The shape that didn't want to be a box!

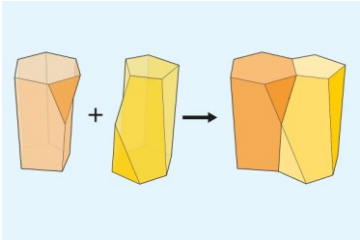


One of the fantastic features of this year's Symposium were the containers used to hold treats for delegates. These are based on the "Scutoid" shape that was only discovered in recent years, and has been cleverly designed into a foldable box by Mitali and Divya Atkins, the founders of Scutoid Design. Mitali and Divya Atkins provide a fascinating insight into this object and their journey in evolving the shape into a container that doesn't want to just be a box!

What is a Scutoid, who discovered it, and why is it important?

Not a term you've come across? Not surprising as it was coined less than ten years ago! Think of a Scutoid as the unsung geometric hero of your own body. It's a shape that mathematicians didn't even have a name for until 2018, yet it is a key feature of human and animal bodies, and thought to be in plants too.

The Scutoid is a geometric solid. It is characterised by having a different polygon at each of its two parallel ends (most commonly a pentagon at one end, and a hexagon at the other). The ends are connected by an additional triangular face that emerges partway along one of the lengths. This extra face is what makes the Scutoid unusual: it means the shape is not the same from top to bottom, and technically rules it out as a true polyhedron, since not all of its faces are flat.



In reality, Scutoids are not a single shape, but a family of shapes. The number of sides at each end can vary, giving rise to different members of the same geometric family, all sharing that characteristic mid-level transition.

In 2018, it was discovered that the Scutoid is the shape all our epithelial cells adopt when tissues bend during development. Epithelial cells form the lining of skin, organs, and body cavities, and as an embryo develops, these cells must curve and pack tightly together to build complex three-dimensional structures. The discovery of the Scutoid solved the long-standing conundrum about tissue packing: How do cells tile both surfaces of a curved tissue without gaps or overlaps, while minimising the energy cost of maintaining contact with their neighbours?

This discovery came through computational modelling. The research was a US-EU collaboration led by Javier Buceta, associate professor of bioengineering at Lehigh University, and Luis M. Escudero of Seville University in Spain. Using Voronoi diagramming – a mathematical tool for understanding geometric organisation – their model predicted that as tissue curvature increases, cells cannot be accommodated by columns or bottle-shapes alone. The model was pointing to a shape that, as Buceta put it, "didn't even have a name in mathematics" [1]. The team then verified the prediction by examining cell packing in real tissues from zebrafish and fruit flies, and found the shape was already there. The results were published in Nature Communications [2].

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The name for the new shape was chosen for the shape's resemblance to the scutellum – the triangular part on the back of a beetle's thorax. The word Scutoid also traces back to the Latin “Scutum”, meaning Shield – fitting for a shape that nature uses to protect the lining of living tissues.

Beyond its biological significance, the Scutoid has implications for tissue engineering and regenerative medicine. Understanding how epithelial cells pack in three dimensions could inform the design of tissue scaffolds – the biodegradable structures used to help cells regenerate – and may eventually help researchers grow artificial organs that more accurately replicate how nature builds them.

From cell shape to cardboard container

Scutoid Design was incorporated in 2023 as a product and industrial design firm. With a passion for innovation, Mitali and Divya Atkins picked up their next challenge: to make Scutoid-shaped packaging, inspired by the name they had chosen for the company.

The Scutoid box began as an exploration of an extraordinary and unique shape. We were intrigued by how the Scutoid's dual geometry could offer something aesthetically and functionally different for packaging. A pair of Scutoids would create two perfectly tessellating compartments. Each would be a complete box within itself, seamlessly integrated into the pair. This offers a unique way to present a product and its accessory, or a gift and its companion piece, two flavours, two samples or two halves of a set for gifting at events.



The most challenging task was to create a net. A net is the flat template that folds up to form a three-dimensional box, and designing one for a Scutoid is considerably harder than it sounds.

The faces between the two polygonal ends of a Scutoid are not flat in the strict geometric sense – they curve subtly as they bridge the transition between the hexagon and pentagon. Treating them as ordinary planar faces, as you would in a conventional box, leads quickly to a geometry that simply won't fold correctly. The angles don't resolve. The edges don't meet. The box refuses to close. The process was entirely iterative: fold, assess, adjust, repeat.

"A net is the flat template that folds up to form a three-dimensional box, and designing one for a Scutoid is considerably harder than it sounds"

However once the basic net existed, we discovered that it was not a single solution, but a starting point. The geometry of the Scutoid allows for many different net configurations – different ways of folding a flat sheet into the Scutoid shaped pairs of containers.

Of everything that came out of this project, for us, one detail stands above the rest. We were able to design the Scutoid pair to be a single net, folded, that becomes two complete Scutoid boxes. One net in; one pair out.

We were honoured to provide The SCSC with the first 150 of these packages customised for the Symposium, filled with sweets for delegates! Perhaps you can think of a use in your company or event where these might help deliver gifts and act as a great talking point!

The Scutoid packaging is UK Design Registered, number 6496179.

References

[1] J. Buceta and L.M. Escudero, "Learn About the Scutoid," P.C. Rossin College of Engineering and Applied Science, Lehigh University, Bethlehem PA, https://engineering.lehigh.edu/bioe/research/learn-about-scutoid, accessed May 2026

[2] P. Gómez-Gálvez et al, "Scutoids are a geometrical solution to three-dimensional packing of epithelia", Nature Communications, vol. 9, article no. 2960, Nature Publishing Group, 27 July 2018. ISSN 2041-1723.

Dr Divya Atkins



Divya Atkins has a background in Computer Science, and has conducted research in formal methods, high-integrity and real-time systems and software metrics. Her experience includes safety-critical development, and project management, and she is interested in computer and network security. Aside from her technical expertise, she has a passion for sustainability, design and craft, which led her to co-found Scutoid Design with Mitali.

Mitali Atkins



Mitali is a product designer by training, having graduated from Central Saint Martins, University of the Arts London. She co-founded Scutoid design with Divya while still completing her BA degree in 2023.

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