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# A Review of Origami and its Applications in Mechanical Engineering

*Undergraduate Library Research Award Essay*

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Composing a *review* paper in any academic field requires a complete and thorough exploration of every available resource related to the topic. In order to capture the current state of the art in origami engineering, I wrote a review paper on applications of origami in mechanical engineering. The project acted as a comprehensive introduction to any engineer entering into the field, making it inherently research intensive. The amount of research required was amplified by the fact that origami engineering is a recently developed yet very active field of study. Today, origami is applied to a wide variety of engineering challenges, ranging from minimally invasive surgical tools and artificial stents to deployable shelters and solar panels in space. To synthesize the entirety of this developing field with the goal of promoting future research, I relied on the resources and services provided by the library system at the University of Notre Dame.

From the outset, studying a new field within engineering was a daunting task. I began two summers ago in the Engineering Library, where I was able to find several textbooks on geometric folding algorithms and computational geometry. These subjects laid the foundation for mathematical origami, which is the theoretical basis for engineering applications. I was able to use textbooks, electronic journals, online searches, and video lectures to dive into the scientific study of a field I had previously only considered a traditional Japanese form of art. I compiled a report over 80 pages long detailing the algorithms and theories used to model and understand folding and unfolding.

Using this knowledge as a starting point, I composed a comprehensive review paper in origami engineering this year. I compiled all available information, including an organized overview of all the current applications, to provide a foundational understanding

of the field. Furthermore, this review acts as a catalog of the major relevant resources that can guide interested readers to additional information. To write a successful review paper, it was necessary to capture the *entire* current state of the art. The online library resources afforded me this opportunity. Key word searches for terms like “origami engineering” and “origami-adapted design” returned hundreds of results and the data collection phase of my research took off. I quickly became more adept in my searches, filtering the papers by the number of times they had been referenced and excluding topics beyond the scope of a mechanical engineering focused review. The library staff encouraged my work and was always very eager to provide assistance and offer advice. One tip that greatly aided my ability to access information was to obtain papers that were referenced by studies that I had previously read. This research tactic allowed me to trace contemporary research back to its origins, which ultimately led to a deeper and more complete level of understanding.

As I began to envision the structure of the publication, it quickly became clear that I had to organize the information in an original and informed manner. To further guide my research, I subdivided the application space into the three main areas that I deemed appropriate: (1) delivery, packaging and storage, (2) manufacturing, and (3) structures. These are the overarching themes that define the current endeavors in origami engineering. Under these headings, I was able to classify each of the research studies I obtained from the library and synthesize findings from over 215 publications into a structured review. Extensive use of the library’s print sources, electronic journals, and loan system allowed me to gain a thorough perspective on origami engineering and compose a comprehensive review of the subject.

I compiled the final manuscript in LaTeX and managed the bibliography in BibTeX. In the end, I had consulted over 30 different academic journals, 10 conference proceedings, and various other materials through the library's print sources, electronic databases, and interlibrary loan system. I relied on the University's access and membership to engineering publications—which I primarily acquired through the Web of Science, Google Scholar, and the OneSearch feature of the library's website—to build my full evaluation of origami engineering. In the completed review, 178 research findings from multiple media were directly referenced. However, it was necessary to submit an abbreviated report for publication, which referenced 96 sources. This version of the review paper is currently being considered for publication in the *Journal of Mechanical Engineering Science*.