Tri-Dimensional Printing as an Advanced Technique in Manufacturing Bioinspired Materials

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Research objectives

Enhance the understanding of the successful mechanisms found in biological materials with the aid of 3D printing. Specifically analyzing:

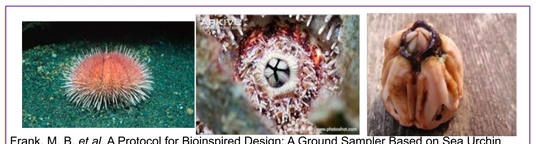
- Structure and function relationship
- Mechanical properties
- Scalability

Background

Nature, through the mechanism of evolution, has developed strategies to produce remarkable biological materials and structures. These systems are often multifunctional, adaptable, self-assemble, and have hierarchical characteristics which contribute to their unique properties that distinguish them from synthetic materials. Understanding nature's motifs provides insight into novel design architecture that is necessary to produce superior synthetic analogs. Tri-dimensional (3-D) printing is a rapid prototyping technique that can generate intricate 3-D structures. This advanced technique is used to replicate the defining characteristics of biological designs to further understand nature's effective mechanisms.

Extract defining characteristics

Aristotle's lantern

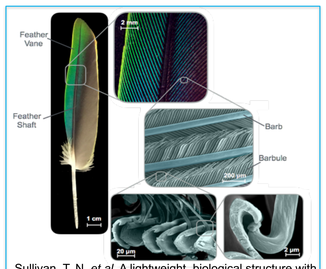


Frank, M. B. *et al.* A Protocol for Bioinspired Design: A Ground Sampler Based on Sea Urchin Jaws. *J. Vis. Exp.* 1–8 (2016). doi:10.3791/53554

Seahorse tail

Shellac / CC BY 2.0.

Feather Barbule



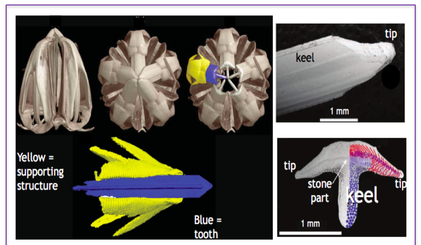
Sullivan, T. N. *et al.* A lightweight, biological structure with tailored stiffness: The feather vane. *Acta Biomater.***41,** 27–39 (2016).

Whale baleen

B. Wang et al. Unpublished.

CT Scanning as a model for 3D printing

Aristotle's lantern



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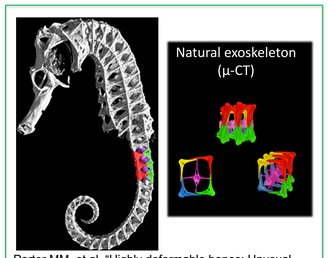
Seahorse tail



Porter MM. et al. "Highly deformable bones: Unusual deformation mechanisms of seahorse armor," *Acta Biomater*, **9**, 6763-6770 (2013).

SEM as an alternative tool

Feather Barbule

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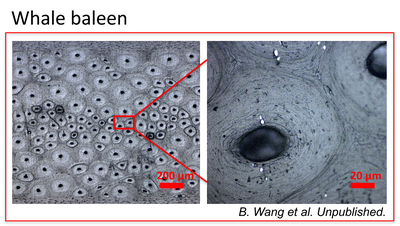
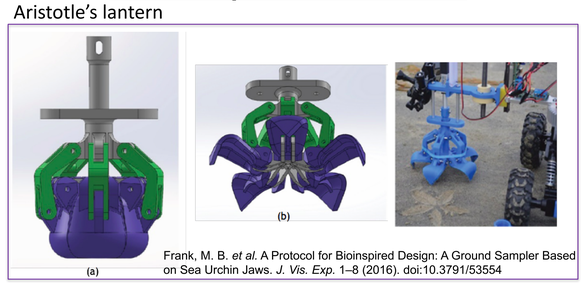
Whale baleen



B. Wang et al. Unpublished.

Bioinspired devices

Aristotle's lantern



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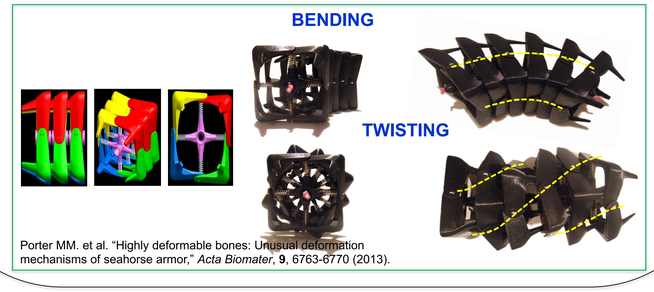
Seahorse tail



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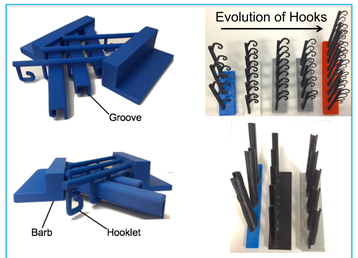

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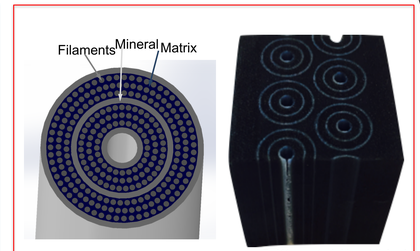

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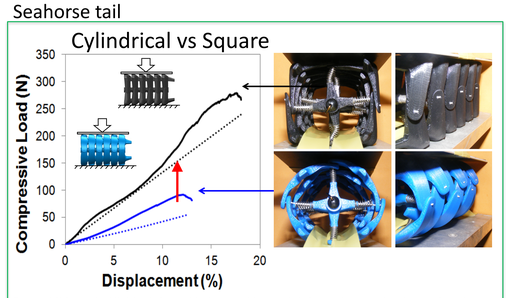
Mechanical properties testing

Seahorse tail



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Conclusion

- 3D printing is successfully used to enhance our understanding of biological materials
- Bioinspired devices capture the principle features of biological structures
- As manufacturing technologies continue to improve, our capability to integrate 3D printing into our research increases.