# LOW-COST MANUFACTURING OF LARGE-SCALE HYDRODYNAMIC SURFACES

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## Objectives

- **Develop a Novel Manufacturing Technology to Manufacture Dimensionally Critical Hydrodynamically Smooth Lifting Surfaces for Naval Vessels.**

**=> Develop a Low Cost *VARTM* Composite Fabrication Technique**

## Manufacturing Approach

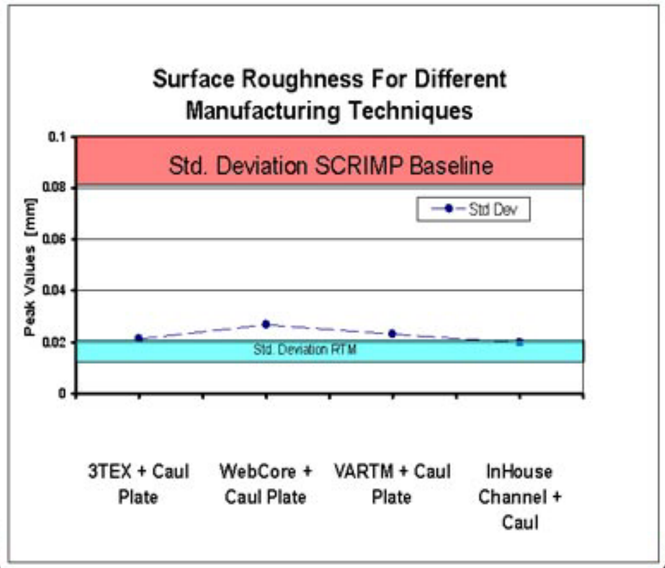
✓ No distribution media required
=> No imprint of distribution media(DM) on the non-mold side

✓ No additional infusion time required
=> Ensure complete wet-out during VARTM process

## Manufacturing concepts

- ❑ Preform Method
  - 3TEX Prefom material
- ❑ Core Concepts
  - Integrated channels
  - UD – CCM core-channel design
- ❑ Processing Technique
  - FASTRAC

## Down-Selection of Concepts




## Evaluation & Conclusion

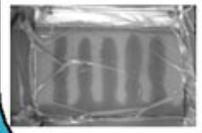
- Standard deviation of surface smoothness of RTM part and SCRIMP part is comparable

✓ RTM-like smooth surface parts can be achieved with several design concepts

✓ Use of caul plate is critical (rigid plastic plate used as caul plate)

✓ Improvement of surface smoothness quality requires new injection schemes to eliminate DM

## UD–CCM Core-Channel Design



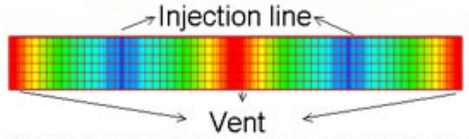
Infusion after 10 min

Dimensions for different channels

| width (mm) | 3 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| height (mm) | 10 | 5 | 5 | 5 | 5 |

- Flow behavior is comparable for all infusion channels
- Optimize width for
  - o Cutting
  - o Reduced resin waste
  - o Avoid less preform dumping into channel

## Alternating Injection Scheme and LIMS simulation




➢ Channels are designed to be alternating vents and injection lines

➢ All injection lines are opened at the same time

## Scale-Up for Twisted Rudder

❖ Caul plate (rigid rubber)

❖ Integrated alternating injection lines and vents along the depth of the rudder

❖ SMART-Molding allows for automated infusion

*¼ scale twisted rudder manufactured by Production Products*

## Conclusion

✓ Surface quality is comparable to RTM parts

✓ Large-scale parts can be infused with vacuum

✓ Injection time is shorted (approximately 30 minutes)

✓ Low-cost tooling(core is the tool) reduces cost

⇒ New low-cost process has been developed and shown potential forscale-up of large hydrodynamicsmooth surfaces