SMART TOOLING

SMART CAUL
CASE STUDY
PYLON FAIRING WITH TIGHT RADII

Using a Smart Tool that acts as a Caul to prevent bridging and pinching in tight corners by bypassing a female cavity mold and laying up on a rigid male Smart Tool that becomes elastic during cure for full compaction.

PROBLEM
Fabricate a pylon fairing with a tight radii while preventing bridging and pinching

OPPORTUNITY
Create a solution using a single male Smart Tool that acts as a caul instead of laying up in a female cavity mold

SOLUTION
A Smart Tool that acts as a caul during cure was combined with a OML cure mold, material was laid up directly on the Smart Caul, closed into the cure mold, autoclave cured, and demolded

THE PROBLEM
The trailing edge pylon fairing was a double contour 8 ply epoxy/carbon fiber laminate with epoxy/copper mesh and epoxy/fiberglass surface plies. Laminate contained a radius along the entire part length; the radius was not constant and changed from .40" to .12" (10.2mm to 3mm).

Laminate came with inherited aluminum female tooling for hand layup and vacuum bag autoclave cure. Carbon laminate containing complex radii and built on an inherited tool requiring layup into the female cavity created difficulties achieving proper ply consolidation and void prevention. The lay-up was a labor intensive process taking 6 hours to complete, and a 50% scrap rate occurred from program start due to inter-ply delamination.

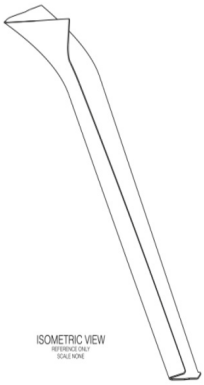
SMART TOOLING PROCESS
A Smart Caul was first vacuum assisted resin transfer was molded (VARTM) off a female carbon fiber caul master, allowing layup over a rigid male Smart Caul, instead of inside the female mold cavity.

Once the layup was complete (in reverse order) on the stiff male Smart Caul, it was dropped directly in the aluminum female mold. No transfer of the layup was necessary. Mold release film was used to cover the Smart Caul to ease the release from the cured laminate.

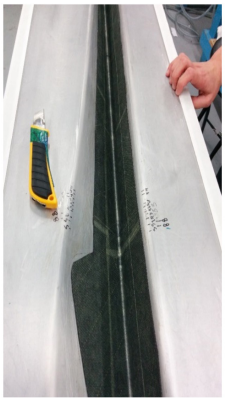
During cure, the Smart Caul becomes elastic and is pressured and translates the force to th elaminate and into the radii, sufficiently compacting and consolidating the laminate.

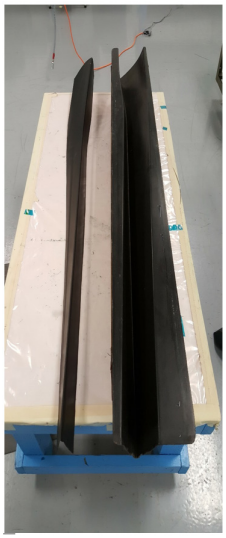
After de-molding, the Smart Caul was reformed under a vacuum bag at 250°F (121°C) in the caul master. The Smart Caul tooling process reduced scrap rate from 50%, to under 3% and labor hours from 6 to 2.

RESULTS
The Smart Caul tooling process significantly reduced scrap rate by 47% and labor hours by 300%. The Smart Caul tooling process also significantly reduced radius thickness and increased overall ply consolidation by 36%, resulting in the desired part nominal thickness. The improved consolidation of the part eliminated inter-ply delamination that was occurring with the previous tooling method.



Part Design


Previous layup method into female cavity


Demolded Smart Caul & composite part


How Smart Caul fits into female mold