



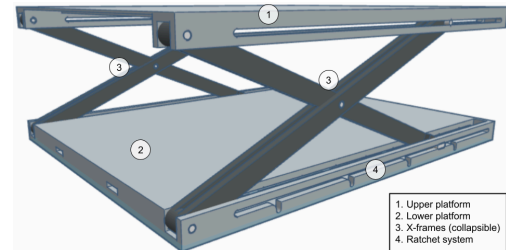
Crucial Issue: As our world becomes more interconnected, trading internationally and domestically through shipping has become key. In fact, shipping transport consists of 250 *million* shipping container trips made yearly, resulting in major economic and environmental implications. Therefore, optimization of shipping transport is crucial. Contrarily, on average, **24% of every ocean container's volume is *unfilled*** (according to D.S. Smith). This overwhelming inefficiency results in unnecessary container trips and CO₂ emissions emitted which is compounded with an increasingly expensive industry suffering rising delays. In 2022, transporting a container from China to the United States **cost 12 times as much** as it did only 2 years prior, while the time it took to make the journey **nearly doubled** (according to the New York Times). As time passes, shippers are being forced into a worsening situation where *profit decreases* through the combination of **higher costs** paired with less revenue generated due to **increasing delays**. Space inefficiency magnifies the issue through more congestion in ports leading to more delays and less goods shipped per container, generating less revenue. Furthermore, maritime shipping results in approximately 3% of global greenhouse gas emissions, surpassing airplanes (according to Yale Climate Connections), an issue only exacerbated through increased shipping trips made due to inefficient space usage. As trade increases through a more connected world, these issues will only worsen, making optimization **vital**. Shipping containers contain empty space largely due to weak packaging preventing the stacking of products. After analyzing shipping manifests, we found that 48% of packages were “un-stackable”, showing the significance of the issue.

Crucial Solution: FlexShelf is a height-adjustable platform that places “un-stackable” products on the bottom platform while additional cargo is loaded on the top platform, maximizing vertical

space usage.

Design, Unique Value, & Benefits: FlexShelf's incorporates the following principles to maximize optimization:

1. Disruption avoidance. Modifying existing ocean containers or creating new, modified ones would increase overall costs and be highly disruptive to the existing established system of container shipping.



2. Height adjustability. Shipping manifests show widespread variety in package dimensions.
3. Collapsibility. FlexShelf must be fully collapsible so it can be easily returned to the point of origin, especially in cases of volume imbalances during trade.

The next best alternatives fail these crucial principles: AutoDeck utilizes costly and disruptive modifications, making it infeasible and unlikely to be accepted into mainstream usage. Meanwhile, ConEXTRA/ConFLEXTRA is not collapsible, making it inconvenient to ship back to the point of origin. Further, it is intended for only lightweight storage, and is therefore unsuitable for heavy packages and tumultuous conditions. Also, both AutoDeck and ConEXTRA/ConFLEXTRA are not designed for intermodal shipping, making them inconvenient for use. As a result, FlexShelf is the most efficient design in the current state of the art for increasing space usage efficiency in intermodal shipping containers.

FlexShelf is approximately 10 feet long. The primary material is recycled aluminum for the platforms and frame, and steel for ratchet pins. FlexShelf weighs 1,000 lbs and supports 8,000 lbs of cargo. While there is a 58,000-lbs weight limit for a 40-foot shipping container, FlexShelf easily stays within this limit, and our analysis confirms that increased volume efficiency through

FlexShelf would outweigh the sacrifice of weight. FlexShelf also operates within internationally accepted standard shipping protocols, making it easy to implement. FlexShelf can be loaded into shipping containers using a forklift; at its destination, FlexShelf can be reloaded with goods designated for the point of origin or collapsed and returned to the point of origin.

We found that on average, FlexShelf could globally improve average volume efficiency from 76% to at least 86%, a 13% improvement, nearly *halving* the inefficiency present in current shipping containers. This has immense implications:

1. 25 million shipping container trips (out of 250 million made annually) could be saved each year, reducing congestion at shipping ports.
2. 51 million tons of CO₂ emissions (out of 940 million tons generated by the shipping industry) could be reduced each year.
3. 13% increase in revenue on average for each trip.

These benefits are of utmost importance and timeliness considering the supply chain issues plaguing the U.S., as seen in the extreme congestion in the Los Angeles port during 2021, the increasingly dire need to reduce greenhouse gas emissions, and the rising cost of shipping.

Price & Cost, Market Size & Revenue: FlexShelf is inexpensive and easy to implement. The supply chain to manufacture FlexShelf already exists: X-frames are used in automotive storage products, such as Autostacker. Therefore, adapting these established procedures for shipping containers would only require higher volume production of existing parts rather than the development of new facilities. As a result, based on economic analysis, the retail price of products using similar designs such as Autostacker, and opinions of experts, we estimate the manufacturing cost of FlexShelf to be \$2,000 per FlexShelf, though this will likely become lower through economies of scale, while the market price would be \$3,000 per FlexShelf. The 13%

increase in volume efficiency within a shipping container, which directly translates to a 13% revenue boost per trip when using FlexShelf, and since today's cost of shipping a 40-foot container from China to the U.S. is \$20,000, we can conclude that the revenue boost would allow FlexShelf to pay for itself in fewer than 10 trips. The materials used also ensure that FlexShelf can last for upwards of 10 years, making it highly feasible.

Due to FlexShelf's inexpensive, feasible, and implementable nature, it is highly marketable to our customers, who primarily consist of companies that handle the packing of goods for intermodal shipping, which includes both overseas and overland shipping. FlexShelf is the only suitable solution to the space inefficiency issue while simultaneously turning a greater and more productive profit for our customers. Further, FlexShelf has enormous potential for reducing greenhouse gases, making it desirable for companies looking to cut down on emissions. Overall, there are thousands of cargo shippers internationally. As a result, the target audience for FlexShelf is sizable—and still growing. The shipping container industry is valued at USD 6.8 Billion (2022) and is projected to reach a value of USD 15.5 Billion (2030) at a CAGR (Compound Annual Growth Rate) of 12.5%, showing it will constantly be expanding. With a more and more globally interconnected world, trading between nations will increase, resulting in a higher need for shipping, especially overseas. Also, as developing countries grow, demand for consumer goods will increase, resulting in more shipping as well. Therefore, inventions, such as FlexShelf, that make this process more efficient will be highly prized. With a growing industry and an immense number of customers along with a highly marketable product, FlexShelf retains a high value as a product, even in the long term.

From a producer's viewpoint, each sale of a FlexShelf gives a revenue of \$1,000. Revenue produced by FlexShelf is projected to be very high, especially since an average of 2.6 million

TEU (twenty-foot equivalent unit) of containers are produced annually and there are currently 30 to 40 million shipping containers in use. Due to the constantly increasing amounts of shipping containers, FlexShelves will always be in demand. Therefore, FlexShelf, even if it is only used in 1% of newly produced containers, would still turn a profit of \$26 million.

Implementation & Customers: Throughout our design and implementation process, our team has been in contact with experts. Discussions with Ravi Chavali, a mechanical engineer, made FlexShelf more robust and improved weight reductions for increased efficiency. Mr. Anthony Bruzzone, director of the international shipping incorporation, Bruzzone Shipping Inc., told us that FlexShelf could help “offer significant flexibility and competitive edge to consolidated shippers, reducing unnecessary volume and alleviating stressors at shipping ports that are creating bottlenecks.” Since beginning this project in 2022, the team has continued working on it. After the initial submission of FlexShelf during the First Lego League 2022 season, the team has submitted a patent for FlexShelf, visited shipping ports to better understand the unloading and loading process, in which FlexShelf’s pre-load plan would be implemented, made changes to our design to increase efficiency, and reached out to potential customers. We have already found customers, one of whom is Bruzzone Shipping Inc. Importantly, Mr. Bruzzone has informed us of several clients that could benefit from a product like FlexShelf immediately. We are in the process of reaching out to these clients.

Our Vision: FlexShelf is highly valuable as a product both to customers and to producers, and holds enormous value in increasing volume efficiency, therefore leading to substantially more efficient shipping. FlexShelf benefits not only shippers, but also the lives of day-to-day people by improving the supply chain they rely on for necessities and more. Our mission is to make this innovation a reality to improve the world on a global scale.