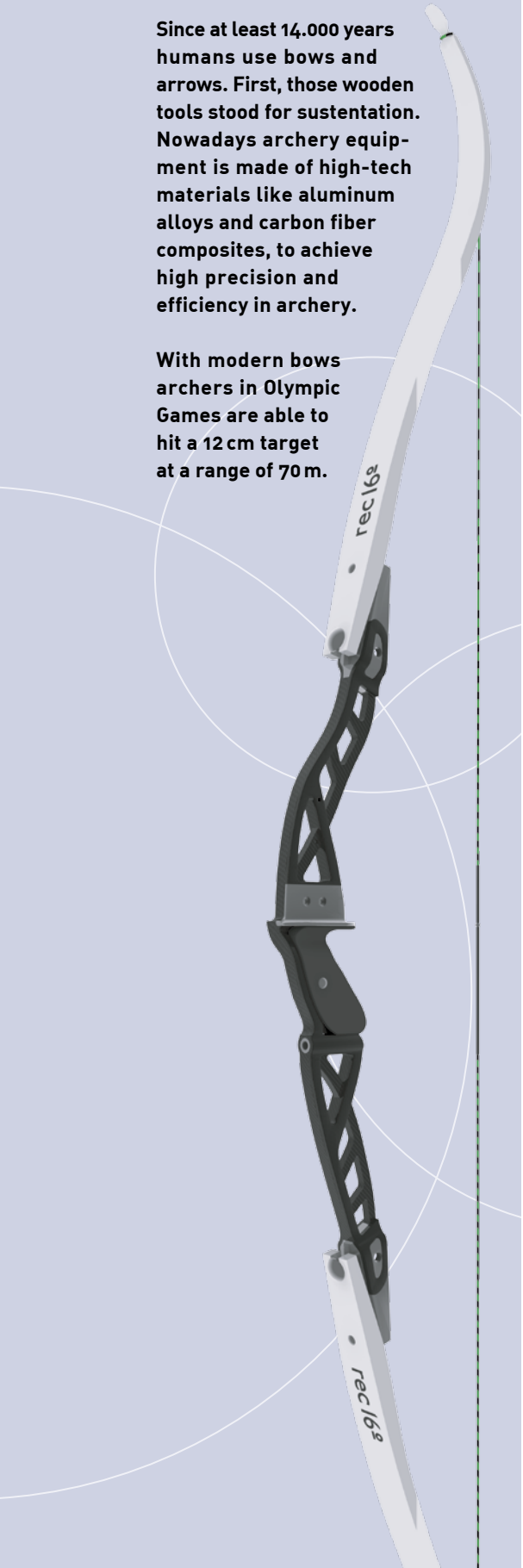
HOCHSCHULE FÜR TECHNIK UND WIRTSCHAFT DRESDEN
UNIVERSITY OF APPLIED SCIENCES

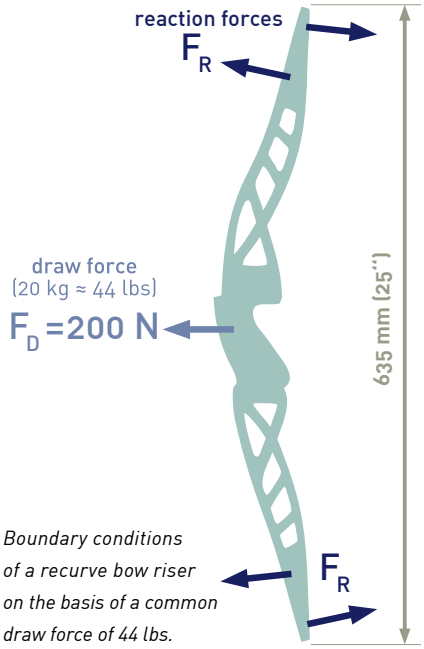
Leibniz-Institut für Polymerforschung Dresden e.V.

# LIGHTWEIGHT RECURVE BOW RISER rec 16º
# Application of a Variable-Axial Fiber Design

**Since at least 14.000 years humans use bows and arrows. First, those wooden tools stood for sustentation. Nowadays archery equipment is made of high-tech materials like aluminum alloys and carbon fiber composites, to achieve high precision and efficiency in archery.**

**With modern bows archers in Olympic Games are able to hit a 12 cm target at a range of 70 m.**




*Boundary conditions of a recurve bow riser on the basis of a common draw force of 44 lbs.*

## Idea

The majority of archers are using aluminum alloy risers. The aim of the presented project is decreasing the mass of risers by using variable-axial carbon fiber structures without any loss of mechanical performance. The motivation to strive for lower weight is that the archer is losing power with every shot by holding the bow with the extended arm. Furthermore, it gets easier to balance the bow. To realize a new generation of carbon composite bow riser the Tailored Fiber Placement (TFP) technology can be applied. Based on finite element (FE) simulation, a new fiber optimization design tool and in cooperation with industrial designers a new riser has been developed.

## Riser

The riser is the center part of a recurve bow. The limbs are connected to this center part, whose main requirements are:

- Resisting high dynamic and static stress
- Absorbing vibrations and shocks
- Low weight along with high stiffness
- Unique design

The majority of current risers are made of aluminum, weighing 950 to 1400 g. Currently even the best carbon risers used in world cups are not lighter, weighing about 1000 to 1350 g.

*Top: Result of the topology optimization*
*Middle and bottom: Side and top view (CAD model) of the new developed riser*

## Design and Development

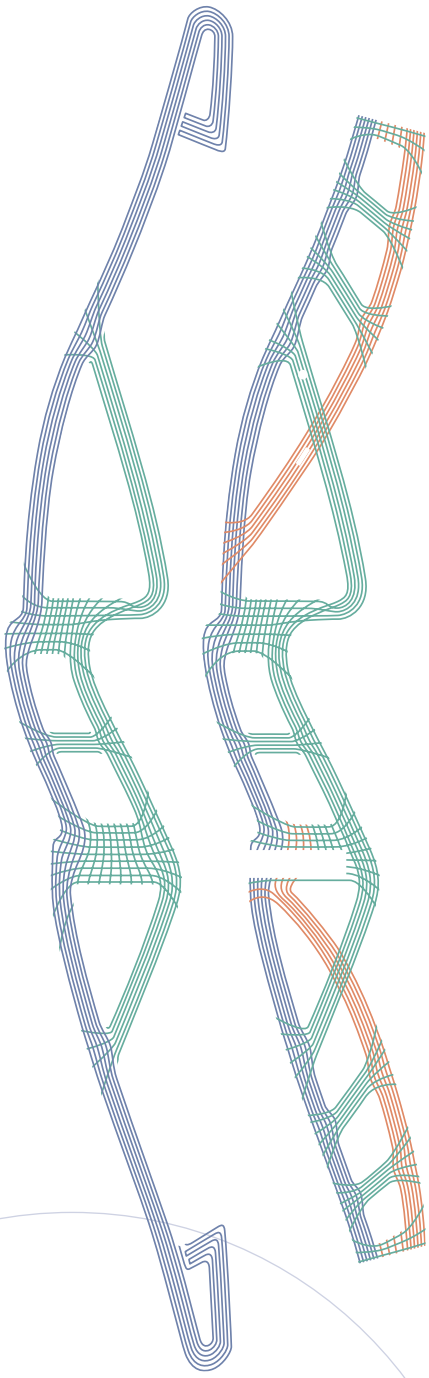
After reverse engineering of a commercial aluminum alloy riser the required stiffness parameters of an existing part have been evaluated and used for further redesign of the carbon composite part. Using finite element (FE) simulation software tools a topology optimization was carried out in a first step. Based on the resulting design proposal, students from the University of Applied Science Dresden, Faculty of Design, developed the final shape.

Redesigned by inspirations from biology and the so called suspension model, the elegant shape now named rec16 bow riser emerged. In a last step the fiber path pattern of the riser's 3D-design was determined for the TFP manufacturing process. For that, the shape was assembled with four layers of carbon fibers.

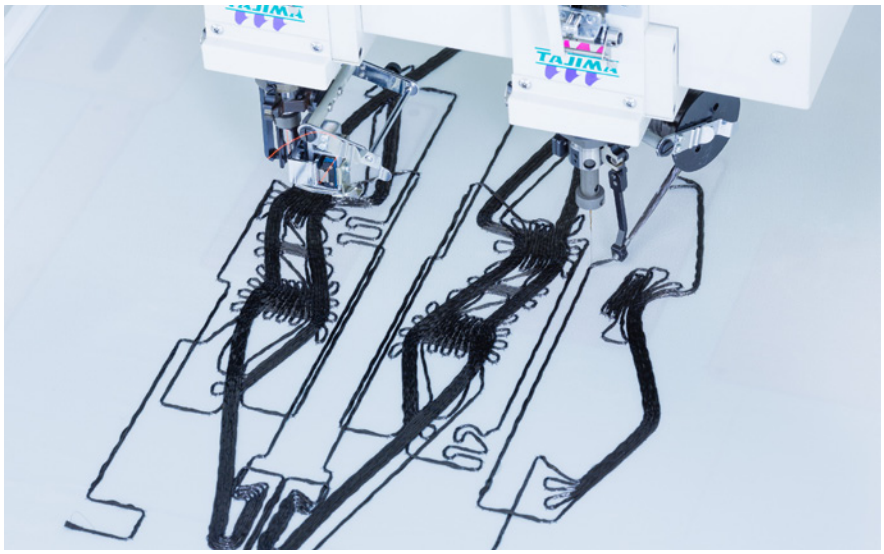
## Manufacturing

Applying the Tailored Fiber Placement technology it is possible to place carbon rovings locally in arbitrary angles along the highly stressed directions of the part architecture. The results are complex curvilinear structured preforms that are able to utilize the full potential of anisotropic carbon fiber composites. Finally, the manfactured preforms are placed in a tool and infiltrated by a resin transfer molding process.

That way it is possible to decrease the weight of a riser made by carbon composite by approx. 40 %, down to approx. 600 g, and increasing the mechanical efficiency at the same time. Additionally, the waste material caused by the manufacturing process got minimized, especially in comparison to milled aluminum alloy risers.



*Fiber path pattern*




*Manufacturing of the carbon fiber preform by TFP technology*

## Contact

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