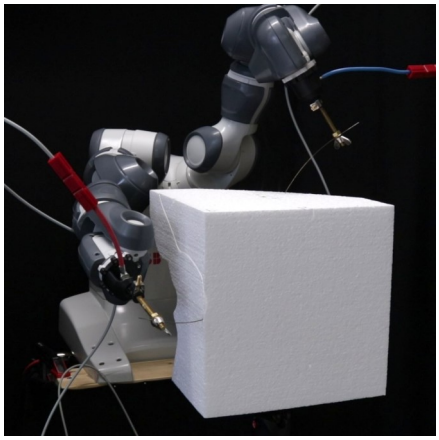
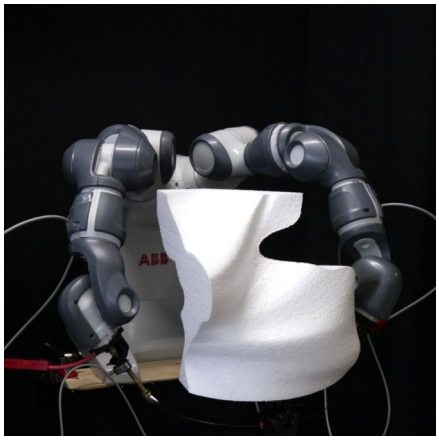
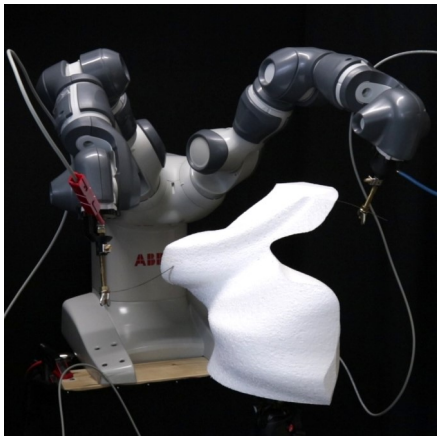
ETH zürich

# Licensing Opportunity

## Robotic hot-wire cutting for complex 3D-objects







### Application

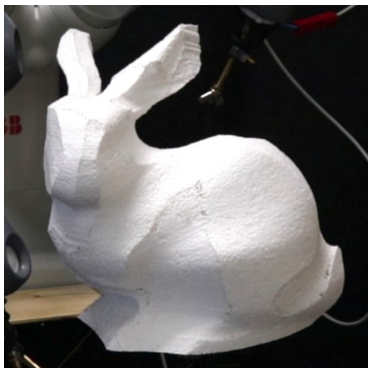
A deformable cutting rod allows the subtractive manufacturing of thermoplastic polymer foams (e.g. polystyrene) in a large variety of shapes, including sign-changing curvatures. The process also becomes more efficient as fewer sweeps of the cutting tool are necessary in order to approximate the target shape. The cutting tool facilitates prototyping or sculpturing. The objects can be used as formworks in concrete casting for building construction, as insulation elements in plant construction or for set design.

### Features & Benefits

- Elastically deformable cutting tool
- Complex shapes (e.g. doubly-curved surfaces)
- Fine and delicate features
- Small number of cuts

### Publications

- “RoboCut: Hot-wire Cutting with Robot-controlled Flexible Rods.”, ACM Trans. Graph. 39, 4, Article 98 (July 2020), https://doi.org/10.1145/3386569.3392465
- Patent pending



*The bunny shape emerges after only two cuts. The shape is completed with ten cuts. Watch the video:*

### Background

Electrically heated wires or blades cut thermoplastic polymer foams, whereby the material melts or evaporates ahead of or on a slight touch of the tool. This process involves no or very low cutting forces, which allows for very large and efficient cuts. The cutting tool is usually a tight, straight wire. This configuration makes the cutting of certain features impossible, e.g. bowl like curvatures. A customized, pre-shaped tool would cut such complex features, but also would restricts itself to these.

### Invention

Using an elastic rod as a cutting tool increases the attainable range of shapes. The tool can dynamically change its shape while passing through the material, making transitions between positive and negative curvatures feasible. Two robotic arms stretch, bend and twist the rod to the desired shape. An algorithm calculates collision-free motion trajectories for the robotic arms and the corresponding deformation of the tool. The target surface is approximated and optimized depending on factors such as the given number of cuts, path smoothness and computation time. A prototype is available for demonstration. Future developments comprise variable cross sections of the cutting tool and non-straight rest shapes.

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**Technology Readiness Level**

1 2 3 4 5 **6** 7 8 9