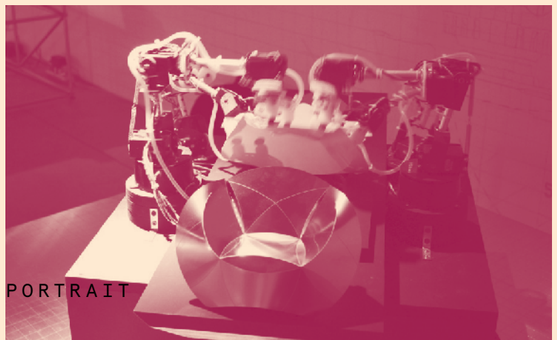
The Incredible Folding Man

Gregory Epps.

Gregory Epps designs by folding, with the help of six-axis industrial robots.

Text Terri Peters
Photos RoboFold

Scale model of Joris Laarman's Asimov Chair, which was produced by mini robots at the Friedman Benda Gallery.



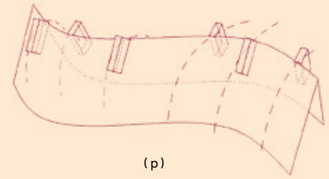
RoboFold's new studio space in Brixton.

Gregory Epps is an extreme folding enthusiast. While studying for his master's in Industrial Design Engineering at the Royal College of Art in London, he created a folding syringe, a folded metal butter dish, a Lego-brick crumpling machine, and a folded plywood structural system with a polypropylene skin that was used in the design of a small house (in collaboration with Unto This Last). Since graduating in 2007, he has found success with his design consultancy, RoboFold, which focuses on machines that fold, software that describes folding geometries, workshops that teach participants about folding, and a range of prototypes, including folded chairs, tables, lighting and building-façade components. 'I am a very empirical engineer,' he says. 'I like understanding a material or process through experience.' Epps is neither a computational expert nor a robotics engineer. He is a designer. Folding is his method, and robots are his medium. He is interested in the beauty of the industrial process and not strictly in performance and output.

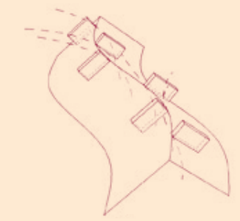
Forget Twitter or Facebook. In 2010 Epps founded curvedfolding.com, a social network and online resource for 'the folding community'. It's a virtual meeting place for developers of folding software, attendees of Epps-organized workshops and conferences, and people who make folded models: some 310 like-minded members who share diagrams, exchange software tips, and swap photos or screenshots of interesting folded constructions.

Despite Epps's interest in experimenting with large folding machines, his current workspace is surprisingly small. To find him, it is necessary to knock on a door marked 'gallery' that lends access to an old storage room on the Wandsworth Common railway station platform in South London. Sandwiched between the platform waiting room and the station office, this unlikely 4-x-3-m designer-in-residence studio is home to two laptops and a monitor that occupy a low desk above which, propped on shelves, are a number of hand-folded metal prototypes.

Sipping coffee made in the storage closet-turned-tea point and hovering over a 'do not sit' sign on a (folded) cardboard chair in the middle of the room, we crowd the space. The disused storage room has been Epps's studio and sometime gallery on and off for about 15 years. When he was a student, it was offered to him free of charge by a neighbour who worked for the railway. He likes it so much that's he ▷

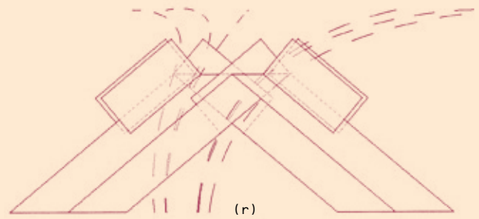


(p)



(q)

Patent drawing. The patent describes the predetermined movement of attachment devices through trajectories that describe the folding of a sheet of material with fold lines to indicate these trajectories. The images show trajectories for a curved folded surface.



(r)

During a three-week course that Epps taught at the RCA, student Marjan van Aubel designed a folded metal chair that celebrates the fabrication process.

been reluctant to move. 'I like the quirky location, and it's close to home,' he says. 'I built everything in here – mezzanine, toilet, sink, shelving – it's all very low-tech, which contrasts nicely with the high-tech nature of the business.'

But things are about to change for Epps, as he prepares to move into an industrial space that he will share with his four robots and CNC router. The robotics intern starts Monday, and he's spent the past week scouting potential warehouse studios in Brixton. The new space will be used in September for workshops accompanying the Shape to Fabrication conference that he's organized, as well as for regular training workshops devoted to experimentation with the RoboFold process. 'We are trying to scale up as fast as possible in order to fund the capital equipment; the conference is a good way to do this and to market ourselves at the same time. The conference exhibition is timed perfectly to coincide with London Design Week, which will bring awareness of the architectural possibilities of the technology to designers – they can play off one another.'

Epps's patented curved folding method is able to incorporate complex geometries designed using the latest digital design software and a material-specific, process-focused approach. For his first high-profile commission, Epps worked with designer Joris Laarman on the Asimov Chair (2009). Part performance and part product, the chair took shape at the Friedman Benda Gallery in New York, where mini robots folded sheet metal to make each model chair, exerting exactly the right amount of pressure to the curved creases to create the desired folds. 'Laarman provided a design that proved difficult to engineer, but we managed to develop a robotics system that could handle it. Usually employed by hobbyists, the small robots have many limitations; after a few weeks of folding, they lose their accuracy.' During the exhibition, the robots produced a limited edition of 1000 chairs made of acid-etched stainless steel at 1:10 scale. 'The next step would be to take it to full scale with Vitra, but should this happen, it will be with a different design. The design of the Asimov makes it unsuitable for real-life use, but it is a beautiful way to demonstrate the technology.'

Initially, Epps thought his ideas would be more interesting to car designers than to architects. As a graduate with start-up funding from Design London, he went to an automotive show with some mock-ups of car designs that used six-axis robots programmed to simultaneously pick up and fold metal, thus illustrating the concept of curved folding. 'Robots are so common in assembly lines,' he says. 'They last about 100,000 hours, and their cost is proportionate to how much time they have left.' He brought three little robots and ran the demonstration every day for a week. An early client, BMW, saw the potential in Epps's approach and commissioned a small project. 'They showed us a design, and we simulated how we could fold it – what the material could do. But when the recession hit, the automotive industry didn't seem like such a great idea any more.'

He began thinking about new possibilities for robotics in industries already interested in such technologies, such as architecture and furniture. 'Most robots in architecture have been used to pick things up, stack things, move things. I want to go beyond that.' His technology offers a new way to build cladding components and to design objects with the level of complexity that the architect has long been able to conceptualize using digital tools. 'We also get multiple robots to work together; the quadruple power of four six-axis robots allows you to do just about anything.'

Currently, Epps is working on a new chair design that, like the Asimov, celebrates the fabrication ▷

'Let the possibilities of the material guide you, and the result will be unexpected'

Prototype of the Intersection 01 table.

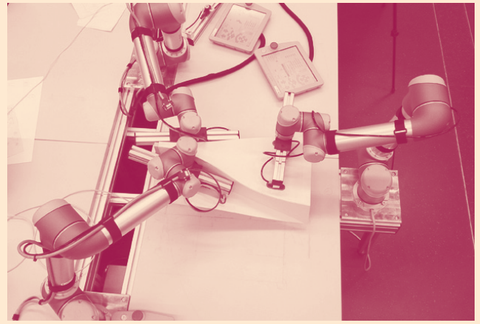
‘I don’t agree with just designing from ego’

process. The design came about during a three-week course he taught at the RCA, where Epps saw a folded metal chair by one of his students as a potential design for testing the RoboFold ‘on demand’ manufacturing method. ‘The idea is that the client could come into the studio, push a button, and watch the robots grip a sheet of metal and fold it and twist it into “his” or “her” chair.’ The chairs would be the same, but they would be made one by one.’ As a designer, Epps would focus on the design and fabrication processes rather than on the output. ‘The sheet of material sits on a box, which becomes part of the chair. The robots push the sheet down, over the box, to make the seat. Then they fold it and pull it over again to make the arms before fixing it back to the box again.’

Epps elaborates: ‘This is a process-based design methodology, where certain conditions are set up, and if you follow them the results are, in a way, automatically produced.’ When he is teaching, this is the point he tries to communicate to his students: what’s important is to understand the inherent properties and limitations of the material, rather than simply to design a shape and then figure out how to build it. ‘I don’t agree with just designing from ego. I think you can too easily end up with shallow results.’ Most of the forms his students come up with are not suitable for RoboFold. Sometimes the curve is too tight or the material too thick. Sometimes the folds required are too deep, causing the material to split.

Intersection 01, a new table design by Epps, reveals the underlying strategy. ‘The table is essentially one surface with one join, but for ease of manufacture we would make it from four pieces. The structural integrity of the table is a result of enclosing a volume with this particular fold pattern. The strange points on the underside occur as the folded surfaces self-intersect where they join along their free edges; relinquishing control in certain areas allows us to control others with more fidelity. This is a general theme in my teaching and practice: let the possibilities of the material guide you, and the result will be unexpected but far more interesting.’

Folding diagrams for the Intersection 01 table.



The design and manufacture of façade panels in Fabio Gramazio and Matthias Kohler’s DFAB studio at ETH Zurich. Co-tutor at the workshop was Dan Piker.

Epps claims he has no plans to scale up the RoboFold process to produce designs for a whole folded building. ‘The process of architecture is so absurdly long that it doesn’t make sense to me. But I would consider doing smaller projects that just happen to be buildings.’ Balanced on the top shelf in his studio is a series of crumpled, hand-folded metal prototypes of façade panels. ‘When Frank Gehry folds a piece of paper as a concept model, it is the whole building he is thinking about.’ Epps’s approach is different. ‘When we fold a piece of metal, we’re thinking about a façade panel or a roof element. A RoboFold component clipped onto an existing façade could be a nice visual accessory.’

Quite recently, a client in New York asked for 1500 curved folded panels for the interior wall of a restaurant. ‘The wall is not meant to be one of those blobby forms, designed with digital tools to create the perfect undulating surface. Building a smooth curving surface is easy nowadays, but this wall – slightly textured and folded – will be something different and more interesting.’ ◁

www.robofold.com