

Engineering Sketch Pad (ESP)



Exercise Solutions

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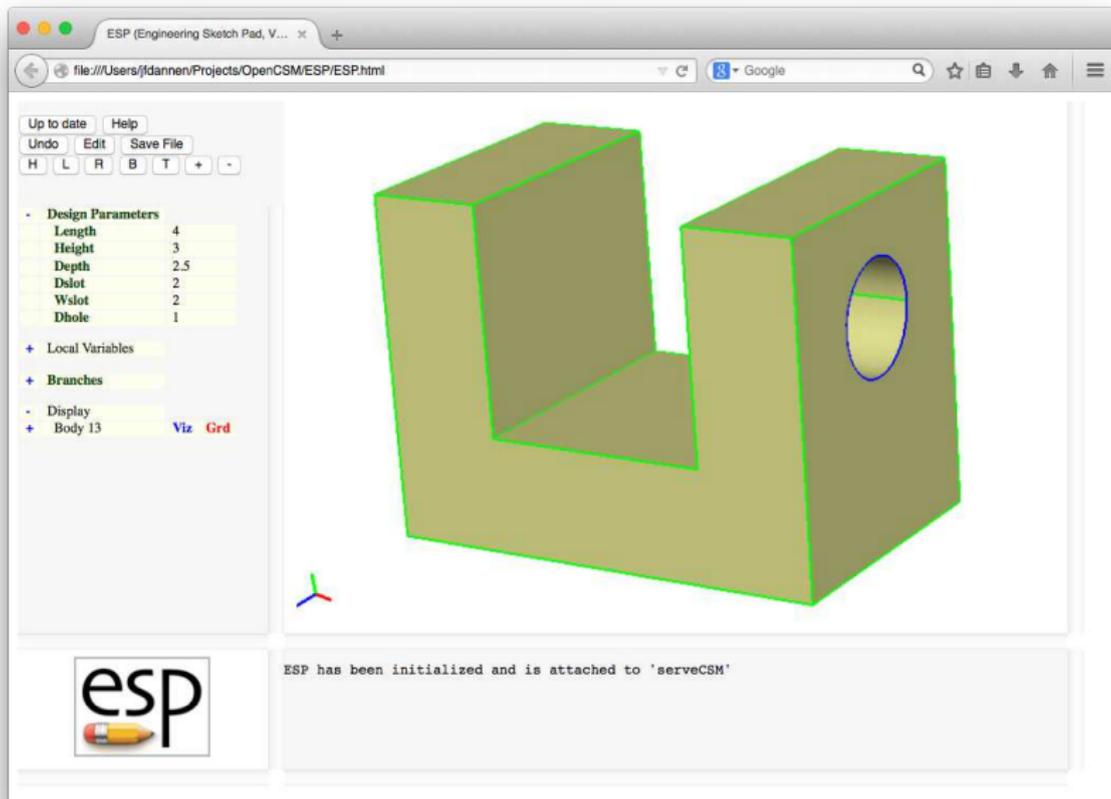
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Massachusetts Institute of Technology

updated for v1.18

Session 2 Solutions

Solids Fundamentals (1)



ESP (Engineering Sketch Pad, V...)

file:///Users/fdannenn/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	



U-shaped Bracket — Step 1

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

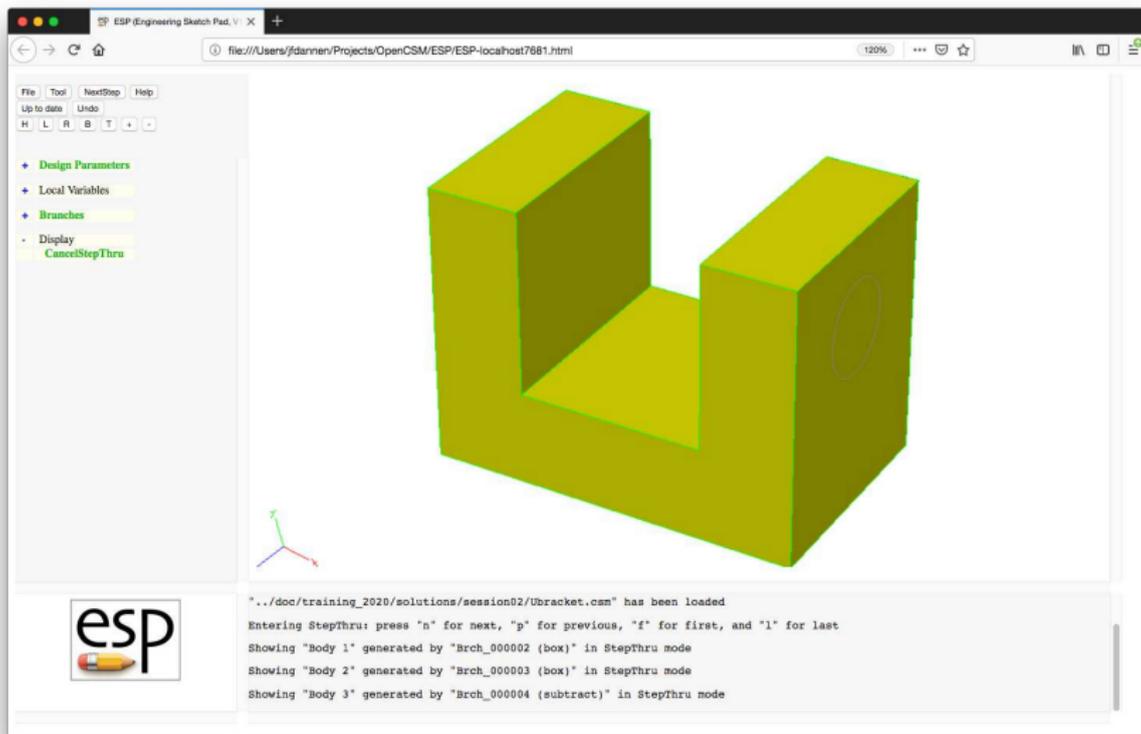


U-shaped Bracket — Step 2

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

120%

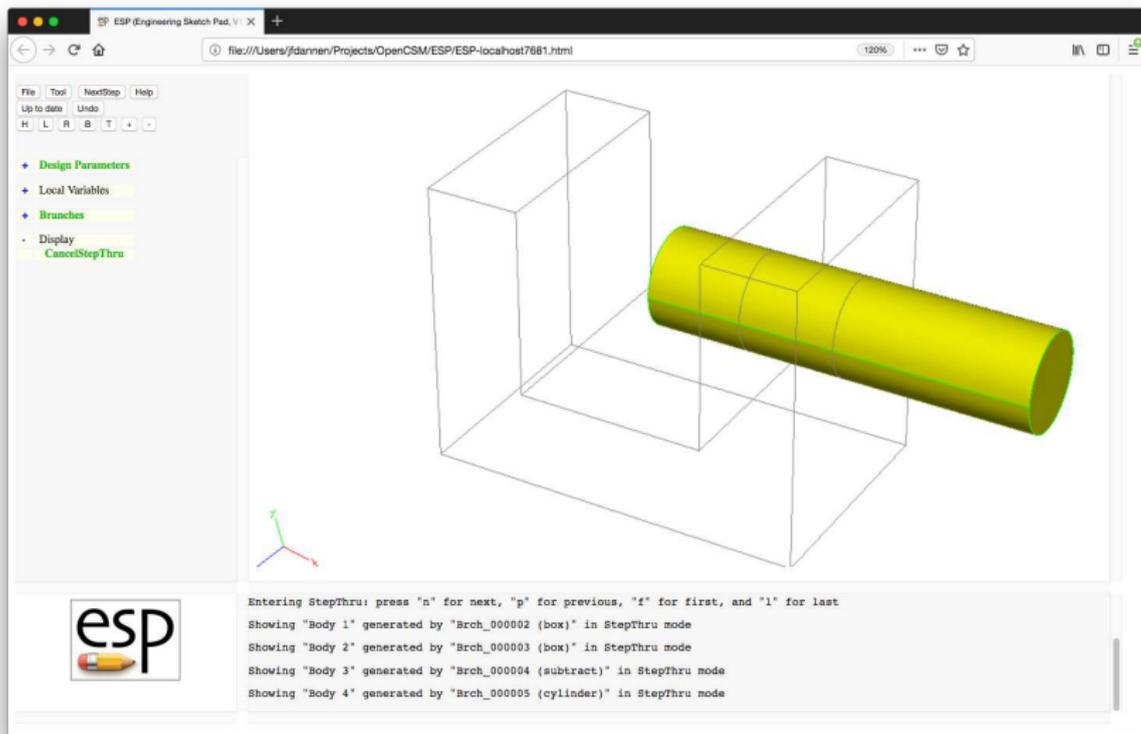
file:///Users/dannen/Projects/OpenCSM/ESP/ESP-localhost7681.html

...

esp

```

".../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

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



U-shaped Bracket — Step 5

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

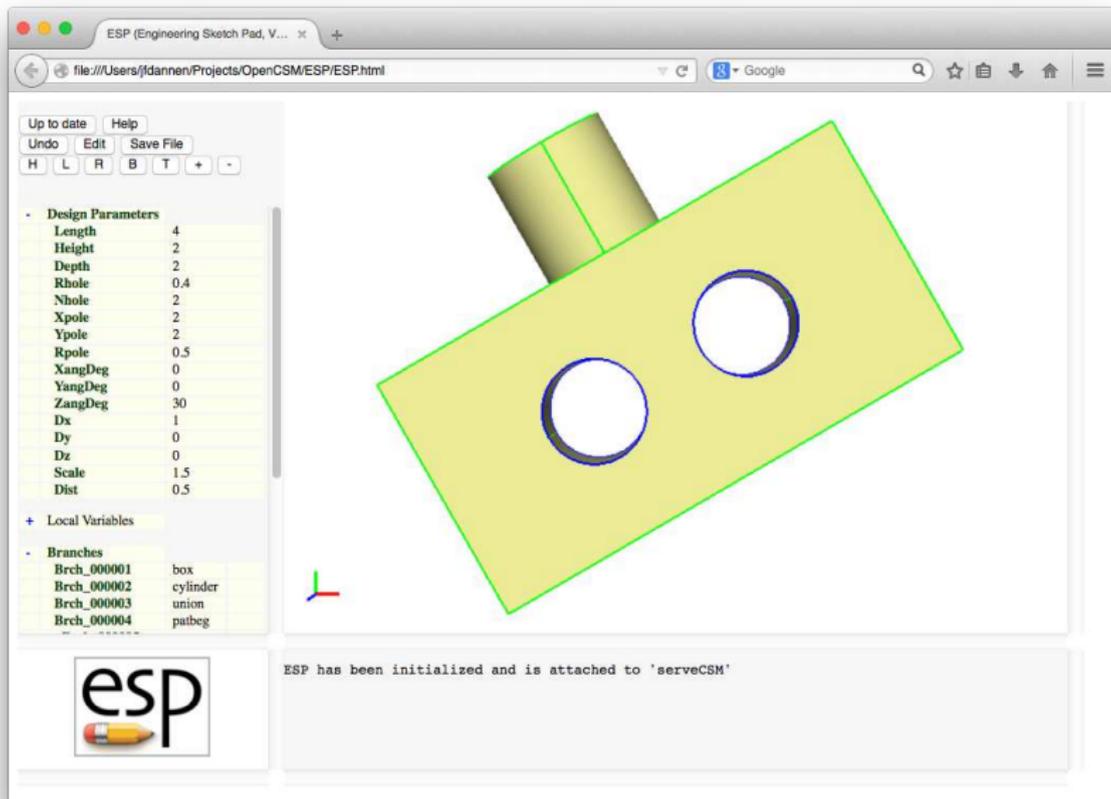
# design parameters
DESPMTR   Length    4.00      # length
DESPMTR   Height    3.00      # height
DESPMTR   Depth     2.50      # depth
DESPMTR   Dslot     2.00      # depth of slot
DESPMTR   Wslot     2.00      # width of slot
DESPMTR   Dhole     1.00      # diameter of hole

# 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/fdannan/Projects/OpenCSM/ESP/ESP.html

Google

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_00001	box
Brch_00002	cylinder
Brch_00003	union
Brch_00004	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	<i>X</i> rotation (deg)	0.
YangDeg	<i>Y</i> rotation (deg)	0.
ZangDeg	<i>Z</i> rotation (deg)	30.
Translation		
Dx		1.0
Dy		0.0
Dz		0.0
Scaling		
Scale	overall scaling factor	1.5



Simple Block — Step 1

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



Simple Block — Step 2

The screenshot shows the ESP (Engineering Sketch Pad) software interface. The main window displays a 3D model of a rectangular box with a yellow cylinder inside. 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 contains a console window with the following text:

```
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
```



Simple Block — Step 3

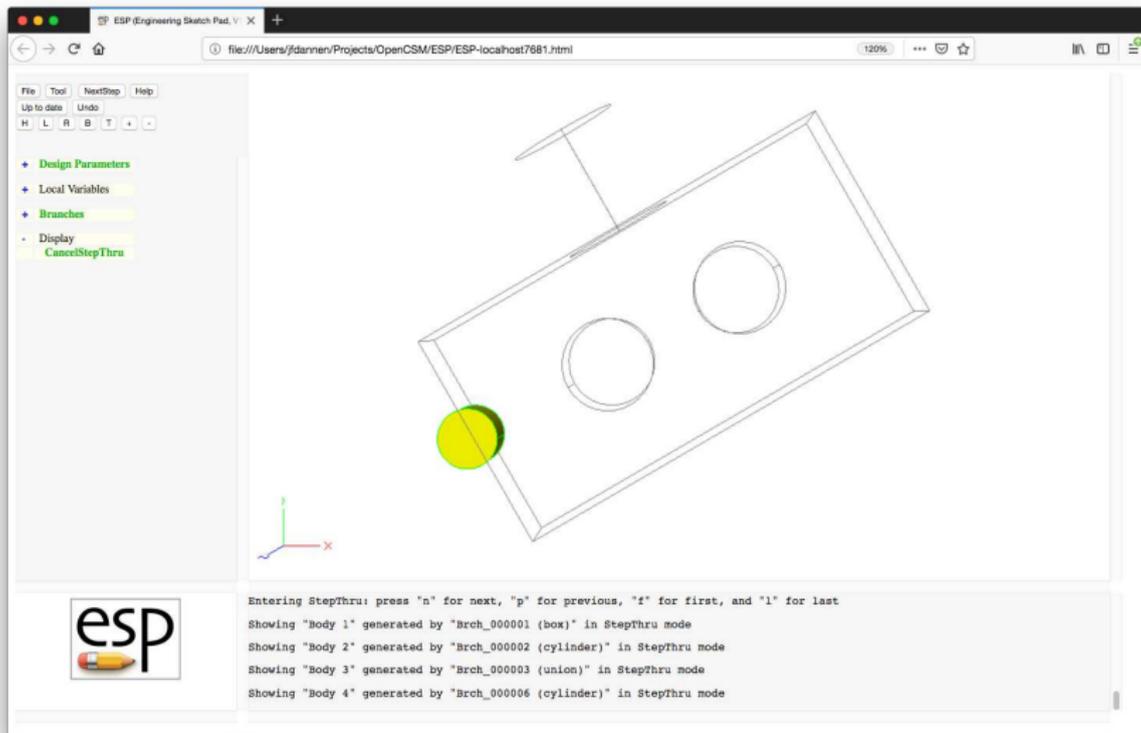
The screenshot shows the ESP (Engineering Sketch Pad) software interface. The main window displays a 3D model of a mechanical part, which is a rectangular block with a cylindrical protrusion on top. The block is highlighted in yellow, and the cylinder is highlighted in green. The model is shown in a perspective view, tilted to show its top and side surfaces. A coordinate system (X, Y, Z) is visible in the bottom left corner of the model area.

The interface includes a menu bar with "File", "Tool", "NextStep", and "Help". Below the menu bar is a toolbar with "Up to date" and "Undo" buttons, and a set of navigation icons (H, L, R, B, T, +, -). A sidebar on the left contains a tree view with the following items:

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

The status bar at the bottom of the window displays 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_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
```

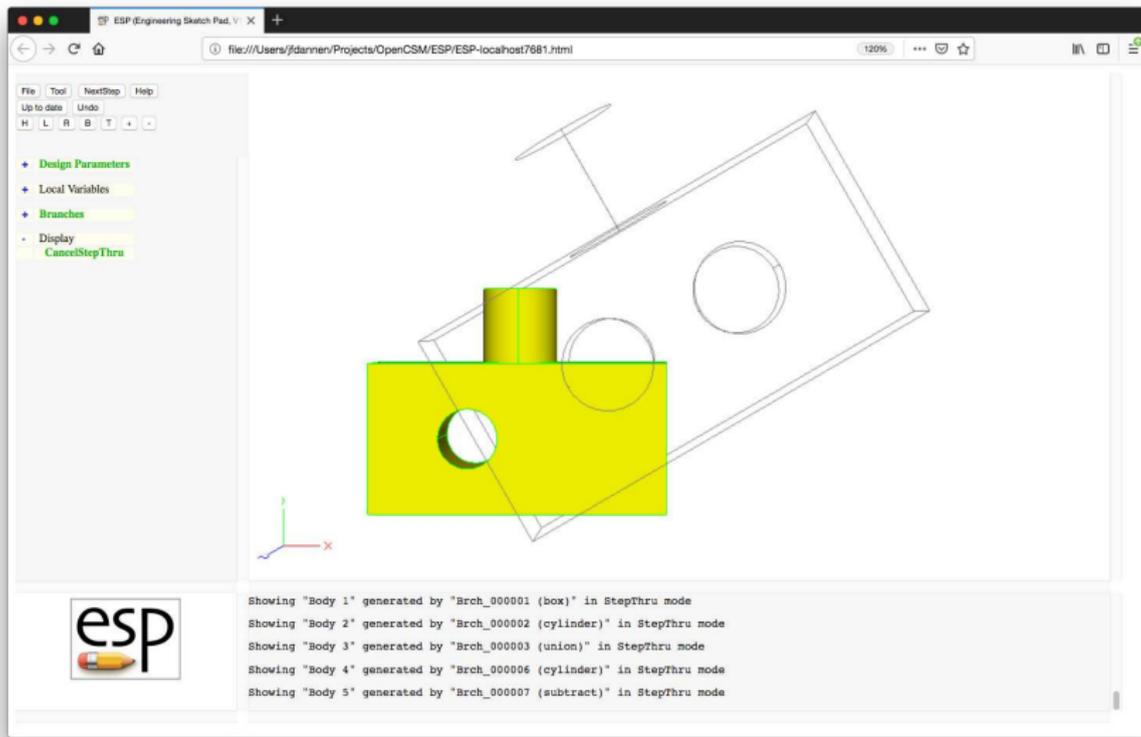


The screenshot shows the ESP (Engineering Sketch Pad) software interface. The main window displays a 3D wireframe model of a rectangular block with a handle on top and two circular features on the front face. A yellow and green sphere is positioned near the bottom-left corner of the block. The interface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

Console output:

```

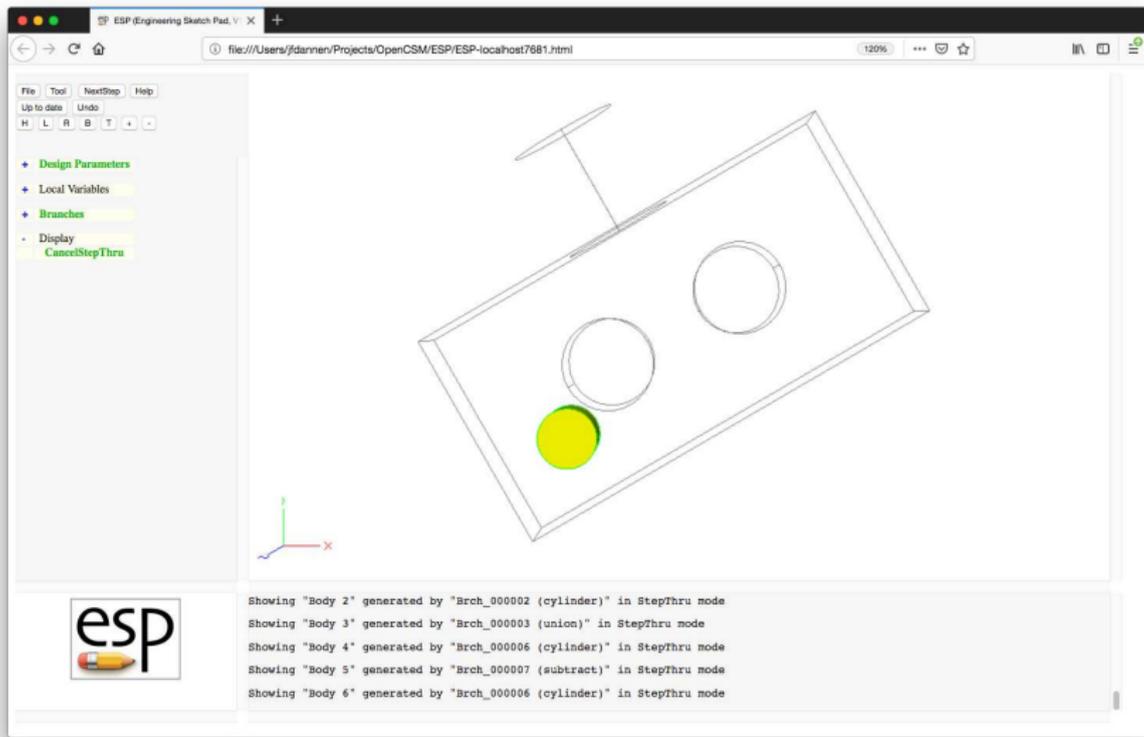
Entering StepThru: press "n" for next, "p" for previous, "f" for first, and "l" for last
Showing "Body 1" generated by "Brch_000001 (box)" in StepThru mode
Showing "Body 2" generated by "Brch_000002 (cylinder)" in StepThru mode
Showing "Body 3" generated by "Brch_000003 (union)" in StepThru mode
Showing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

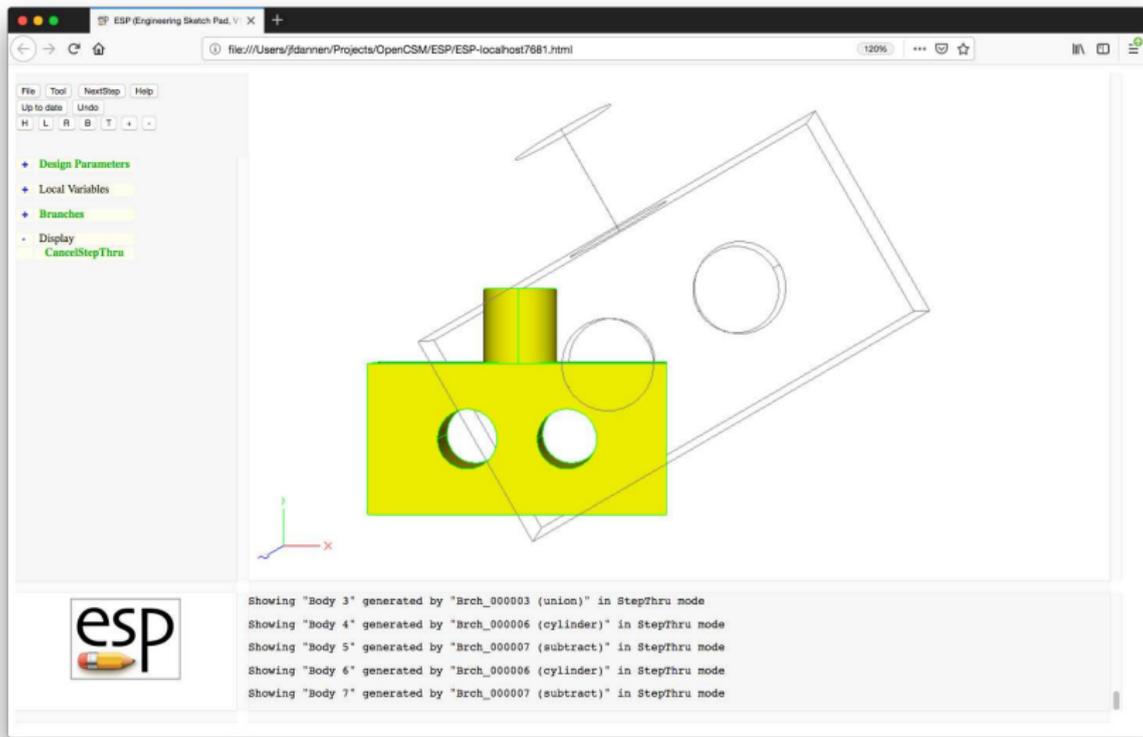
Showing "Body 1" generated by "Brch_000001 (box)" in StepThru mode
 Showing "Body 2" generated by "Brch_000002 (cylinder)" in StepThru mode
 Showing "Body 3" generated by "Brch_000003 (union)" in StepThru mode
 Showing "Body 4" generated by "Brch_000006 (cylinder)" in StepThru mode
 Showing "Body 5"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



The screenshot shows the ESP (Engineering Sketch Pad) software interface. The main window displays a 3D model of a rectangular block with a cylindrical hole and a smaller cylinder on top. 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 bodies:

```

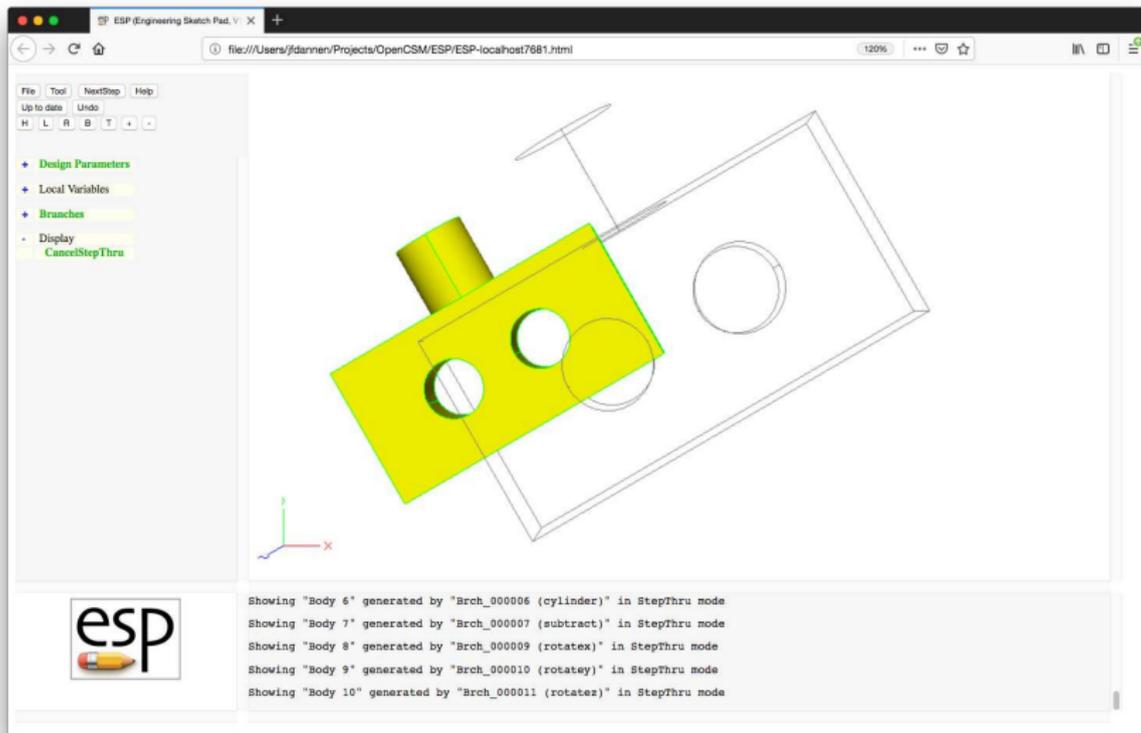
Showing "Body 2" generated by "Brch_000002 (cylinder)" in StepThru mode
Showing "Body 3" generated by "Brch_000003 (union)" in StepThru mode
Showing "Body 4" generated by "Brch_000006 (cylinder)" in StepThru mode
Showing "Body 5" generated by "Brch_000007 (subtract)" in StepThru mode
Showing "Body 6"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

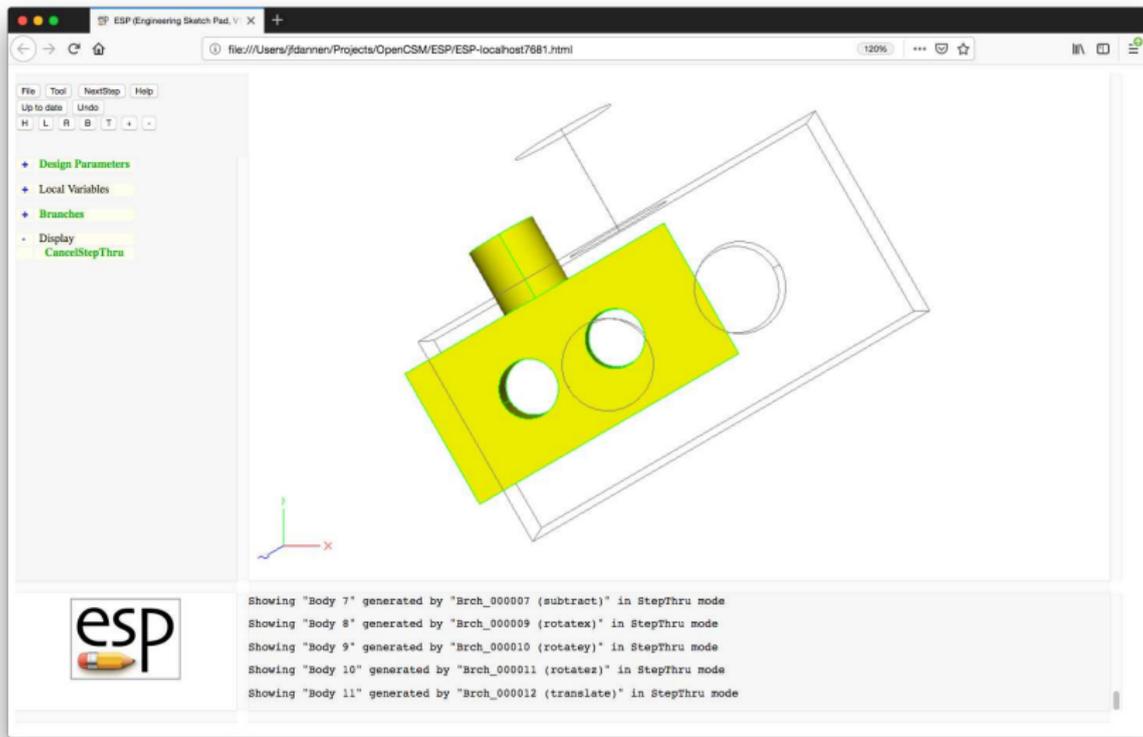
Showing "Body 3" generated by "Brch_000003 (union)" in StepThru mode
Showing "Body 4" generated by "Brch_000006 (cylinder)" in StepThru mode
Showing "Body 5" generated by "Brch_000007 (subtract)" in StepThru mode
Showing "Body 6" generated by "Brch_000006 (cylinder)" in StepThru mode
Showing "Body 7"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



Simple Block — Step 10

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 (rotatey)" 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)



Simple Wing (1)

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

The interface includes a menu bar with the following options: Up to date, Help, Undo, Edit, Save File, H, L, R, B, T, +, -. Below the menu bar is a sidebar with a tree view containing:

- + Design Parameters
- + Local Variables
- + Branches
- Display
- + Body 13 Viz Grd

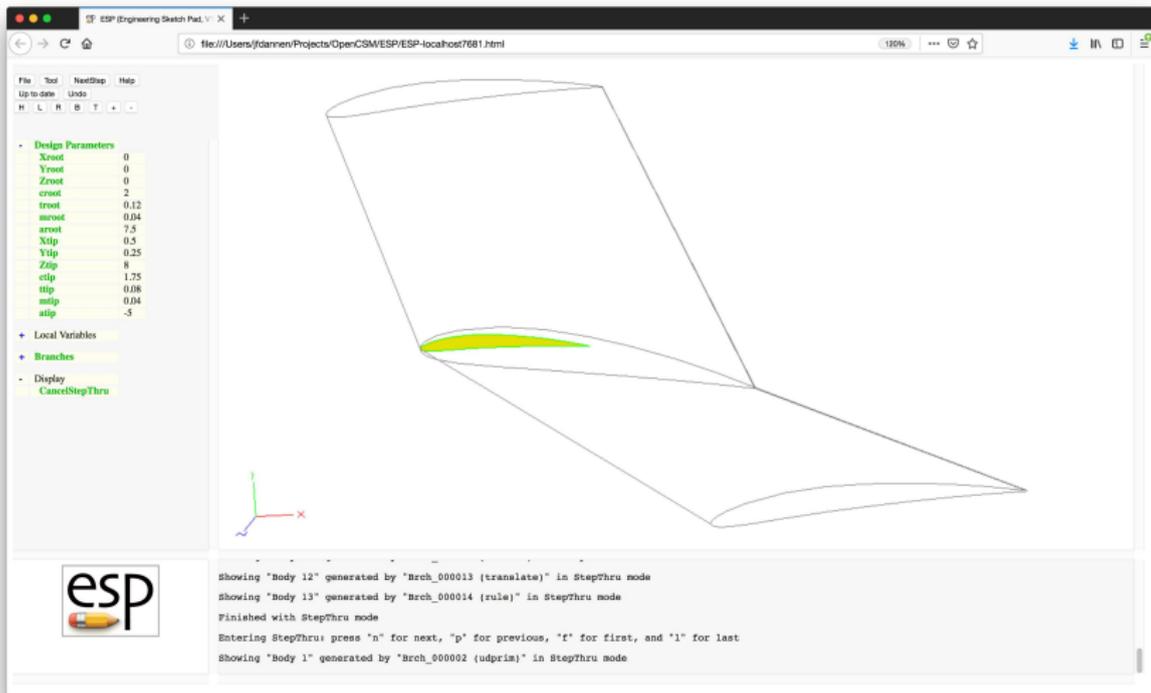
The main workspace displays a 3D model of a wing, rendered in a light green color with a dark green outline. A small red and blue coordinate system is visible in the bottom left corner of the workspace.

At the bottom left of the interface is the ESP logo. At the bottom right, a status bar displays the text: "ESP has been initialized and is attached to 'serveCSM'".

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`?

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

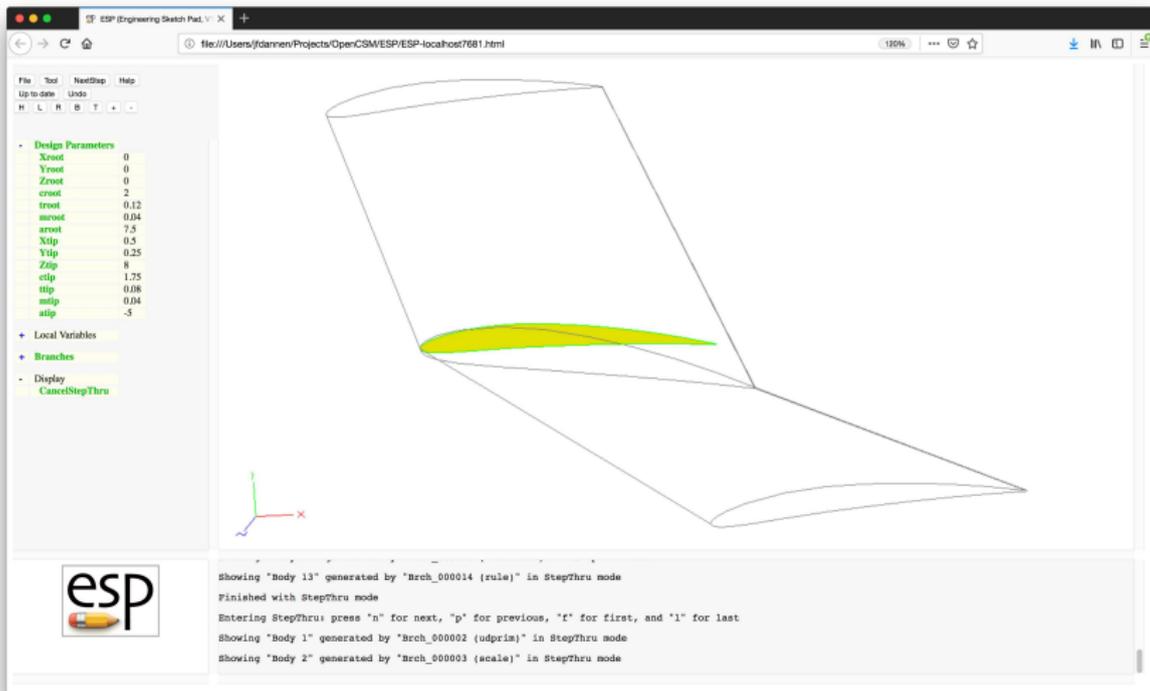


The screenshot shows the ESP (Engineering Sketch Pad) software interface. The main window displays a 3D wireframe model of a wing. The left sidebar contains a 'Design Parameters' list with the following values:

Parameter	Value
Xroot	0
Yroot	0
Zroot	0
crroot	2
trroot	0.12
surroot	0.04
srroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
cltip	1.25
stip	0.08
mdtip	0.04
stip	-5

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

```
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
```



ESP (Engineering Sketch Pad, V. X)

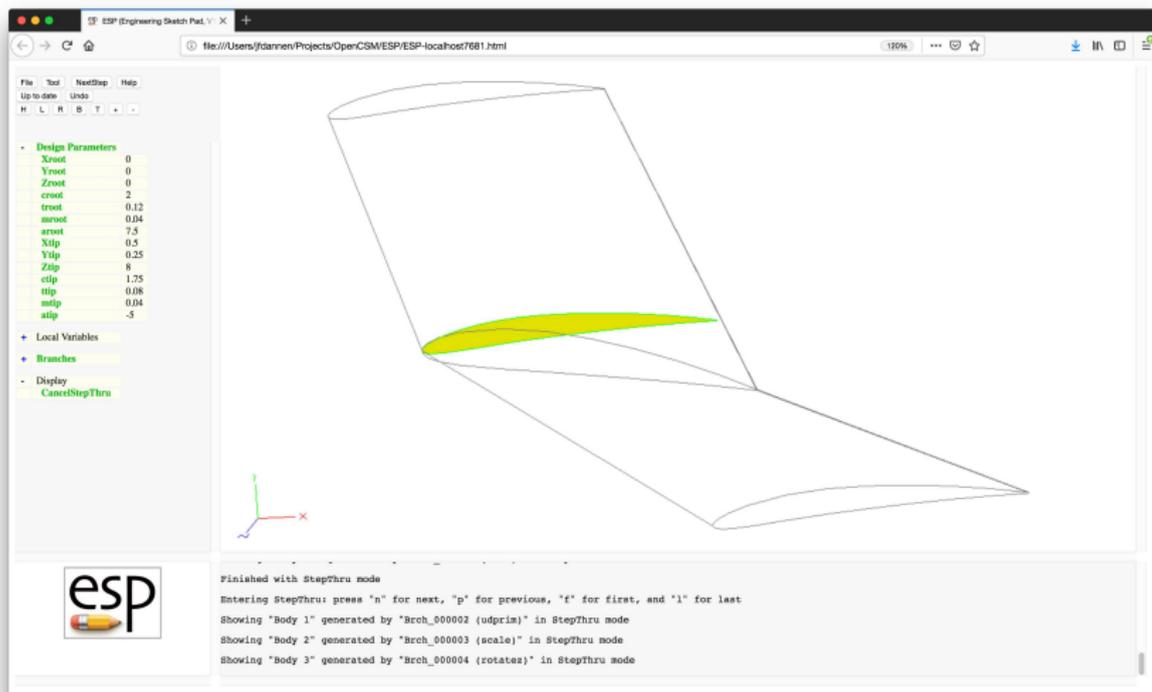
file:///Users/foannen/Projects/Open/CSM/ESP/ESP-localhost7681.html 100%

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
surroot	0.04
srroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
cltip	1.25
stip	0.08
mdtip	0.04
stip	-5
- Local Variables
- Branches
- Display
 - CancelStepThru

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:

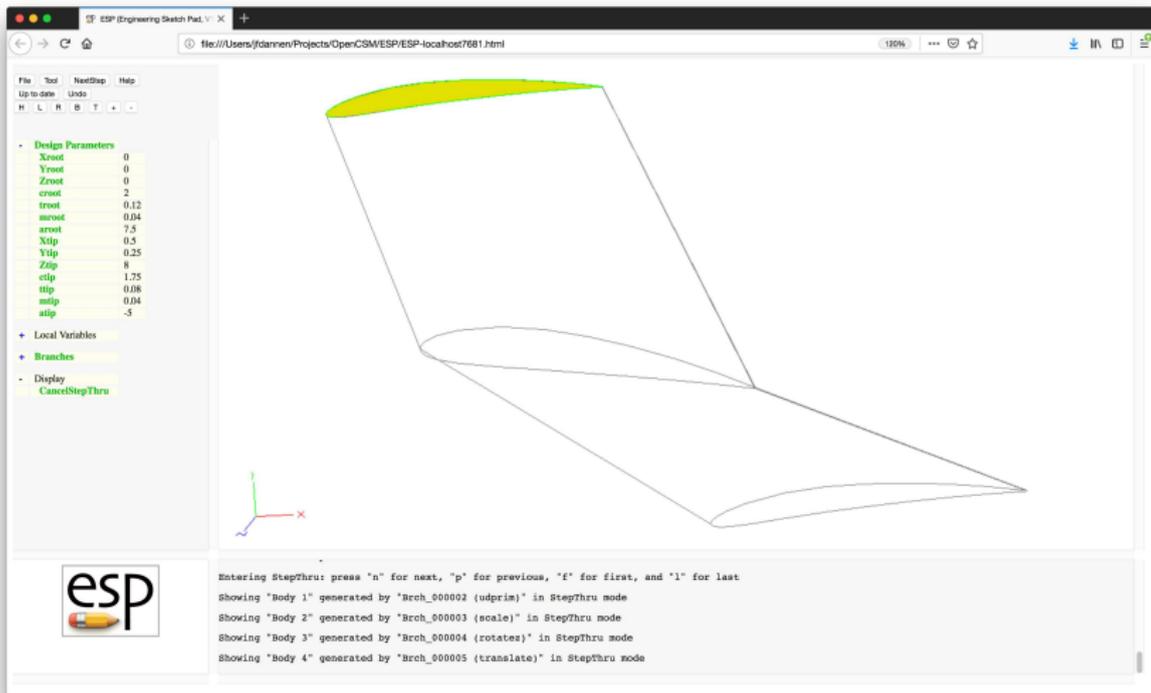
Parameter	Value
Xroot	0
Yroot	0
Zroot	0
crroot	2
trroot	0.12
surroot	0.04
aroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
cltip	1.25
stip	0.08
mdtip	0.04
atip	-5

The main workspace displays a 3D wireframe model of a wing. A yellow-green shaded surface is visible on the upper part of the wing, representing a specific body or surface. A small 3D coordinate system (X, Y, Z) is shown in the bottom left corner of the workspace.

At the bottom of the window, a text area contains the following information:

```

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
Showing "Body 3" generated by "Brch_000004 (rotates)" in StepThru mode
    
```



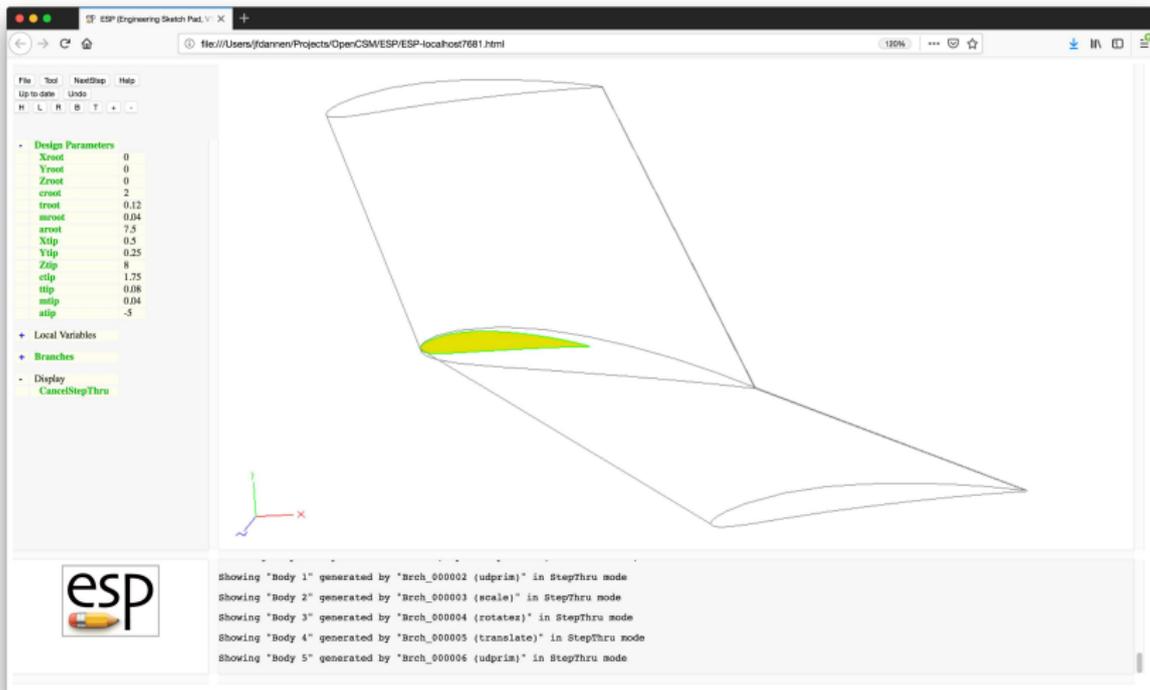
The screenshot shows the ESP software interface. On the left, there is a 'Design Parameters' list:

Parameter	Value
Xroot	0
Yroot	0
Zroot	0
crroot	2
trroot	0.12
surroot	0.04
srroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
cltip	1.25
mtip	0.08
atip	-5

Below the parameters is a 3D coordinate system with X, Y, and Z axes. The main window displays a 3D wireframe model of a wing. The leading edge is highlighted in yellow. The bottom of the interface shows 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_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
  
```



ESP (Engineering Sketch Pad) V X

file:///Users/foannen/Projects/Open/CSW/ESP/ESP-localhost7681.html 100%

File Edit View Help

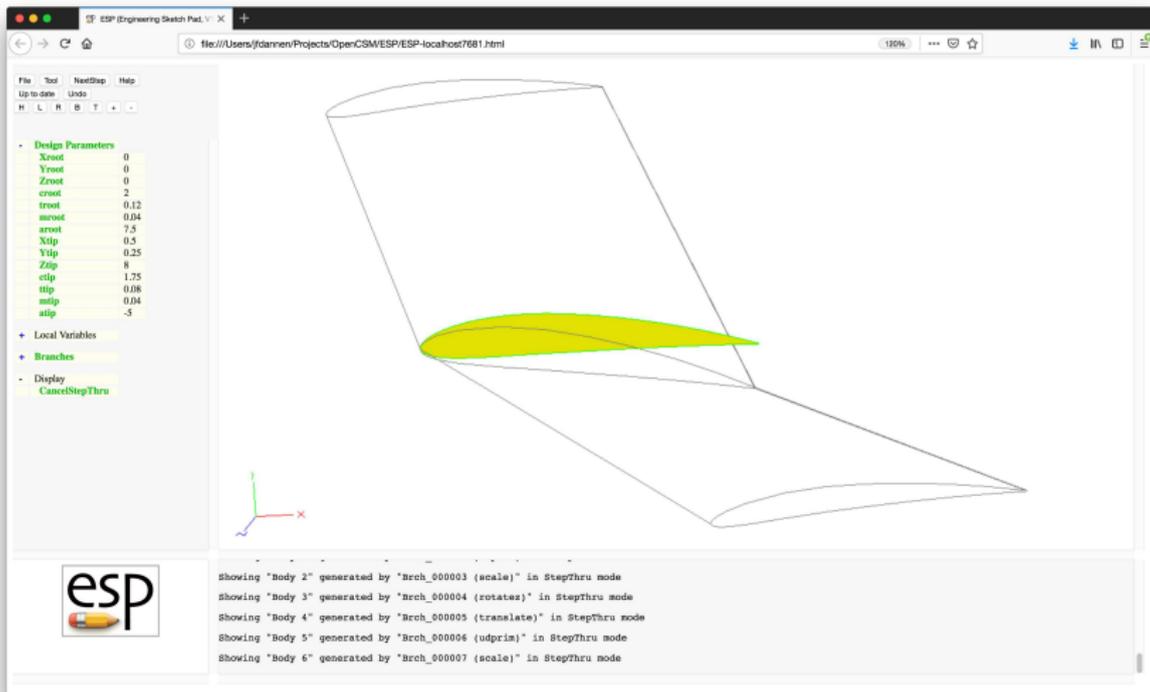
Up-to-date Undo

H L R B T +

- Design Parameters

Xroot	0
Yroot	0
Zroot	0
cxroot	2
trroot	0.12
surroot	0.04
srroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
cltip	1.25
ttip	0.08
mtip	0.04
stip	-5
- Local Variables
- Branches
- Display
 - CancelStepThru

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
 Showing "Body 5" generated by "Brch_000006 (udprim)" in StepThru mode



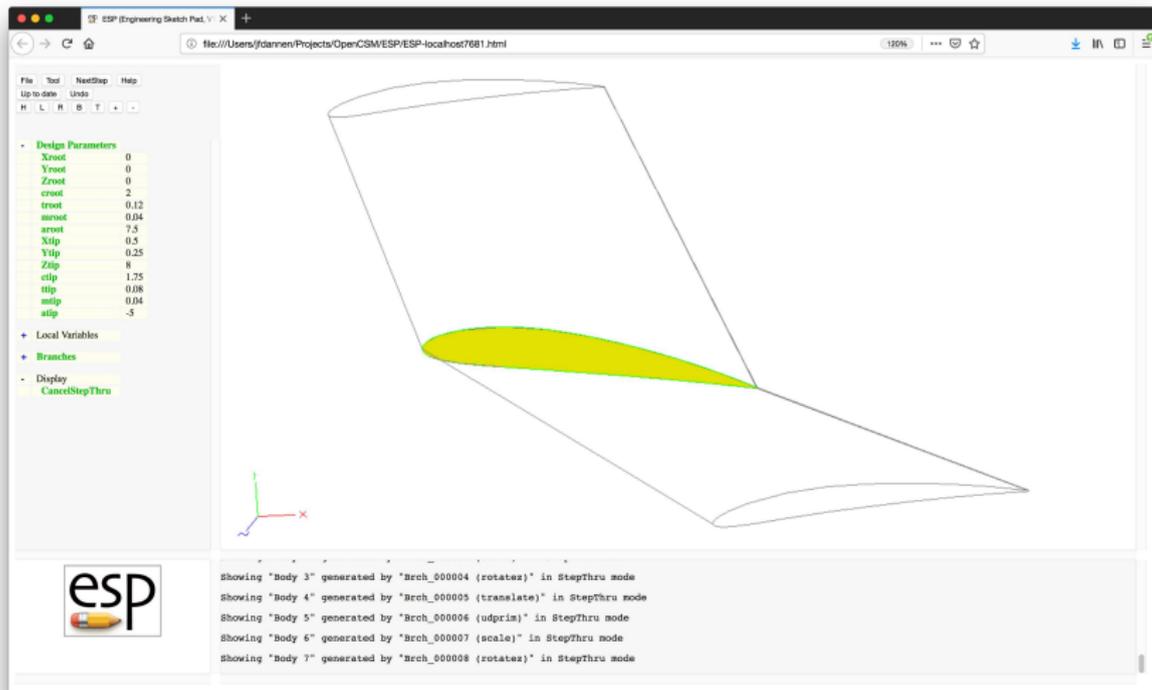
The screenshot displays the ESP (Engineering Sketch Pad) interface. The main window shows a 3D wireframe model of a wing with a yellow-green surface. The left sidebar contains a 'Design Parameters' list with the following values:

Parameter	Value
Xroot	0
Yroot	0
Zroot	0
cxroot	2
trroot	0.12
surroot	0.04
arcroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
cltip	1.25
stip	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 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
Showing "Body 6" generated by "Brch_000007 (scale)" in StepThru mode
  
```

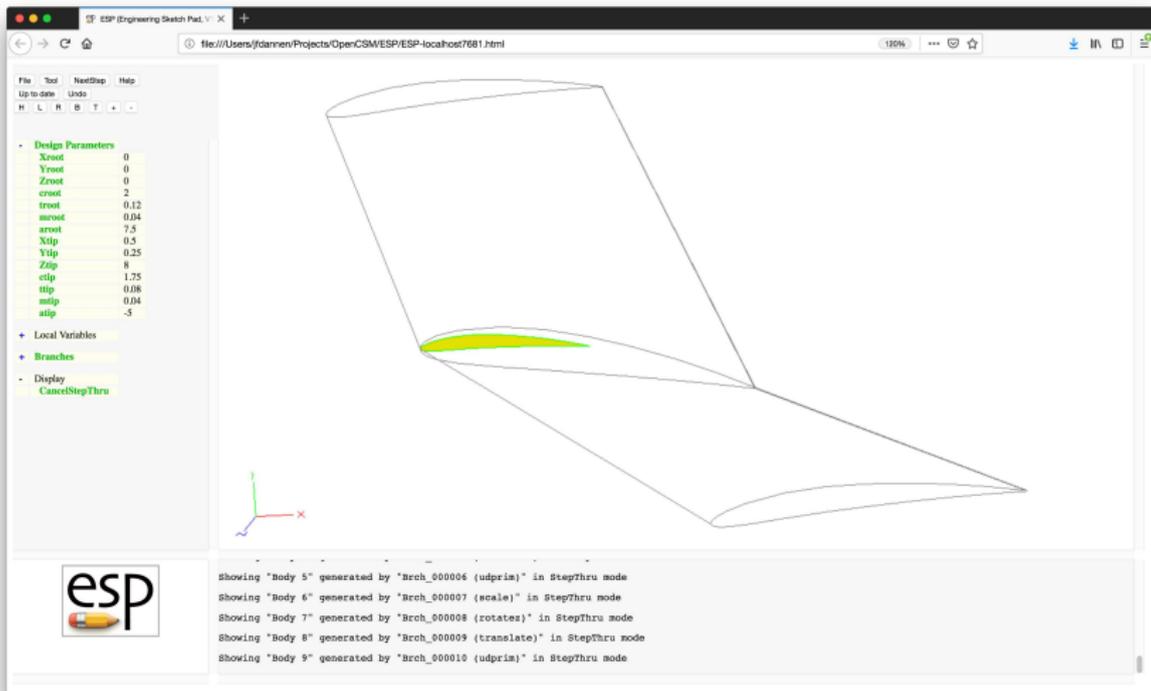


File Tool NextStep Help
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- Design Parameters

Xroot	0
Yroot	0
Zroot	0
xroot	2
trroot	0.12
surroot	0.04
srroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
cltip	1.25
mtip	0.08
stip	-5
- Local Variables
- Branches
- Display
 - CancelStepThru

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
 Showing "Body 6" generated by "Brch_000007 (scale)" in StepThru mode
 Showing "Body 7" generated by "Brch_000008 (rotates)" in StepThru mode

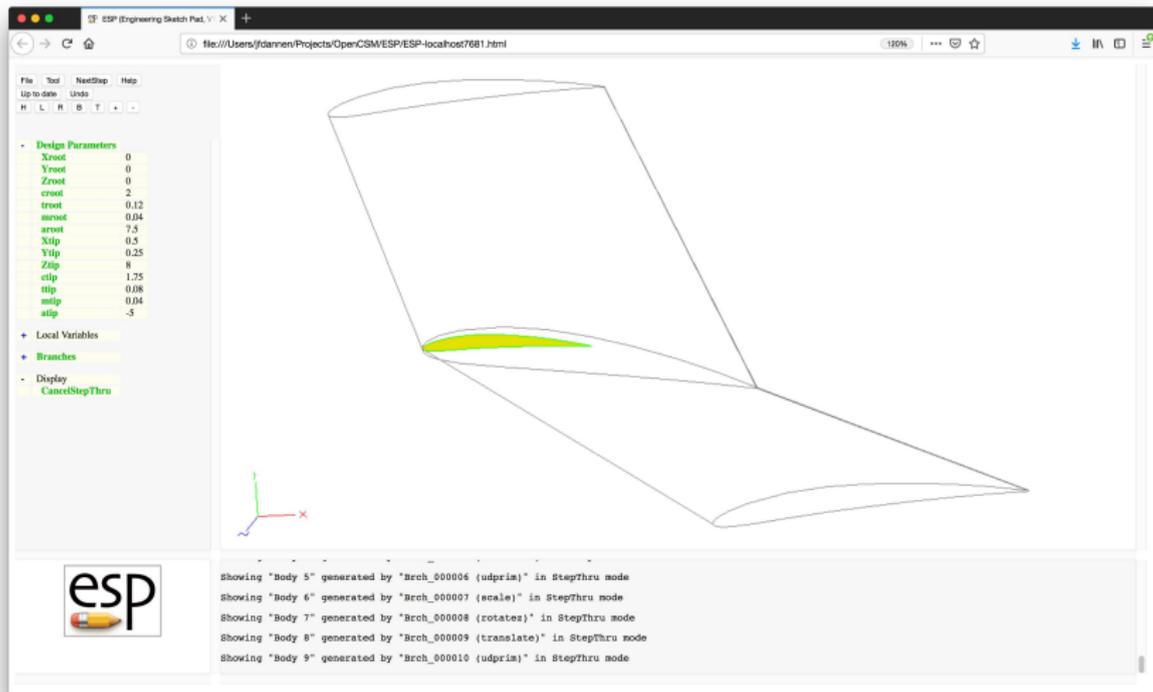


File Edit NeedStep Help
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- Design Parameters

Xroot	0
Yroot	0
Zroot	0
xroot	2
trroot	0.12
surroot	0.04
srroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
cltip	1.25
ttip	0.08
mtip	0.04
stip	-5
- Local Variables
- Branches
- Display
 - CancelStepThru

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

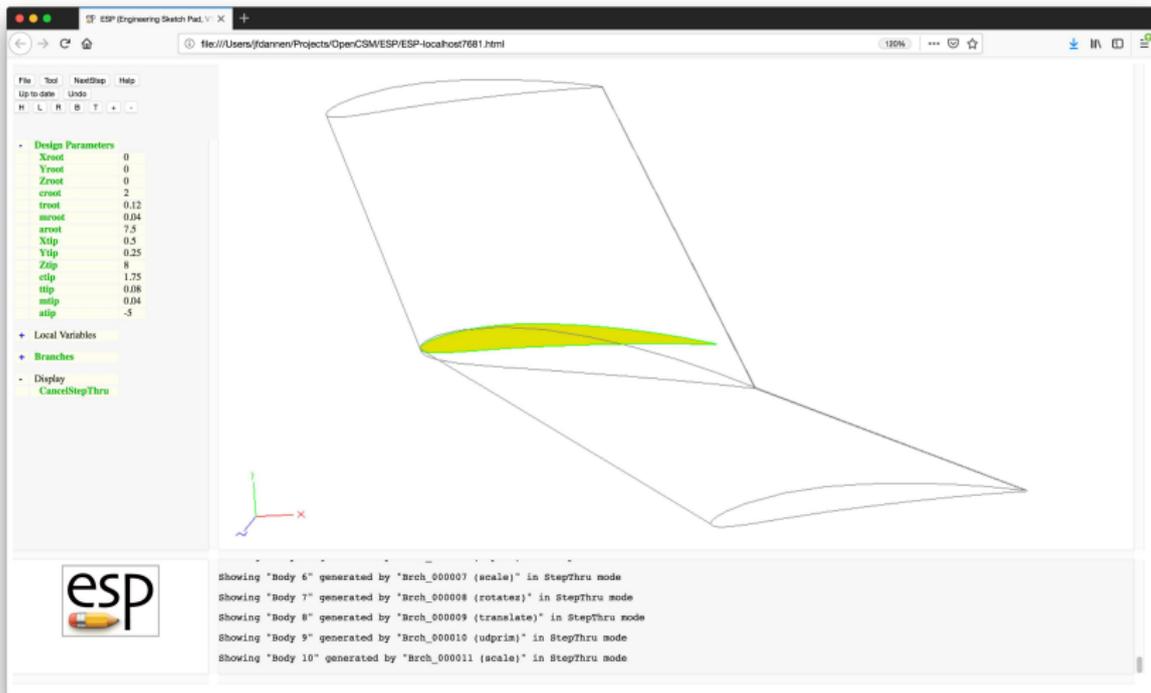


File Edit View Help
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- Design Parameters

Xroot	0
Yroot	0
Zroot	0
xroot	2
troot	0.12
surroot	0.04
surrot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
cltip	1.25
ttip	0.08
mtip	0.04
stip	-5
- Local Variables
- Branches
- Display
 - CancelStepThru

Showing "Body 5" generated by "Brch_000006 (udprism)" 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 (udprism)" 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' table and a 'Local Variables' section.

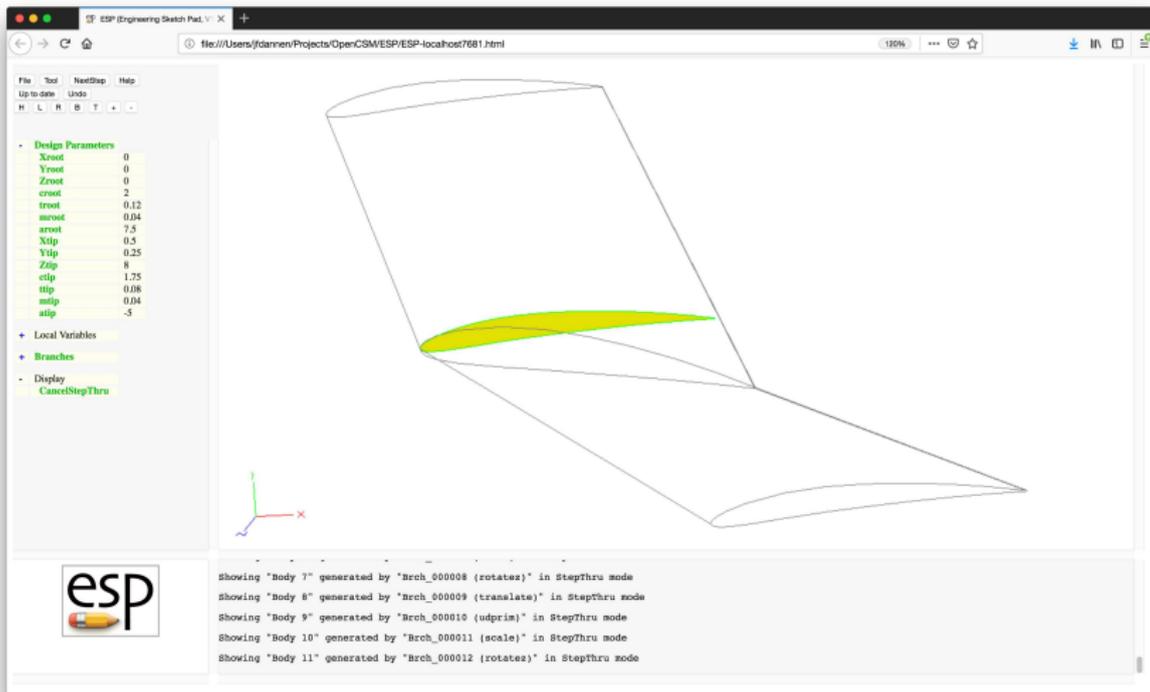
Design Parameters	
Xroot	0
Yroot	0
Zroot	0
cxroot	2
trroot	0.12
surroot	0.04
srroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
cltip	1.25
stip	0.08
mtip	0.04
atip	-5

Below the parameters, there are sections for 'Local Variables', 'Branches', and 'Display' (containing 'CancelStepThru').

At the bottom of the interface, a log window displays the following text:

```

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
Showing "Body 10" generated by "Brch_000011 (scale)" in StepThru mode
  
```



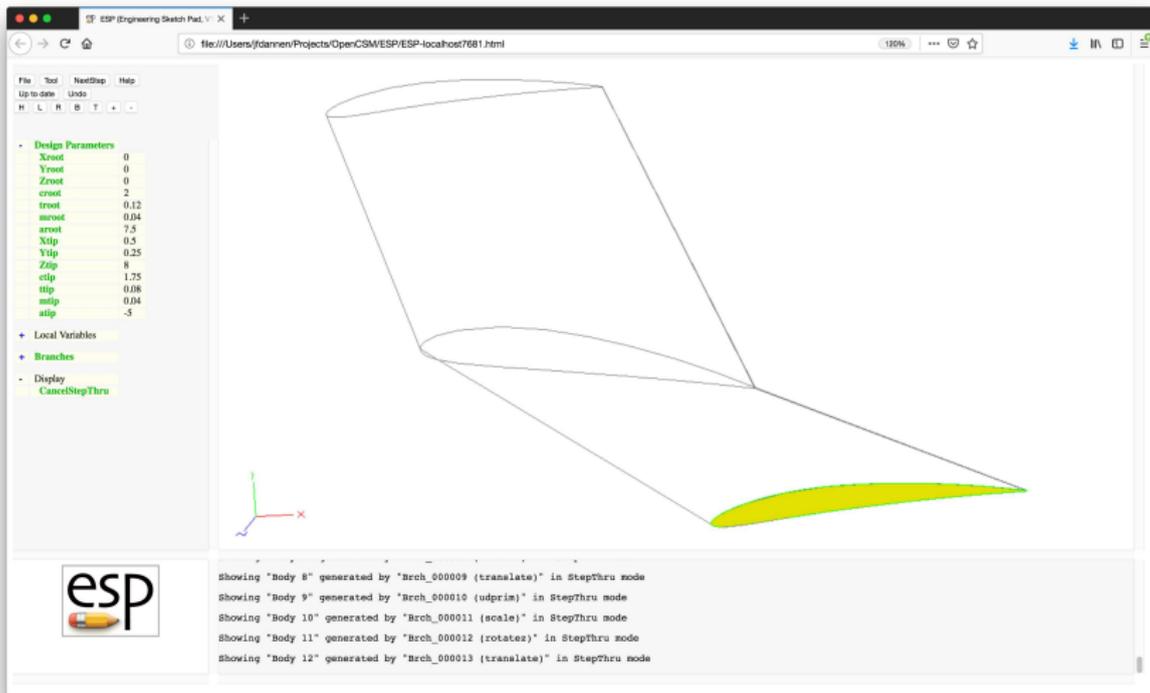
The screenshot displays the ESP (Engineering Sketch Pad) interface. The main window shows a 3D wireframe model of a wing with a yellow-green shaded airfoil section. The left sidebar contains a 'Design Parameters' table and other settings.

Design Parameters	
Xroot	0
Yroot	0
Zroot	0
cxroot	2
trroot	0.12
surroot	0.04
srroot	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
cltip	1.25
stip	0.08
mtip	0.04
atip	-5

Below the parameters, there are sections for 'Local Variables', 'Branches', and 'Display'. The 'Display' section shows 'CancelStepThru'.

At the bottom of the interface, a log window displays the following text:

```
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
Showing "Body 11" generated by "Brch_000012 (rotatez)" in StepThru mode
```



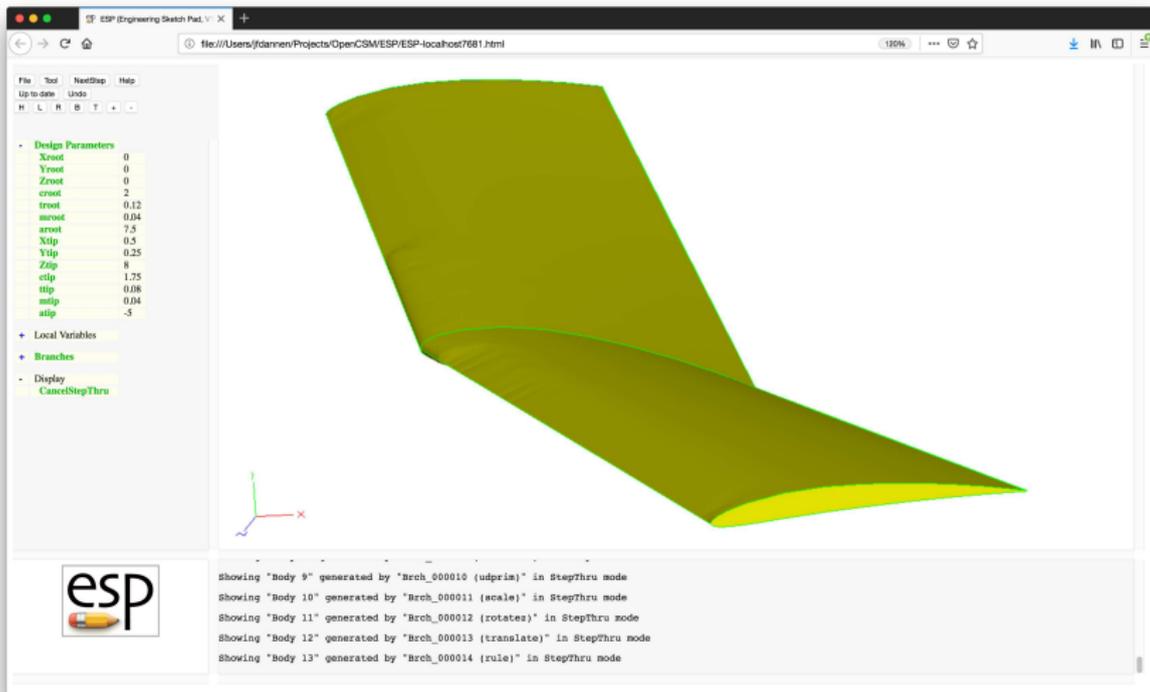
The screenshot shows the ESP (Engineering Sketch Pad) interface. On the left, a 'Design Parameters' table lists various variables and their values:

Design Parameters	Value
Xroot	0
Yroot	0
Zroot	0
crust	2
trout	0.12
srout	0.04
srout	7.5
Xtip	0.5
Ytip	0.25
Ztip	8
cltip	1.25
stip	0.08
mtip	0.04
atip	-5

Below the parameters is a 3D coordinate system with X, Y, and Z axes. The main workspace displays a 3D wireframe model of a wing structure. At the bottom of the workspace, a console window shows the following log messages:

```

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. To the left of the model is a panel with a tree view containing the following items:

- Design Parameters
 - Xroot 0
 - Yroot 0
 - Zroot 0
 - crout 2
 - frout 0.12
 - srout 0.04
 - arout 7.5
 - Xtip 0.5
 - Ytip 0.25
 - Ztip 8
 - cltip 1.25
 - stip 0.08
 - mtip 0.04
 - atip -5
- Local Variables
- Branches
- Display
 - CancelStepThru

At the bottom of the interface, there is a status bar with the ESP logo on the left and a list of bodies on the right:

```

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
  
```

```
# 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

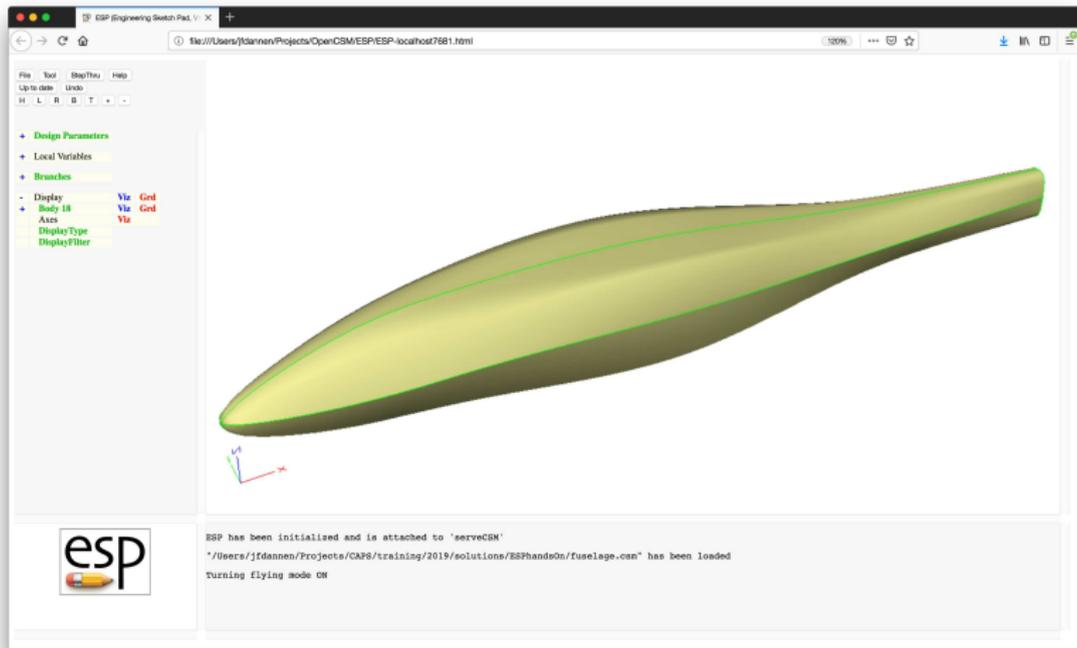


Simple Wing — Alternative DESPMTRs

```
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?



Simple Fuselage (4)

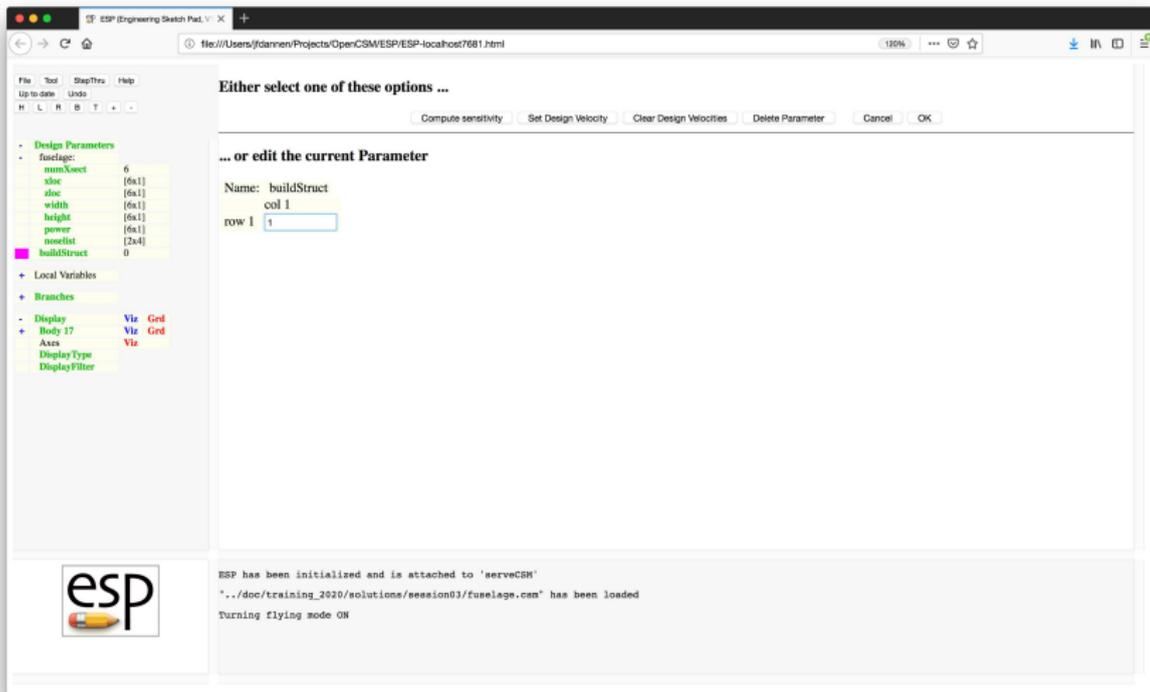
The screenshot shows the ESP (Engineering Sketch Pad) interface. The main window displays a 3D model of a fuselage, which is a series of overlapping, curved, red and blue segments arranged in a line, tapering towards the right. A small 3D coordinate system is visible in the bottom left corner of the model area.

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

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - Body 25 Viz Gnd
 - Axes Viz Gnd
 - DisplayType
 - DisplayFilter

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

```
ESP has been initialized and is attached to 'serveCRH'  
'/Users/jfdannen/Projects/CAPS/training/2019/solutions/ESPbandsOn/fuselage.csm' has been loaded  
Parameter 'buildStruct[1,1]' has been changed to 1 ==> Re-build is needed <===  
Entire build complete, which generated 1 Body(s)  
Turning flying mode ON
```



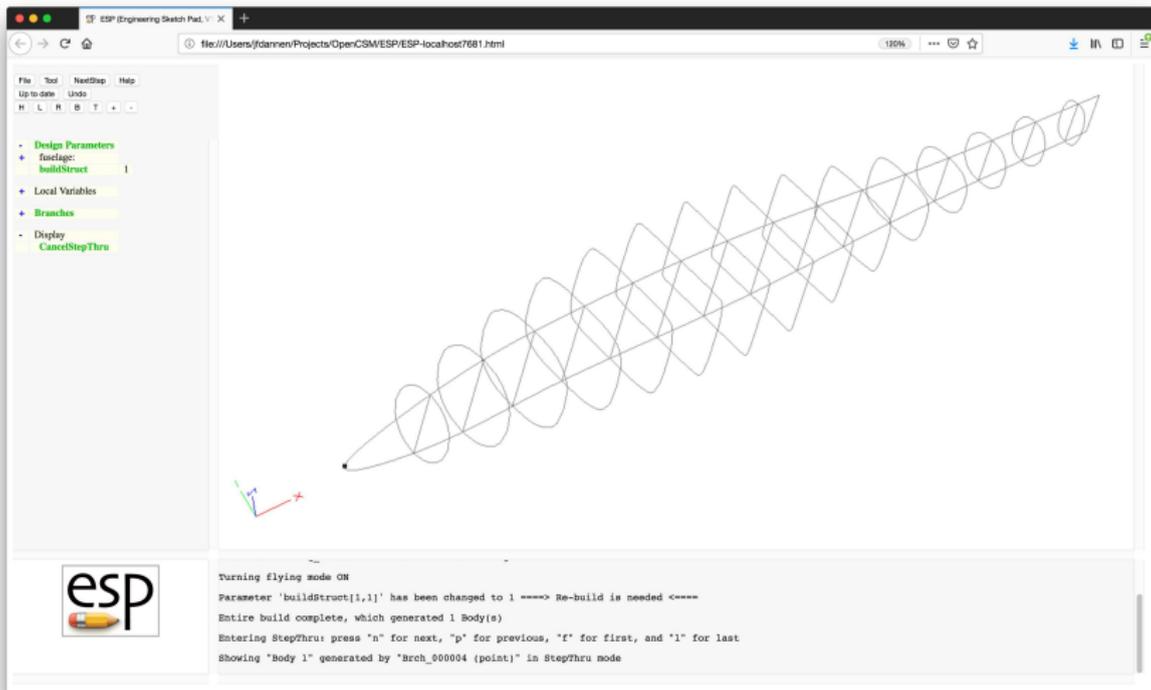
The screenshot shows the ESP (Engineering Sketch Pad) software interface. The main window displays a dialog box titled "Either select one of these options ...". The dialog has several buttons at the top: "Compute sensitivity", "Set Design Velocity", "Clear Design Velocities", "Delete Parameter", "Cancel", and "OK". Below these buttons, the text reads "... or edit the current Parameter". The current parameter is identified as "Name: buildStruct" and "col 1". A text input field for "row 1" contains the value "1".

On the left side of the interface, a tree view shows the "Design Parameters" section expanded. The parameters listed are:

- fuselage:
 - numXsect: 6
 - slac: [6x1]
 - zloc: [6x1]
 - width: [6x1]
 - height: [6x1]
 - power: [6x1]
 - noselet: [2x4]
 - buildStruct: 0
- Local Variables
- Branches
- Display:
 - Body 17: Via Grid
 - Axis: Via
 - Display Type: DisplayFilter

At the bottom left of the interface is the ESP logo. At the bottom right, a status bar displays the following text:

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



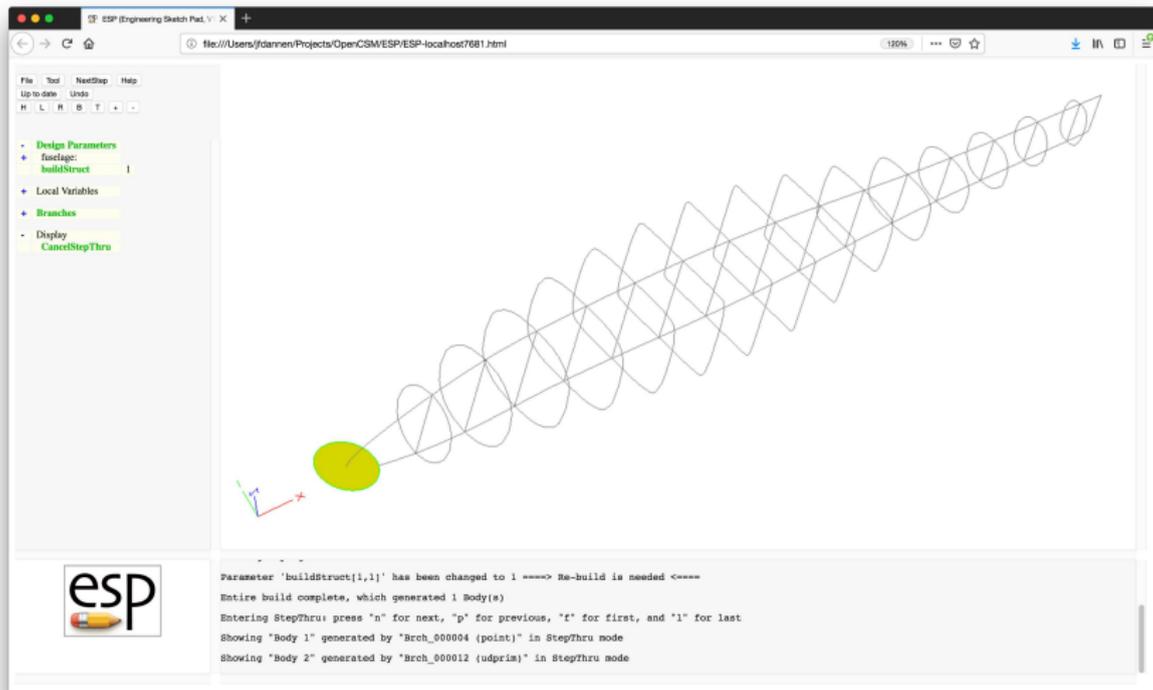
The screenshot shows the ESP (Engineering Sketch Pad) software interface. The main window displays a 3D wireframe model of a fuselage, which is a series of overlapping diamond shapes forming a tapered, elongated structure. The model is oriented diagonally. A small 3D coordinate system with red, green, and blue axes is visible in the bottom-left corner of the 3D view.

On the left side, there is a sidebar with a tree view showing the design structure:

- 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
    
```

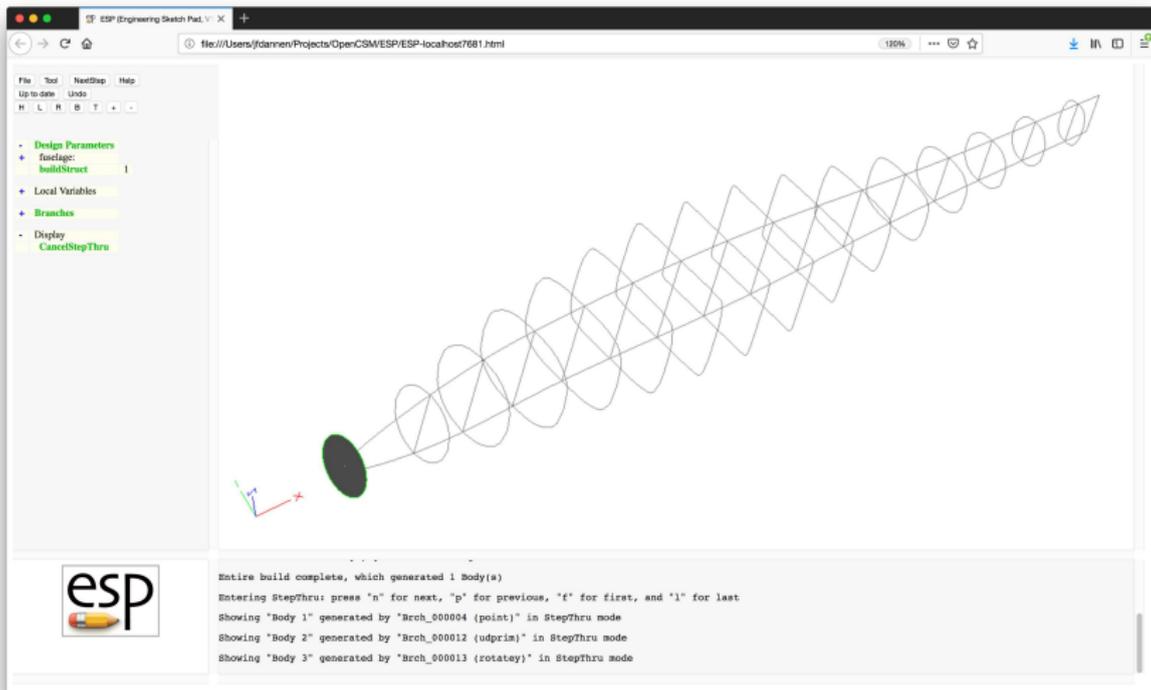


The screenshot shows the ESP (Engineering Sketch Pad) interface. The main window displays a 3D model of a fuselage, which is a series of overlapping ellipsoids forming a tapered, multi-lobed shape. A green circular base is visible at the front. A coordinate system with red, green, and blue axes is shown at the bottom left of the model.

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

- 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
```



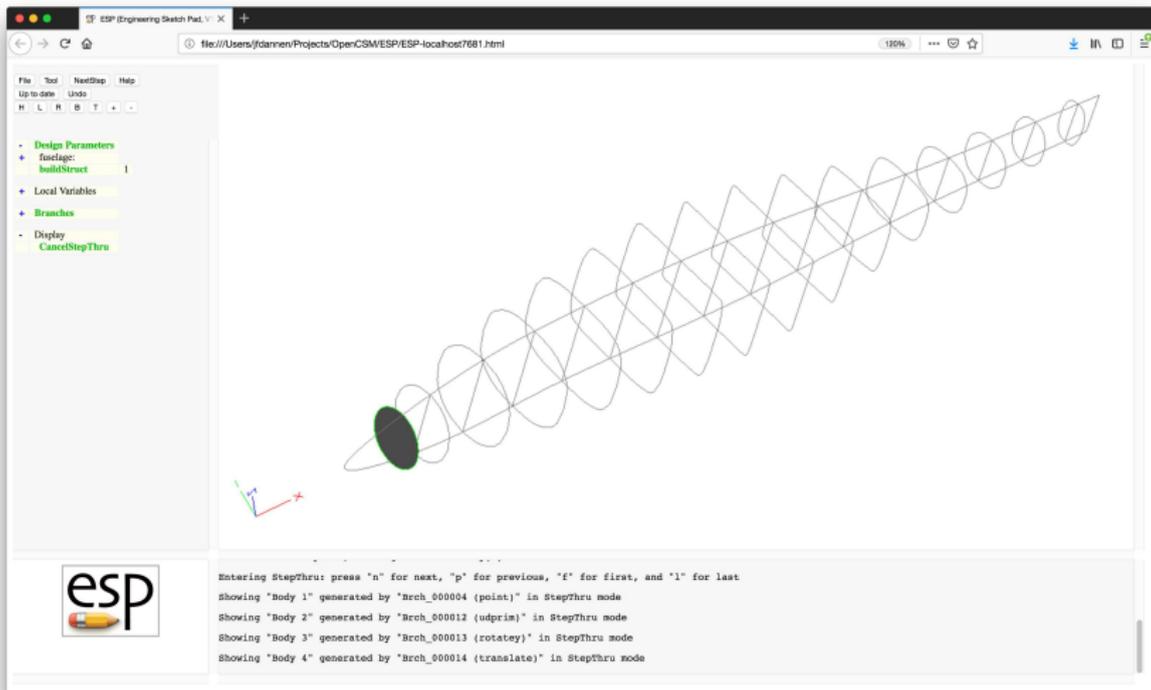
The screenshot shows the ESP (Engineering Sketch Pad) software interface. The main 3D view displays a wireframe model of a fuselage, which is a series of overlapping elliptical shapes forming a tapered, elongated structure. A small 3D coordinate system is visible in the bottom-left corner of the 3D view.

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

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

```

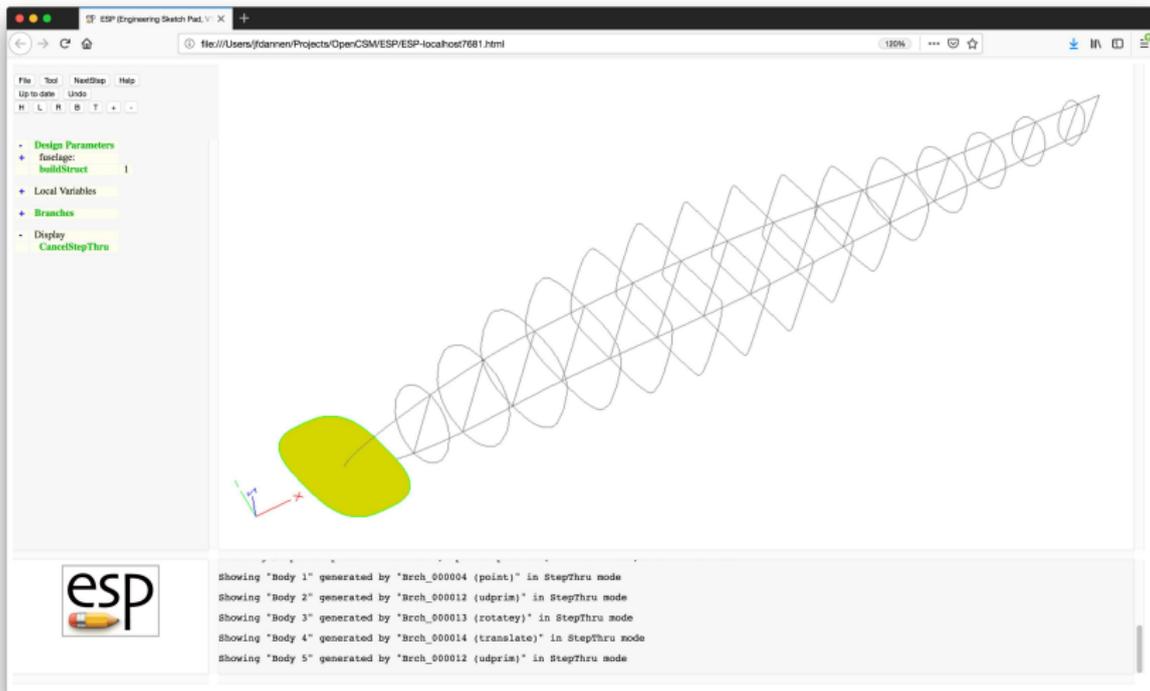
Entire build complete, which generated 1 Body(s)
Entering StepThru: press 'n' for next, 'p' for previous, 'f' for first, and 'l' for last
Showing "Body 1" generated by "Brch_000004 (point)" in StepThru mode
Showing "Body 2" generated by "Brch_000012 (udprim)" in StepThru mode
Showing "Body 3" generated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



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

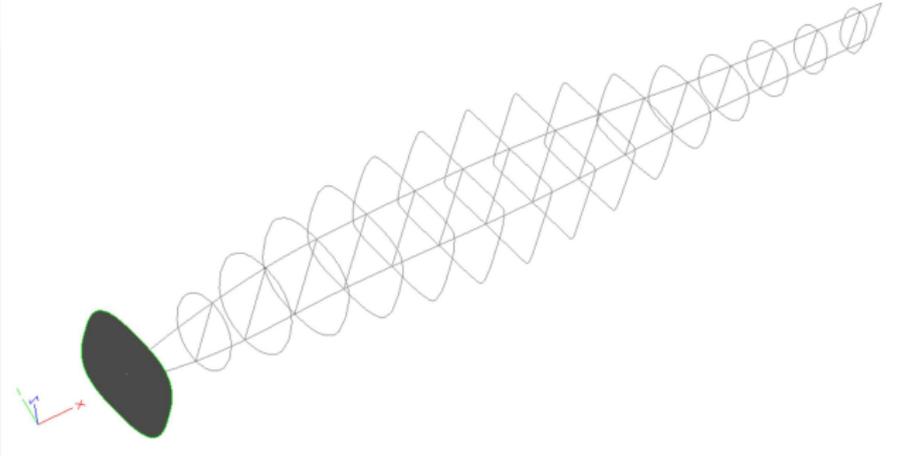
entering StepThru: press "n" for next, "p" for previous, "f" for first, and "l" for last
Showing "Body 1" generated by "Brch_000004 (point)" in StepThru mode
Showing "Body 2" generated by "Brch_000012 (udprim)" in StepThru mode
Showing "Body 3" generated by "Brch_000013 (rotatex)" in StepThru mode
Showing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



File Edit NextStep Help
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- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

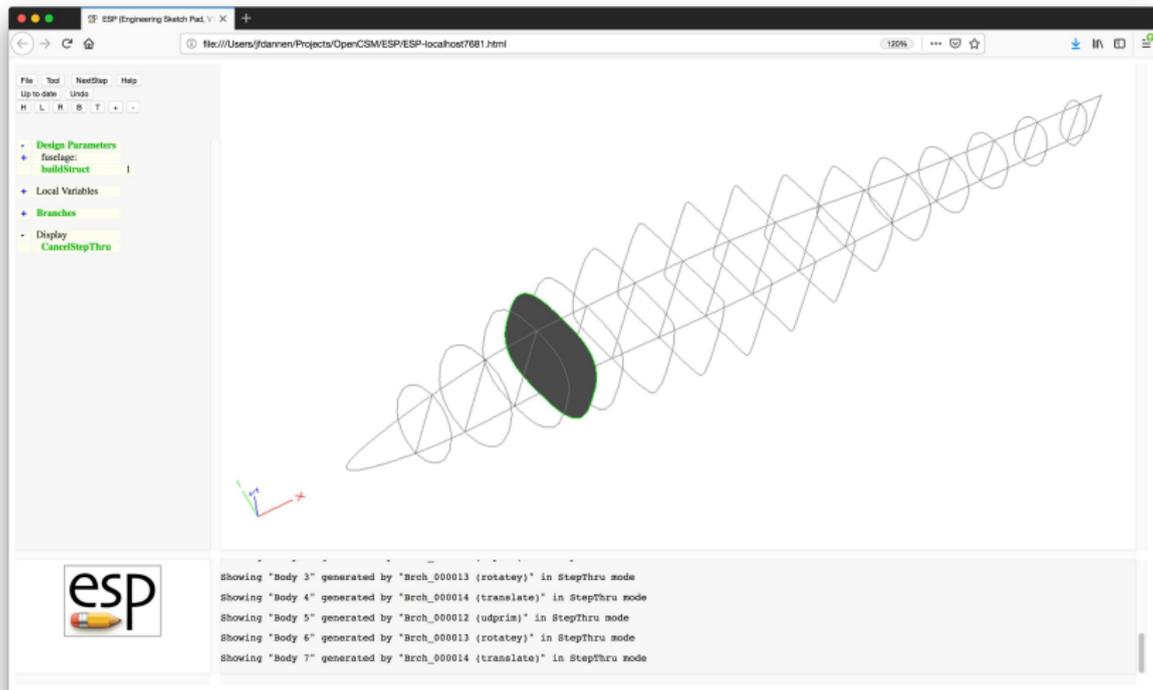
Showing "Body 1" generated by "Brch_000004 (point)" in StepThru mode
 Showing "Body 2" generated by "Brch_000012 (udprim)" in StepThru mode
 Showing "Body 3" generated by "Brch_000013 (rotatey)" in StepThru mode
 Showing "Body 4" generated by "Brch_000014 (translate)" in StepThru mode
 Showing "Body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



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- 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 (rotatety)" 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 (rotatety)" in StepThru mode

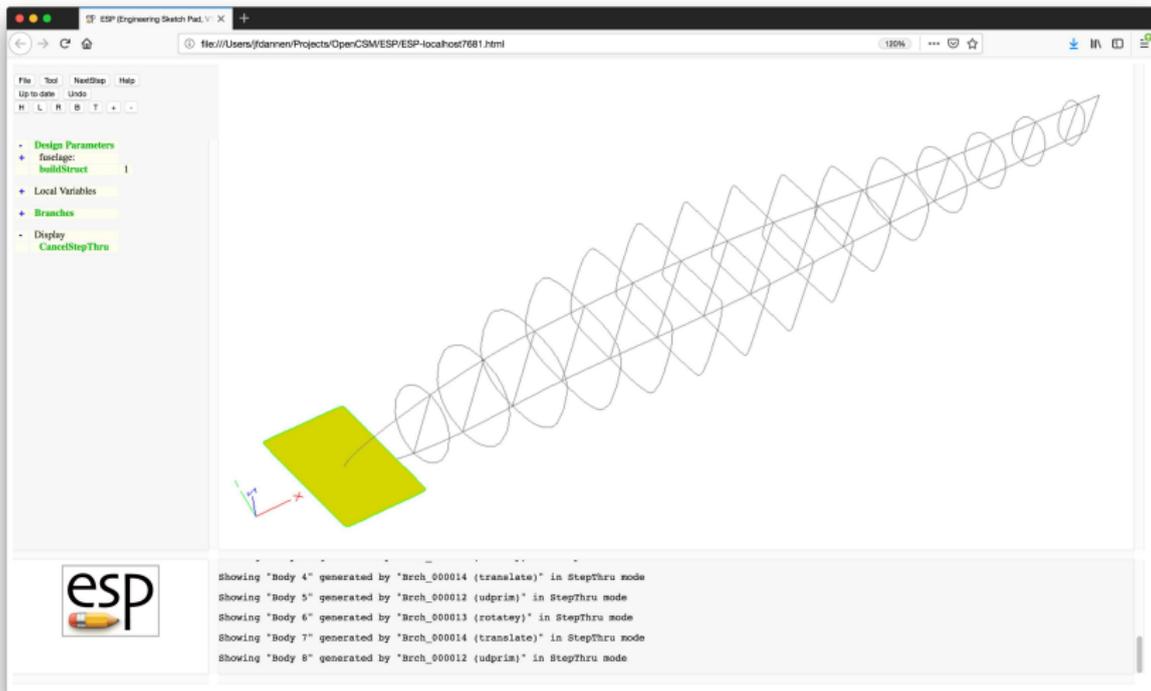


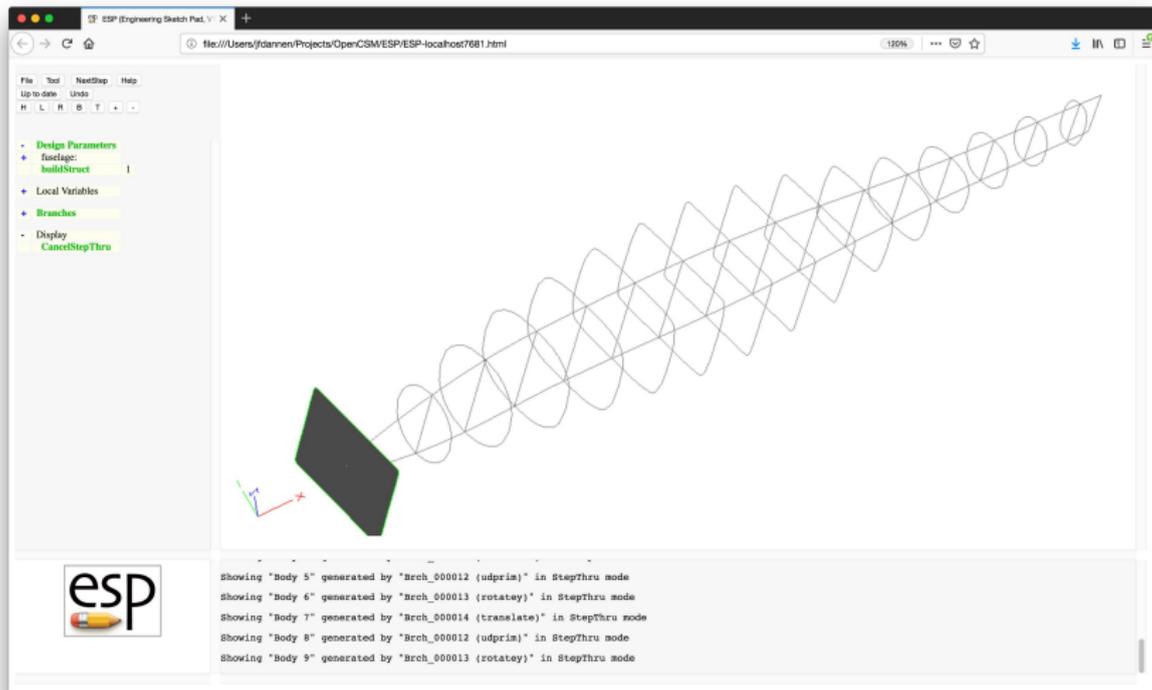
The screenshot shows the ESP (Engineering Sketch Pad) software interface. The main workspace displays a wireframe model of a fuselage, with a dark green oval cross-section highlighted. The left sidebar contains a design tree with the following structure:

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

The console window at the bottom displays the following text:

```
Showing "Body 3" generated by "Brch_000013 (rotatety)" 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 (rotatety)" in StepThru mode
Showing "Body 7" generated by "Brch_000014 (translate)" in StepThru mode
```

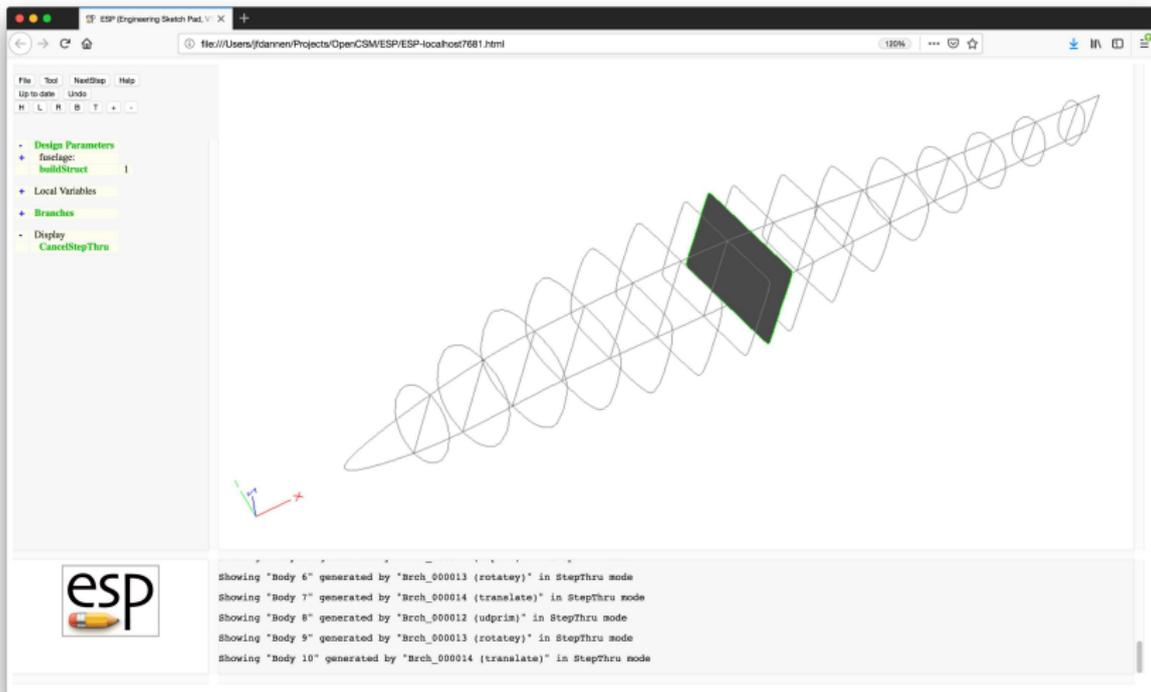




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- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

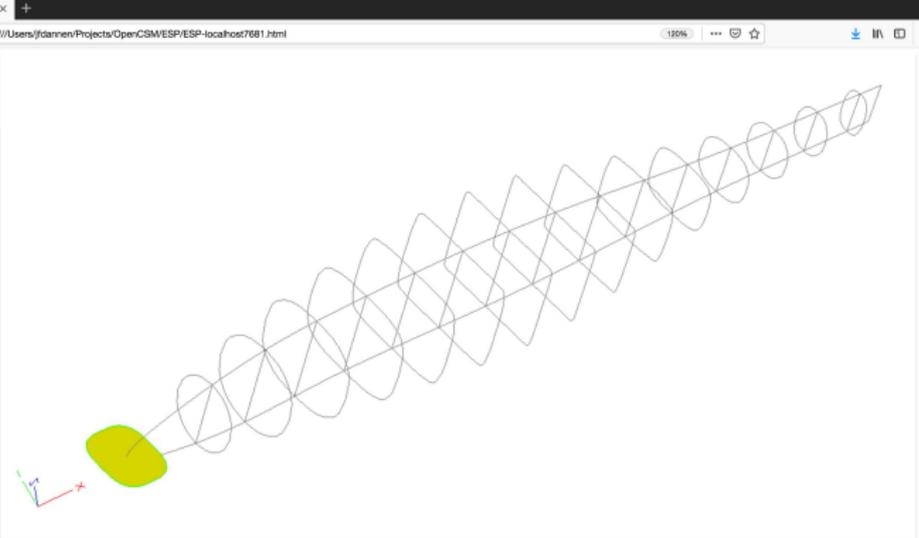
Showing "Body 5" generated by "Brch_000012 (udprim)" in StepThru mode
 Showing "Body 6" generated by "Brch_000013 (rotatety)" in StepThru mode
 Showing "Body 7" generated by "Brch_000014 (translate)" in StepThru mode
 Showing "Body 8" generated by "Brch_000012 (udprim)" in StepThru mode
 Showing "Body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



File Edit View Help
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- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

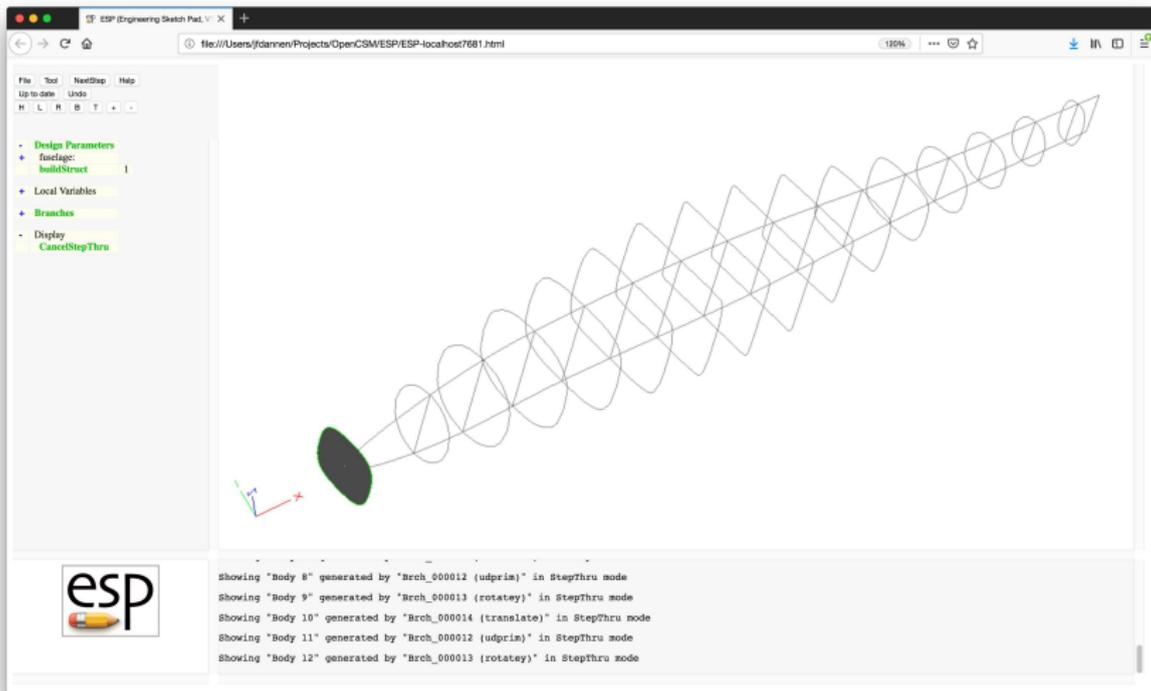
Showing "Body 6" generated by "Brch_000013 (rotatety)" in StepThru mode
 Showing "Body 7" generated by "Brch_000014 (translate)" in StepThru mode
 Showing "Body 8" generated by "Brch_000012 (udprim)" in StepThru mode
 Showing "Body 9" generated by "Brch_000013 (rotatety)" in StepThru mode
 Showing "Body 10" generated by "Brch_000014 (translate)" in StepThru mode



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

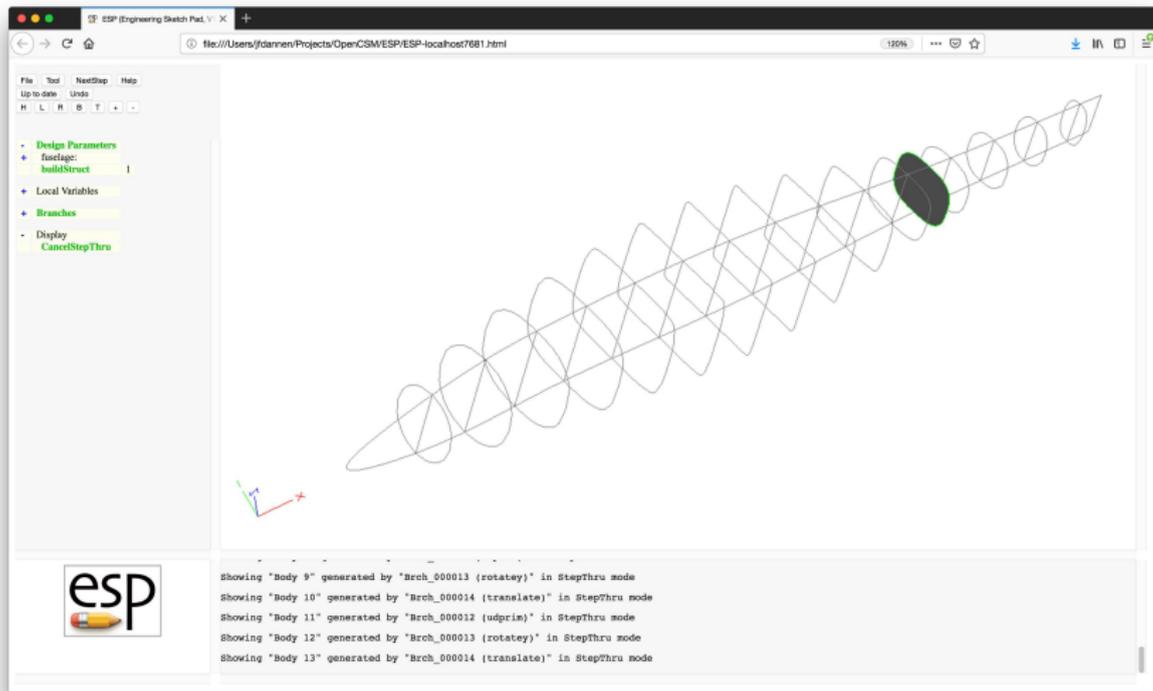
Showing "Body 7" generated by "Brch_000014 (translate)" in StepThru mode
 Showing "Body 8" generated by "Brch_000012 (udprism)" in StepThru mode
 Showing "Body 9" generated by "Brch_000013 (rotatey)" in StepThru mode
 Showing "Body 10" generated by "Brch_000014 (translate)" in StepThru mode
 Showing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

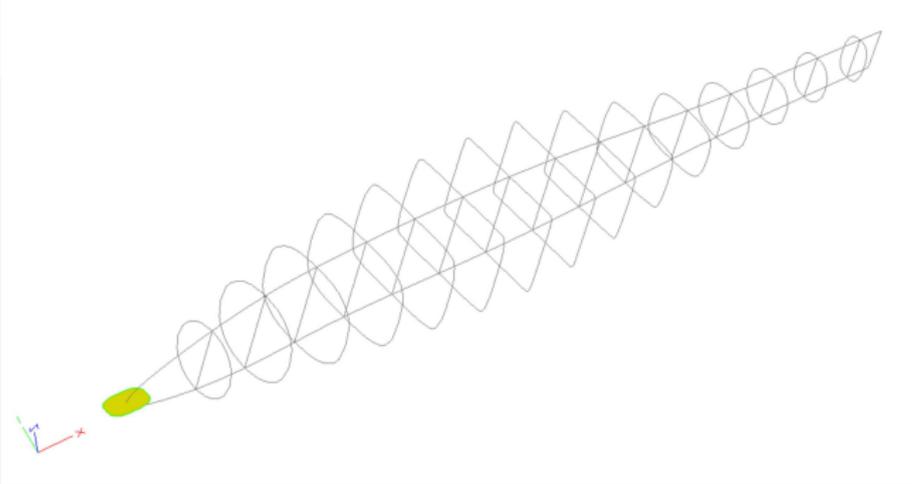


File Edit NextStep Help
Up-to-date Undo
H L R B T +

- 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

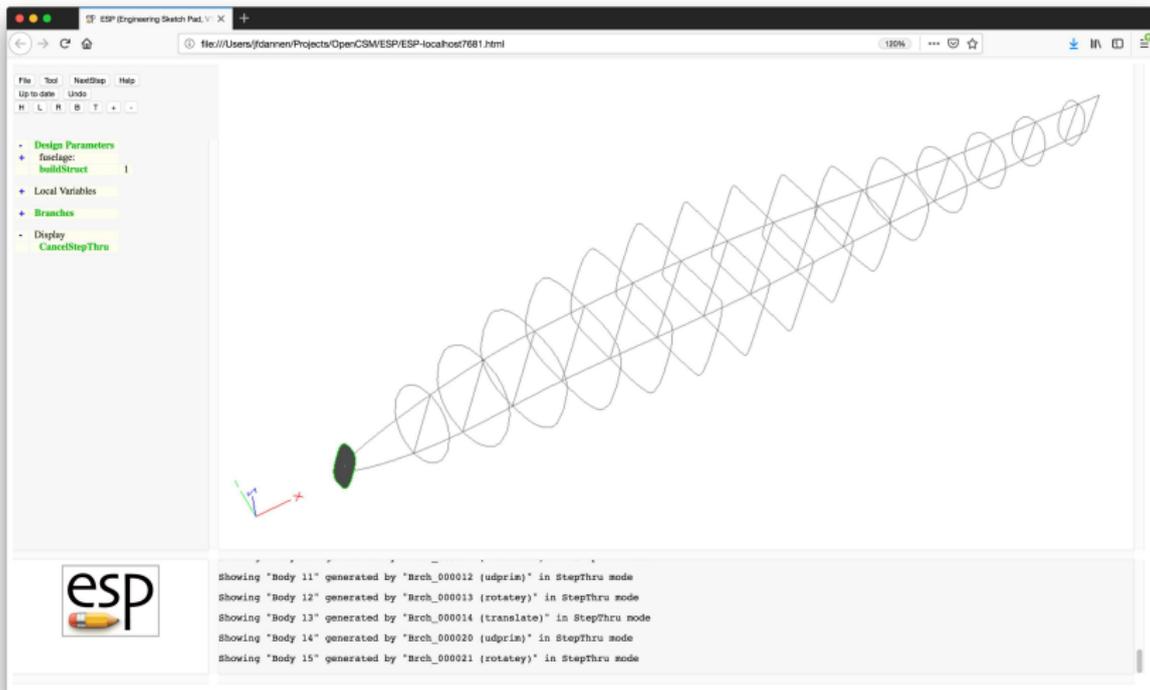




File Edit NextStep Help
Up-to-date Undo
H L R B T +

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

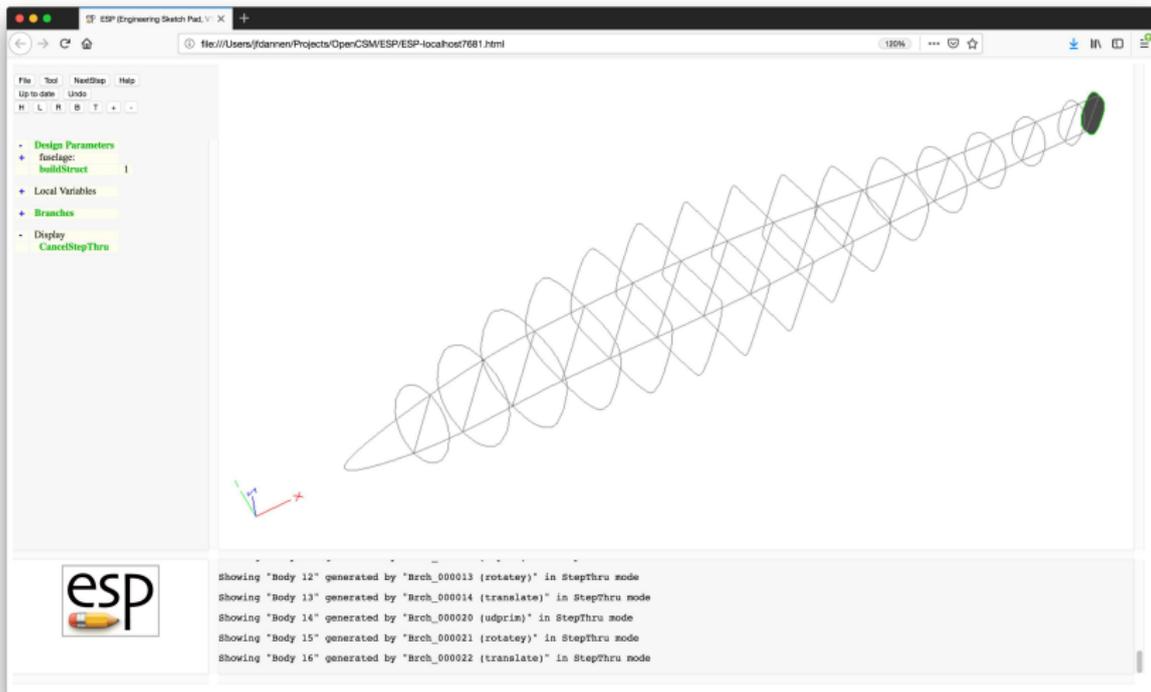
Showing "Body 10" generated by "Brch_000014 (translate)" in StepThru mode
 Showing "Body 11" generated by "Brch_000012 (udprism)" in StepThru mode
 Showing "Body 12" generated by "Brch_000013 (rotatey)" in StepThru mode
 Showing "Body 13" generated by "Brch_000014 (translate)" in StepThru mode
 Showing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

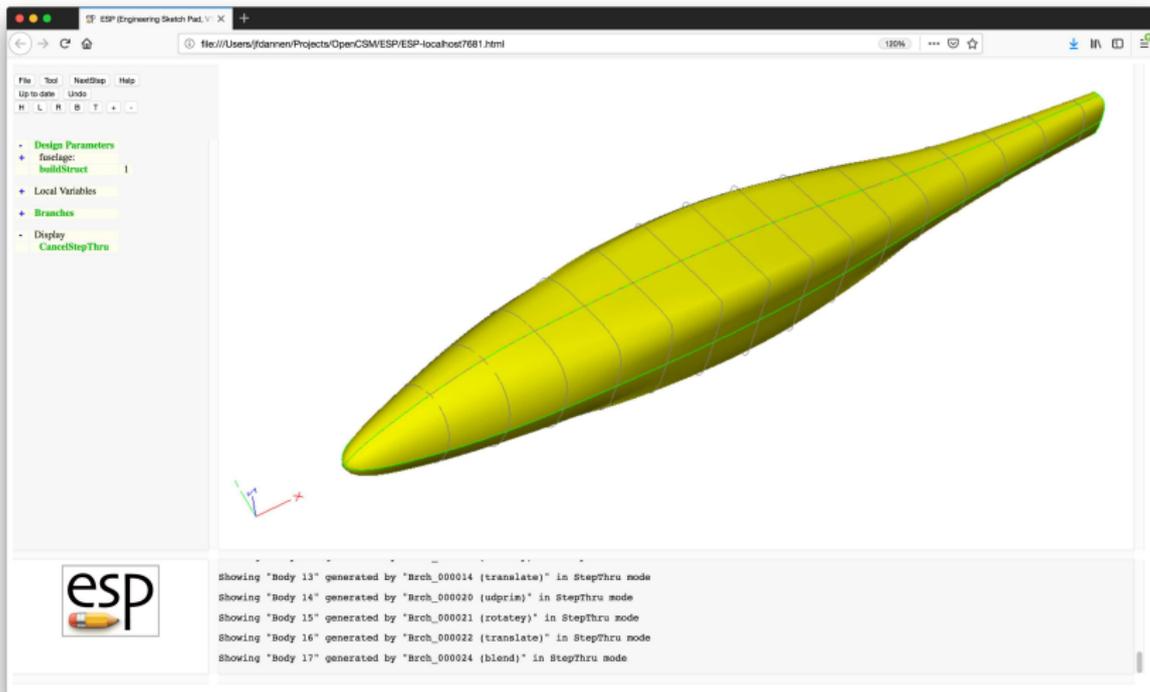


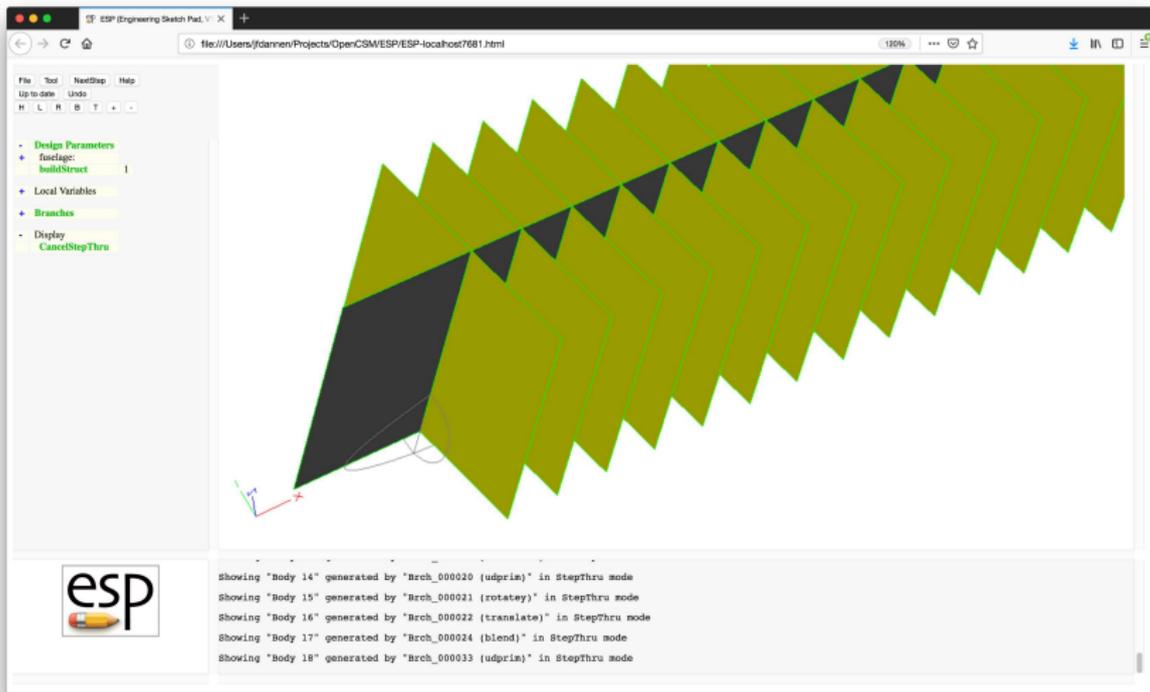
File Tool NextStep Help
Up-to-date Undo
H L R B T +

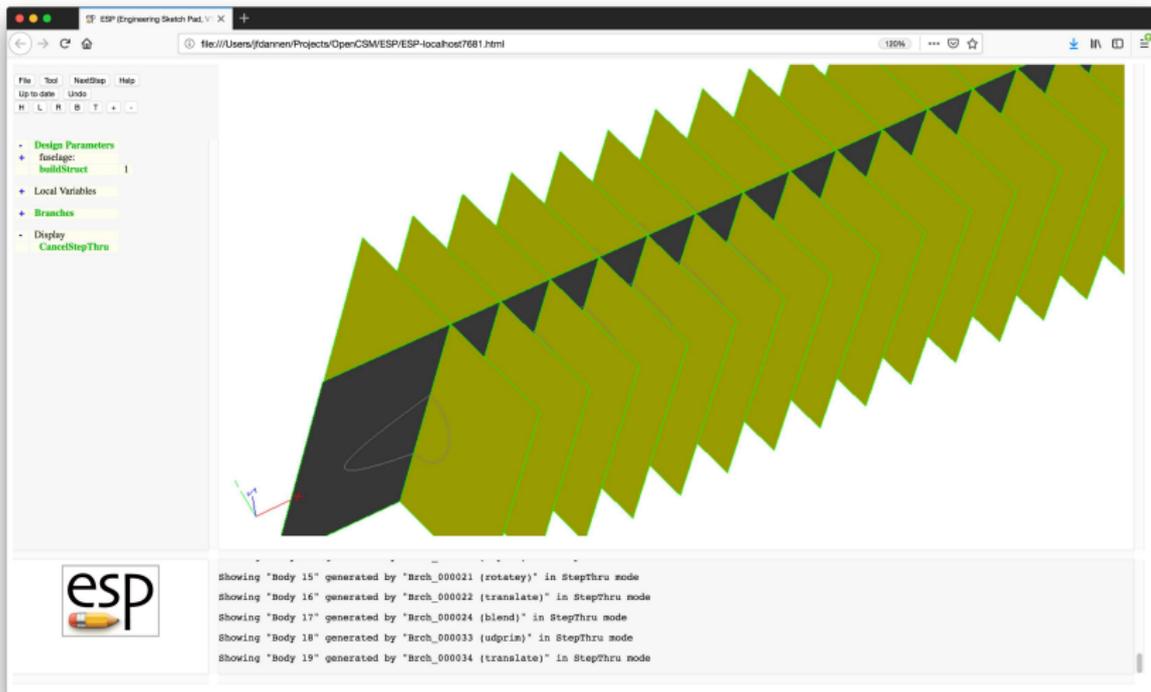
- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - CancelStepThru

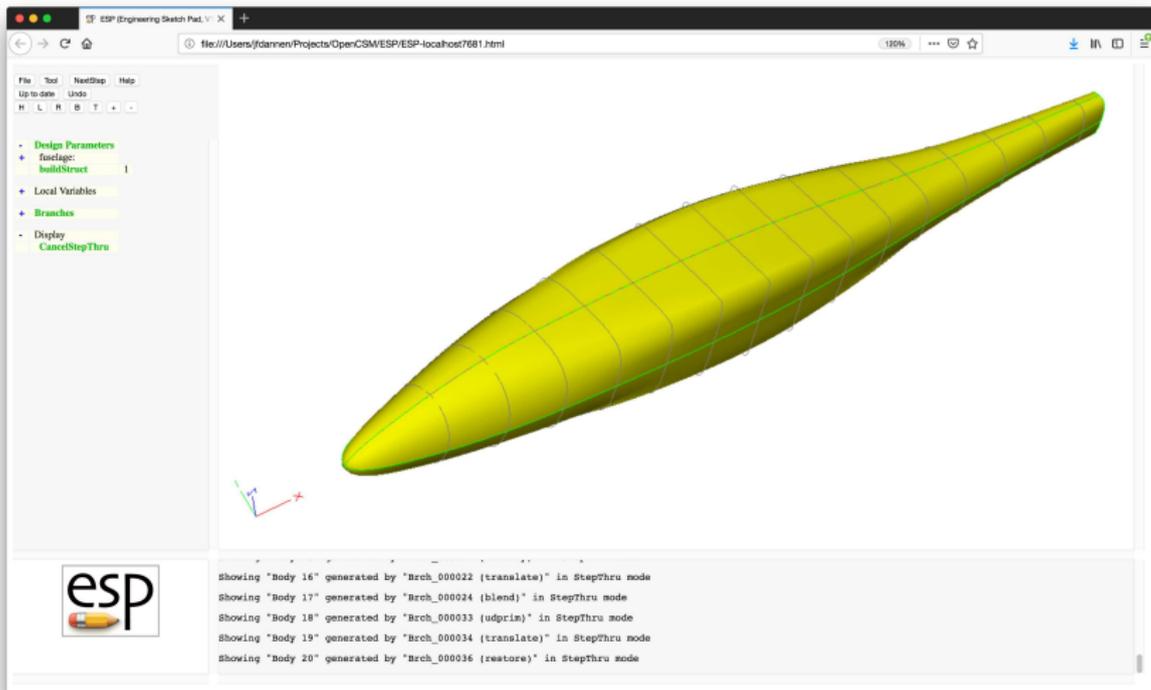
Showing "Body 11" generated by "Brch_000012 (udprism)" in StepThru mode
 Showing "Body 12" generated by "Brch_000013 (rotatey)" in StepThru mode
 Showing "Body 13" generated by "Brch_000014 (translate)" in StepThru mode
 Showing "Body 14" generated by "Brch_000020 (udprism)" in StepThru mode
 Showing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



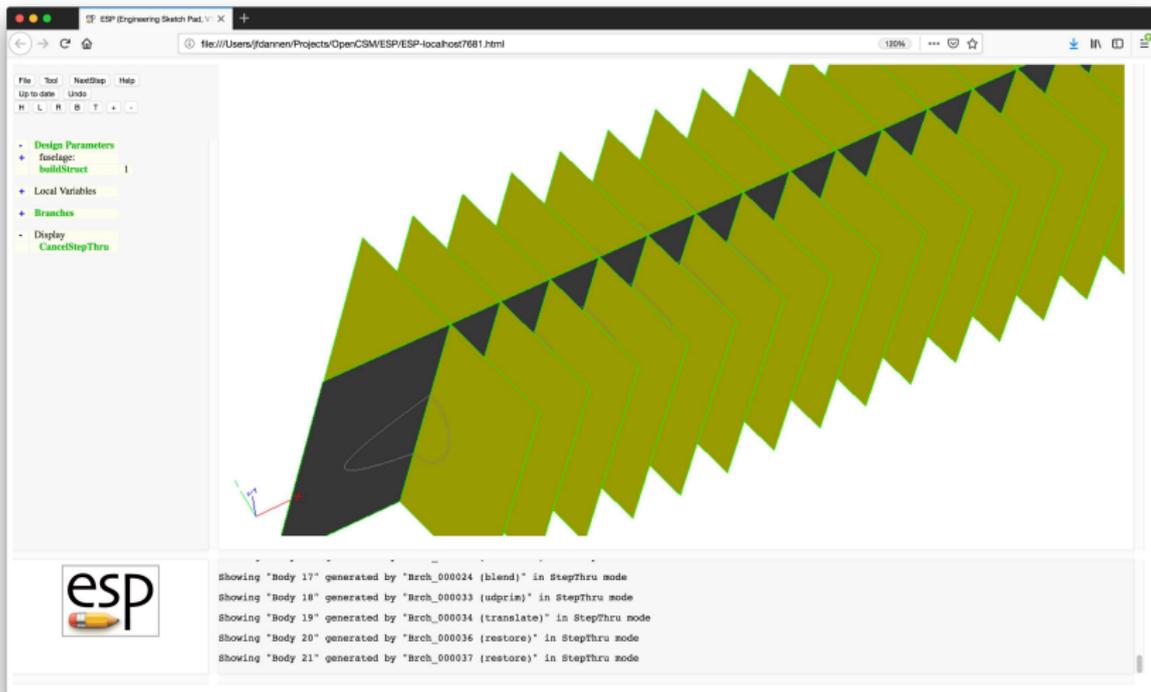








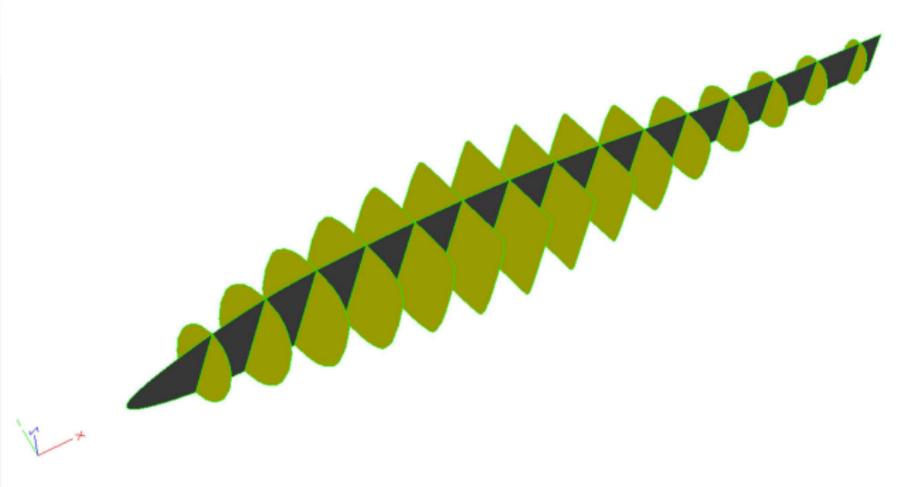
Showing "Body 16" generated by "Brch_000022 (translate)" in StepThru mode
 Showing "Body 17" generated by "Brch_000024 (blend)" in StepThru mode
 Showing "Body 18" generated by "Brch_000033 (udprim)" in StepThru mode
 Showing "Body 19" generated by "Brch_000034 (translate)" in StepThru mode
 Showing "Body 20" generated by "Brch_000036 (reatore)" 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

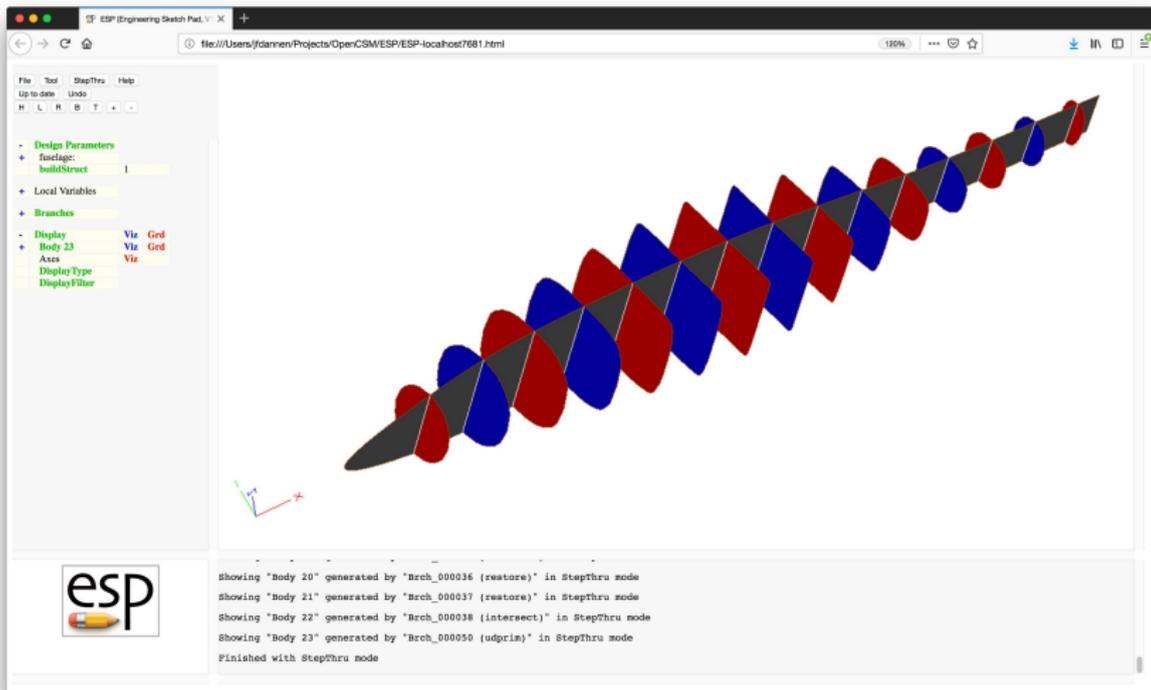
Showing "Body 17" generated by "Brch_000024 (blend)" in StepThru mode
 Showing "Body 18" generated by "Brch_000033 (udprin)" in StepThru mode
 Showing "Body 19" generated by "Brch_000034 (translate)" in StepThru mode
 Showing "Body 20" generated by "Brch_000036 (restore)" in StepThru mode
 Showing "Body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



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

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

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
 Showing "Body 22" generated by "Brch_000038 (intersect)" in StepThru mode



The screenshot shows the ESP (Engineering Sketch Pad) software interface. The main window displays a 3D model of a fuselage, which is a long, tapered, cylindrical shape. The fuselage is composed of several segments, each with a different color: red, blue, and grey. The segments are arranged in a sequence that tapers from left to right. The model is shown in a perspective view, with a coordinate system (x, y, z axes) visible in the bottom left corner of the main window.

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

- Design Parameters
 - fuselage:
 - buildStruct 1
- Local Variables
- Branches
- Display
 - Body 23 Viz Red
 - Axis Viz Red
 - DisplayType
 - DisplayFilter

```

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 (udprin)" 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 1
DIMENSION fuselage:zloc          fuselage:numXsect 1 1
DIMENSION fuselage:width         fuselage:numXsect 1 1
DIMENSION fuselage:height        fuselage:numXsect 1 1
DIMENSION fuselage:power         fuselage:numXsect 1 1
DIMENSION fuselage:noselist      2          4 1

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
```



Simple Fuselage — .csm File (2)

```
# 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
```

```
# 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

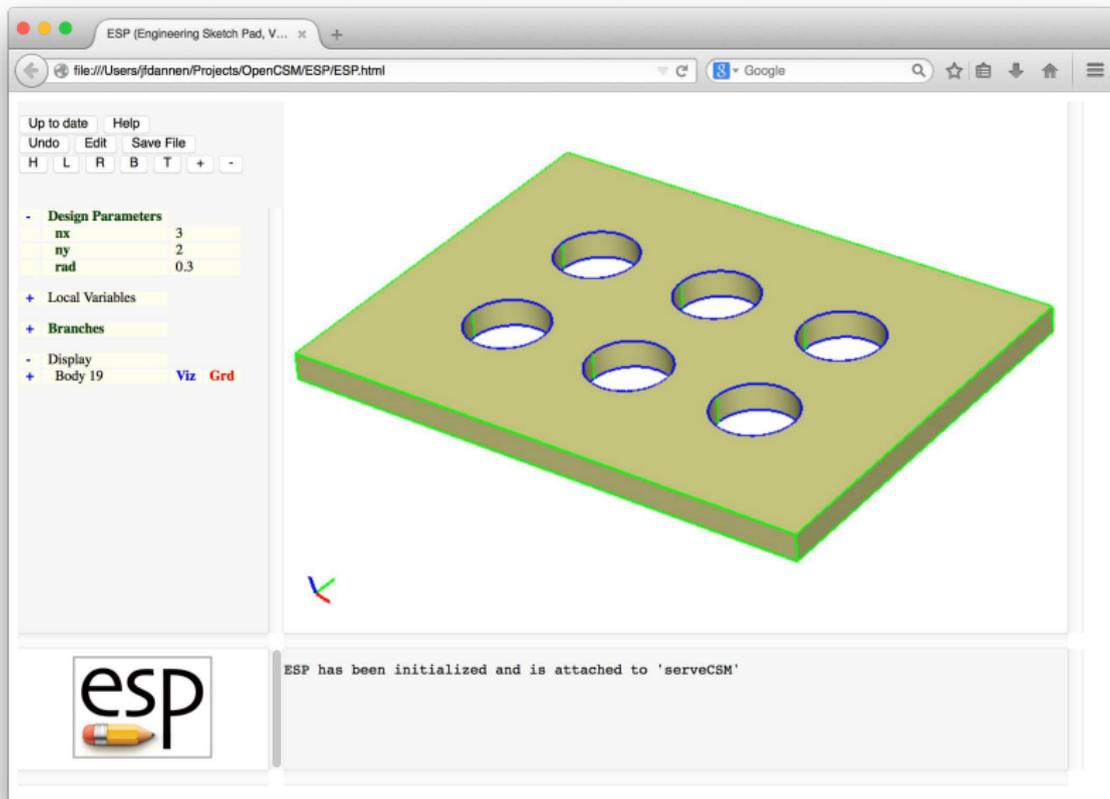
# make the bulkhead/symmetry Edges white
UDPRIM    editAttr  filename <<
    EDGE   ADJ2FACE  tagType=bulkhead
    AND    ADJ2FACE  tagType=symmetry
    SET    _color=white
>>

ENDIF

END
```

Session 5 Solutions

CSM Language (2)



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?

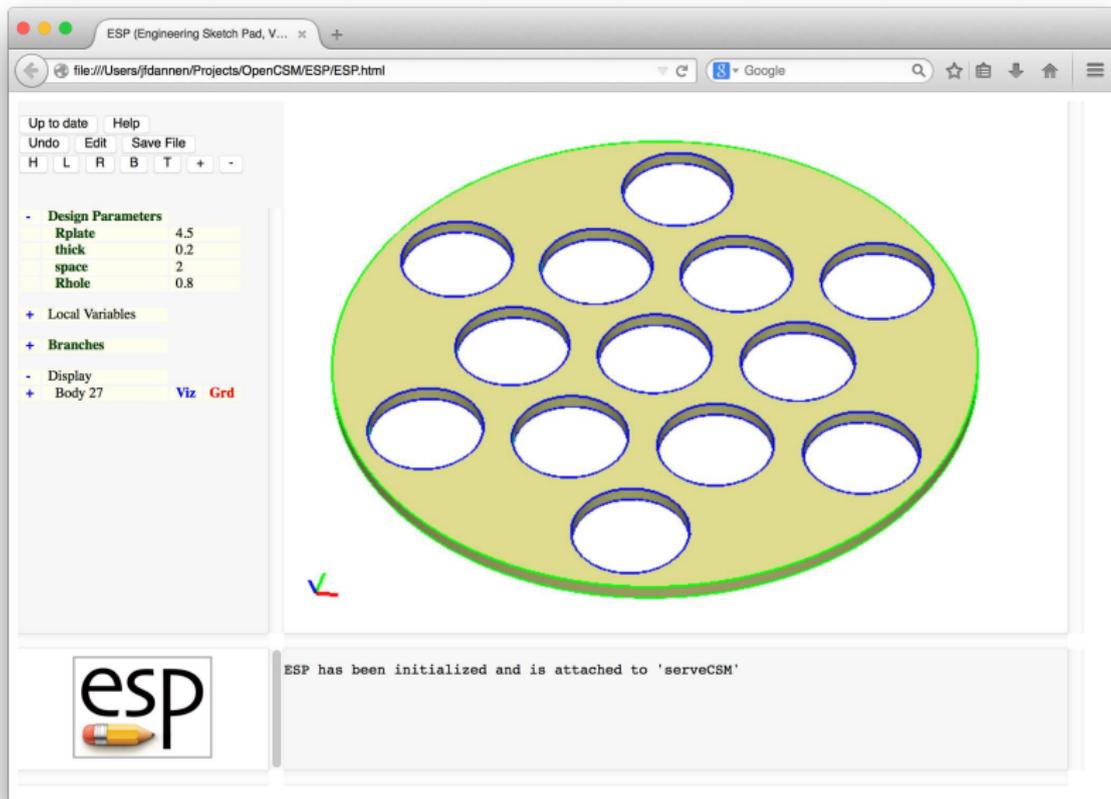
```
# rect_pat
# written by John Dannenhoffer

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...)

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

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_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
```

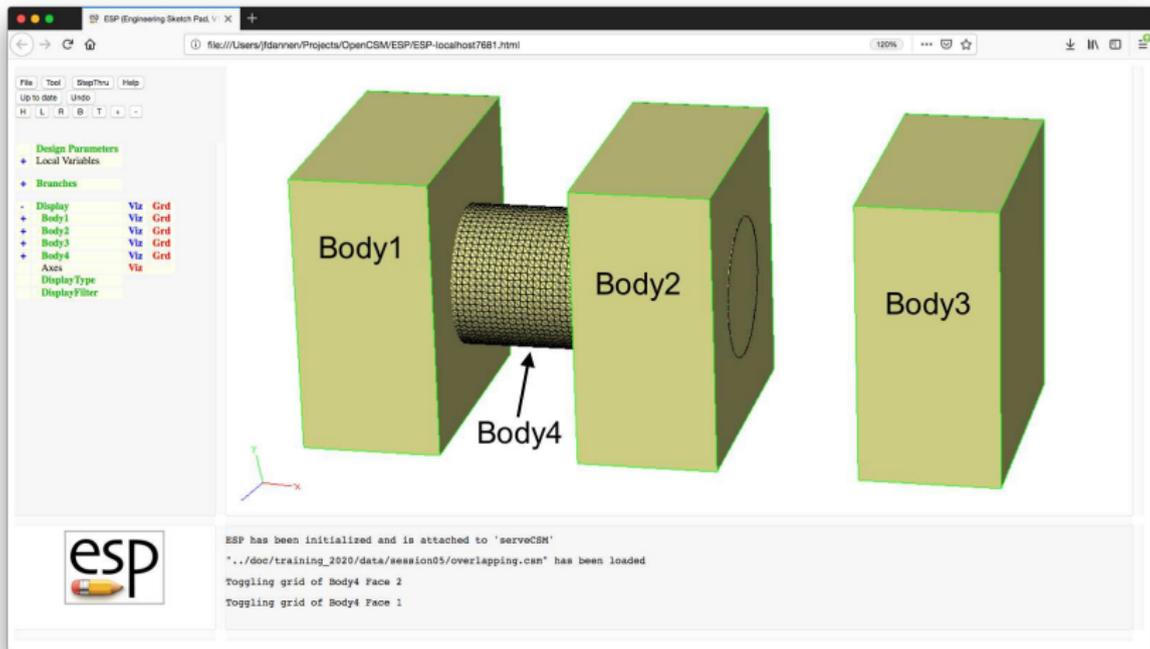
```
# pattern for holes
SET nr int(Rplate/space)

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 Bodys 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
```

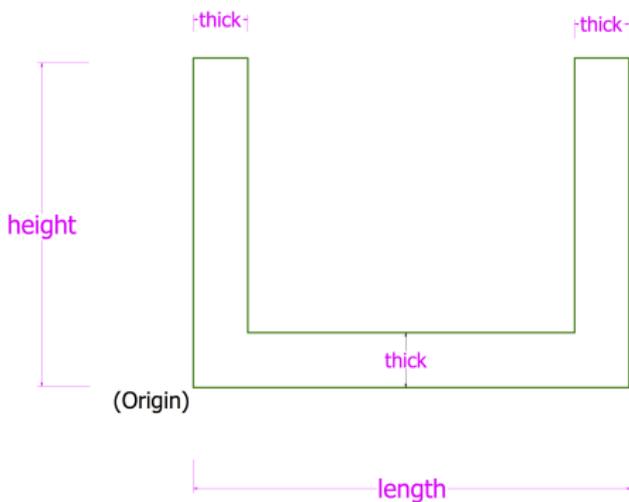
Session 7 Solutions

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
```



U-bracket (version 1)

Sketcher Solution

The screenshot displays the ESP Engineering Sketch Pad interface. The main workspace shows a green U-bracket sketch with yellow constraint labels: 'H1' for horizontal segments, 'V1' for vertical segments, and 'A1' for an angle constraint. The left sidebar contains a 'Design Parameters' tree with 'Local Variables' and 'Branches' (Brch_000001 to Brch_000017). Below the tree are 'Display' and 'Axis' options. The bottom console window shows the following text:

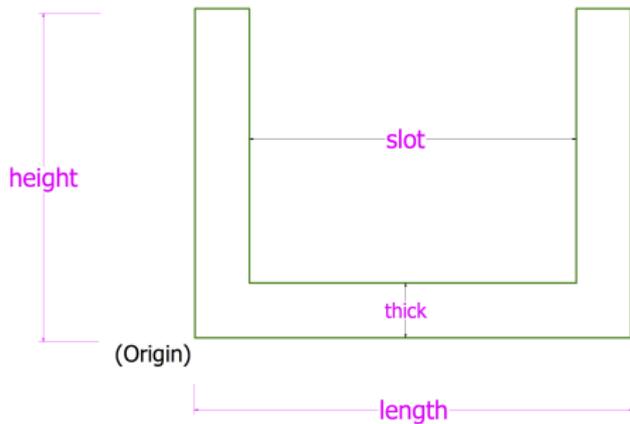
```
ndof=16 ncon=16
Valid constraints at points
'f' (fix x) 'y' (fix y)
'p' (perp) 't' (tangent)
'a' (angle)
'w' (width) 'd' (depth)
Valid constraints on segments
'h' (horiz) 'v' (vertical)
'l' (colline) 'l' (length)
Valid constraints on circles
```

ESP has been initialized and is attached to 'nerveCDN'
'../data/training/session02/Ubracket1.csm' has been loaded



U-bracket (version 2)

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)

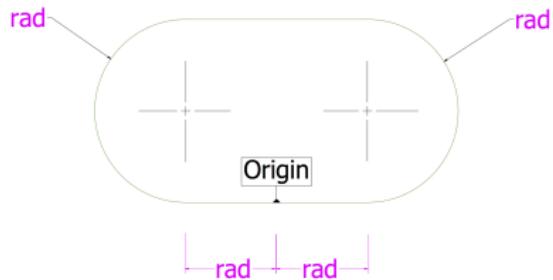
Sketcher Solution

The screenshot displays the ESP Engineering Sketch Pad interface. The main workspace shows a green U-bracket sketch with yellow dimension lines and labels: 'H' for height, 'W' for width, 'R' for radius, and 'L' for length. The left sidebar contains a tree view with sections for Design Parameters, Local Variables, Branches, Display, Axis, and Display Filter. The bottom console window shows the following text:

```
ndof=16 ncon=16
Valid constraints at points
'f' (fix x) 'y' (fix y)
'p' (perp) 't' (tangent)
'a' (angle)
'w' (width) 'd' (depth)
Valid constraints on segments
'l' (horiz) 'v' (vertical)
'l' (incline) 'l' (length)
Valid constraints on circles
'...
```

Below the console, a message states: "ESP has been initialized and is attached to 'nerveCDN'". A file path is also visible: ".../data/training/session02/Ubracket2.esm" has been loaded.

Problem

**Measurements:**

rad = 0.50

```

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 Pad interface. The main workspace shows a green oval-shaped sketch with several yellow constraint markers (S, P, A, W, H, L, I) placed at key points and segments. The left sidebar contains a tree view with sections for Design Parameters, Local Variables, Branches, and Display. The bottom status bar shows initialization messages and a list of valid constraints.

Design Parameters:

- Branch_000001: skbeg
- Branch_000002: skend
- Branch_000011: select
- Branch_000022: ascert
- Branch_000023: ascert
- Branch_000024: ascert
- Branch_000025: ascert
- Branch_000026: ascert
- Branch_000027: ascert
- Branch_000028: ascert
- Branch_000029: ascert
- Branch_000030: ascert

Display:

- Body 7: Via Grid
- Axis: Via Grid
- Display Type: Display Filter

Valid constraints at points:

- 'f' (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 'nerveCAD'
 ".../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
```



Biconvex airfoil (with arcs)

Sketcher Solution

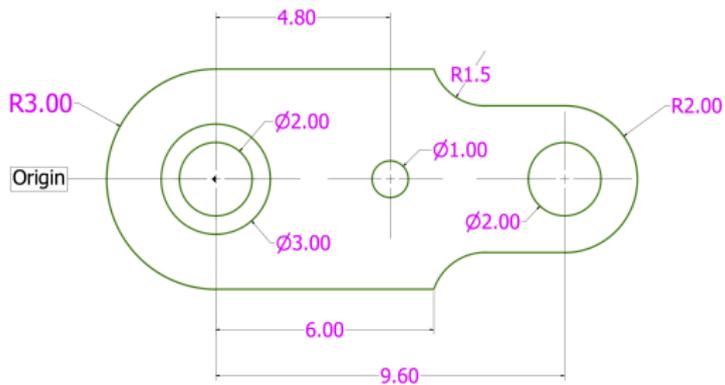
The screenshot displays the ESP Engineering Sketch Pad interface. The main workspace shows a green biconvex airfoil sketch centered on a coordinate system. The left sidebar contains a tree view with the following sections:

- Design Parameters
- Local Variables
- Branches
 - Brch_000001 skbeg
 - Brch_000011 skend
 - Brch_000012 select
 - Brch_000013 ascert
 - Brch_000014 ascert
 - Brch_000015 ascert
 - Brch_000016 ascert
 - Brch_000017 ascert
 - Brch_000018 ascert
 - Brch_000019 ascert
 - Brch_000020 ascert
 - Brch_000021 ascert
- Display
 - Body 4 Via Grid
 - Axes Via Grid
 - Display Type
 - Display Filter

The bottom status bar contains the following text:

```
ndof=6 ncos=6
Valid constraints at points
'f' (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
```

ESP has been initialized and is attached to 'nerveCDN'
".../data/training/session02/biconvex_aros.csm" has been loaded



ESP Engineering Sketch Pad v. X

file://Users/dannen/Projects/OpenCSME/ESP-localhost7661.html

File Search Step/Trg Help

Home/Tools Undo

H L R B T +

Design Parameters

Local Variables

Branches

- Brch_000001 sketch
- Brch_000001 skelnd
- Brch_000002 extrude
- Brch_000003 cylinder
- Brch_000004 subtract
- Brch_000005 chamfer
- Brch_000006 cylinder
- Brch_000007 subtract
- Brch_000008 cylinder
- Brch_000009 subtract
- Brch_000010 offset
- Brch_000011 ascent
- Brch_000012 ascent
- Brch_000013 ascent
- Brch_000014 ascent
- Brch_000015 ascent
- Brch_000016 ascent
- Brch_000017 ascent
- Brch_000018 ascent
- Brch_000019 ascent

Display Via Gnd

Body 18 Via Gnd

Axis Via Gnd

DisplayType

DisplayFilter

ndof=20 ncon=20

Valid constraints at points

- 'x' (fix x) 'y' (fix y)
- 'p' (perp) 't' (tangnt)
- 'a' (angle) 'l' (ltagmt)
- 'w' (width) 'd' (depth)

Valid constraints on segments

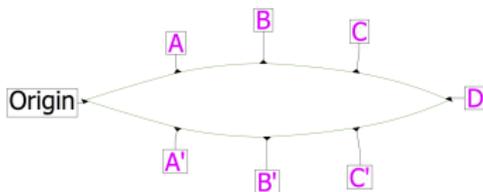
- 'h' (horiz) 'v' (vertical)
- 'l' (incline) 'l' (length)

Valid constraints on circles

ESP has been initialized and is attached to 'nerveCD'

"../data/training/session02/swivelbase.csm" has been loaded

Problem



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



Biconvex Airfoil (with splines)

Sketcher Solution

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

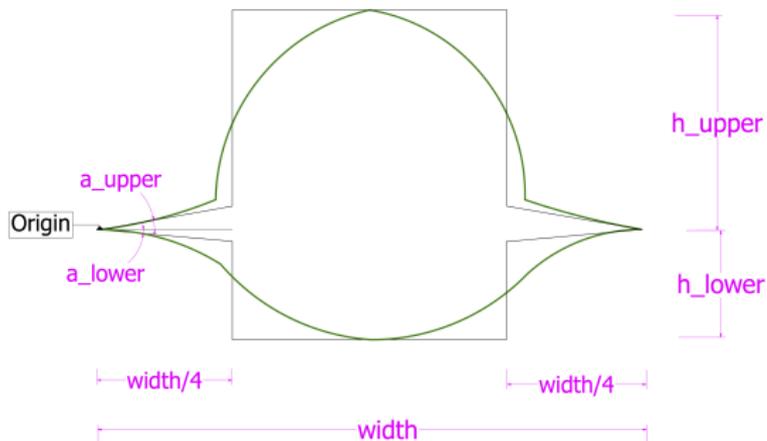
- Design Parameters
- Local Variables
- Branches
 - Brch_000001 sk/leg
 - Brch_000030 sk/crd
 - Brch_000031 reflect
 - Brch_000032 assect
 - Brch_000033 assect
 - Brch_000034 assect
 - Brch_000035 assect
 - Brch_000036 assect
 - Brch_000037 assect
 - Brch_000038 assect
 - Brch_000039 assect
 - Brch_000040 assect
- Display
 - Body 11 Via Crd
 - Axis Via Crd
 - DisplayType
 - DisplayFilter

The bottom status bar shows the following text:

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

ESP has been initialized and is attached to 'nerveCDN'
'../data/training/session02/biconvex_spline.oss' has been loaded

Problem

**Measurements:**

$width = 5.00$
 $h_{upper} = 2.00$
 $h_{lower} = 1.00$
 $a_{upper} = 10^\circ$
 $a_{lower} = 5^\circ$

Note:

4 Bezier Cubics



Fuselage X-section (with Beziers)

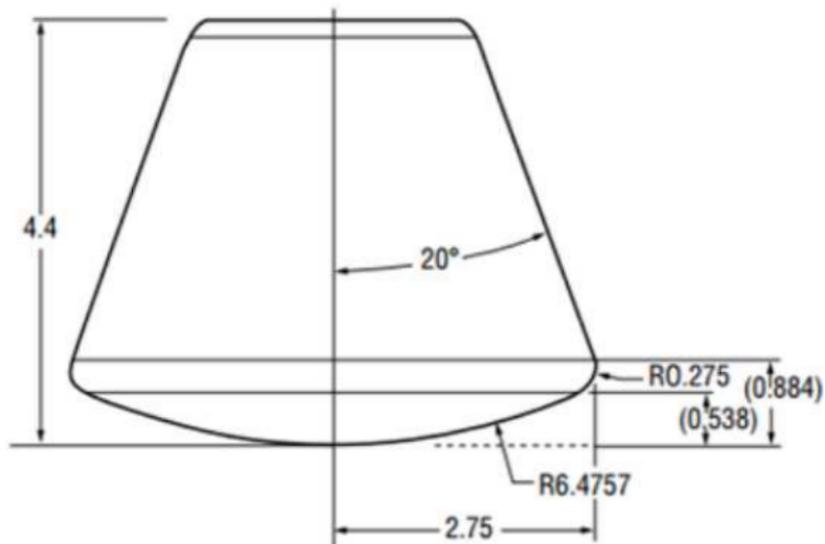
Sketcher Solution

The screenshot displays the ESP Engineering Sketch Pad interface. The main workspace shows a green fuselage X-section sketch with a central horizontal axis labeled 'XZ' and a vertical axis labeled 'YZ'. The sketch is defined by a series of Bezier curves and straight lines, with control points labeled 'H', 'X', 'M', 'Y', and 'D'. The left sidebar contains a 'Design Parameters' panel with a tree view of branches and local variables. The bottom status bar shows the following text:

```
ndof=26 ncon=26
Valid constraints at points
'f' (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
```

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

Problem



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

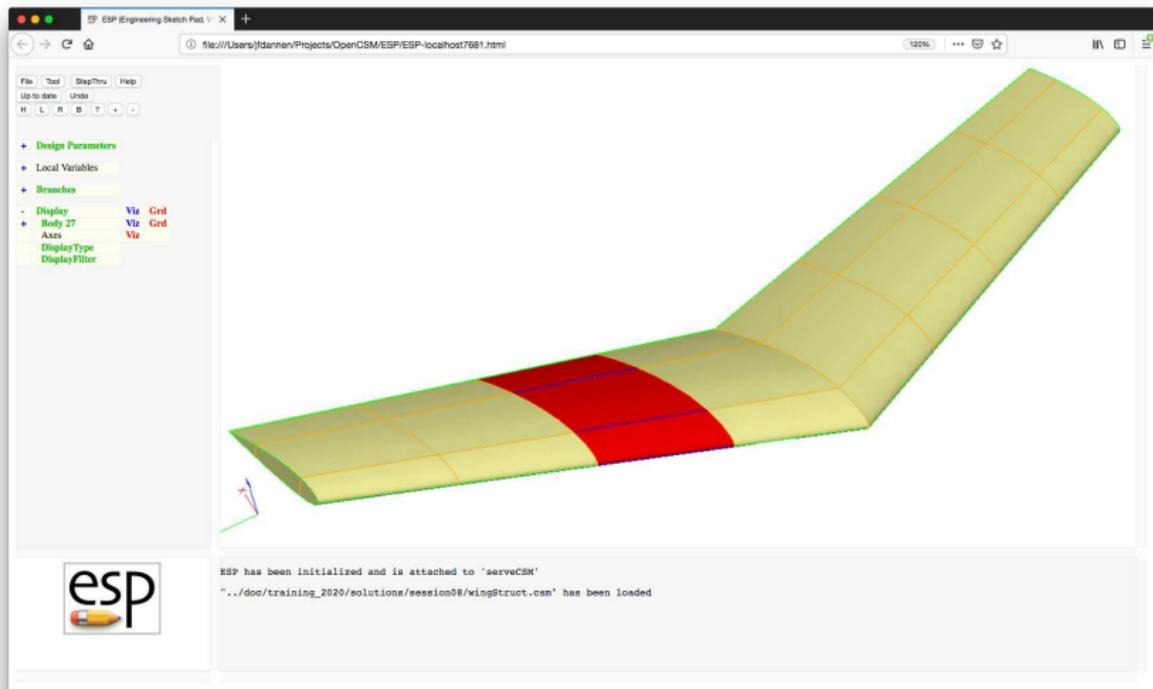
Session 8 Solutions

Selection & Attribution



Wing with structure

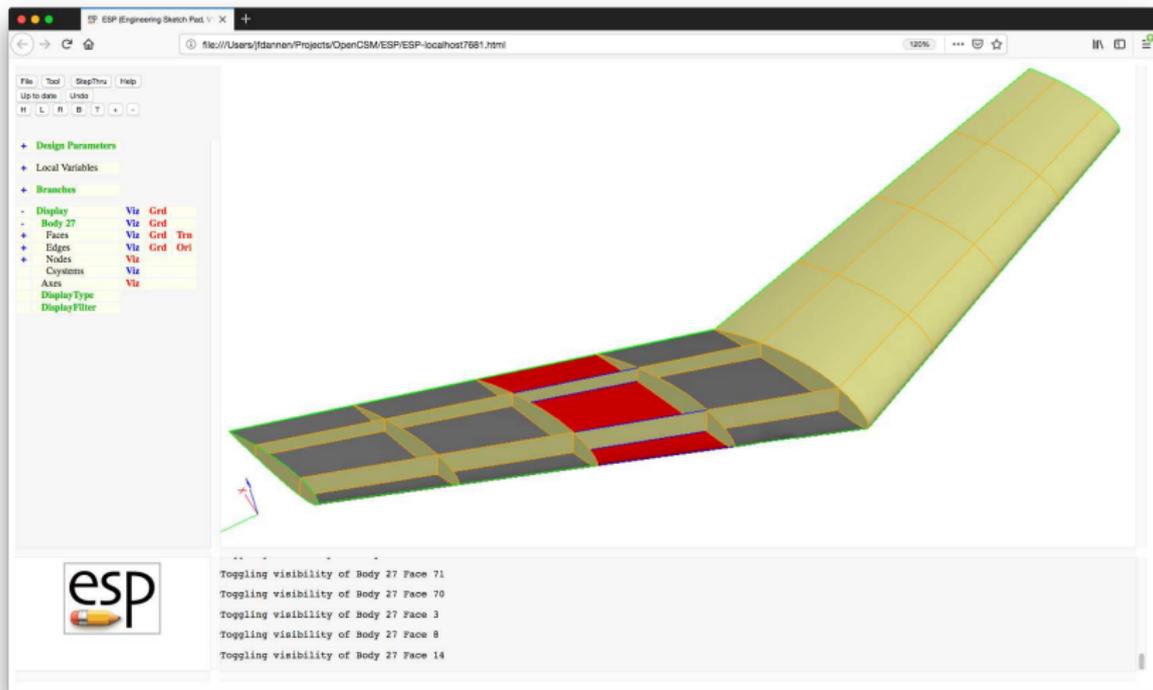
Structure is not shown





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:camber    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:alphan    -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
```



wingStruct.csm (5)

```
# 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

>>
```