PRESS TO OPEN

Nature-Inspired Design for Easy-to-Open Metal Cans

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Opening packages is a struggle for many individuals. 40% of people have a daily struggle with opening packages, and even 55% have injured themselves trying to open a package. One of the packaging types that people struggle with the most is metal cans. This everyday struggle highlights a need for a more accessible and intuitive opening.

RESEARCH QUESTIONS

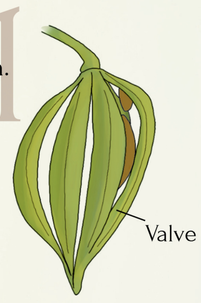
- How does nature achieve sealing, protecting, and controlling access?
- How can biological strategies inspire a safer, user-friendly opening mechanism for metal cans?

BIOLOGICAL INSPIRATION

Using a top-down and biology-pull approach, several organisms were examined as possible inspiration for a more intuitive opening mechanism. These included explosive seed pods, shellfish, the heart valve, the Venus flytrap, and the touch-me-not plant.
Explosive seed pods (Impatiens glandulifera) were studied in more detail and were the main source of inspiration. These pods store tension between a rigid inner layer and an astringent outer layer. When stimulated, weak zones break, after which the built-up energy is released, and the seeds are launched. The detailed biological mechanism is illustrated below.

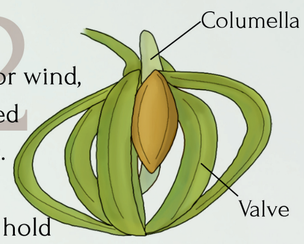
1

The seed pod is under significant stored tension. An outer layer of cells actively tries to contract, but is restrained by a stiff inner layer, storing energy like a stretched spring. The pod is held together at its seam (dehiscence zones), which weaken as the fruit matures.



2

A stimulus, like a light touch or wind, provides the final force needed to break the weakened seams. This break acts as a trigger, releasing the constraints that hold the pod's valves in their stressed, bowed shape.



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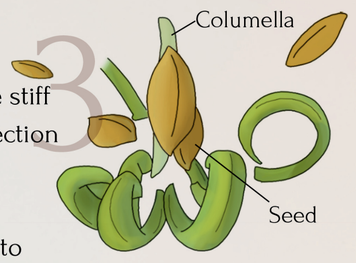
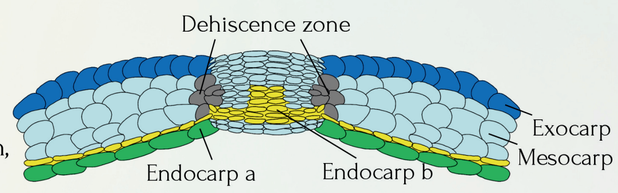
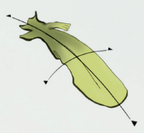
Once triggered, flexible zones in the stiff inner layer allow the valve's cross-section to instantly flatten. This geometric change unlocks the stored energy, allowing the contracting outer layer to power an explosive coiling that launches the seeds.

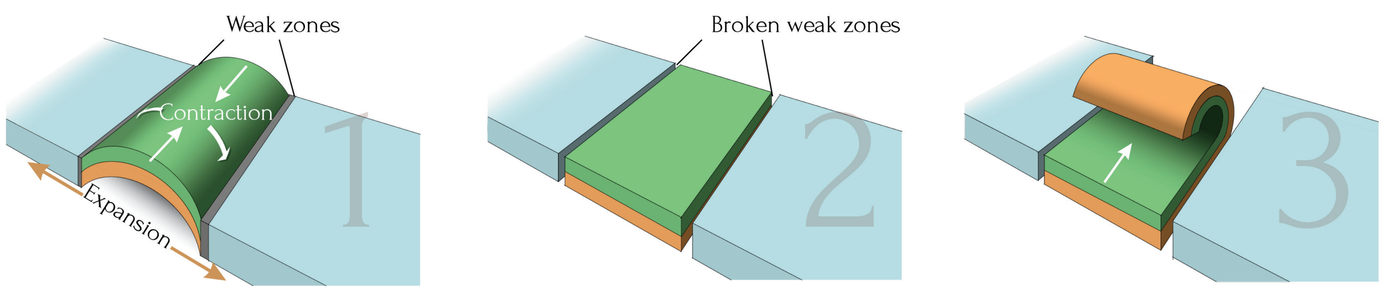


Elastic strain builds as the outer exocarp contracts against the stiff inner endocarp b. As the fruit matures, weak dehiscence zones form. When these rupture, flex points in the endocarp b let the valve flatten, releasing stored energy and triggering explosive coiling.





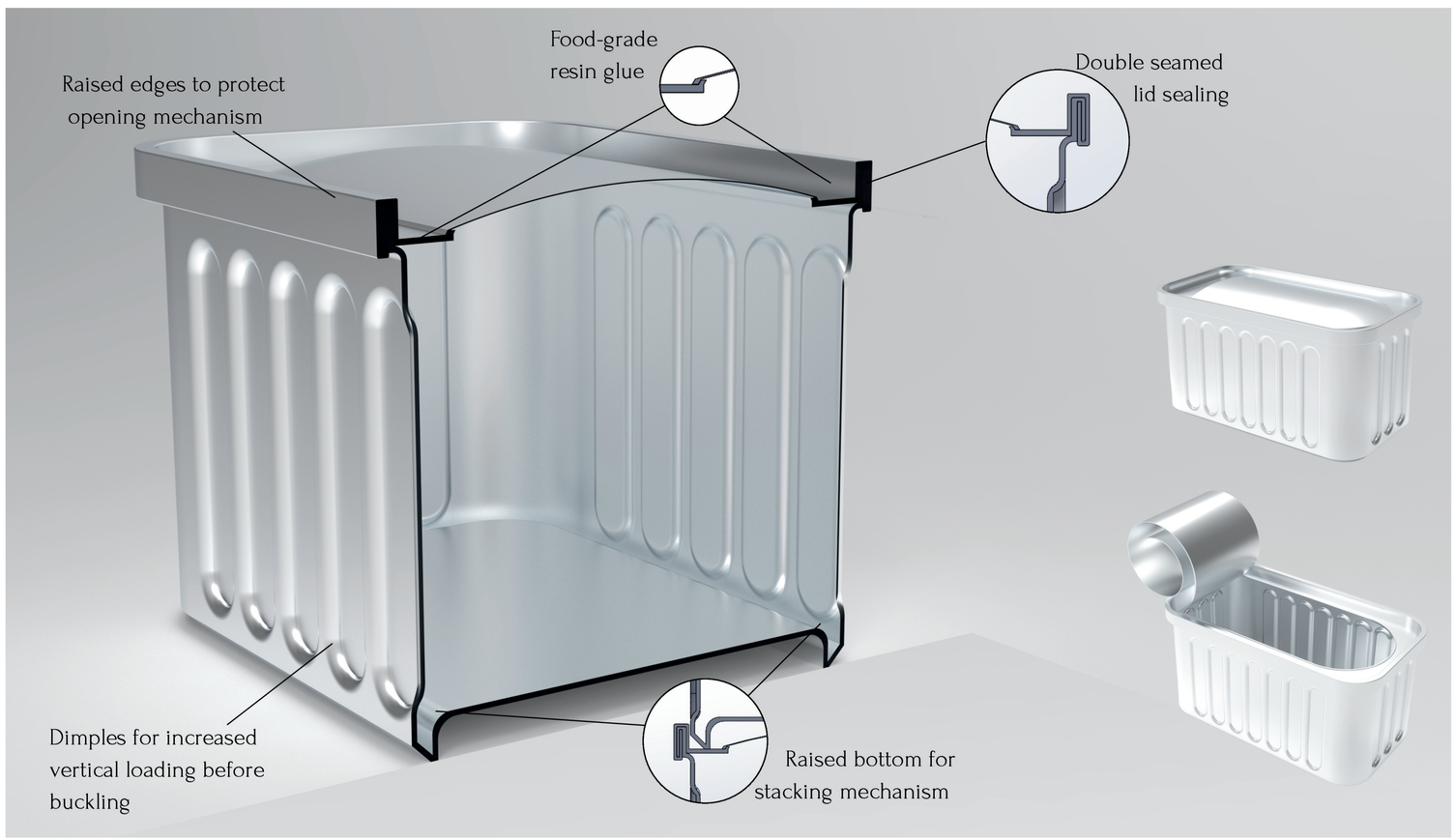
Elastic energy builds from opposing forces: the outer exocarp contracts via turgor pressure, while the stiff, asymmetrically lignified inner endocarp b resists. This internal tension drives explosive seed dispersal.



A bilayer structure uses an active outer layer that contracts in one direction against a much stiffer inner layer, building up elastic tension. At selected weak points, designed interfaces between the layers, a small trigger (such as touch or internal pressure) causes these zones to fail. Once they give way, the valve snaps from a bowed to a flat shape via built-in flexures, instantly releasing the stored energy and producing a rapid coiling motion.

DESIGN TRANSLATION

A Biology Design Principle (BDP) and Abstracted Design Principle (ADP) were elaborated for the explosive seed pods to develop a solution inspired by nature. With the BDP, the biological principles and functions behind the explosive seed pods were analysed, understood, and represented. In the ADP, these biological strategies were translated into an engineering design solution by using the underlying mechanisms of action.



In conclusion, a safer and better way to open metal food cans was designed. Using the biology-pull method, the exploding seed pod inspired a mechanical principle with two layers forming a bi-state material. This was applied to a redesigned can with an optimised opening mechanism. Future steps would be to optimise the design further, looking at the glue needed for the lid in more detail, and the recyclability of this can.

OPENING MECHANISM

Inspired by explosive seed pods, the metal can opens by releasing stored energy. A small touch triggers a chain reaction, causing the upper metallic layer to instantly coil away.

PRIMED STATE

The can is sealed with a metallic lid engineered to function like a slap bracelet. This lid stores elastic energy in its sealed, bowed shape because it naturally wants to coil. When triggered by a simple press, it releases this energy to coil open. This design simplifies the concept from the ADP into one layer, which is beneficial for manufacturing, recyclability and cost.

TRIGGER

The user applies pressure with the finger, starting at one side of the bowed valve and moving across its length.

SEAL FAILURE

This progressive press-and-slide motion concentrates force along the adhesive line, causing this "weak zone" to peel apart and fail sequentially, like unzipping a zipper.

OPENING ACTION

As the adhesive seal breaks, the valve is released from its constraints. It instantly releases its stored energy by first flattening its cross-section and then rapidly coiling backwards, tearing away from the opening and providing access to the content.

- Deegan, R. D. (2012). Finessing the fracture energy barrier in ballistic seed dispersal. Proceedings of the National Academy of Sciences of the United States of America, 109(14), 5166–5169. https://doi.org/10.1073/pnas.1119737109
- Denny, M., & Miller, L. (2006). Jet propulsion in the cold: mechanics of swimming in the Antarctic scallopAdamussium colbecki. Journal Of Experimental Biology, 209(22), 4503–4514. https://doi.org/10.1242/jeb.02538
- Hofhuis, H., Moulton, D., Lessinnes, T., Routier-Kierzkowska, A.-L., Bomblies, K., Dello Ioio, R., Jönsson, H., Hay, A., & Smith, R. S. (2016). Morphomechanical innovation drives explosive seed dispersal. Cell, 166(1), 222–233. https://doi.org/10.1016/j.cell.2016.05.003
- Poppinga, S., Gude, M., Zollner, M., Mischo, B., & Speck, T. (2012). Finessing the fracture energy barrier in ballistic seed dispersal. Proceedings of the National Academy of Sciences of the United States of America, 109(12), 4363–4368. https://doi.org/10.1073/pnas.1119737109
- Sloot, R., Flinterman, L., Heins, M., Lafeber, M., Boeije, H., Poos, R., Eysink, P., Nielen, M., & Korevaar, J. (2016). Reumatische aandoeningen in Nederland: ervaringen en kengetallen. Nvt. https://www.narcis.nl/publication/RecordID/publicat%3A1002985