

# UAV INLET DUCT

Using a Smart Tool that acts like a mandrel during cure solution to produce a UAV inlet duct with trapped geometry costs 47% less than a conventional multi-piece metal mandrel solution.



## PROBLEM

Fabricate a 52" long by 12" dia. inlet duct using a clean tooling solution with the lowest up front capital cost and equal or better composite part cost.

## OPPORTUNITY

Deliver a mandrel solution that requires lower up front cost than a multi-piece metal mandrel and can be deployed with both prepreg and dry carbon fiber with resin infusion to make the composite part.

## SOLUTION

A Smart Tool that acts as a mandrel during cure was used to produce a UAV inlet duct that has lower up front cost than a multi-piece mandrel, is compatible with both prepreg & dry carbon fiber/VARTM manufacturing, and resulted in equivalent composite part performance and lower cost.

## QUOTED SOLUTIONS

The customer was quoted both a multi-piece metal mandrel solution at \$75,000 and a Smart Tool that acts as a mandrel solution at \$40,000.

## SMART TOOLING PROCESS

The Smart Tool that acts as a mandrel had a release film pre-applied, allowing the layup process to begin right away. The Smart Tool is rigid at layup, allowing prepreg to be directly applied to the Smart Tool, making layup easy.

After lay up is finished, the applied prepreg and Smart Tool is vacuum bagged, and placed in an autoclave for a 9 hour cure cycle

Once the cure is complete, the consumable material is removed and the cured composite and Smart Tool are placed in an oven. Once the temperature is above 325°F (162°C), the Smart Tool that acts as a mandrel during cure is extracted from the composite part and put into a heated reforming mold, a vacuum bag is pulled through the Smart Tool and sealed to the mold, vacuum is applied, and the mold and Smart Tool are cooled, resulting in a Smart Tool with original geometric tolerance and ready to make another inlet duct.

## RESULTS

Overall, the Smart Tool solution that acts as a mandrel tooling cost was a 47% savings. The Smart Tools that act as mandrels during cure are also compatible with hand applied carbon

fiber prepreg, and hand-applied braided socks and vacuum-assisted resin transfer molding (VARTM). This flexibility allows the UAV inlet duct to be made with significant savings, and in this case, reduce composite part costs from about \$6,000 using hand applied prepreg, down to \$3,100 using dry carbon fiber and epoxy infusion, a 48% savings.

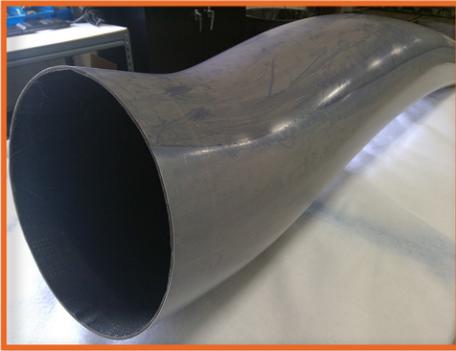


Smooth Inner Surface of Composite Part

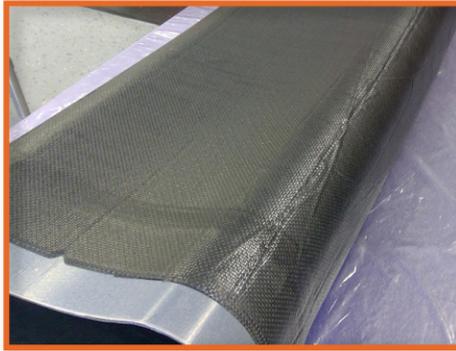


Finished Composite Part

## SMART TOOLING PROCESS



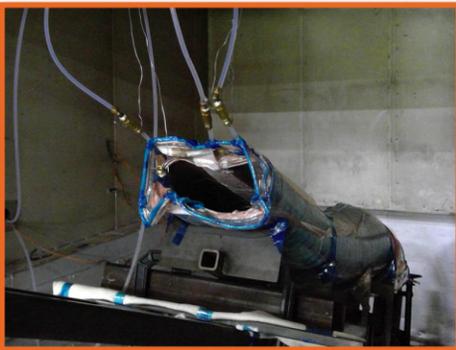
Rigid room-temperature Smart Tool with barrier-release film



Carbon fiber prepreg laid up on the Smart Tool



Laid up Smart Tool bagged and ready for cure in an autoclave



Smart Tool in the oven ready for infusion



Elastic Smart Tool being extracted from cured composite part



Extracted Smart Tool ready to be reformed

## COMPOSITE PART DETAILS

Composite Material	Carbon Epoxy
Process Method	1 - Hand applied prepreg with autoclave cure 2 - Dry carbon fiber sock and infused epoxy with oven cure
Layup Method	Hand Layup
Overall Dimensions	52" long x 12" dia.
Total Surfaces	12.63 sq. ft.
Composite Thickness	0.063