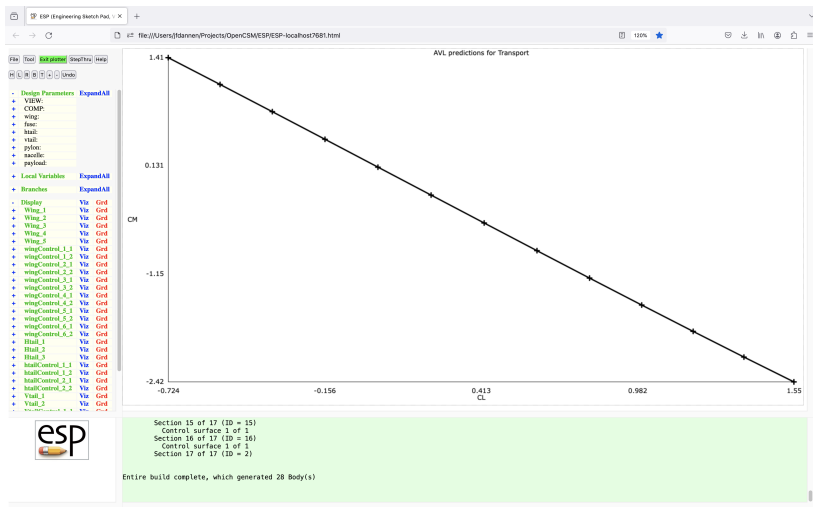


Generation 08 — add pyscript for avl





Generation 08 — add pyscript for avl

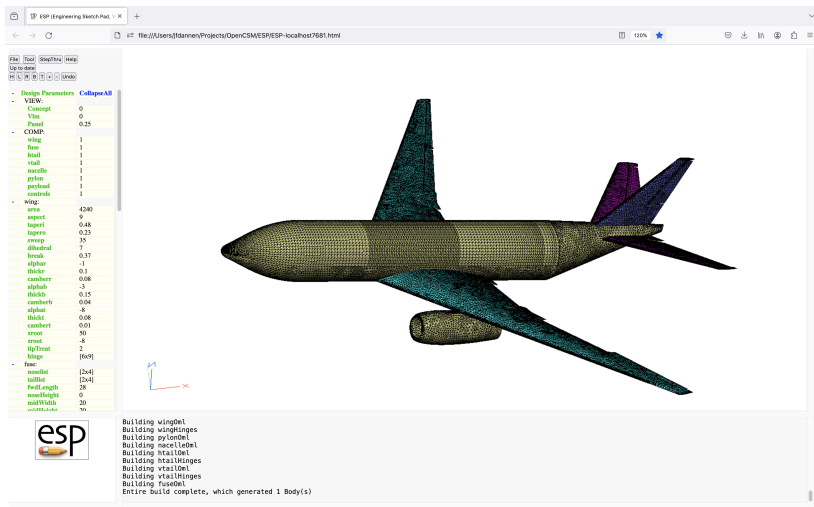


- New files:

python/avl.py (121 lines)

- Modified files:

<nothing>

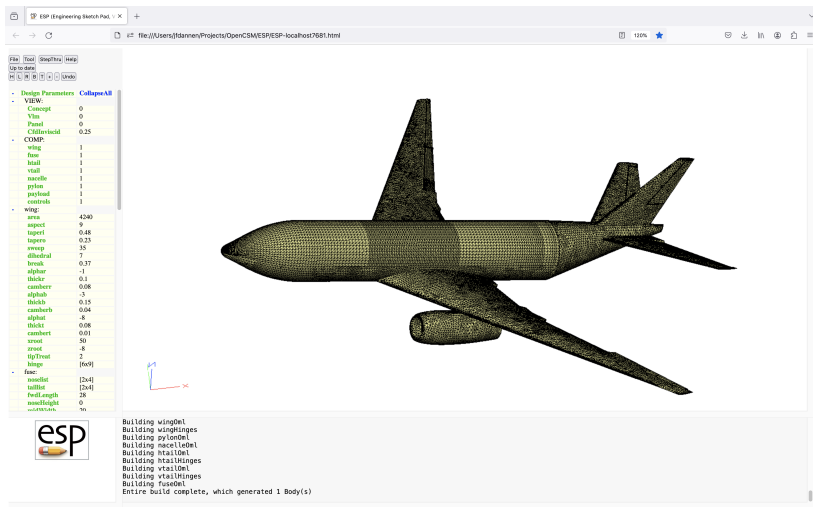


- New files:

<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)



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
- Vin 0
- Panal 0
- CfdInviscid 0.25

COMP:

- wing 1
- fuse 1
- htail 1
- vtail 1
- nacelle 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
- zroot 50
- zroot -8
- tipTreat 2
- hinge {609}

fuse:

- nacelle [2x4]
- tailfin [2x4]
- tailLength 28
- nacelleHeight 0
- tailfinHeight 0

Building wing0el
Building wingHinges
Building pylon0el
Building nacelle0el
Building htail0el
Building htailHinges
Building vtail0el
Building vtailHinges
Building fusel0el
Entire Build complete, which generated 1 Body(s)



Generation 10 — add CfdInviscid view

ESP (Engineering Sketch Pad) v X

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

120%

File Tools Sketch Help

Up to date

Undo

Design Parameters Collapse All

- VIEW:
 - Concept 0
 - Vin 0
 - Panel 0
 - CfdInviscid 0.25
- COMP:
 - wing 1
 - fuse 1
 - htail 1
 - vtail 1
 - nacelle 1
 - pylon 1
 - payload 1
 - controls 1
- wing:
 - area 4290
 - aspect 9
 - taperf 0.48
 - tapero 0.23
 - sweep 35
 - dihedral 7
 - break 0.37
 - alpha -1
 - thick 0.1
 - camber 0.08
 - alpha0 -5
 - thickb 0.15
 - camberb 0.04
 - alpha1 -8
 - thick1 0.08
 - camber1 0.01
 - zroot 50
 - zroot -8
 - tipTreat 2
 - hinge {609}
- fuse:
 - nacelle [2x4]
 - tail [2x4]
 - fwlLength 28
 - nacelleHeight 0
 - ...ATMData

Building vtail01
Building vtailHinges
Building fusel
Entire build complete, which generated 1 Body(s)

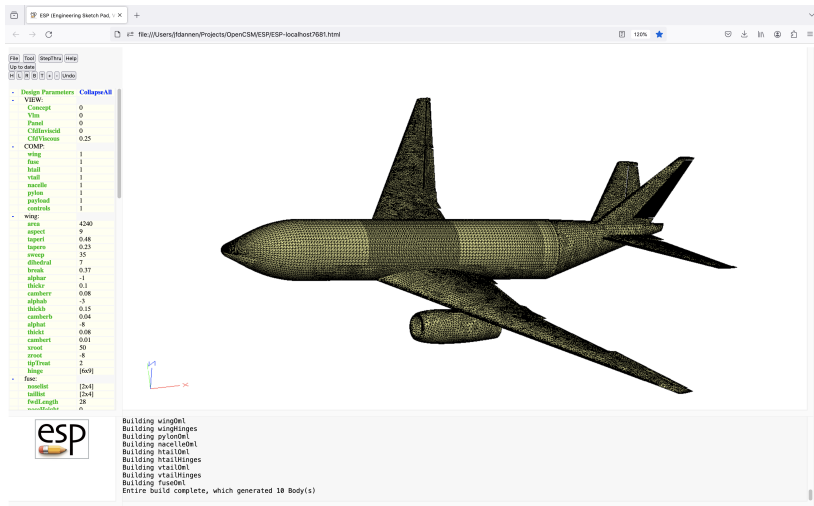
Turning flying mode ON
Turning flying mode OFF
Turning flying mode ON

- New files:

`view/CfdInviscid.udc` (145 lines)

- Modified files:

`transport.csm` (5 lines)



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 tree view of the design parameters, with the 'VIEW' section expanded. The 'VIEW' section lists the following parameters:

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

The 'COMP' section lists the following parameters:

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

The 'wing' section lists the following parameters:

- area: 4240
- aspect: 9
- taper1: 0.48
- taper2: 0.23
- sweep: 35
- dihedral: 7
- break: 0.37
- alpha: -1
- thickr: 0.1
- camber: 0.08
- alpha: -3
- thickb: 0.15
- camberb: 0.04
- alpha: -8
- thickt: 0.08
- cambert: 0.01
- root: 50
- root: -8
- tipFront: 2
- lunge: [60]

The 'fuse' section lists the following parameters:

- naselle: [2x4]
- tail: [2x4]
- tailLength: 28
- tailWidth: 0

The bottom status bar displays the following text:

```
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 SketchTools Help

Up to date

Undo

Design Parameters CollapseAll

- VIEW:
 - Concept: 0
 - Vin: 0
 - Panel: 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
 - alpha0: -3
 - thickb: 0.15
 - camberb: 0.04
 - alpha1: -8
 - thickc: 0.08
 - camberc: 0.01
 - root: 50
 - root: -8
 - tipYrnt: 2
 - hinge: [609]
- fuse:
 - nosetot: [2x4]
 - tailtot: [2x4]
 - tailLength: 28
 - tailWidth: 0

Building pylon0m1
Building nacelle0m1
Building htail0m1
Building htailHinges
Building vtail0m1
Building vtailHinges
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)



Generation 12 — add pyscript for fun3d

The screenshot shows the ESP Engineering Sketch Pad interface. On the left, a sidebar contains a tree view with categories like Design Parameters, Local Variables, and Branches. The main workspace displays a Python script titled 'Contents of: ../data/MultiModels/Transport/gen12/python/fun3d_inv.py'. The script is a Jupyter-style notebook with code cells and output. The code imports pyCAPS and os modules, sets up a problem name, and defines various parameters for a transport model. The output shows the creation of an AIM object and a list of file paths used by the model.

```
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.cfgpnttr.VIEW.Concept = 0
25 transport.cfgpnttr.VIEW.CfdInviscid = 1
26
27 # Enable just wing
28 transport.cfgpnttr.COMP.wing = 1
29 transport.cfgpnttr.COMP.fuse = 0
30 transport.cfgpnttr.COMP.htail = 0
31 transport.cfgpnttr.COMP.vtail = 0
32 transport.cfgpnttr.COMP.nacelle = 0
33 transport.cfgpnttr.COMP.pylon = 0
34 transport.cfgpnttr.COMP.payload = 0
35 transport.cfgpnttr.COMP.controls = 0
36
37 #-----
38
39 # Create afmr4 AIM
40 afmr4 = capsProblem.analysis.create(aim = "afmr4AIM",
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- 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 Tools Snap/Free Help

Up to date

Design Parameters Collapse All

VIEW:

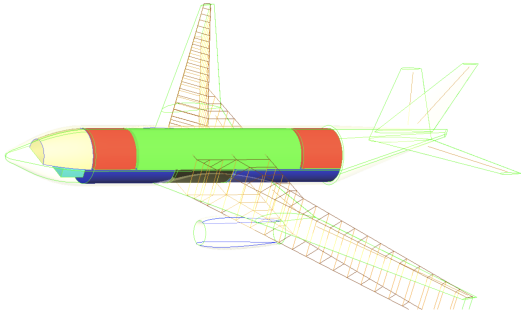
- Concept 1
- Vin 0
- Panels 0
- CdfVlocus 0
- CdfVlocus 0
- Pan 0

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
- alpha 1
- thick 0.15
- camherr 0.04
- alpha 1
- thick 0.08
- camherr 0.01
- xroot 50
- zroot -8
- tipTreat 2
- hinge [609]
- spw 0.2
- spw2 0.7
- spw3 1



..../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"

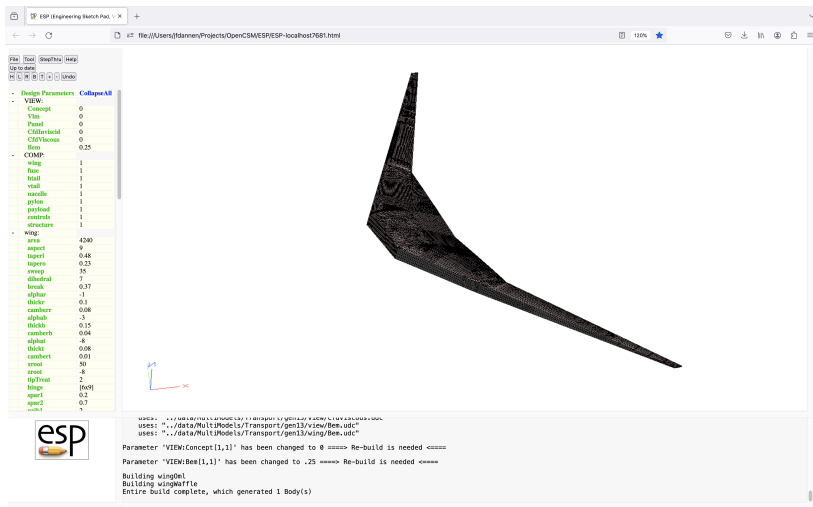
uses:/data/MultiModels/Transport/gen13/pylon/Petrs.udc"

uses:/data/MultiModels/Transport/gen13/payload/Petrs.udc"

uses:/data/MultiModels/Transport/gen13/nacelle/Petrs.udc"

uses:/data/MultiModels/Transport/gen13/wing/Calc.udc"

uses:/data/MultiModels/Transport/gen13/htail/Calc.udc"



The screenshot shows the ESP software interface. On the left, a tree view lists design parameters under 'VIEW' and 'COMP'. The 'VIEW' section includes parameters like Concept, Vm, Pm, CldIncid, CldViscous, and Rem. The 'COMP' section includes parameters like wing, fuse, htail, vtail, nacelle, pylon, payload, controls, and structure. Below these, a detailed list of parameters for the wing is shown, including area, aspect, taper, taper0, sweep, dihedral, break, alpha, thick, camber, alpha0, thick, camber, xroot, zroot, tipTreat, hinge, spar, and spar2.

On the right, a 3D model of a wing is displayed. The wing is dark gray and has a complex, multi-faceted shape. It is shown from a perspective view, highlighting its curved and twisted geometry.

At the bottom, a console window displays 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 wingNelle
Entire Build complete, which generated 1 Body(s)
```

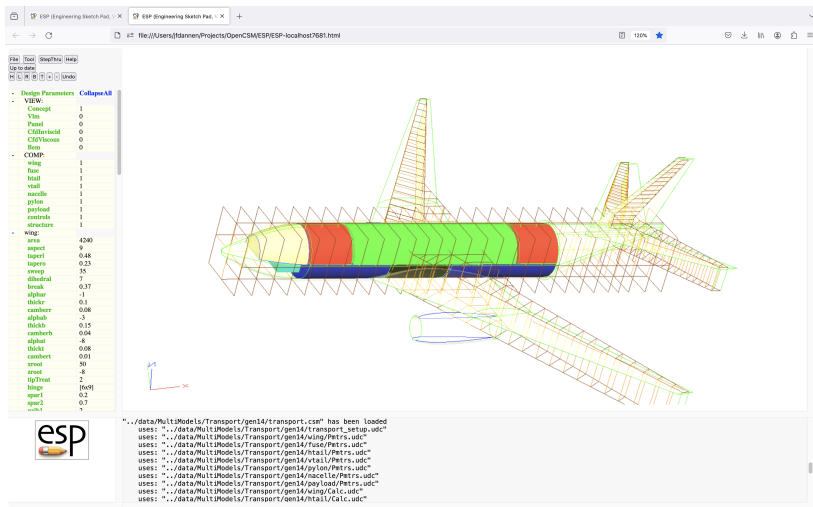
- New files:

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)

Generation 14 — add BEM for whole aircraft



ESP (Engineering Sketch Pad) - X

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

120%

File Tool Graph/Tree Help

Up to date

File Tool Graph/Tree Help

Design Parameters Collapse All

VIEW:

- Concept: 1
- Vin: 0
- Panels: 0
- Cd/Wing: 0
- Cd/Wing: 0
- Vin: 0

COMP:

- wing: 1
- fuse: 1
- tail: 1
- vtail: 1
- nacelle: 1
- pylon: 1
- payload: 1
- controls: 1
- structure: 1

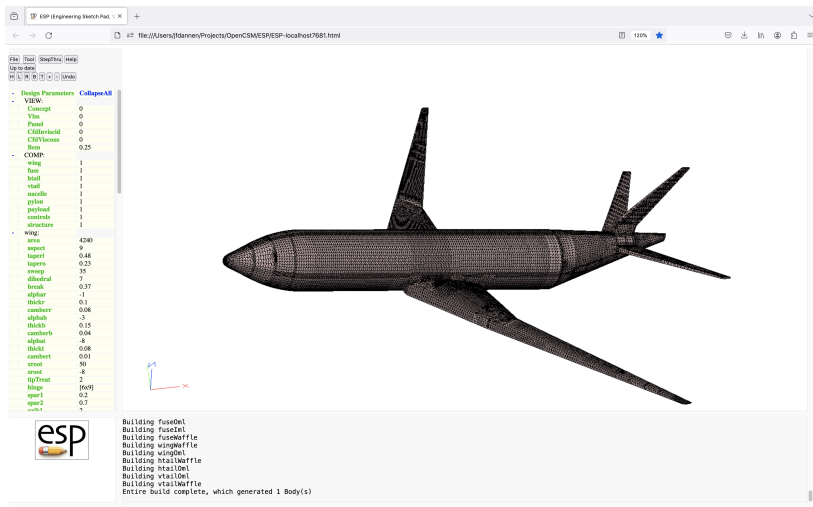
wing:

- area: 4290
- aspect: 9
- taper: 0.48
- taper: 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
- sweep: 50
- aspect: -8
- tipTreat: 2
- hinge: [609]
- spar: 0.2
- spar: 0.7
- root: 1

uses:

- uses: ".../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/wing/Calc.udc"
- uses: ".../data/MultiModels/Transport/gen14/htail/Calc.udc"

esp



- 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/dannen/Projects/OpenCSM/ESP/ESP-localhost7681.html

120%

File Tools Snap/Show Help

Up to date

Design Parameters Collapse All

VIEW:

- Concept 0
- Vin 0
- Panel 0
- ChildInclud 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
- taper0 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
- aroot -8
- tipTreat 2
- hinge {fac0}
- 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
```