Crease, Fold, Pour is a line of research that proposes a new method of casting freeform reinforced concrete geometries with the use of folded thin-gauge plastics as semi-rigid formwork. The research seeks to expand the architectural discipline’s ongoing exploration of flexible formwork processes beyond the predominant membrane tectonic (non-rigid textiles) by incorporating methods of folding. The act of folding, often relegated to ornamental paper and origami, remains an under-utilized tectonic operation in architectural lexicon.

The importance of concrete construction is without debate; it is one of the most prevalent tectonic tools of architectural construction and practice. Despite the increasing ease and ability to digitally describe complex geometries, the casting of reinforced concrete has remained largely restrained to rectilinear geometries. Contemporary examples of freeform concrete have predominantly relied upon rigid molds subtractively machined from larger stock—a process which remains time intensive, materially inefficient, and expensive.

Textiles used for tension-resisting formwork offer the advantage of being hundreds of times lighter than conventional rigid formwork. While acknowledging the formal beauty and efficiency produced from fabric formwork, Crease, Fold, Pour seeks to grant the designer new avenues of formal authorship without compromising its elegant efficiency.
The project seeks to hybridize techniques of fabric formwork and conventional rigid formwork construction as a means to diversify and expand the methods of casting freeform concrete geometry. The unlikely catalyst of this hybridized approach is origami. Folding techniques offer greater control, precision, attenuation, and articulation of concrete forms than the fabric formwork equivalent. Aided by the increasing prevalence and accessibility of software modeling tools, the practice of origami folding has attained previously unrealizable geometric precision and complexity as well as astounding rigidity by simply creasing a single intact sheet of flat stock material. This research posits that such techniques of folding, combined with customized tabbing techniques, can create viable, efficient, and formally innovative concrete formwork. The first phase of research concluded with the construction of a full-scale, site-cast, reinforced concrete totem (Figure 1). This totem was built from folded-plastic formwork and cast using a customized concrete recipe (Figure 2).

Although able to retain greater geometric definition and determinacy, one of the least-forgiving constraints of folded-plastic formwork is its inability to accommodate the outward hydrostatic pressure of freshly poured concrete. Like fabric formwork, folded-plastic formwork is vulnerable to distortion and material failure, requiring that large monolithic concrete forms be poured in shallow, sequential layers. Upon achieving final-set and sufficient compressive capacity, each layer of concrete can support the next without compromising the structure (Figure 3). This stratified pouring technique can thus avoid excessive accumulation of hydrostatic pressure, but raises new concerns such as insufficient bonding between strata, total length of set-time, surface bubble accumulation, and the necessity of incremental pour access points.

Despite these challenges, the totem was erected in three consecutive days of continuous pouring using a custom-designed, fast-set, self-consolidating concrete recipe. The completed prototype acts as a proof-of-concept to evaluate and demonstrate the tectonic integrity of folded formwork construction.

Research Assistants: Eric Pasche, Brandon Vieth, Lauren Bebry, Eric Meyer, Jason Prasad, Adam Smith

MACIEJ KACZYNSKI is a senior lecturer at the University of Michigan where he has taught graduate seminars on digital fabrication. He also acts as Assistant Director of the Taubman College FABLab. Maciej researches methods of novel material manipulation and tectonic assembly made possible by tools of robotic and digital fabrication. His research also focuses on upon the flow of material resources in the built environment and resultant waste streams.

Maciej has designed and constructed installations at the Whitney Museum of American Art, Artists Space NY, RISD, University of Michigan Museum of Art, and Art Prize. His professional experience includes work at MOS, KVA MAtX, Office dA, and Studio for Architecture. Maciej received his M.Arch with advanced placement from Harvard University and a Bachelor of Science in Architecture from The University at Buffalo, SUNY.