HyperSizer...Design Right, Fly Light.

Recent HyperSizer design and analysis projects.

HyperFEA™

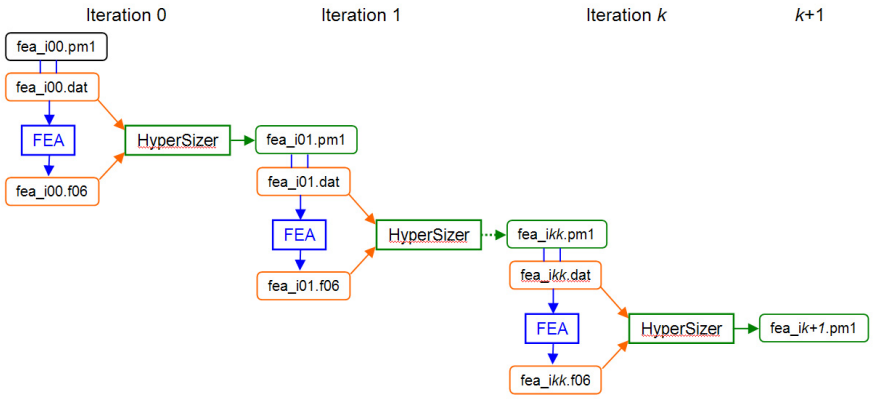
Automatic Iteration HyperSizer uses FEA computed element forces to size a structure's panels and beams. After optimizing a structure's cross sectional dimensions and selecting the optimum materials and composite layups with these forces, HyperSizer will generate the FEM data for the next iteration of FEA internal computed loads. This coupling process has in the past been manually iterated. Now with HyperFEA™, this process can be automatically iterated until convergence is achieved.

After updating the FEM element stiffnesses, HyperFEA submits the NASTRAN FEA solution, and reads the results for the next HyperSizer sizing optimization. HyperFEA also interactively plots weights of panels and beams as it iterates.

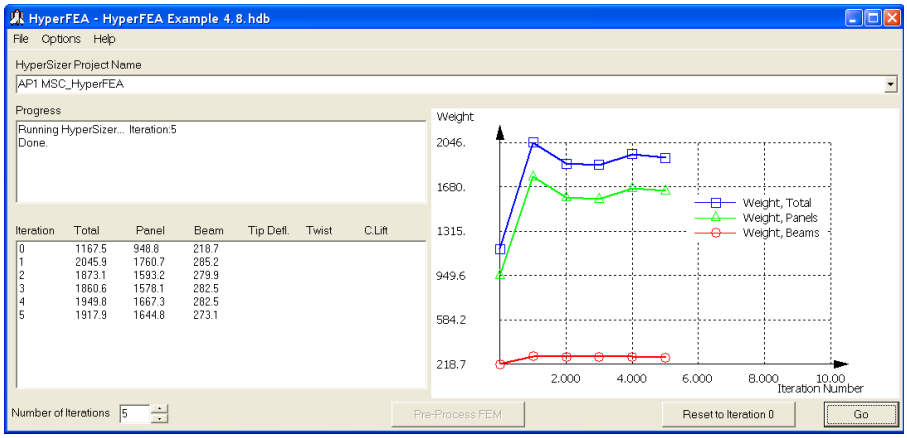
HyperSizer reads from the NASTRAN F06 file, the shell element (ex: CQUAD4) and beam element (ex: CBAR) forces. After sizing, HyperSizer generates NASTRAN PSHELL and MAT2 data that fully represents laminates, sandwich, and stiffened panels. This Property and Material data is contained in the *.PM1 file.

Pre Processing the FEM HyperFEA provides an option to "pre-processes" the FEM model file by moving all elements, loads, temperatures, properties, materials, etc. into separate files and replacing them in the original FEM file with "INCLUDE" statements. In the process, a file naming convention is adopted for tracking the iterations. This convention is to append "_i00", "_i01", "_i02", etc. to the FEM and FEA output file names to represent iterations 0, 1, 2,..respectively.

```
BEGIN BULK
$
PARAM,POST,-1
PARAM,OGEOM,NO
PARAM,AUTOSPC,YES
PARAM,GRDPNT,0
$
INCLUDE 'Ap1.PLOAD'
INCLUDE 'Ap1.FORCE'
INCLUDE 'Ap1.TEMP'
INCLUDE 'Ap1.SPC'
INCLUDE 'Ap1.GRID'
INCLUDE 'Ap1.SHEL'
INCLUDE 'Ap1_i00.PM1'
INCLUDE 'Ap1_i00.CL1'
$
ENDDATA
```



From the interface, the user can select the number of iterations to perform, or restart from the last iteration, or reset to iteration zero.



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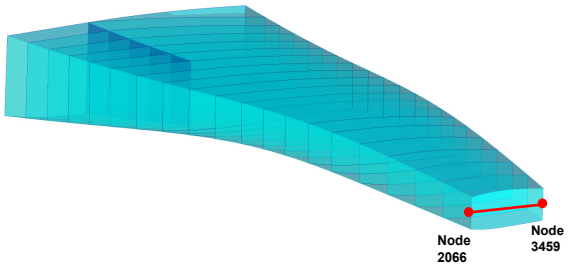
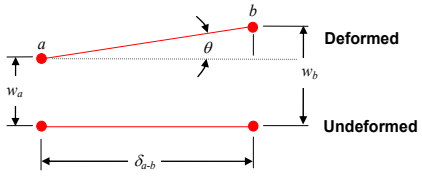
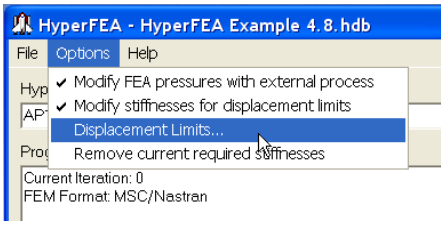
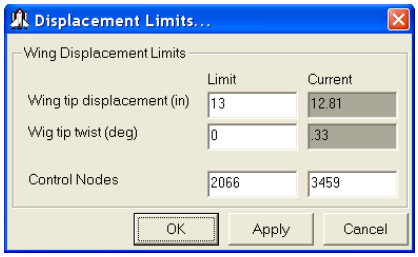
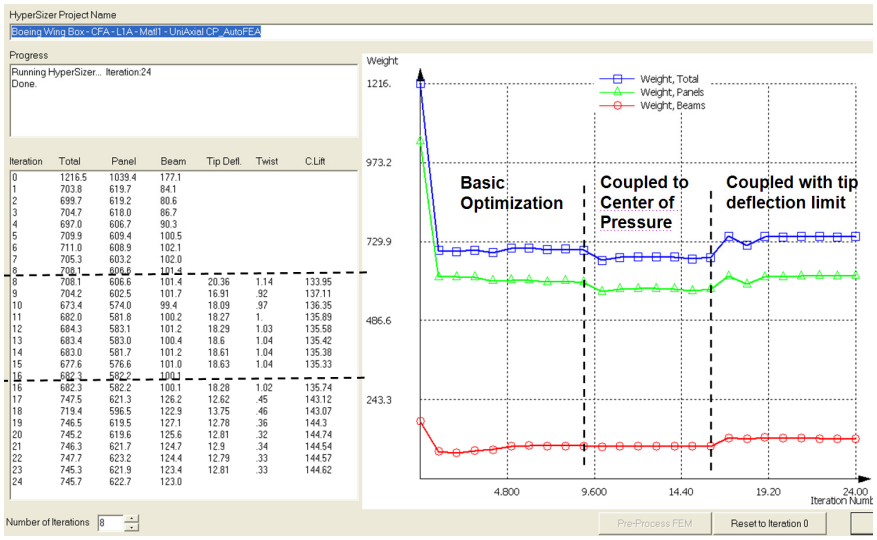




$$\theta = \tan^{-1}\left(\frac{w_b - w_a}{\delta_{a\to b}}\right)$$







Iteration	Total	Panel	Beam	Tip Defl.	Twist	C.Lift
0	1216.5	1039.4	177.1			
1	703.8	619.7	84.1			
2	699.7	619.2	80.6			
3	704.7	618.0	86.7			
4	697.0	606.7	90.3			
5	709.9	609.4	100.5			
6	711.0	608.9	102.1			
7	705.3	603.2	102.0			
8	708.1	606.6	101.4			
8	708.1	606.6	101.4	20.36	1.14	133.95
9	704.2	602.5	101.7	16.91	.92	137.11
10	673.4	574.0	99.4	18.09	.97	136.35
11	682.0	581.8	100.2	18.27	1.	135.89
12	684.3	583.1	101.2	18.29	1.03	135.58
13	683.4	583.0	100.4	18.6	1.04	135.42
14	683.0	581.7	101.2	18.61	1.04	135.38
15	677.6	576.6	101.0	18.63	1.04	135.33
16	682.3	582.2	100.1			
16	682.3	582.2	100.1	18.28	1.02	135.74
17	747.5	621.3	126.2	12.62	.45	143.12
18	719.4	596.5	122.9	13.75	.46	143.07
19	746.5	619.5	127.1	12.78	.36	144.3
20	745.2	619.6	125.6	12.81	.32	144.74
21	746.3	621.7	124.7	12.9	.34	144.54
22	747.7	623.2	124.4	12.79	.33	144.57
23	745.3	621.9	123.4	12.81	.33	144.62
24	745.7	622.7	123.0			

Wing Box Optimization Example

HyperFEA has been customized for aircraft wing box applications to include controlling the wing tip deflection and twist, and for updating the external pressure distribution (Center of Lift) as a function of the wing twist. Wing tip deflection and twist are determined by reading FEM displacements at user identified “control-grids”.

HyperFEA controls the wing tip deflection with the panel’s membrane A_{11} stiffness term or with the beam’s EA. Wing twist is controlled with the panel’s in-plane shear stiffness, A_{33}. HyperFEA mimics the process of a NASTRAN Sol 200 to determine these stiffness targets and mimics the process of a coupled CFD analysis to know how the center of wing lift varies based on its elastic twist.

This iterative convergence is not history dependent, therefore at any iteration in the progressive design process, the user can change the design requirements from that given state, and move forward and get the correct answer usually within two more iterations to dampen out the step change. A new additional requirement such as a wing tip deflection or twist, or adding a higher fidelity analysis such as non-linear beam column or bonded joint strength, can be inserted into, or removed from the progressive design process at any iteration to quantify their weight impact.

In this wing box example, the iteration plot is broken into three sizing phases. Iterations 1-8 are performed without considering the effects of twist or deflection. Starting at Iteration 8, the external process of modifying pressure due to wing-tip twist is activated. Predictably, this results in a net reduction in load and a corresponding 4% reduction in weight. Starting on Iteration 16, a deflection limit of 13 inches is imposed. While this imposes a 38% decrease in the current deflection result of 18", the overall resized weight is increased only 8% to meet this criteria.

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