The research demonstrates the innovative use of fabrication technologies developed by RoboFold in the domain of curved folding within industrial, product and architectural design.

The integrated process from design to fabrication by RoboFold to incorporate curved folding in objects of multiple scales is described. The methodology of fabricating curved folded designs that incorporate the design of a form through the use of flat sheet materials is elucidated in detail, which includes experimentation, geometric analysis and form development. The changes in material behavior that occur in response to curved folding are explained in a broad sense. Geometric and material analyses that lead to optimization of the fabrication process are explained in detail with regard to the availability of sheet materials in the domain of industrial manufacturing.

The principle of folding has been long used to develop structural forms and spatial enclosures as well as to study the relationship of two-dimensional planar geometries and three-dimensional forms (Figure 1). The basic principle of folding is based on creases or score-lines (technically) which are classified as ridges and valleys, based on the direction of fold. Folding in geometry leads to new forms of inter-connected systems where all faces that are formed from a planar surface are interdependent in terms of
structural flow. This property can be exploited to create efficient structural systems such as folded plate structural roofs. Almost all the materials available in market come as flat sheets, straight out of the factories. The manufacturing industry is optimized to produce materials as sheets. This inspires and drives the principle of RoboFold to develop folded geometries from flat sheets. The folding technique incorporated by RoboFold is revolutionized by using robotic arms to fold specific sizes of metal sheets without using any molds. The control of this type of fabrication is done through use of sophisticated digital tools coupled with simple analog techniques.

RoboFold has patented the process to form metal directly using 6-axis industrial robots. No mold-tools are required to form the metal, giving the ability to design and customize the geometry of each part (Figure 2). The entire process, from design to production, is simulated and controlled in CAD (Computer Aided Design) software.

Curved folding can also be used as a form finding tool where a global form is informed by the curved folding experiments on a micro scale. Folded geometries using curved folds inherit a structural strength and exhibit an improved performance as opposed to straight folded geometries. Projects such as ARUM by Zaha Hadid Architects in the Venice Biennale 2012 is comprised of components of folded aluminium panels with varying morphologies. This was a result of the global form which informed the project and design of individual components. RoboFold provided consultancy services for this project and the linear approach could not be followed and the fabrication process was customized. It is suggested that principles of curved folding, applied with performance analysis tools, can inform large scale architectural projects and boundaries of the current systems can be pushed and explored further.

WORKS CITED
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GREGORY EPPS is the founder of RoboFold in London. Since graduating in 2007, with a Masters in Industrial Design Engineering at the Royal College of Art, London, he has found success with his own design consultancy Robofold, which focuses on machines that fold, software that can describe folding geometries, teaching design workshops about folding, and prototyping folded chairs, tables, lighting, and even building façade components. Gregory presented his work and ran workshops at various conferences including AAG/Paris, IaaC/ Barcelona, Bartlett/UCL, TU Delft/RDM Campus, DFAB/ETH Zurich and DHUB/Barcelona. Gregory is a regular external juror for project reviews at the AA DRL (Design Research Laboratory).