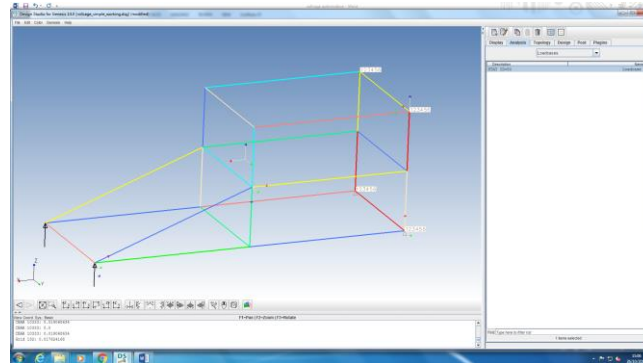
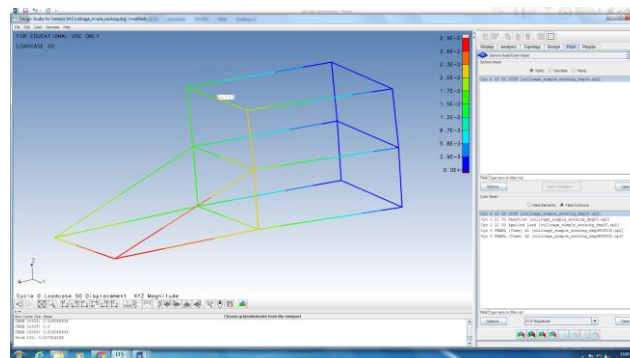


Spaceframe optimisation

The below shows a spaceframe that is loaded and constrained as shown;

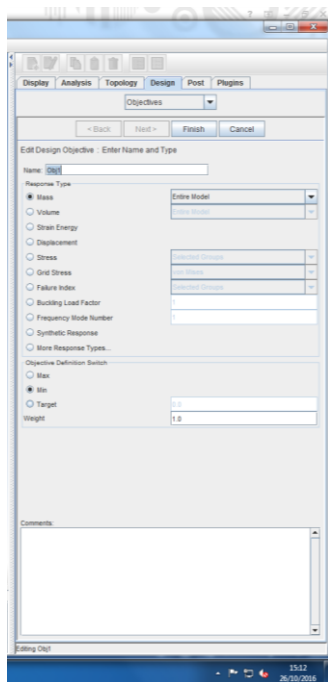


The purpose of this optimisation is to optimise the tube thicknesses and diameters to minimise the mass of this spaceframe whilst maintaining the displacement of grid 132 shown below

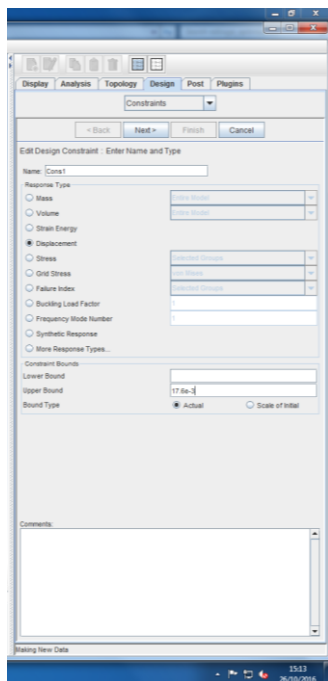


Note that initially this grid displaces by 17.6mm with all of the tubes at 50mm inside diameter and 2mm wall thickness.

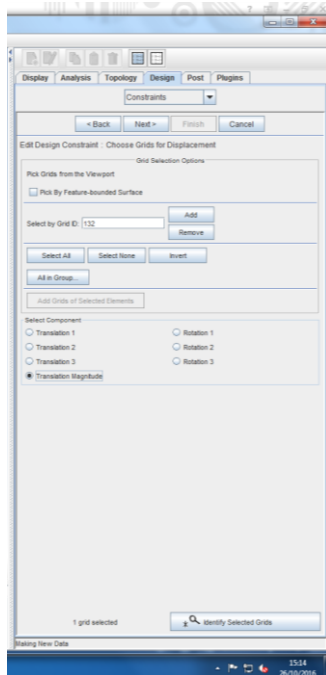
Thus the objective is to minimise mass



The constraint is a displacement constraint of 17.6mm

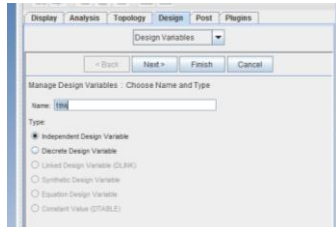


Applied to node 132 in 'translation magnitude'

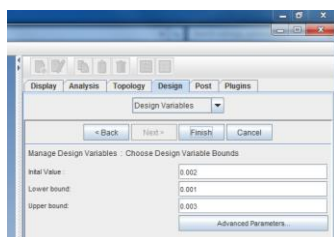


Note that there are 25 tubes therefore we need 50 variable (thickness and diameter for each tube)

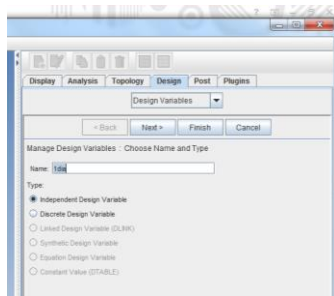
Initially we will look at independent design variable for the thickness



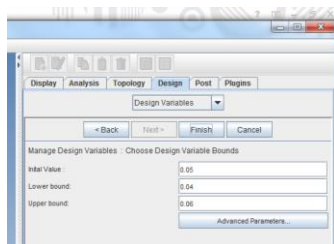
Such that the initial values are 2mm and the lower bound is 1mm whilst the upper bound is 3mm.



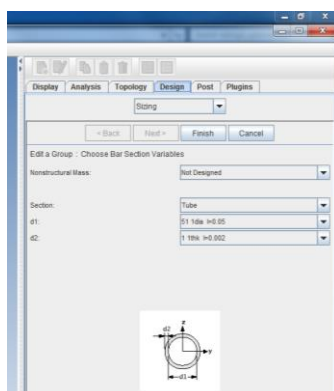
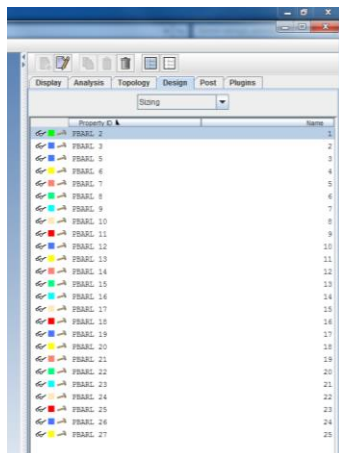
For the diameters initially we will also assume that these are independent variables



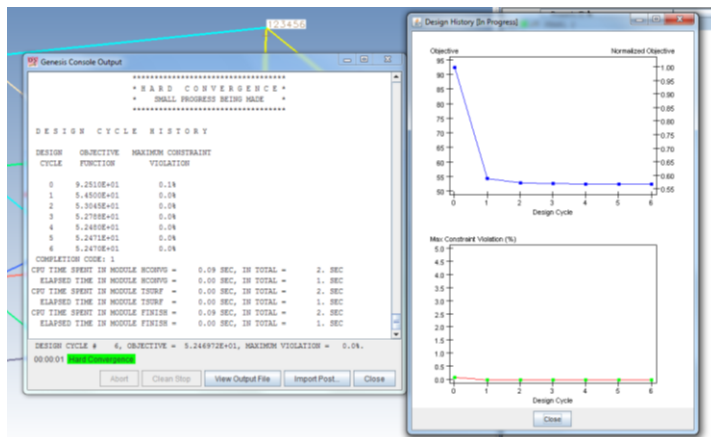
Such that the initial values are 50mm and the lower bound is 40mm whilst the upper bound is 50mm



We then need to point the tubes to the correct variables under sizing

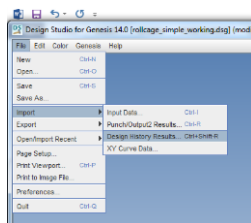


This should then optimise



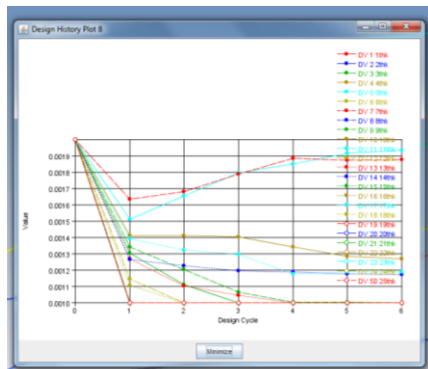
Note that this converges in 6 cycles and 1 second

Read the *HIS file in



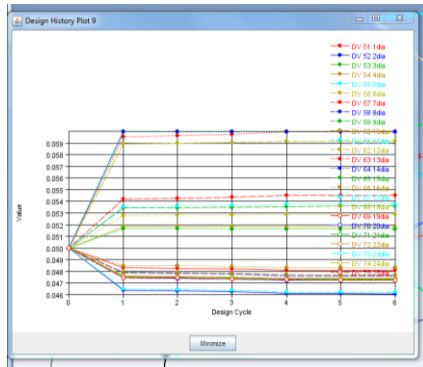
Go to post>design history plot

If we look at the tube diameters we see the following



Initially they were all 2mm and some have reduced to 1mm by iteration 6 whilst others have remained at ~2mm.

The diameters are as follows



Note that all of the tubes start at 50mm and some increase to 60mm whilst others reduce to ~46mm.

If we open the *.HIS file in a text editor we see the following

```
DESIGN CYCLE # 0, OBJECTIVE = 9.251035E+01, MAXIMUM
LOCATION # 0.0
DESIGN VARIABLE # 1 = 2.000000E-03 1thk
DESIGN VARIABLE # 2 = 2.000000E-03 2thk
DESIGN VARIABLE # 3 = 2.000000E-03 3thk
DESIGN VARIABLE # 4 = 2.000000E-03 4thk
DESIGN VARIABLE # 5 = 2.000000E-03 5thk
DESIGN VARIABLE # 6 = 2.000000E-03 6thk
DESIGN VARIABLE # 7 = 2.000000E-03 7thk
DESIGN VARIABLE # 8 = 2.000000E-03 8thk
```

Initially the objective (mass) is 92.5kg and the violation is 0%.

By the 6 iteration this objective has reduced to 52.5kg and the violation is still 0%.

```
DESIGN VARIABLE # 71 = 4.728234E-02 21dia
DESIGN VARIABLE # 72 = 4.740679E-02 22dia
DESIGN VARIABLE # 73 = 4.725882E-02 23dia
DESIGN VARIABLE # 74 = 4.735178E-02 24dia
DESIGN VARIABLE # 75 = 4.725882E-02 25dia
DESIGN CYCLE # 6, OBJECTIVE = 5.251035E+01, MAXIMUM
VIOLATION # 0.0%
DESIGN VARIABLE # 1 = 1.000065E-03 1thk
DESIGN VARIABLE # 2 = 1.000162E-03 2thk
DESIGN VARIABLE # 3 = 1.000065E-03 3thk
DESIGN VARIABLE # 4 = 1.269546E-03 4thk
```

This means that node 132 is still displacing by 17.6mm but the mass has reduced from 92.5kg to 52.5kg – a reduction of 43%.

Note that this is not manufacturable. To ensure this we would need to specify discrete variables rather than independent variables.