

Engineering Sketch Pad (ESP)



Exercise Solutions

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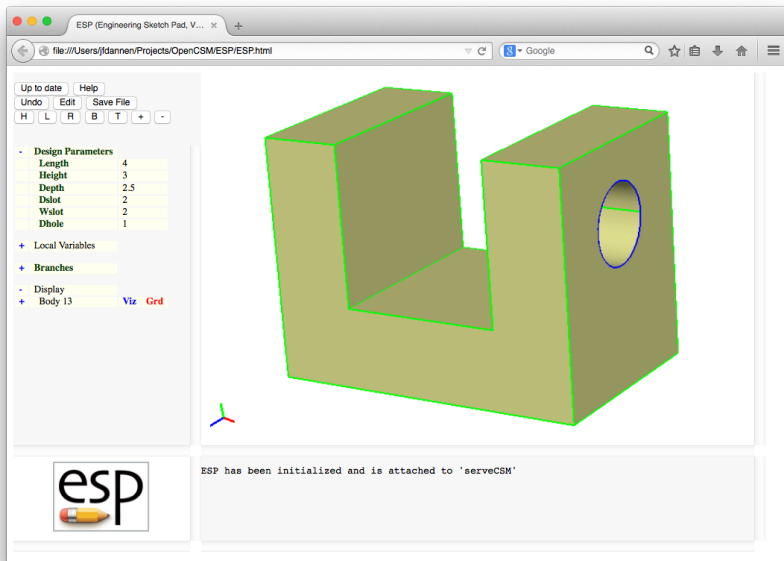
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updated for v1.19

Session 2 Solutions

Solids Fundamentals (1)



ESP (Engineering Sketch Pad, V...)

file:///Users/ldannen/Projects/OpenCSM/ESP/ESP.html

Up to date Help

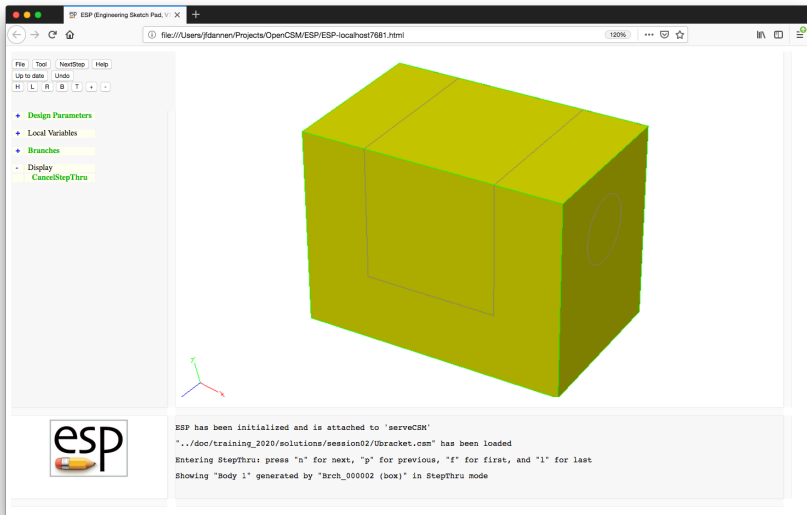
Undo Edit Save File

H L R B T + -

- Design Parameters
 - Length 4
 - Height 3
 - Depth 2.5
 - Dslot 2
 - Wslot 2
 - Dhole 1
- Local Variables
- Branches
- Display
- Body 13 Viz Grd

ESP has been initialized and is attached to 'serveCSM'

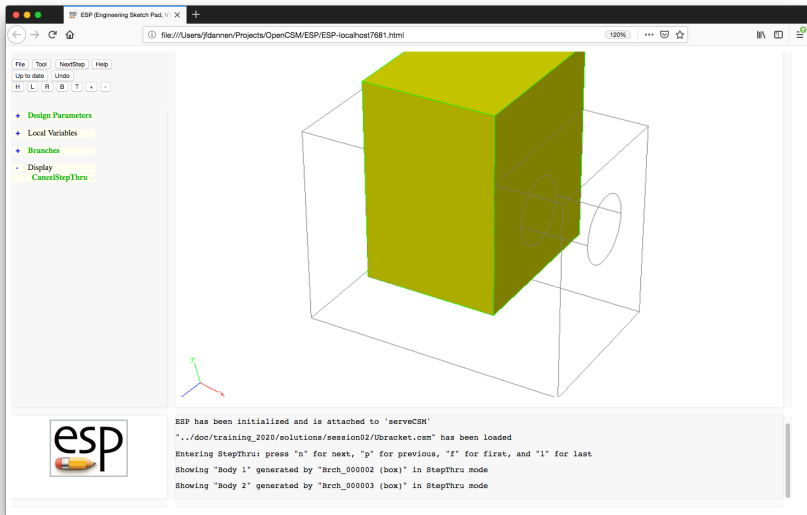
Length	length in (X -direction)	4.00
Height	height of the two legs (Y -direction)	3.00
Depth	depth (in Z -direction)	2.50
Dslot	depth of slot (in Y -direction)	2.00
Wslot	width of slot (in X -direction)	2.00
	slot is centered in X -direction	
Dhole	diameter of hole	1.00
	hole is centered in Z -direction	
	center of hole is down Dhole from top	



The screenshot shows the ESP (Engineering Sketch Pad) software interface. The main window displays a 3D model of a yellow rectangular box with a circular hole on the right side. The interface includes a menu bar (File, Tool, NextStep, Help), a toolbar (Up to date, Undo, H, L, R, B, T, +, -), and a left-hand panel with a tree view containing: Design Parameters, Local Variables, Branches, Display, and CancelStepThru. The bottom status bar contains the ESP logo and a console window with the following text:

```

ESP has been initialized and is attached to 'serveCSM'
'../doc/training_2020/solutions/session02/Ubracket.csm' has been loaded
Entering StepThru: press "n" for next, "p" for previous, "f" for first, and "l" for last
Showing "Body 1" generated by "Brch_000002 (box)" in StepThru mode
    
```



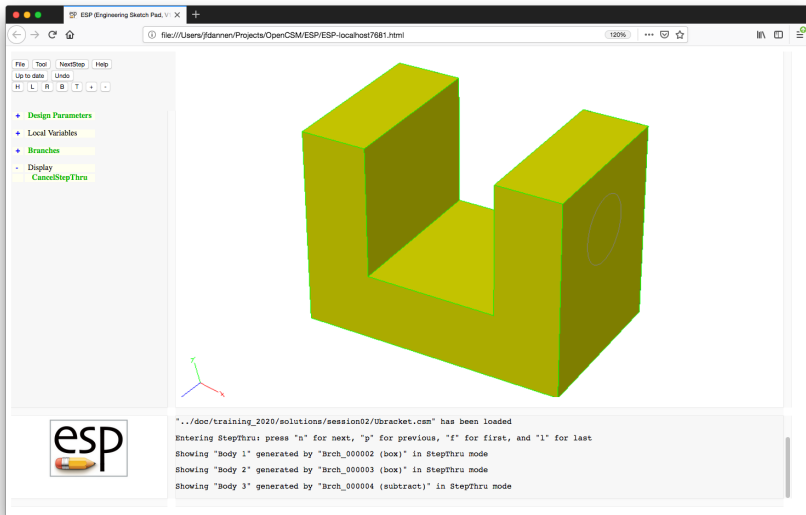
ESP (Engineering Sketch Pad, V. X)

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

File Tool NextStep Help
Up to date Undo
H L R B T +

- + Design Parameters
- + Local Variables
- + Branches
- Display
 - CancelStepThru

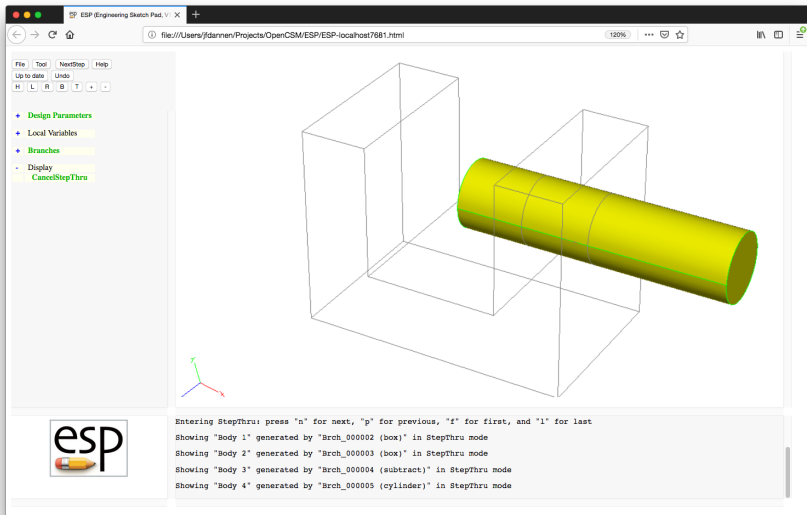
ESP has been initialized and is attached to 'serveCSM'
 '../doc/training_2020/solutions/session02/Ubracket.csm' has been loaded
 Entering StepThru: press "n" for next, "p" for previous, "f" for first, and "l" for last
 Showing "Body 1" generated by "Brch_000002 (box)" in StepThru mode
 Showing "Body 2" generated by "Brch_000003 (box)" in StepThru mode



File Tool NextStep Help
Up to date Undo
H L R B T + -

- + Design Parameters
- + Local Variables
- + Branches
- Display
 - CancelStepThru

\"../../doc/training_2020/solutions/session02/Ubracket.csm\" has been loaded
Entering StepThru: press \"n\" for next, \"p\" for previous, \"f\" for first, and \"l\" for last
Showing \"Body 1\" generated by \"Brch_000002 (box)\" in StepThru mode
Showing \"Body 2\" generated by \"Brch_000003 (box)\" in StepThru mode
Showing \"Body 3\" generated by \"Brch_000004 (subtract)\" in StepThru mode

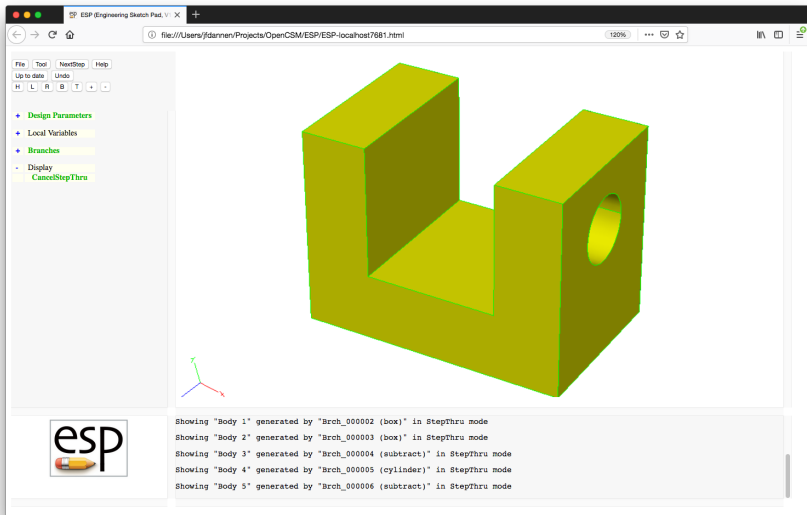


File Tool NextStep Help
Up to date Undo
H L R B T + -

- + Design Parameters
- + Local Variables
- + Branches
- Display
 - CancelStepThru

esp

Entering StepThru: press "n" for next, "p" for previous, "f" for first, and "l" for last
 Showing "Body 1" generated by "Brch_000002 (box)" in StepThru mode
 Showing "Body 2" generated by "Brch_000003 (box)" in StepThru mode
 Showing "Body 3" generated by "Brch_000004 (subtract)" in StepThru mode
 Showing "Body 4" generated by "Brch_000005 (cylinder)" in StepThru mode



File | Tool | NextStep | Help
 Up to date | Undo
 H | L | R | B | T | + | -

- + Design Parameters
- + Local Variables
- + Branches
- Display
 - CancelStepThru

Showing "Body 1" generated by "Brch_000002 (box)" in StepThru mode
 Showing "Body 2" generated by "Brch_000003 (box)" in StepThru mode
 Showing "Body 3" generated by "Brch_000004 (subtract)" in StepThru mode
 Showing "Body 4" generated by "Brch_000005 (cylinder)" in StepThru mode
 Showing "Body 5" generated by "Brch_000006 (subtract)" in StepThru mode



U-shaped Bracket — .csm File

```
# Ubracket
# written by John Dannenhoffer

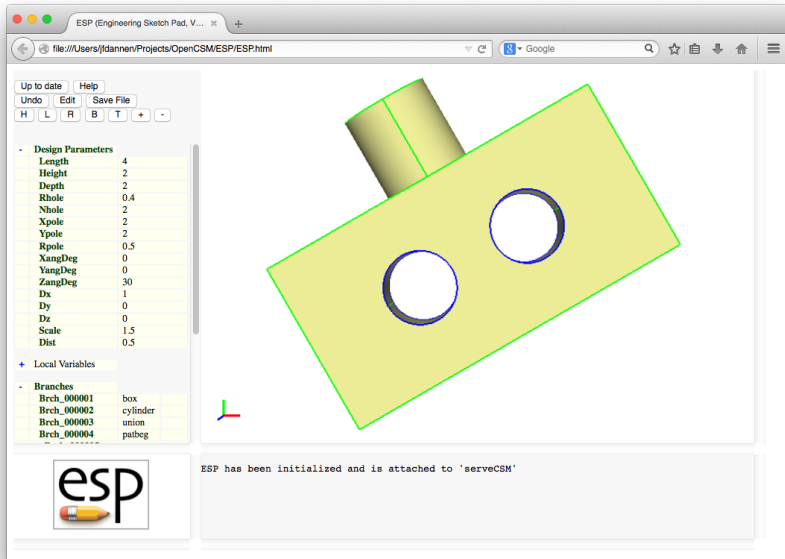
# design parameters
DESPMTR Length 4.00 # length
DESPMTR Height 3.00 # height
DESPMTR Depth 2.50 # depth
DESPMTR Dslot 2.00 # depth of slot
DESPMTR Wslot 2.00 # width of slot
DESPMTR Dhole 1.00 # diameter of hole

# bracket shape
SET thick (Length-Wslot)/2

BOX 0 0 0 Length Height Depth
BOX thick Height-Dslot 0 Length-2*thick Height Depth
SUBTRACT

# hole
CYLINDER Length/2 Height-Dhole Depth/2 \
3*Length/2 Height-Dhole Depth/2 Dhole/2
SUBTRACT

END
```



ESP (Engineering Sketch Pad, V...)

file:///Users/ldannen/Projects/OpenCSM/ESP/ESP.html

Up to date Help

Undo Edit Save File

H L R B T + -

- Design Parameters

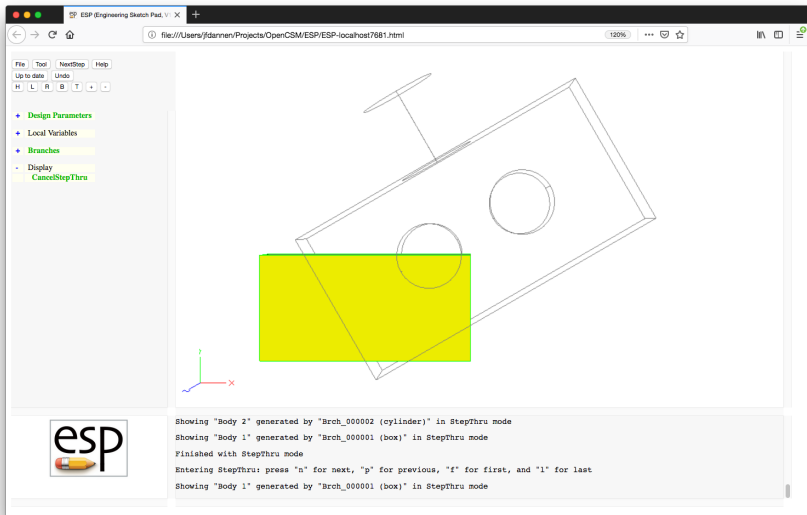
Length	4
Height	2
Depth	2
Rhole	0.4
Nhole	2
Xpole	2
Ypole	2
Rpole	0.5
XangDeg	0
YangDeg	0
ZangDeg	30
Dx	1
Dy	0
Dz	0
Scale	1.5
Dist	0.5
- Local Variables
- Branches

Brch_000001	box
Brch_000002	cylinder
Brch_000003	union
Brch_000004	patbeg

ESP has been initialized and is attached to 'serveCSM'

Box		
Length	length of box	4.0
Height	height of box	2.0
Depth	depth of box anchored at $X = Z = 0$ centered at $Y = 0$	2.0
Holes		
Rhole	radii of the holes	0.4
Nhole	number of holes holes are equally spaced	2
Pole		
Xpole	X -location of top of pole	2.0
Ypole	Y -location of top of pole	2.0
Rpole	radius of pole	0.5

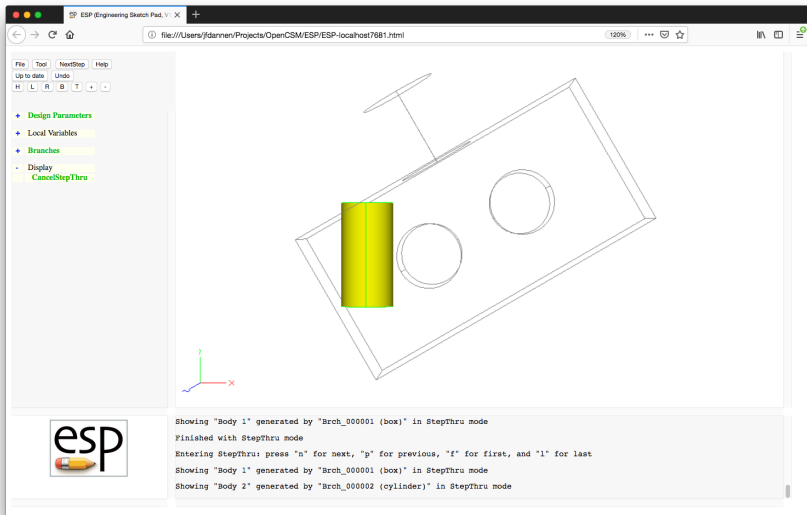
Rotation about origin		
XangDeg	X rotation (deg)	0.
YangDeg	Y rotation (deg)	0.
ZangDeg	Z rotation (deg)	30.
Translation		
Dx		1.0
Dy		0.0
Dz		0.0
Scaling		
Scale	overall scaling factor	1.5



File | Tool | NextStep | Help
 Up to date | Undo
 H | L | R | B | T | + | -

- + Design Parameters
- + Local Variables
- + Branches
- Display
 - CancelStepThru

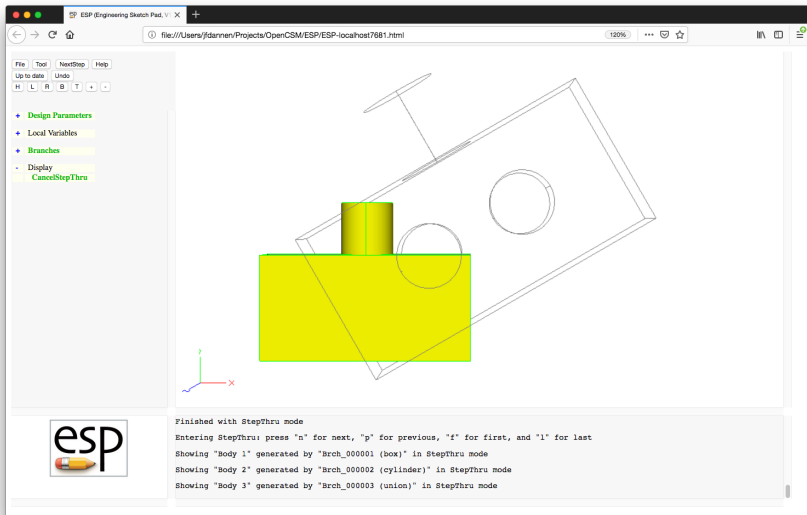
Showing "Body 2" generated by "Brch_000002 (cylinder)" in StepThru mode
 Showing "Body 1" generated by "Brch_000001 (box)" in StepThru mode
 Finished with StepThru mode
 Entering StepThru: press "n" for next, "p" for previous, "f" for first, and "l" for last
 Showing "Body 1" generated by "Brch_000001 (box)" in StepThru mode



File | Tool | NextStep | Help
 Up to date | Undo
 H | L | R | B | T | + | -

- + Design Parameters
- + Local Variables
- + Branches
- Display
 - CancelStepThru

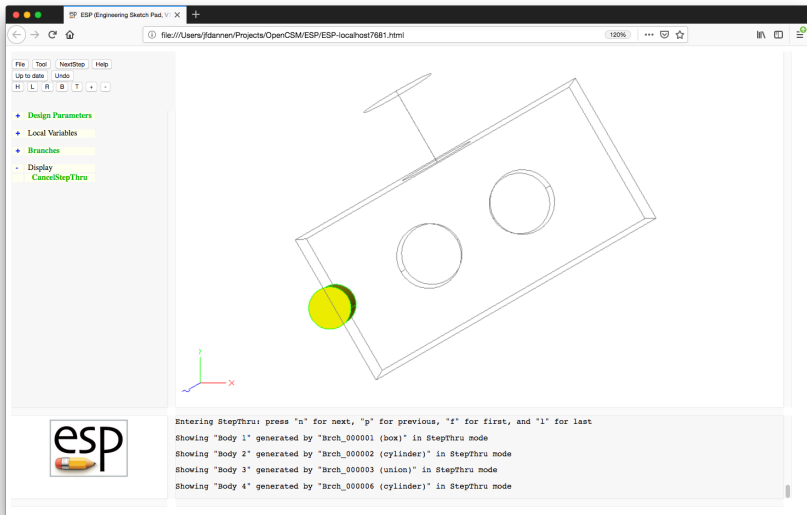
Showing "Body 1" generated by "Brch_000001 (box)" in StepThru mode
 Finished with StepThru mode
 Entering StepThru: press "n" for next, "p" for previous, "f" for first, and "l" for last
 Showing "Body 1" generated by "Brch_000001 (box)" in StepThru mode
 Showing "Body 2" generated by "Brch_000002 (cylinder)" in StepThru mode



File | Tool | NextStep | Help
 Up to date | Undo
 H | L | R | B | T | + | -

- + Design Parameters
- + Local Variables
- + Branches
- Display
 - CancelStepThru

Finished with StepThru mode
 Entering StepThru: press "n" for next, "p" for previous, "f" for first, and "l" for last
 Showing "Body 1" generated by "Brch_000001 (box)" in StepThru mode
 Showing "Body 2" generated by "Brch_000002 (cylinder)" in StepThru mode
 Showing "Body 3" generated by "Brch_000003 (union)" in StepThru mode



The screenshot shows the ESP (Engineering Sketch Pad) software interface. The main window displays a 3D model of a rectangular box with a handle on top and two circular features on the front face. A yellow and green sphere is positioned near the bottom-left corner of the box. A 3D coordinate system is visible in the bottom-left corner of the model area.

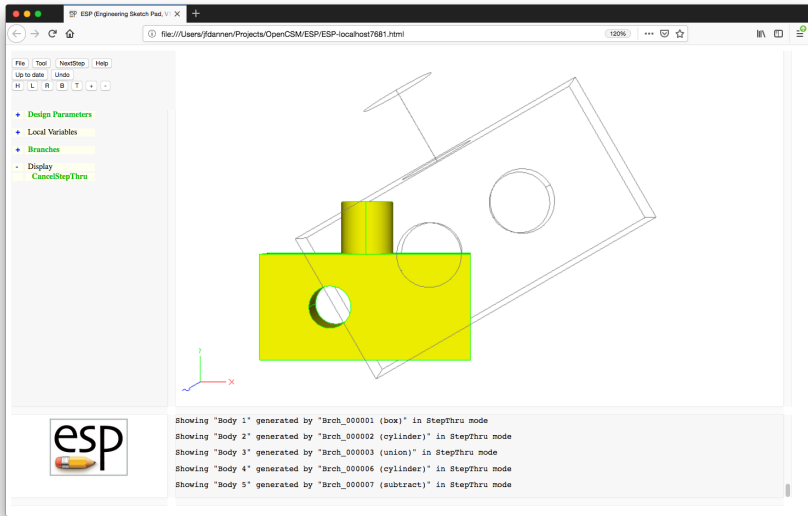
The left sidebar contains a tree view with the following items:

- + Design Parameters
- + Local Variables
- + Branches
- Display
 - CancelStepThru

The bottom status bar contains the ESP logo and a console window with the following text:

```

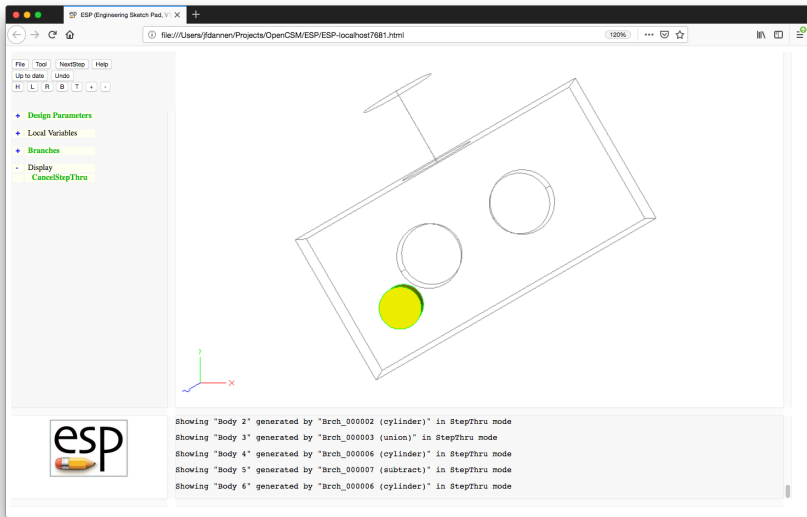
Entering StepThru: press "n" for next, "p" for previous, "f" for first, and "l" for last
Showing "Body 1" generated by "Brch_000001 (box)" in StepThru mode
Showing "Body 2" generated by "Brch_000002 (cylinder)" in StepThru mode
Showing "Body 3" generated by "Brch_000003 (union)" in StepThru mode
Showing "Body 4" generated by "Brch_000006 (cylinder)" in StepThru mode
  
```



File Tool NextStep Help
 Up to date Undo
 H L R B T + -

- + Design Parameters
- + Local Variables
- + Branches
- Display
 - CancelStepThru

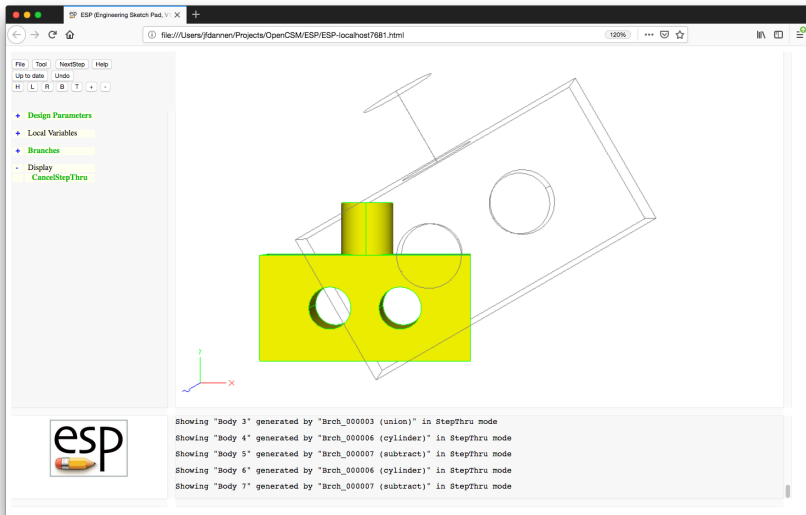
Showing "Body 1" generated by "Brch_000001 (box)" in StepThru mode
 Showing "Body 2" generated by "Brch_000002 (cylinder)" in StepThru mode
 Showing "Body 3" generated by "Brch_000003 (union)" in StepThru mode
 Showing "Body 4" generated by "Brch_000006 (cylinder)" in StepThru mode
 Showing "Body 5" generated by "Brch_000007 (subtract)" in StepThru mode



The screenshot displays the ESP (Engineering Sketch Pad) software interface. The main window shows a 3D model of a rectangular block with a circular hole and a cylindrical protrusion. The interface includes a menu bar (File, Tool, NextStep, Help), a toolbar (Up to date, Undo, H, L, R, B, T, +, -), and a left sidebar with design parameters (Design Parameters, Local Variables, Branches, Display, CancelStepThru). The bottom status bar shows a log of generated bodies:

```

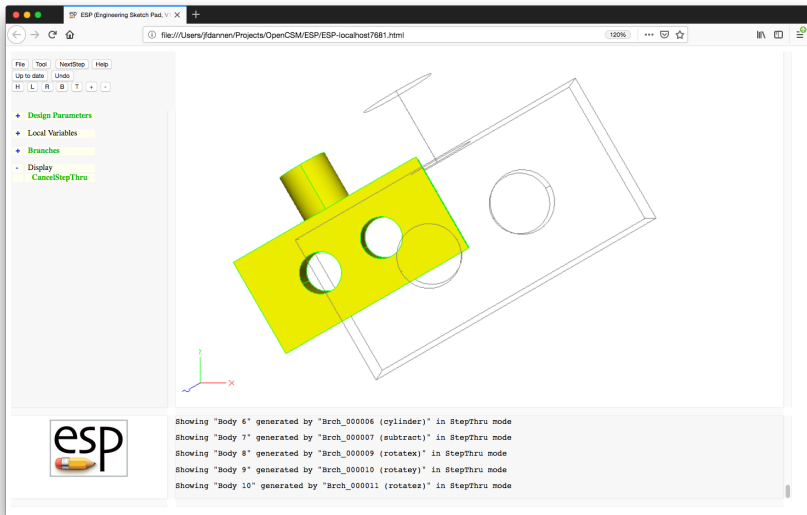
Showing "Body 2" generated by "Brch_000002 (cylinder)" in StepThru mode
Showing "Body 3" generated by "Brch_000003 (union)" in StepThru mode
Showing "Body 4" generated by "Brch_000006 (cylinder)" in StepThru mode
Showing "Body 5" generated by "Brch_000007 (subtract)" in StepThru mode
Showing "Body 6" generated by "Brch_000006 (cylinder)" in StepThru mode
  
```



File | Tool | NextStep | Help
 Up to date | Undo
 H | L | R | B | T | + | -

- + Design Parameters
- + Local Variables
- + Branches
- Display
 - CancelStepThru

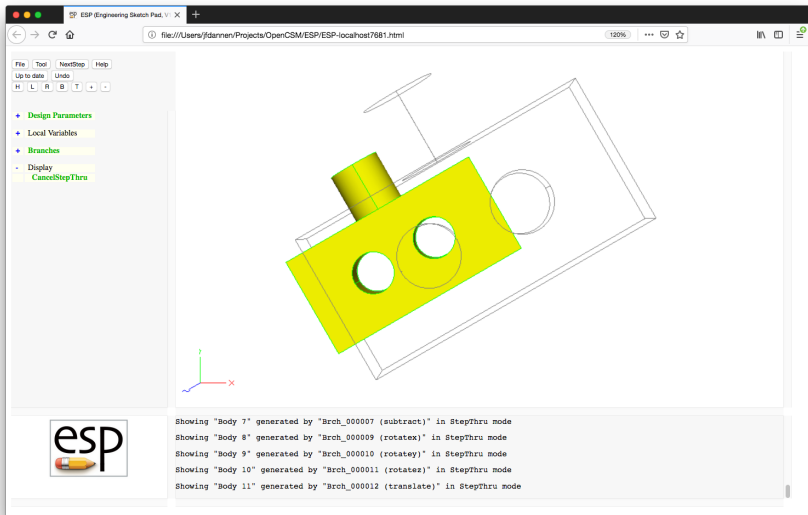
Showing "Body 3" generated by "Brch_000003 (union)" in StepThru mode
 Showing "Body 4" generated by "Brch_000006 (cylinder)" in StepThru mode
 Showing "Body 5" generated by "Brch_000007 (subtract)" in StepThru mode
 Showing "Body 6" generated by "Brch_000006 (cylinder)" in StepThru mode
 Showing "Body 7" generated by "Brch_000007 (subtract)" in StepThru mode



File | Tool | NextStep | Help
 Up to date | Undo
 H | L | R | B | T | + | -

- + Design Parameters
- + Local Variables
- + Branches
- Display
 - CancelStepThru

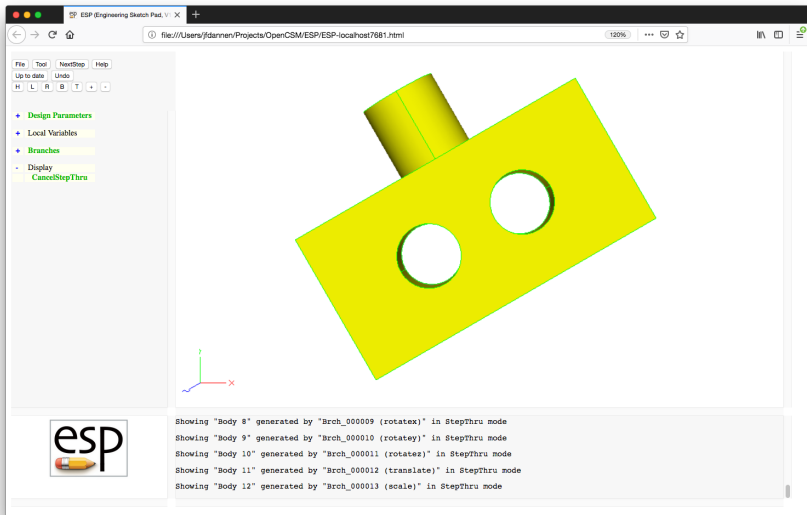
Showing "Body 6" generated by "Brch_000006 (cylinder)" in StepThru mode
 Showing "Body 7" generated by "Brch_000007 (subtract)" in StepThru mode
 Showing "Body 8" generated by "Brch_000009 (rotatex)" in StepThru mode
 Showing "Body 9" generated by "Brch_000010 (rotatay)" in StepThru mode
 Showing "Body 10" generated by "Brch_000011 (rotatez)" in StepThru mode



File Tool NextStep Help
Up to date Undo
H L R B T + -

- + Design Parameters
- + Local Variables
- + Branches
- Display
 - CancelStepThru

Showing "Body 7" generated by "Brch_000007 (subtract)" in StepThru mode
Showing "Body 8" generated by "Brch_000009 (rotatex)" in StepThru mode
Showing "Body 9" generated by "Brch_000010 (rotatey)" in StepThru mode
Showing "Body 10" generated by "Brch_000011 (rotatez)" in StepThru mode
Showing "Body 11" generated by "Brch_000012 (translate)" in StepThru mode



The screenshot shows the ESP (Engineering Sketch Pad) software interface. The main window displays a 3D model of a yellow rectangular plate with two circular holes and a cylindrical protrusion. The interface includes a menu bar (File, Tool, NextStep, Help), a toolbar (Up to date, Undo, H, L, R, B, T, +, -), and a console window at the bottom. The console window displays the following text:

```
Showing "Body 8" generated by "Brch_000009 (rotatex)" in StepThru mode
Showing "Body 9" generated by "Brch_000010 (rotatex)" in StepThru mode
Showing "Body 10" generated by "Brch_000011 (rotatex)" in StepThru mode
Showing "Body 11" generated by "Brch_000012 (translate)" in StepThru mode
Showing "Body 12" generated by "Brch_000013 (scale)" in StepThru mode
```



Simple Block — .csm File (1)

```
# block
# written by John Dannenhoffer
```

```
DESPMTR Length 4.0
DESPMTR Height 2.0
DESPMTR Depth 2.0
DESPMTR Rhole 0.4
DESPMTR Nhole 2
DESPMTR Xpole 2.0
DESPMTR Ypole 2.0
DESPMTR Rpole 0.5
DESPMTR XangDeg 0.
DESPMTR YangDeg 0.
DESPMTR ZangDeg 30.
DESPMTR Dx 1.0
DESPMTR Dy 0.0
DESPMTR Dz 0.0
DESPMTR Scale 1.5
DESPMTR Dist 0.5
```

```
# base block
```

```
BOX 0.0 -Height/2 0.0 Length Height Depth
```



Simple Block — .csm File (2)

```
# post
CYLINDER Xpole      0.0      Depth/2  Xpole      Ypole      Depth/2  Rpole
UNION

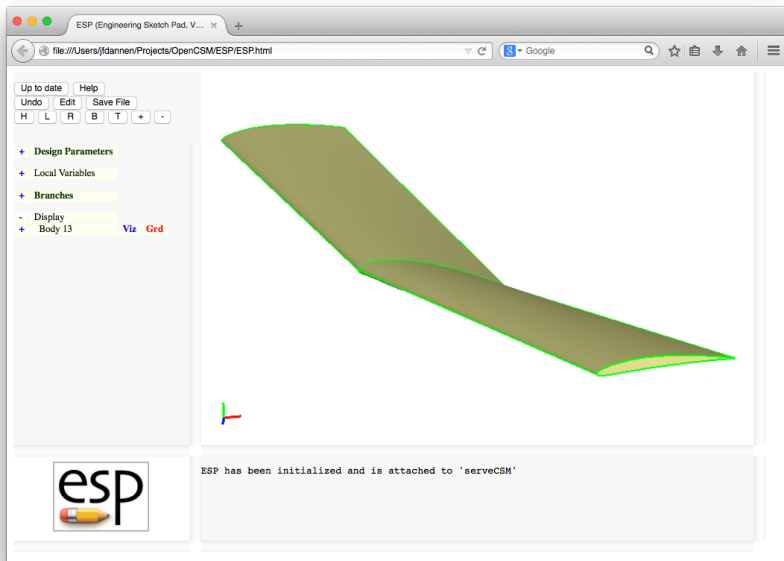
# Nhole holes
PATBEG   ihole      Nhole
      SET      xhole  Length*ihole/(Nhole+1)
      CYLINDER xhole  0.0      0.0      xhole      0.0      Depth      Rhole
SUBTRACT
PATEND

# transformations
ROTATEX  XangDeg    0.0      0.0
ROTATEY  YangDeg    0.0      0.0
ROTATEZ  ZangDeg    0.0      0.0
TRANSLATE Dx        Dy        Dz
SCALE    Scale

END
```

Session 3 Solutions

Solids Fundamentals (2)



The screenshot shows the ESP (Engineering Sketch Pad) web application interface. The browser address bar displays the file path: `file:///Users/ldannen/Projects/OpenCSM/ESP/ESP.html`. The application title is "ESP (Engineering Sketch Pad, V...".

The left sidebar contains a menu with the following items:

- Up to date
- Help
- Undo
- Edit
- Save File
- H L R B T + -
- + Design Parameters
- + Local Variables
- + Branches
- Display
- + Body 13 Viz Grd

The central 3D view displays a green wireframe model of a wing. A small 3D coordinate system is visible in the bottom left corner of the 3D view.

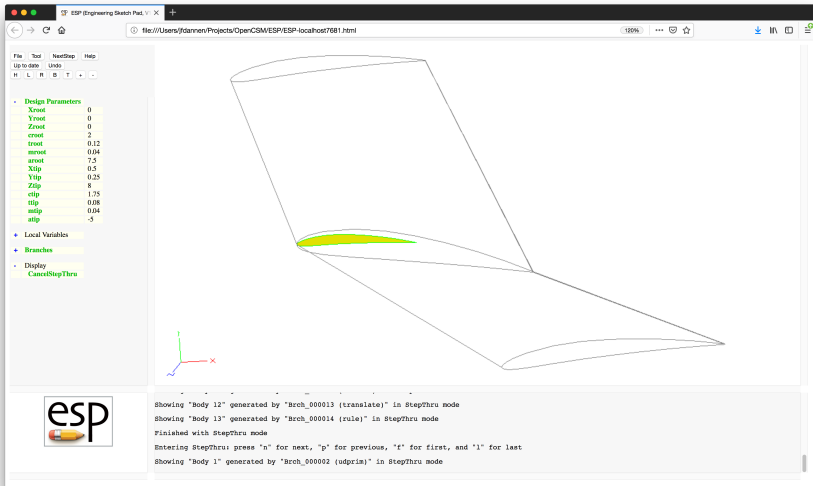
The bottom status bar displays the text: "ESP has been initialized and is attached to 'serveCSM'".

The ESP logo is visible in the bottom left corner of the application window.

Xroot	X-coordinate of root leading edge	0.00
Yroot	Y-coordinate of root leading edge	0.00
Zroot	Z-coordinate of root leading edge	0.00
croot	chord of root	2.00
troot	thickness/chord of root	0.12
mroot	camber/chord of root	0.04
aroot	angle of attack of root (deg)	7.50
Xtip	X-coordinate of tip leading edge	0.50
Ytip	Y-coordinate of tip leading edge	0.25
Ztip	Z-coordinate of tip leading edge	8.00
ctip	chord of tip	1.75
ttip	thickness/chord of tip	0.08
mtip	camber/chord of tip	0.04
atip	angle of attack of tip (deg)	-5.00

- What happens if you switch from RULE to BLEND?
- What happens if we change the sequence of transformations from SCALE, ROTATEZ, TRANSLATE to ROTATEZ, SCALE, TRANSLATE?
- What happens if we do the TRANSLATE first?
- Could you change the Design Parameters to `area`, `aspectRatio`, `taperRatio`, `sweep`, and `twist`?

$$AR = \frac{b^2}{S} \quad S = b(c_{\text{tip}} + c_{\text{root}})/2 \quad \tau = \frac{c_{\text{tip}}}{c_{\text{root}}}$$

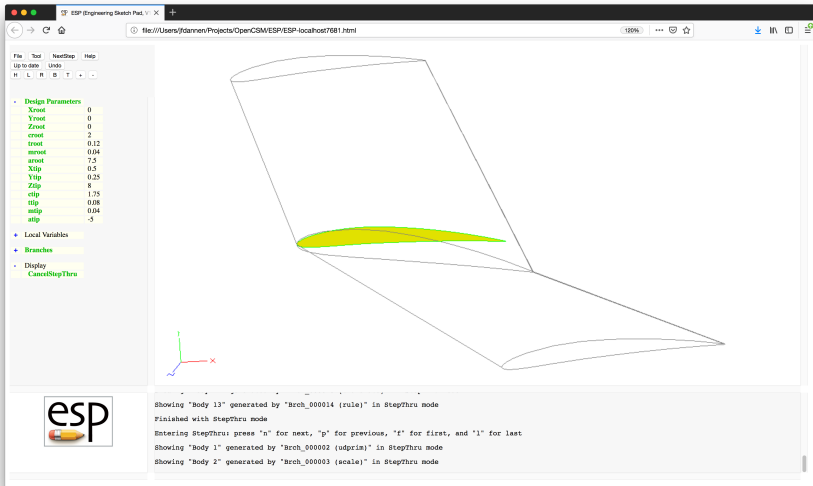


File Edit NextStep Help
Up to date Undo
H L R B T + -

- Design Parameters

Xroot	0
Yroot	0
Zroot	0
crroot	2
trroot	0.12
srroot	0.04
aroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
ctip	1.75
ttip	0.08
mtip	0.04
stip	-5
- Local Variables
- Branches
- Display
 - CancelStepThru

Showing "Body 12" generated by "Brch_000013 (translate)" in StepThru mode
Showing "Body 13" generated by "Brch_000014 (rule)" in StepThru mode
Finished with StepThru mode
Entering StepThru: press 'n' for next, 'p' for previous, 'f' for first, and 'l' for last
Showing "Body 1" generated by "Brch_000002 (udprim)" in StepThru mode



The screenshot shows the ESP Engineering Sketch Pad interface. The main window displays a 3D wireframe model of a wing with a yellow-green shaded surface. The left sidebar contains a 'Design Parameters' list with the following values:

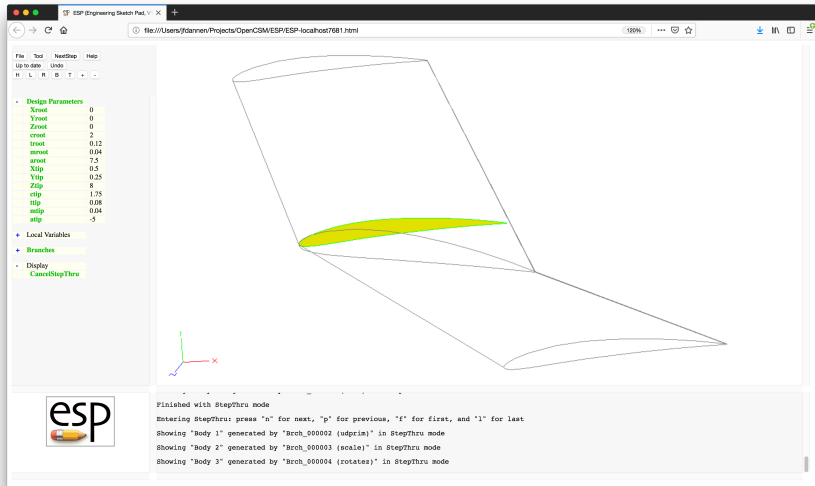
Parameter	Value
Xroot	0
Yroot	0
Zroot	0
crroot	2
trroot	0.12
mrroot	0.04
aroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
ctip	1.75
ttip	0.08
mtip	0.04
stip	-5

Below the parameters are sections for 'Local Variables', 'Branches', and 'Display' (containing 'CancelStepThru'). A small 3D coordinate system is visible in the bottom left of the main view.

The bottom status bar contains the ESP logo and the following text:

```

Showing "Body 13" generated by "Brch_000014 (rule)" in StepThru mode
Finished with StepThru mode
Entering StepThru press 'n' for next, 'p' for previous, 'f' for first, and 'l' for last
Showing "Body 1" generated by "Brch_000002 (udprim)" in StepThru mode
Showing "Body 2" generated by "Brch_000003 (scale)" in StepThru mode
  
```



The screenshot shows the ESP Engineering Sketch Pad interface. On the left, a 'Design Parameters' list is visible:

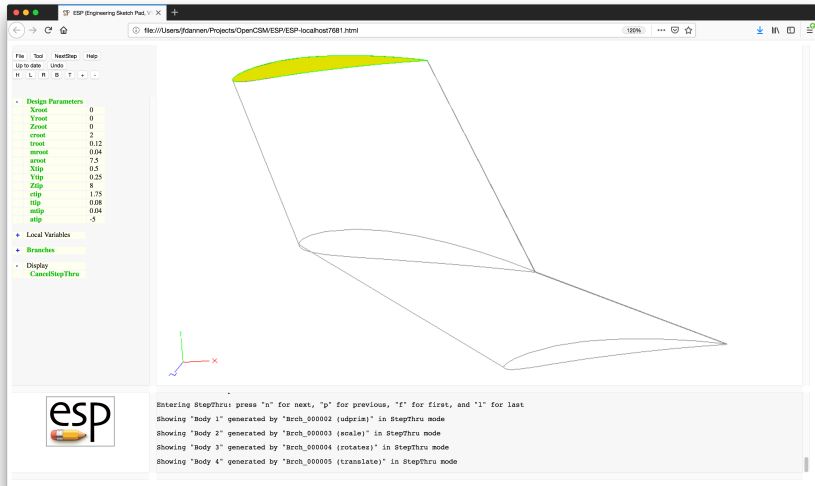
- Xroot: 0
- Yroot: 0
- Zroot: 0
- crroot: 2
- trroot: 0.12
- srroot: 0.04
- aroot: 7.5
- Xtip: 0.5
- Ytip: 0.25
- Ztip: 8
- ctip: 1.75
- ctip: 0.08
- mtip: 0.04
- stip: -5

The main workspace displays a 3D wireframe model of a wing. A yellow-green shaded surface is applied to the upper part of the wing, representing a camber or airfoil profile. A small 3D coordinate system (x, y, z) is visible in the bottom left corner of the workspace.

At the bottom of the window, a console window shows the following text:

```

Finished with StepThru mode
Entering StepThru: press "n" for next, "p" for previous, "f" for first, and "l" for last
Showing "Body 1" generated by "Brch_000002 (udpris)" in StepThru mode
Showing "Body 2" generated by "Brch_000003 (scale)" in StepThru mode
Showing "Body 3" generated by "Brch_000004 (rotates)" in StepThru mode
    
```



The screenshot shows the ESP Engineering Sketch Pad interface. The main window displays a 3D wireframe model of a wing with a yellow-green shaded top surface. A small 3D coordinate system is visible in the bottom left corner of the main view.

Design Parameters

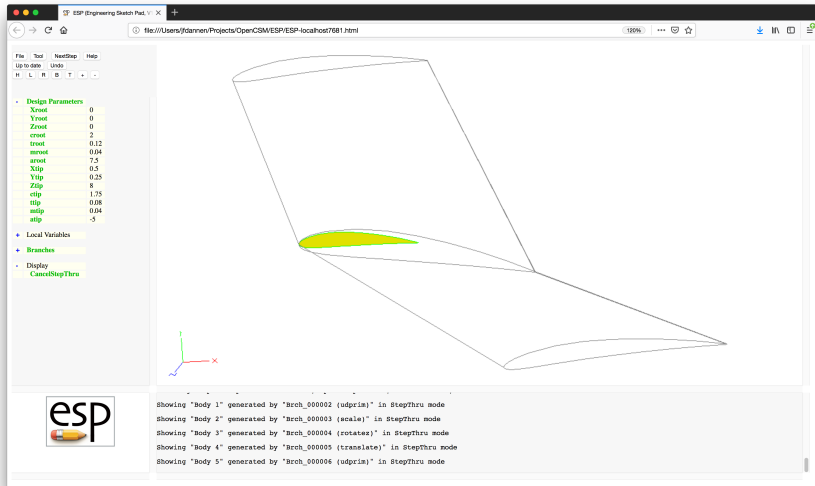
Parameter	Value
Xroot	0
Yroot	0
Zroot	0
crroot	2
trroot	0.12
srroot	0.04
aroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
ctip	1.75
ttip	0.08
mtip	0.04
stip	-5

Local Variables

- Branches
- Display
 - CancelStepThru

esp

Entering StepThru: press "n" for next, "p" for previous, "f" for first, and "l" for last
 Showing "Body 1" generated by "Brch_000002 (udprim)" in StepThru mode
 Showing "Body 2" generated by "Brch_000003 (scale)" in StepThru mode
 Showing "Body 3" generated by "Brch_000004 (rotatez)" in StepThru mode
 Showing "Body 4" generated by "Brch_000005 (translate)" in StepThru mode



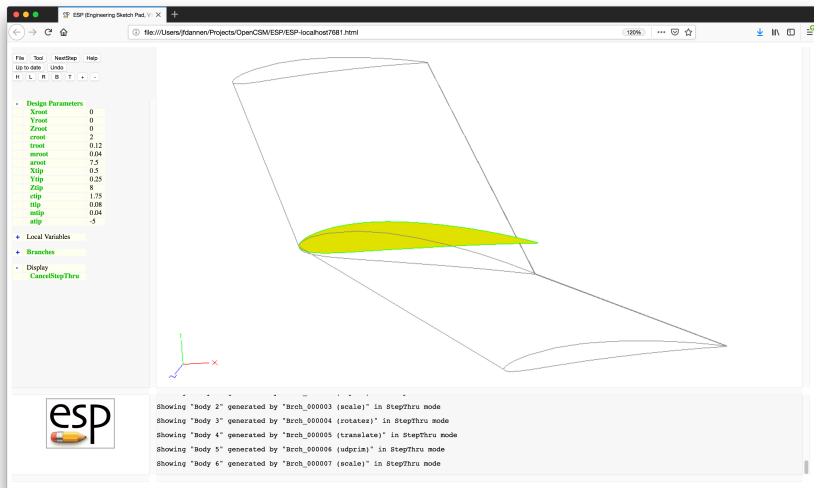
The screenshot shows the ESP Engineering Sketch Pad interface. The main window displays a 3D wireframe model of a wing with a yellow-green shaded airfoil section. The left sidebar contains a 'Design Parameters' list with the following values:

Parameter	Value
Xroot	0
Yroot	0
Zroot	0
crroot	2
trroot	0.12
mrroot	0.04
aroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
ctip	1.75
ttip	0.08
mtip	0.04
stip	-5

Below the parameters are sections for 'Local Variables', 'Branches', and 'Display' (with 'CancelStepThru' checked). At the bottom of the interface, a log shows the following messages:

```

Showing "Body 1" generated by "Brch_000002 (udprim)" in StepThru mode
Showing "Body 2" generated by "Brch_000003 (scale)" in StepThru mode
Showing "Body 3" generated by "Brch_000004 (rotates)" in StepThru mode
Showing "Body 4" generated by "Brch_000005 (translate)" in StepThru mode
Showing "Body 5" generated by "Brch_000006 (udprim)" in StepThru mode
  
```



The screenshot shows the ESP Engineering Sketch Pad interface. The main window displays a 3D model of a wing, which is highlighted in yellow. The wing is shown within a wireframe bounding box. The left sidebar contains a list of design parameters and local variables. The bottom status bar shows the current step in the construction process.

Design Parameters

Xroot	0
Yroot	0
Zroot	0
crroot	2
trroot	0.12
srroot	0.04
aroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
ctip	1.75
ttip	0.08
mtip	0.04
stip	-5

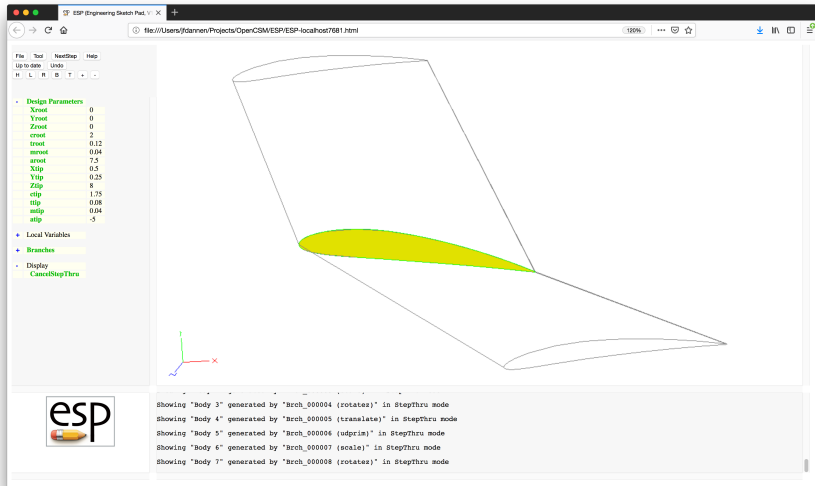
Local Variables

- Branches
- Display
 - CancelStepThru

Status Bar:

```

Showing "Body 2" generated by "Brch_000003 (scale)" in StepThru mode
Showing "Body 3" generated by "Brch_000004 (rotatez)" in StepThru mode
Showing "Body 4" generated by "Brch_000005 (translate)" in StepThru mode
Showing "Body 5" generated by "Brch_000006 (udprim)" in StepThru mode
Showing "Body 6" generated by "Brch_000007 (scale)" in StepThru mode
  
```



The screenshot displays the ESP Engineering Sketch Pad interface. The main window shows a 3D model of a wing, which is highlighted in yellow. The wing is positioned within a wireframe bounding box. The interface includes a menu bar (File, Tool, NextStep, Help), a toolbar, and a browser address bar showing the file path: file:///Users/foannen/Projects/Open-CSM/ESP/ESP-localhost7681.html. The left sidebar contains a tree view with sections for Design Parameters, Local Variables, Branches, and Display. The Design Parameters section lists various parameters and their values.

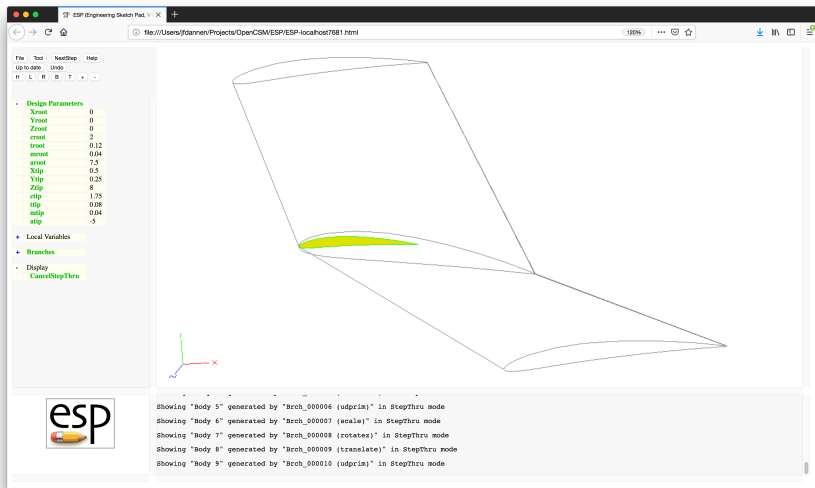
Parameter	Value
Xroot	0
Yroot	0
Zroot	0
crroot	2
trroot	0.12
mrroot	0.04
aroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
ctip	1.75
ctip	0.08
mtip	0.04
atip	-5

Below the Design Parameters section, there are sections for Local Variables, Branches, and Display. The Display section shows a checkbox for 'CancelStepThru'.

The bottom of the interface features the ESP logo and a console window displaying the following text:

```

Showing "Body 3" generated by "Brch_000004 (rotates)" in StepThru mode
Showing "Body 4" generated by "Brch_000005 (translate)" in StepThru mode
Showing "Body 5" generated by "Brch_000006 (udpri)" in StepThru mode
Showing "Body 6" generated by "Brch_000007 (scale)" in StepThru mode
Showing "Body 7" generated by "Brch_000008 (rotates)" in StepThru mode
  
```

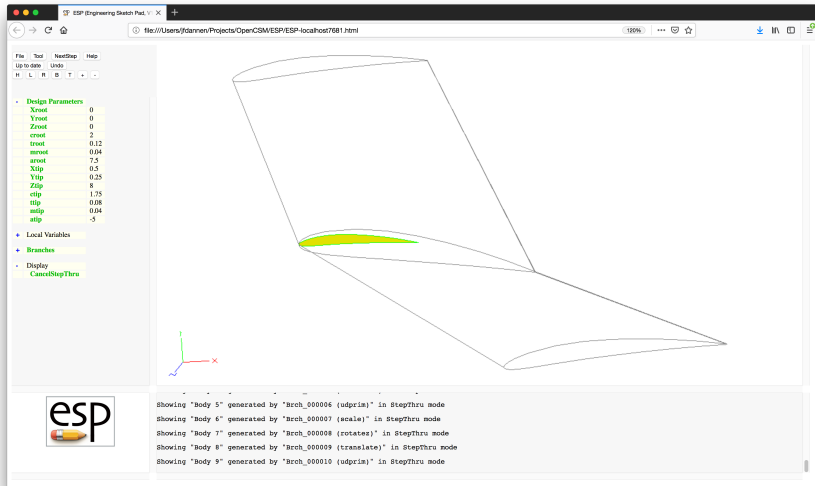
The screenshot displays the ESP Engineering Sketch Pad interface. The main window shows a 3D wireframe model of a wing with a yellow-green shaded airfoil section. The left sidebar contains a 'Design Parameters' list with the following values:

Parameter	Value
Xroot	0
Yroot	0
Zroot	0
crroot	2
trroot	0.12
mrroot	0.04
aroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
ctip	1.75
ttip	0.08
mtip	0.04
atip	-5

Below the parameters are sections for 'Local Variables', 'Branches', and 'Display', with 'CancelStepThru' listed under 'Display'. At the bottom of the interface, a log shows the following messages:

```

Showing "Body 5" generated by "Brch_000006 (udprim)" in StepThru mode
Showing "Body 6" generated by "Brch_000007 (scale)" in StepThru mode
Showing "Body 7" generated by "Brch_000008 (rotates)" in StepThru mode
Showing "Body 8" generated by "Brch_000009 (translate)" in StepThru mode
Showing "Body 9" generated by "Brch_000010 (udprim)" in StepThru mode
  
```



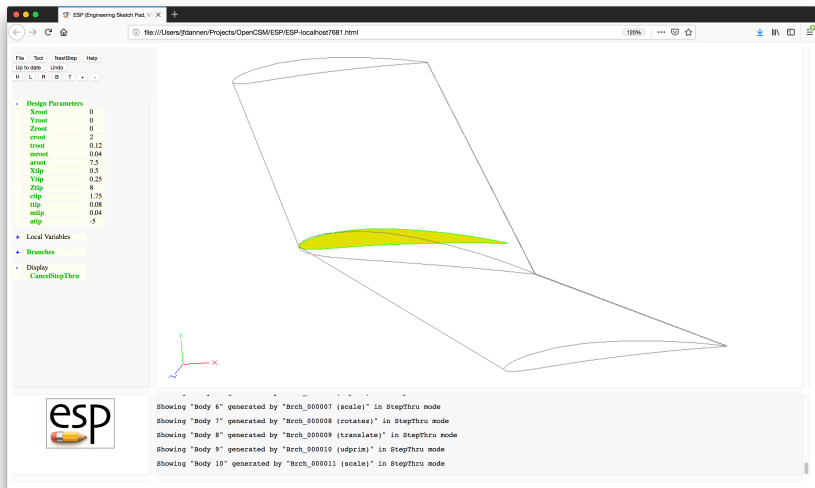
The screenshot displays the ESP Engineering Sketch Pad interface. The main window shows a 3D wireframe model of a wing with a yellow-green shaded airfoil cross-section. The left sidebar contains a 'Design Parameters' list with the following values:

Parameter	Value
Xroot	0
Yroot	0
Zroot	0
crroot	2
trroot	0.12
mrroot	0.04
aroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
ctip	1.75
ttip	0.08
mtip	0.04
stip	-5

Below the parameters are sections for 'Local Variables', 'Branches', and 'Display', with 'CancelStepThru' listed under 'Display'. At the bottom of the interface, a log shows the following messages:

```

Showing "Body 5" generated by "Brch_000006 (udprim)" in StepThru mode
Showing "Body 6" generated by "Brch_000007 (scale)" in StepThru mode
Showing "Body 7" generated by "Brch_000008 (rotates)" in StepThru mode
Showing "Body 8" generated by "Brch_000009 (translate)" in StepThru mode
Showing "Body 9" generated by "Brch_000010 (udprim)" in StepThru mode
  
```



The screenshot shows the ESP Engineering Sketch Pad interface. The main window displays a 3D model of a wing, which is a yellow-green surface with a black outline. The wing is shown in a perspective view, with a small coordinate system (x, y, z) visible in the bottom left corner of the model area.

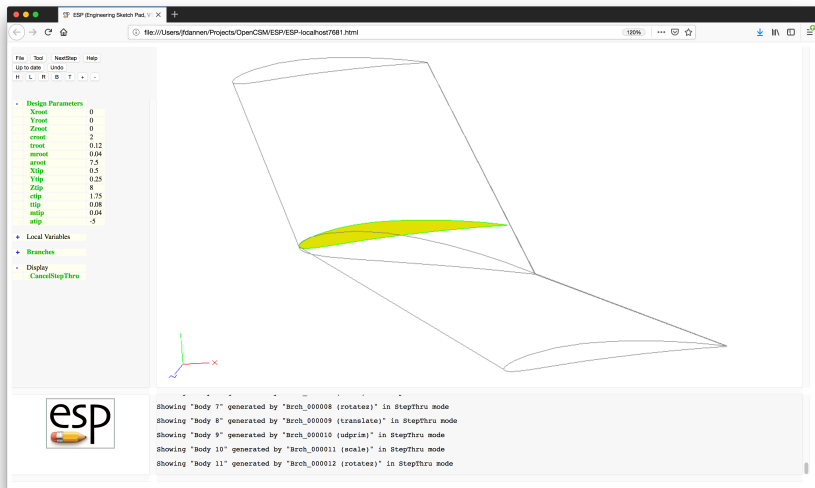
The left sidebar contains a list of design parameters and variables:

- Design Parameters**
 - Xroot: 0
 - Yroot: 0
 - Zroot: 0
 - croot: 2
 - troot: 0.12
 - mroot: 0.04
 - aroot: 7.5
 - Xtip: 0.5
 - Ytip: 0.25
 - Ztip: 8
 - ctip: 1.75
 - ttip: 0.08
 - mtip: 0.04
 - atip: -5
- Local Variables**
- Branches**
- Display**
 - CancelStepThru

The bottom of the interface shows a list of bodies generated in StepThru mode:

```

Showing "Body 6" generated by "Brch_000007 (scale)" in StepThru mode
Showing "Body 7" generated by "Brch_000008 (rotatez)" in StepThru mode
Showing "Body 8" generated by "Brch_000009 (translate)" in StepThru mode
Showing "Body 9" generated by "Brch_000010 (udprim)" in StepThru mode
Showing "Body 10" generated by "Brch_000011 (scale)" in StepThru mode
  
```



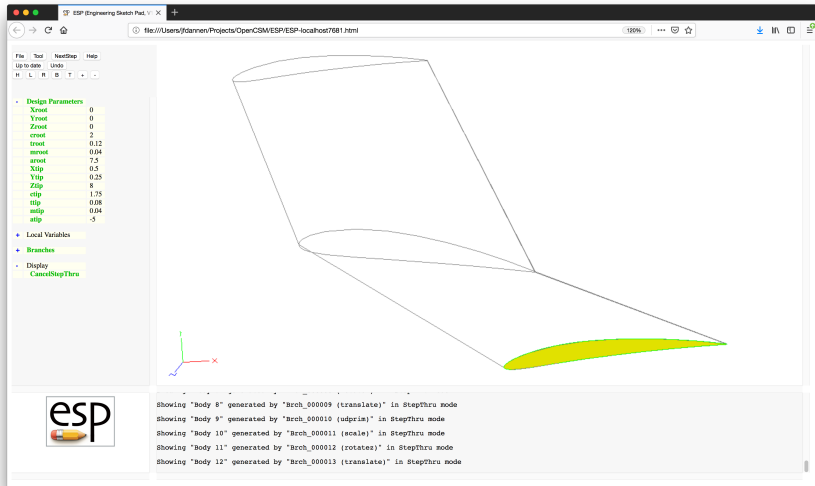
The screenshot displays the ESP Engineering Sketch Pad interface. The main window shows a 3D model of a wing with a yellow-green surface, positioned within a wireframe bounding box. The left sidebar contains a 'Design Parameters' list with the following values:

Parameter	Value
Xroot	0
Yroot	0
Zroot	0
crroot	2
trroot	0.12
srroot	0.04
aroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
ctip	1.75
ttip	0.08
mtip	0.04
stip	-5

Below the parameters are sections for 'Local Variables', 'Branches', and 'Display', with 'CancelStepThru' listed under 'Display'. At the bottom of the interface, a log window shows the following messages:

```

Showing "Body 7" generated by "Brch_000008 (rotatez)" in StepThru mode
Showing "Body 8" generated by "Brch_000009 (translate)" in StepThru mode
Showing "Body 9" generated by "Brch_000010 (udprism)" in StepThru mode
Showing "Body 10" generated by "Brch_000011 (scale)" in StepThru mode
Showing "Body 11" generated by "Brch_000012 (rotatez)" in StepThru mode
  
```



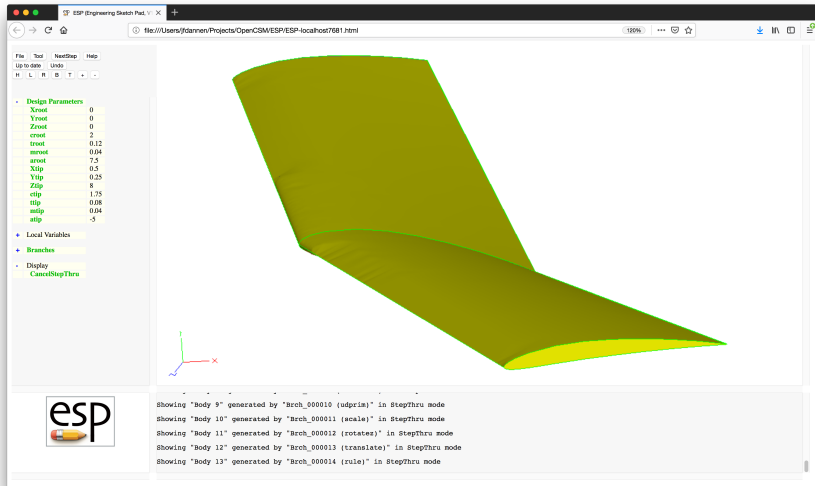
The screenshot shows the ESP Engineering Sketch Pad interface. The main window displays a 3D wireframe model of a wing. The left sidebar contains a 'Design Parameters' list with the following values:

Parameter	Value
Xroot	0
Yroot	0
Zroot	0
crroot	2
trroot	0.12
srroot	0.04
aroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
ctip	1.75
ttip	0.08
mtip	0.04
stip	-5

The console window at the bottom displays the following commands:

```

Showing "Body 8" generated by "Brch_000009 {translate}" in StepThru mode
Showing "Body 9" generated by "Brch_000010 {udprim}" in StepThru mode
Showing "Body 10" generated by "Brch_000011 {scale}" in StepThru mode
Showing "Body 11" generated by "Brch_000012 {rotatez}" in StepThru mode
Showing "Body 12" generated by "Brch_000013 {translate}" in StepThru mode
  
```



The screenshot shows the ESP Engineering Sketch Pad interface. The main window displays a 3D model of a wing, which is a curved surface tapering to a point. The model is rendered in a yellowish-green color. The interface includes a menu bar (File, Tool, NextStep, Help), a toolbar, and a left-hand panel with a tree view showing Design Parameters, Local Variables, Branches, and Display. The Design Parameters list includes variables like Xroot, Yroot, Zroot, croot, troot, mroot, aroot, Xtip, Ytip, Ztip, ctip, ttip, mtip, and stip. The bottom of the window shows a console window with the following text:

```

Showing "Body 9" generated by "Brch_000010 (udprim)" in StepThru mode
Showing "Body 10" generated by "Brch_000011 (scale)" in StepThru mode
Showing "Body 11" generated by "Brch_000012 (rotates)" in StepThru mode
Showing "Body 12" generated by "Brch_000013 (translate)" in StepThru mode
Showing "Body 13" generated by "Brch_000014 (rule)" in StepThru mode
  
```



Simple Wing — .csm File (1)

```
# wing
# written by John Dannenhoffer

# design parameters
DESPMTR  Xroot      0.00      # X-coordinte of root leading edge
DESPMTR  Yroot      0.00      # Y-coordinte of root leading edge
DESPMTR  Zroot      0.00      # Z-coordinte of root leading edge
DESPMTR  croot      2.00      # chord of root
DESPMTR  troot      0.12      # thickness/chord of root
DESPMTR  mroot      0.04      # camber/chord of root
DESPMTR  aroot      7.50      # angle of attack of root (deg)
DESPMTR  Xtip       0.50      # X-coordinte of tip leading edge
DESPMTR  Ytip       0.25      # Y-coordinte of tip leading edge
DESPMTR  Ztip       8.00      # Z-coordinte of tip leading edge
DESPMTR  ctip       1.75      # chord of tip
DESPMTR  ttip       0.08      # thickness/chord of tip
DESPMTR  mtip       0.04      # camber/chord of tip
DESPMTR  atip       -5.00      # angle of attack of tip (deg)
```

MARK

```
# rite wing tip
UDPRIM    naca    thickness  ttip    camber  mtip
SCALE     ctip
ROTATEZ   -atip    0        0
TRANSLATE Xtip    Ytip    -Ztip

# wing root
UDPRIM    naca    thickness  troot   camber  mroot
SCALE     croot
ROTATEZ   -aroot  0        0
TRANSLATE Xroot   Yroot   Zroot

# left wing tip
UDPRIM    naca    thickness  ttip    camber  mtip
SCALE     ctip
ROTATEZ   -atip    0        0
TRANSLATE Xtip    Ytip    Ztip
```

ruled surface

RULE

END

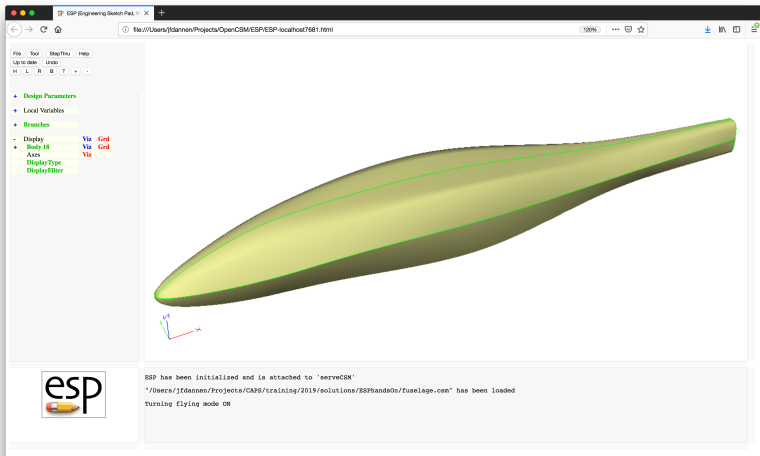


Simple Wing — Alternative DESPMTRs

```
DESPMTR  area      30.00    # wing area
DESPMTR  aspect    8.533    # aspect ratio
DESPMTR  taper     0.875    # taper ratio
DESPMTR  sweep     3.583    # wing sweep (deg)
DESPMTR  dihedral  1.791    # dihedral (deg)
```

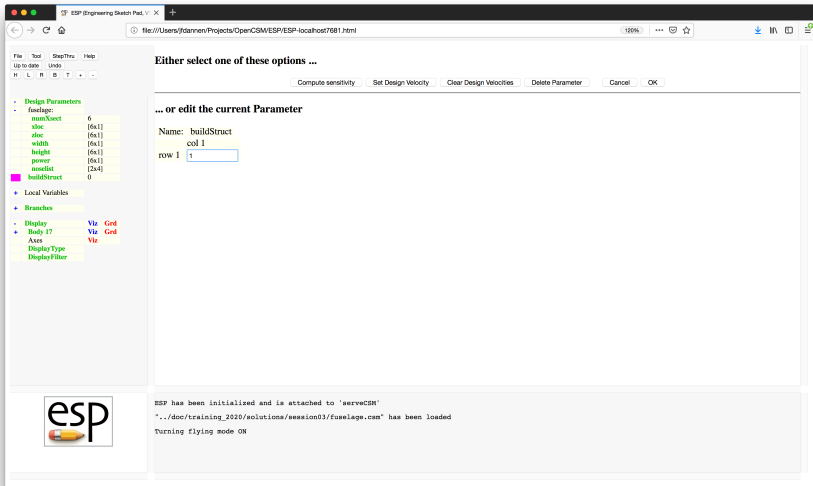
```
SET      span      sqrt(area*aspect)
SET      cmean     area/span
SET      croot     2*cmean/(1+taper)
SET      ctip      croot*taper
SET      Xtip      span/2*sind(sweep)
SET      Ytip      span/2*sind(dihedral)
SET      Ztip      span/2
```

- Fuselage by blending a series of super-ellipses (SUPELLs), where the dimensions of the X-sections are provided in arrays



xloc	width	zcent	height	power
0.0	0.0	0.0	0.0	2
1.0	1.0	0.1	1.0	2
4.0	1.6	0.4	2.0	3
8.0	1.6	0.4	2.0	3
12.0	1.0	0.3	1.2	2
16.0	0.8	0.2	0.4	2

- Can you make the radius at the nose 0.2 in a top view and 0.1 in a side view?
- Can you make the fuselage between the two sections whose power is 3 have a constant cross-section?
- Can you create a SheetBody that has a plane of symmetry and cross-sections at every y , starting at $y = 1/2$ and spaced with $\Delta y = 1$?
- Can you color the odd-numbered bulkheads red and even-numbered bulkheads blue?
- Can you color the Edges at the intersections of the symmetry plane and bulkheads white?



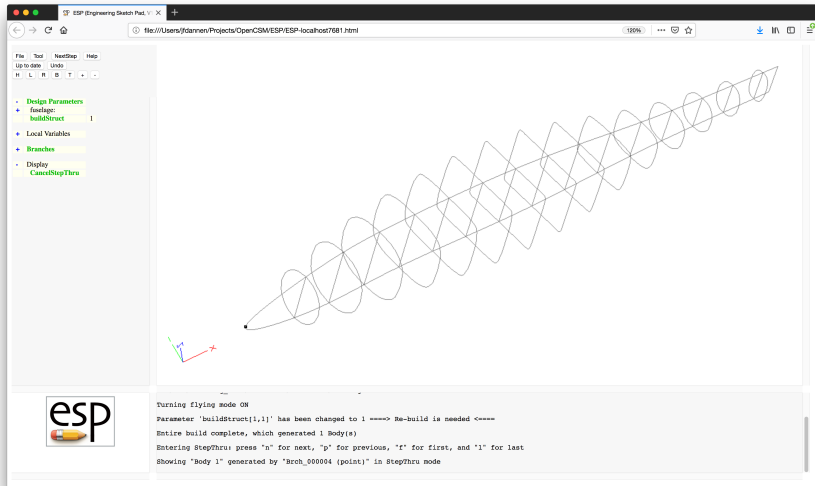
The screenshot shows the ESP (Engineering Sketch Pad) software interface. A dialog box is open, titled "Either select one of these options ...". The dialog contains several buttons: "Compute sensitivity", "Set Design Velocity", "Clear Design Velocities", "Delete Parameter", "Cancel", and "OK". Below these buttons, there is a section titled "... or edit the current Parameter". This section shows the name of the parameter as "buildStruct" and a table with two columns: "col 1" and "row 1". The value for "row 1" is "1".

On the left side of the interface, there is a tree view showing the design parameters for the fuselage:

- Design Parameters
 - fuselage:
 - numXsect 6
 - side (6x1)
 - zloc (6x1)
 - width (6x1)
 - height (6x1)
 - power (6x1)
 - nosefit [2x4]
 - buildStruct 0
- Local Variables
- Branches
 - Display Viz Grid
 - Body 17 Viz Grid
 - Axis Viz
 - Display Type
 - Display Filter

At the bottom of the interface, there is a status bar with the ESP logo and the following text:

```
ESP has been initialized and is attached to 'serveCSM'
'../doc/training_2020/solutions/session03/fuselage.csm' has been loaded
Turning flying mode ON
```



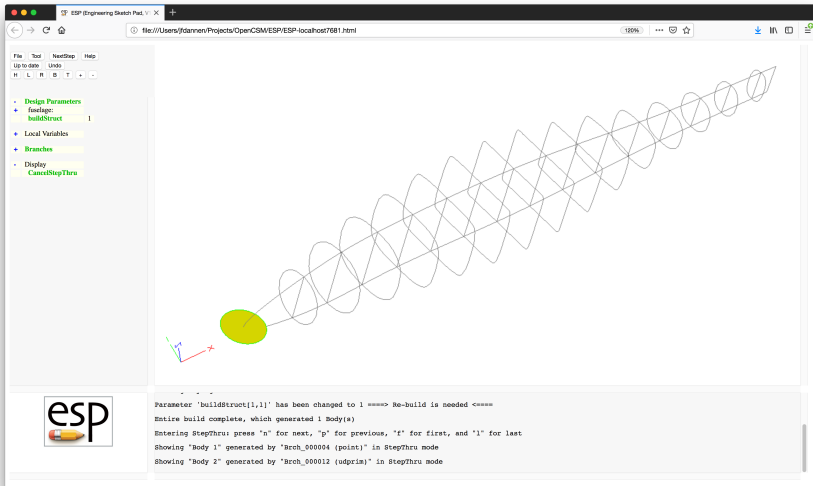
The screenshot shows a web browser window displaying the ESP Engineering Sketch Pad interface. The main canvas shows a 3D wireframe model of a fuselage, which is a series of overlapping elliptical shapes forming a tapered, elongated structure. A coordinate system with red, green, and blue axes is visible in the bottom-left corner of the sketch area.

The left sidebar contains a tree view with the following items:

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru



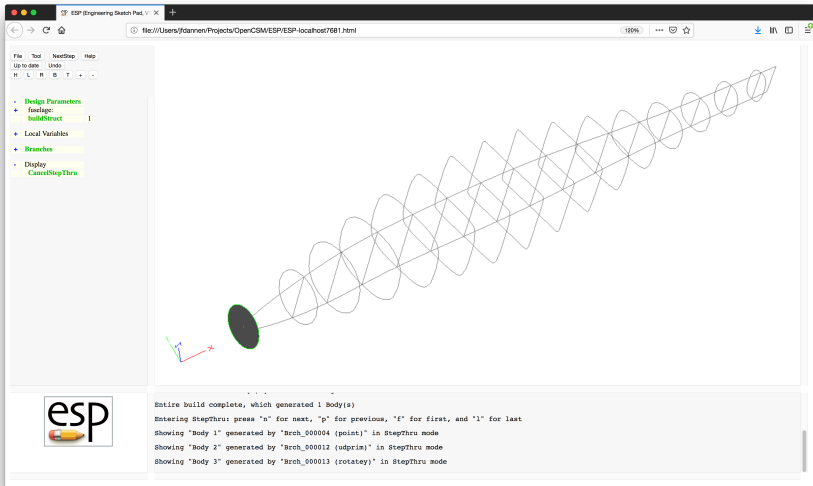
```
Turning flying mode ON
Parameter 'buildStruct[1,1]' has been changed to 1 ==> Re-build is needed <====
Entire build complete, which generated 1 Body(s)
Entering StepThru press "n" for next, "p" for previous, "f" for first, and "l" for last
Showing "Body 1" generated by "Brch_000004 (point)" in StepThru mode
```



File | Tool | NextStep | Help
Up to date Undo
M L R B T +

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

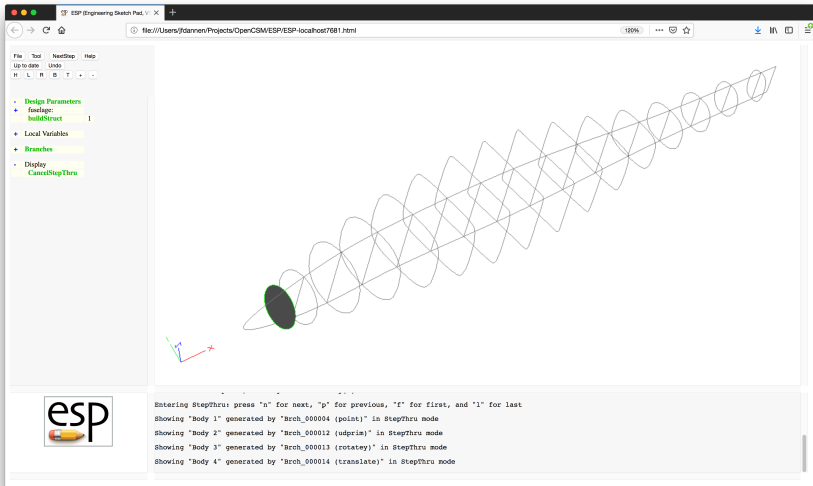
Parameter 'buildStruct[1,1]' has been changed to 1 ==> Re-build is needed <==>
 Entire build complete, which generated 1 Body(s)
 Entering StepThru press 'n' for next, 'p' for previous, 'f' for first, and 'l' for last
 Showing "Body 1" generated by "Brch_000004 (point)" in StepThru mode
 Showing "Body 2" generated by "Brch_000012 (udprim)" in StepThru mode



File | Tool | NextStep | Help
 Up to date Undo
 H L R B T + -

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

entire build complete, which generated 1 Body(s)
 Entering StepThru: press "n" for next, "p" for previous, "f" for first, and "l" for last
 Showing "Body 1" generated by "Brch_000004 (point)" in StepThru mode
 Showing "Body 2" generated by "Brch_000012 (udprism)" in StepThru mode
 Showing "Body 3" generated by "Brch_000013 (rotatery)" in StepThru mode



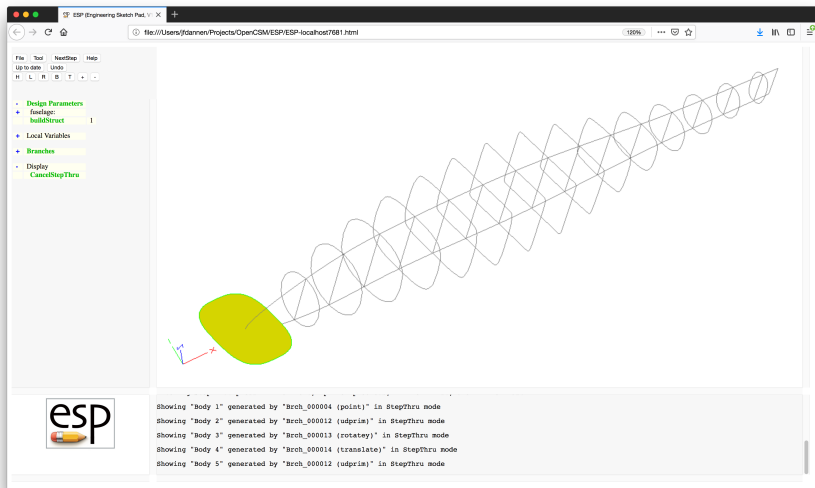
File Tool NextStep Help
Up to date Undo
M L R B T + -

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

esp

```

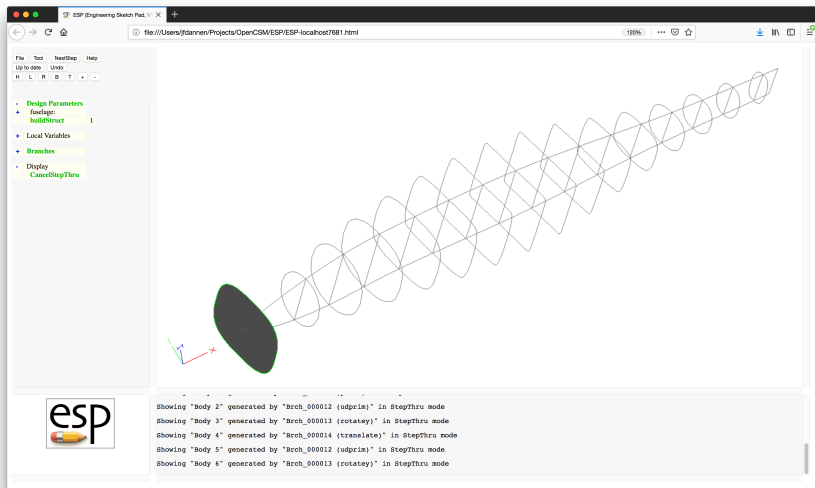
Entering StepThru: press "n" for next, "p" for previous, "f" for first, and "l" for last
Showing "Body 1" generated by "Brch_000004 (point)" in StepThru mode
Showing "Body 2" generated by "Brch_000012 (udprim)" in StepThru mode
Showing "Body 3" generated by "Brch_000013 (rotatex)" in StepThru mode
Showing "Body 4" generated by "Brch_000014 (translate)" in StepThru mode
  
```



File | Tool | NextStep | Help
Up to 9999 Undo
H L R B T + -

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

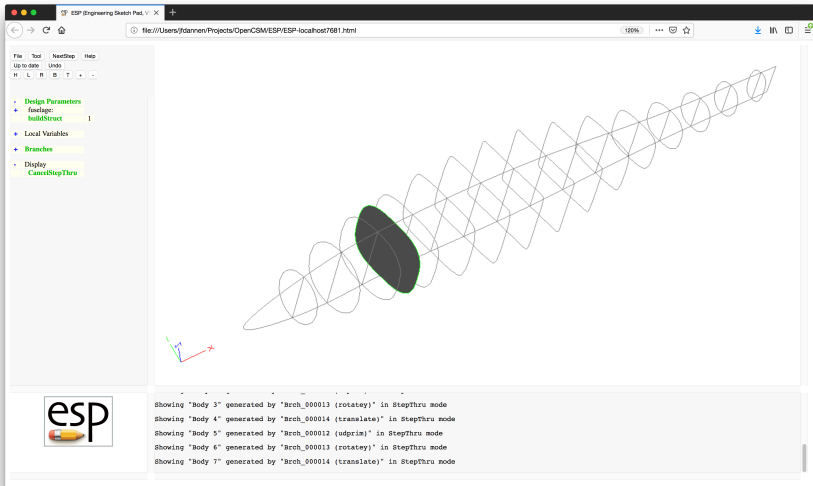
Showing "Body 1" generated by "Brch_000004 (point)" in StepThru mode
 Showing "Body 2" generated by "Brch_000012 (udprim)" in StepThru mode
 Showing "Body 3" generated by "Brch_000013 (rotatex)" in StepThru mode
 Showing "Body 4" generated by "Brch_000014 (translate)" in StepThru mode
 Showing "Body 5" generated by "Brch_000012 (udprim)" in StepThru mode

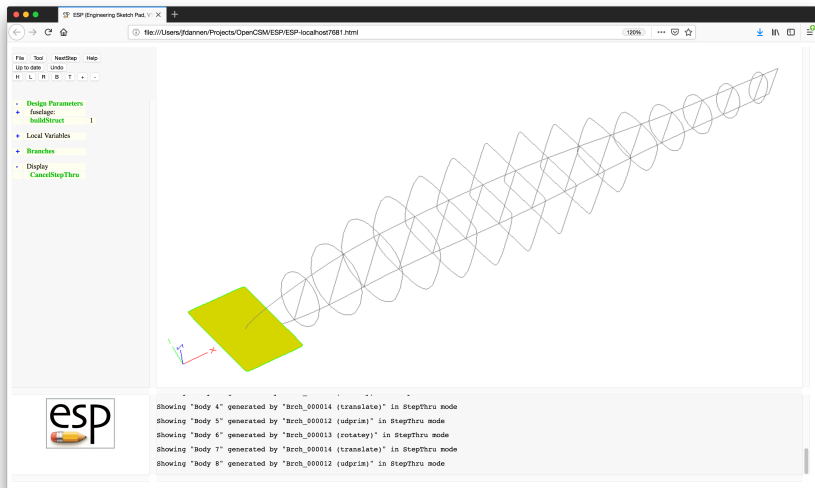


File | Tool | NextStep | Help
Up to 9999 Undo
M L R B T + -

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

Showing "Body 2" generated by "Brch_000012 (udprim)" in StepThru mode
 Showing "Body 3" generated by "Brch_000013 (rotate)" in StepThru mode
 Showing "Body 4" generated by "Brch_000014 (translate)" in StepThru mode
 Showing "Body 5" generated by "Brch_000012 (udprim)" in StepThru mode
 Showing "Body 6" generated by "Brch_000013 (rotate)" in StepThru mode

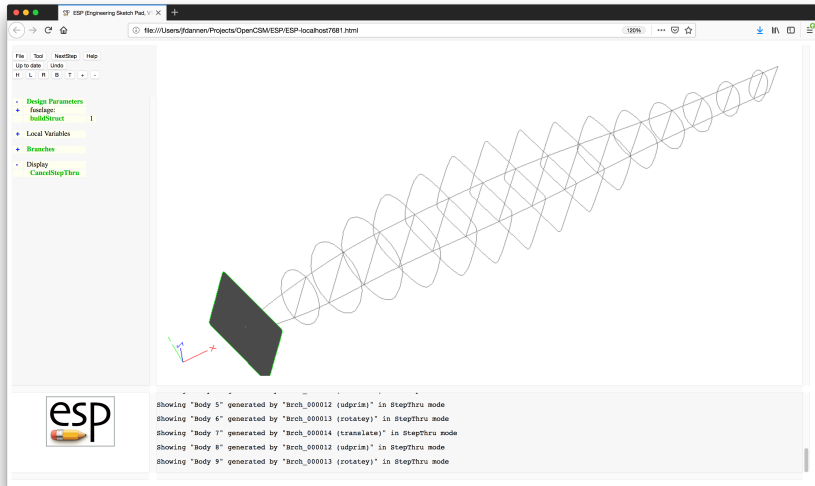




File | Tool | NextStep | Help
Up to date Undo
M L R B T + -

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

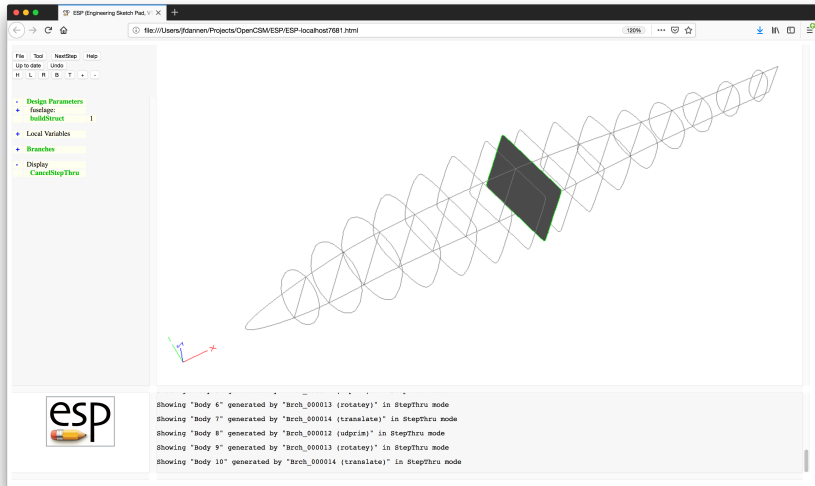
Showing "Body 4" generated by "Brch_000014 (translate)" in StepThru mode
 Showing "Body 5" generated by "Brch_000012 (udprim)" in StepThru mode
 Showing "Body 6" generated by "Brch_000013 (rotatay)" in StepThru mode
 Showing "Body 7" generated by "Brch_000014 (translate)" in StepThru mode
 Showing "Body 8" generated by "Brch_000012 (udprim)" in StepThru mode

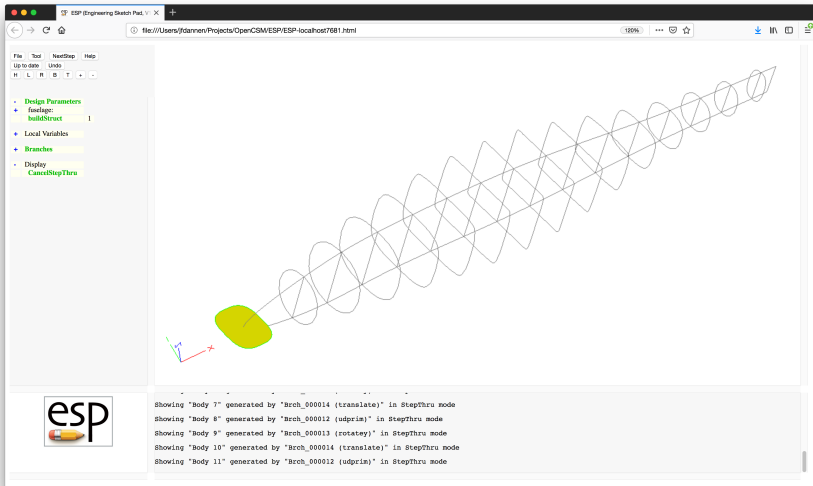


File | Tool | NextStep | Help
Up to date | Undo
M | L | R | B | T | + | -

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

Showing "Body 5" generated by "Brch_000012 (udprim)" in StepThru mode
 Showing "Body 6" generated by "Brch_000013 (rotatey)" in StepThru mode
 Showing "Body 7" generated by "Brch_000014 (translate)" in StepThru mode
 Showing "Body 8" generated by "Brch_000012 (udprim)" in StepThru mode
 Showing "Body 9" generated by "Brch_000013 (rotatey)" in StepThru mode

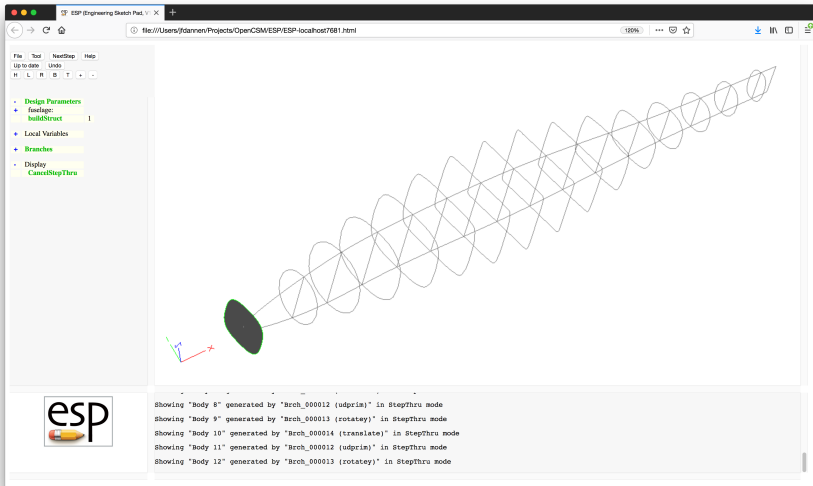




File | Tool | NextStep | Help
Up to date Undo
M L R B T + -

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

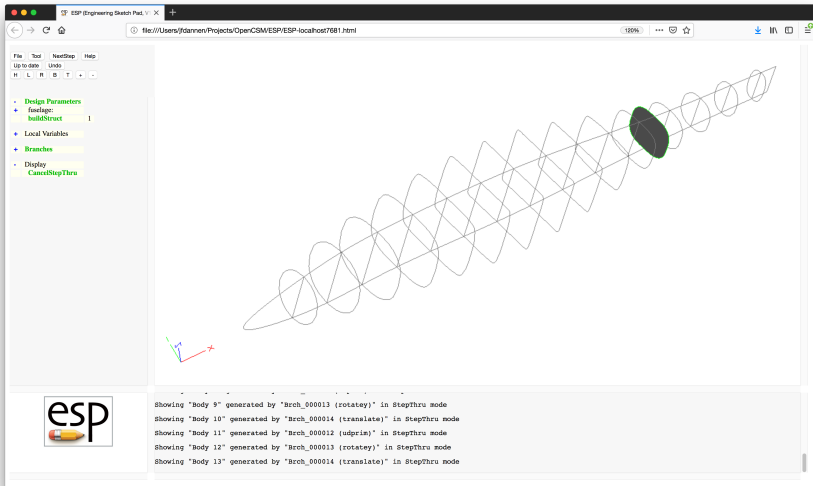
Showing "Body 7" generated by "Brch_000014 (translate)" in StepThru mode
 Showing "Body 8" generated by "Brch_000012 (udprism)" in StepThru mode
 Showing "Body 9" generated by "Brch_000013 (rotatety)" in StepThru mode
 Showing "Body 10" generated by "Brch_000014 (translate)" in StepThru mode
 Showing "Body 11" generated by "Brch_000012 (udprism)" in StepThru mode



File Tool NextStep Help
Up to 9999 Undo
M L R B T + -

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

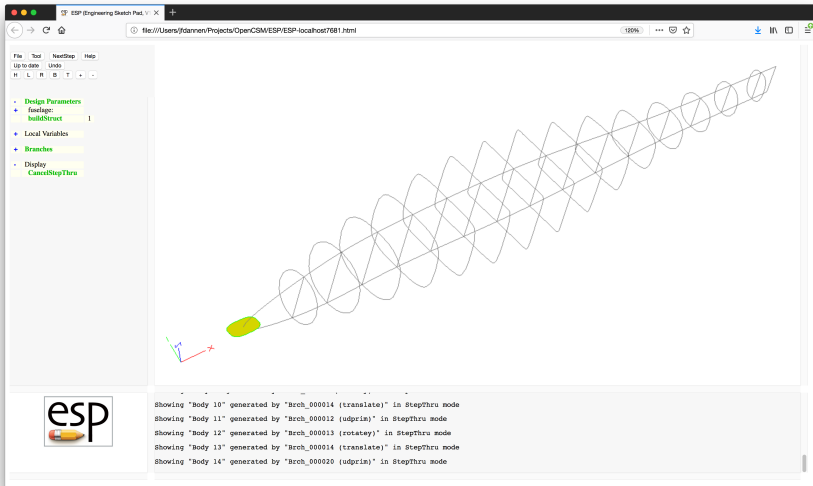
Showing "Body 8" generated by "Brch_000012 (udprim)" in StepThru mode
Showing "Body 9" generated by "Brch_000013 (rotatey)" in StepThru mode
Showing "Body 10" generated by "Brch_000014 (translate)" in StepThru mode
Showing "Body 11" generated by "Brch_000012 (udprim)" in StepThru mode
Showing "Body 12" generated by "Brch_000013 (rotatey)" in StepThru mode



File Tool NextStep Help
Up to 9999 Undo
M L R B T + -

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

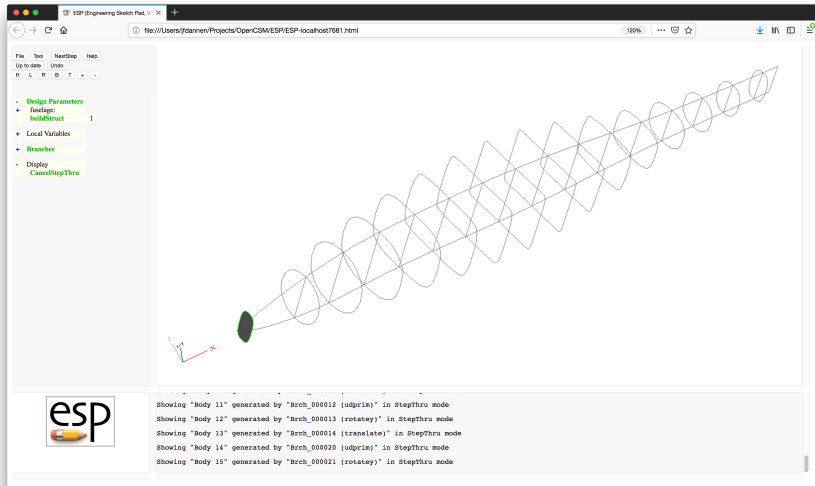
Showing "Body 9" generated by "Brch_000013 (rotate)" in StepThru mode
 Showing "Body 10" generated by "Brch_000014 (translate)" in StepThru mode
 Showing "Body 11" generated by "Brch_000012 (udpri)" in StepThru mode
 Showing "Body 12" generated by "Brch_000013 (rotate)" in StepThru mode
 Showing "Body 13" generated by "Brch_000014 (translate)" in StepThru mode



File | Tool | NextStep | Help
Up to date Undo
H L R B T + -

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

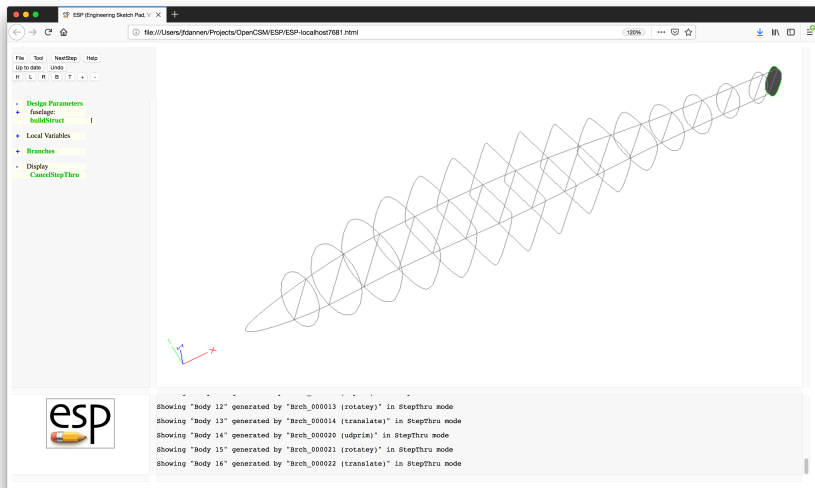
Showing "Body 10" generated by "Brch_000014 (translate)" in StepThru mode
 Showing "Body 11" generated by "Brch_000012 (udprn)" in StepThru mode
 Showing "Body 12" generated by "Brch_000013 (rotatey)" in StepThru mode
 Showing "Body 13" generated by "Brch_000014 (translate)" in StepThru mode
 Showing "Body 14" generated by "Brch_000020 (udprn)" in StepThru mode



File Tool NextStep Help
Up to 5000 Undo
M L R B T + -

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

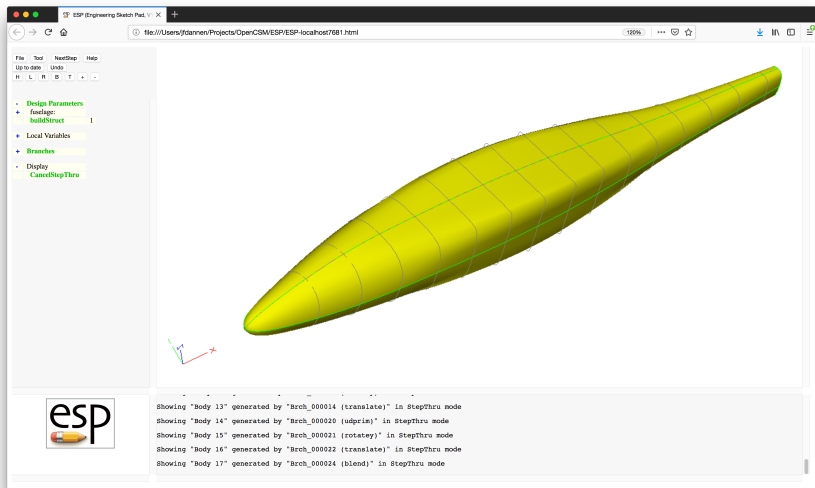
Showing "Body 11" generated by "Brch_000012 (udprim)" in StepThru mode
 Showing "Body 12" generated by "Brch_000013 (rotatey)" in StepThru mode
 Showing "Body 13" generated by "Brch_000014 (translate)" in StepThru mode
 Showing "Body 14" generated by "Brch_000020 (udprim)" in StepThru mode
 Showing "Body 15" generated by "Brch_000021 (rotatey)" in StepThru mode

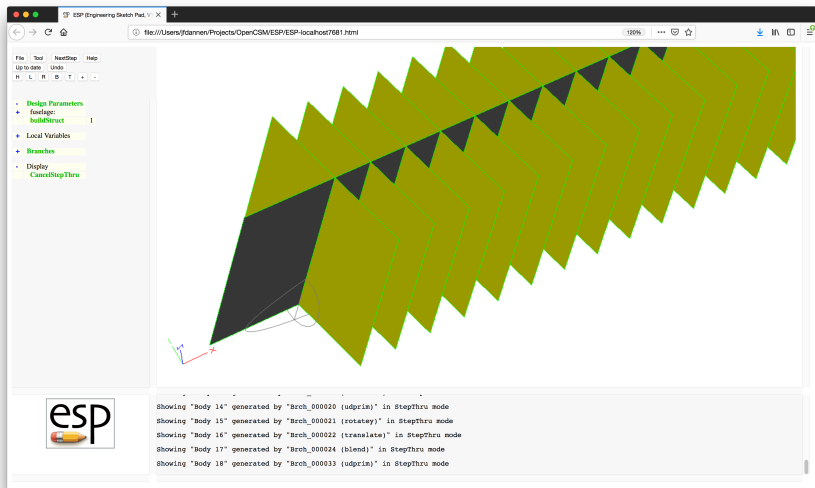


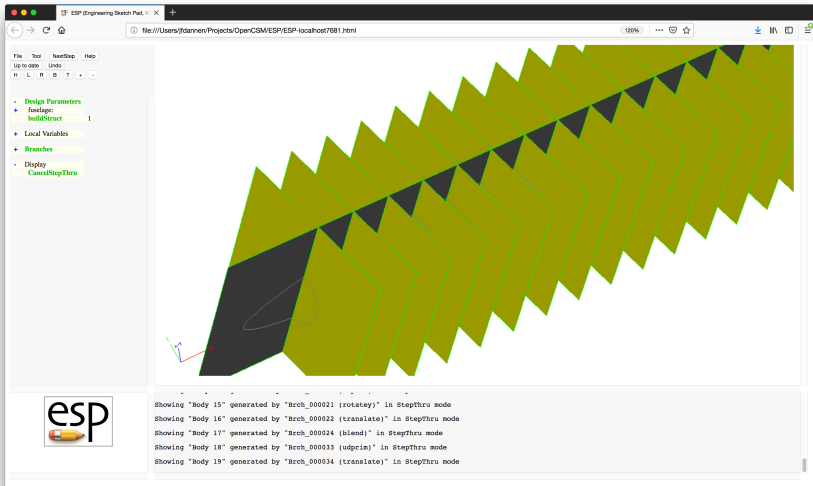
File | Tool | NextStep | Help
Up to 9999 Undo
M L R B T + -

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

Showing "Body 12" generated by "Brch_000013 (rotatey)" in StepThru mode
 Showing "Body 13" generated by "Brch_000014 (translate)" in StepThru mode
 Showing "Body 14" generated by "Brch_000020 (udgrin)" in StepThru mode
 Showing "Body 15" generated by "Brch_000021 (rotatey)" in StepThru mode
 Showing "Body 16" generated by "Brch_000022 (translate)" in StepThru mode





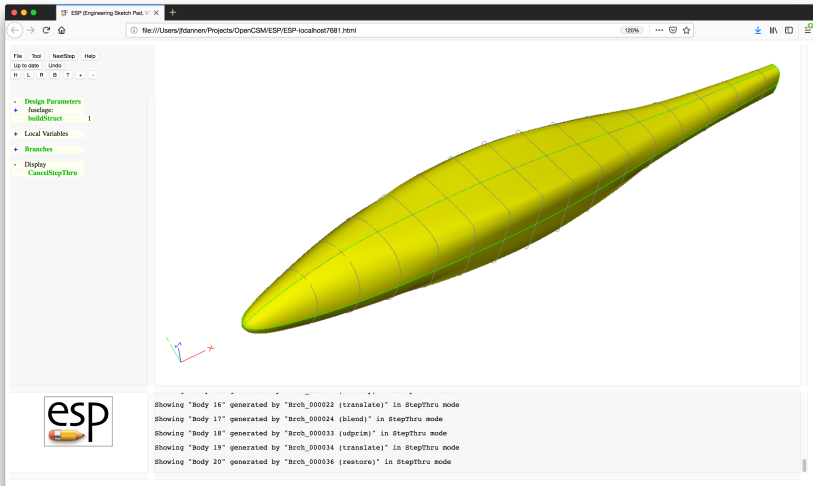


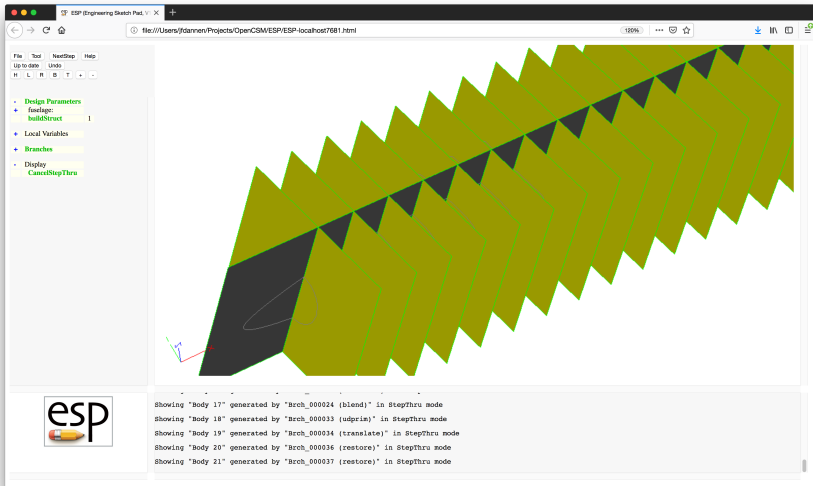
File | Tool | NextStep | Help
Up to date | Undo

M | L | R | B | T | +

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

Showing "Body 15" generated by "Brch_000021 (rotatey)" in StepThru mode
 Showing "Body 16" generated by "Brch_000022 (translate)" in StepThru mode
 Showing "Body 17" generated by "Brch_000024 (blend)" in StepThru mode
 Showing "Body 18" generated by "Brch_000033 (udprin)" in StepThru mode
 Showing "Body 19" generated by "Brch_000034 (translate)" in StepThru mode



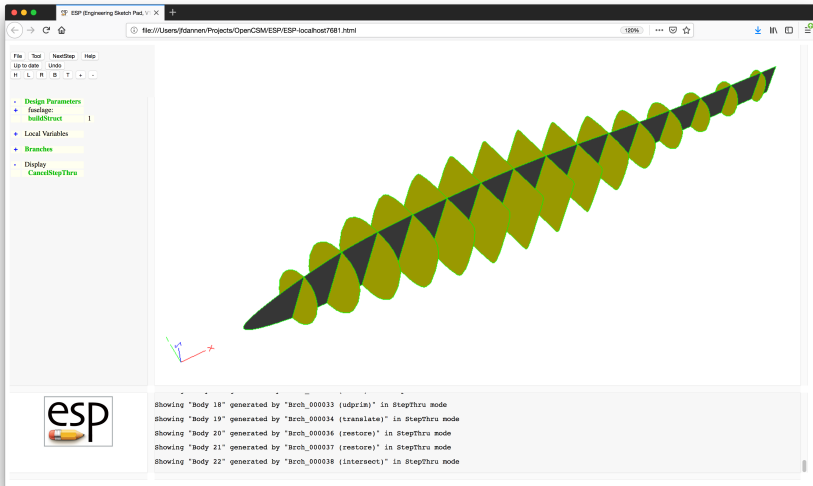


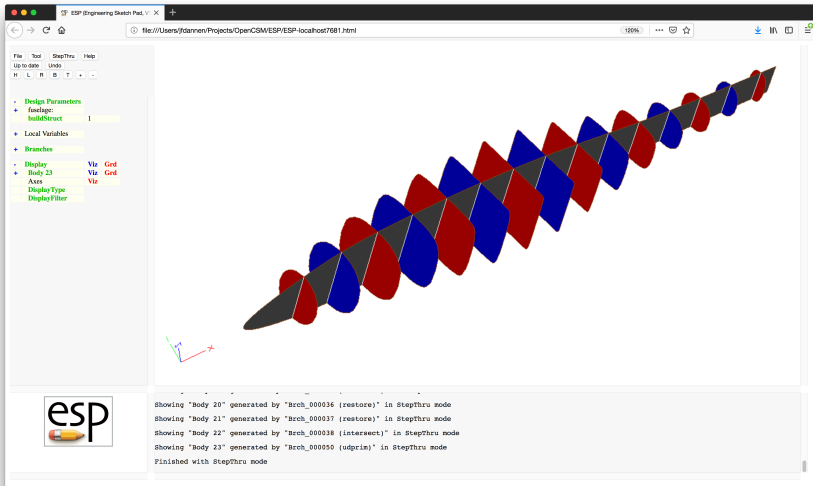
File | Tool | NextStep | Help
Up to date | Undo

M | L | R | B | T

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

Showing "Body 17" generated by "Brch_000024 (blend)" in StepThru mode
 Showing "Body 18" generated by "Brch_000033 (udprism)" in StepThru mode
 Showing "Body 19" generated by "Brch_000034 (translate)" in StepThru mode
 Showing "Body 20" generated by "Brch_000036 (restore)" in StepThru mode
 Showing "Body 21" generated by "Brch_000037 (restore)" in StepThru mode





File Edit StepThru Help
Up to date Undo
M L R B T + -

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - Body 23 Via Red
 - Axes Via Red
 - Display Type
 - Display Filter

Showing "Body 20" generated by "Brch_000036 (restore)" in StepThru mode
 Showing "Body 21" generated by "Brch_000037 (restore)" in StepThru mode
 Showing "Body 22" generated by "Brch_000038 (intersect)" in StepThru mode
 Showing "Body 23" generated by "Brch_000050 (udprn)" in StepThru mode
 Finished with StepThru mode



Simple Fuselage — .csm File (1)

```
# fuselageAlone
# written by John Dannenhoffer

# fuselage design Parameters
CFGPMTR                fuselage:numXsect 6
DIMENSION fuselage:xloc fuselage:numXsect 1
DIMENSION fuselage:zloc fuselage:numXsect 1
DIMENSION fuselage:width fuselage:numXsect 1
DIMENSION fuselage:height fuselage:numXsect 1
DIMENSION fuselage:power fuselage:numXsect 1
DIMENSION fuselage:noselist 2                4

DESPMTR fuselage:xloc "0; 1.0; 4.0; 8.0; 12.0; 16.0;"
DESPMTR fuselage:zloc "0; 0.1; 0.4; 0.4; 0.3; 0.2;"
DESPMTR fuselage:width "0; 1.0; 1.6; 1.6; 1.0; 0.8;"
DESPMTR fuselage:height "0; 1.0; 2.0; 2.0; 1.2; 0.4;"
DESPMTR fuselage:power "2; 2; 3; 3 3 3;"
DESPMTR fuselage:noselist "0.2; 0; 1; 0;\
                           0.1; 0; 0; 1;"

CFGPMTR buildStruct 0 # set to 1 to build structure
```

```
# build fuselage OML
MARK

# sharp or rounded nose
SET isect 1
IFTHEN fuselage:width[isect] eq 0 and fuselage:height[isect] eq 0
    POINT fuselage:xloc[isect] 0 fuselage:zloc[isect]

# blunt nose
ELSE
    UDPRIM supell rx fuselage:width[isect]/2 \
                ry fuselage:height[isect]/2 \
                n fuselage:power[isect]
    ROTATEY 90 0 0
    TRANSLATE fuselage:xloc[isect] 0 fuselage:zloc[isect]
ENDIF
```



Simple Fuselage — .csm File (3)

```
# intermediate sections
PATBEG jsect fuselage:numXsect-2
      SET isect jsect+1

      UDPRIM supell rx fuselage:width[isect]/2 ry fuselage:height[isect]/2 n fusela
      ROTATEY 90 0 0
      TRANSLATE fuselage:xloc[isect] 0 fuselage:zloc[isect]
PATEND

# sharp or rounded tail
SET isect fuselage:numXsect
IFTHEN fuselage:width[isect] eq 0 and fuselage:height[isect] eq 0
      POINT fuselage:xloc[isect] 0 fuselage:zloc[isect]

# blunt tail
ELSE
      UDPRIM supell rx fuselage:width[isect]/2 ry fuselage:height[isect]/2 n fusela
      ROTATEY 90 0 0
      TRANSLATE fuselage:xloc[isect] 0 fuselage:zloc[isect]
ENDIF

# blend the sections into the fuselage
BLEND fuselage:noselist
```



```
# optionally build the structure
IFTHEN    buildStruct EQ 1

# get the fuselage bounding box
SET  xmin  @xmin
SET  xmax  @xmax
SET  ymin  @ymin
SET  ymax  @ymax
SET  zmin  @zmin
SET  zmax  @zmax

# store OML for later use
STORE  fuseOML
```

```
# create a waffle that is "1" bigger than the OML
UDPRIM waffle depth zmax-zmin+2 filename <<

# symmetry plane
POINT A AT xmin-1 0
POINT B AT xmax+1 0
LINE . A B      tagType=symmetry

# make the bulkheads
PATBEG ibulk xmax-xmin-1
    POINT C AT ibulk+1/2 ymin-1
    POINT D AT x@C      ymax+1
    LINE . C D          tagType=bulkhead tagIndex=!val2str(ibulk,0)
PATEND

>>
```



Simple Fuselage — .csm File (6)

```
# translate the waffle down and store it
TRANSLATE 0 0 zmin-1
STORE fuseWaffle

# trim the waffle to the fuselage
RESTORE fuseOML
RESTORE fuseWaffle
INTERSECT

# alternate the bulkhead colors red/blue/red/...
SET color $red
PATBEG ibulk 99
    SELECT FACE $tagType $bulkhead $tagIndex val2str(ibulk,0)
        ATTRIBUTE _color color

    IFTHEN color EQ $red
        SET color $blue
    ELSE
        SET color $red
    ENDIF
PATEND
```

```
# this will get called when we run out of bulkheads
CATBEG $face_not_found
CATEND

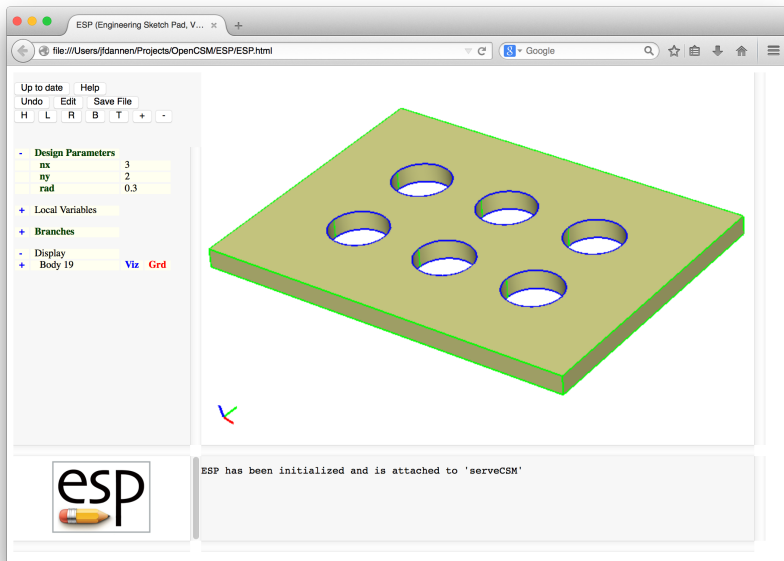
# make the bulkhead/symmetry Edges white
UDPRIM    editAttr  filename <<
    EDGE  ADJ2FACE  tagType=bulkhead
    AND   ADJ2FACE  tagType=symmetry
    SET   _color=white
>>

ENDIF

END
```

Session 5 Solutions

CSM Language (2)



The screenshot displays the ESP (Engineering Sketch Pad) software interface. The main window shows a 3D model of a rectangular plate with six circular holes. The interface includes a menu bar with options like 'Up to date' and 'Help', a toolbar with 'Undo', 'Edit', and 'Save File', and a design tree on the left. The design tree lists 'Design Parameters' (nx: 3, ny: 2, rad: 0.3), 'Local Variables', 'Branches', 'Display', and 'Body 19' (Viz, Grd). The status bar at the bottom indicates 'ESP has been initialized and is attached to 'serveCSM''.

nx	number of holes in X -direction	3.00
ny	number of holes in Y -direction	2.00
rad	radius of each hole	0.30
	distance between hole centers	1.00

- Can you make a single hole in the center of the plate?
- Can you change your solution to have the holes spaced so that they fill the plate?
- What if you make the radius of the hole too big?


```

# rect_pat
# written by John Dannenhoffer

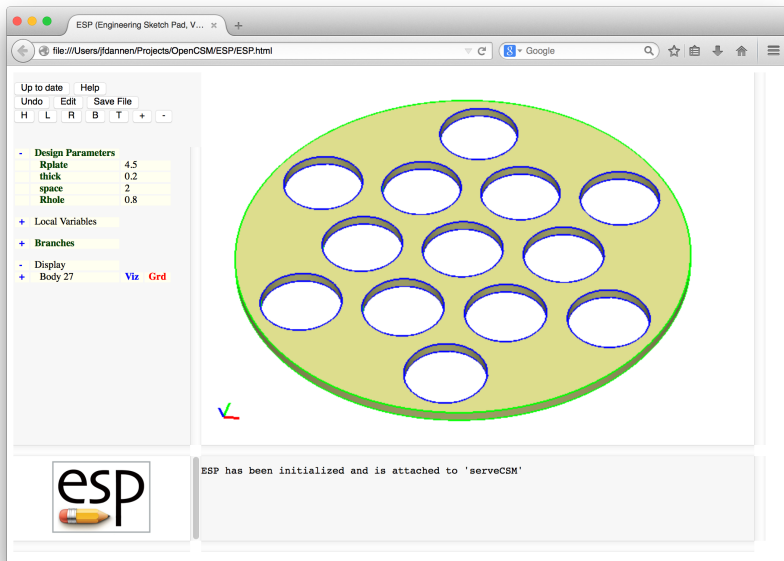
DESPMTR   nx           3
DESPMTR   ny           2
DESPMTR   rad          0.30
DESPMTR   space        1.00

# base plate (big enough to contain all holes)
BOX       0.00  0.00  -0.10  space*nx+1  space*ny+1  0.20

# 2D array of holes (with given spacing)
PATBEG ix nx
  PATBEG iy ny
    CYLINDER ix*space iy*space -0.20 \
            ix*space iy*space +0.20  rad
  SUBTRACT
PATEND
PATEND

END

```



ESP (Engineering Sketch Pad, V... x +

file:///Users/fldannen/Projects/OpenCSM/ESP/ESP.html

Google

Up to date Help

Undo Edit Save File

H L R B T + -

- Design Parameters

Rplate	4.5
thick	0.2
space	2
Rhole	0.8
- + Local Variables
- + Branches
- Display
- + Body 27 Viz Grd

ESP has been initialized and is attached to 'serveCSM'

Rplate	radius of plate	4.50
thick	thickness of plate	0.20
space	distance between hole centers	2.00
Rhole	radius of holes	0.80
	number of holes selected automatically	



Round Plate with Holes (3)

```
# round_pat
# written by John Dannenhoffer

# default design parameters
DESPMTR  Rplate    4.5000  # radius    of plate
DESPMTR  thick     0.2000  # thickness of plate
DESPMTR  space     2.0000  # distance between hole centers
DESPMTR  Rhole     0.8000  # radius of holes

# make sure holes do not intersect with each other
IFTHEN   space LT 2*Rhole
        THROW 999
ENDIF

# overall plate
CYLINDER 0 0 -thick/2 0 0 +thick/2 Rplate
```

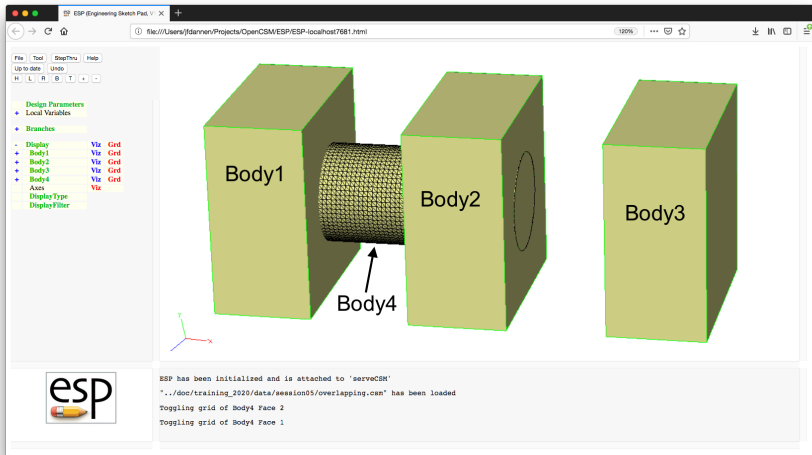
```
# pattern for holes
SET nr int(Rplate/space)

PATBEG iy 1+2*nr
  PATBEG ix 1+2*nr

    SET xc "(ix-nr-1)*space + (iy-nr-1)*space*cosd(60)"
    SET yc "(iy-nr-1)*space*sind(60)"
    SET r hypot(xc,yc)+Rhole

    # mask hole if not within circle
    IFTHEN r LT Rplate-0.001
      CYLINDER xc yc -thick xc yc +thick Rhole
      SUBTRACT
    ENDIF
  PATEND
PATEND

END
```



- Write `.csm` file to:
 - set `overlap1` to 1 if Bodys 1 and 4 overlap, otherwise set it to 0
 - set `overlap2` to 1 if Bodys 2 and 4 overlap, otherwise set it to 0
 - set `overlap3` to 1 if Bodys 3 and 4 overlap, otherwise set it to 0
- Try to use a pattern to do this compactly

```

# overlapping
# written by John Dannenhoffer

# Body 1
BOX      0  0  0  1  2  2
STORE    body 1

# Body 2
BOX      2  0  0  1  2  2
STORE    body 2

# Body 3
BOX      4  0  0  1  2  2
STORE    body 3

# Body 4
CYLINDER 0  1  1  3  1  1  0.5
STORE    body 4

```



```
# determine which or Bods 1, 2, 3 intersect Body 4
PATBEG      ibody 3
  SET       !$overlap+ibody 1
  RESTORE   body  ibody
  RESTORE   body  4
  INTERSECT

  CATBEG    $did_not_create_body
    SET     !$overlap+ibody 0
  CATEND

  STORE    ...
PATEND
```

```
# show Bodys
RESTORE    body  1
ATTRIBUTE  _name $Body1

RESTORE    body  2
ATTRIBUTE  _name $Body2

RESTORE    body  3
ATTRIBUTE  _name $Body3

RESTORE    body  4
ATTRIBUTE  _name $Body4

END
```

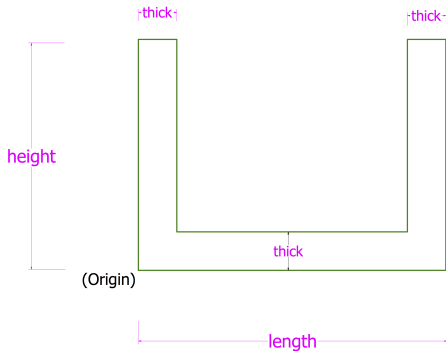
Session 7 Solutions

Sketcher Fundamentals



U-bracket (version 1)

Problem



Measurements

length = 4.00

height = 3.00

thick = 0.5



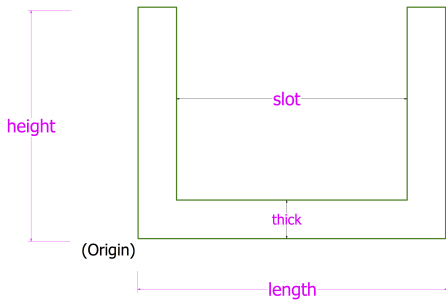
U-bracket (version 1)

Programmatic Solution

```
DESPMTR  length      4.00000
DESPMTR  height      3.00000
DESPMTR  thick       0.50000

SKBEG    0.0          0.0          0.0
  LINSEG length      0.0          0.0
  LINSEG length      height     0.0
  LINSEG length-thick height     0.0
  LINSEG length-thick thick      0.0
  LINSEG thick        thick      0.0
  LINSEG thick        height     0.0
  LINSEG 0.0          height     0.0
  LINSEG 0.0          0.0        0.0
SKEND
```


Problem

**Measurements**

length = 4.00

height = 3.00

thick = 0.5

slot = 2.00

Note: slot
is centered



U-bracket (version 2)

Programmatic Solution

```
DESPMTR  height  3.00000
DESPMTR  thick   0.50000
DESPMTR  slot    2.00000

SET       length  slot+2*thick

SKBEG     0.0      0.0      0.0
  LINSEG  length   0.0      0.0
  LINSEG  length   height  0.0
  LINSEG  length-thick height  0.0
  LINSEG  length-thick thick   0.0
  LINSEG  thick    thick   0.0
  LINSEG  thick    height  0.0
  LINSEG  0.0      height  0.0
  LINSEG  0.0      0.0     0.0
SKEND
```




U-bracket (version 2)

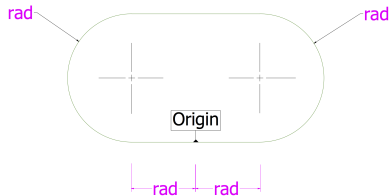
Sketcher Solution

The screenshot displays the ESP Engineering Sketch Pack interface. The main workspace shows a green U-bracket sketch with yellow dimension lines and labels (A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z). The left sidebar contains a tree view with sections for Design Parameters, Local Variables, Branches, Display, Body 10, Axis, Display Type, and Display Filter. The bottom panel shows a console window with the following text:

```
ndof=16  ncon=16
Valid constraints at points
'a' (fix x)      'y' (fix y)
'p' (perp)      't' (tangent)
'u' (angle)
'v' (width)     'd' (depth)
Valid constraints on segments
'b' (horiz)     'e' (vertical)
'l' (incline)  'i' (length)
Valid constraints on circles
'c' (radius)
```

ESP has been initialized and is attached to 'nerveCRM'
'../data/training/session02/Ubracket2.csm' has been loaded

Problem



Measurements:
rad = 0.50

Programmatic Solution

```

DESPMTR   rad           0.50000

SKBEG      0.0          0.0  0.0
  LINSEG   rad          0.0  0.0
  CIRARC   2*rad        rad  0.0   rad  2*rad  0.0
  LINSEG   -rad         2*rad  0.0
  CIRARC  -2*rad        rad  0.0  -rad   0.0  0.0
  LINSEG   0.0          0.0  0.0
SKEND

```

The screenshot displays the ESP Engineering Sketch Pack interface. The main workspace shows a green oval shape defined by several yellow constraint markers. The left sidebar contains a tree view with the following sections:

- Design Parameters
- Local Variables
- Branches
 - Brch_000001: d0deg
 - Brch_000010: d0rad
 - Brch_000021: r0select
 - Brch_000022: a0sort
 - Brch_000023: a0sort
 - Brch_000024: a0sort
 - Brch_000025: a0sort
 - Brch_000026: a0sort
 - Brch_000027: a0sort
 - Brch_000028: a0sort
 - Brch_000029: a0sort
 - Brch_000030: a0sort
- Display
 - Body 7: Via, Grid
 - Axis: Via, Grid
 - Display Type
 - Display Filter

The console window at the bottom left shows the following text:

```

ndof=12  ncon=12
Valid constraints at points
'a' (fix x)      'y' (fix y)
'p' (perp)      't' (tangent)
'a' (angle)
'w' (width)     'd' (depth)
Valid constraints on segments
'b' (horiz)     'v' (vertical)
'l' (incline)  'l' (length)
Valid constraints on circles
  
```

The console window at the bottom right shows the following text:

```

ESP has been initialized and is attached to 'nerveCRM'
'../data/training/session02/oval.csm' has been loaded
  
```

Problem

**Measurements:**

chord = 2.00

thick = 0.10

Note:

Circular Arcs



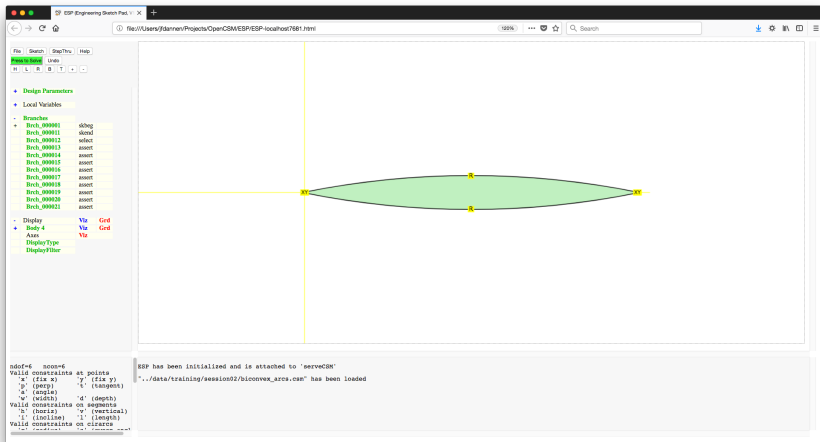
Biconvex airfoil (with arcs)

Programmatic Solution

```
DESPMTR   chord   2.00000
DESPMTR   thick   0.10000

SET        rad     radius(0,0,thick,chord,0)

SKBEG     0.0      0.0      0.0
  CIRARC  chord/2  -thick  0.0   chord  0.0   0.0
  CIRARC  chord/2   thick   0.0   0.0   0.0   0.0
SKEND
```



The screenshot displays the ESP Engineering Sketch Pack interface. The main workspace shows a green biconvex airfoil shape defined by several arcs and lines. The left sidebar contains a tree view with the following sections:

- Design Parameters
- Local Variables
- Branches
 - Brch_000001: sketch
 - Brch_000011: sketch
 - Brch_000012: reflect
 - Brch_000013: assort
 - Brch_000014: assort
 - Brch_000015: assort
 - Brch_000016: assort
 - Brch_000017: assort
 - Brch_000018: assort
 - Brch_000019: assort
 - Brch_000020: assort
 - Brch_000021: assort
- Display
 - Body 4: Via Grid
 - Axis: Via Grid
 - DisplayType: DisplayFilter

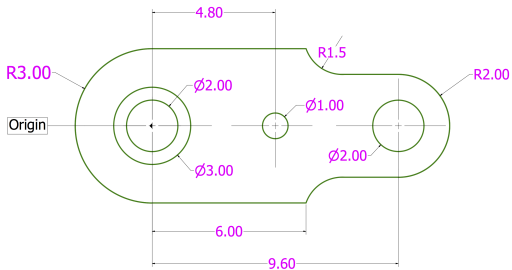
The bottom panel shows the following text:

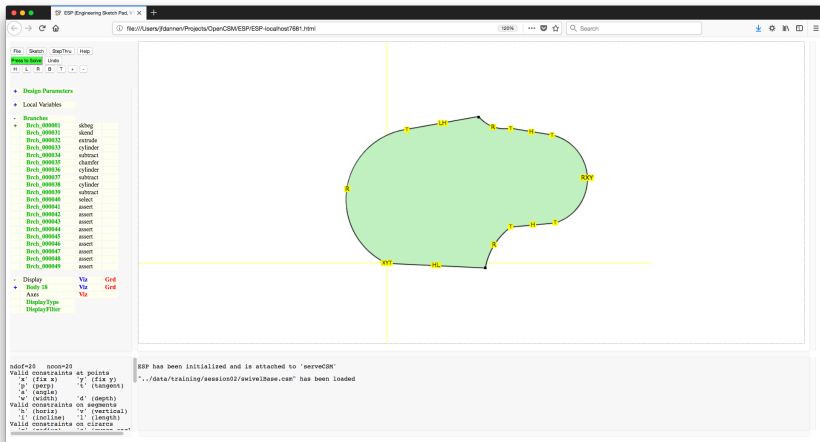
```

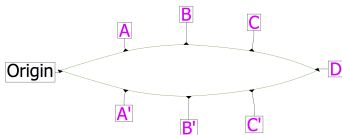
ndof=6  ncon=6
Valid constraints at points
'a' (fix x)      'y' (fix y)
'p' (perp)      't' (tangent)
'a' (angle)
'w' (width)     'd' (depth)
Valid constraints on segments
'b' (horiz)     'v' (vertical)
'l' (incline)  'l' (length)
Valid constraints on circles

```

Additional text in the bottom panel indicates: "ESP has been initialized and is attached to 'nerveCRM'" and ".../data/training/session02/biconvex_arcs.csm" has been loaded.







	x	y
A:	.255	.075
B:	.500	.100
C:	.745	.075
D:	1.00	0.00

The screenshot displays the ESP Engineering Sketch Pack interface. The main workspace shows a green biconvex airfoil shape defined by several vertices marked with 'XX'. A vertical yellow line and a horizontal yellow line intersect at the leftmost vertex. The left sidebar contains the 'Design Parameters' tree, listing local variables and branches. The bottom panel shows the console output, including the number of degrees of freedom (ndof=18, ncon=18) and a list of valid constraints at points, segments, segments, and circles.

Design Parameters:

- Local Variables:
 - Branches:
 - Brch_000001: skchd
 - Brch_000010: skchd
 - Brch_000011: skchd
 - Brch_000012: ascert
 - Brch_000013: ascert
 - Brch_000014: ascert
 - Brch_000015: ascert
 - Brch_000016: ascert
 - Brch_000017: ascert
 - Brch_000018: ascert
 - Brch_000019: ascert
 - Brch_000048: ascert
 - Display:
 - Body II: **Yta** **Grid**
 - Axis: **Yta** **Grid**
 - DisplayType: **Yta**
 - DisplayFilter: **Yta**

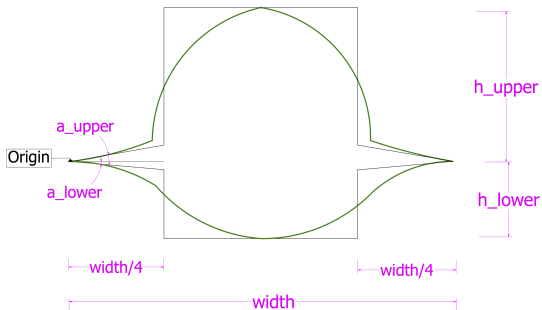
Console Output:

```

ndof=18  ncon=18
Valid constraints at points
  'a' (fix x)      'y' (fix y)
  'p' (perp)      't' (tangent)
  'a' (angle)
  'w' (width)     'd' (depth)
Valid constraints on segments
  'h' (horiz)     'v' (vertical)
  'l' (incline)  'l' (length)
Valid constraints on circles
  'r' (radius)
  
```

ESP has been initialized and is attached to 'nerveCRM'.
 ".../data/training/session02/biconvex_spline.com" has been loaded

Problem

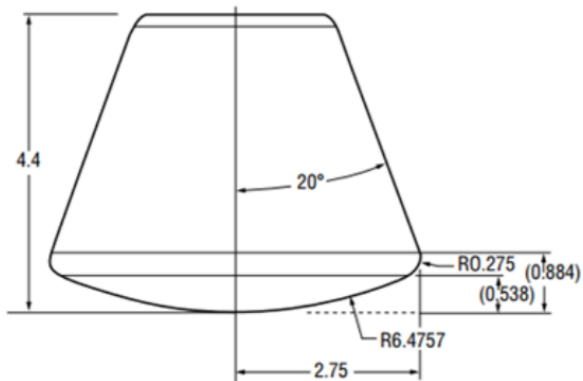
**Measurements:**

width = 5.00
h_upper = 2.00
h_lower = 1.00
a_upper = 10°
a_lower = 5°

Note:

4 Bezier Cubics

Problem



width	=	2.75000
baserad	=	6.47570
cornrad	=	0.27500
coneangle	=	20.00000
height	=	4.40000

The screenshot shows the ESP (Engineering Sketch Pad) interface. The main workspace displays a green capsule-shaped sketch with several constraints labeled: H, T, R, Y, X, Y, X, Y, X, Y, X, Y. A yellow arrow points to the bottom-right corner constraint with the text "X=width-cornrad".

The left sidebar shows the design tree with the following structure:

- Design Parameters
- Local Variables
- Branches
 - Brech_00001 skbeg
 - Brech_00024 skend
 - Brech_00025 revolve
 - Brech_00026 skew
 - Brech_00027 rotate
 - Brech_00028 mirror
 - Brech_00029 join
- Display
 - Viz Viz Red
 - Body 12 Viz Red
 - Axis Viz Red
 - Display Type
 - Display Filter

The bottom panel shows the following text:

```

ndof=15  ncon=15
Valid constraints at points
'x' (fix x)      'y' (fix y)
'p' (perp)      't' (tangent)
'a' (angle)
'w' (width)     'd' (depth)
Valid constraints on segments
'h' (horiz)     'v' (vertical)
'l' (incline)  'l' (length)
Valid constraints on circles
    
```

Below the text, a message states: "ESP has been initialized and is attached to 'serveCSH'".

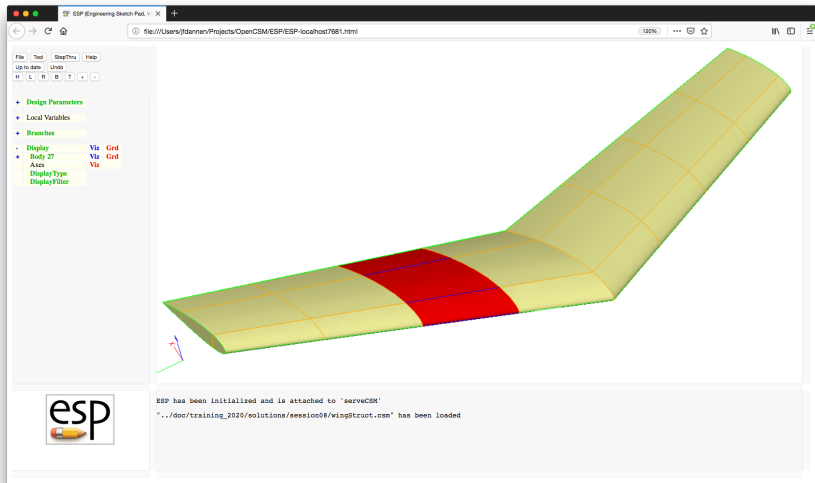
Session 8 Solutions

Selection & Attribution



Wing with structure

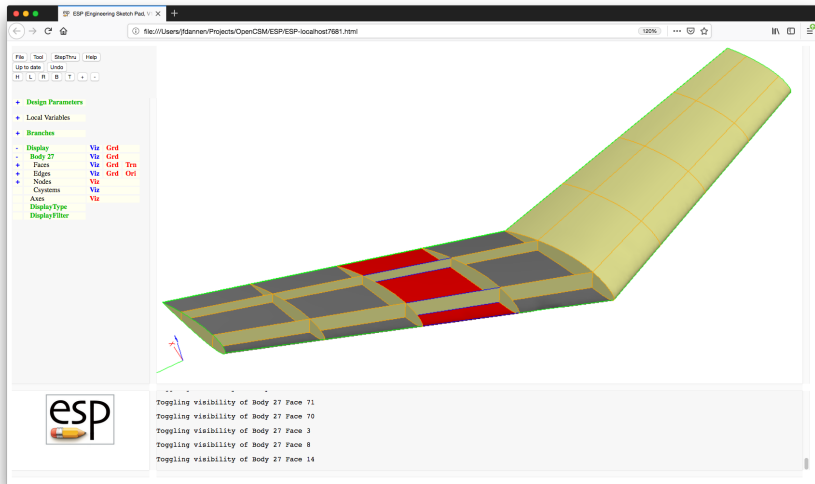
Structure is not shown





Wing with structure

Structure is shown for right wing



- Right wing upper skin panels (Faces)
 - `tagComp=riteWing`
 - `tagType=upper`
- Right wing lower skin panels (Faces)
 - `tagComp=riteWing`
 - `tagType=lower`
- Right wing leading edge (Edge)
 - `tagComp=riteWing`
 - `tagType=leadingEdge`
- Right wing trailing edge panels (Faces)
 - `tagComp=riteWing`
 - `tagType=trailingEdge`
- Right wing tip panels (Faces)
 - `tagComp=riteWing`
 - `tagType=tip`

- Right wing spars (Faces)
 - tagComp=riteWing
 - tagType=spar
 - tagIndex=1 for forward spar or tagIndex=2 for rearward spar
- Right wing ribs (Faces)
 - tagComp=riteWing
 - tagType=rib
 - tagIndex=1 for inboard rib, ..., tagIndex=3 for outboard rib
- Left wing is attributed similarly to right wing (Faces & Edges)
- Ribs at the wing root (Faces)
 - tagComp=rootWing
 - tagType=rib
 - tagIndex=0

```

# Design Parameters for OML
DESPMTR   wing:area      10.0    # wing area
DESPMTR   wing:aspect    6.00    # aspect ratio
DESPMTR   wing:taper     0.60    # taper ratio
DESPMTR   wing:sweep     20.0    # deg (of leading edge)
DESPMTR   wing:thickr    0.12    # thickness ratio at root
DESPMTR   wing:camherr   0.06    # camber ratio at root
DESPMTR   wing:thickt    0.16    # thickness ratio at tip
DESPMTR   wing:cambert   0.02    # camber ratio at tip
DESPMTR   wing:alphat   -5.00    # setting angle at tip
DESPMTR   wing:dihedral  4.00    # deg
DESPMTR   wing:xroot     0.00    # xloc at root LE
DESPMTR   wing:yroot     0.00    # yloc at root LE
DESPMTR   wing:zroot     0.00    # zloc at root LE

CFGPMTR   SHARP_TE      0        # make the trailing edge blunt

```

```
# Design Parameters for structure
DESPMTR  wing:spar1    0.20    # location of fwd spar
DESPMTR  wing:spar2    0.70    # location of rwr spar
CFGPMTR  wing:nrib     3.00    # number of ribs per wing

# wing local variables
SET      wing:span     sqrt(wing:aspect*wing:area)
SET      wing:chordr    2*wing:area/wing:span/(1+wing:taper)
SET      wing:chordt    wing:chordr*wing:taper
SET      wing:ytip      -wing:span/2
SET      wing:xtip      -wing:ytip*tand(wing:sweep)
SET      wing:ztip      -wing:ytip*tand(wing:dihedral)
SET      wing:mac       sqrt(wing:area/wing:aspect)
```

```
# make wing OML
# lay out left wing
MARK
  # root
  UDPRIM      naca      thickness wing:thickr      camber  wing:camberr\
              sharpTE  SHARP_TE

  SCALE      wing:chordr
  ROTATEX    90  0  0

  # left tip
  UDPRIM      naca      thickness wing:thickt      camber  wing:cambert\
              sharpTE  SHARP_TE

  SCALE      wing:chordt
  ROTATEX    90  0  0
  ROTATEY    wing:alpat  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
SELECT    FACE ruledBody  3
          ATTRIBUTE tagType $upper
SELECT    FACE ruledBody  4
          ATTRIBUTE tagType $lower
SELECT    EDGE ruledBody 3 ruledBody 4 1
          ATTRIBUTE tagComp $leftWing
          ATTRIBUTE tagType $leadingEdge
IFTHEN    SHARP_TE EQ 0
          SELECT    FACE ruledBody 5
                ATTRIBUTE tagType $trailingEdge
ELSE
          SELECT    EDGE ruledBody 3 ruledBody 4 2
                ATTRIBUTE tagComp $leftWing
                ATTRIBUTE tagType $trailingEdge
ENDIF
```



```

# right wing too
STORE      LeftWing 0 1
RESTORE    LeftWing
    ATTRIBUTE tagComp $riteWing
    SELECT  EDGE $tagType $leadingEdge
    IFTHEN  @iedge GT 0
        SELECT EDGE $tagType $leadingEdge
        ATTRIBUTE tagComp $riteWing
    ENDIF
    SELECT  EDGE $tagType $trailingEdge
    IFTHEN  @iedge GT 0
        SELECT EDGE $tagType $trailingEdge
        ATTRIBUTE tagComp $riteWing
    ENDIF
    CATBEG  $edge_not_found
    CATEND

MIRROR    0 1 0
JOIN

SELECT    EDGE ruledBody 3 ruledBody 3 1
    ATTRIBUTE tagType $root
SELECT    EDGE ruledBody 4 ruledBody 4 1
    ATTRIBUTE tagType $root
STORE    WingOml

```

```
# make wing waffle
RESTORE   WingOml
SET       xmin      @xmin-0.1
SET       xmax      @xmax+0.1
SET       ymin      0
SET       ymax      @ymax+0.1
SET       zmin      @zmin-0.1
SET       zmax      @zmax+0.1
STORE    .

UDPARG    waffle     depth wing:nrib      # ensures rebuild
UDPARG    waffle     depth wing:spar1
UDPARG    waffle     depth wing:spar2
UDPARG    waffle     depth zmax-zmin filename <<
```

```

# construction lines for spars
CPOINT A   AT           0+wing:spar1*wing:chordr 0
CPOINT B   AT   wing:xtip+wing:spar1*wing:chordt -wing:ytip
CPOINT C   AT           0+wing:spar2*wing:chordr 0
CPOINT D   AT   wing:xtip+wing:spar2*wing:chordt -wing:ytip

CLINE AB    A  B
CLINE CD    C  D

# rite spars
POINT E   ON  AB   YLOC  ymin
POINT F   ON  AB   YLOC  ymax
LINE  EF  E   F   tagComp=riteWing  tagType=spar  tagIndex=1

POINT G   ON  CD   YLOC  ymin
POINT H   ON  CD   YLOC  ymax
LINE  GH  G   H   tagComp=riteWing  tagType=spar  tagIndex=2

```

```

# rite ribs
PATBEG irib wing:nrib
    CPOINT I AT xmin -wing:ytip*irib/(wing:nrib+1)
    CPOINT J AT xmax y@I
    LINE . I J tagComp=riteWing tagType=rib tagIndex=!val2str(irib,0)
PATEND

# root rib
CPOINT I AT xmin 0
CPOINT J AT xmax y@I
LINE . I J tagComp=rootWing tagType=rib tagIndex=0

# left spars
POINT E AT x@E -y@E
POINT F AT x@F -y@F
LINE EF E F tagComp=leftWing tagType=spar tagIndex=1

POINT G AT x@G -y@G
POINT H AT x@H -y@H
LINE GH G H tagComp=leftWing tagType=spar tagIndex=2

```

```
# left ribs
PATBEG irib wing:nrib
    CPOINT I AT xmin wing:ytip*irib/(wing:nrib+1)
    CPOINT J AT xmax y@I
    LINE . I J tagComp=leftWing tagType=rib tagIndex=!val2str(irib,0)
PATEND
>>
TRANSLATE 0 0 zmin
STORE WingWaffle
```

```
# trim the waffle to be the ribs and spars
RESTORE  WingOml
RESTORE  WingWaffle
INTERSECT

# score the wing skin with the waffle
RESTORE  WingOml
RESTORE  WingWaffle
SUBTRACT
EXTRACT  0

# combine the two
UNION
```

- Put the Attribute LoadPoint=leftTip on the Node that is at the intersection of the forward spar, wing tip, and upper skin on the left wing

```
UDPRIM      editAttr  filename <<
NODE  ADJ2FACE  tagComp=leftWing  tagType=spar  tagIndex=1
AND    ADJ2FACE  tagComp=leftWing  tagType=upper
AND    ADJ2FACE  tagComp=leftWing  tagType=tip
SET                                LoadPoint=leftTip
>>
```

- For the upper and lower skin panels on the rite wing that are between the first and second rib, make their color red and their grid white

```
UDPRIM   editAttr  filename <<
FACE HAS   tagComp=riteWing tagType=upper
AND  ADJ2FACE tagType=rib tagIndex=1
AND  ADJ2FACE tagType=rib tagIndex=2
SET                                     _color=red
SET                                     _bcolor=red
SET                                     _gcolor=white

FACE HAS   tagComp=riteWing tagType=lower
AND  ADJ2FACE tagType=rib tagIndex=1
AND  ADJ2FACE tagType=rib tagIndex=2
SET                                     _color=red
SET                                     _bcolor=red
SET                                     _gcolor=white
```

>>

- Make the Edges blue that are between two red panels

```
UDPRIM    editAttr  filename <<
EDGE      ADJ2FACE  _color=red
AND       ADJ2FACE  tagType=spar
SET                               _color=blue

EDGE      HAS       tagType=leadingEdge
AND       ADJ2FACE  _color=red
SET                               _color=blue

>>
```