ANTICH

TECHNICAL WEAVING

INTRODUCTION

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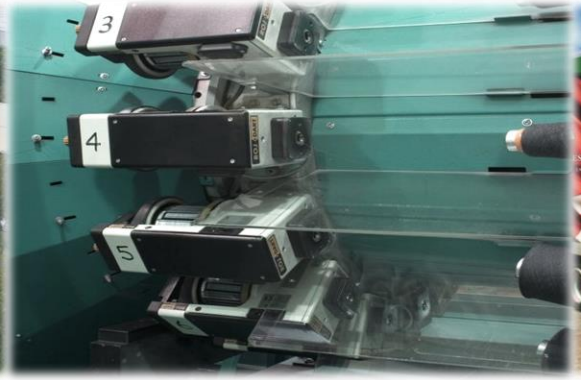
Weaving business with 3 strands

- **Commission Worsted Weaving** – 24/5 operation, producing around 160,000 LM/month of the finest quality fabric every week. Feeding into Couture, High Street & Corporate clients
- **Fine English Tailoring** – Full made to measure tailoring services supplying true "Made in England" suits into Saville Row and beyond as well as our own in-house shop
- **Advanced Composites** – After several years in R&D, the company has now invested over £2m in state-of-the-art equipment to provide a complete production facility for composite reinforcement fabric and preforms
  - Fully computerised production with statistical process and quality control systems from early beginnings
  - **Textile R&D Division**: new P1 Dornier looms, horizontal take-off for thick 3D woven preforms, automated rewinding, precise tension creels, preform stabilisation, tapering & trimming capability, as well as R&D resin transfer moulding
  - **Textile Manufacturing Division**: new P2 Dornier looms with multi-beam warp capability, Loom Take Up Machine (Batching Motion), Sectional Warping Machine fitted with swivel creels capable of handling variable package sizes and yarn types across all technical fibres


HISTORY

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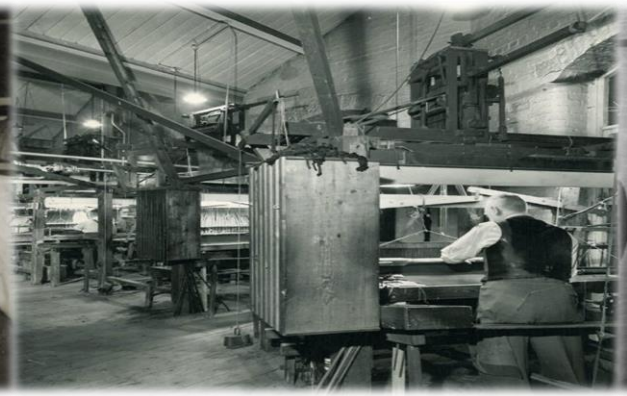
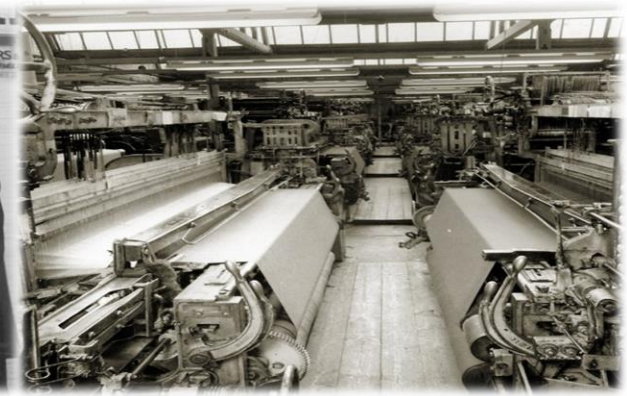
- Antich & Sons was **established in 1989** as a commission weaver to the fine worsted industry
- Moved into current **57,000 ft²** facility in 1996, expansion plans in place for another **28,000 ft²**
- The history of weaving in Huddersfield goes back to the **14th century**, with a rapid expansion during the industrial revolution
- The name '**Made in Huddersfield, England**' became a highly revered global brand, which appeared on the selvedges of many fabrics worldwide. These high-quality fabrics were the choice of Kings and Princesses alike
- This know-how and tradition is now carried forward into the 21st century
- Our craftmanship, efficiency and productivity have allowed us to translate and expand our **extensive apparel knowledge** to our **technical weaving department**
- We can convert multiple high-performance yarns into aesthetic textiles designed for **structural and lightweight components**

New Possibilities

Transferring technology & skills to Advanced Composites

COMPOSITE TEXTILE R&D DIVISION

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- Single rapier weaving loom for 3D woven preforms
- Horizontal take-off platform
- Double rapier weaving looms with precise tension creels
- Automated yarn winding system

COMPOSITE TEXTILE R&D DIVISION

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TECHNICAL WEAVING

- Purpose built temperature and humidity-controlled **environment** with high filtration extraction system
- Dedicated, brand new, **state-of-the-art Dornier looms** all with optimised surfaces and contact points for handling delicate composite reinforcement yarns
- **Specialised single rapier loom** for high thickness multilayer 3D weaving up to 770 mm wide, coupled with a 6m Horizontal Take-Off (HTO) to allow a straight draw of preforms from the loom
- This HTO was the first in the UK and the largest ever built by Dornier, giving Antich & Sons a unique, **world class 3D weaving capability**
- **Automated re-winding system** for a diverse range of yarns with different linear densities and varying degrees of brittleness or strength

COMPOSITE TEXTILE R&D DIVISION

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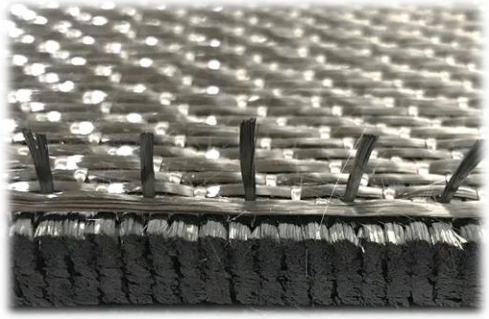
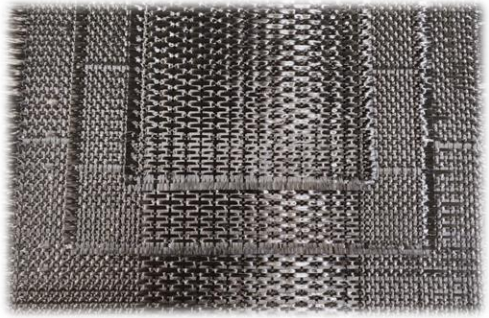
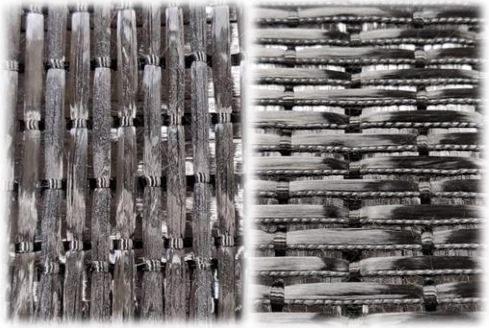
Antich & Sons have been involved in a number of funded R&D projects in the following fields:

- Aluminium Matrix Composites for **automotive & aerospace applications** – Developing 3D woven alumina preforms which are infiltrated to produce AMC components and inserts
- **3D Carbon Fibre Preforms for RTM** – Developing techniques to produce stable net-shape preforms ready for resin transfer moulding, with use cases in both the automotive and aerospace industries
- **Adaptive Modelling & Simulation** – Developing state of the art software to allow prediction of the mechanical performance of real world “as woven” 3D woven composite materials
- **3D Carbon Fibre Preforms for H2 storage tanks** – Novel high density array of mini vessels approach to H2 storage tanks which make better use of packaging space than traditional composite overwound pressure vessels







COMPOSITE TEXTILE R&D DIVISION

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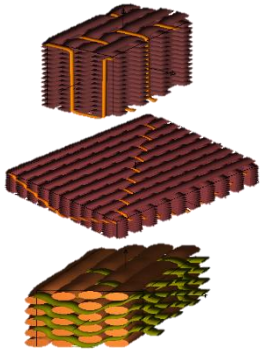
Over recent years Antich & Sons have moved from weaving 3D fabric to producing finished preforms, developing capability in the following areas:

- **Thick Sections** – Carbon fibre preforms have been produced up to 12 mm thick with an orthogonal weave design. Current Dobby loom configuration allows:



  - Orthogonal up to 16 warp/17 weft layers
  - Angle Interlock up to 11warp/12weft layers with a 3x3 binder pattern, 9/10 layers for 2x2, or 6/7 layers for 1x1 binder pattern
  - Layer-to-Layer up to 4warp/5weft layers with stuffers, or 5/6 layers with no stuffers

- **Tapering** – Adjustment of density coupled with ply drops. Methods developed for accurate, semi-automated trimming of floats to create smooth repeatable tapers
- **Stabilisation** – Wide array of stabilisation / binder methods have been tested. Two very effective methods established for full through-thickness stabilisation
- **Trimming** – Many edge trimming technologies have been tested. Three effective methods established

COMPOSITE TEXTILE R&D DIVISION

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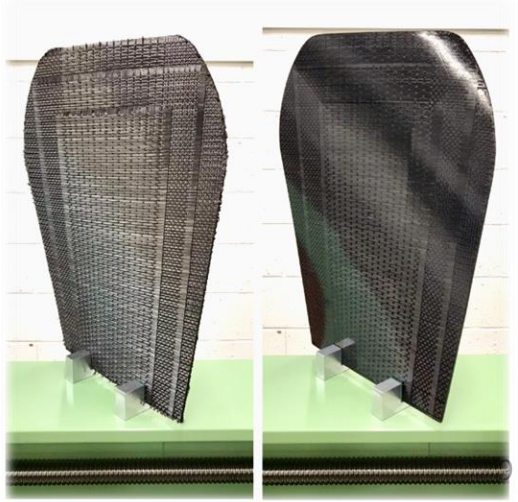
The stabilisation, tapering and trimming have been validated in a generic 3D demonstrator which was moulded in house by Antich & Sons

- **Fabric Preparation** – Converting long section fabric into individual tapered preforms
  - Thickness varying from 12 mm to 4 mm
  - Dimensions of tapered component 600 x 400 mm
  - Variable weave density in an Angle Interlock design
  - Variable use of carbon fibre tows (single & double tows)
  - Floating layers facilitate easy trimming
- **Preform Trimming** – Several methods established for different use cases. High quality & accuracy achieved
- **Binder Activation** – Heat and pressure to rapidly activate binder and produce stiff, stable, infusible preforms
  - Use of thermoplastic-coated carbon fibre for preform stabilization
  - Use of resin-coated carbon fibre tow for preform stabilization
- **Resin Transfer Moulding** – Low pressure moulding with development tooling to fully infuse thick preforms



MANUFACTURING DIVISION - WARPING

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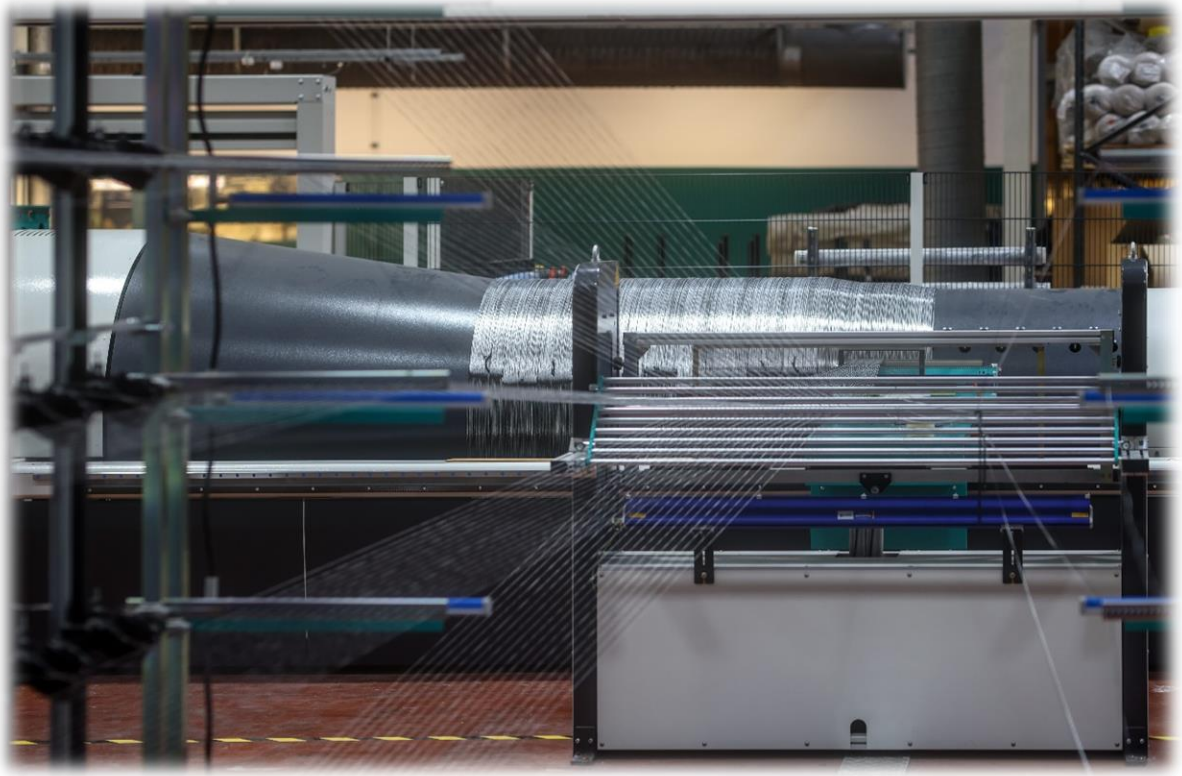
- Swivel frame creels (enables creel loading even during operation)
- 340 positions available
- ACCUTENSE yarn tensioner for monofil & multifil yarns (carbon, glass, aramid fibre)



- PROWARP Sectional Warping machine
- Working width up to 2200 mm
- Beaming speed of max. 500 m/min

MANUFACTURING DIVISION - WEAVING

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State-of-the-art weaving looms

- Weaving width up to 2200 mm
- Capability of weaving from double warp beams for single & multilayer fabrics
- High volume manufacturing of up to 32,000 LM/ month

Loom Take-up Machine (Batching Motion)

- Tight and compact rolls
- Batching diameter up to 1500 mm
- Suitable for heavy industrial fabrics

WEAVING CAPABILITY

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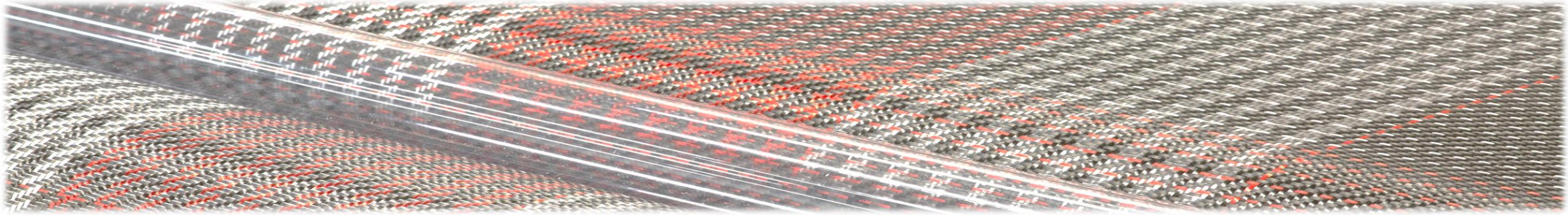
TECHNICAL WEAVING

Dedicated looms for 2D fabric manufacture and 3D preforms:

- **Weave Design**: Plain Weave, 2x2 Twill Weave, 5 Harness Satin, Herringbone & many other bespoke weave designs
- **Fibre type**:
  - Carbon Fibres: High Strength, Intermediate and High Modulus Carbon Fibre (1K, 3K, 6K, 12K, 24K, 48K)
  - Glass Fibres: E - , S- and R- type / Basalt Fibers
  - Ceramic Fibres: Nextel™Aluminium Oxide / Quartz / Silicon Carbide Fibres
  - Para - and meta – aramid Fibres: Kevlar™, Nomex™, Twaron™
  - Polypropylene (Innegra™), UHMWPE (Dyneema™), High Tenacity Polyester, Zylon (PBO)
  - Hybrid and specialty yarns for thermoplastic applications
  - Natural Fibres: flax, hemp, cotton and woollen fibres
- **Fabric width**: 0.7 metres (*3D textiles*) / 1.8 metres (*2D textiles from creel*) / 2 metres (*2D textiles from warp beam*)
- **Fabric volume**: Capability of producing 1,500 (*3D textiles)* and 32,000 LM/ month (*2D textiles)*
- **Fibre load**: uni- and bi-directional woven fabrics can be produced in both warp (UD0°) and weft (UD90°) versions



FUTURE OPPORTUNITIES

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3D Woven Textiles in Composite Manufacturing

Advantages of 3D Woven Textiles

- **High Strength and Stiffness:** provides improved mechanical properties such as tensile strength, stiffness, and impact resistance
- **Tailored Architecture**: complex geometries can be created, allowing for the optimization of material properties in specific directions
- **Improved Damage Tolerance**: the 3D architecture can help in distributing stresses more evenly, enhancing damage resistance
- **Reduced Delamination**: the integration of layers in 3D weaving significantly reduces delamination issues common in traditional 2D textiles
- **Lightweight**: can offer high performance with low weight, ideal for aerospace, automotive, and marine industries

Disadvantages of 3D Woven Textiles

- **Limited Design Flexibility**: certain complex shapes may be difficult or expensive to produce using current 3D weaving technologies
- **Processing Complexity**: the use of 3D textiles in composites may require advanced techniques and additional steps, complicating the manufacturing process
- **Quality Control Challenges**: due to the intricate structure, ensuring uniformity and consistent quality during production can be difficult

FUTURE OPPORTUNITIES

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3D Woven Textiles in Composite Manufacturing

Aerospace Components

- Aircraft fuselage panels
- Wing spars and ribs
- Thermal protection systems for space shuttles
- Engine components such as fan blades and casings

Automotive Components

- Crash structures and energy-absorbing panels
- Suspension arms
- Reinforced body panels
- Interior components such as lightweight seat frames

Sports Equipment

- Bicycle frames
- Ski and snowboard components
- Tennis racket frames
- Helmets and protective gear

Defence and Ballistics

- Body armour
- Blast resistant panels for vehicles
- Protective enclosures for sensitive equipment

Renewable Energy Systems

- Wind turbine blades
- Lightweight supports for solar panels

Marine Industry

- Hull Reinforcements
- Propeller blades
- Buoyant and impact-resistance for boats

Medical Devices and Implants

- Artificial ligaments and tendons
- Reinforced prostethics
- Scaffolds for tissue engineering

Thermal Protection Systems

- Heatshields for spacecraft re-entry
- Insulation for rocket nozzles and thrusters
- Protection layers for satellites exposed to extreme thermal cycling

FUTURE OPPORTUNITIES

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Antich & Sons are interested in supporting **future investment in 3D weaving capabilities** in line with market growth in various sectors

- Investment in a Jacquard Loom would build on the existing knowledge and capability in 3D weaving, leading to a wider range of structural components such as:
    - Near-net shape vanes and airfoils
    - 3D fan blades with taper contour
    - Structural components: rib-stiffened structures, ‘I’ and ‘T’ pieces (pleat weaving)
    - Aircraft engine containment cases (use of contour weaving)
    - Composite fan cases (use of contour weaving)
    - Ceramic matrix composites for hot section components

- We aim to provide an independent capability for 3D composite reinforcements to be developed

- A suitable investment in the 3D woven technology would support the development of future structural engine applications where capability today does not exist (performance improvement such as through-thickness performance and higher temperature resistance - PMCs, CMCs and MMCs)

- This will also reduce process cost while improving wastage factors, leading to lower cost for fibres, resins and intermediates on the long term

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OPENING TIMES
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