High Volume Preforming for Structural Applications using Engineering Fabrics

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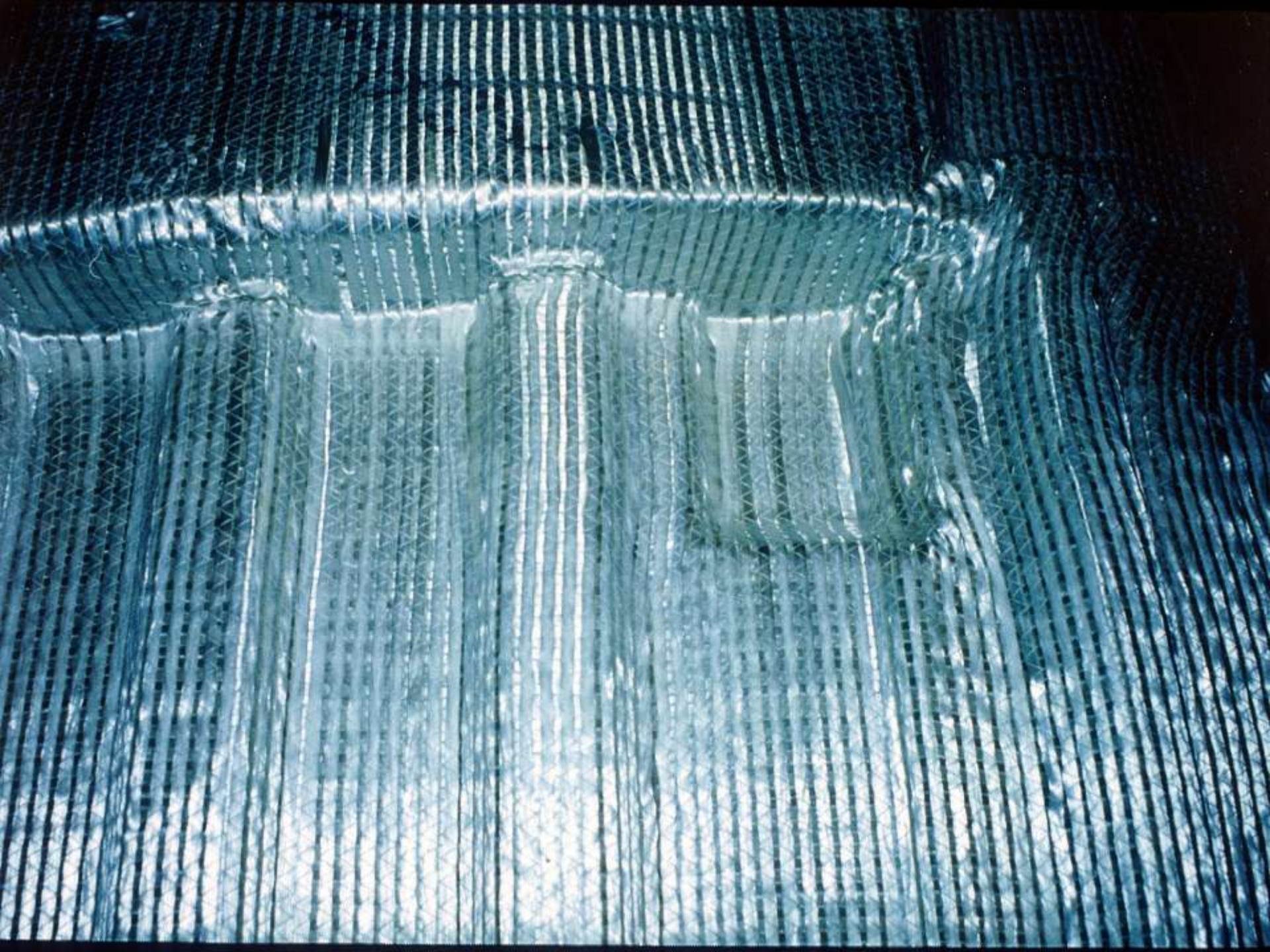
Where are Preforms Used

- Mid to High Volume Closed Molding
- All Liquid Composite Molding Processes
- RTM, SRIM, VARTM, Quickstep, VEC, ETC.
- RTM Lite, Resin Infusion
- Wet Compression Molding

Oriented Conformable Engineering Fabrics

- Simple Shapes Do not Require Preforming
- Can be Difficult to Handle
- Excellent for Preforming using Binders for Stabilization
- Excellent Physical Properties
- Can be Costly
- Superb for Structural Applications



CompForm

- Uses Light cure for Fiberglass Materials
- Uses New Binders for Carbon Fiber and Opaque Materials
- Target Markets are Automotive and Higher Volume Applications
- Very High degree of Process Flexibility
- Can be fully Automated

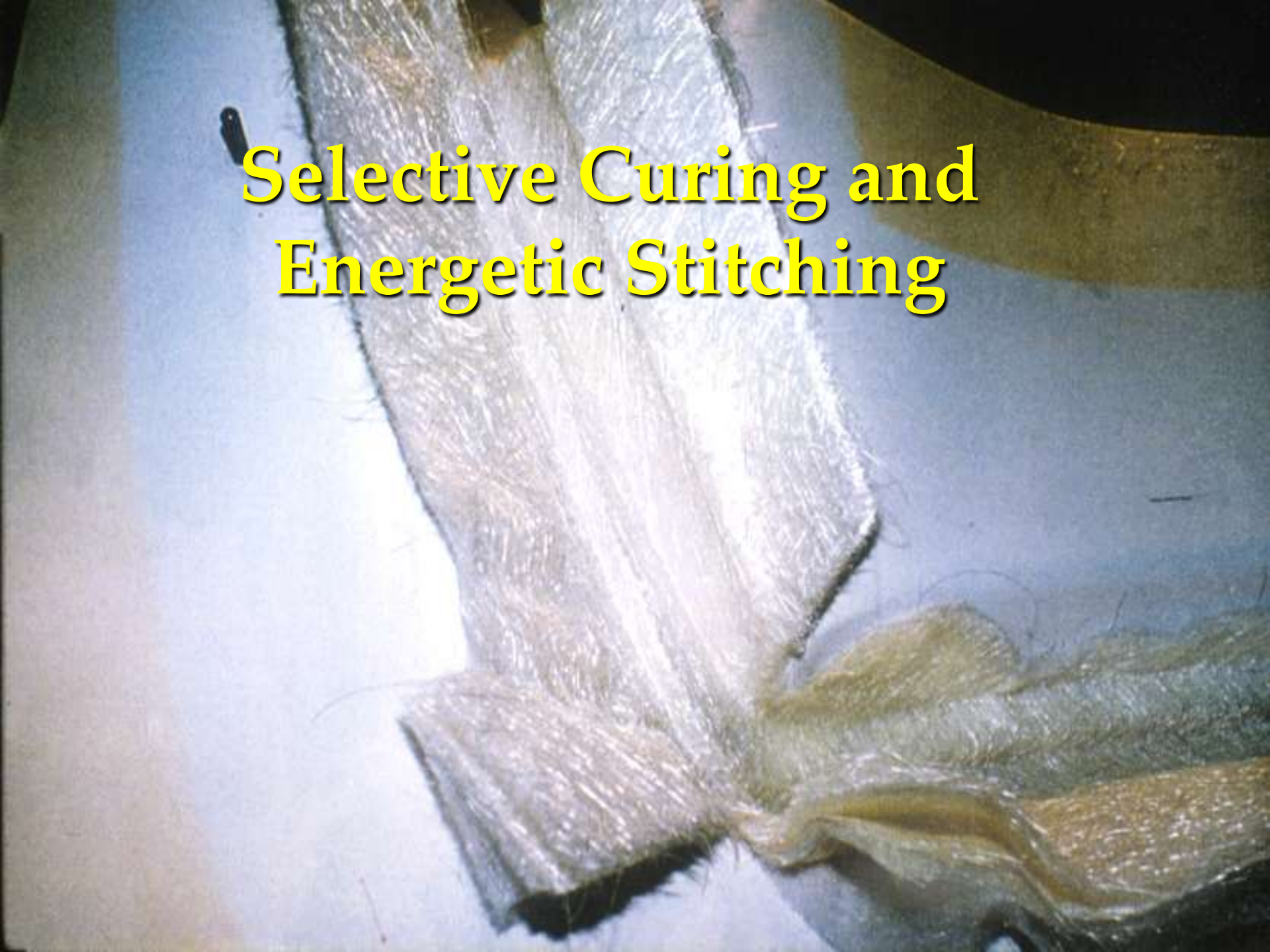
Light Cure, CompForm

- **Light Cure is Very fast and Efficient**
- **Works on all Fiberglass Materials**
  - Engineering Fabrics
  - Continuous and Chopped Strand Mats
  - All Veils
- **Works with Directed Fiber Preforming**
- **Selective Curing**

Light Cure, CompForm

- Energetic Stitching
- Complex Preforms
- Virtually no Heating of Materials
- Low Energy usage
- Flexible Cell Designs
- Binders are Compatible with all common Matrix Resins
- Can Preform behind and onto skins and films

Selective Curing

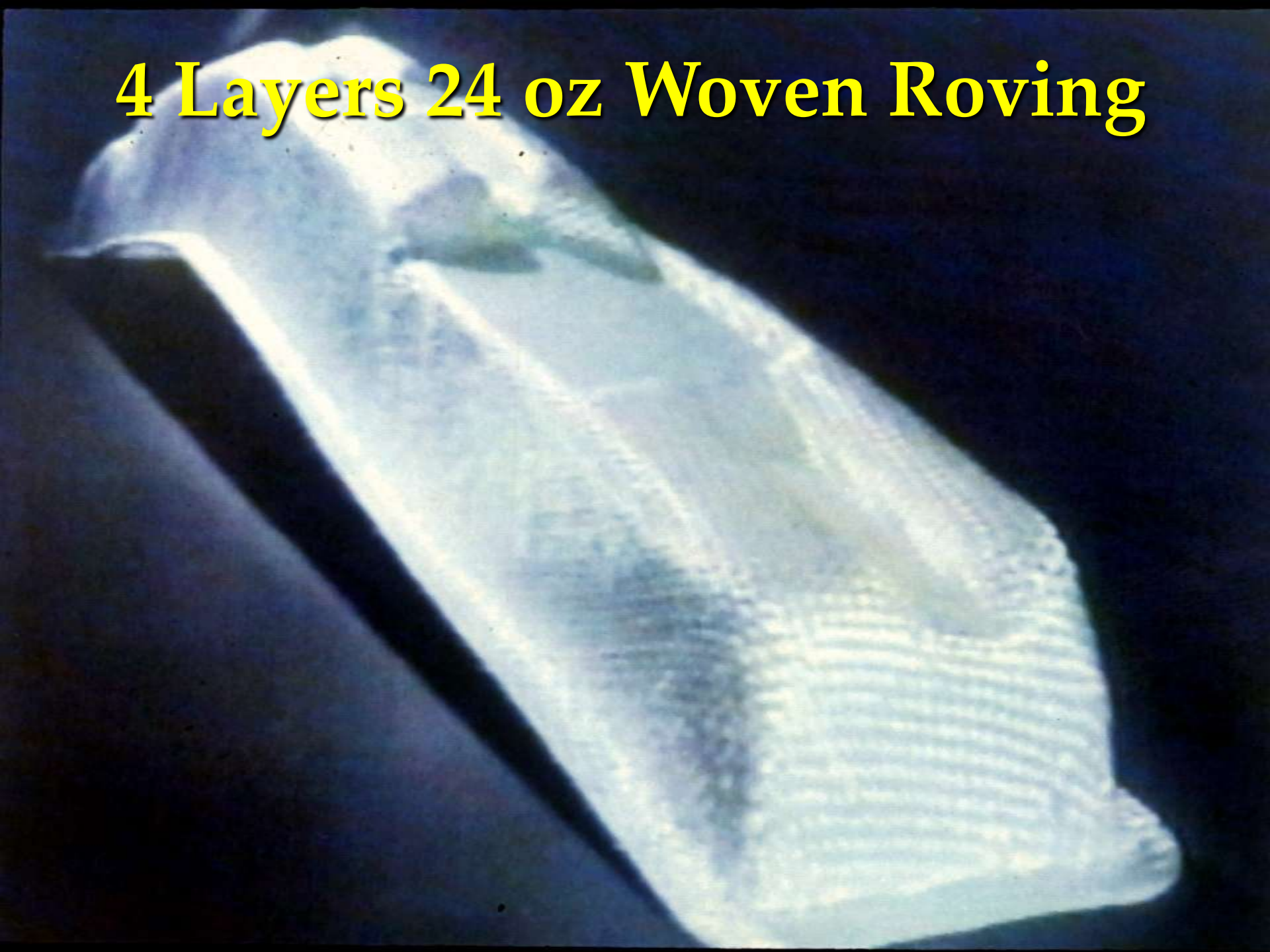

Selective Curing and
Energetic Stitching

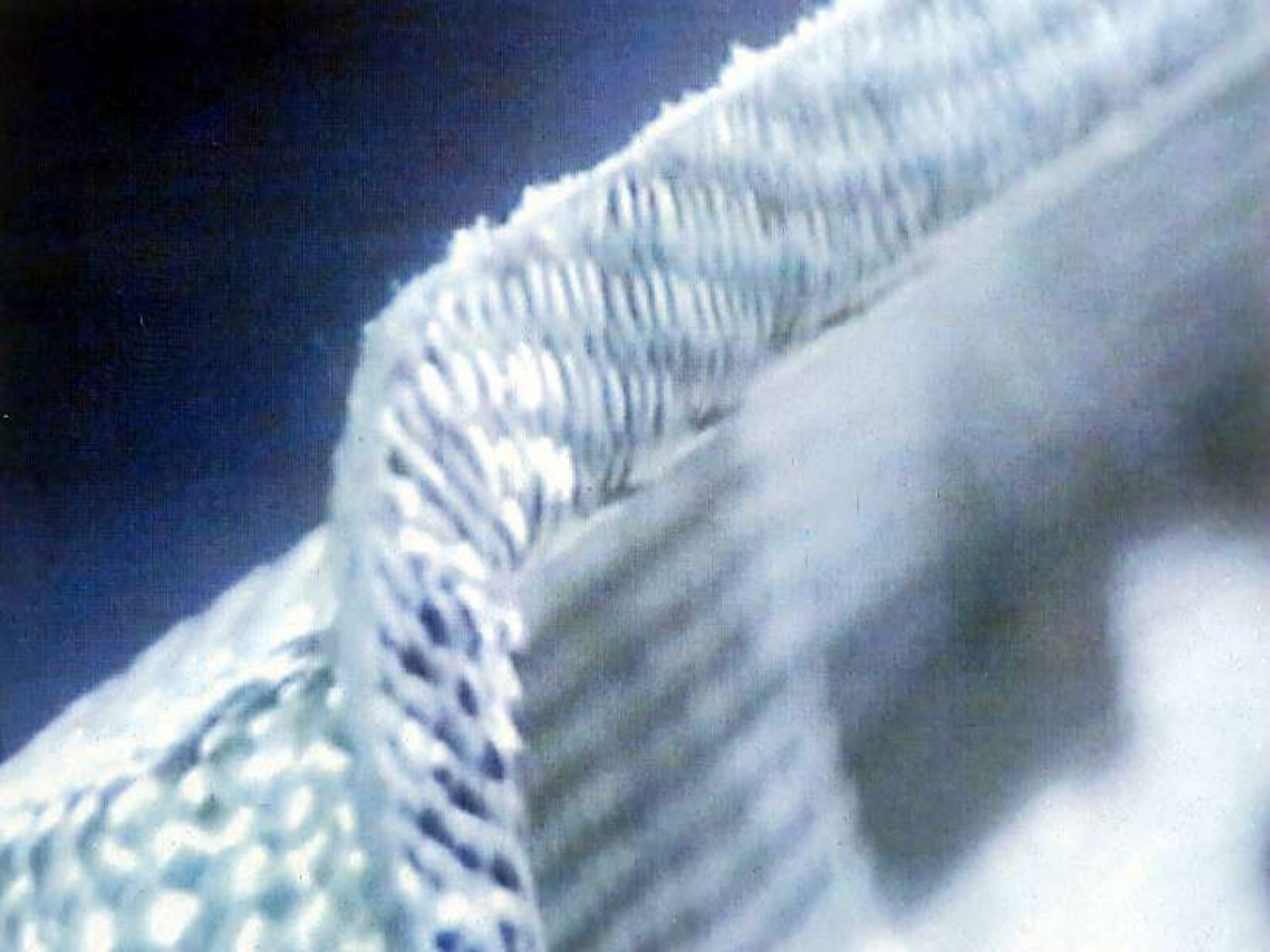
Cores and Fasteners

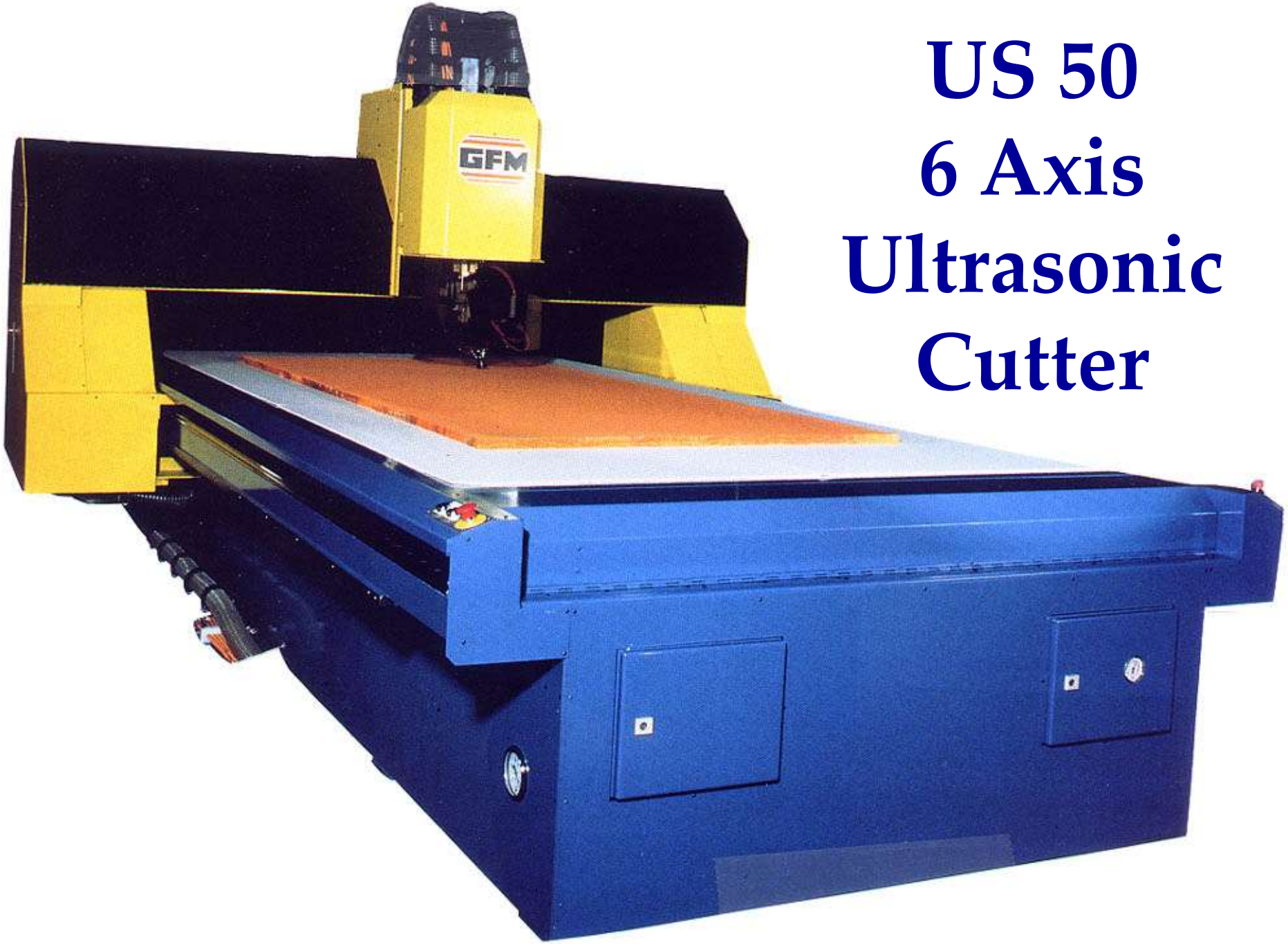
- Foams and Wood
- Metal stiffeners, Honeycomb
- Metal or Plastic fasteners
- Flow Media, Wiring, Etc.
- Attachment Sub-Plates
- Sensors

Net Shape Preforms

- Net Shape Mandatory for High Volume
- Net Shape Yields High Degree of Accuracy in the Molded Part
- Net Shape Keeps the Parting Line Sealed
- Net Shape allows Resin Packing and High Transfer Pressures
- Faster, Cheaper and Cleaner than Machining molded Parts


4 Layers 24 oz Woven Roving

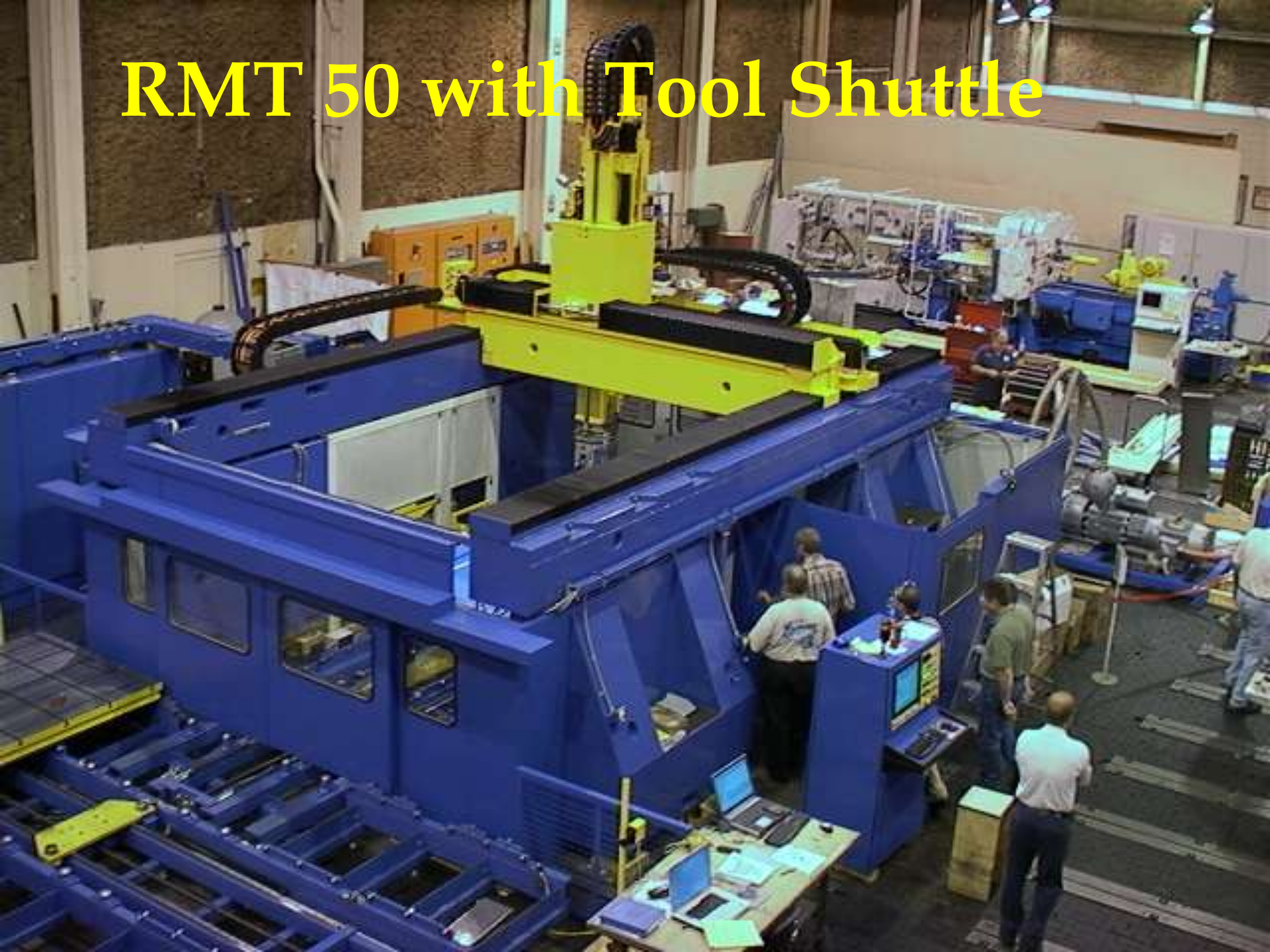




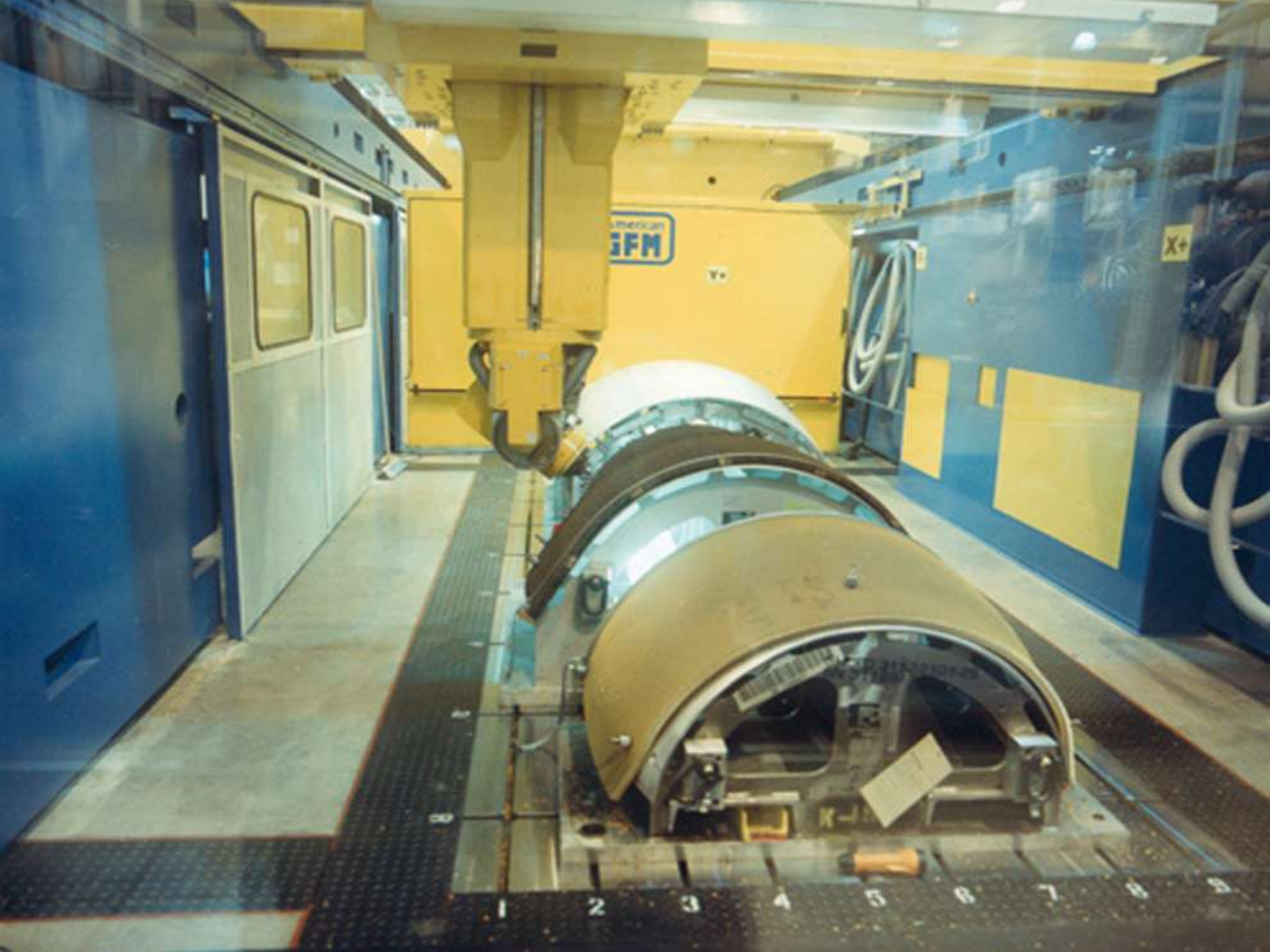
US 50
6 Axis
Ultrasonic
Cutter


RMT 50
6 Axis
Ultrasonic
Cutter

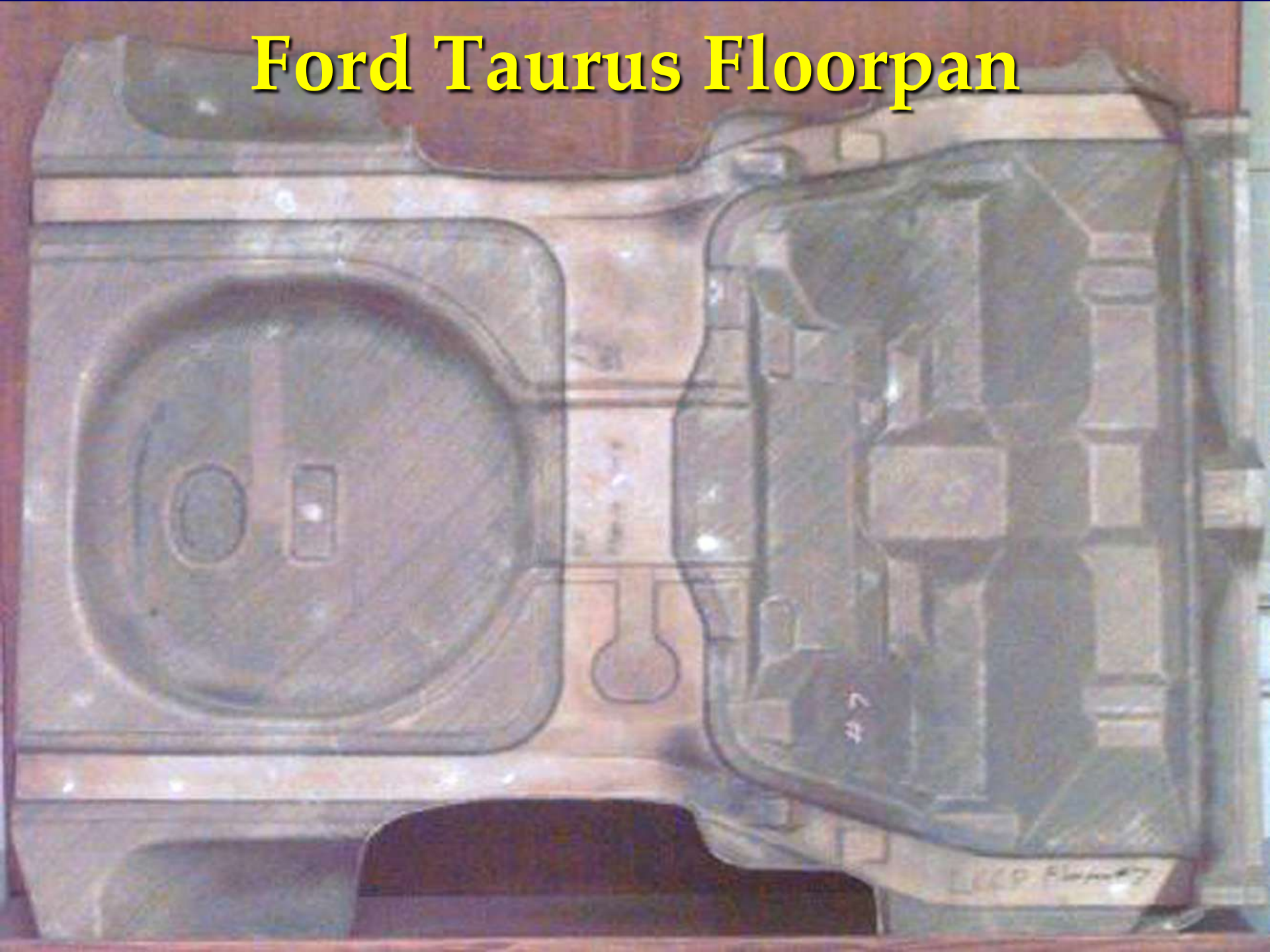
RMT 50 with Tool Shuttle



Dual Gantry RMT 50


GFM
X+
1 2 3 4 5 6 7 8 9

Ford Taurus Floorpan



LCCP Vehicle Assembly

LCCP

ACC Pickup Box Tailgate

Small Rotary Table with Auto Tool Changer

Midsize Light Cure Preforming Machine

Large Light Cure Preform Machine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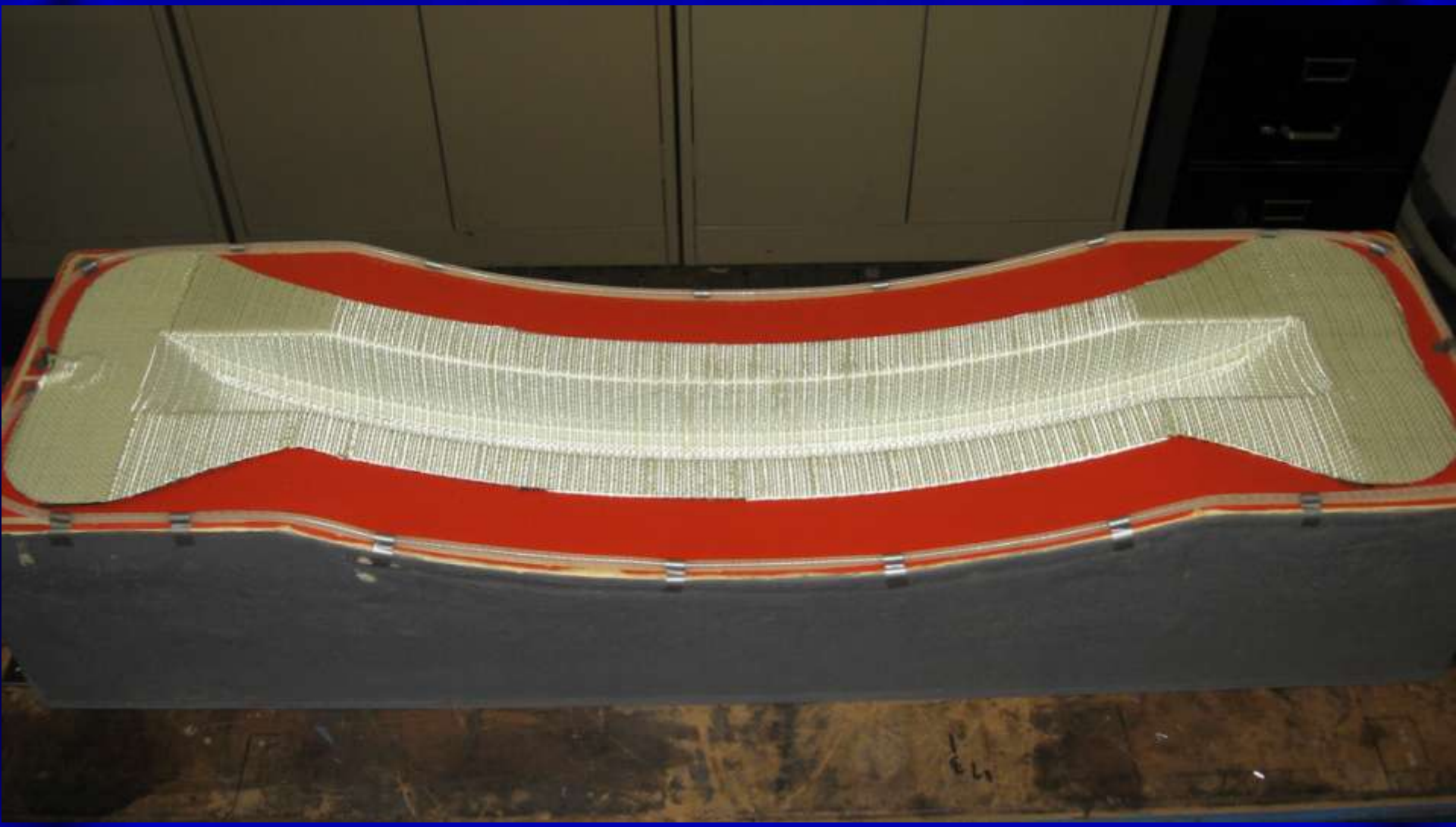
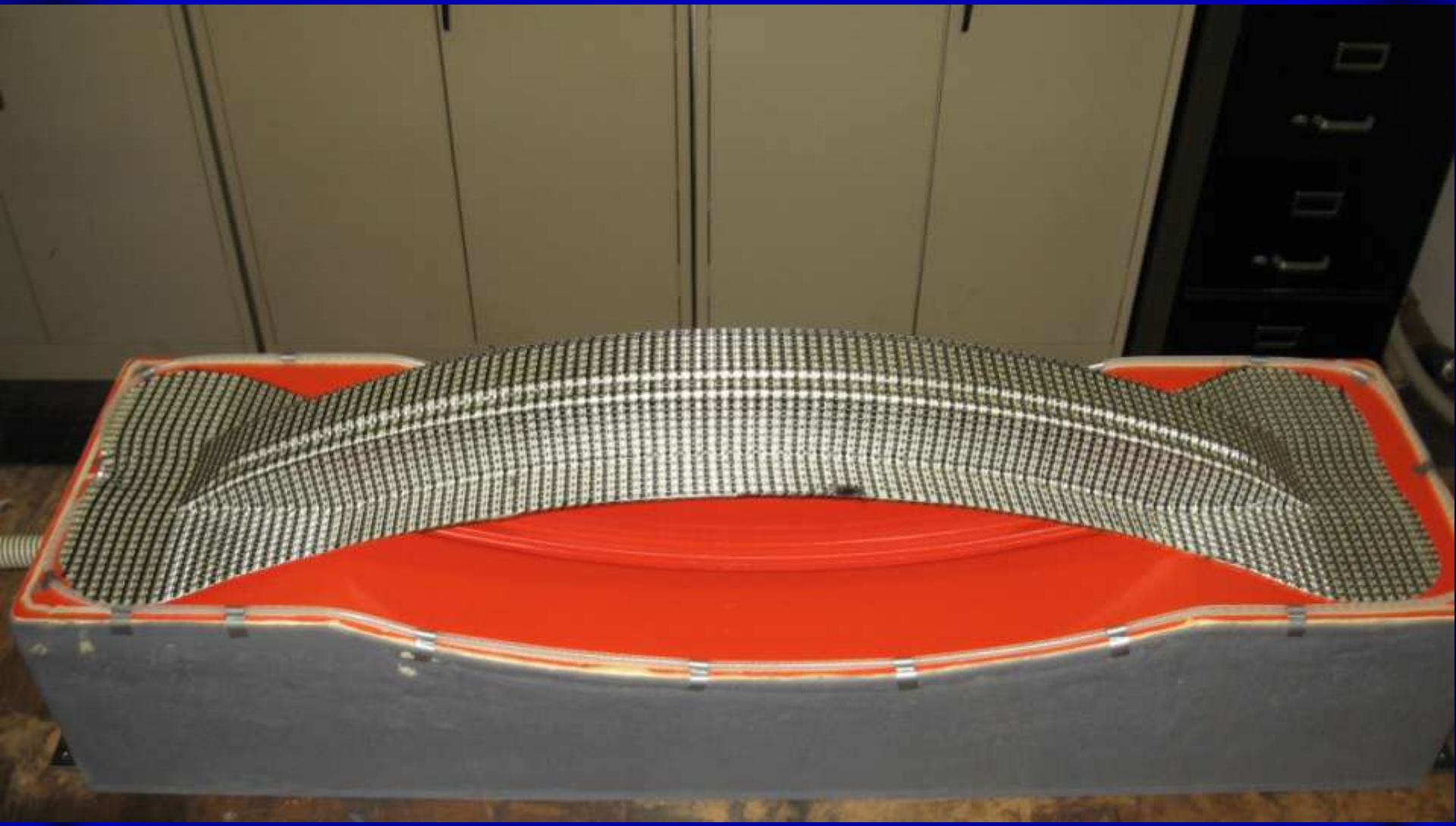
Typical Preform Progression





Light Cure Advantages

- Extremely Fast Cycles Possible
- User Determines Binder %
- User Determines Binder Location
- Compatible Binders
- Complex Preforms
- Selective Curing
- Complex Shapes
- Low Energy Cure

Light Cure Advantages

- Virtually any Reinforcing Material
- Conformability of Certain Materials
- High Volume Fractions
- Cores and Fasteners
- Anisotropy
- Preform Assembly for Difficult Shapes
- Preforms to any Thickness

Light Cure Disadvantages

- Single Step Thickness Limited
- Anything Opaque
- Liquid Binder Application
- Capital Cost of High Intensity Lighting
- Material Scrap can be High in some Applications
- Binder Cost Relatively High

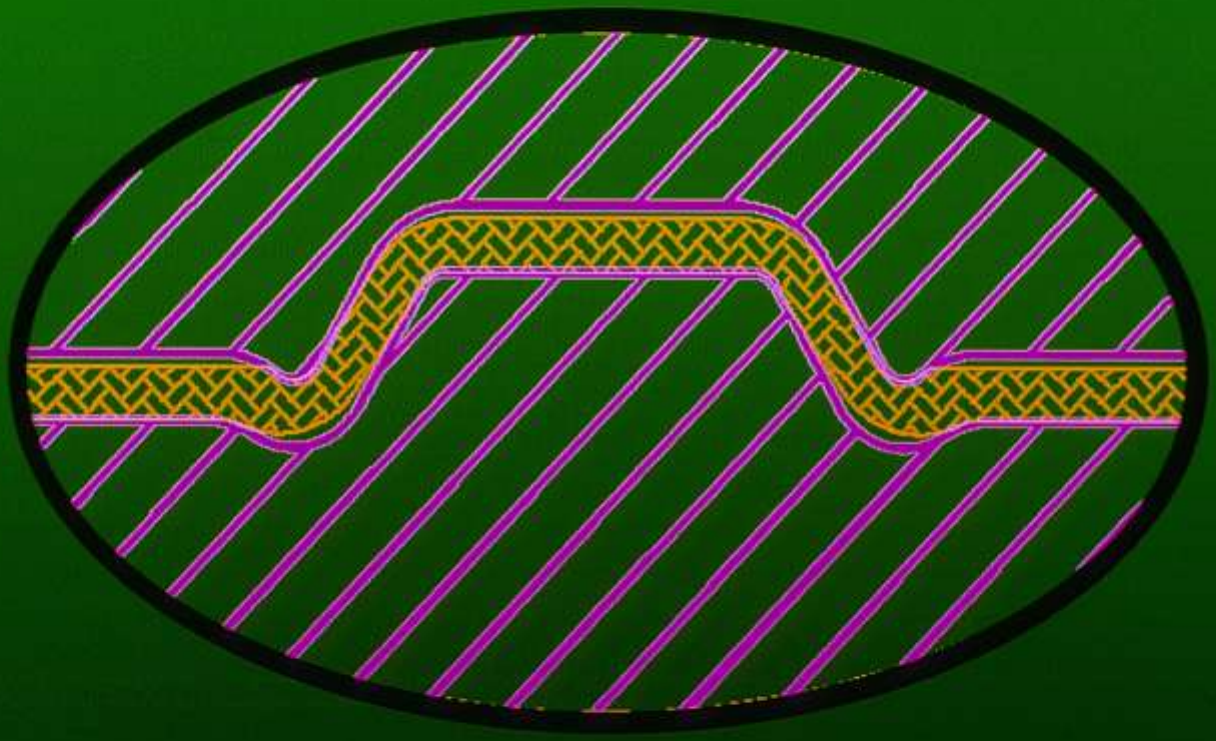
Conformability

- Conformability is the most Important Criteria for Preforming any Roll good or Engineering Material
- During Preforming Densities and Thickness Change Locally
- During Preforming Fiber Orientation changes as a function of the shape

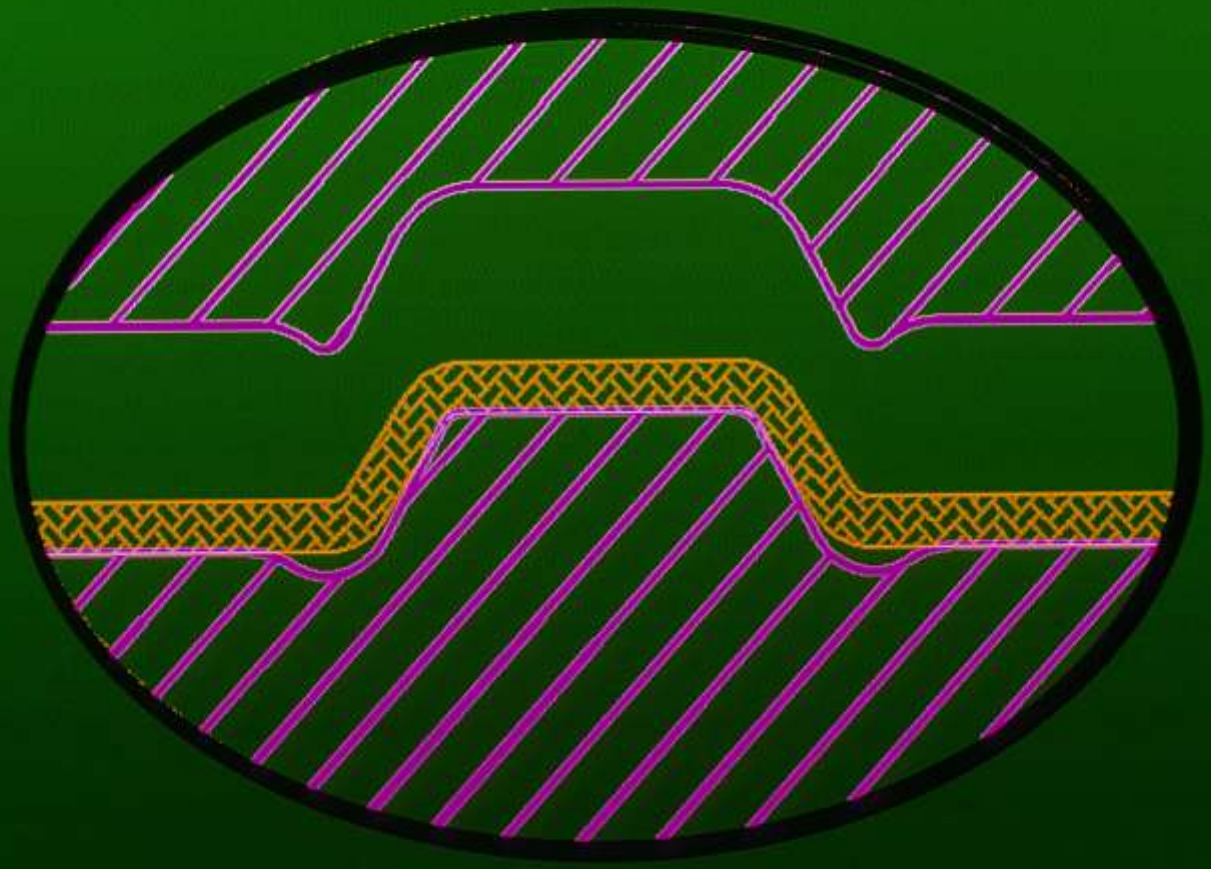
Springback

- Material follows the contour creating the through plane forming pressure
- All fiber reinforcing materials spring back to some degree
- To Control Race-tracking and resin rich areas the tooling must compensate
- Every material is different

OVERFORMING



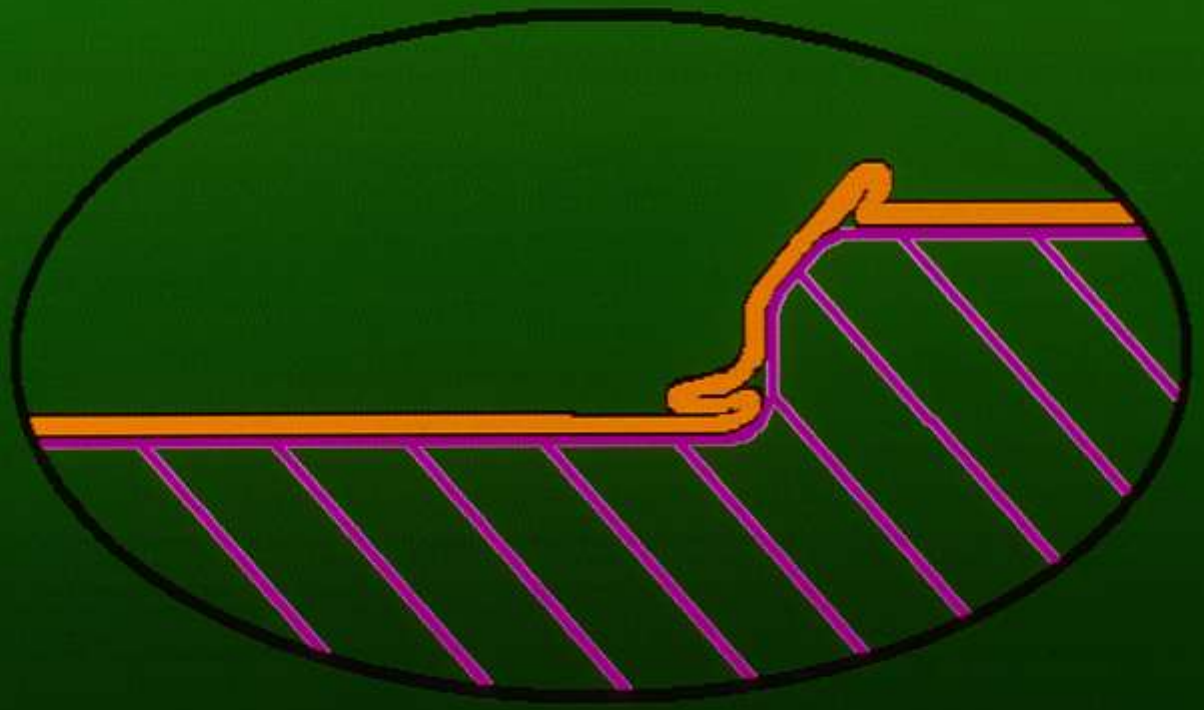
AFTER OVERFORMING

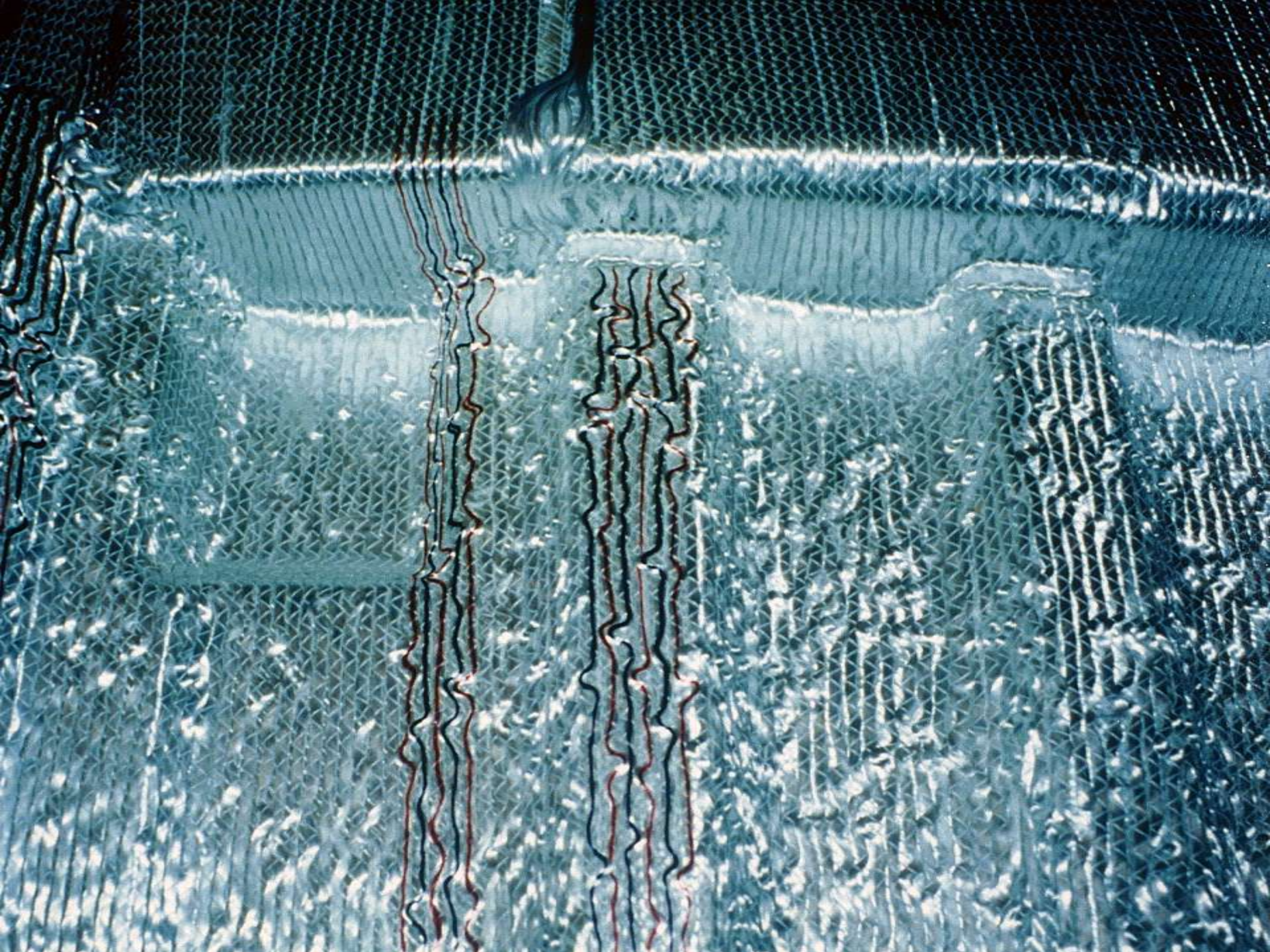


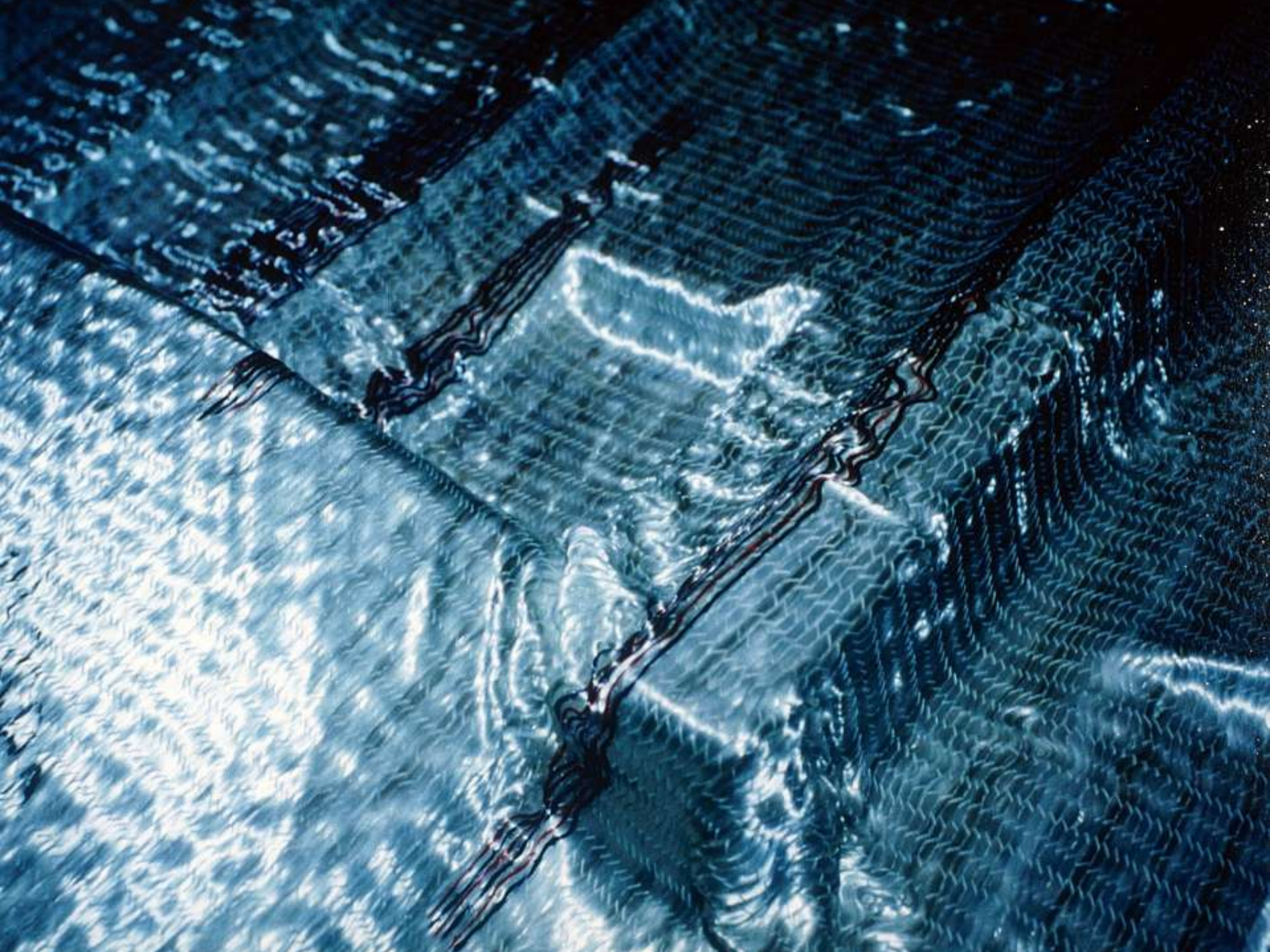
Thickening, Folding, Creasing, Bunching and Thinning

- Non Elastic Reinforcing Materials Cannot Stretch
- Fibers must Move or Break during Preforming of Roll Good Materials
- The above Problems create Dry Spots, Non-Fills and/or integrity Problems in the Molded Part

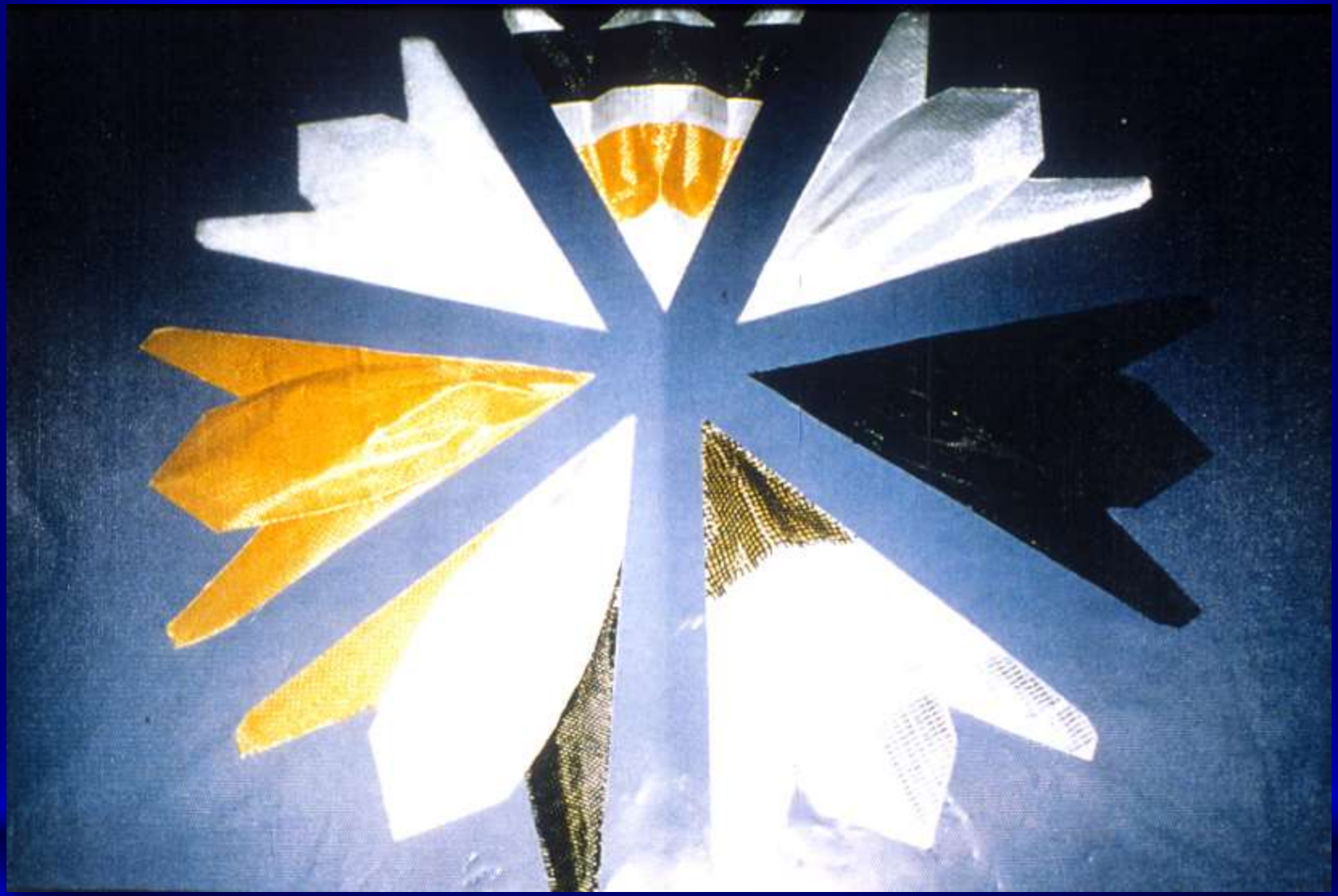
FOLDING & BUNCHING & THICKENING







Carbon Fiber and Hybrid Preforms



Carbon Fiber Preforming

- Light Cure has very limited application with Carbon Fiber
  - Single layer or with Fiberglass
- Typically Heat is used to cure or melt Binders, thermoset or thermoplastic
- Tackifiers commonly used for Manual Preforming
- New Low Temp and Anaerobic Binders in Development
- Generally Everything earlier applies to Carbon Fiber Preforming as well

Preforming Considerations

- Performance
  - Conformability is Number ONE Consideration
  - Reinforcing Materials Selection
  - Net Shape?
  - Cores and fasteners?
- Cost
  - Volume Driven
  - Reinforcing Material Cost
  - Trim scrap
- Design must take into consideration material processing characteristics.
- Quality-Must be SPC Capable Process

Questions?