The Design and Research Studio Responsive Structures focuses on exploring concepts of folding as a form-generator for structural and architectural systems that allow the ability to respond to diverse social and climatic time-based scenarios. The studio will research the embedded kinetic possibilities of folded structures and focus on a parametric modeling process that allows performance evaluation of different types of origami surfaces. The workflow between scripting based form generation and physical prototyping will be established to explore the scalability from a thin microstructure to a thickened structure.

INTRODUCTION:
Architects and engineers are fascinated by the form-generating potential of origami, and the potential to build large-scale structures from sheets of folded, flat materials. Applications of origami and folded structures have been promoted in the past successfully for engineering solutions by researchers such as Robert J. Lang and Glaucio H. Paulino. In architecture, the concept of the fold echoes in Rem Koolhaas and Peter Eisenman, who understand folding as an aesthetic and programmatic technique in a series of projects such as the Educatorium in Utrecht, Netherlands, built in 1997. Foreign Office Architects (FOA) has also explored the potential of structural folding with their Yokohama Terminal project in 2002. But these projects don’t focus on the deplorability of a structure. Instead they explore frozen states for aesthetic, programmatic and structural purposes.

We will not only review different types of folding – with special focus on kinetic and structural properties - but also discuss the problems of producing these forms at the building scale. Special attention is given to static and dynamic stability. The research first aims to create a catalogue on different types, documenting their different tectonic and kinetic systems, which are used to investigate and develop a new range of physical systems. Secondly, the research explores the question if these newly discovered principles extracted from a microstructure can be “scaled up” to perform as structural and architectural systems. Within this process, representation (digital modeling, drawing and model making) is deployed as a mode of research.

METHOD:
Phase I - Geometry: The research will begin with selective modeling of folding mechanisms: these include man-made mechanisms and mechanism in nature.

Phase II - Prosthesis: In the second phase technological, artificial equivalents are proposed in different configurations based on origami folds, which index the valley and mountain folds, pleats, reverse folds, squash folds, and sinks. Both the folding processes between retracted and deployed states, and the in-between states of the system are investigated.

Phase III - Material: In the third phase, models and principles will be transferred into the construction of new architectural systems in consideration of different scales and scalability. The material selection and manufacturing strategies for origami-inspired architecture are of special importance. A number of issues arise from the scaling required to produce large-scale origami structures from conceptual models produced at small scale. These include material issues such as the selection of materials and whether the materials need to have the strain capacity for bending at the edges (as exhibited by paper) or whether complex hinge mechanisms need to be constructed to mimic the material folds.

Phase IV - Amalgamation: Each student will develop an architectural project based their research responding to changes such as climate, natural catastrophes, human interaction, program. Projects might include ephemeral architectures, large scale stadia, performance spaces, deployable refugee camps, buildings with responsive facades, deployable bridges, and others.