

Additive Manufacturing of Emergency Food & Liquid Storage Solution

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1. Executive Summary

Disasters, both natural and man-made, can wreak havoc on people's lives, homes, and communities. Access to basic requirements becomes essential for survival in circumstances like these. The provision of needs, such as food and water to disaster victims, comes first in the aftermath of disasters like earthquakes and hurricanes. Planting, particularly for food storage and distribution, is crucial to meeting these victims' longer-term requirements.

To guarantee that the disaster victims have a steady supply of food, food storage is required. This can make use of methods that enable the distribution of vast amounts of food, but it can also be used to store food for specific families. The practicalities of getting food from storage facilities to those in need must also be taken into account. This may entail finding ways to distribute food to affected communities, such as by establishing food distribution facilities or even mobile food trucks. Effective food distribution and storage during emergencies can save lives. According to the International Food Safety Authorities Network, “food in affected areas may become contaminated with dangerous microbiological and chemical agents” [1]. This is why there is a great necessity to be able to transport clean and healthy packages of food to the victims within disaster areas. Proper planning and preparation can help ensure that those affected by disasters have access to the necessary resources for survival. It is essential that governments, aid organizations, and individuals work together to plan for the immediate and long term needs of disaster victims, including food storage and dispersion.

The solution proposed by the team is a stackable rectangular prism-like container that is designed to keep the contents within it fresh and protected from external elements, such as air, moisture, and contaminants. The container part of this design is made of plastic. It also has an airtight seal that prevents air from entering or leaving the container. In the context of food storage and dispersion for disaster victims, these prism-like containers can be an essential tool.

2. Industry Overview

The lack of effective food preservation and storage techniques is what spurred the development of airtight containers. In catastrophe situations where power may be unavailable, conventional methods like refrigeration may not be reliable. Also, if perishable food items are not stored properly, they can swiftly decay. For those affected by calamities, inadequate food storage can result in food shortages, malnutrition, and other health issues. Food may be stored safely and securely in airtight containers, which can be moved to different locations as needed. This helps catastrophe relief efforts succeed by ensuring a consistent supply of food for disaster victims.

In the event of natural or man-made calamities, the lack of food storage and preservation is a severe commercial and scale concern. The World Food Programme estimates that there are 828 million people who do not have access to enough food, and natural disasters can make this situation worse [2]. Poor food preservation and storage can cost a lot of money because of things like food wastage, lost nutritional value, and an increased risk of becoming sick from eating certain foods. Malnutrition has a significant financial cost; estimates place it at over \$3.5 trillion

annually around the world [3]. Moreover, food shortages can have a big financial impact. As a result, storing and distributing food supplies is one of the many disaster relief efforts that governments, humanitarian organizations, and private citizens all invest a lot of time and money in. Airtight containers offer a practical solution to the problems of food scarcity and preservation at a reasonable price. They also improve the effectiveness of disaster relief efforts.

Concerning food storage and disaster aid, the proposed design of a stackable airtight container is required to handle a number of challenges. The requirement for effective and space-saving storage solutions is one of the main difficulties in crisis scenarios. This problem can be solved by using stackable airtight containers, which make it simple and orderly to store food supplies and demand less storage space.

Additionally, the container's airtight seal helps to keep the food fresh and nutritious for a longer amount of time, which is important in circumstances when regular access to fresh food may be restricted. By supplying catastrophe victims with a steady and secure supply of food, this can assist to avoid malnutrition and other health problems.

Moreover, the stackable airtight container is portable and makes it possible to distribute food supplies to those in need effectively. In order to ensure that food is provided to disaster victims in a timely and efficient manner, this can assist assistance groups in optimizing their logistics and resources.

Overall, a practical and essential answer to the problems of food storage and preservation in disaster relief efforts, the proposed design of a stackable airtight container will improve the wellbeing of catastrophe victims.

3. Design, Functionality, and Durability

The rectangular prism-shaped stackable airtight container that is being designed is composed of strong, long-lasting material that is both lightweight and manageable. Users can clearly view the contents of the container because of its clear design. The container's airtight seal lowers the likelihood of food spoilage and waste while preserving the food's nutritional value and freshness for a longer period of time.

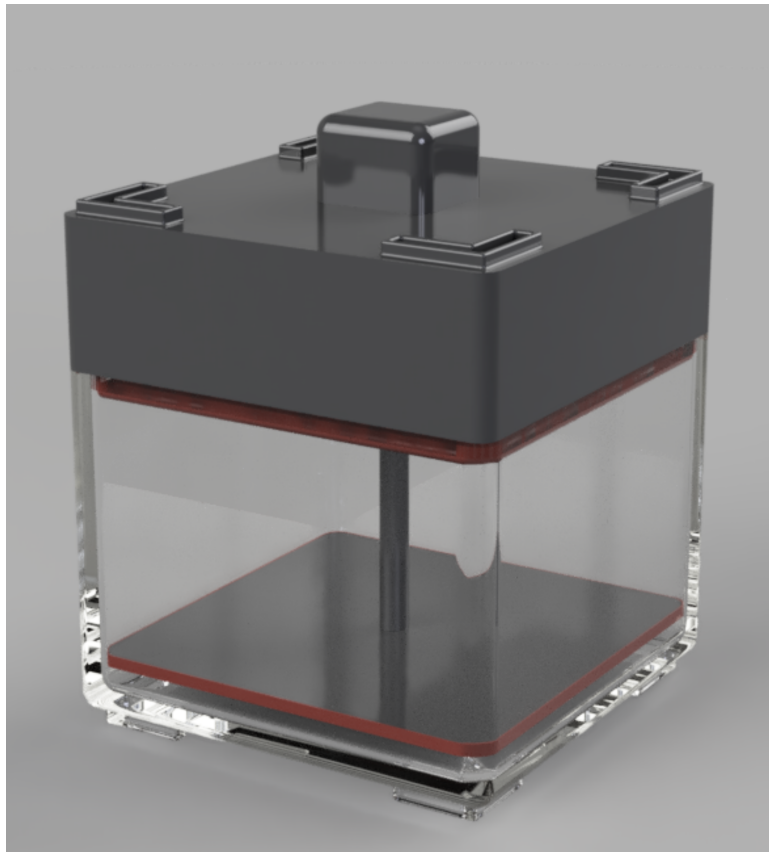
Because of the container's stackable form, it is simple to arrange and store numerous containers in a small area, enabling effective storage space use in disaster relief scenarios. The container is designed with easy stacking and transporting in mind.

The container has a straightforward snap-on cover that creates a safe and airtight seal, making it simple to use. The lid is simple to take off, making it simple and quick to reach the contents. The container's design also makes it simple to clean and maintain, which makes it a useful and dependable option for emergency relief efforts and other circumstances where food storage is essential. The proposed stackable airtight container's characteristics and functions have been optimized as a whole to offer a workable and effective solution to the problems of food storage and preservation in disaster relief efforts. Health, safety, and quality factors are crucial when creating a food storage container for disaster relief activities.

An airtight seal, secure materials, stackable construction, and clear containers are all things to take into account. The airtight seal lessens the chance of food waste and spoiling while preserving the food's nutritional content and freshness. Food-grade materials that are safe, non-toxic, and easy to clean must be used to build the container. By maximizing storage capacity, the container's stackable design makes it simpler to transport and distribute food supplies to people in need. The container's balance, which prevents them from tumbling over and inflicting harm or damage, is another factor in stackability safety. The contents of the container are easily seen because of its transparent design, making it simpler to keep an eye on the food supply and reduce waste. To ensure that the containers are free of defects or damage that could compromise their effectiveness or safety, they must be rigorously inspected and subjected to quality control testing. There is still another important consideration.

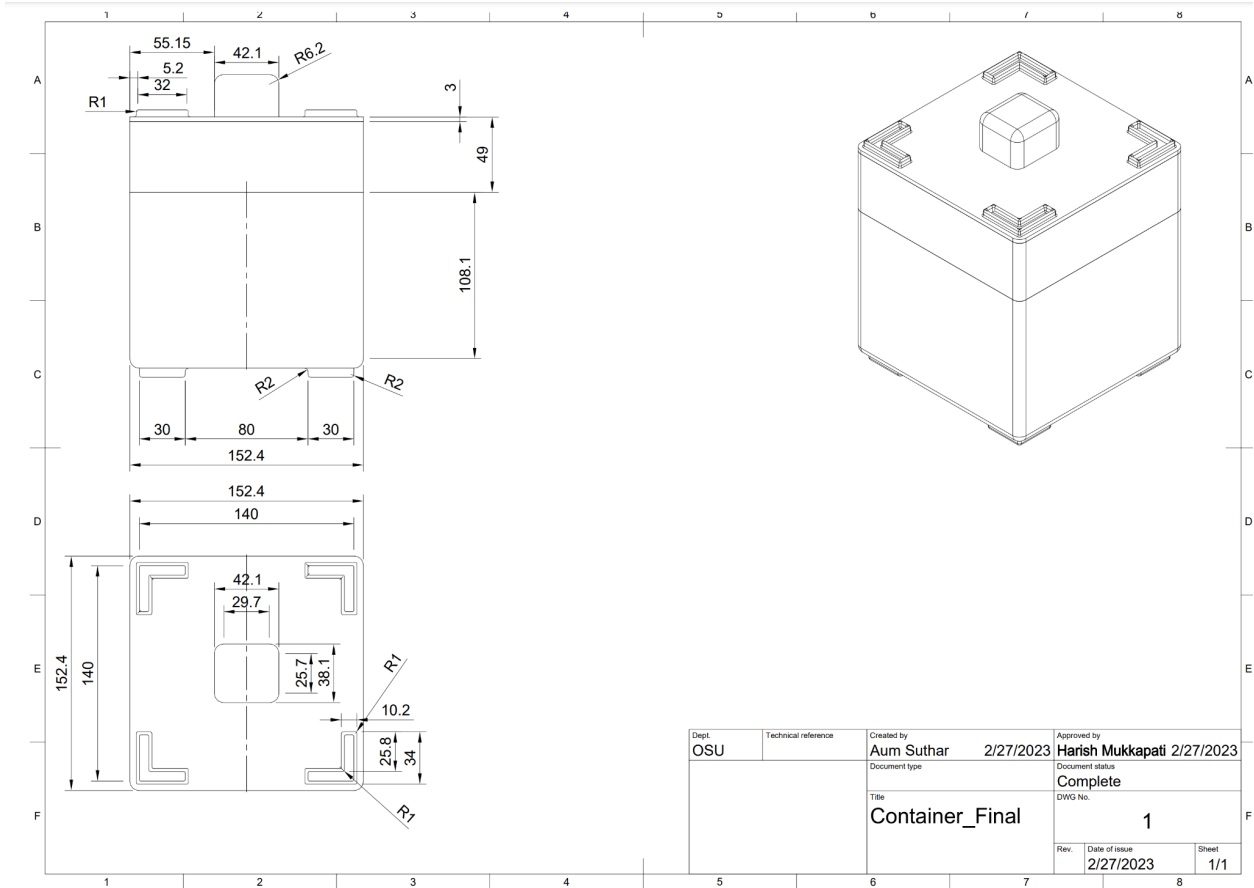
Overall, quality, safety, and health factors were taken into account when designing the proposed stackable airtight container. To guarantee the container's security and efficiency in disaster relief operations, it is crucial to make sure it is regularly maintained, cleaned, and inspected. Below is a render of an example of what the final product is to look like. To create the mechanisms for the container, the team utilized an online tutorial [4].

1.1 Picture 1

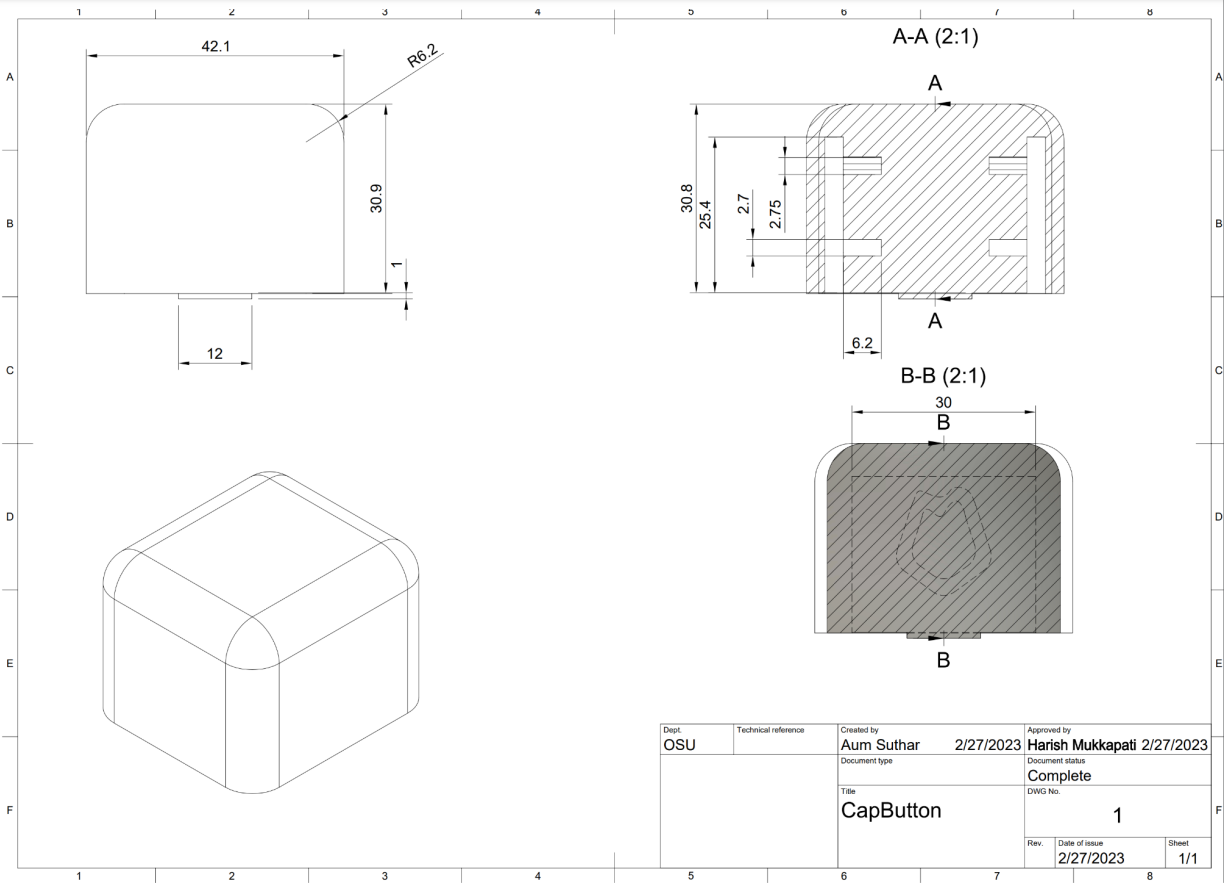


Below are various section drawings containing the dimensions of each of the parts that go into the container designed by the team.

1.2 Container Section Drawing

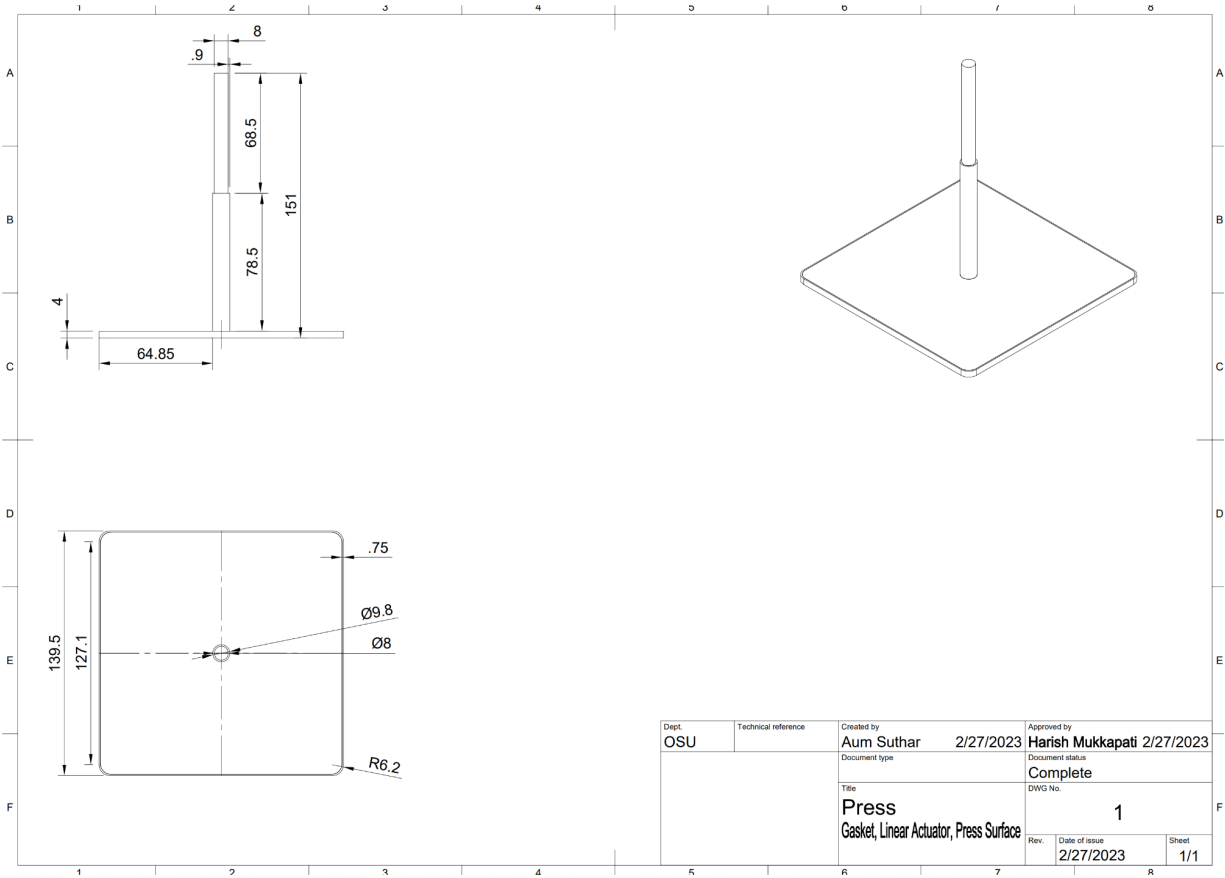


1.3 Cap Button Section Drawing

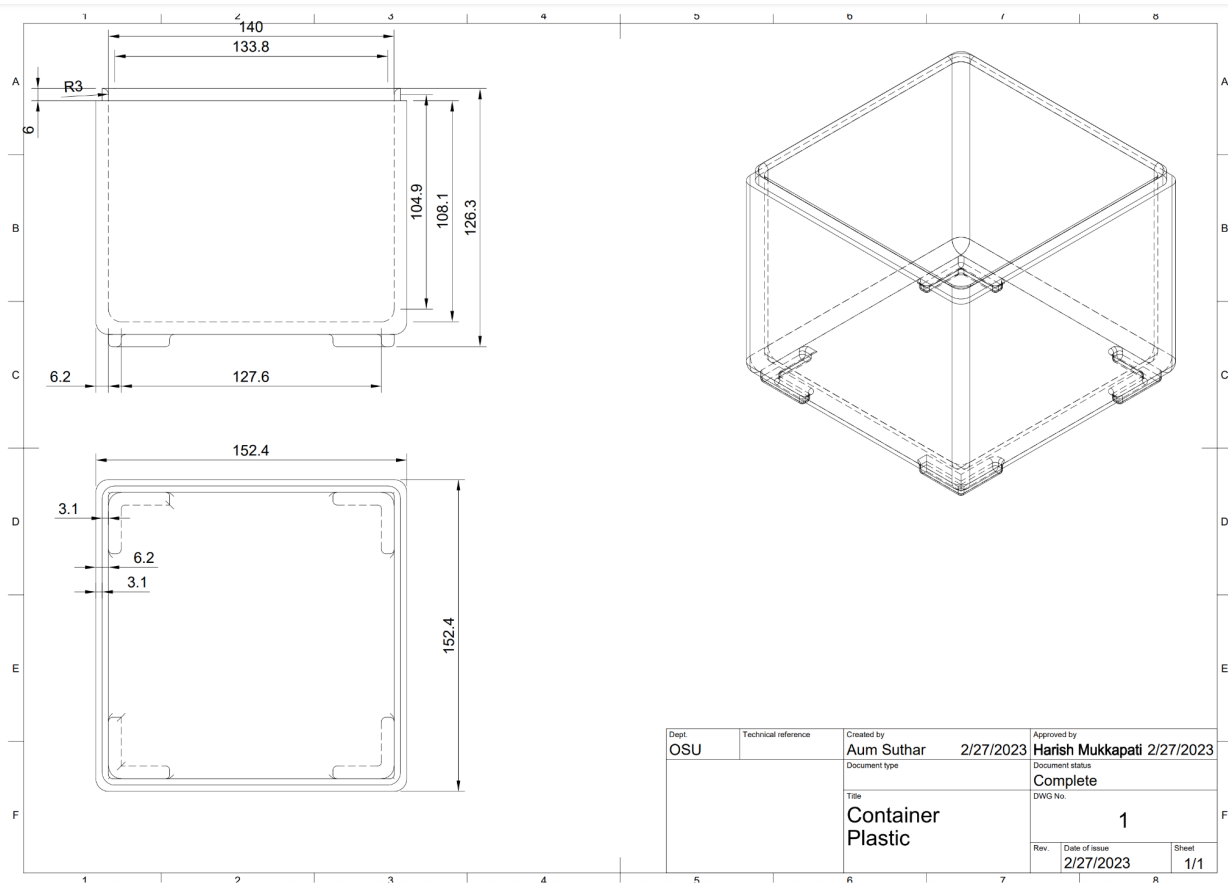


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1.5 Press Section Drawing



1.6 Container Plastic Section Drawing



The tolerance for the container is to be determined by each specific manufacturing plant, who will attempt to account for quality control and other important factors.

Thorough testing must be done to determine the stackable airtight container's durability, strength, and resilience to wear and tear in order to guarantee that it will continue to perform during the required product lifetime. Load testing, impact testing, environmental testing, leakage testing, and material testing are a few of the testing techniques that could be used. In order to evaluate a container's ability to support weight and resistance to deformation, load testing entails applying a certain weight or force to the container. To evaluate the stability and strength of the containers, a number of them may be stacked, each with a different weight. To simulate the effects of dropping or harsh handling, the container is subjected to hits or strikes of varied intensities during impact testing [5]. This test could be carried out by dropping the container from various heights onto various surfaces and looking for any evidence of wear or damage. To determine a container's resistance to corrosion, discoloration, and deterioration over time, environmental testing entails subjecting it to a variety of external factors, including temperature, humidity, and UV radiation [6]. This test could be carried out by submitting the container to extremely high temperatures and levels of humidity as well as prolonged exposure to UV light. To determine how resistant the container is to leaks and to make sure the airtight seal is operating

as intended, leakage testing entails placing the container in a pressurized environment. Applying a vacuum to the container and looking for any indications of air leakage or pressure drop could be used to perform this test. Testing the materials used to build the container to make sure they adhere to quality and safety standards is known as material testing. To make sure the materials utilized are secure and long-lasting, this test could entail doing chemical analysis, tensile testing, and other material tests.

The stackable airtight container can be thoroughly examined for quality and durability using these and other testing techniques, assuring that it will remain functioning for the needed amount of time after purchase.

4. Design Integration and Utilization of DDM materials and processes

By providing greater flexibility, quicker prototyping, and lower costs, additive manufacturing, often known as 3D printing, has the potential to disrupt conventional manufacturing processes. Manufacturers can increase the value of their products by merging additive manufacturing with conventional processes. This improves product quality, increases customisation, and shortens lead times [7]. The proposed stackable airtight container could benefit from the integration of additive manufacturing technologies with conventional techniques in a number of ways, including customization, prototyping, quality control, and manufacturing effectiveness. With the use of additive manufacturing, producers may create containers with distinctive shapes and sizes that satisfy certain consumer demands. For instance, the container could be altered to fit in a certain storage space or to hold a specified amount of food supplies. Additive manufacturing offers quicker development of product designs, allowing manufacturers to swiftly iterate and test various design concepts without the need for expensive tooling. This may result in shorter product development cycles and shorter time to market. High-quality items with exact geometry and tolerances can be created using additive manufacturing. Manufacturers can ensure that each container satisfies quality and safety criteria before it is transported to customers by integrating 3D scanning and inspection technologies. Complex shapes and structures that would be challenging or impossible to make using conventional techniques can be produced with additive manufacturing. Manufacturers can lower tooling expenses and boost production effectiveness by combining 3D printing with conventional manufacturing methods like injection molding.

Manufacturers can increase the value of their products by enhancing quality, expanding customisation, and cutting lead times by combining additive manufacturing capabilities with conventional processes. In the instance of the proposed stackable airtight container, additive manufacturing might be utilized to create specialized lids or other components, cutting tooling costs and increasing manufacturing effectiveness. Also, before each container is sent, its quality might be checked using 3D scanning and inspection technology to make sure it complies with safety and quality standards.

The stackable airtight container that is being proposed can be produced using additive manufacturing techniques, which can provide a number of advantages like increased flexibility, quicker prototyping, and lower prices. Yet, the additive manufacturing method may also have certain negative aspects.

More flexibility, quicker prototyping, and lower tooling costs are some potential advantages of adopting additive printing technologies for the suggested airtight container. With the use of additive manufacturing, producers may create containers with distinctive shapes and sizes that satisfy certain consumer demands. Additive manufacturing offers quicker development of product designs, allowing manufacturers to swiftly iterate and test various design concepts without the need for expensive tooling. This may result in shorter product development cycles and shorter time to market. Complex shapes and structures that would be challenging or impossible to manufacture using conventional techniques can be created with additive manufacturing. Manufacturers may save tooling costs and boost productivity by combining 3D printing with conventional manufacturing techniques like injection molding.

For the suggested airtight container, employing additive manufacturing may have some disadvantages, including slower production rates, material restrictions, and the need for post-processing. While it is possible to make parts quickly with additive manufacturing, it could not be as quick for bigger numbers as conventional manufacturing techniques. The materials that can be utilized in some additive manufacturing processes may be restricted, which may affect the product's overall strength or durability. To produce a final object, additive manufacturing procedures may need extra post-processing operations, such as sanding or painting.

The choice to use additive manufacturing techniques to create the suggested stackable airtight container would ultimately depend on the precise design specifications, production volumes, and materials employed. Additive manufacturing might be a good choice if the advantages of customization and lower tooling costs balance the disadvantages of slower production and more post-processing requirements. Yet, conventional manufacturing techniques might be more suitable if speed or material strength are major concerns. It is crucial to thoroughly weigh the advantages and disadvantages of each strategy before selecting the one that best satisfies the product's design and manufacturing requirements.

5. Digital and physical infrastructure: Systems integration, utilization, value chain leverage, agility, lean and continuous improvement

By encouraging collaboration and resource sharing, the dissemination of designs and the coordination of manufacturing among large enterprises and hobbyist producers can assist increase the supply chain's resilience. The stackable airtight container's proposed design can be shared in a number of ways, including open-source platforms, design contests, and collaborations with manufacturers.

One method of disseminating the design is to release it under an open-source license, such as Creative Commons, which allows unrestricted usage and modification. Smaller enterprises would be able to use the design for mass manufacturing in this way, and amateur builders would have access to it and the freedom to alter it to suit their needs.

A network or collaborative platform could be built to manage manufacturing across many organizations. This technology might link producers and designers, enabling in-production communication and feedback in real-time. In addition to enhancing the overall quality of the product, this strategy may assist lower costs and shorten lead times.

The proposed design may be produced utilizing a variety of materials and production techniques, enabling supply chain resilience. Manufacturers can swiftly respond to changes in demand and supply chain disruptions by utilizing 3D printing and other additive manufacturing technologies. The stackable construction makes it possible to store and transport items effectively, lowering the chance of damage occurring during delivery.

The proposed design of the stackable airtight container can assist increase the supply chain's resilience overall by sharing the design and encouraging collaboration between large enterprises and hobbyist producers. The stackable architecture and the use of flexible manufacturing techniques can also help firms adjust to shifting market conditions and guarantee consistent product quality.

6. Cost Benefit / Value Analysis

When compared to current designs, the stackable airtight container's proposed design has a number of advantages that, over time, can add value and save costs. First off, using additive manufacturing techniques can drastically cut production costs, especially for small-batch or custom orders. Small enterprises and hobbyist manufacturers who may lack the funds to invest in conventional manufacturing techniques may find the product to be more readily available as a result.

Second, the container's stackable form has major advantages for both storage and transportation efficiency. The stackable shape of the containers enables for simple stacking and storage in a variety of combinations, unlike conventional containers, which can be large and challenging to store or move. This can increase overall logistics effectiveness, conserve space, and lower shipping costs.

The container's sturdy design and airtight seal can also assist shield the contents from contamination, deterioration, and damage. Over time, this may contribute to a reduction in waste and product loss, resulting in further cost savings.

The proposed design of the stackable airtight container offers a comprehensive solution that unifies all of these properties in one product, whereas existing designs and solutions might provide some of these advantages separately. Over time, this can result in considerable time and money savings, especially for industries that demand efficient and reliable goods storage and transportation.

7. Conclusions

In conclusion, the proposed design of the stackable airtight container offers a thorough remedy for the storage and transportation of items that fuses cutting-edge production techniques, innovative design, and robust materials. The rectangular prism shape, which may be stacked, the clear container, which makes it simple to see what's within, and the airtight seal, which guards against contamination, damage, and rotting, are the main features of the design.

The container is produced using additive manufacturing techniques to lower costs, boost productivity, and offer manufacturing flexibility. Rapid prototyping, customisation, and on-demand production are made possible through the use of 3D printing and other additive manufacturing technologies, which also lower lead times and costs.

Innovative digital and infrastructure design enables efficient coordination and dissemination of manufacturing among major enterprises and artisan makers. While the collaborative platform provides for real-time discussion and feedback during the creation process, the open-source license model permits unrestricted usage and modification of the design.

The uniqueness and ingenuity of the work come from the integration of cutting-edge manufacturing techniques, cutting-edge design, and digital infrastructure to produce an all-encompassing solution that addresses the major problems associated with the storage and

transportation of commodities. Particularly for sectors that demand effective and dependable storage and transportation of goods, the stackable design, airtight seal, and use of durable materials give substantial value and cost savings over time.

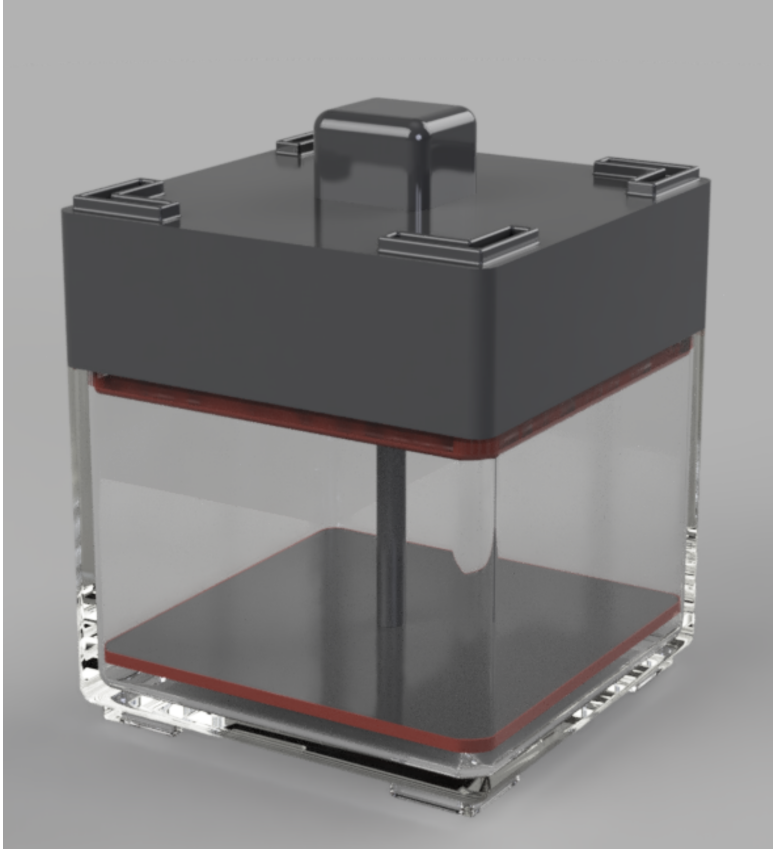
The design and manufacturing plan has a large influence since it offers a scalable solution that can be tailored for different industries and applications. Using flexible materials and additive manufacturing techniques helps producers respond swiftly to changes in demand and supply chain disruptions, lowering the likelihood of product loss or waste. Overall, the proposed design of the stackable airtight container offers a valuable and long-term cost-saving solution to the major problems associated with the storage and transportation of commodities.

8. References

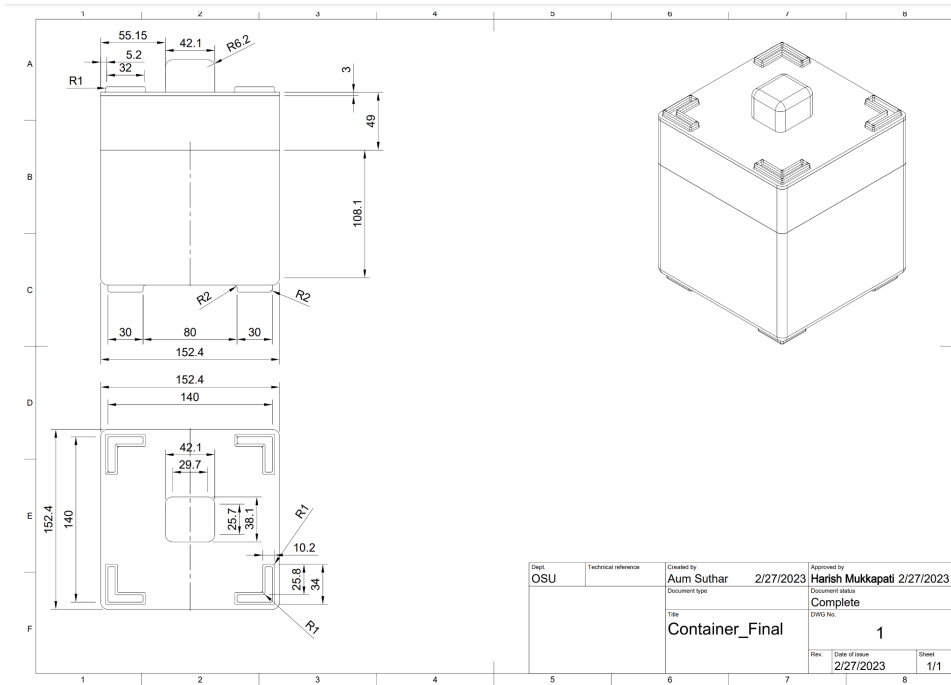
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9. Appendix

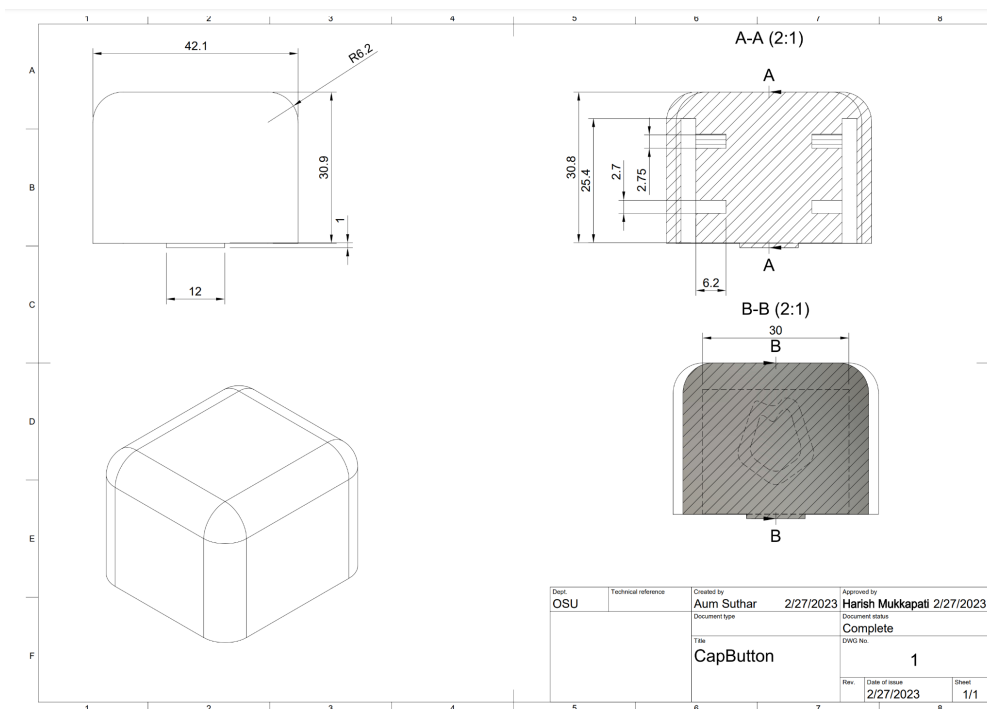
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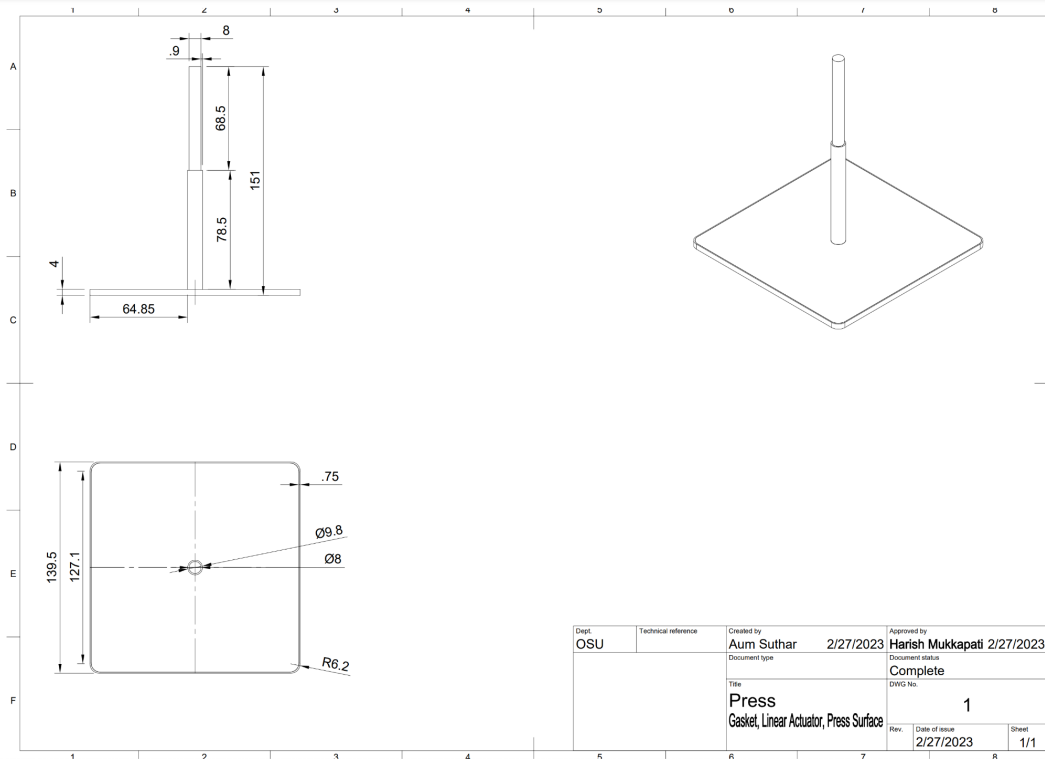
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1.3 Cap Button Section Drawing



1.5 Press Section Drawing



1.6 Container Plastic Section Drawing

