Robo Pinch

DIGITAL DESIGN, ARCHITECTURAL MODELS, ROBOTIC FABRICATION

Project Director: Professor Karl Daubmann
Research Assistant: Stella Zhujing Zhang, Richard Foley
Applicant's Role: experiment workflow design, material and robot action testing, plaster casting, exhibition design and installation
Taubman College Research through Making
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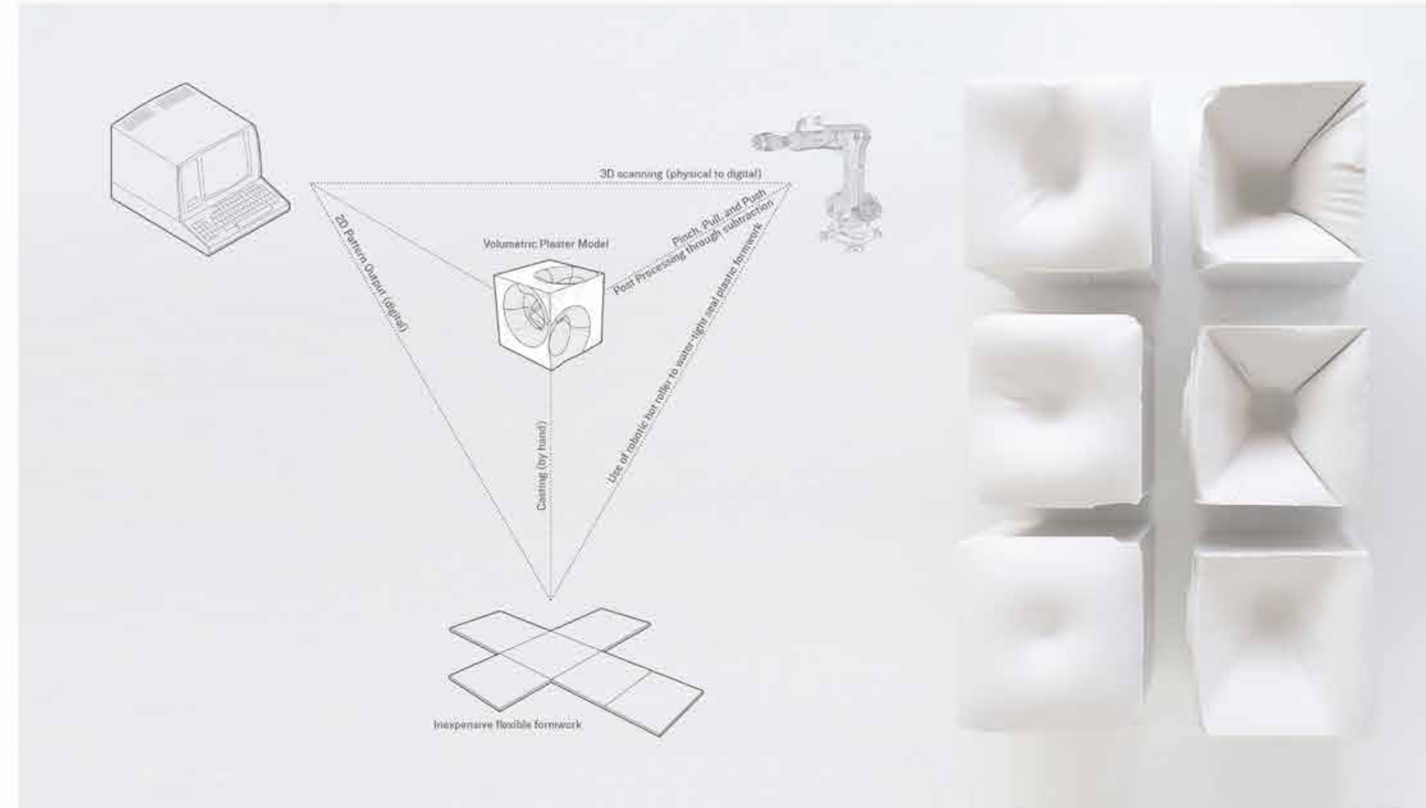
RoboPinch includes the robot as a speculative collaborator in the production of plaster form and volume studies. Plaster is inexpensive, moves quickly from liquid to solid, and can be worked after it is formed. Coupling a process with an inexpensive fabric and flexible form-work allows for additional distortions prior to the material phase- change.

Gaudi's hanging chain models stand as amazing precedents as they allow for the small-scale speculation of much larger work as informed by physical, tactile, and gravitational feedback. Where the human hand excels in the tangible and sensual relationship to material, the robotic hand brings precision, reproducibility, and the ability to recalibrate and tune design decisions. This project couples a parametric solid modeling tool into the process so slight digital revisions can be made and additional solid forms translated into material.

While this project resides in a very technical and technological domain, broader design and educational ambitions are central. This project brings robotic and human collaborators together but is very clear about why each party is involved. The project makes voluptuous and volumetrically complex, manifold models using very precise tools through a delicate balance of prediction, discovery, and validation. The models are reproducible, delicate, and imprecise at the same time.

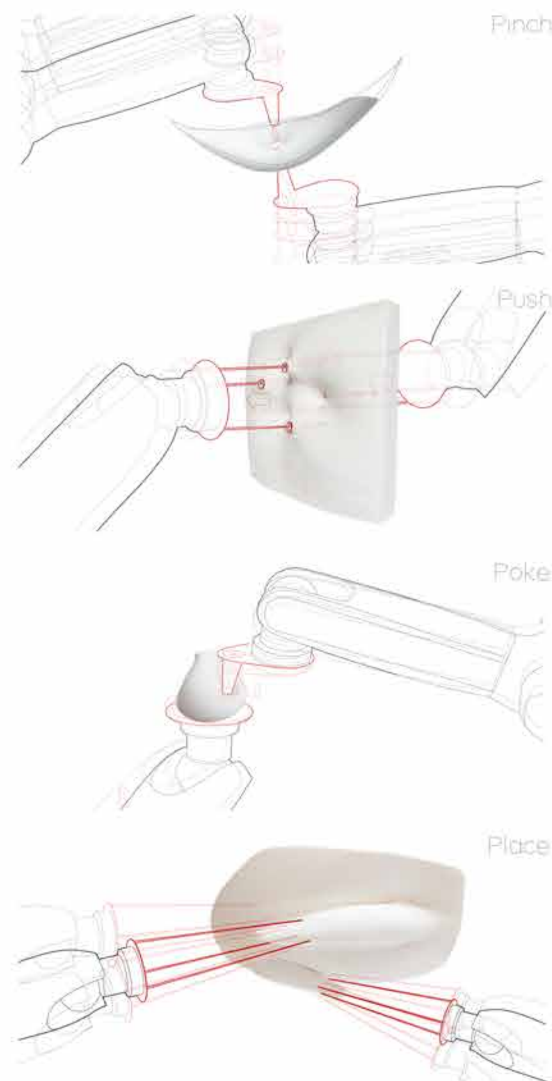
The final output of this project is a series of speculative 'houses'. The models are imagined as in- habitable but foreground solid/void and building/site relationships. RoboPinch considers the fact that architects must always work in an environment of translation, output, and conversion. We use small tools at our desks analogous to large industrial machines. Like Louis Kahn considering the crane as an extension of the body, we see robots as extensions of ourselves able to bring new abilities and capacities, helping us to uncover and discover new design opportunities in this act of translation.



Robotic Manipulation of Fabric Formwork for the Creation of Plaster Architectural Models

Translation does not always result in a 1:1 exchange but instead, new discoveries can be made through the translation process. Within a discipline such as architecture that historically relies on others to execute designs, translating from digital to physical becomes one more exchange to discover additional insights into a design. In response to this translation-heavy practice, many new technologies are emerging that both capture and communicate instructions for construction. The connection between digital tools and computer-controlled output gives architects the opportunity to speculate on form, material, and the process of making. Industrial robotics offers an opportunity for this speculation with the confidence that decisions can later be translated to larger processes.

As a means to investigate the translative impact of industrial robotics, fabric-formed plaster models became a focus to explore this topic. Architectural plaster models offer a rich territory for exploration as the volume and weight inevitably distort flexible form-work. The phase change from fluid to solid allows for distortions, sags, and wrinkles while freshly cast plaster can still be modified through cutting, carving, and drilling. This project developed a process of creating malleable plaster molds to be precisely and robotically distorted during casting, and robotically post-processed to further modify form and volume.

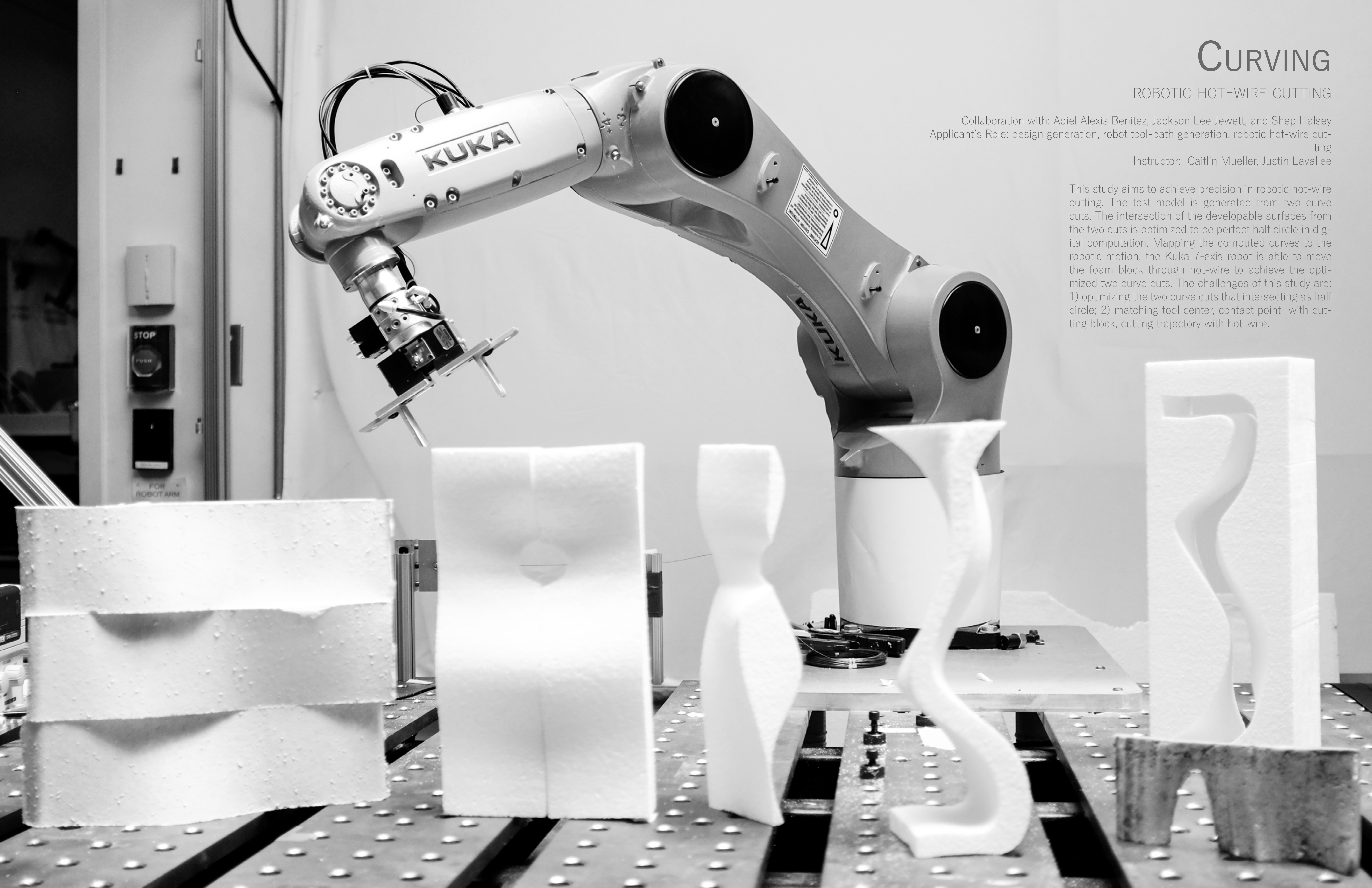


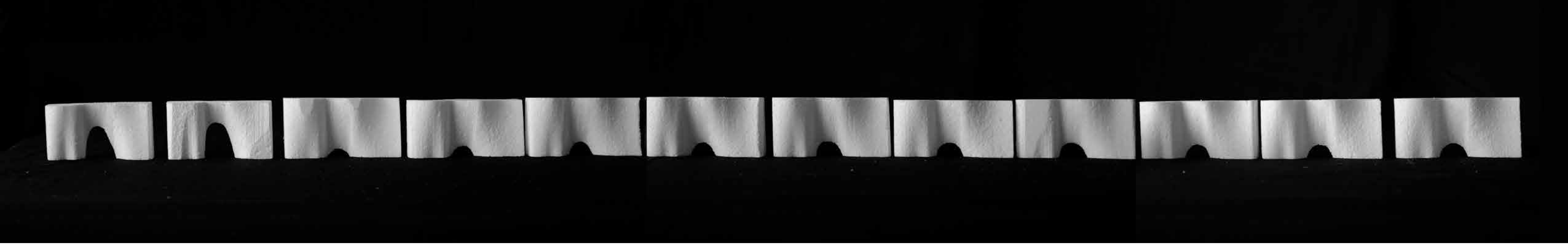
Curving

ROBOTIC HOT-WIRE CUTTING

Collaboration with: Adiel Alexis Benitez, Jackson Lee Jewett, and Shep Halsey
Applicant's Role: design generation, robot tool-path generation, robotic hot-wire cutting
Instructor: Caitlin Mueller, Justin Lavallee

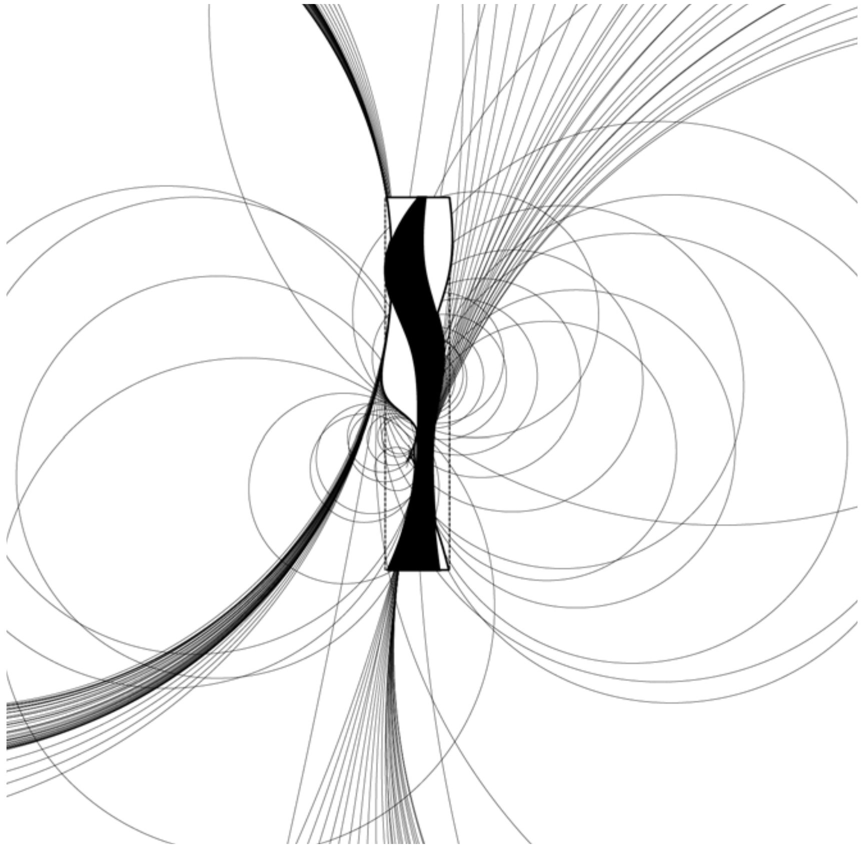
This study aims to achieve precision in robotic hot-wire cutting. The test model is generated from two curve cuts. The intersection of the developable surfaces from the two cuts is optimized to be perfect half circle in digital computation. Mapping the computed curves to the robotic motion, the Kuka 7-axis robot is able to move the foam block through hot-wire to achieve the optimized two curve cuts. The challenges of this study are: 1) optimizing the two curve cuts that intersecting as half circle; 2) matching tool center, contact point with cutting block, cutting trajectory with hot-wire.



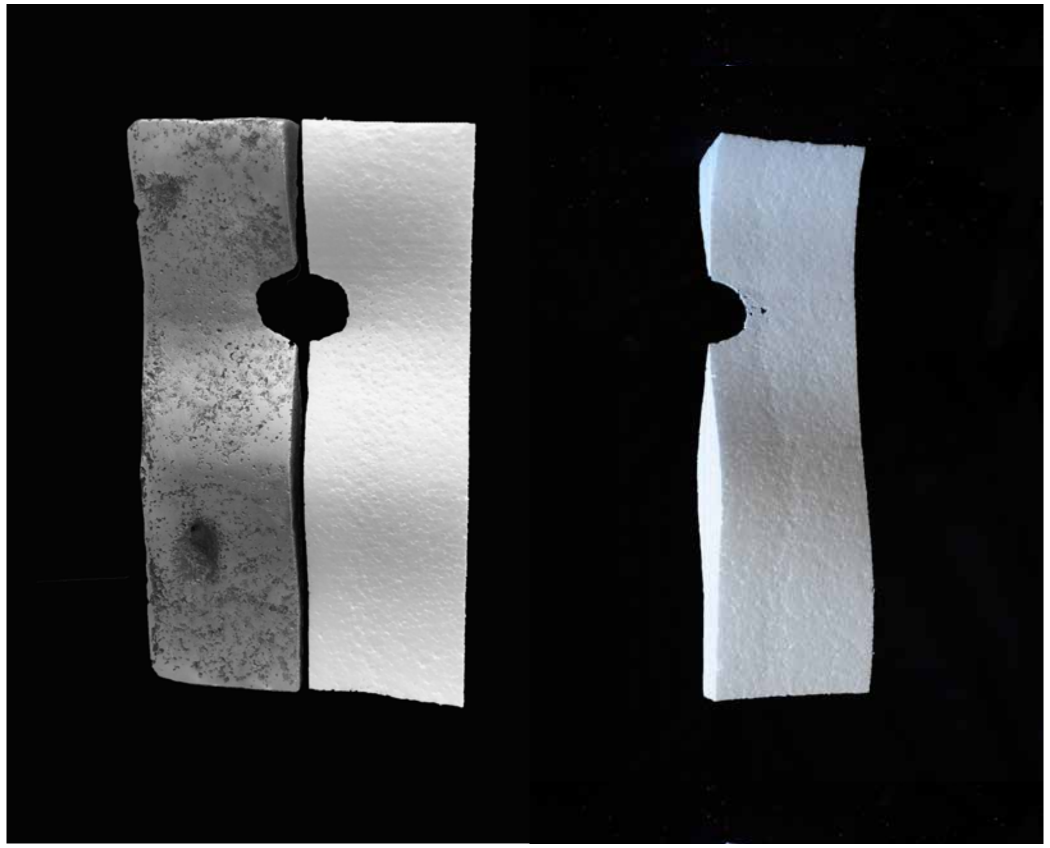


results from fine tuning tool speed, hot-wire intensity

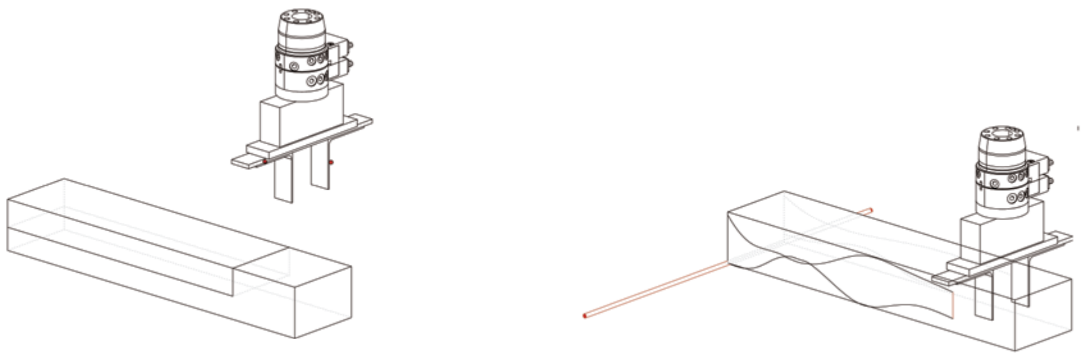
Long exposure image of the whole cutting process

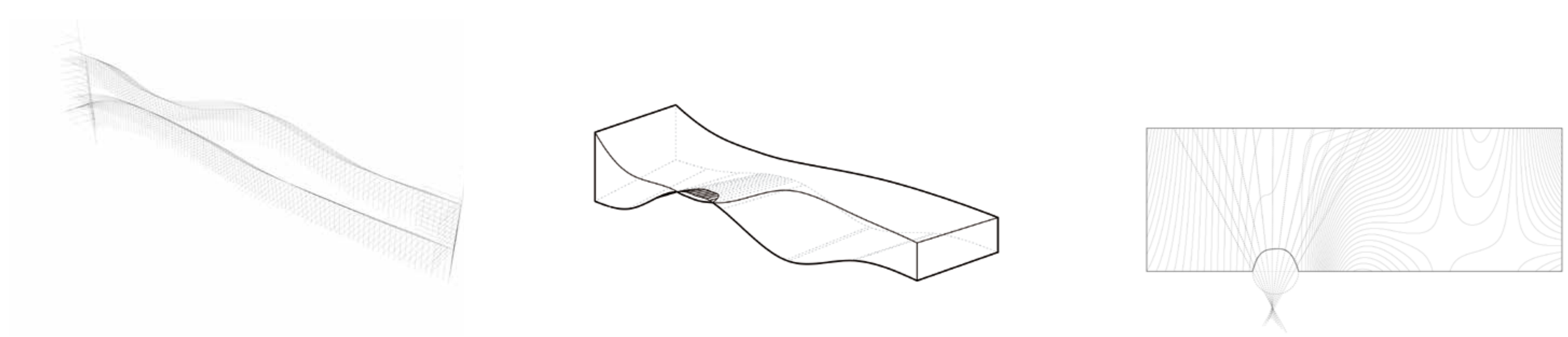


Geometry generation, computation optimization



Curve cut foams+ aluminum cast





Robotic hot-wire cutting foam block process diagram